Table 4.1.1. Average emission factors and particle MMAD for barley straw burned in two wind tunnel configurations.

	Barley Straw		
	Average Emission Factor (% dry fuel)*		
Species	CEWF	CRNF	Average
Moisture (%wet basis)	6.8	6.9	6.9
CO	10.217	9.517	9.867
NO	0.104	0.147	0.126
NO_x (as NO_2)	0.257	0.287	0.272
SO_2	0.004	0.004	0.004
THC	1.947	0.882	1.414
HC (by GC)	0.753	0.383	0.568
CH_4 (by GC)	0.316	0.178	0.247
NMHC	1.631	0.703	1.167
NMHC (by GC)	0.437	0.205	0.321
CO_2	106.591	127.856	117.223
Total S	0.006	0.005	0.005
SO_2/Total S	0.713	0.820	0.766
PM	0.879	0.674	0.776
PM10	0.870	0.667	0.768
PM2.5	0.846	0.640	0.743
MMAD (µm)	0.293	0.314	0.304

*Emission factors do not add to 100% as a result of incorporation of atmospheric oxygen in emission species.

Table 4.1.2 Average emission factors and particle MMAD for corn stover burned in two wind tunnel configurations.

Species	Corn Stover Average Emission Factor (% dry fuel)* CEWF	CRNF	Average
Moisture (%wet basis)	8.2	9.0	8.6
CO	3.744	4.013	3.878
NO	0.071	0.079	0.075
NO_x (as NO_2)	0.177	0.188	0.182
SO_2	0.019	0.021	0.020
THC	0.615	0.647	0.631
HC (by GC)	0.346	0.291	0.319
CH_4 (by GC)	0.180	0.169	0.175
NMHC	0.435	0.478	0.456
NMHC (by GC)	0.166	0.122	0.144
CO_2	121.501	141.242	131.371
Total S	0.023	0.024	0.023
SO_2/Total S	0.816	0.883	0.850
PM	0.783	0.478	0.631
PM10	0.771	0.471	0.621
PM2.5	0.742	0.454	0.598
MMAD (μm)	0.156	0.212	0.184

*Emission factors do not add to 100% as a result of incorporation of atmospheric oxygen in emission species.

Table 4.1.3. Average emission factors and particle MMAD for rice straw burned in two wind tunnel configurations.

	Rice Straw			
	Average Emission Factor (% dry fuel)*			
Species	CEWF	CRNF	Average CEWF, CRNF	Average All tests
Moisture (%wet basis)	8.2	8.8	8.5	8.6
CO	3.919	2.515	3.217	3.139
NO	0.120	0.171	0.146	0.150
NO_x (as NO_2)	0.250	0.309	0.280	0.284
SO_2	0.045	0.074	0.060	0.062
THC	0.457	0.425	0.441	0.449
HC (by GC)	0.191	0.077	0.134	0.125
CH_4 (by GC)	0.105	0.048	0.077	0.072
NMHC	0.329	0.359	0.344	0.337
NMHC (by GC)	0.086	0.029	0.057	0.053
CO_2	123.107	111.203	117.155	116.215
Total S	0.052	0.101	0.076	0.080
SO_2/Total S	0.916	0.789	0.853	0.843
PM	0.373	0.329	0.351	0.349
PM10	0.364	0.330	0.347	0.346
PM2.5	0.343	0.303	0.323	0.322
MMAD (µm)	0.129	0.097	0.113	0.123

*Emission factors do not add to 100% as a result of incorporation of atmospheric oxygen in emission species.

Table 4.1.4. Average emission factors and particle MMAD for wheat straw burned in two wind tunnel configurations.

Species	Wheat Straw Average Emission Factor (% dry fuel)* CEWF	 CRNF	 Average
Moisture (%wet basis)	7.2	7.4	7.3
CO	9.527	3.811	6.669
NO	0.074	0.144	0.109
NO_x (as NO_2)	0.177	0.289	0.233
SO_2	0.027	0.066	0.047
THC	1.165	0.282	0.724
HC (by GC)	0.764	0.188	0.476
CH_4 (by GC)	0.320	0.044	0.182
NMHC	0.845	0.238	0.542
NMHC (by GC)	0.444	0.144	0.294
CO_2	98.511	140.464	119.488
Total S	0.030	0.082	0.056
SO_2/Total S	0.908	0.802	0.855
PM	0.713	0.450	0.582
PM10	0.706	0.441	0.574
PM2.5	0.671	0.417	0.544
MMAD (μm)	0.215	0.125	0.170

*Emission factors do not add to 100% as a result of incorporation of atmospheric oxygen in emission species.

Table 4.1.5. Average emission factors and particle MMAD for almond tree prunings (results shown for measured stack gas velocity and velocity computed by carbon balance).

	Almond Prunings	
	Average Emission Factor (% dry fuel)*	
Species	Measured velocity	Estimated velocity
Moisture (%wet basis)	18.3	18.3
CO	5.300	3.193
NO	0.188	0.171
NO_x (as NO_2)	0.407	0.362
SO_2	0.006	0.006
THC	1.221	0.562
HC (by GC)	0.297	0.269
CH_4 (by GC)	0.129	0.117
NMHC	1.092	0.445
NMHC (by GC)	0.168	0.152
CO_2	263.946	183.282
Total S	0.008	0.005
SO_2/Total S	0.827	1.130
PM	0.482	0.436
PM10	0.475	0.430
PM2.5	0.453	0.410
MMAD (μm)	0.158	

*Emission factors do not add to 100% as a result of incorporation of atmospheric oxygen in emission species.

Table 4.1.6. Average emission factors and particle MMAD for Douglas fir slash (results shown for measured stack gas velocity and velocity computed by carbon balance).

	Douglas Fir Slash	
	Average Emission Factor (% dry fuel)*	
Species	Measured velocity	Estimated velocity
Moisture (%wet basis)	30.0	30.0
CO	5.621	5.540
NO	0.046	0.059
NO_x (as NO_2)	0.145	0.195
SO_2	0.005	0.009
THC	0.751	0.886
HC (by GC)	0.236	0.313
CH_4 (by GC)	0.150	0.190
NMHC	0.601	0.697
NMHC (by GC)	0.086	0.124
CO_2	203.553	223.742
Total S	0.005	0.009
SO_2/Total S	0.996	1.080
PM	0.491	0.734
PM10	0.477	0.715
PM2.5	0.430	0.652
MMAD (µm)	0.19	

*Emission factors do not add to 100% as a result of incorporation of atmospheric oxygen in emission species.

Table 4.1.7 Average emission factors and particle MMAD for Ponderosa pine slash (results shown for measured stack gas velocity and velocity computed by carbon balance).

	Ponderosa Pine Slash	
	Average Emission Factor (% dry fuel)*	
Species	Measured velocity	Estimated velocity
Moisture (%wet basis)	24.5	24.5
CO	4.342	4.284
NO	0.065	0.131
NO_x (as NO_2)	0.143	0.283
SO_2	0.003	0.009
THC	0.503	0.505
HC (by GC)	0.185	0.290
CH_4 (by GC)	0.085	0.133
NMHC	0.418	0.371
NMHC (by GC)	0.100	0.156
CO_2	153.337	213.606
Total S	0.002	0.009
SO_2/Total S	1.276	1.140
PM	0.391	0.604
PM10	0.371	0.574
PM2.5	0.332	0.514
MMAD (µm)	0.24	

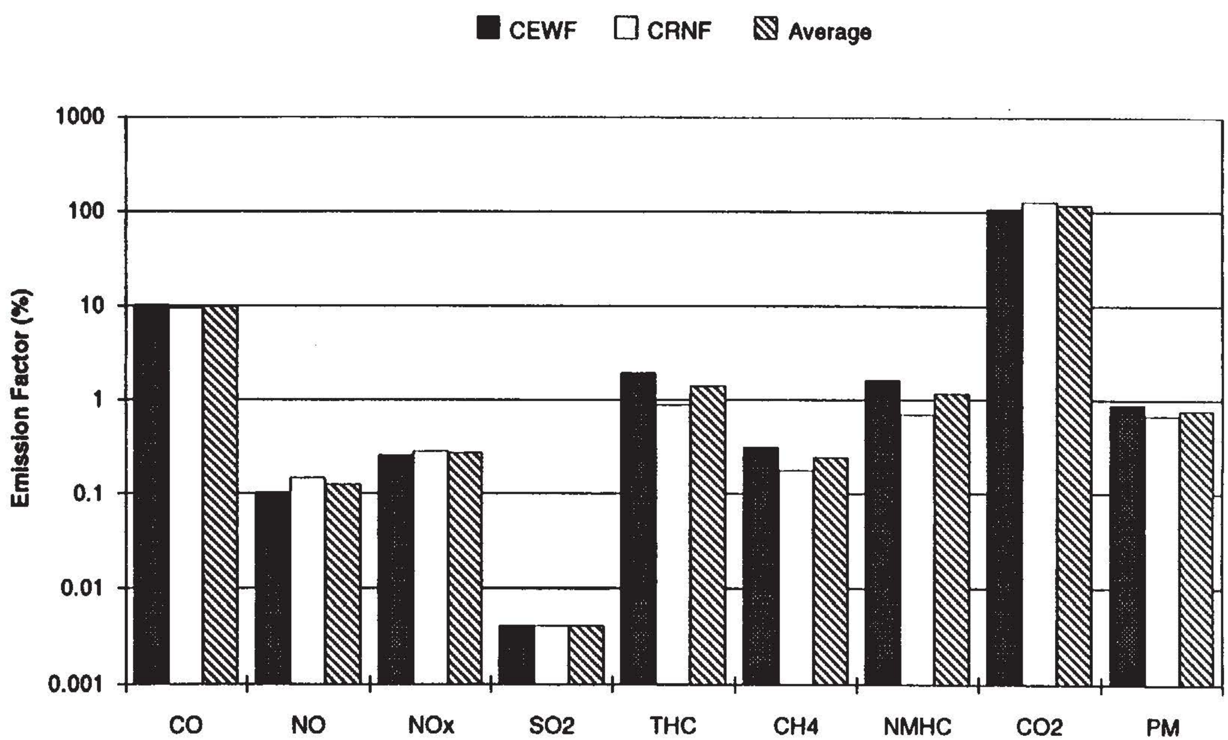
*Emission factors do not add to 100% as a result of incorporation of atmospheric oxygen in emission species.

Table 4.1.8 Average emission factors and particle MMAD for walnut tree prunings (results shown for measured stack gas velocity and velocity computed by carbon balance).

	Walnut Prunings	
	Average Emission Factor (% dry fuel)*	
Species	Measured velocity	Estimated velocity
Moisture (%wet basis)	33.1	33.1
CO	7.096	5.004
NO	0.249	0.157
NO_x (as NO_2)	0.532	0.339
SO_2	0.021	0.014
THC	0.834	0.629
HC (by GC)	0.277	0.225
CH_4 (by GC)	0.202	0.164
NMHC	0.633	0.465
NMHC (by GC)	0.075	0.061
CO_2	201.828	164.291
Total S	0.022	0.016
SO_2/Total S	0.938	0.870
PM	0.508	0.322
PM10	0.498	0.315
PM2.5	0.468	0.296
MMAD (μm)	0.12	

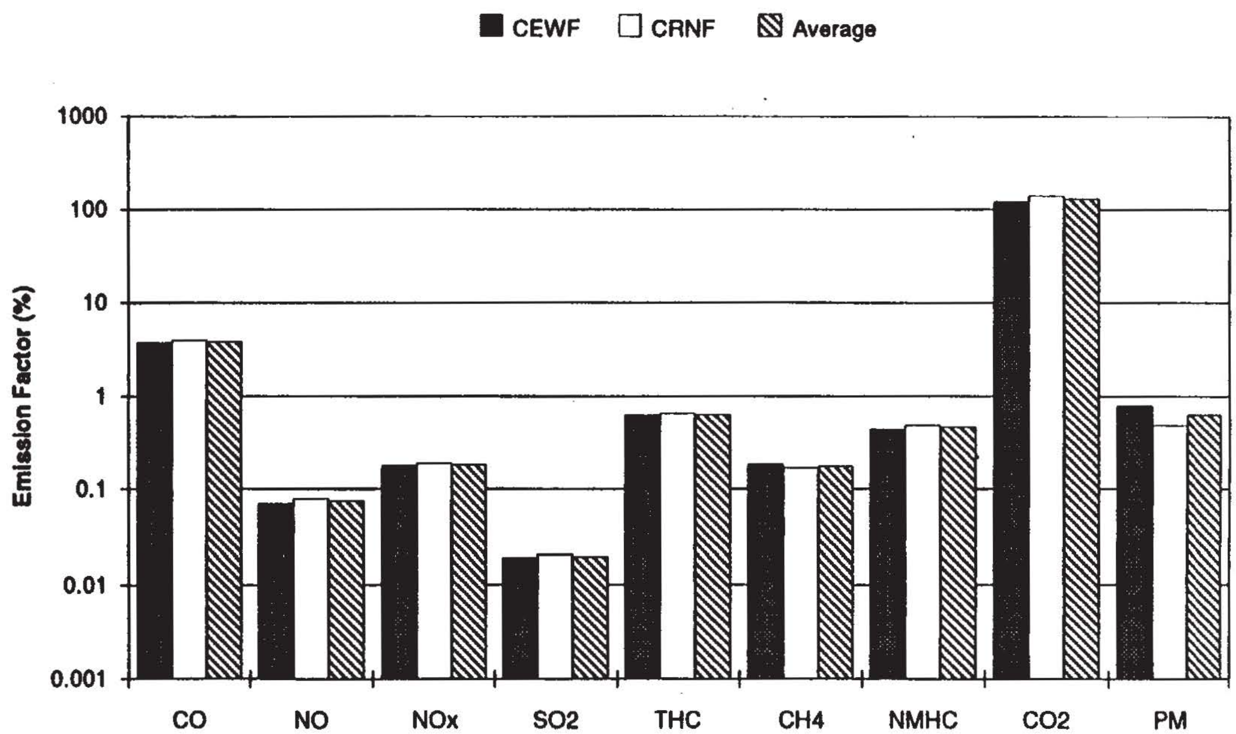
*Emission factors do not add to 100% as a result of incorporation of atmospheric oxygen in emission species.

Figure 4.1.1. Average emission factors for barley straw burned in two wind tunnel configurations.



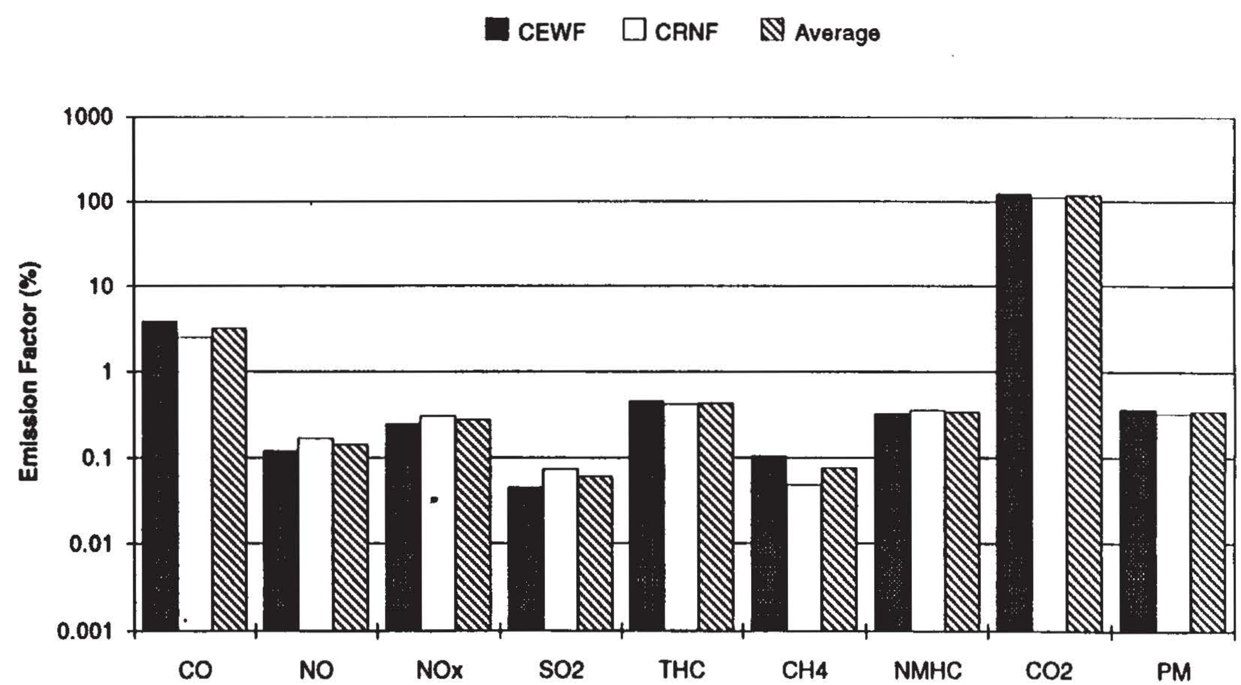
(Emission factor expressed as % dry fuel weight)

Figure 4.1.2. Average emission factors for corn stover burned in two wind tunnel configurations.



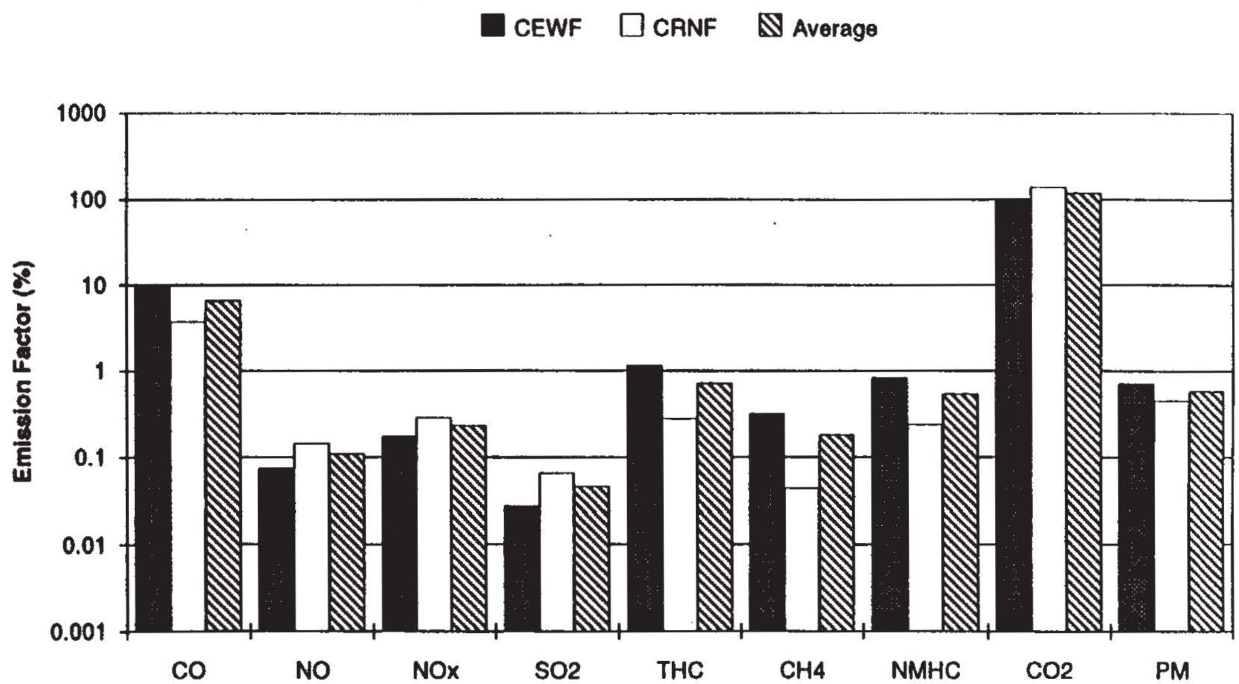
(Emission factor expressed as % dry fuel weight)

Figure 4.1.3. Average emission factors for rice straw burned in two wind tunnel configurations.



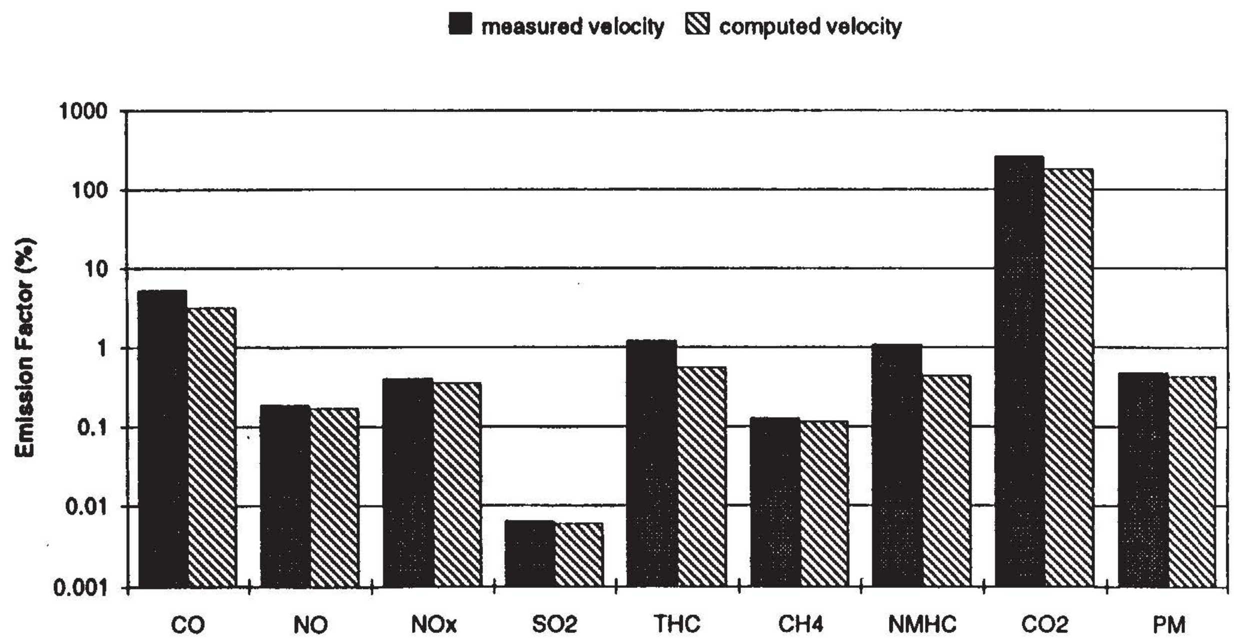
(Emission factor expressed as % dry fuel weight)

Figure 4.1.4. Average emission factors for wheat straw burned in two wind tunnel configurations.



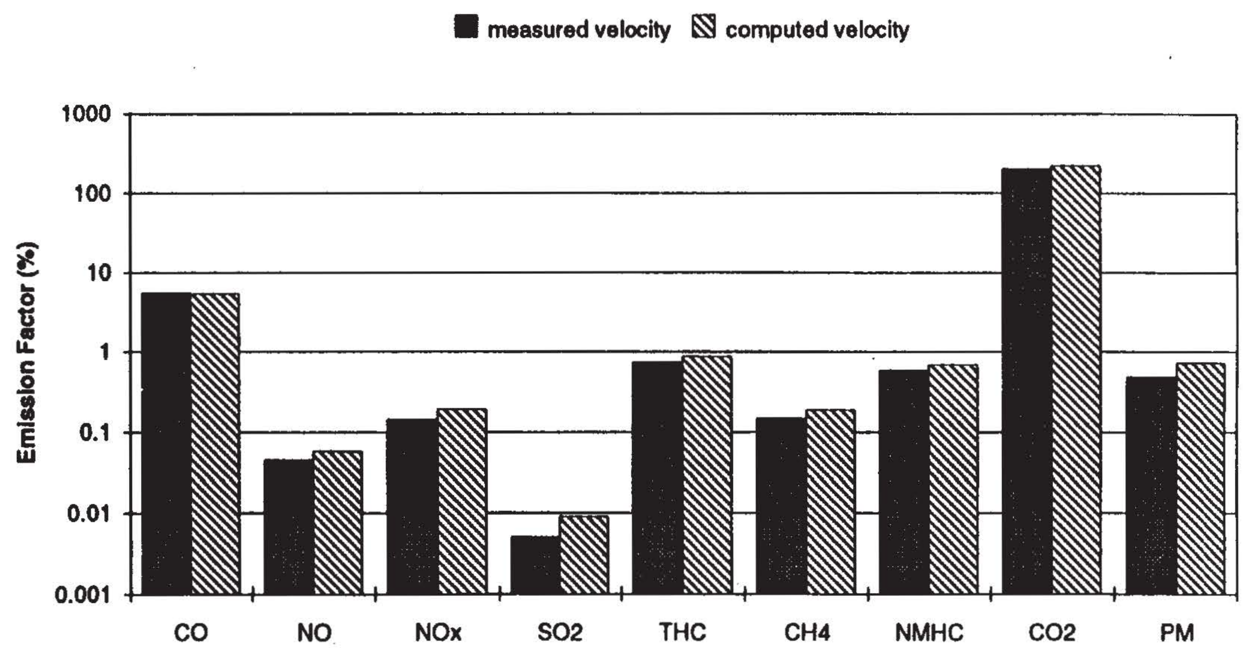
(Emission factor expressed as % dry fuel weight)

Figure 4.1.5. Average emission factors for almond tree prunings from measured stack gas velocity and velocity computed by carbon balance.



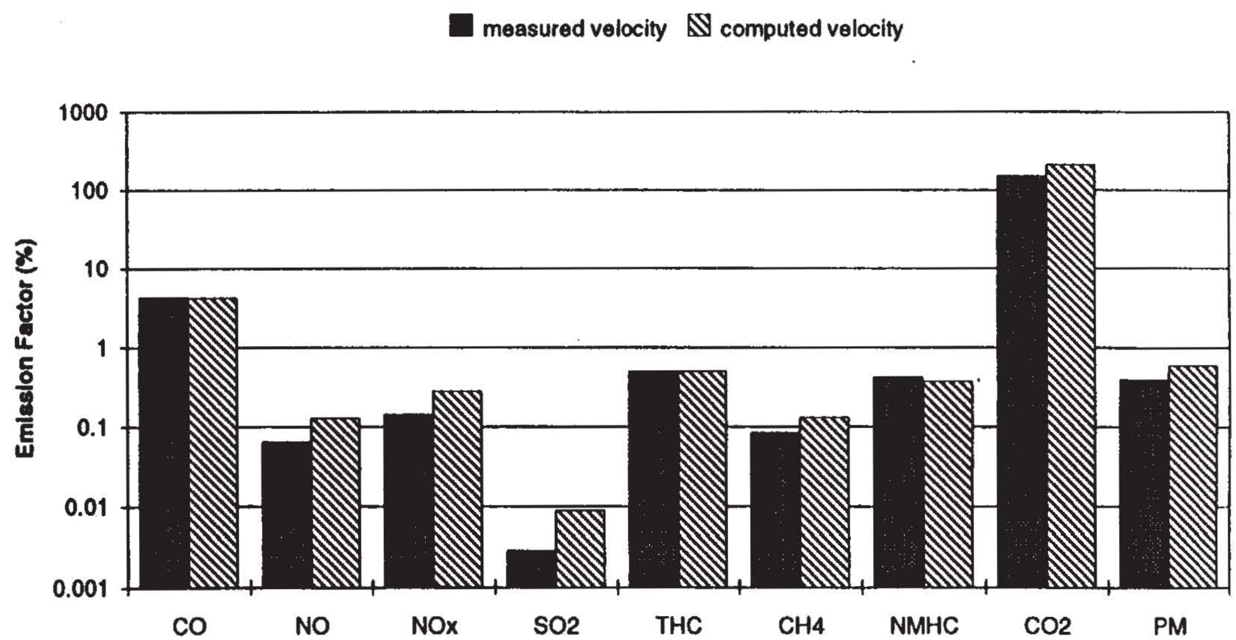
(Emission factor expressed as % dry fuel weight)

Figure 4.1.6. Average emission factors for Douglas fir slash from measured stack gas velocity and velocity computed by carbon balance.



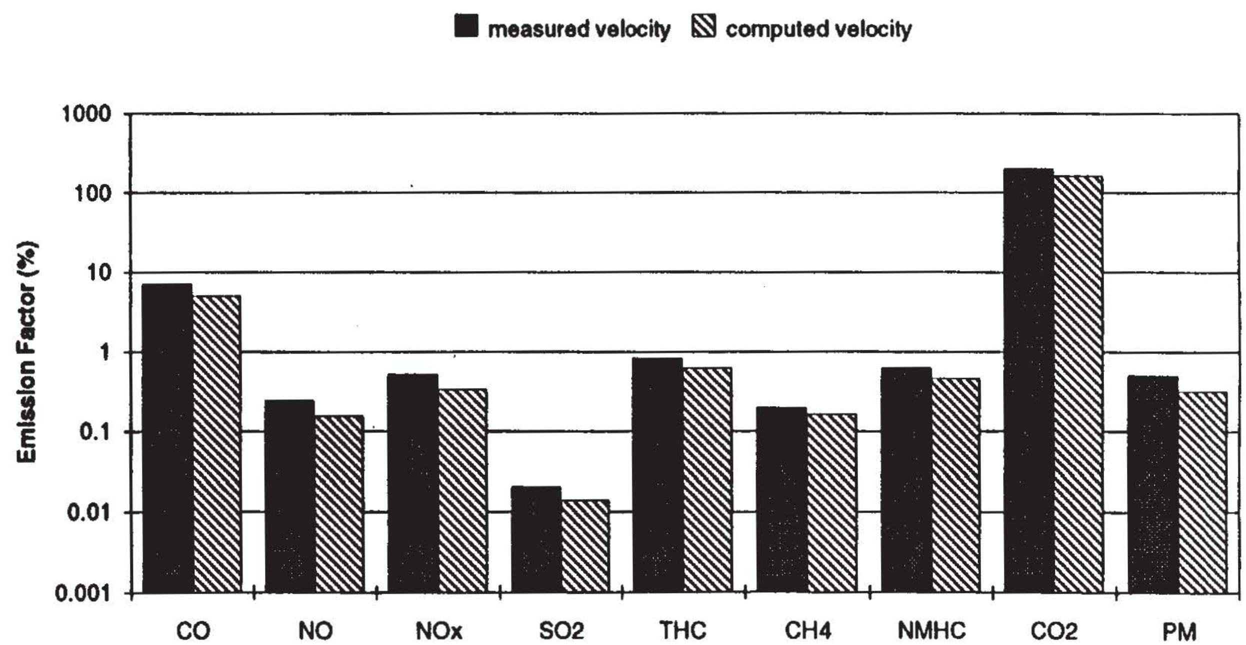
(Emission factor expressed as % dry fuel weight)

Figure 4.1.7. Average emission factors for Ponderosa pine slash from measured stack gas velocity and velocity computed by carbon balance.



(Emission factor expressed as % dry fuel weight)

Figure 4.1.8. Average emission factors for walnut tree prunings from measured stack gas velocity and velocity computed by carbon balance.



(Emission factor expressed as % dry fuel weight)

Table 4.2.1. Approach to isokinetic for total filter nozzle velocity.

Date of Test	Fuel	Traverse	Stack Gas Velocity (m/s) Measured	Stack Gas Velocity (m/s) Computed	Sample Volume (L)	Sample Duration (min)	Temperature (°C) Stack Gas	Temperature (°C) Impinger	Nozzle Velocity (m/s)	% Isokinetic Measured	% Isokinetic Computed
15-Sep-92	Barley	1	2.22	2.75	468	48	28.53	14.03	2.18	98	79
15-Sep-92	Barley	2	2.17	2.48	246	24	35.48	17.59	2.27	105	92
17-Sep-92	Barley	1	2.23	2.59	245	24	32.33	15.78	2.27	102	88
17-Sep-92	Barley	2	2.17	2.13	235	24	36.54	18.82	2.17	100	102
7-Oct-92	Corn	1	2.28	2.21	335	36	38.46	16.82	2.04	89	92
7-Oct-92	Corn	2	2.27	2.74	235	24	57.38	22.04	2.06	91	75
9-Oct-92	Corn	1	2.92	3.34	292	24	27.97	15.64	2.74	94	82
9-Oct-92	Corn	2	2.89	3.85	593	48	41.49	22.41	2.73	94	71
30-Apr-92	Rice	1	1.94	2.06	426	48	53.15	20.86	1.88	97	91
30-Apr-92	Rice	2	1.85	2.48	437	48	56.89	21.22	1.91	103	77
9-Jun-92	Rice	1	1.87	2.34	492	48	67.02	20.05	2.08	111	89
9-Jun-92	Rice	2	1.95	1.70	410	48	73.89	22.60	1.71	88	101
9-Jun-92	Rice	3	1.98	2.28	418	48	84.27	29.30	1.73	88	76
10-Jul-92	Rice	1	2.86	2.63	577	48	52.45	20.89	2.55	89	97
10-Jul-92	Rice	2	2.91	2.41	619	48	55.64	28.05	2.78	95	115
14-Jul-92	Rice	1	2.52	2.82	532	48	51.40	16.73	2.33	93	83
14-Jul-92	Rice	2	2.52	3.43	540	48	58.44	18.58	2.33	92	68
14-Jul-92	Rice	3	2.47	3.16	638	48	61.84	20.95	2.74	111	87
2-Sep-92	Rice	1	2.95	3.90	617	48	26.37	13.59	2.89	98	74
2-Sep-92	Rice	2	3.11	3.05	661	48	32.07	16.00	3.07	98	101
2-Sep-92	Rice	3	3.96	4.29	796	48	43.69	17.41	3.58	90	83
2-Sep-92	Rice	4	3.49	3.16	726	48	42.79	16.56	3.26	93	103
21-Oct-92	Rice	1	3.21	3.70	694	48	33.31	17.08	3.22	100	87
21-Oct-92	Rice	2	3.08	2.90	663	48	36.74	17.68	3.05	99	105
23-Oct-92	Rice	1	2.41	2.26	257	24	55.87	22.74	2.26	94	100
23-Oct-92	Rice	2	2.31	2.39	253	24	59.45	20.42	2.19	95	92
11-Aug-92	Wheat	1	2.03	1.99	548	48	34.26	13.10	2.50	123	125
11-Aug-92	Wheat	2	2.15	2.37	521	48	42.54	20.69	2.38	110	100
13-Aug-92	Wheat	1	3.02	3.47	669	48	26.37	15.59	3.16	104	91
13-Aug-92	Wheat	2	2.68	4.02	662	48	31.40	19.63	3.12	116	78

Table 4.2.1. (continued) Approach to isokinetic for total filter nozzle velocity.

Date of Test	Fuel	Traverse	Stack Gas Velocity (m/s) Measured	Stack Gas Velocity (m/s) Computed	Sample Volume (L)	Sample Duration (min)	Temperature (°C) Stack Gas	Temperature (°C) Impinger	Nozzle Velocity (m/s)	% Isokinetic Measured	% Isokinetic Computed
6-Apr-93	Almond	1	3.66	3.31	533	40	36.90	14.15	2.90	79	88
6-Apr-93	Almond	2	5.33	3.02	363	24	58.31	15.93	3.10	58	103
30-Apr-93	Douglas Fir	1	1.36	2.37	175	24	38.46	18.43	1.60	118	68
30-Apr-93	Douglas Fir	2	1.56	1.45	275	24	33.92	20.48	2.58	165	177
30-Apr-93	Douglas Fir	3	2.15	2.87	253	24	73.13	21.17	2.11	98	73
29-Apr-93	Ponderosa Pine	1	2.29	3.48	275	24	87.18	29.24	2.26	99	65
29-Apr-93	Ponderosa Pine	2	1.67	2.68	382	48	46.15	24.84	1.75	105	65
12-Nov-92	Walnut	1	2.97	1.88	603	48	32.37	10.89	2.75	92	146
12-Nov-92	Walnut	2	2.66	3.99	462	39	50.04	18.70	2.52	95	63

Table 4.2.2. Regression statistics for computed vs. measured stack gas velocity.

Case	slope	intercept ($m\ s^{-1}$)	r^2	95% Confidence Intervals slope		intercept	
All fires	0.544	1.393	0.331	0.31	0.78	0.79	0.20
All fires less outlier	0.770	0.866	0.443	0.51	1.03	0.21	1.53
All fires less outlier (constrained)	1.103	0	0.355	1.04	1.17	--	--
Spreading fires	0.987	0.316	0.604	0.68	1.29	-0.47	1.10
Spreading fires (constrained)	1.107	0	0.595	1.05	1.17	--	--
Pile fires	0.301	1.916	0.185	-0.06	0.66	0.94	2.89
Pile fires (constrained)	0.966	0	--	0.77	1.16	--	--

Figure 4.2.1. Comparison of stack gas velocity measured with anemometer and velocity computed by carbon balance.

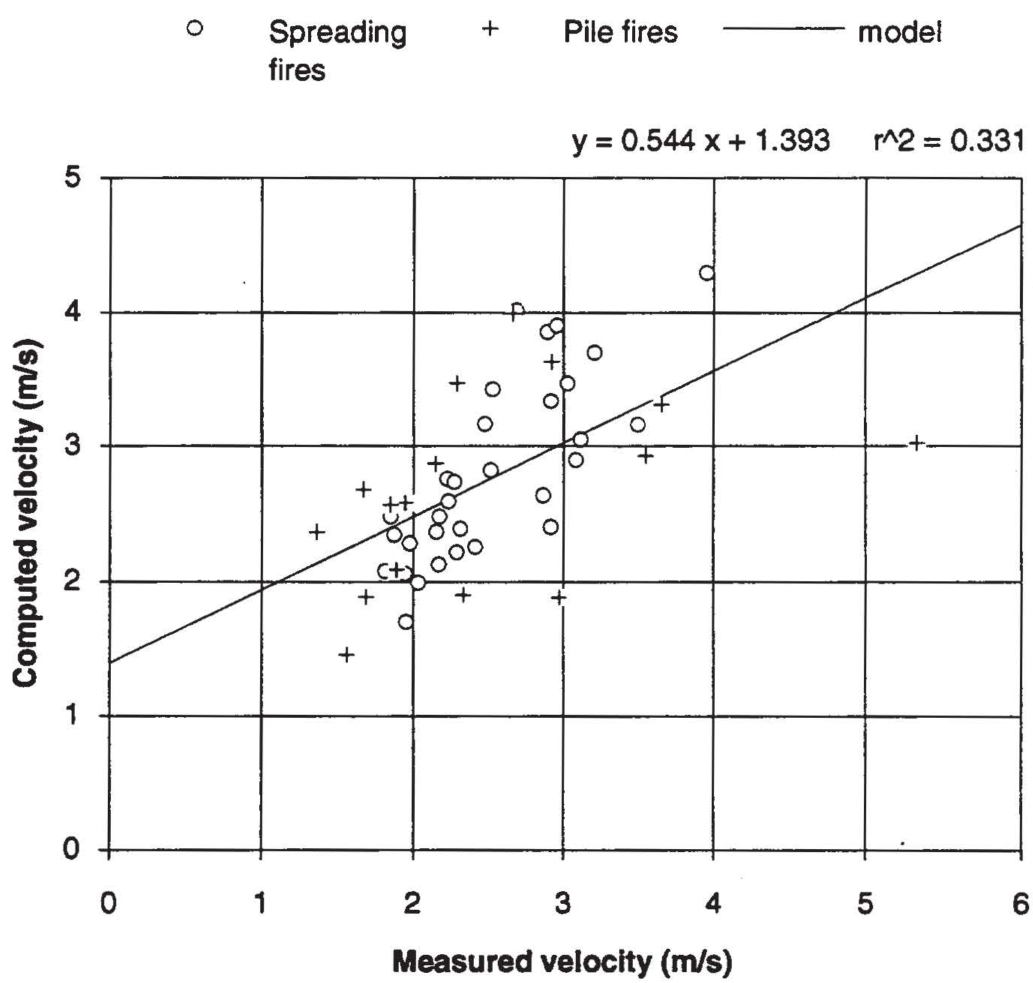


Figure 4.2.2. Comparison of stack gas velocity measured with anemometer and velocity computed by carbon balance (reduced data set).

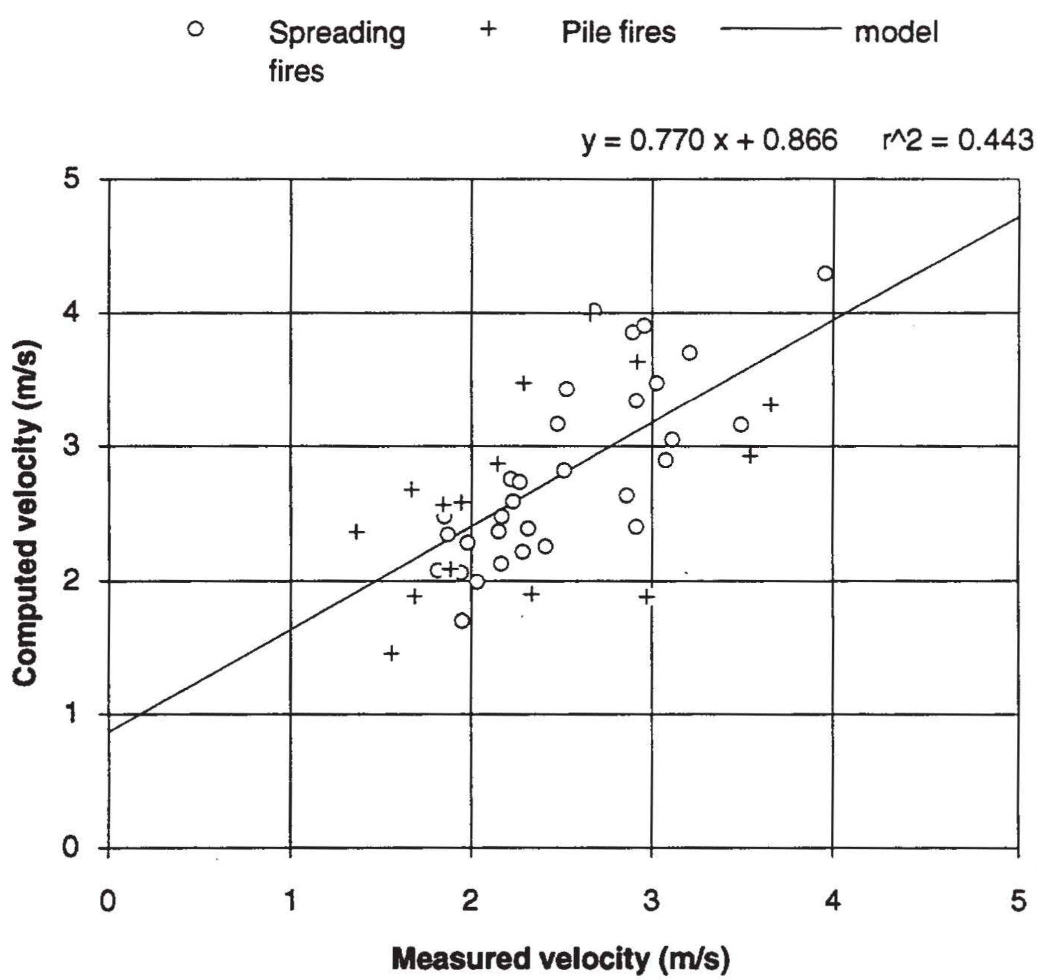


Figure 4.2.3. Comparison of stack gas velocity measured with anemometer and velocity computed by carbon balance (reduced data set, zero intercept).

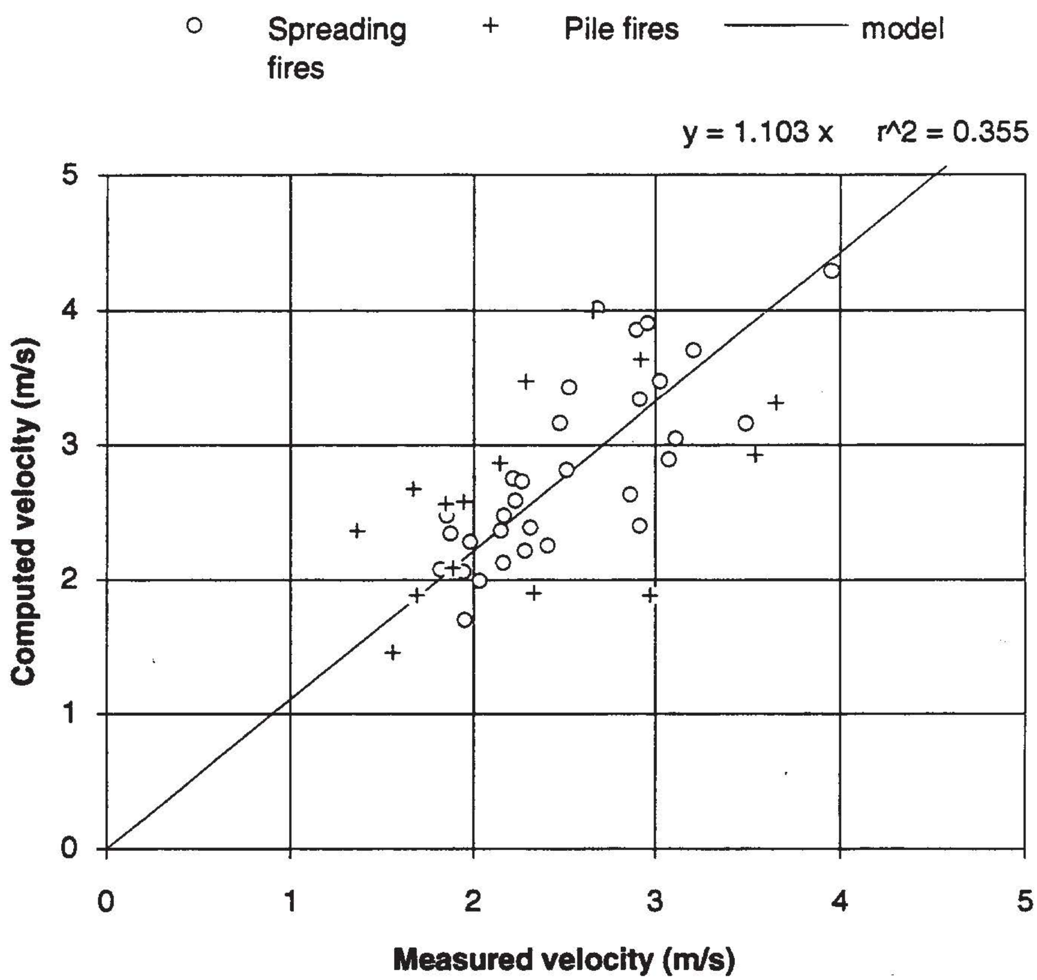


Figure 4.2.4. Regression models for computed vs. measured stack gas velocity (spreading fires).

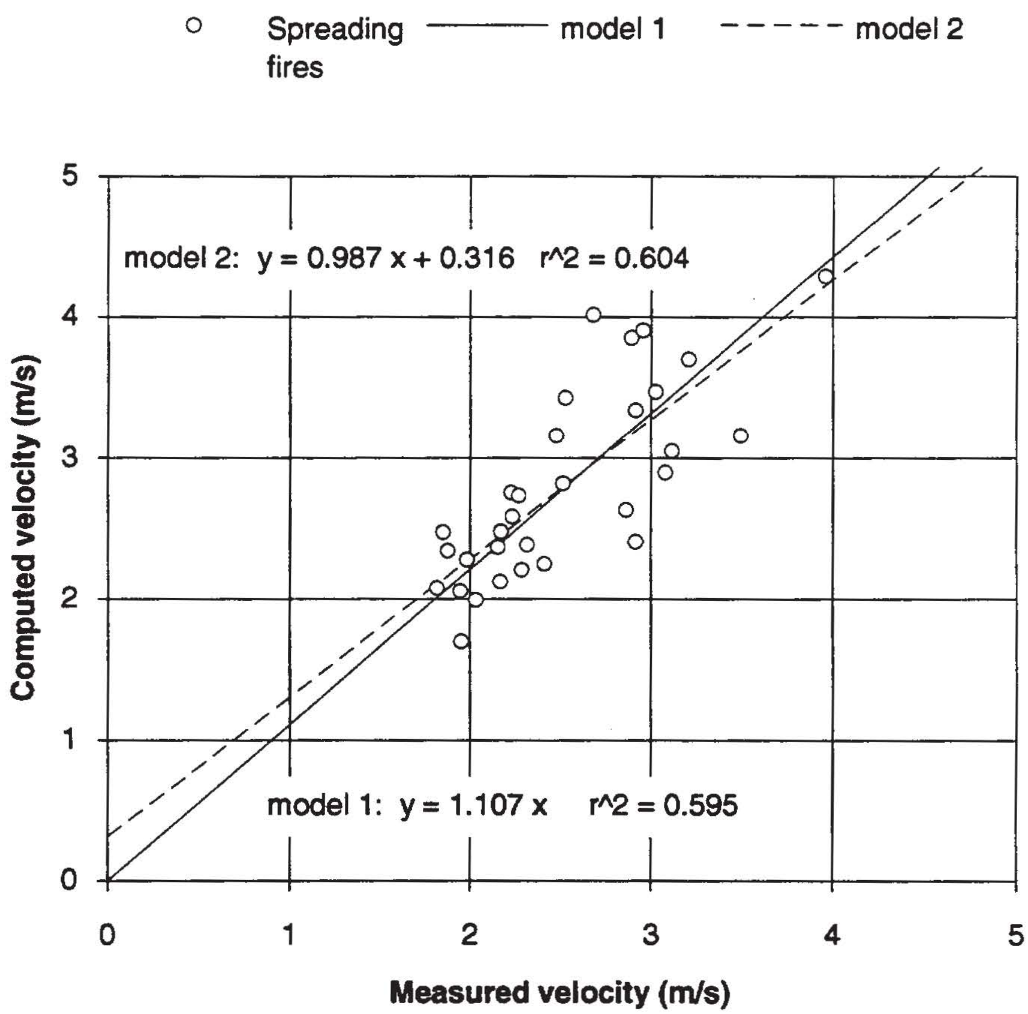


Figure 4.2.5. Regression models for computed vs. measured stack gas velocity (pile fires).

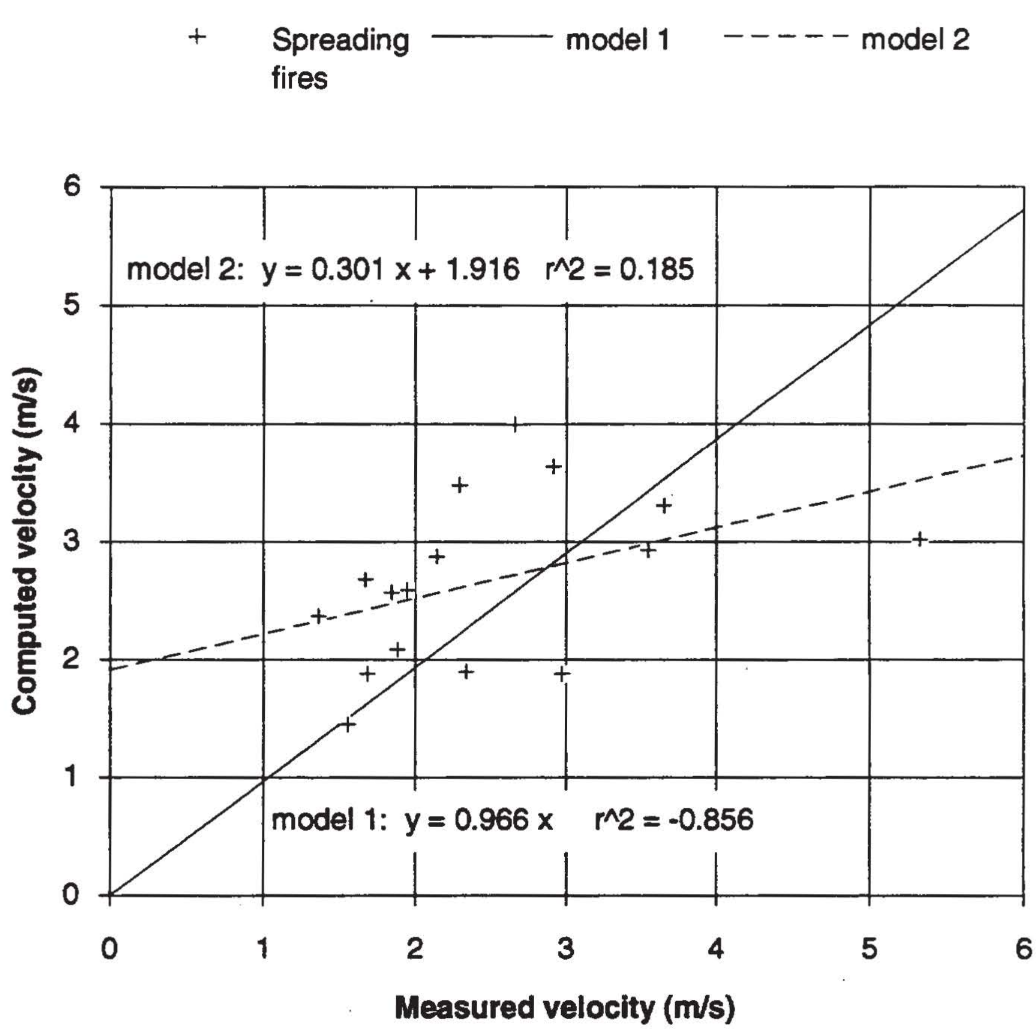


Figure 4.2.6. Particulate matter concentrations from DRI, CNL, and cascade impactor samplers in relation to concentration from total filter (open symbols spreading fires, closed symbols pile fires).

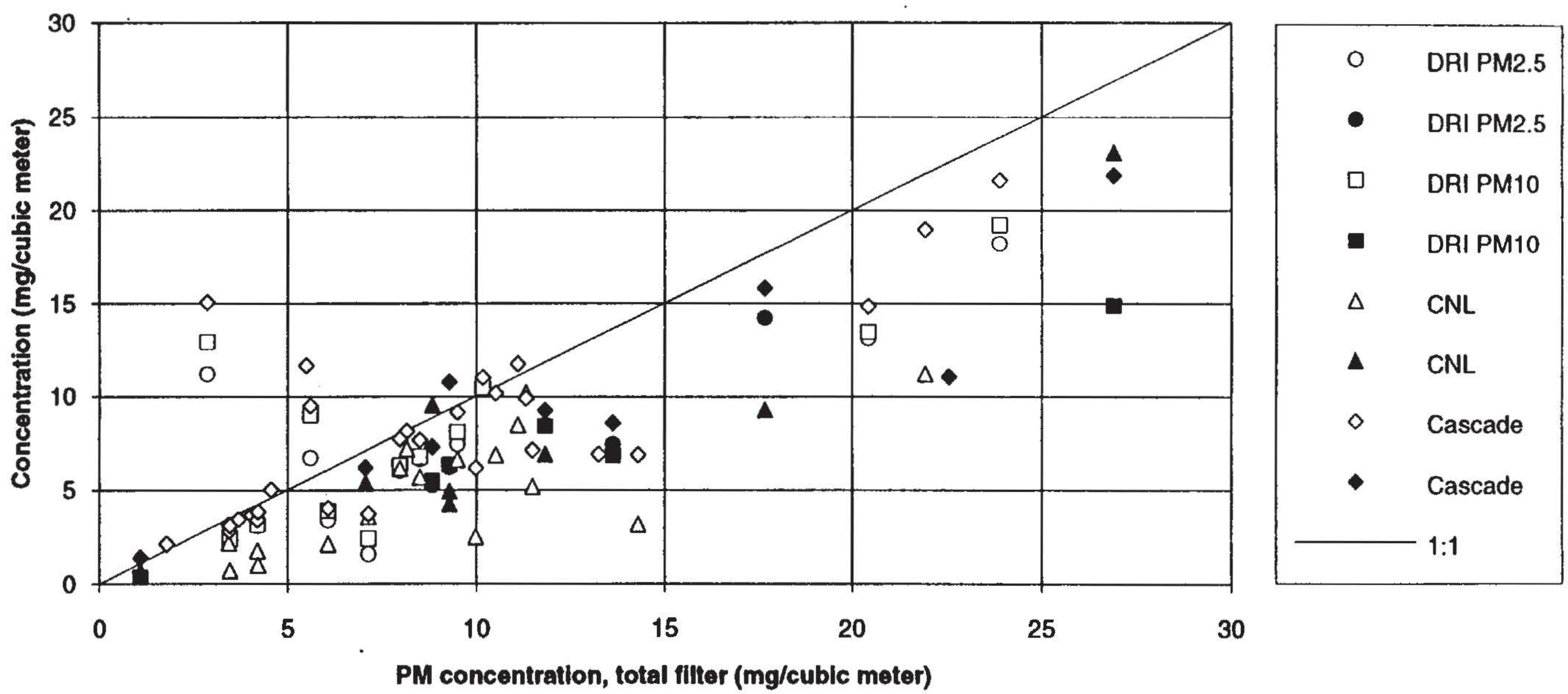


Figure 4.2.7. Particulate matter concentrations, total filter and DRI PM10 Impactor - Spreading fires.

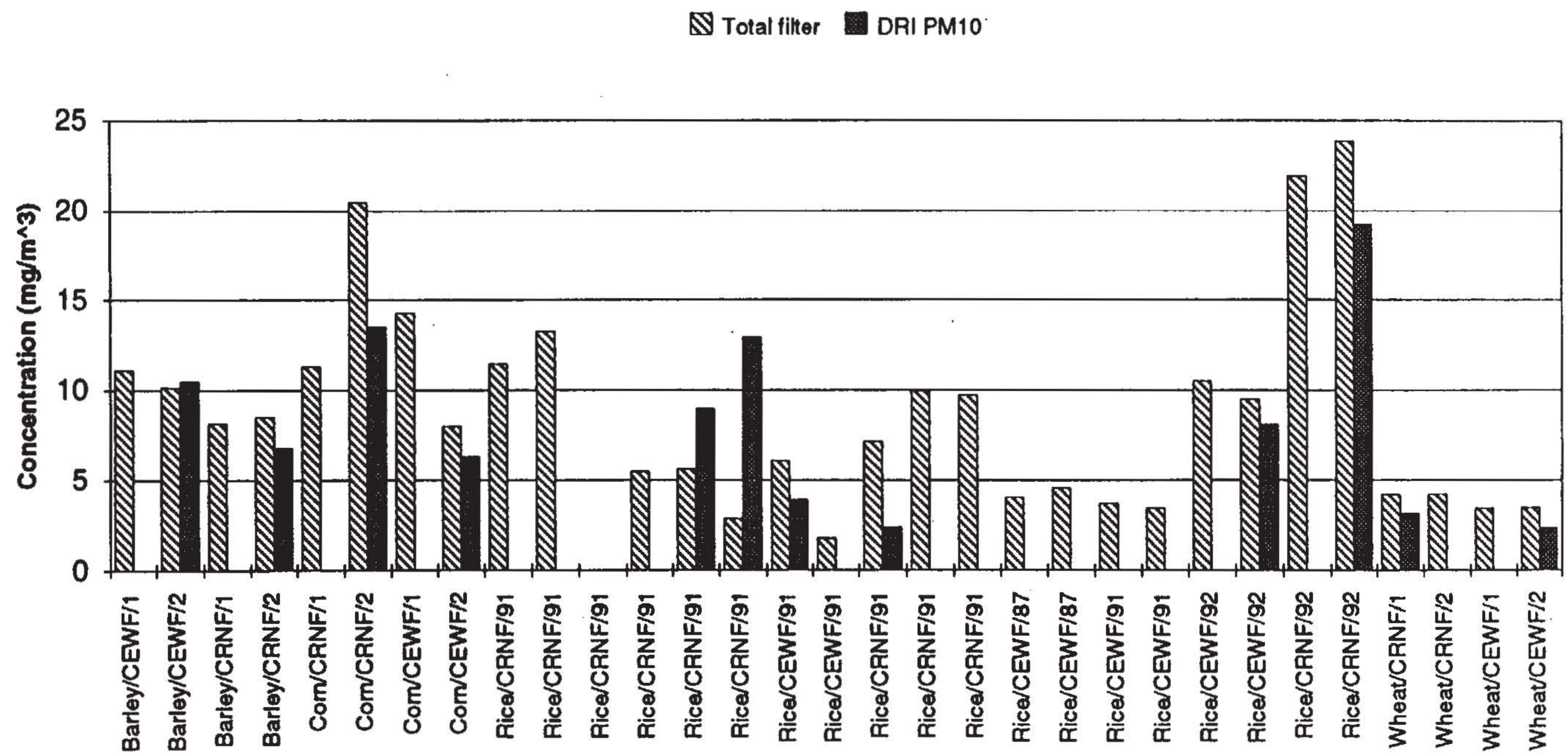


Figure 4.2.8. Particulate matter concentrations, total filter and DRI PM10 impactor - Pile fires.

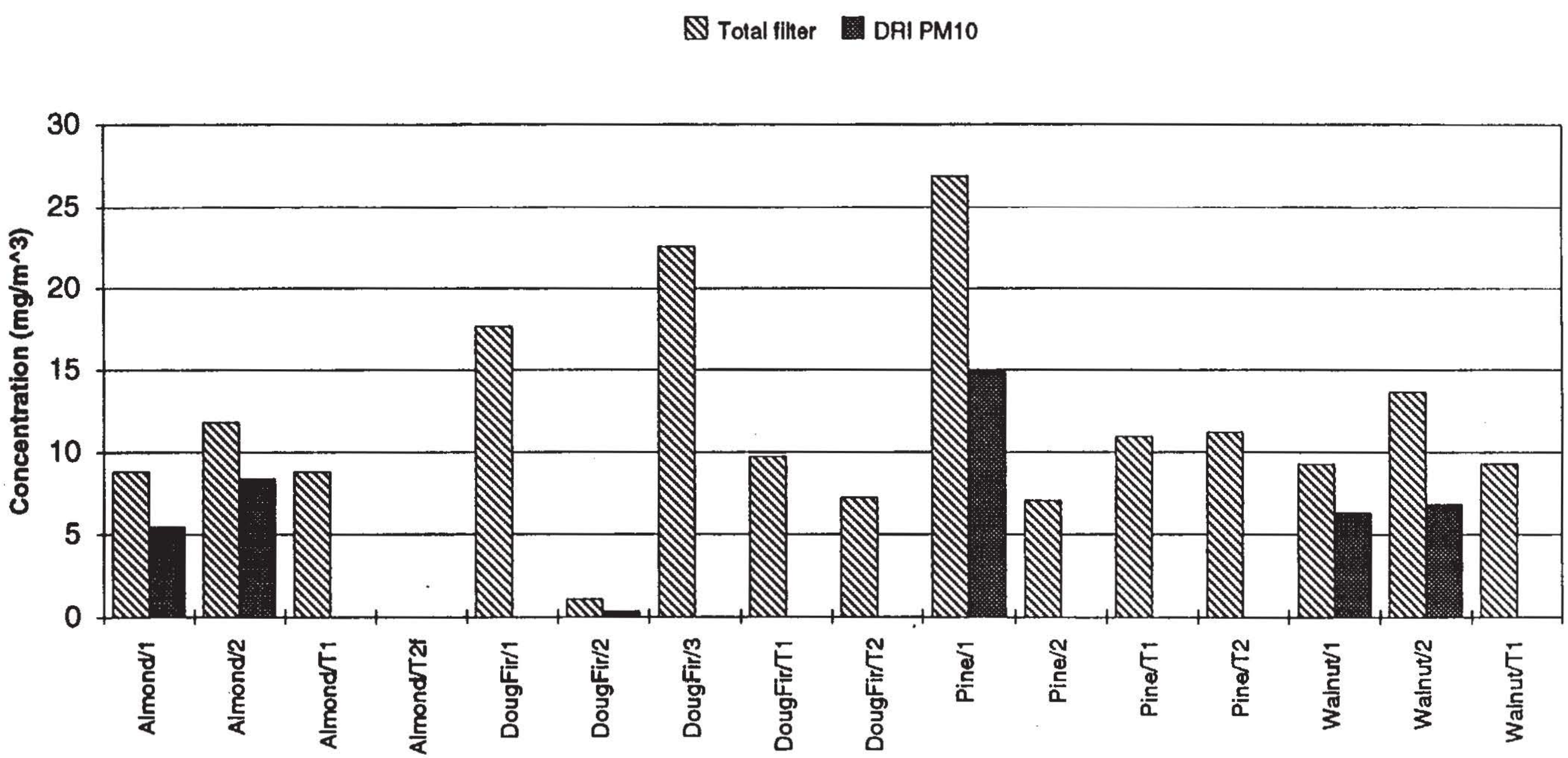


Figure 4.2.9. Particulate matter concentrations, total filter and CNL filter - Spreading fires.

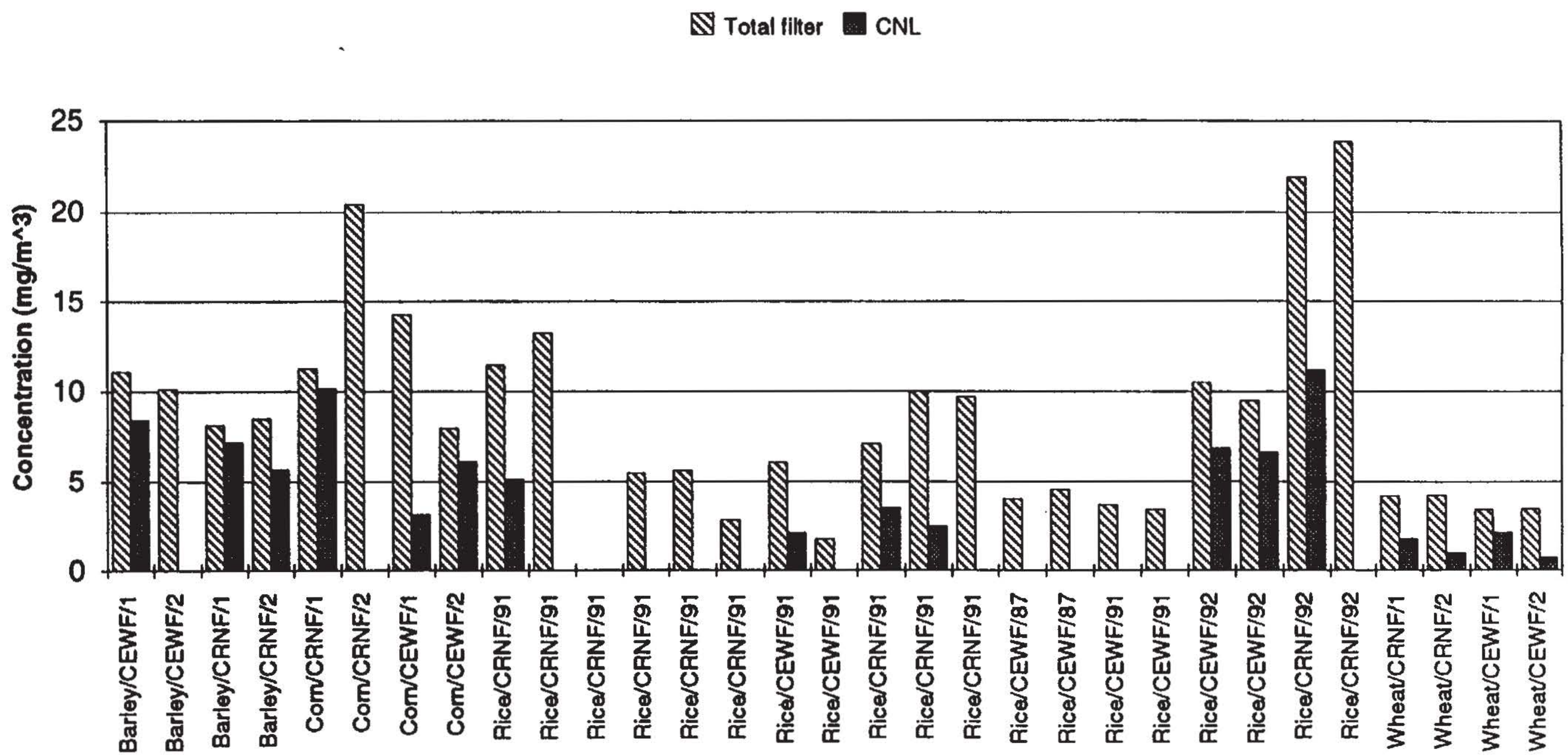


Figure 4.2.10. Particulate matter concentrations, total filter and CNL filter - Pile fires.

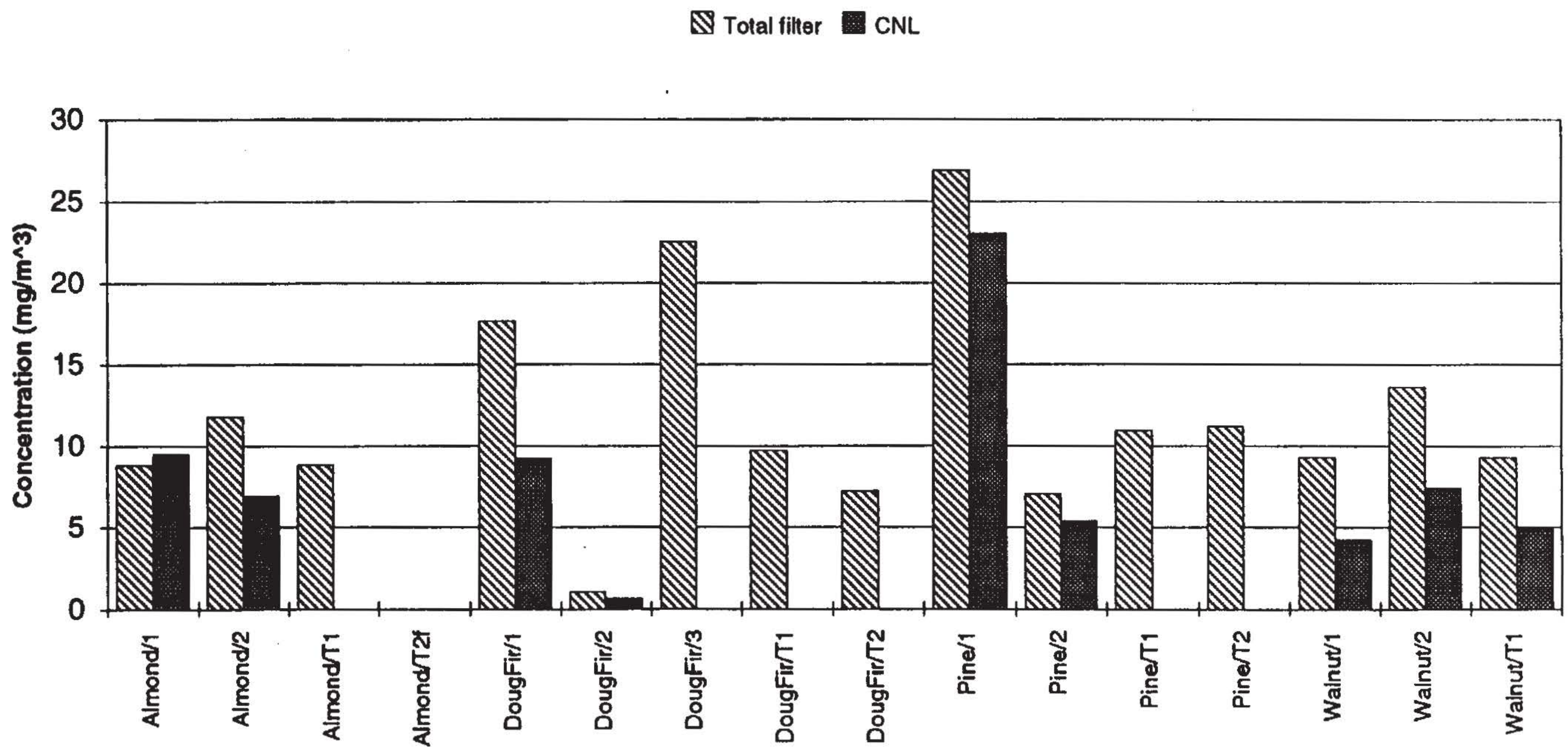


Figure 4.2.11. Particulate matter concentrations, total filter and cascade impactor - Spreading fires.

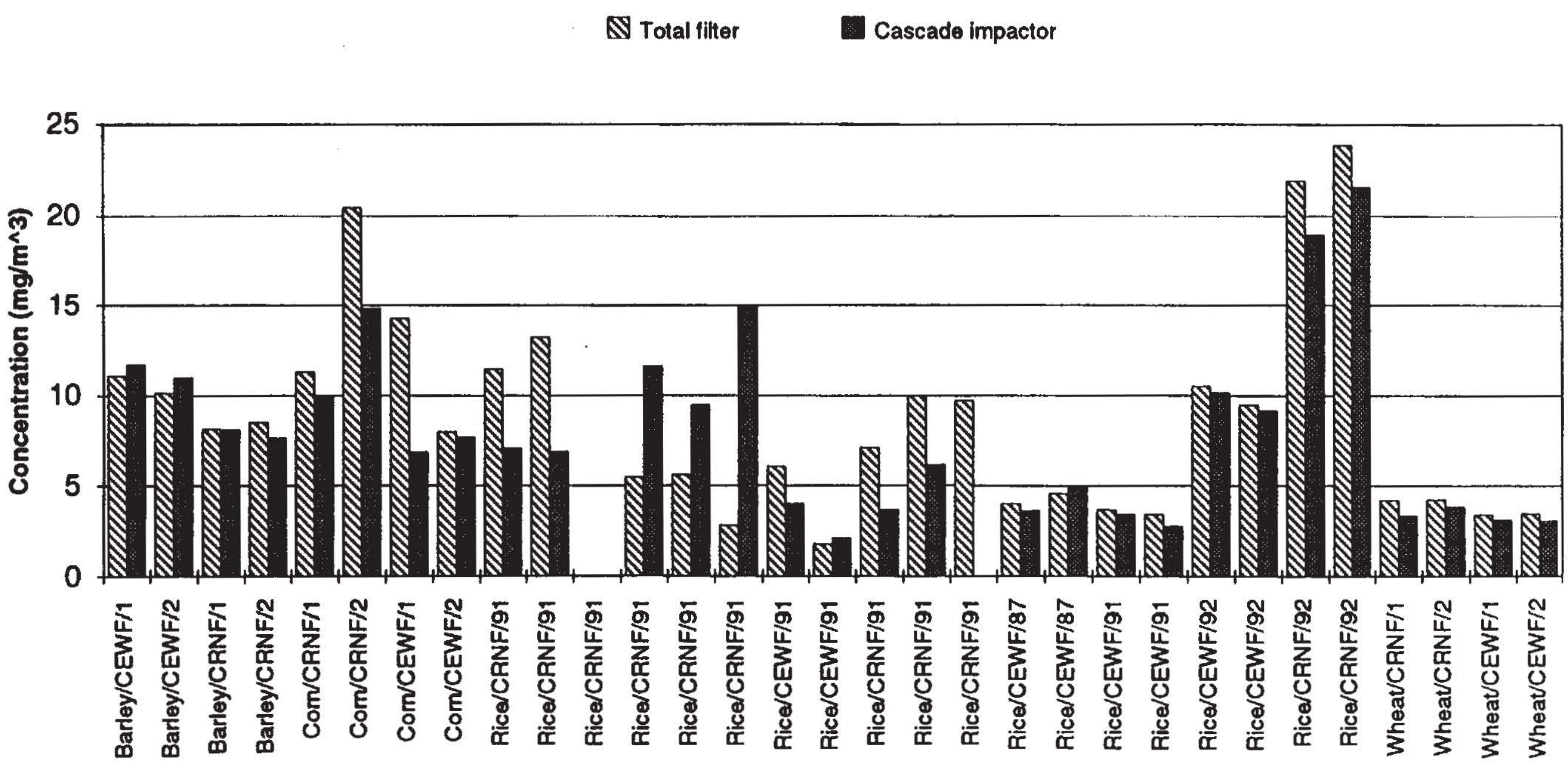


Figure 4.2.12. Particulate matter concentrations, total filter and cascade impactor - Pile fires.

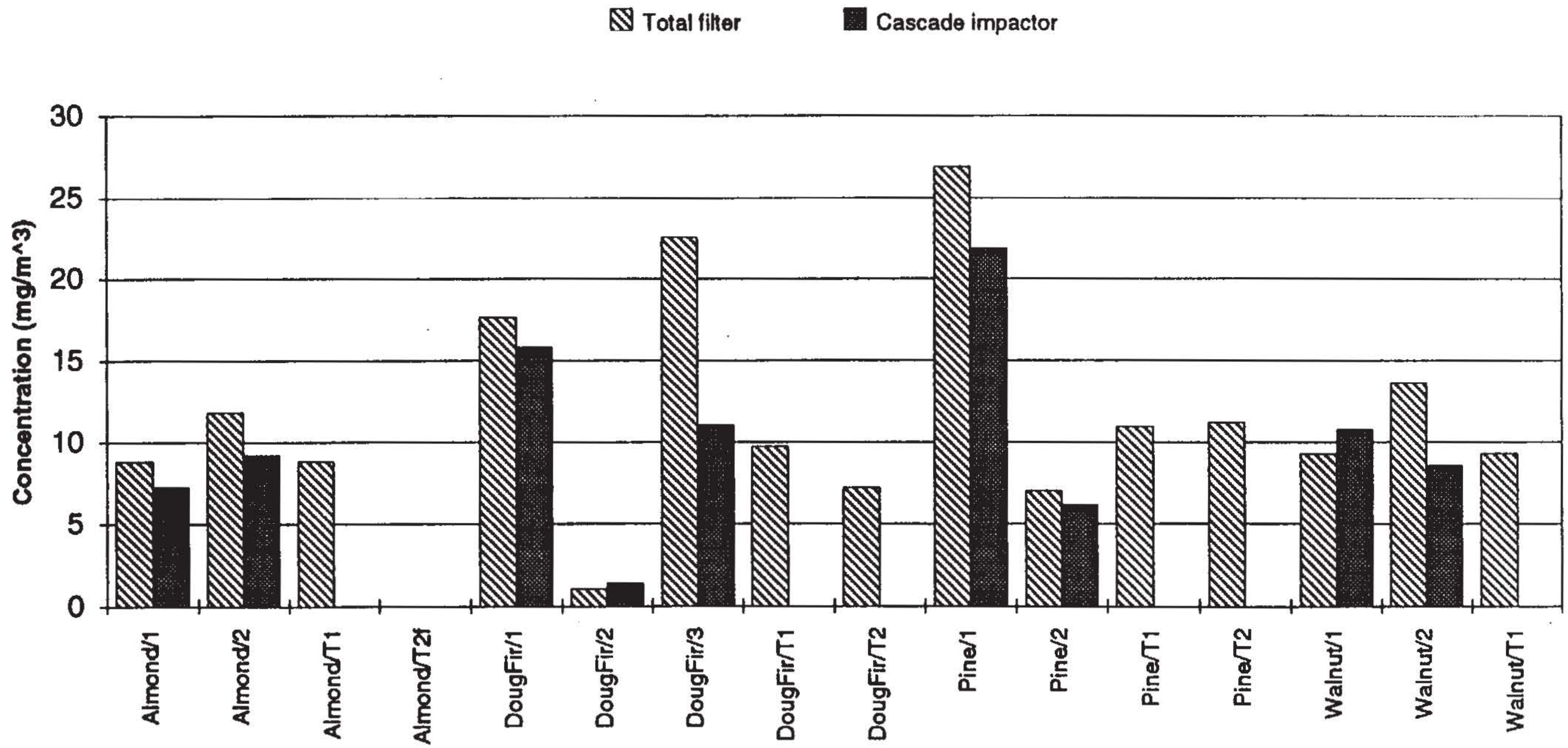
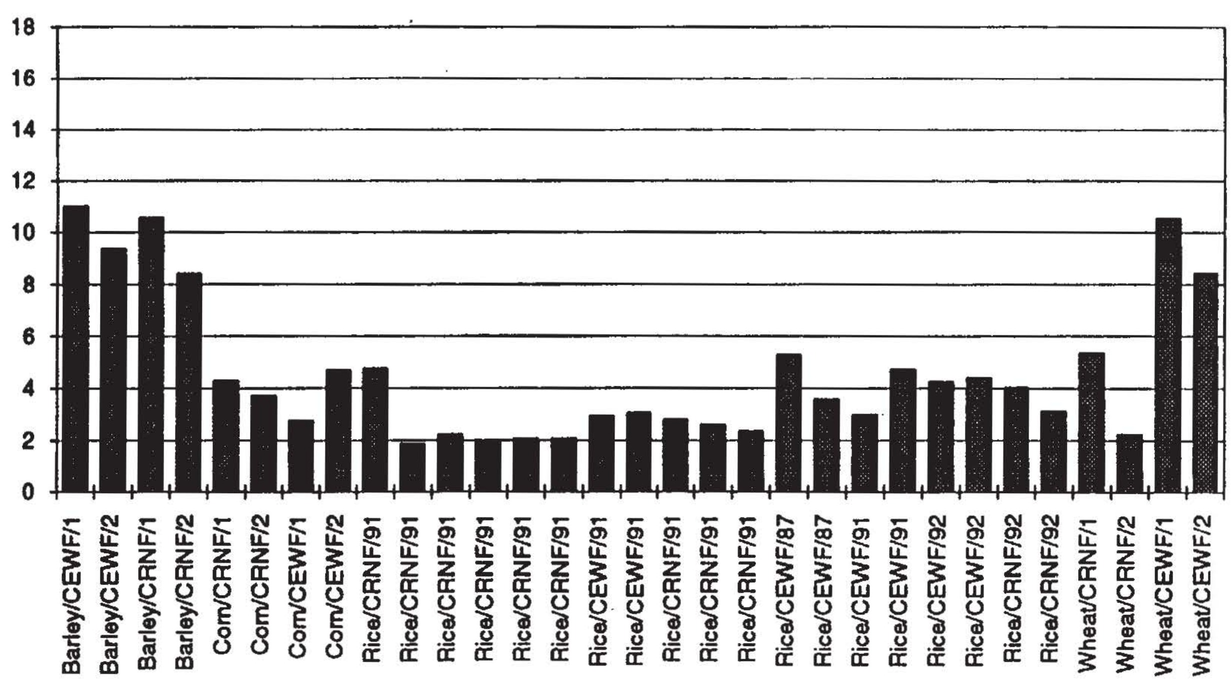
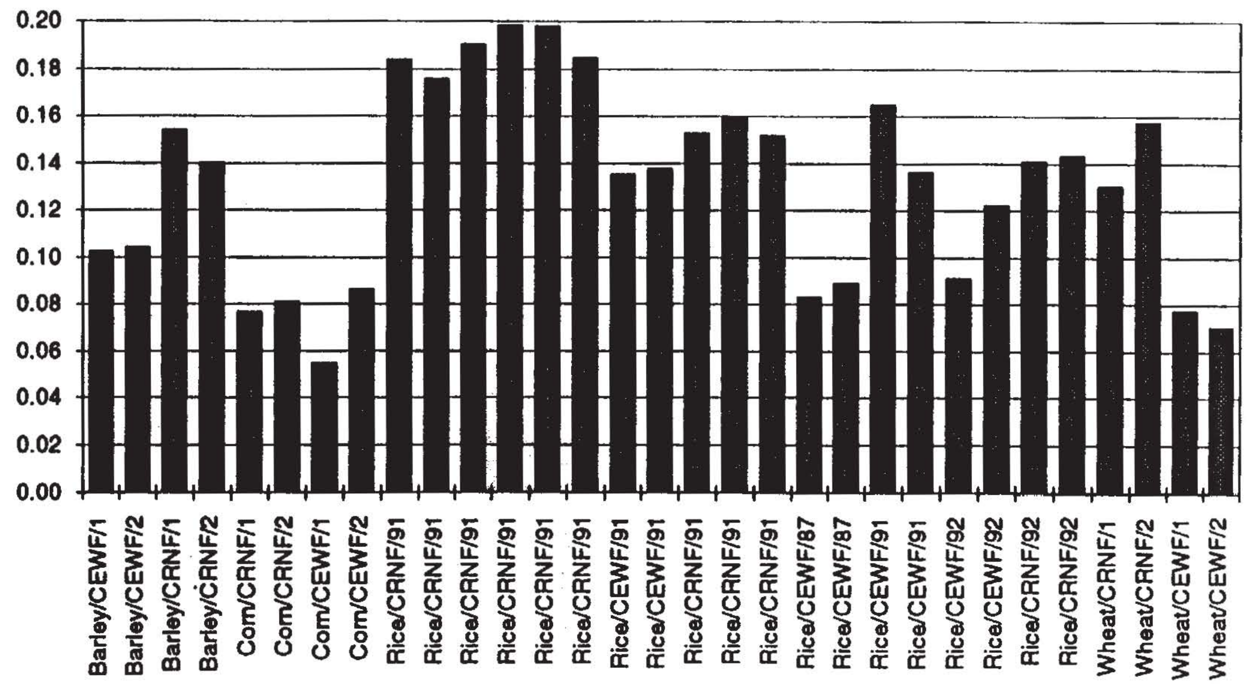


Figure 4.3.1.1. CO emission factor (% integrated basis) - Spreading Fires



(Emission factor as % dry fuel weight. Integrated basis refers to method of equation [8])

Figure 4.3.1.2. NO emission factor (% integrated basis) - Spreading Fires



(Emission factor as % dry fuel weight. Integrated basis refers to method of equation [8])

Figure 4.3.1.3. NOx emission factor (% integrated basis) - Spreading Fires

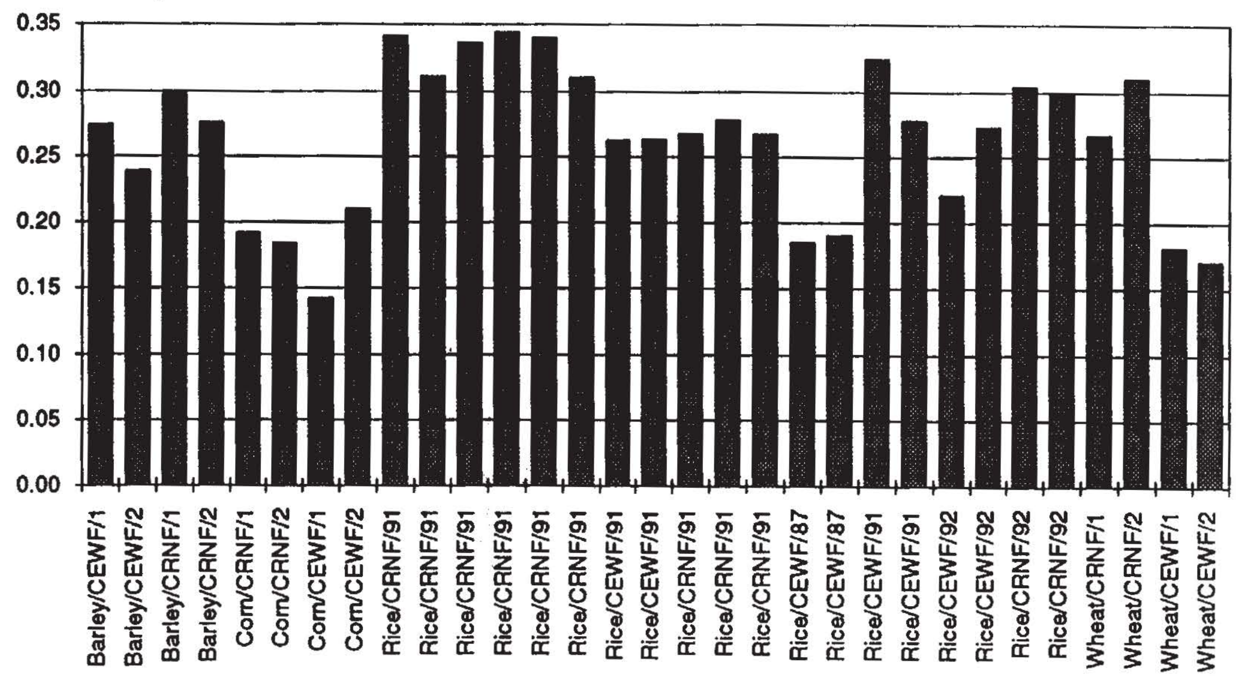


Figure 4.3.1.4. Fraction of NOx emitted as NO - Spreading fires.

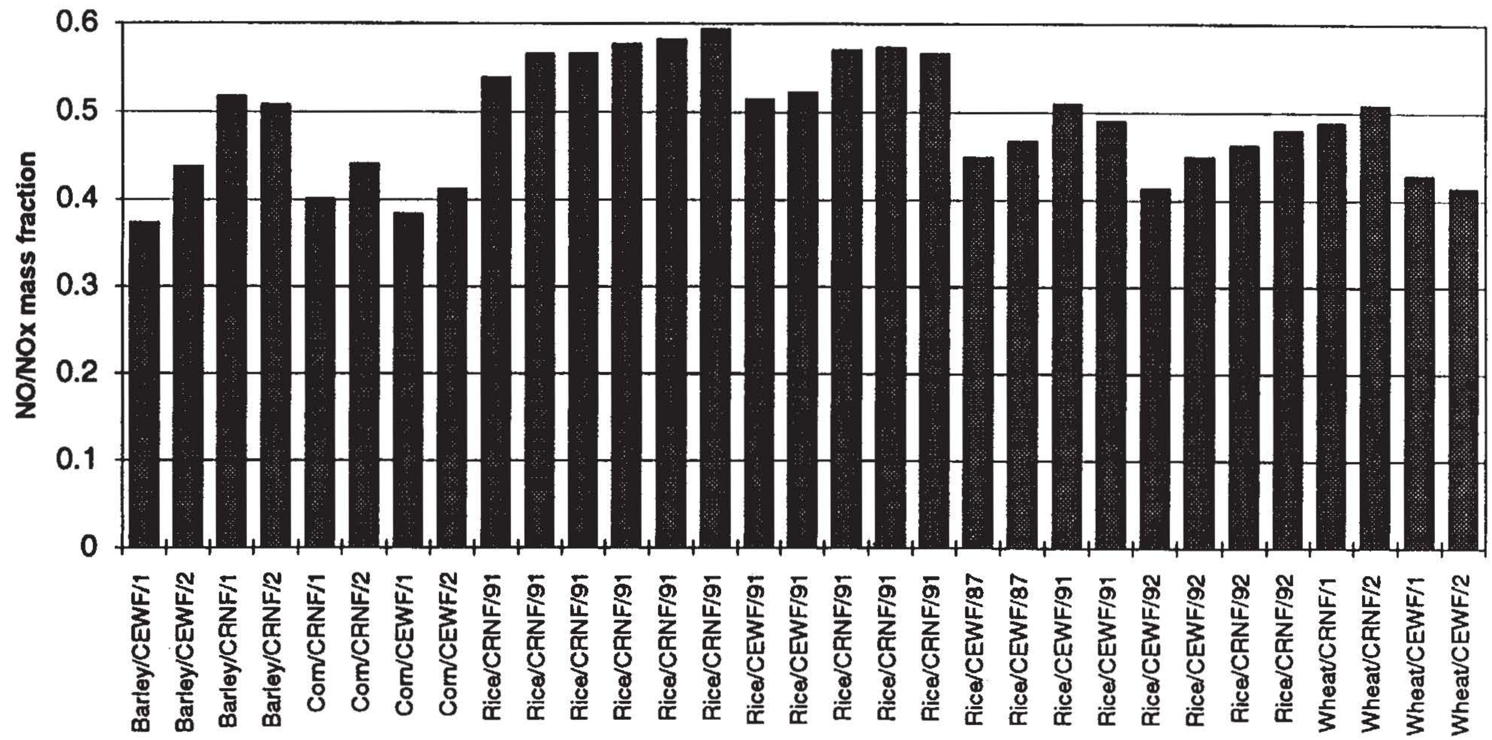


Figure 4.3.1.5. SO2 emission factor (% integrated basis) - Spreading Fires

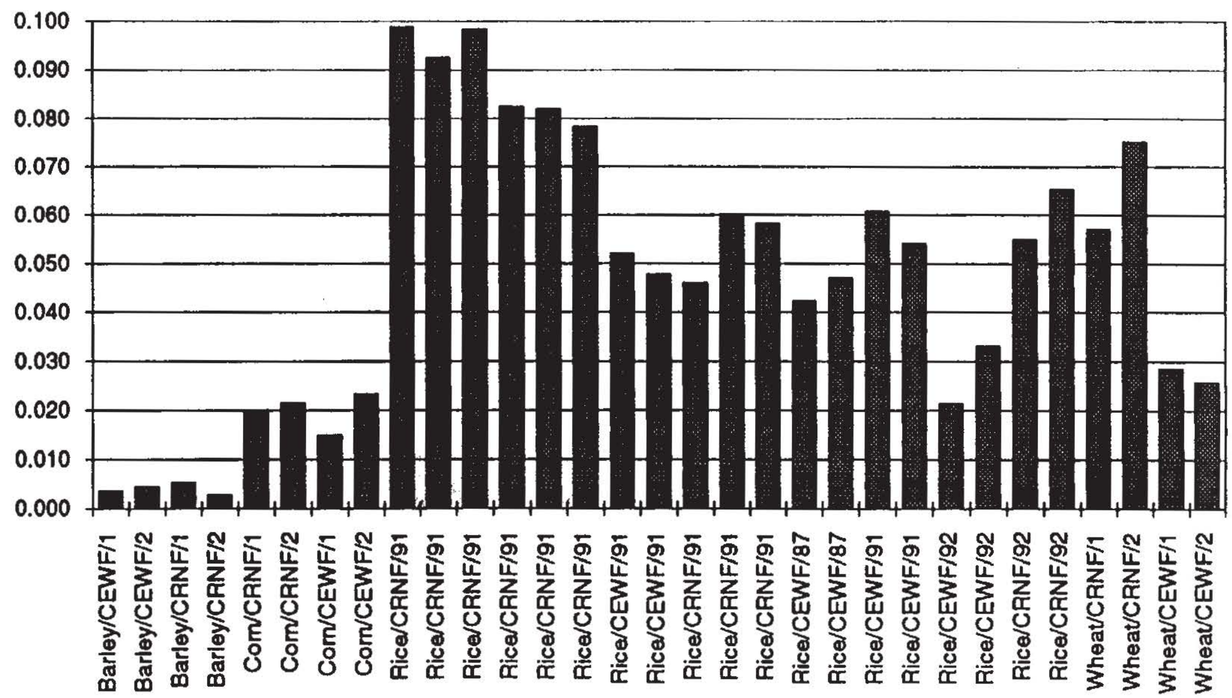


Figure 4.3.1.6. THC emission factor (% integrated basis) - Spreading Fires

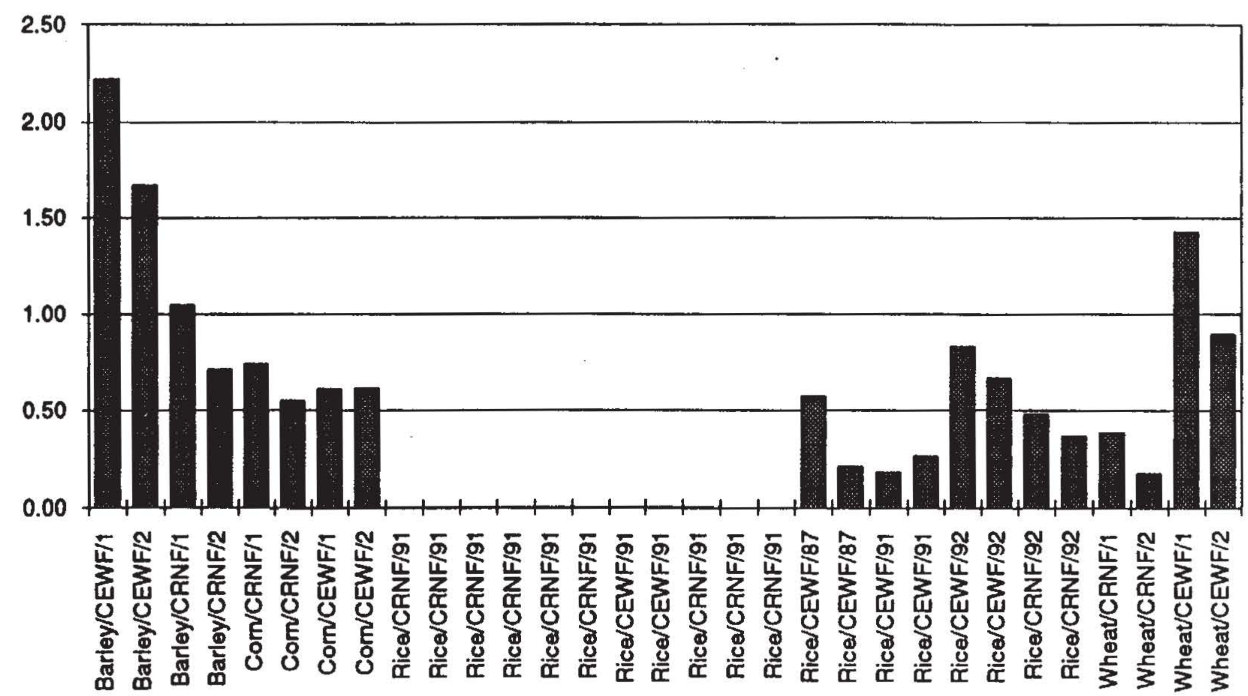


Figure 4.3.1.7. HC emission factor (%, by GC) - Spreading Fires

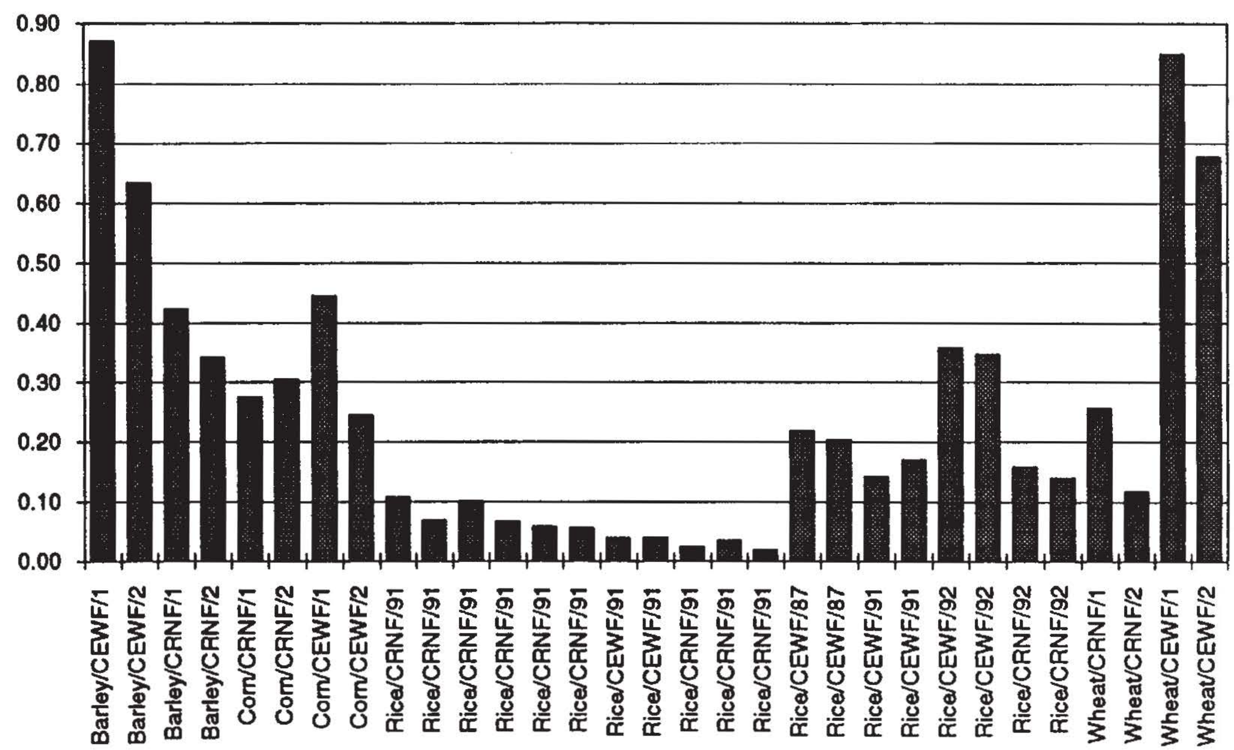


Figure 4.3.1.8. CH4 emission factor (%, by GC) - Spreading Fires

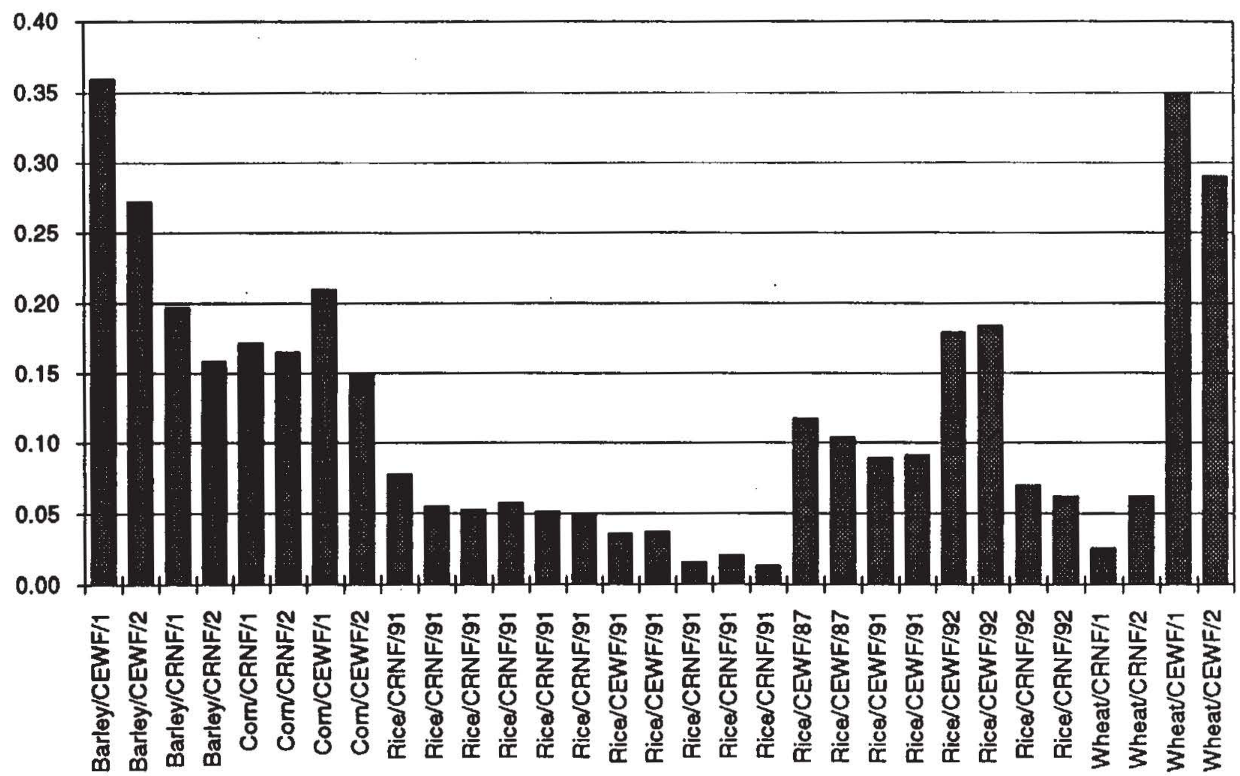


Figure 4.3.1.9. NMHC emission factor (% integrated basis) - Spreading Fires

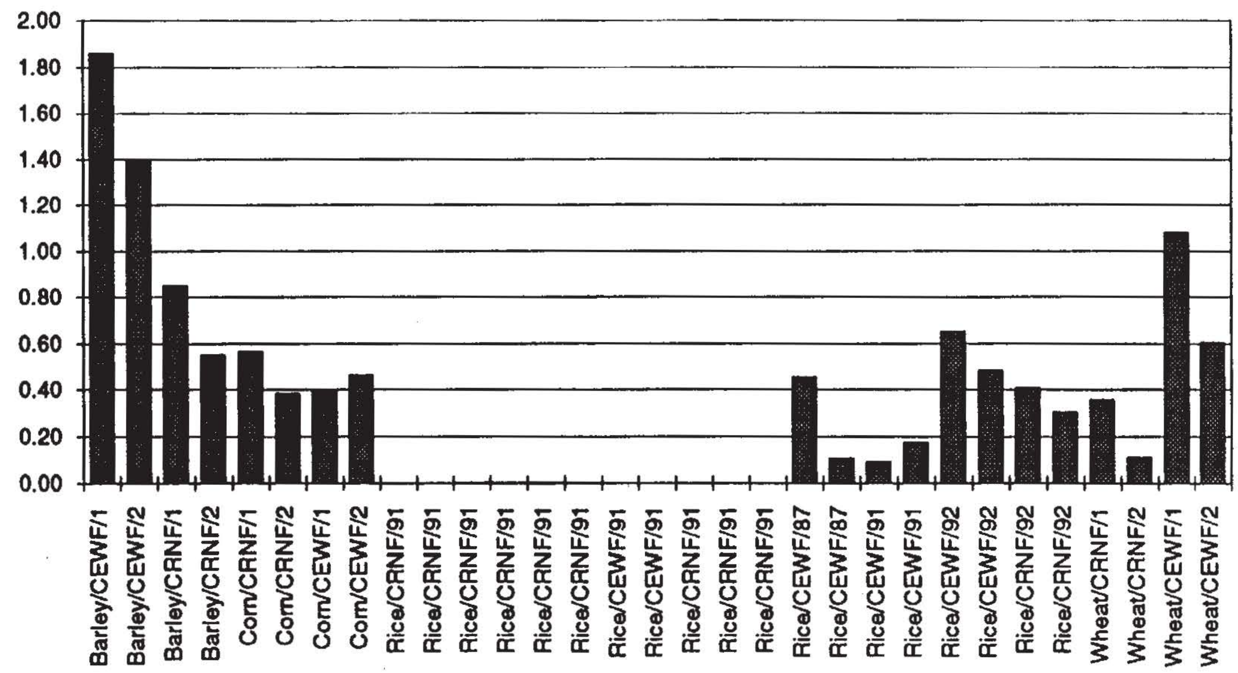


Figure 4.3.1.10. NMHC emission factor (%, by GC) - Spreading Fires

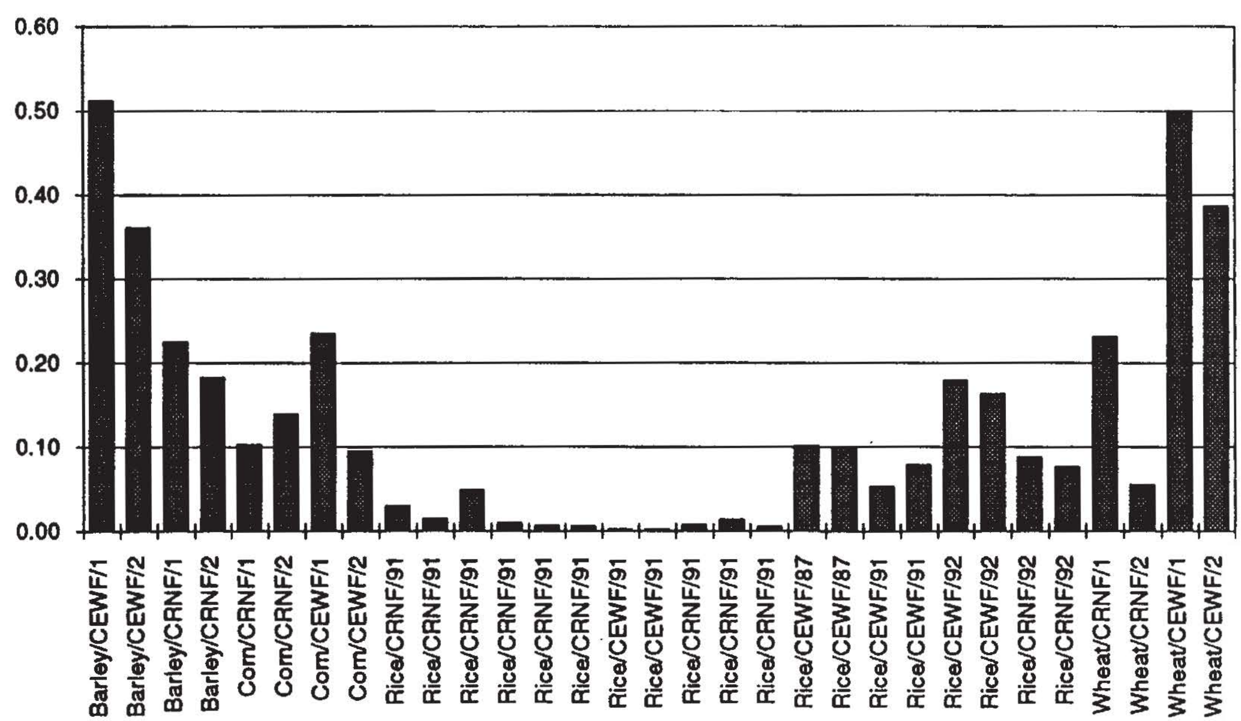


Figure 4.3.1.11. CO2 emission factor (%, by GC) - Spreading Fires

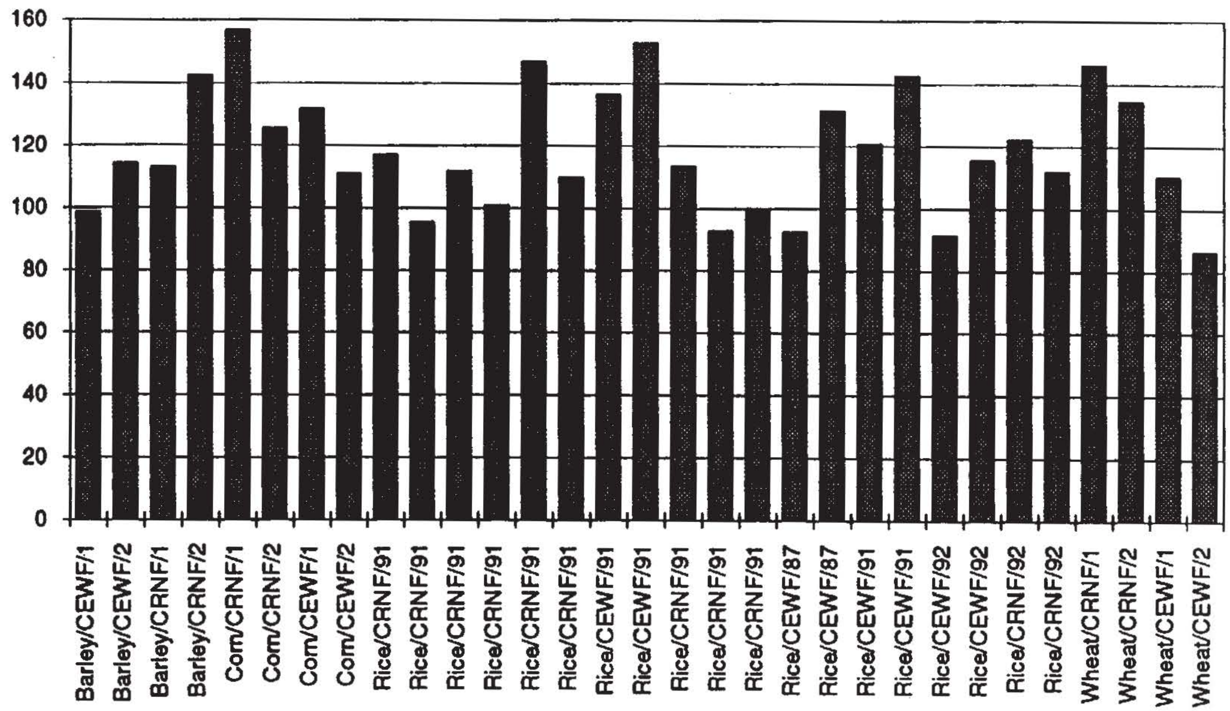


Figure 4.3.1.12. Total Sulfur emission factor (% as SO2 integrated basis) - Spreading Fires

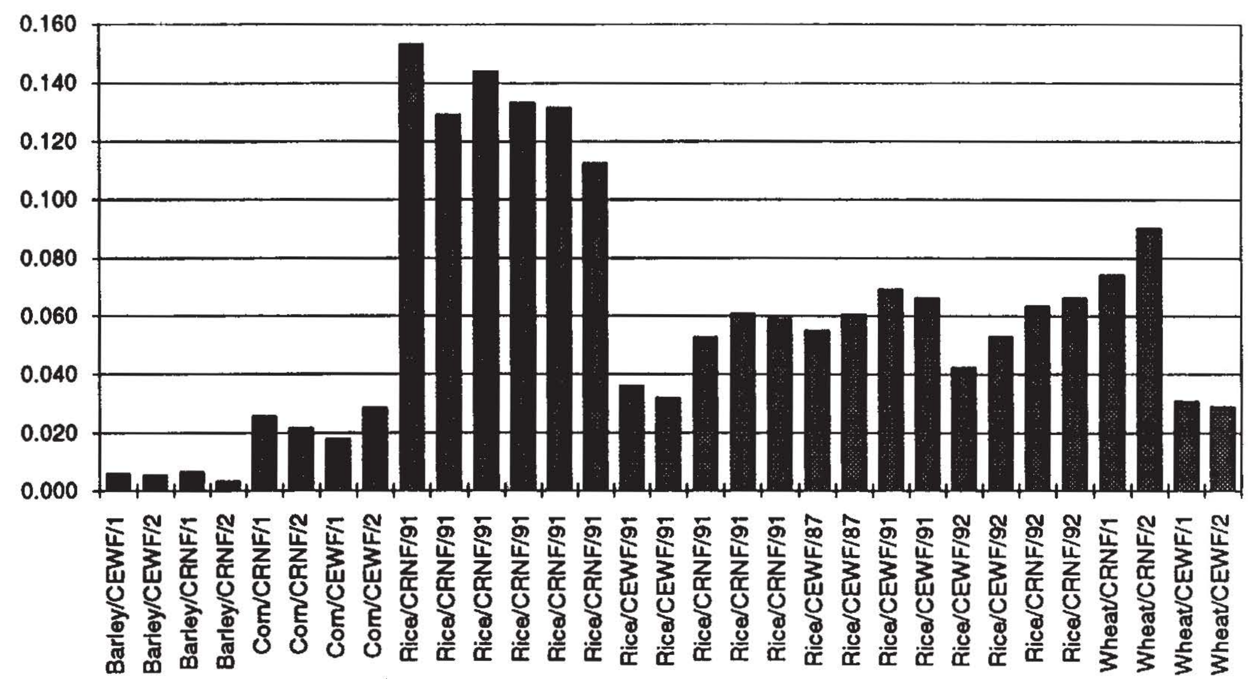


Figure 4.3.1.13. SO2/Total S - Spreading Fires

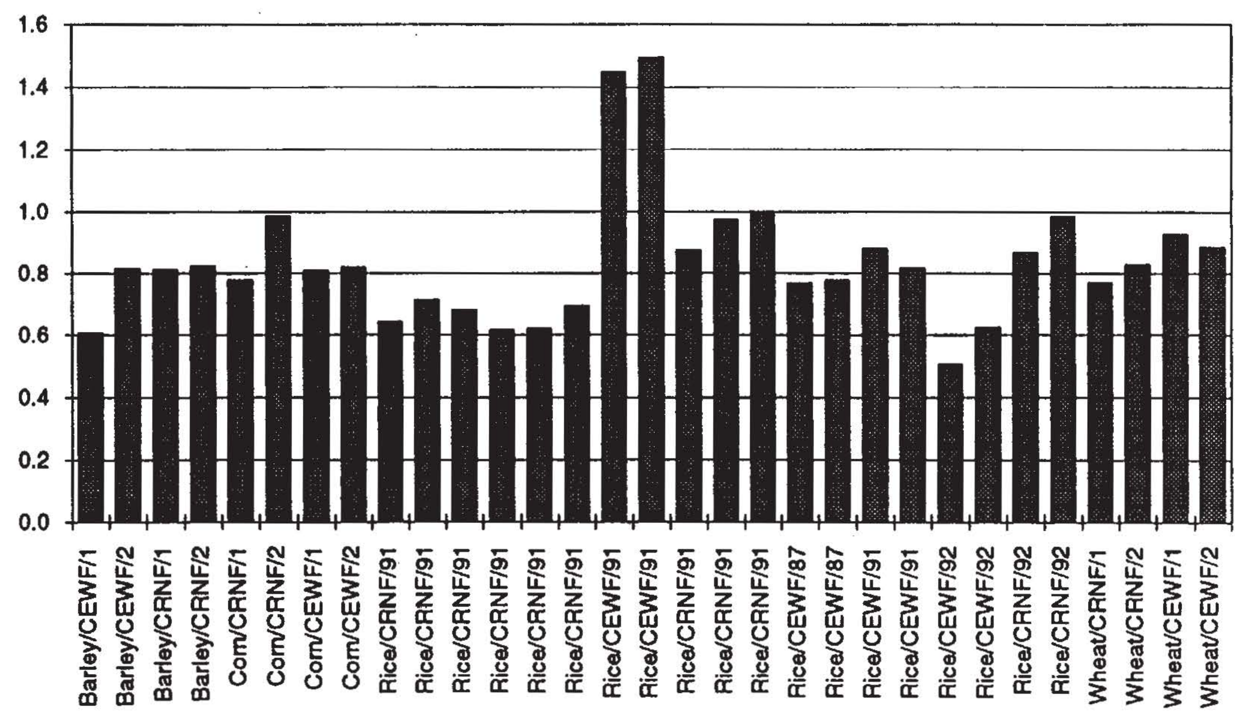
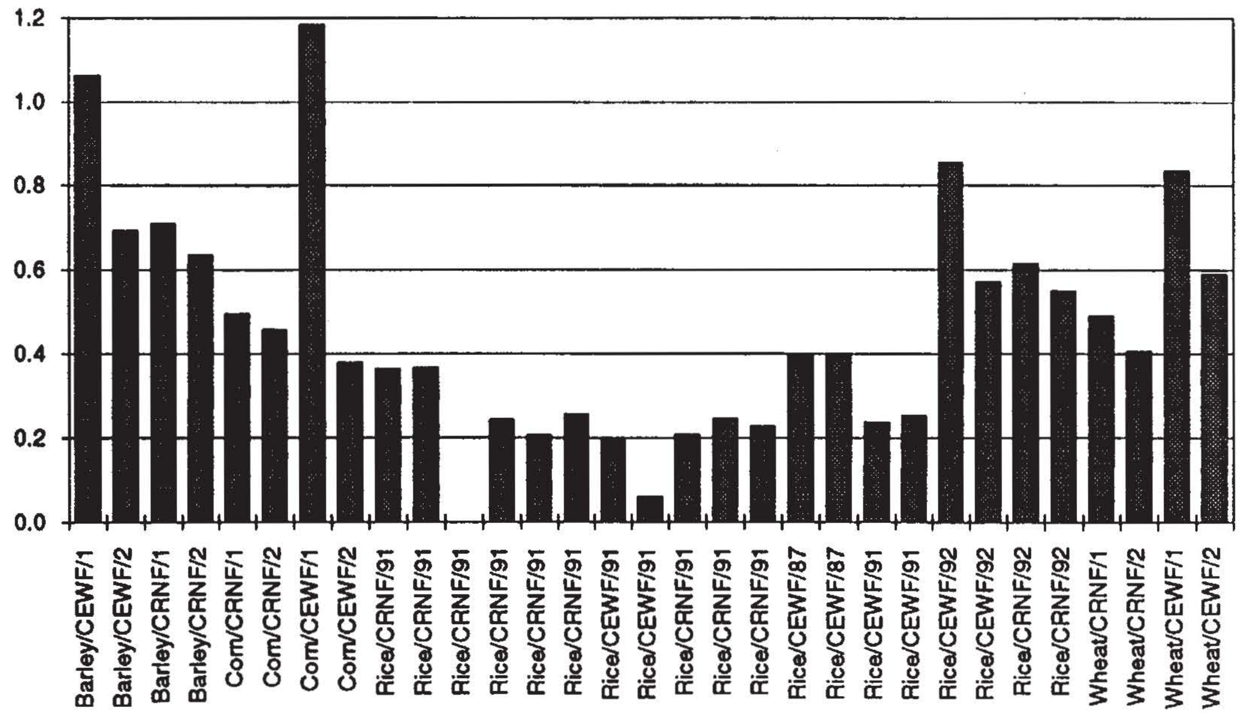


Figure 4.3.1.14. PM emission factor (%) - Spreading Fires



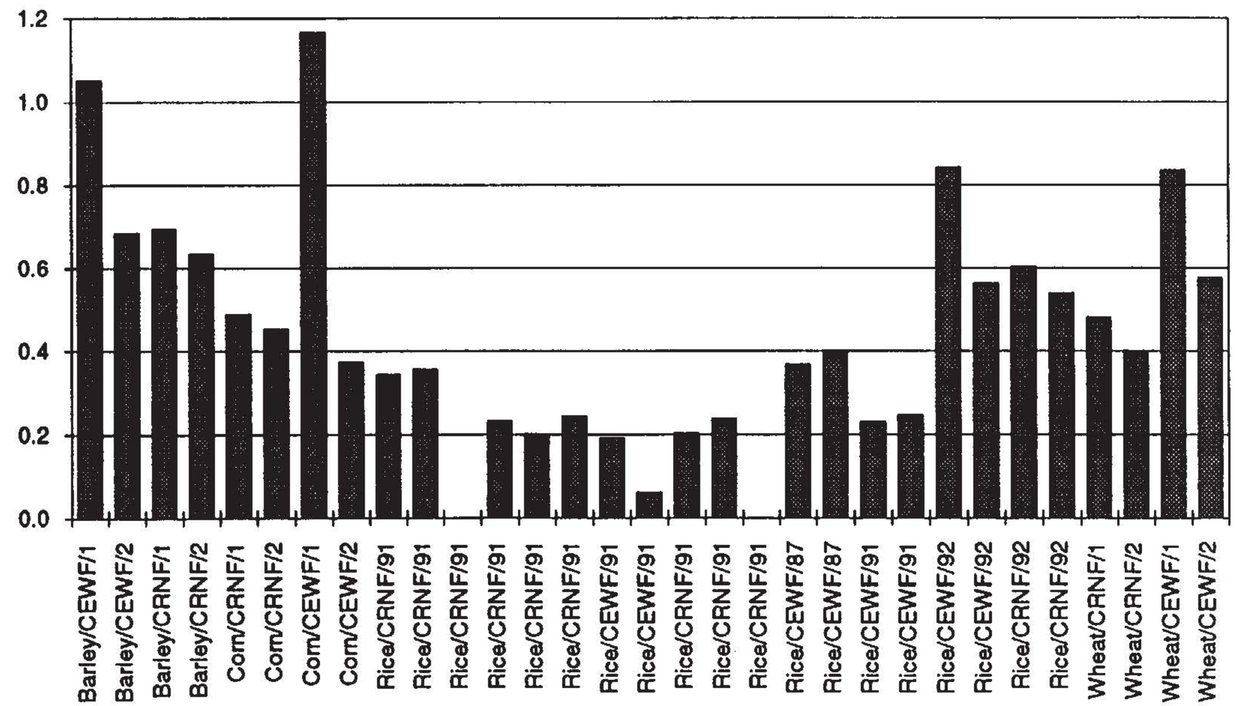
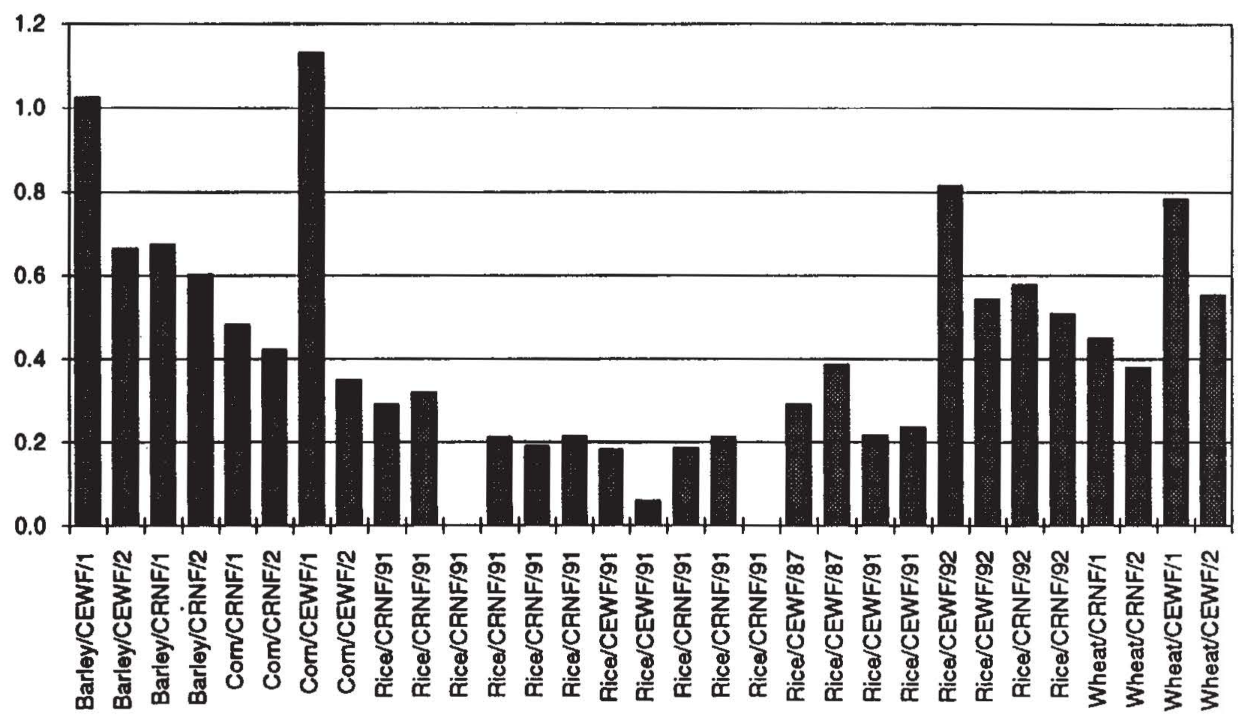


Figure 4.3.1.15. PM10 emission factor (%) - Spreading Fires

Figure 4.3.1.16. PM2.5 emission factor (%) - Spreading Fires



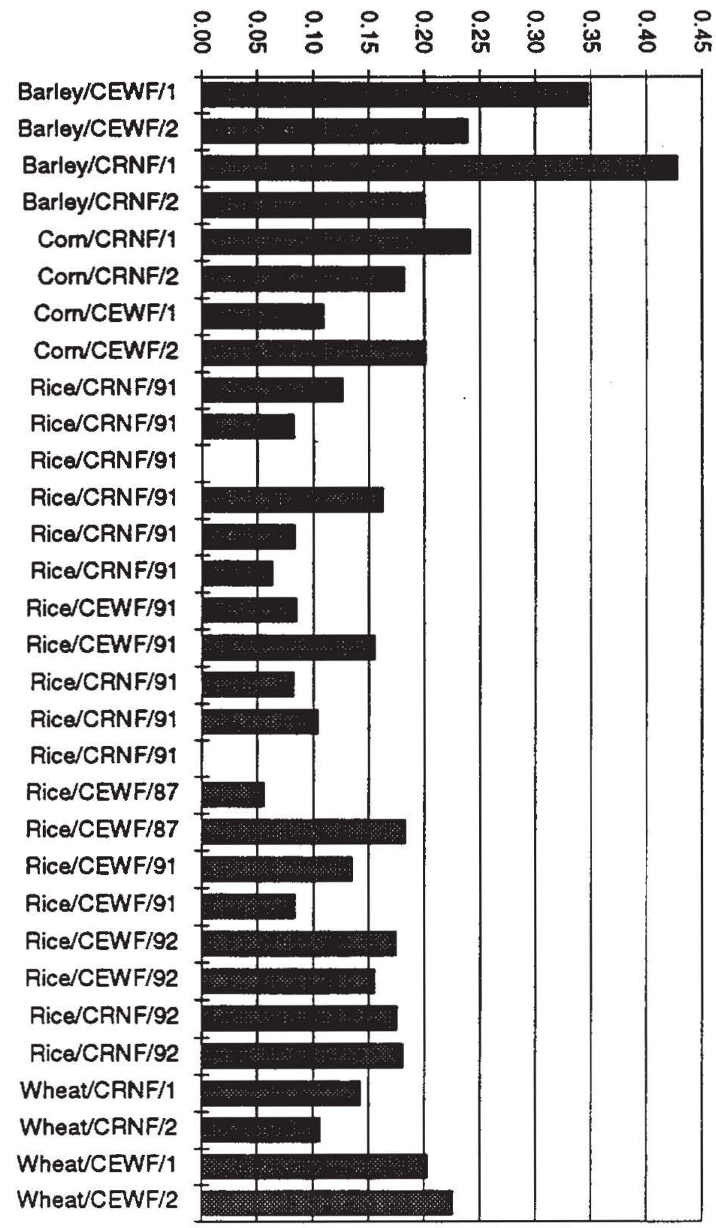


Figure 4.3.1.17. MMAD (μm) - Spreading Fires

Figure 4.3.1.18. Average CO emission factor (% integrated basis) - Spreading Fires

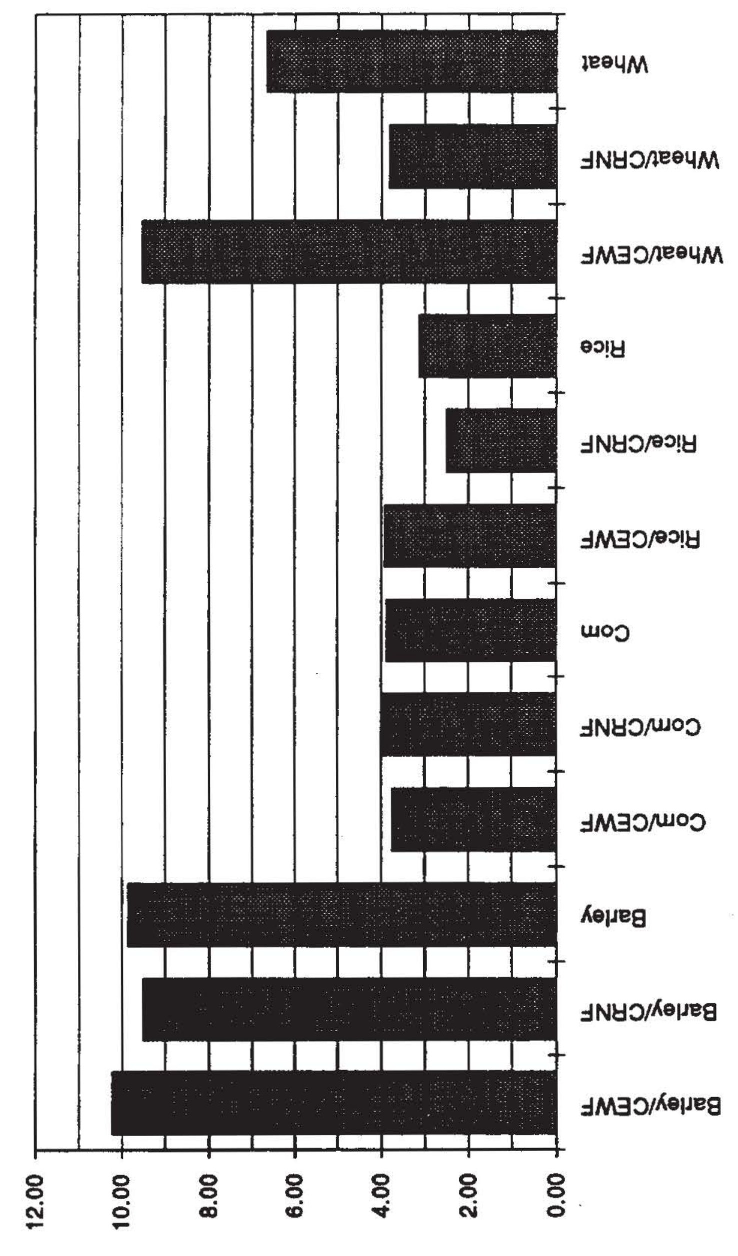


Figure 4.3.1.19. Average NO emission factor (% integrated basis) - Spreading Fires

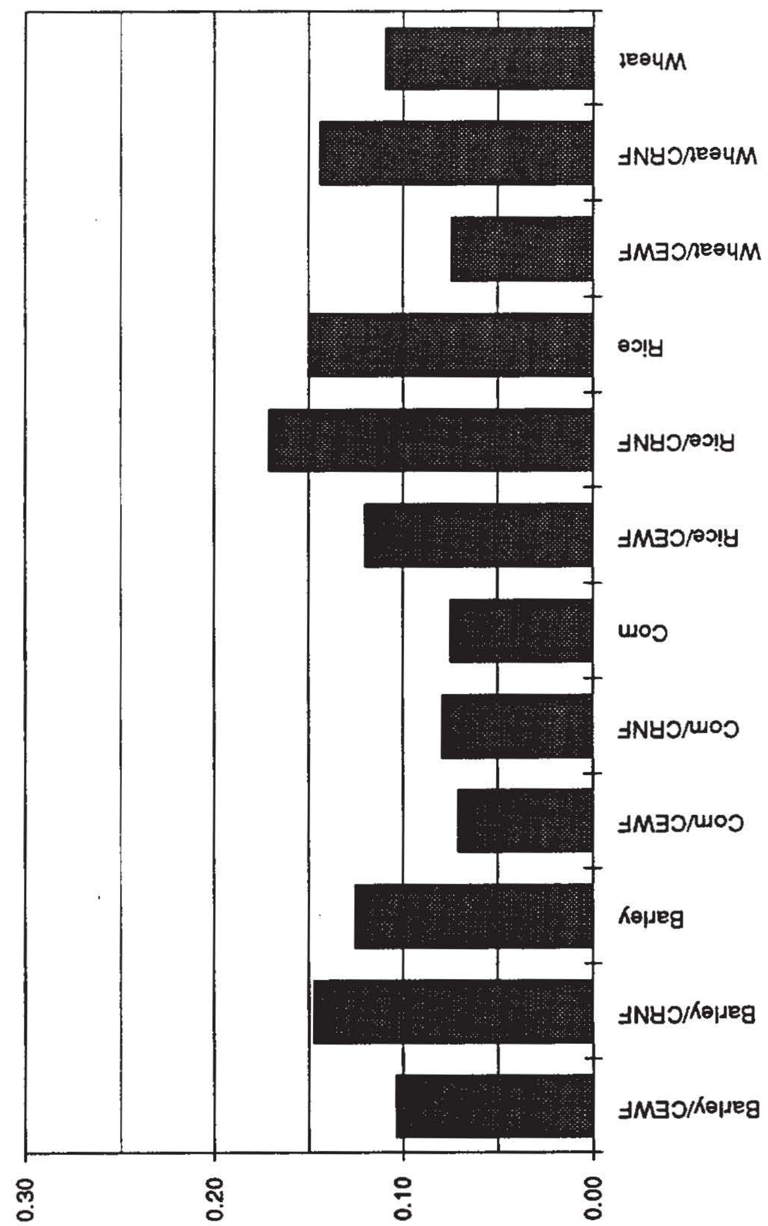


Figure 4.3.1.20. NOx emission factor (% as NO2, integrated basis) - Spreading Fires

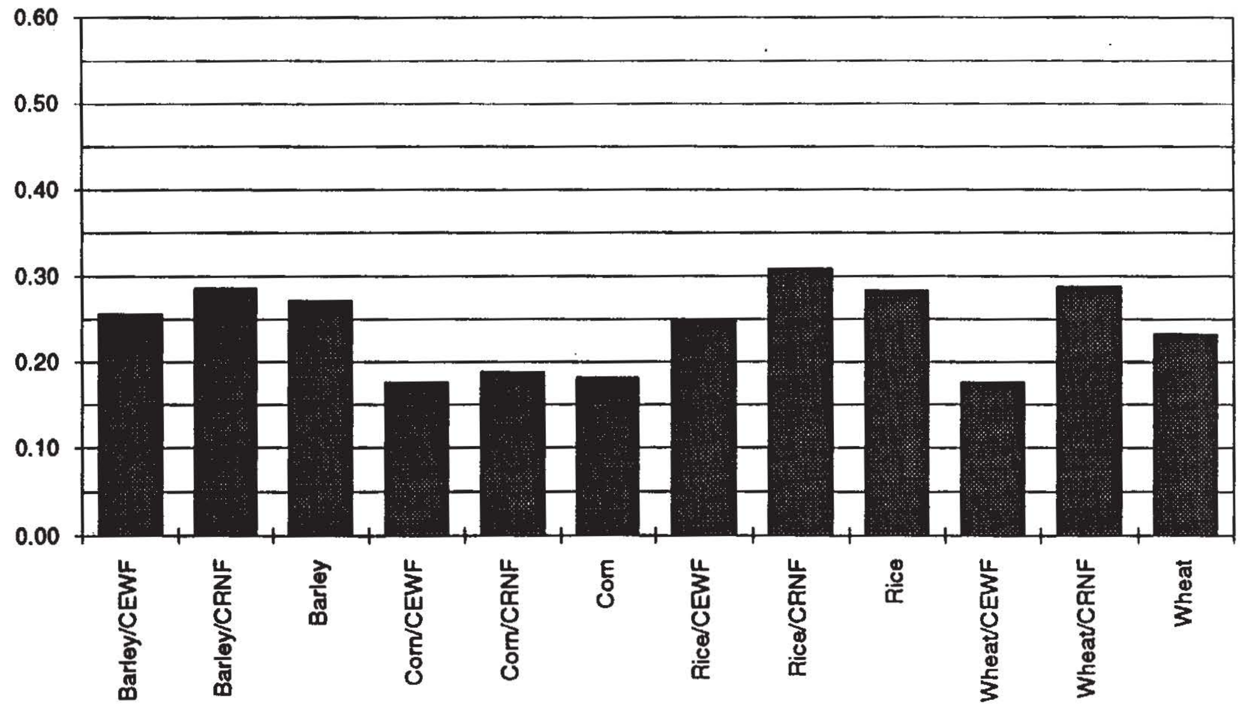


Figure 4.3.1.21. Average SO2 emission factor (% integrated basis) - Spreading Fires

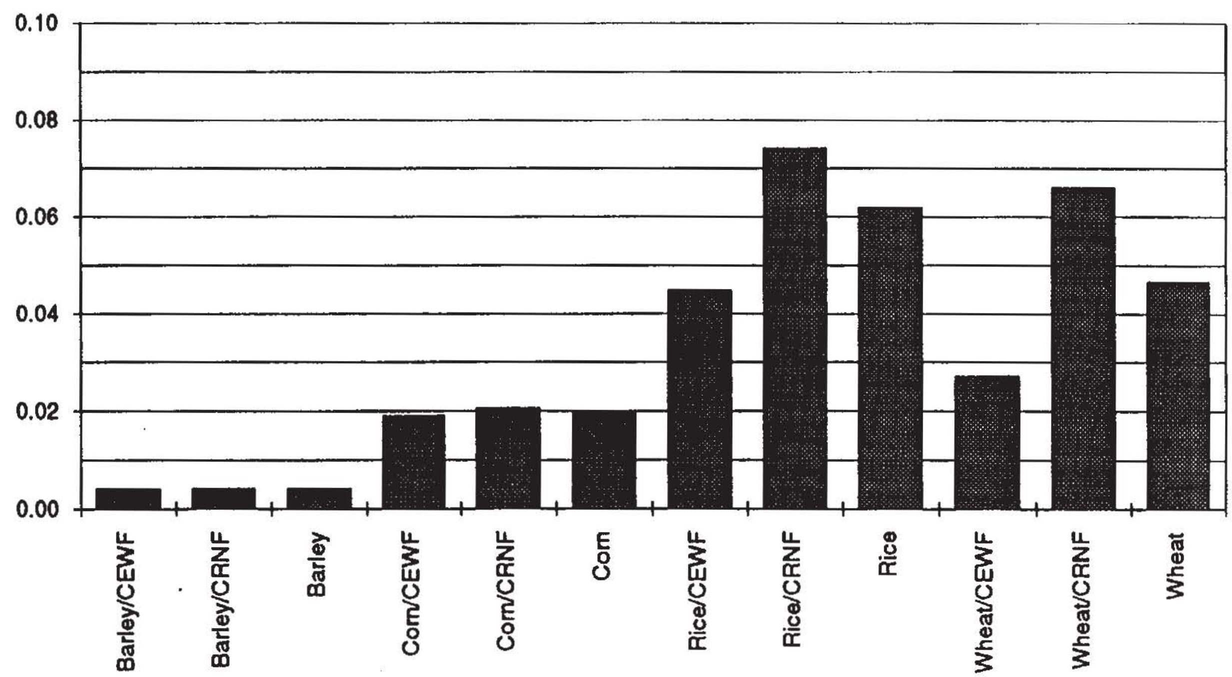


Figure 4.3.1.22. Average THC emission factor (% as CH_4, integrated basis) - Spreading Fires

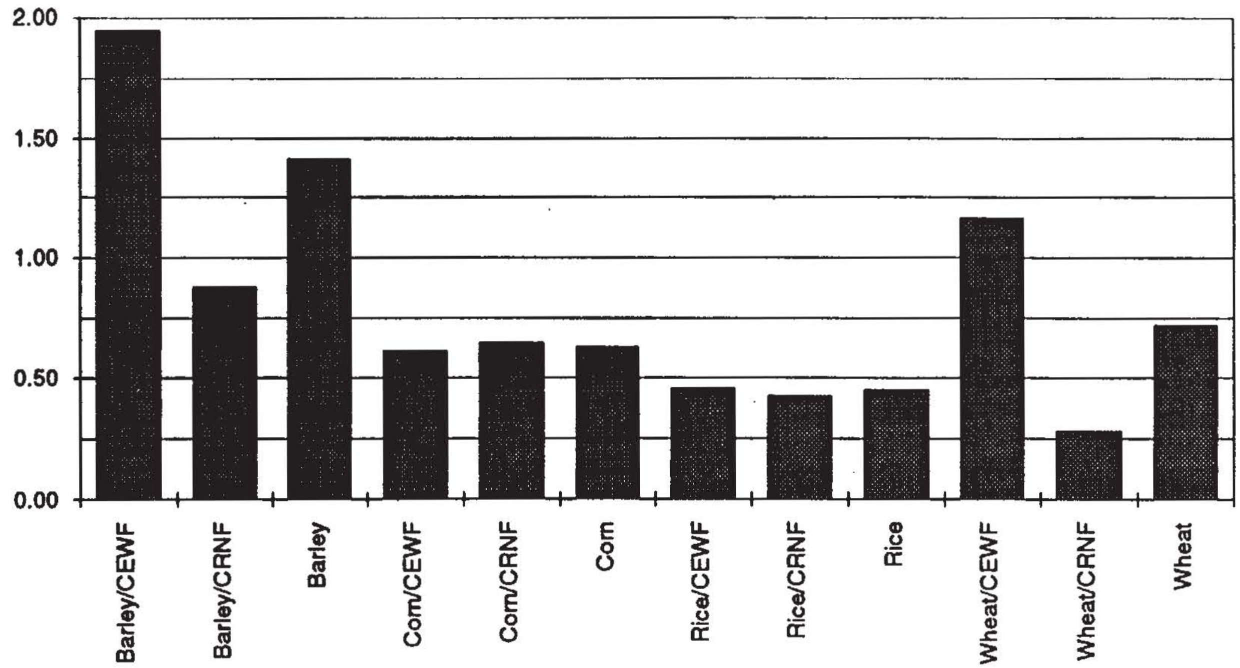


Figure 4.3.1.23. Average HC emission factor (% as CH4, by GC) - Spreading Fires

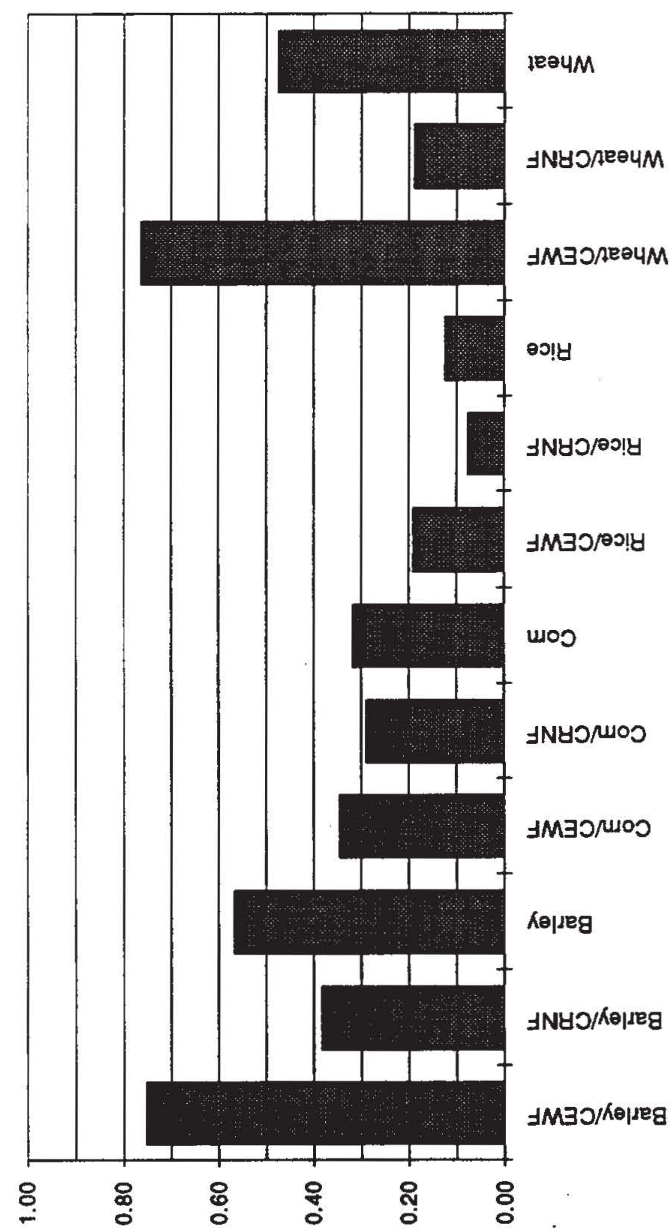


Figure 4.3.1.24. Average CH4 emission factor (%, by GC) - Spreading Fires

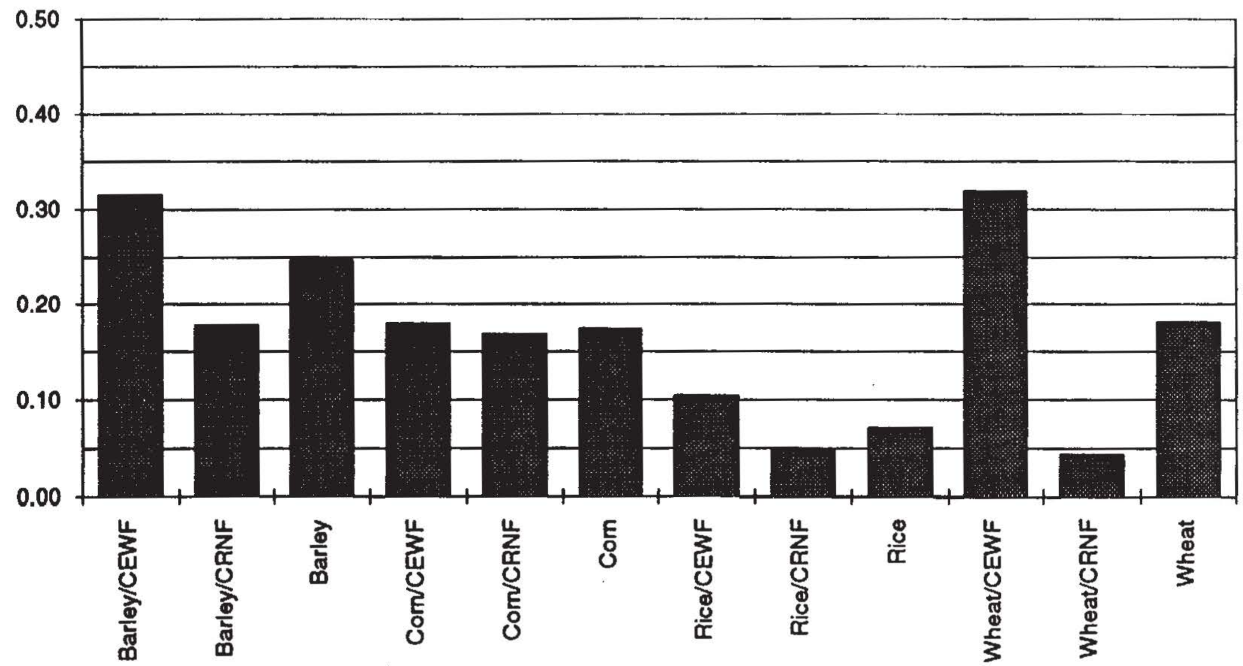
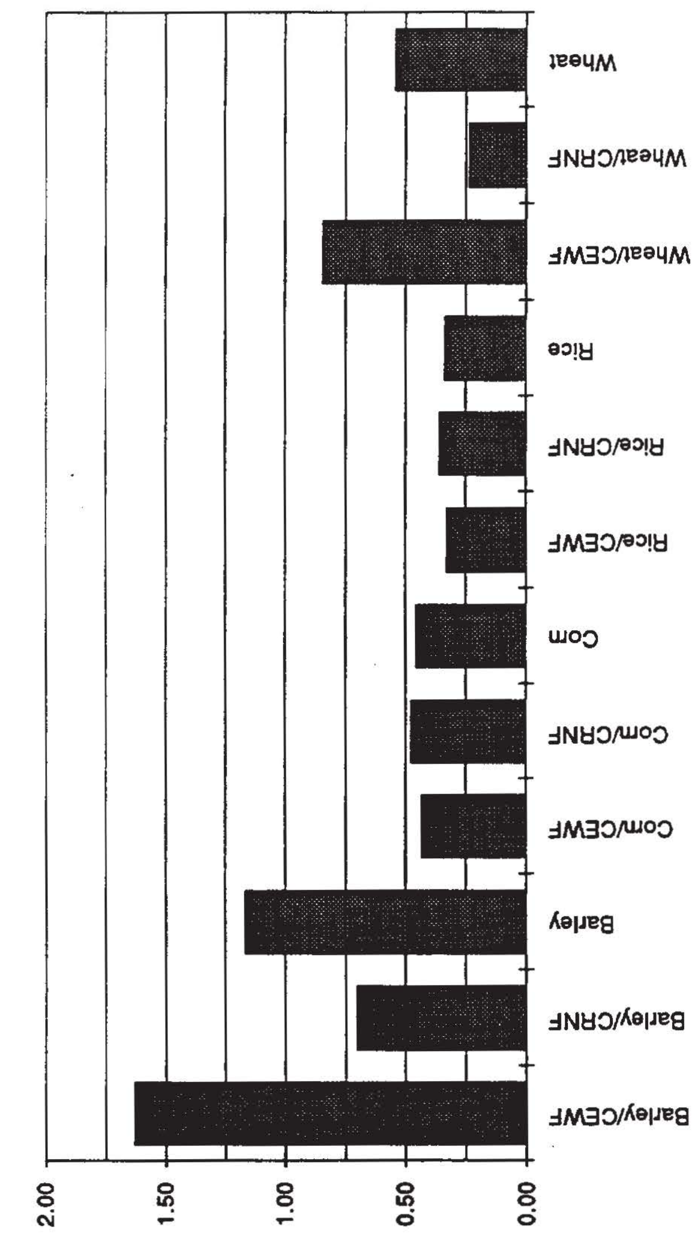


Figure 4.3.1.25. Average NMHC emission factor (% as CH4, integrated basis) - Spreading Fires



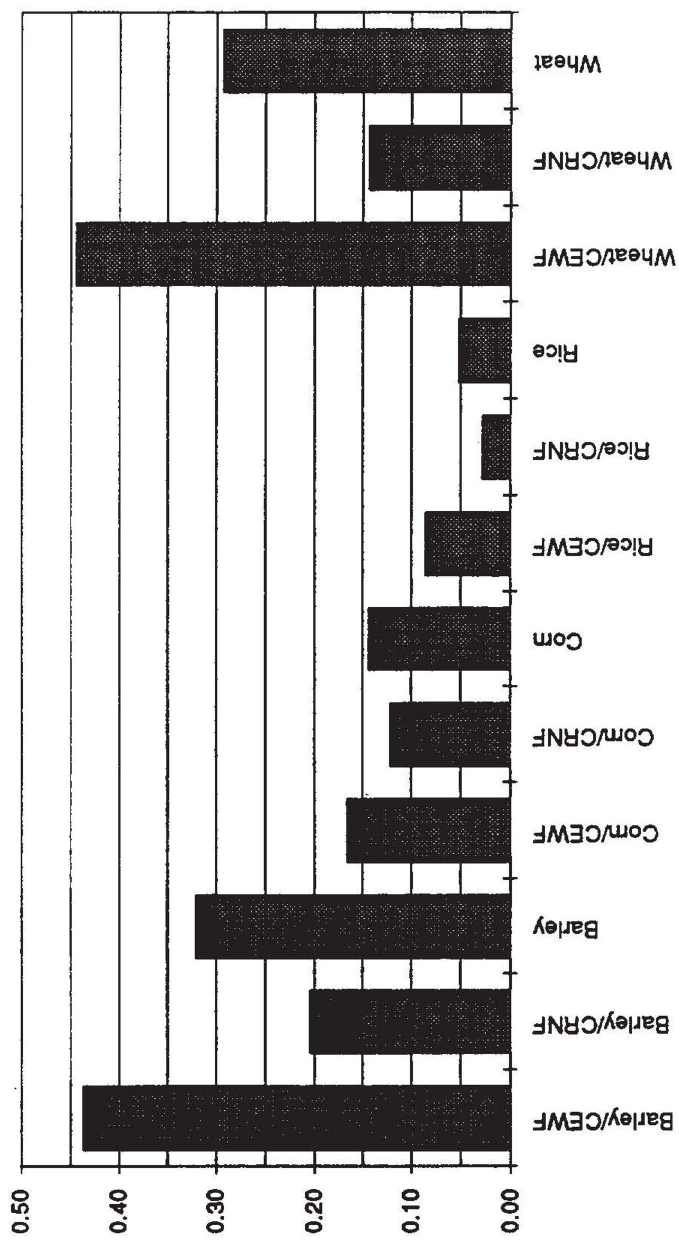


Figure 4.3.1.26. Average NMHC emission factor (% as CH_4, by GC) - Spreading Fires

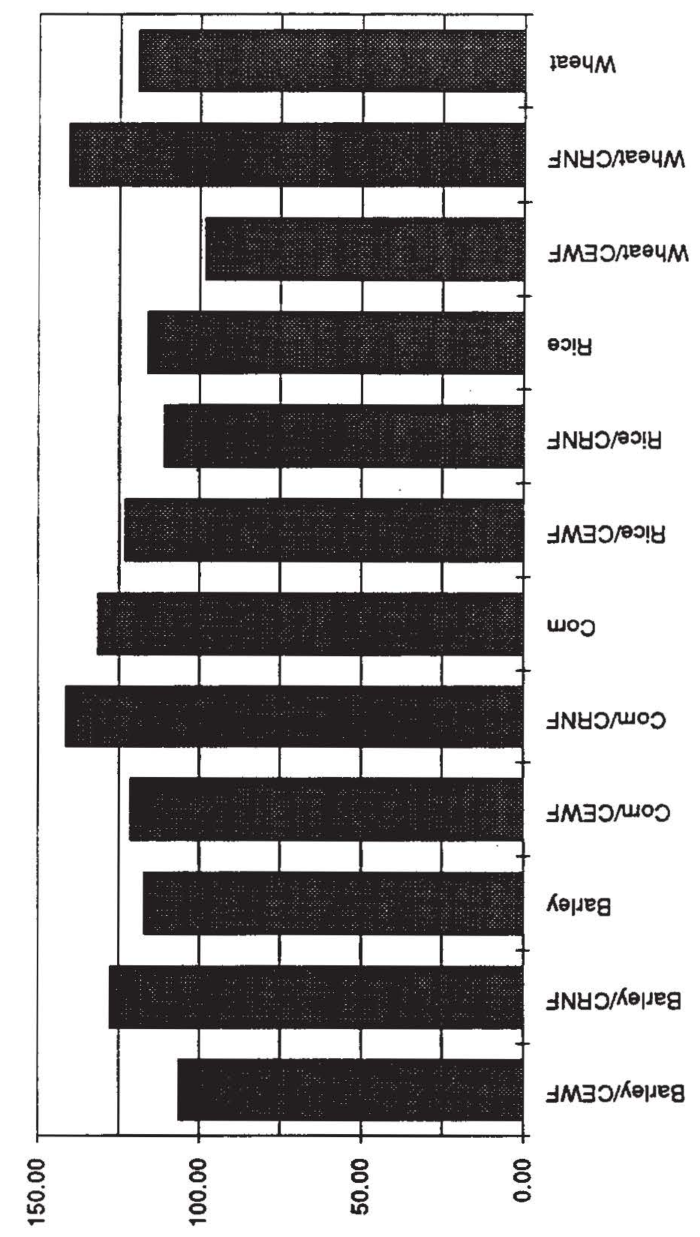


Figure 4.3.1.27. Average CO_2 emission factor (%, by GC) - Spreading Fires

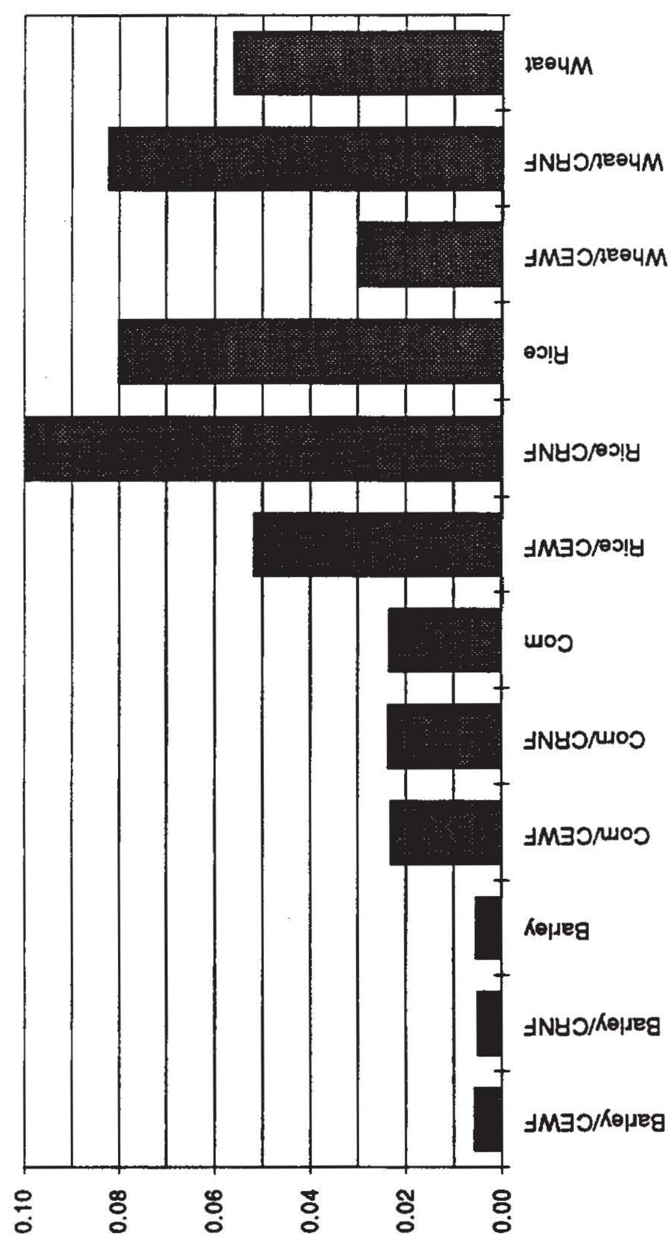


Figure 4.3.1.28. Average Total S emission factor (% as SO_2, integrated basis) - Spreading Fires

Figure 4.3.1.29. SO2/Total S - Spreading Fires

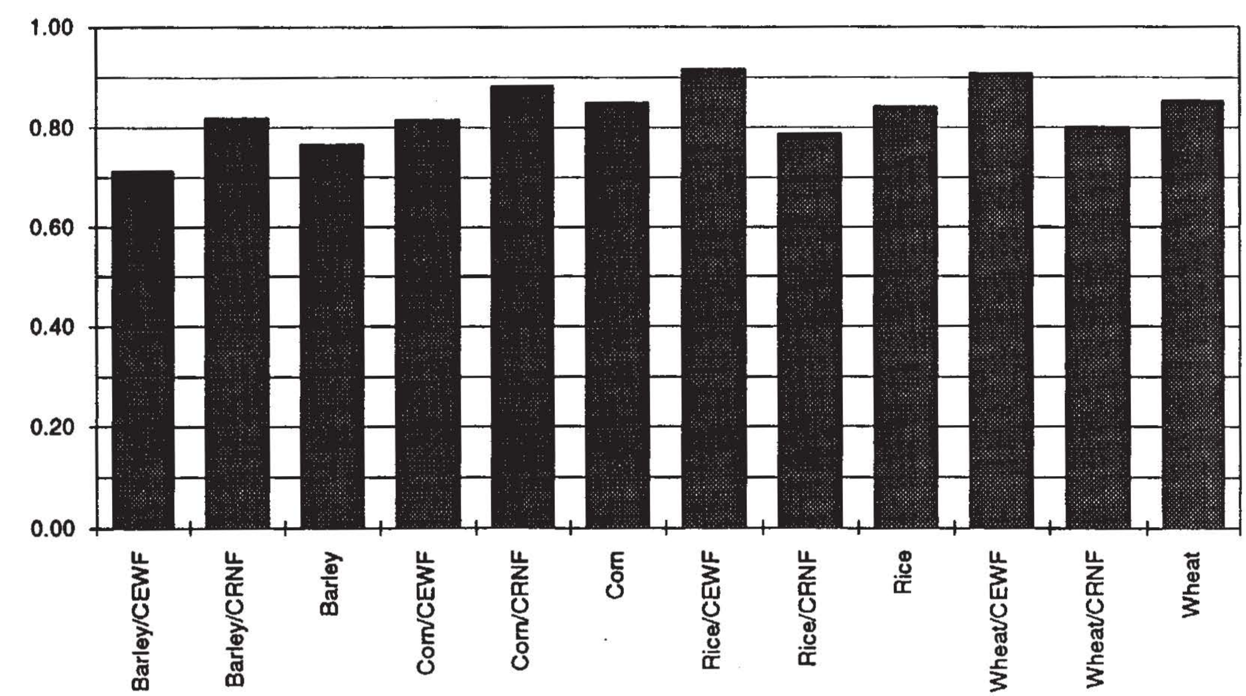


Figure 4.3.1.30. PM emission factor (%) - Spreading Fires

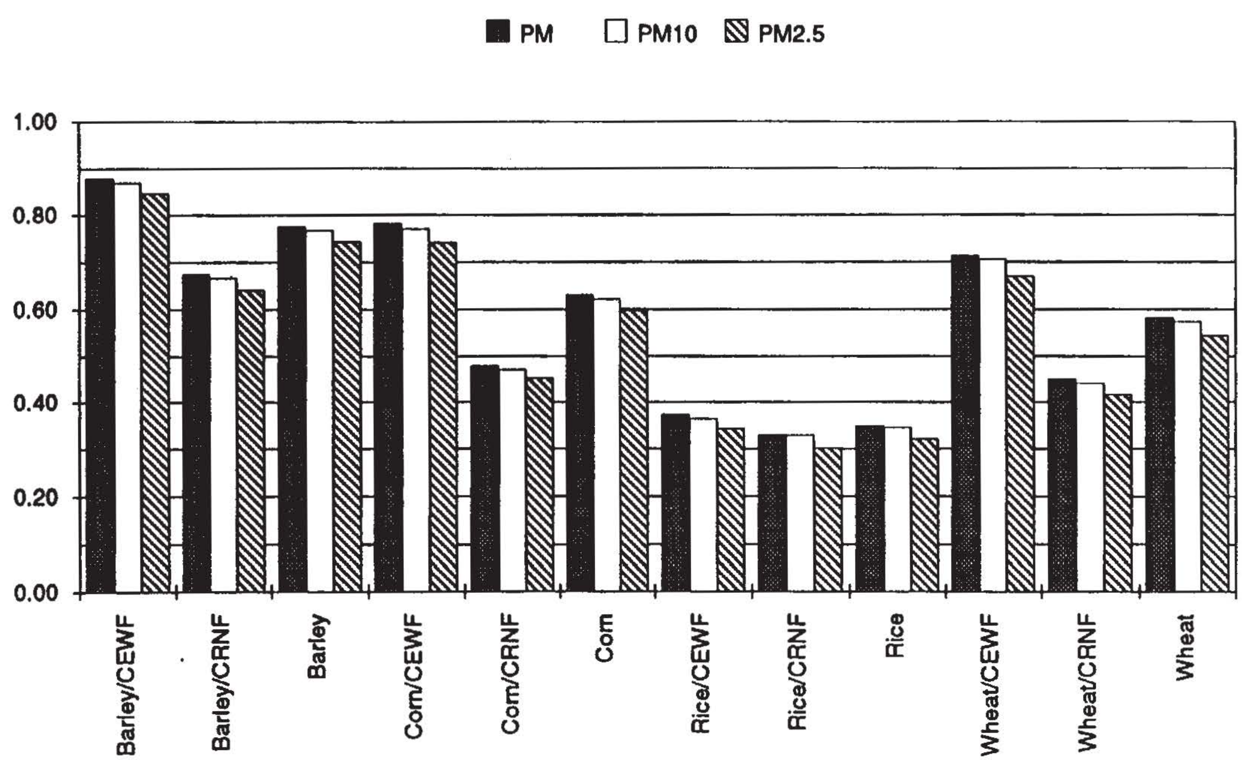
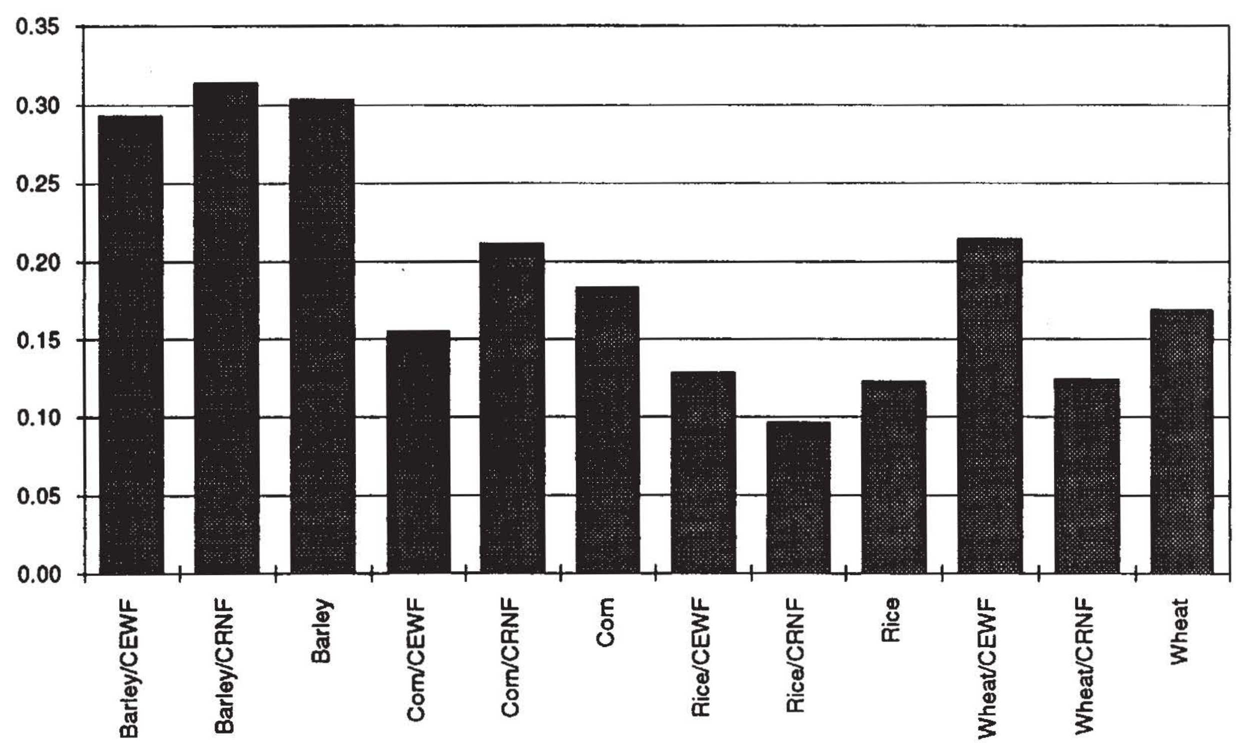


Figure 4.3.1.31. Average MMAD (μm) - Spreading Fires



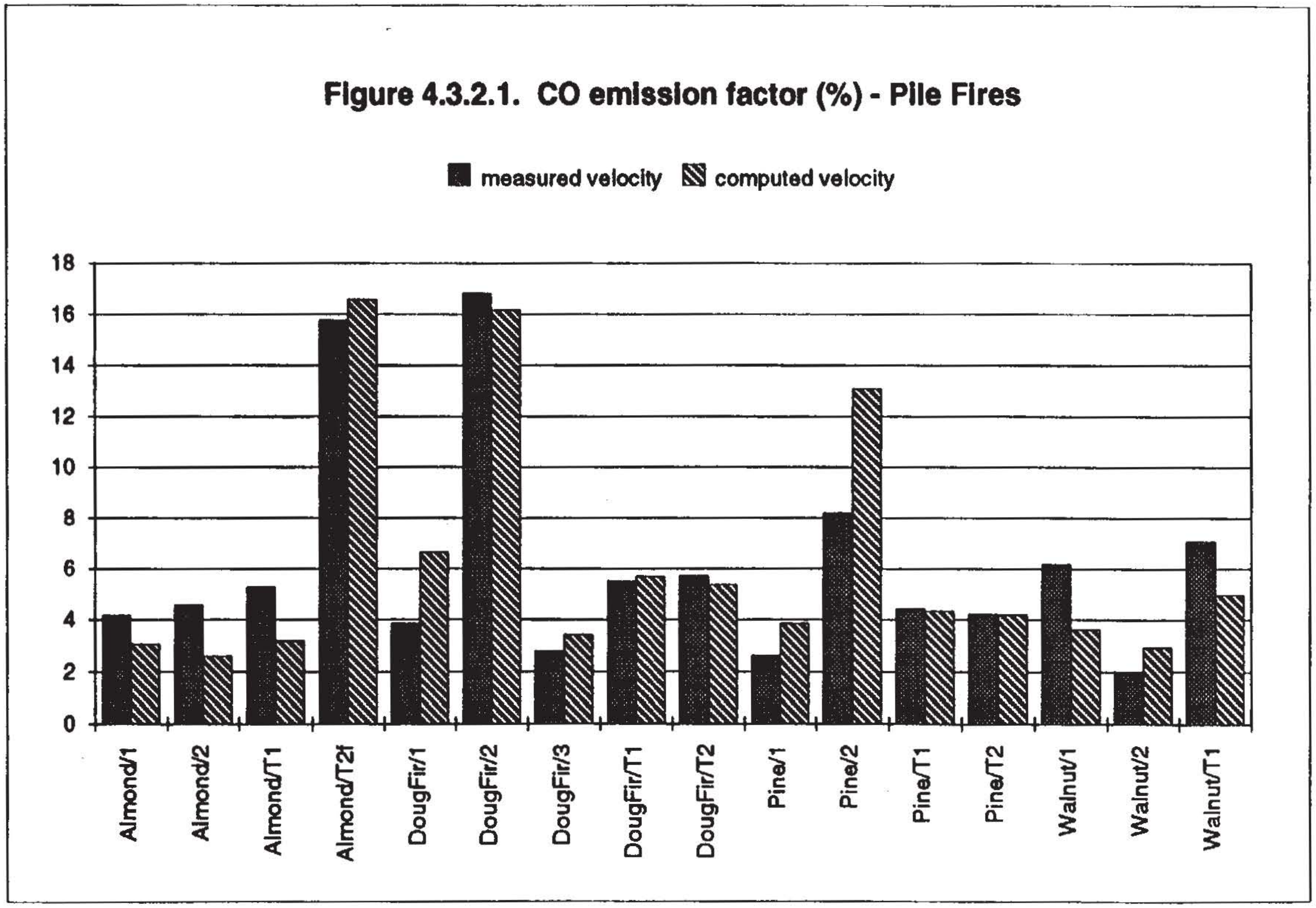


Figure 4.3.2.1. CO emission factor (%) - Pile Fires
measured velocity
computed velocity
0
2
4
6
8
10
12
14
16
18
Almond/1
Almond/2
Almond/T1
Almond/T2f
DougFir/1
DougFir/2
DougFir/3
DougFir/T1
DougFir/T2
Pine/1
Pine/2
Pine/T1
Pine/T2
Walnut/1
Walnut/2
Walnut/T1

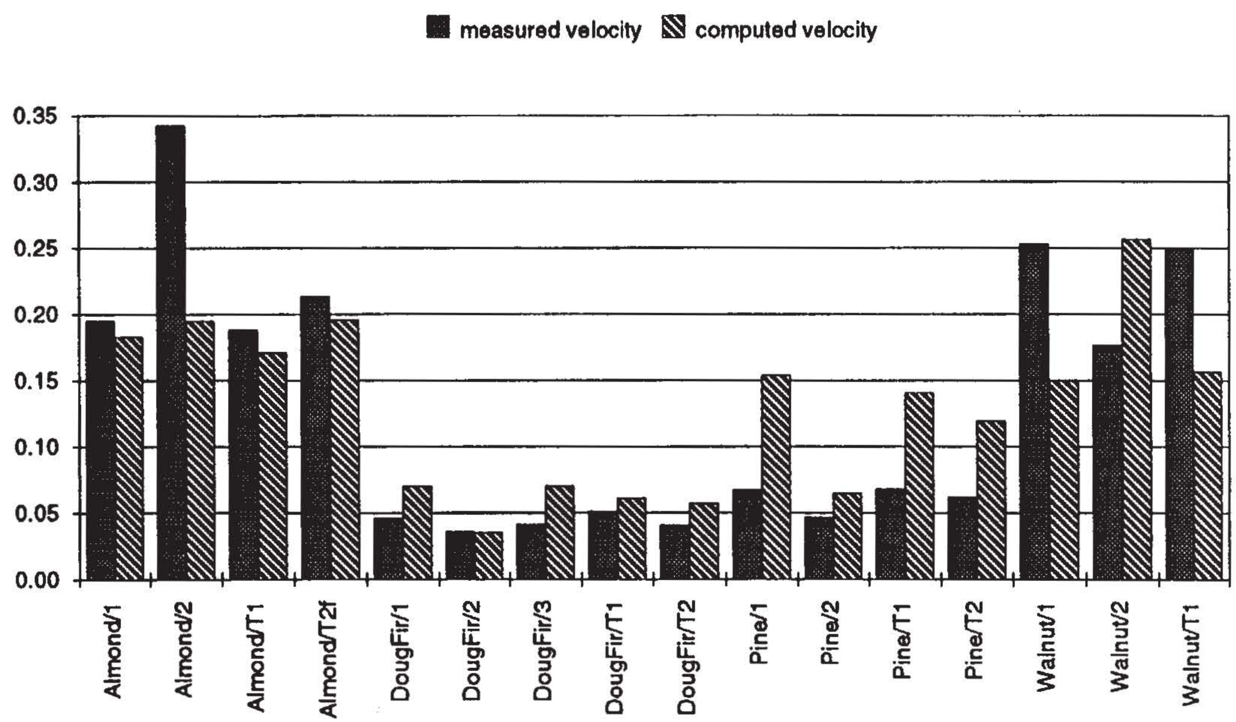


Figure 4.3.2.2. NO emission factor (%) - Pile Fires

Figure 4.3.2.3. NOx emission factor (% as NO2) - Pile Fires

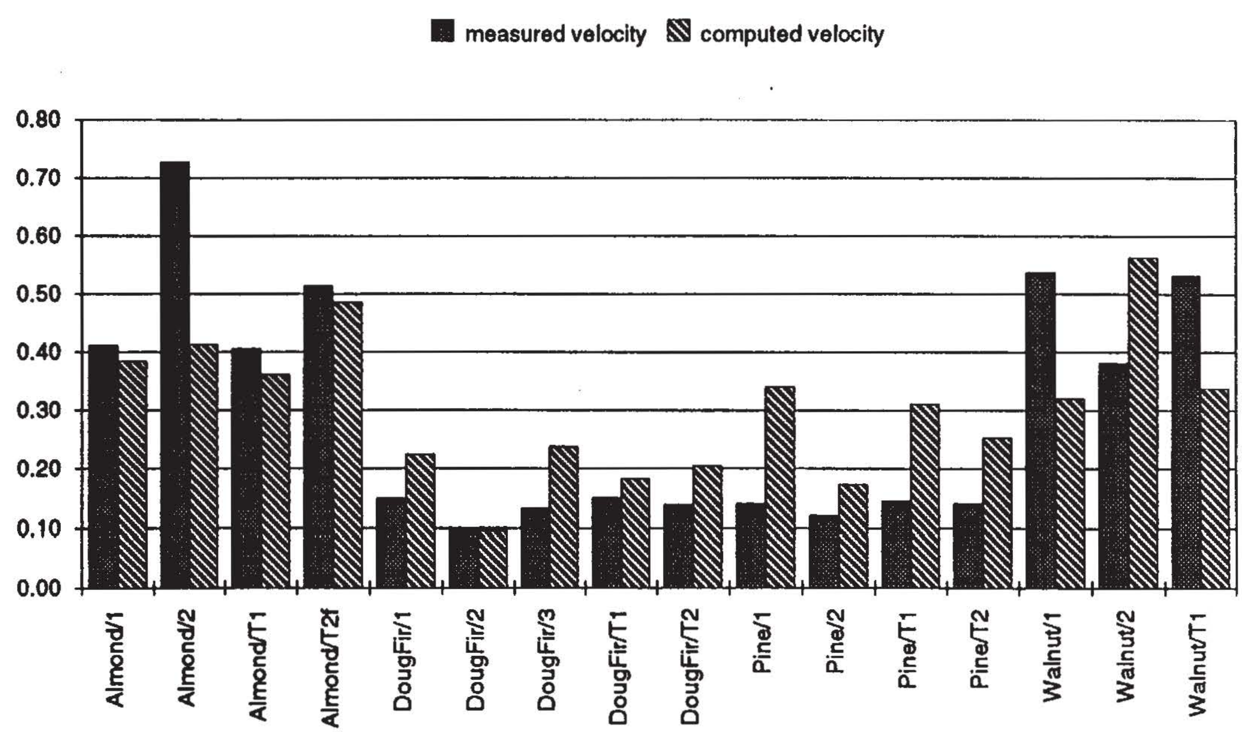


Figure 4.3.2.4. Fraction of NOx emitted as NO - Pile fires.

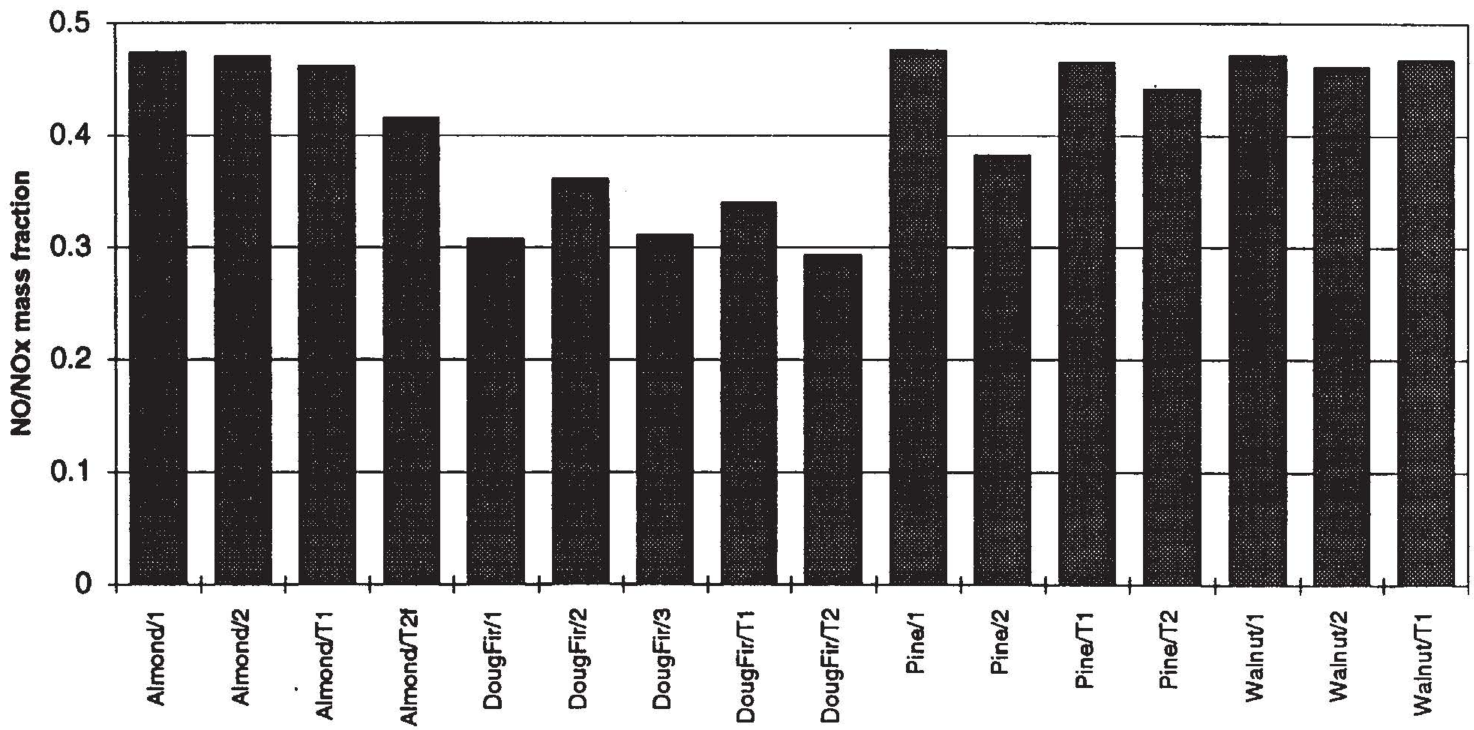


Figure 4.3.2.5. SO2 emission factor (%) - Pile Fires

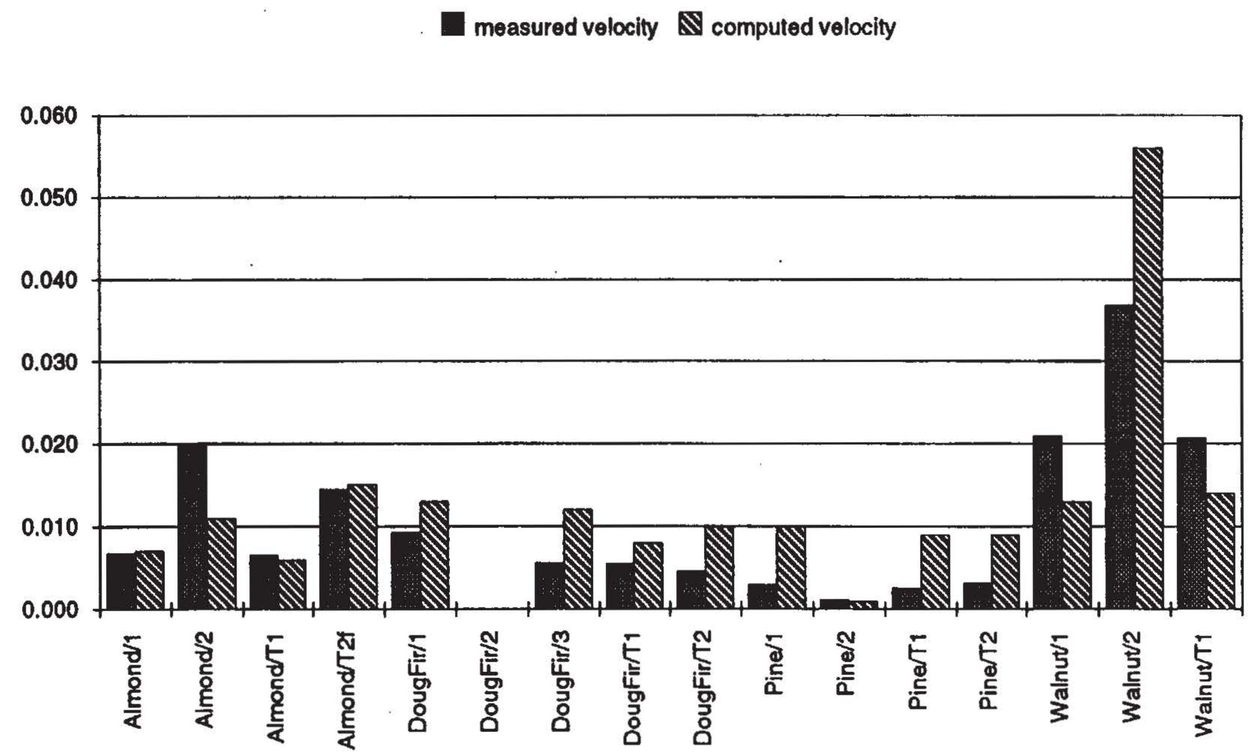


Figure 4.3.2.6. THC emission factor (% as CH4) - Pile Fires

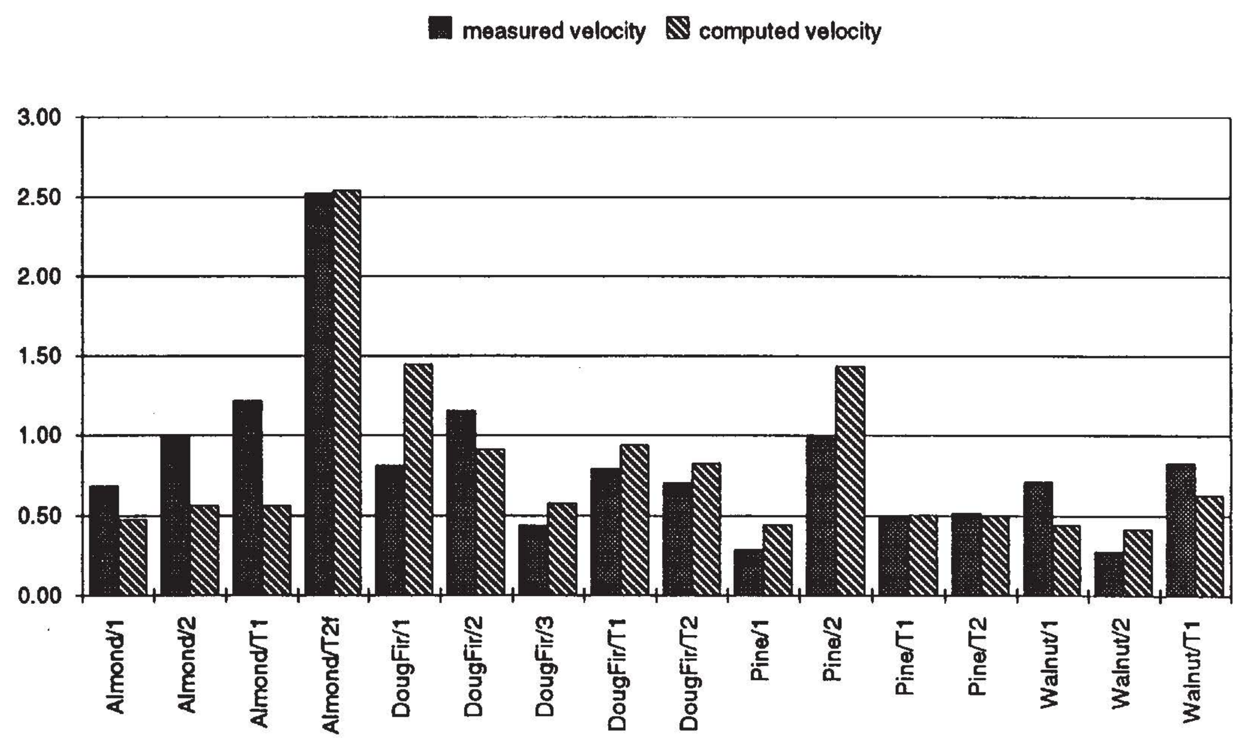


Figure 4.3.2.7. HC emission factor (% as CH4, by GC) - Pile Fires

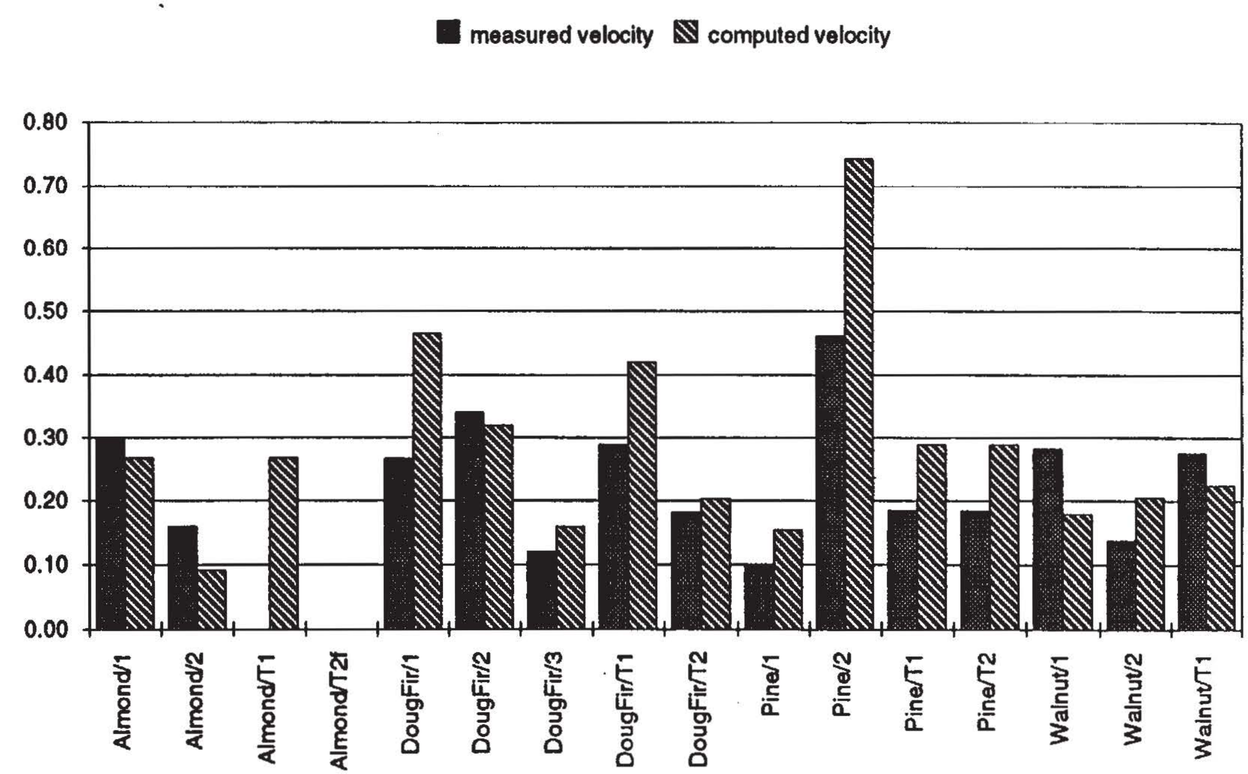


Figure 4.3.2.8. CH4 emission factor (%, by GC) - Pile Fires

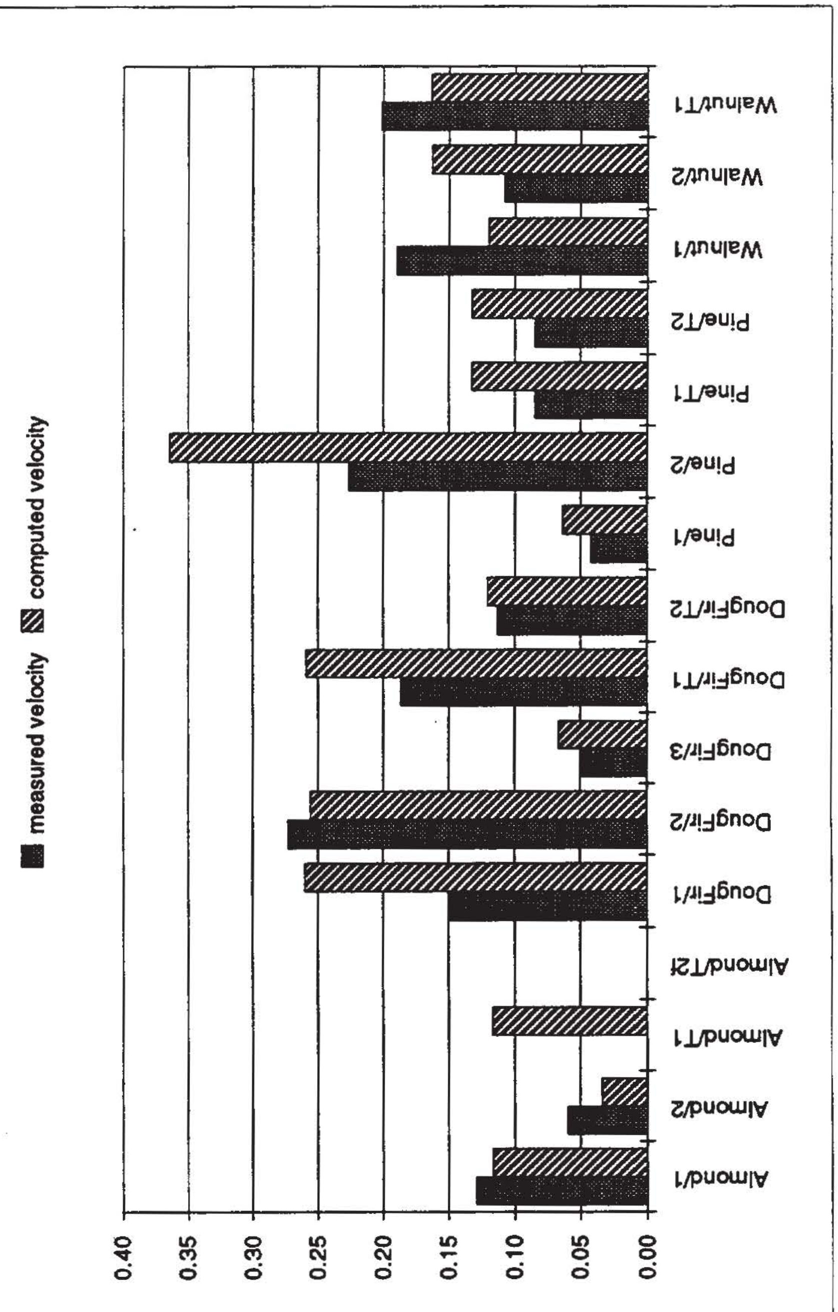


Figure 4.3.2.9. NMHC emission factor (%) - Pile Fires

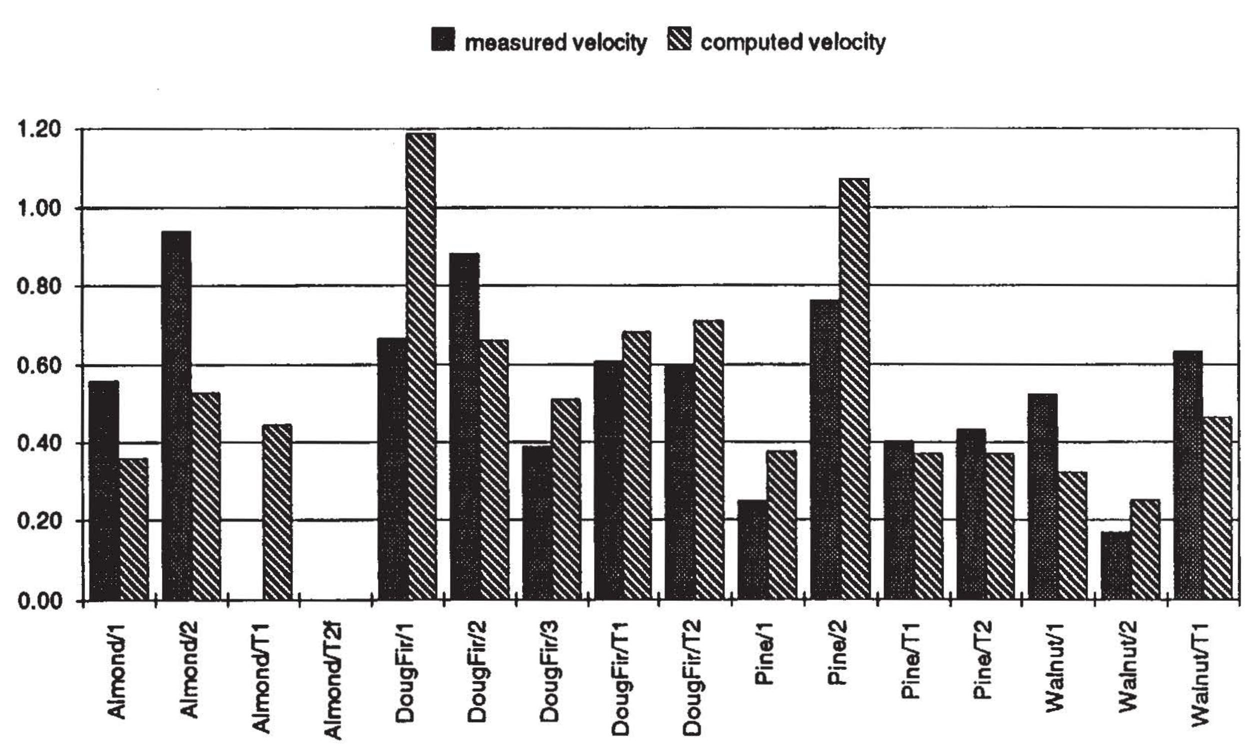
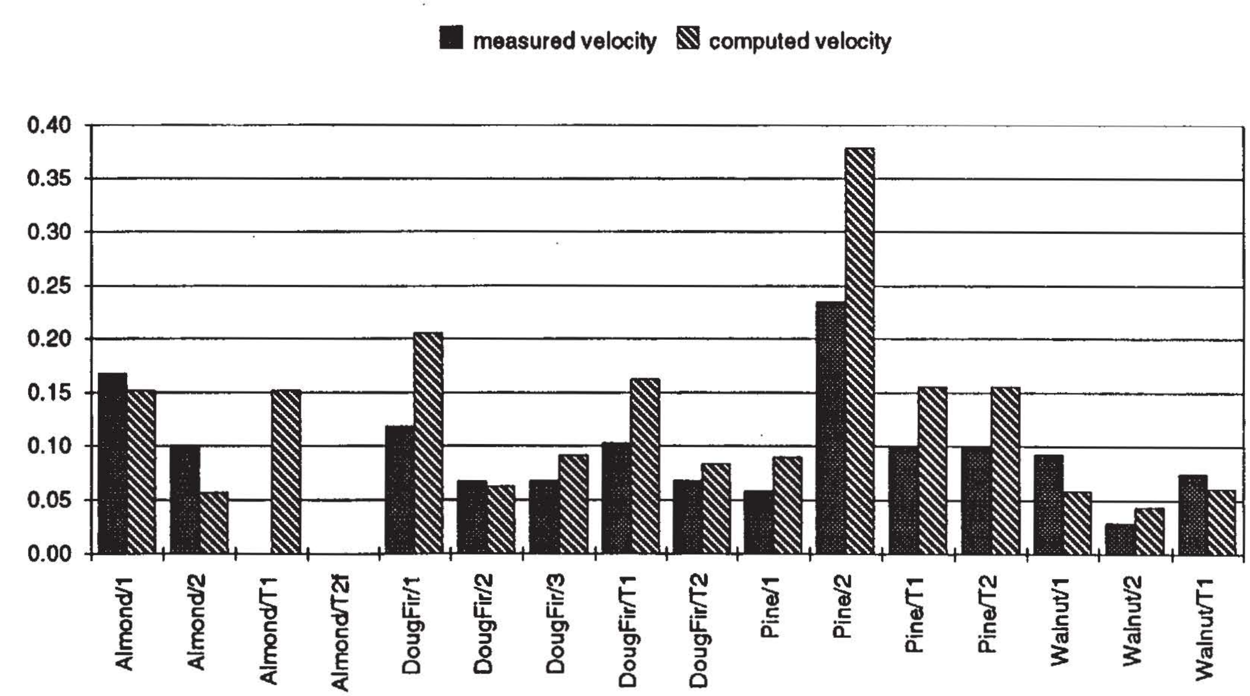


Figure 4.3.2.10. NMHC emission factor (% as CH4, by GC) - Pile Fires



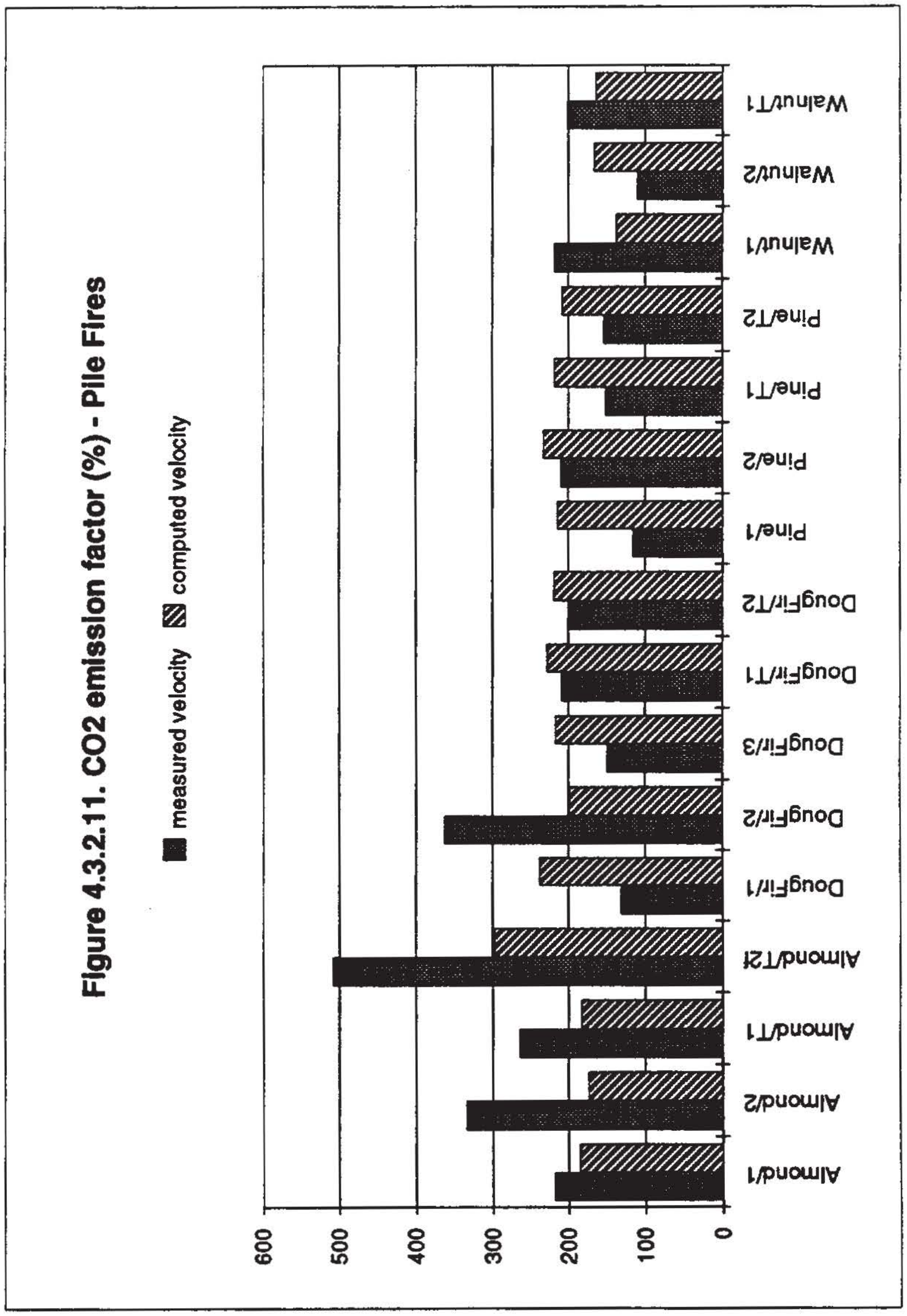


Figure 4.3.2.11. CO2 emission factor (%) - Pile Fires

Figure 4.3.2.12. Total S emission factor (% as SO2) - Pile Fires

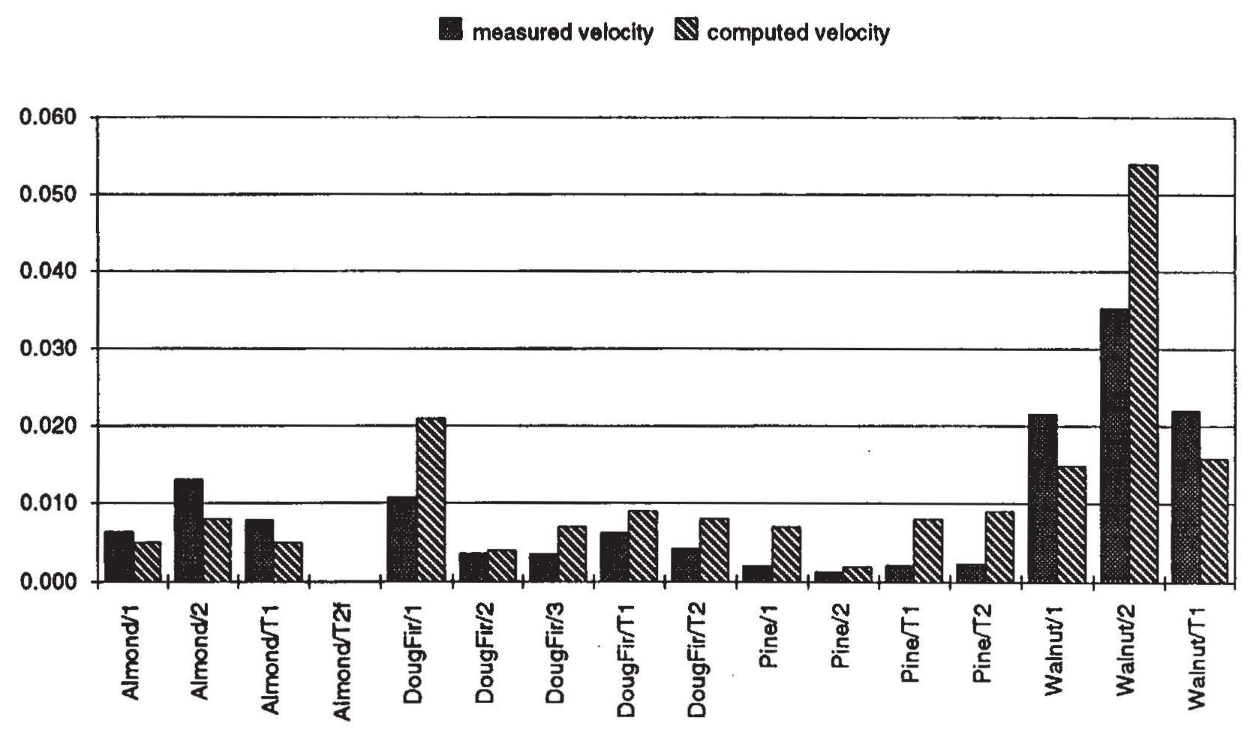
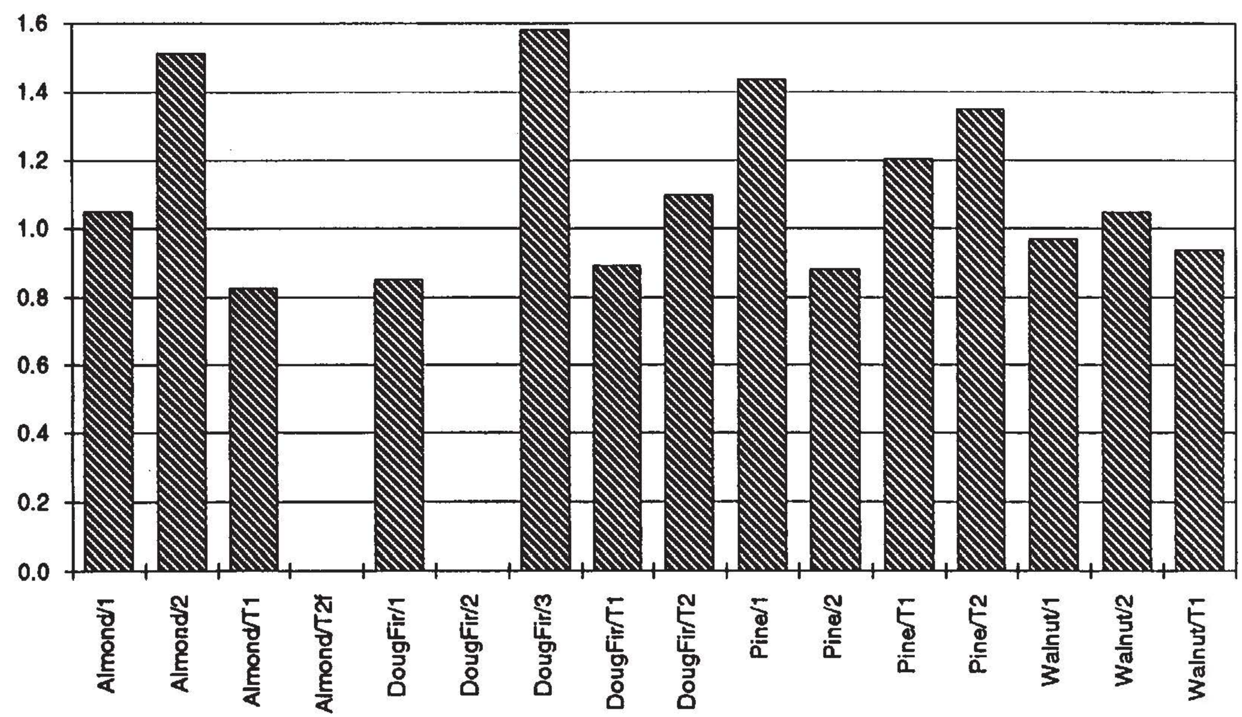


Figure 4.3.2.13. SO2/Total S - Pile Fires



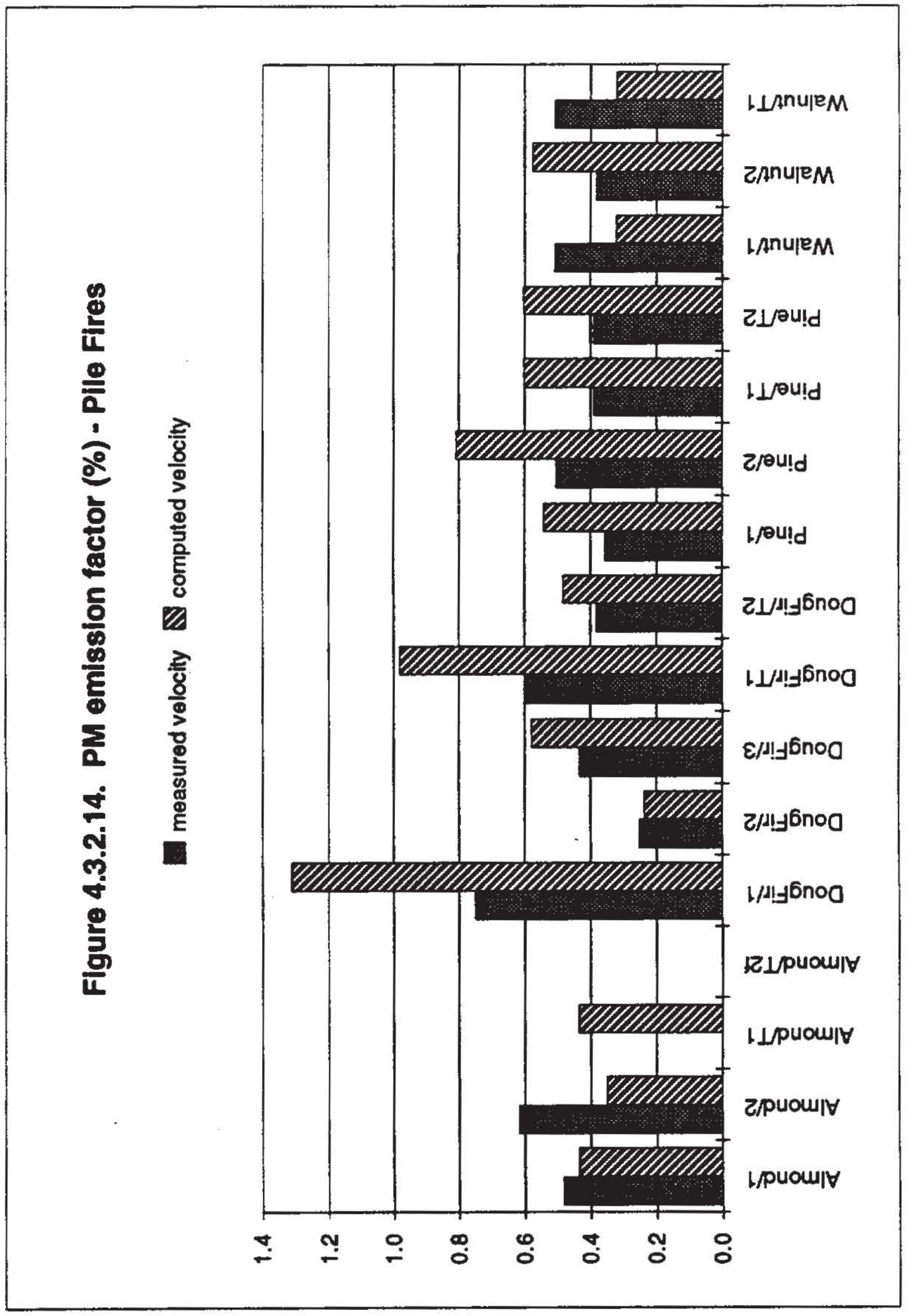


Figure 4.3.2.14. PM emission factor (%) - Pile Fires

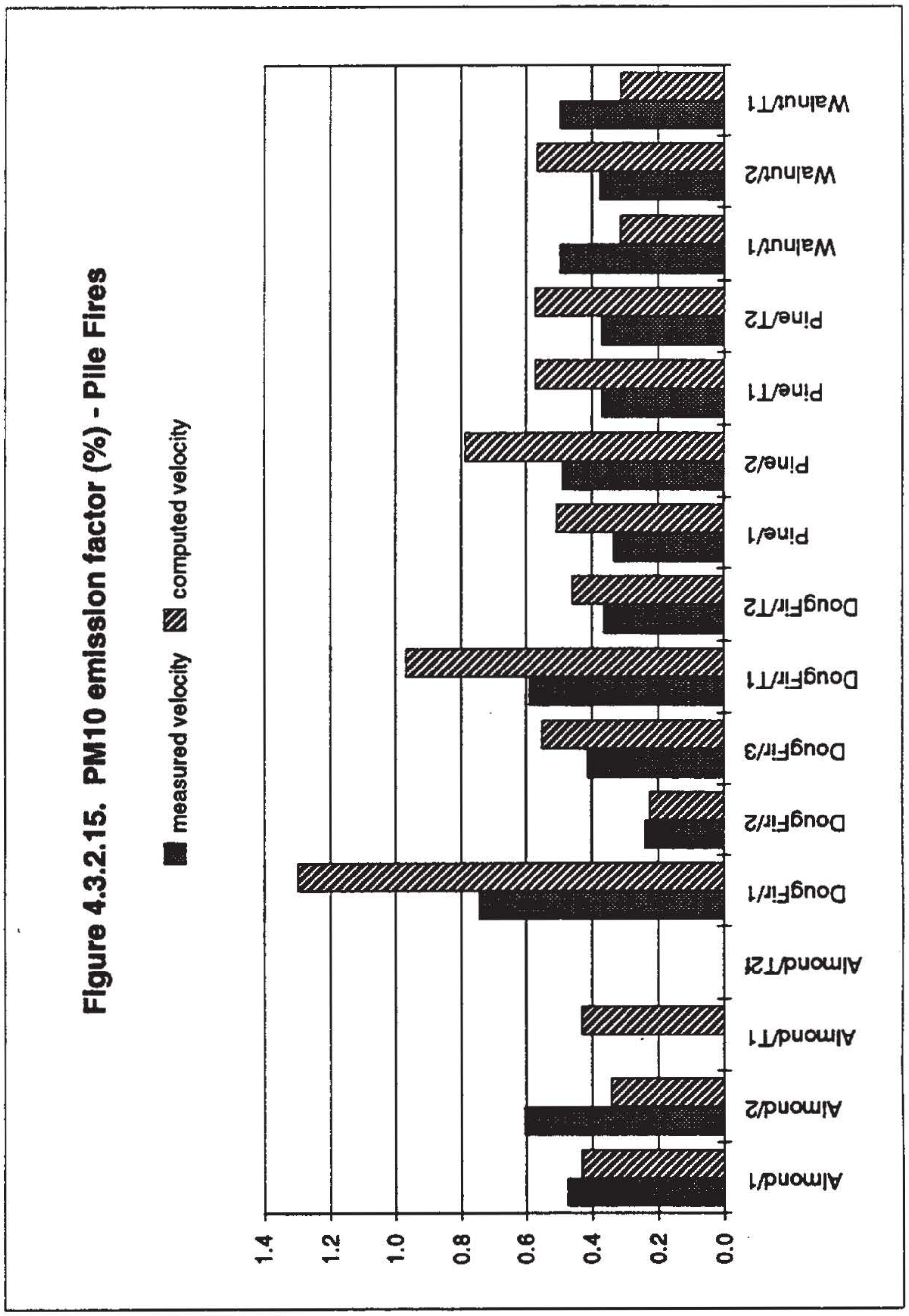


Figure 4.3.2.15. PM10 emission factor (%) - Pile Fires

Figure 4.3.2.16. PM2.5 emission factor (%) - Pile Fires

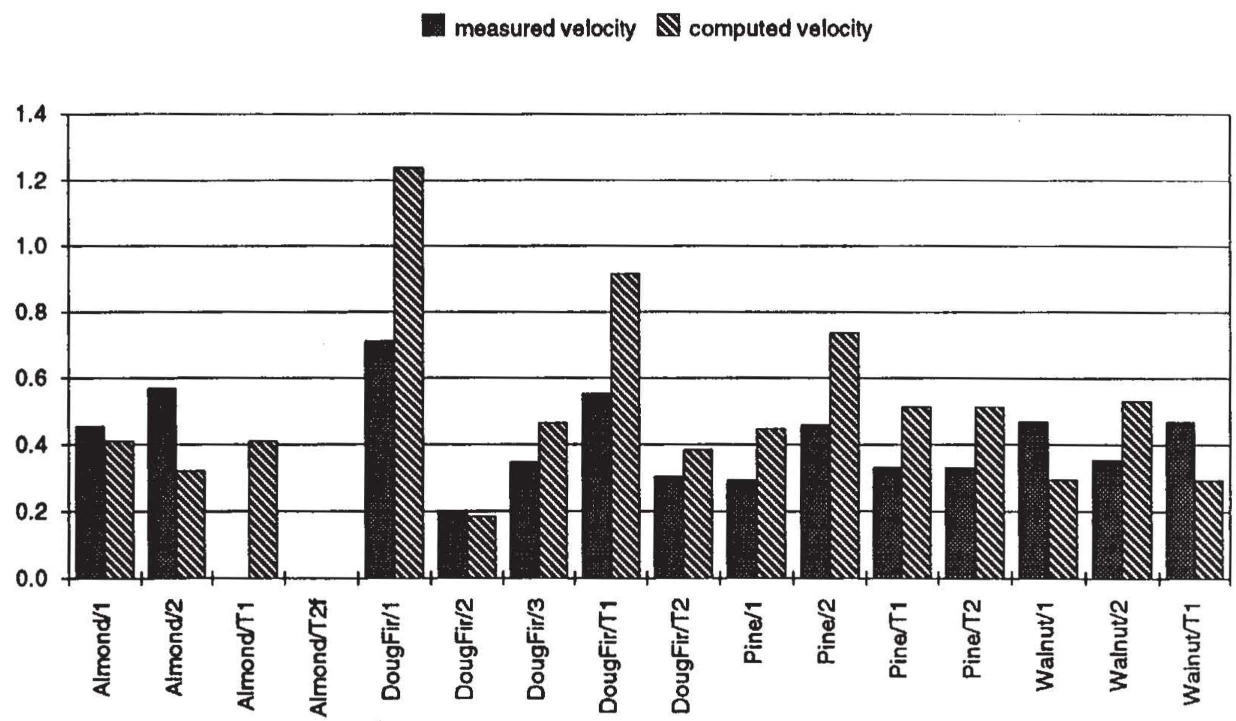


Figure 4.3.2.17. MMAD (µm) - Pile Fires

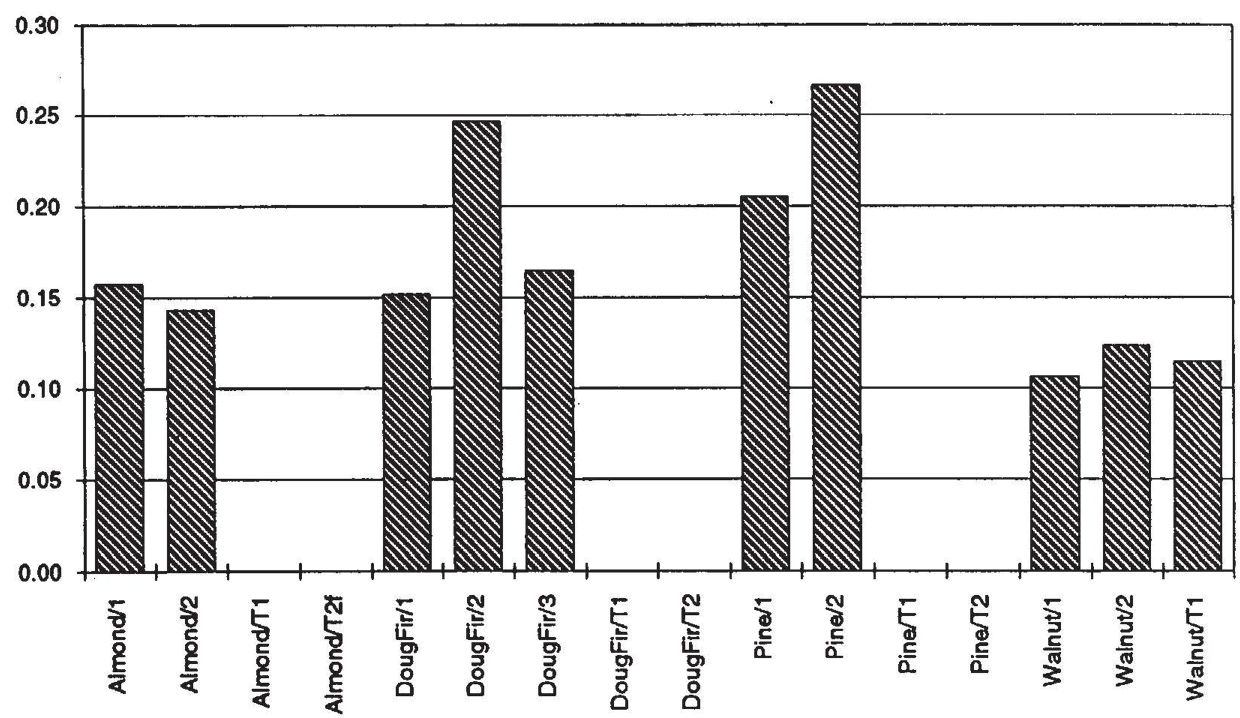


Figure 4.3.2.18. Average CO emission factor (%) - Pile Fires

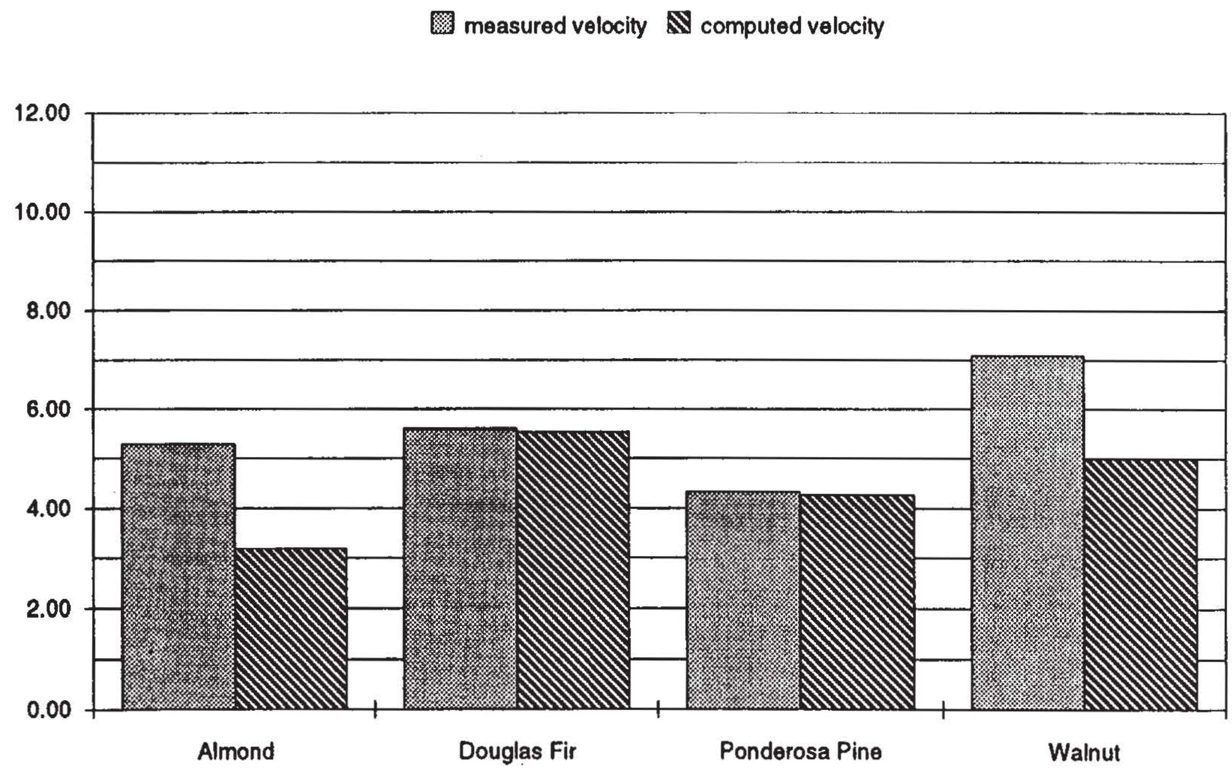


Figure 4.3.2.19. Average NO emission factor (% as NO2) - Pile Fires

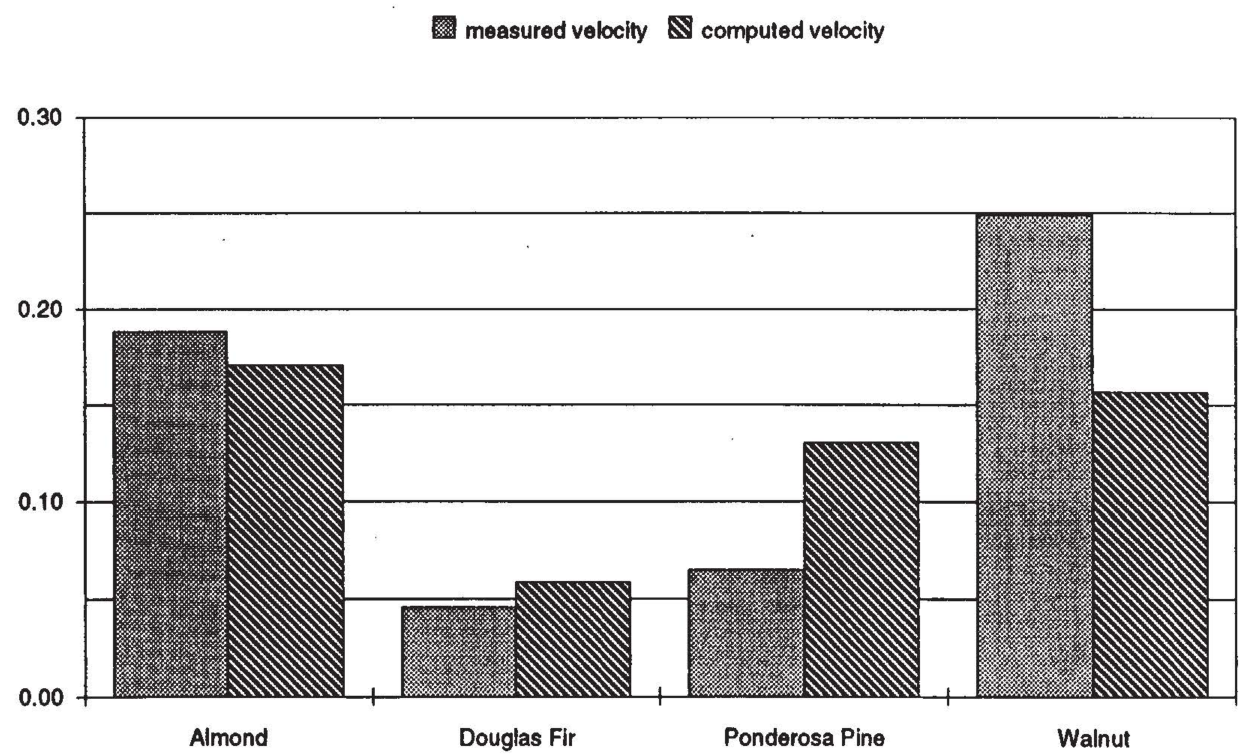


Figure 4.3.2.20. Average NOx emission factor (%) - Pile Fires

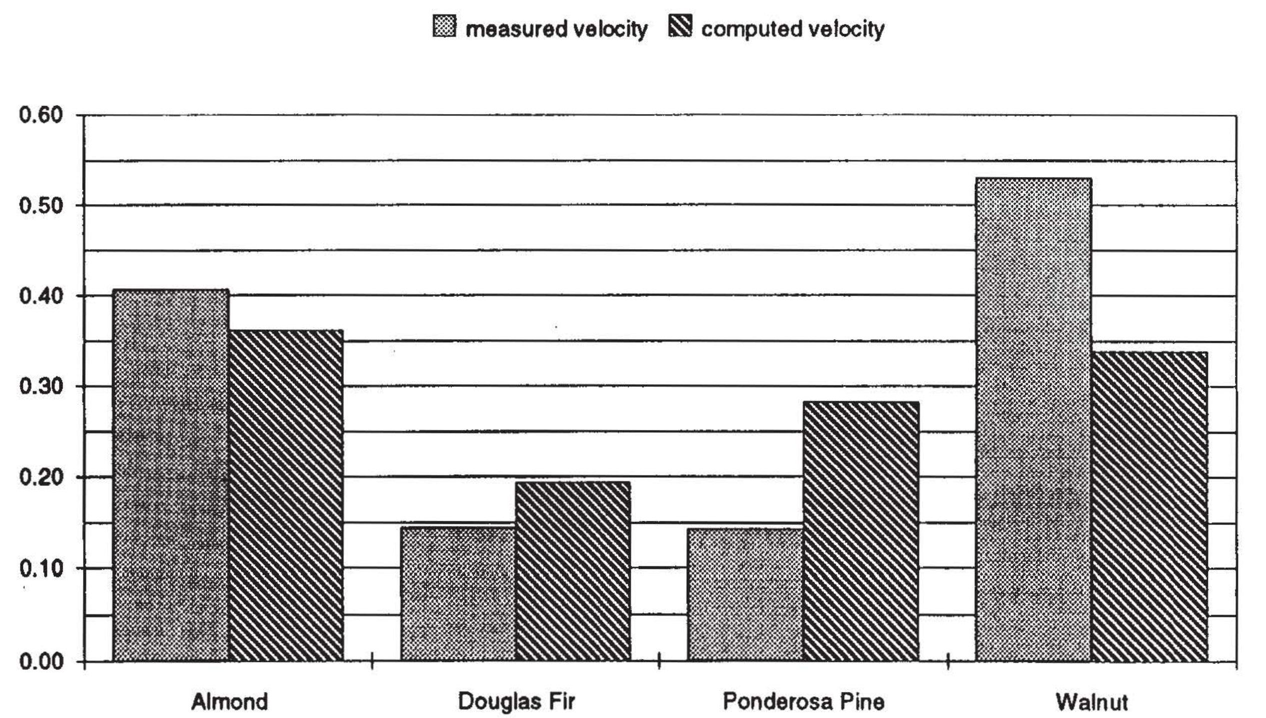


Figure 4.3.2.21. Average SO2 emission factor (%) - Pile Fires

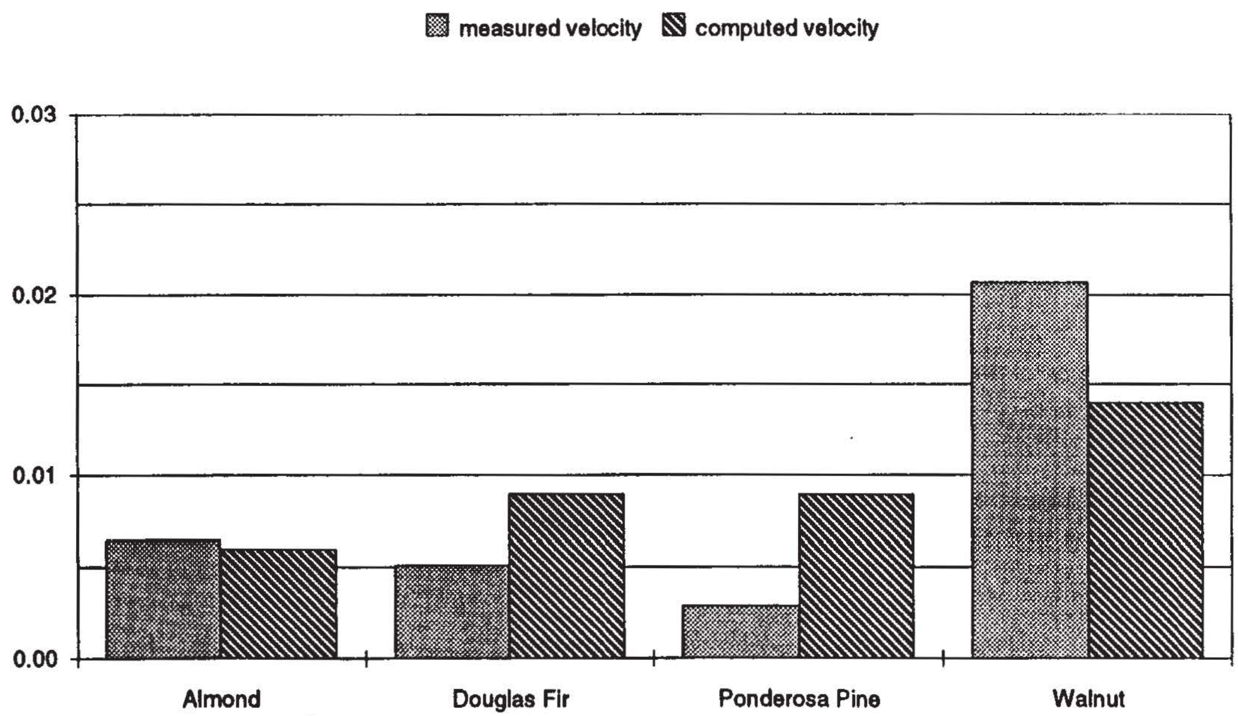


Figure 4.3.2.22. Average THC emission factor (% as CH4) - Pile Fires

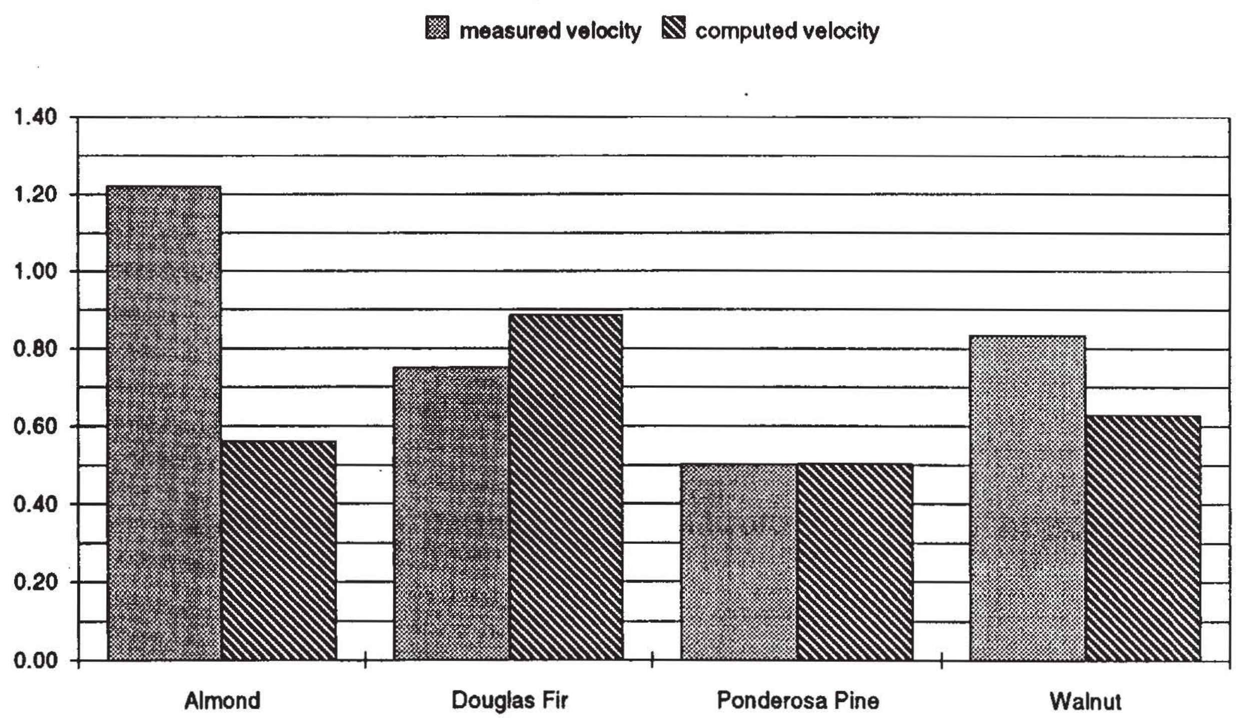


Figure 4.3.2.23. Average HC emission factor (% as CH4, by GC) - Pile Fires

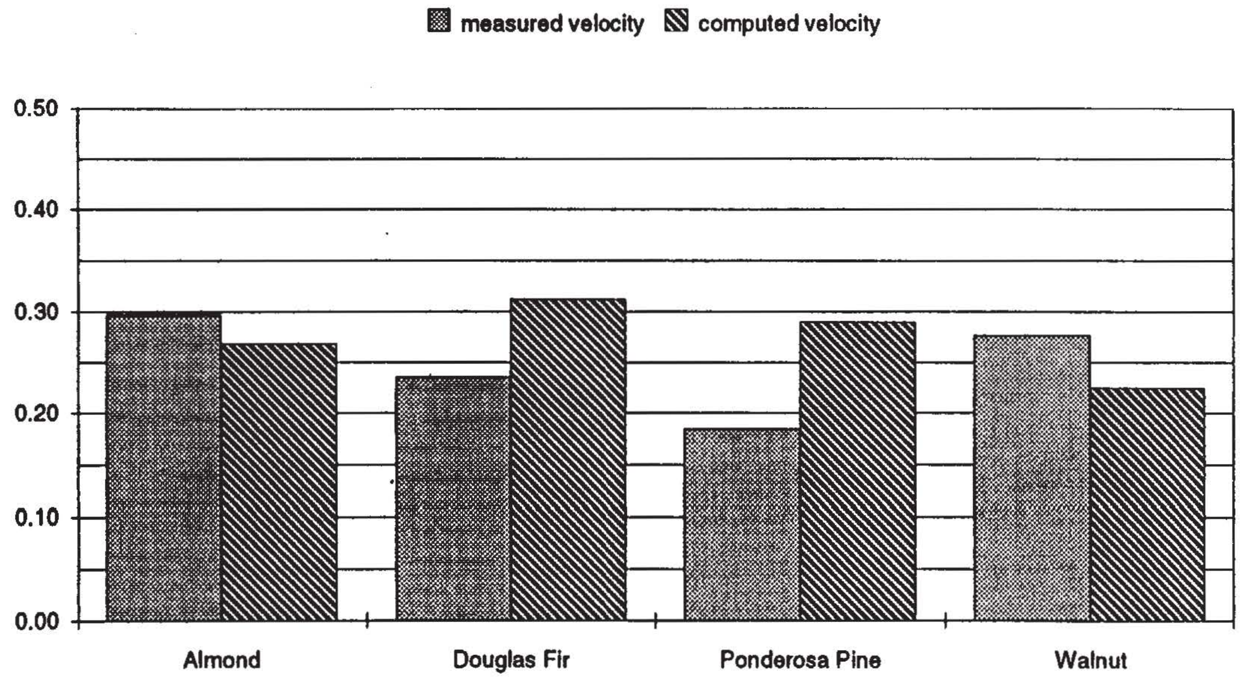


Figure 4.3.2.24. Average CH4 emission factor (%, by GC) - Pile Fires

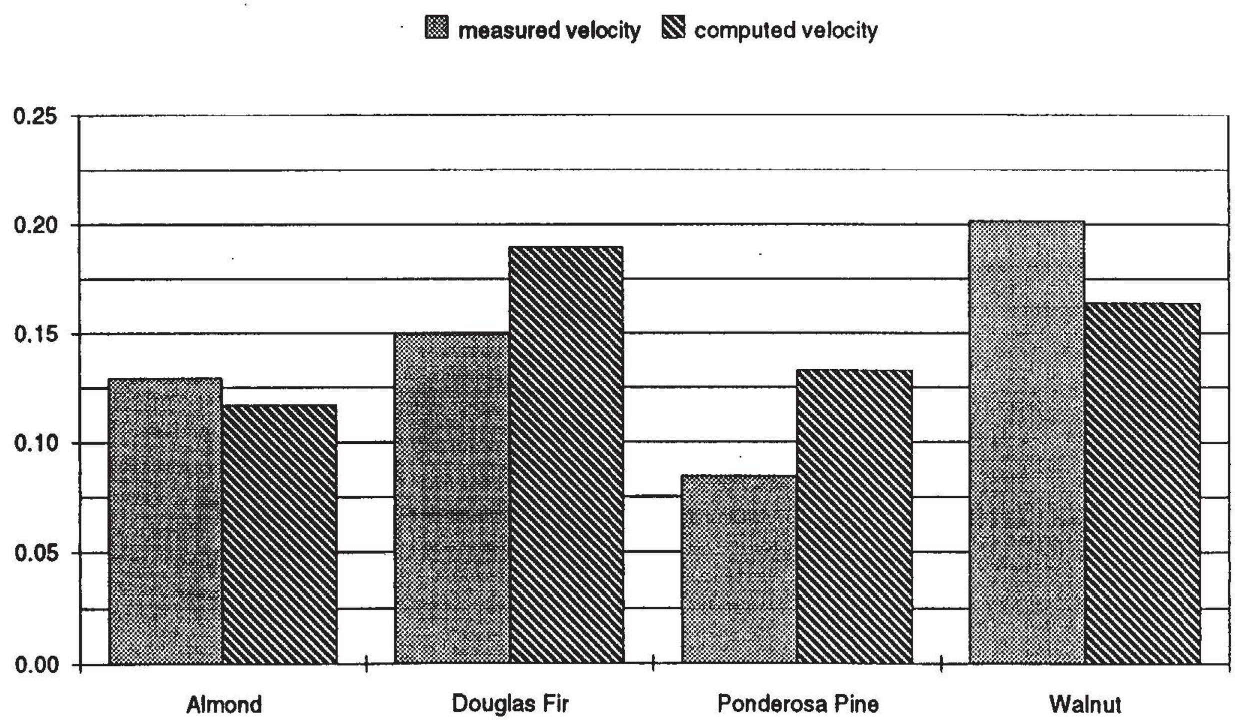


Figure 4.3.2.25. Average NMHC emission factor (% as CH4) - Pile Fires

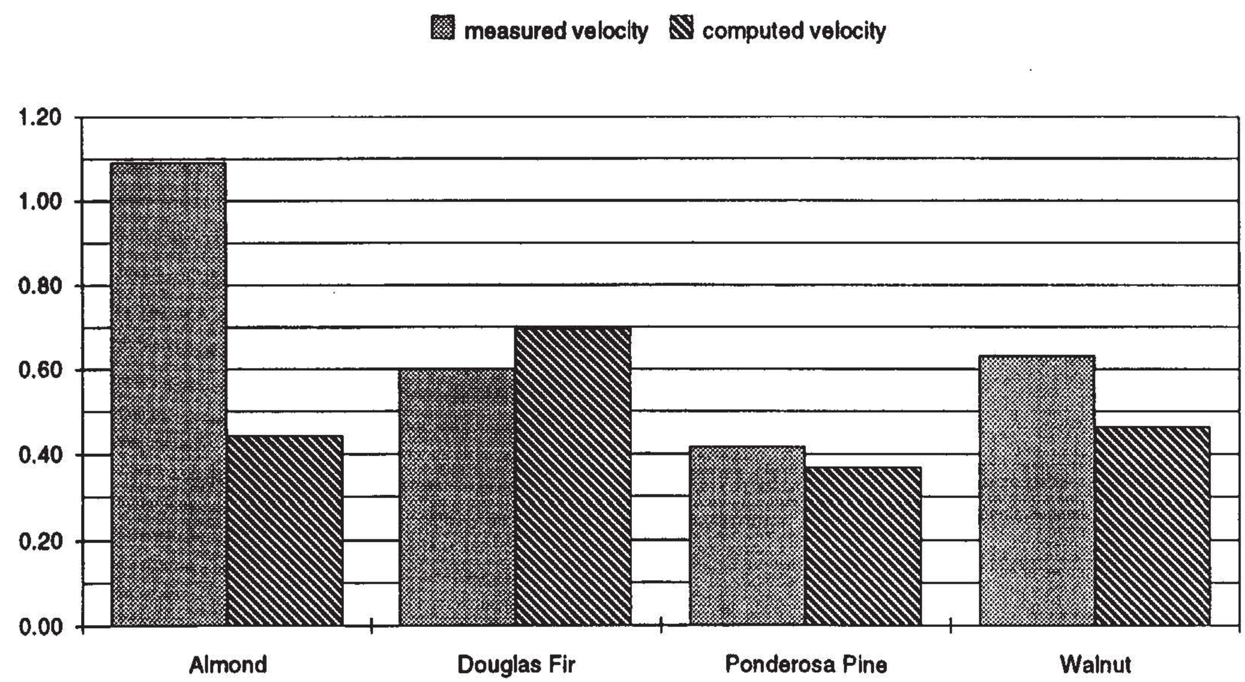


Figure 4.3.2.26. Average NMHC emission factor (% as CH4, by GC) - Pile Fires

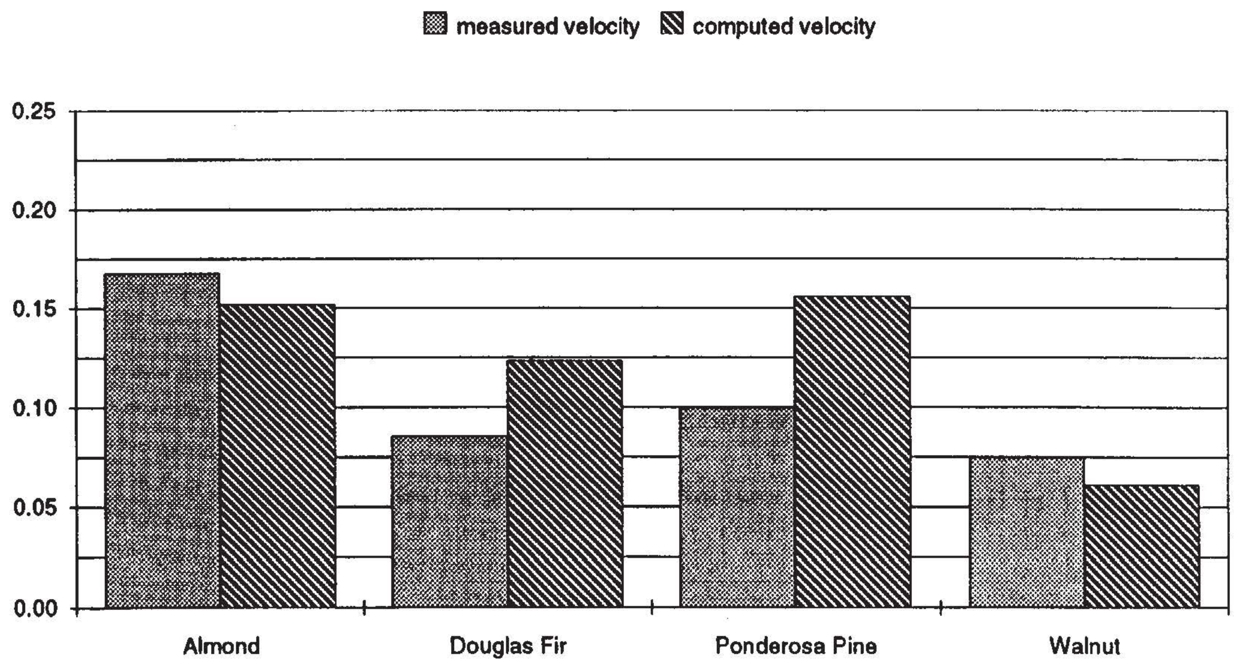


Figure 4.3.2.27. Average CO2 emission factor (%) - Pile Fires

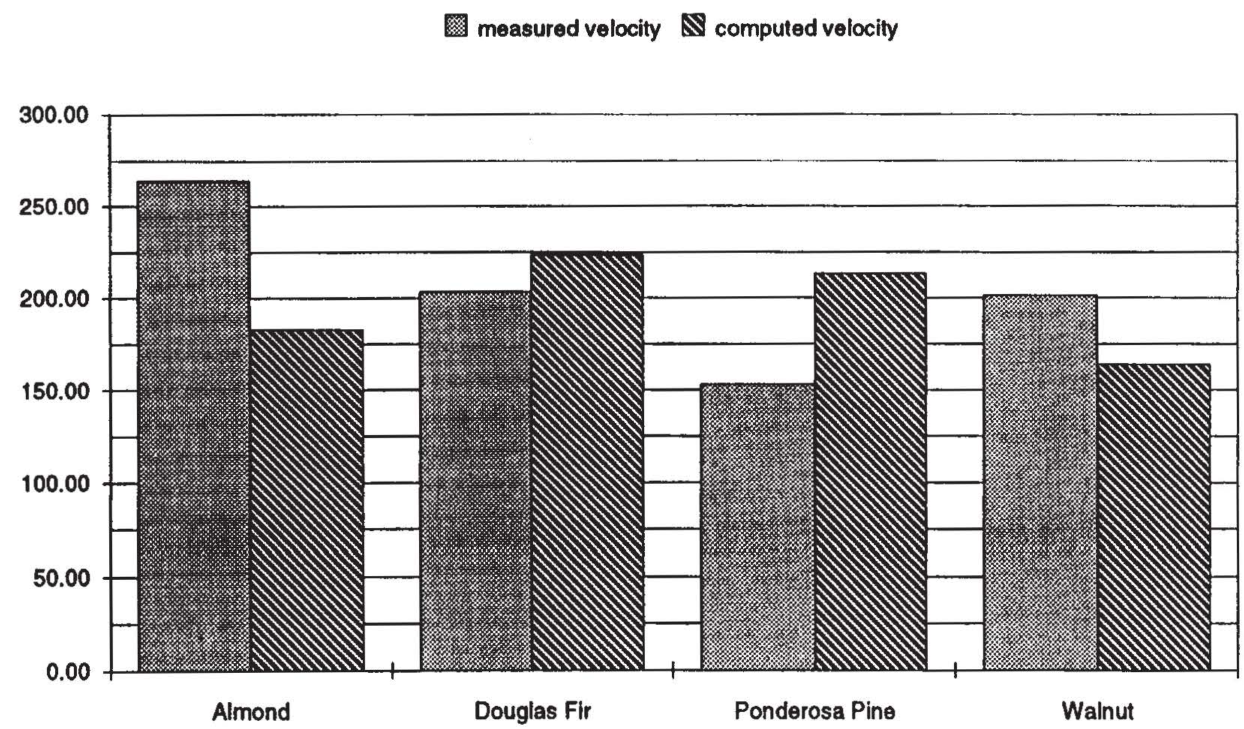
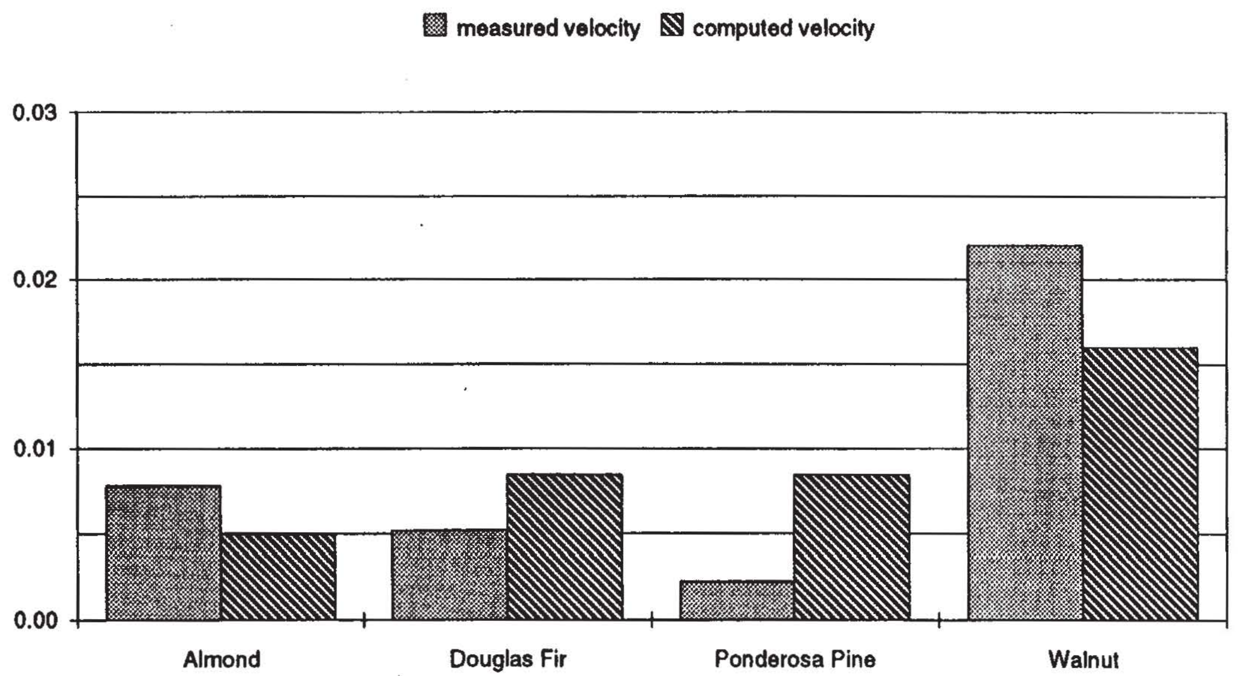


Figure 4.3.2.28. Average Total S emission factor (% as SO2) - Pile Fires



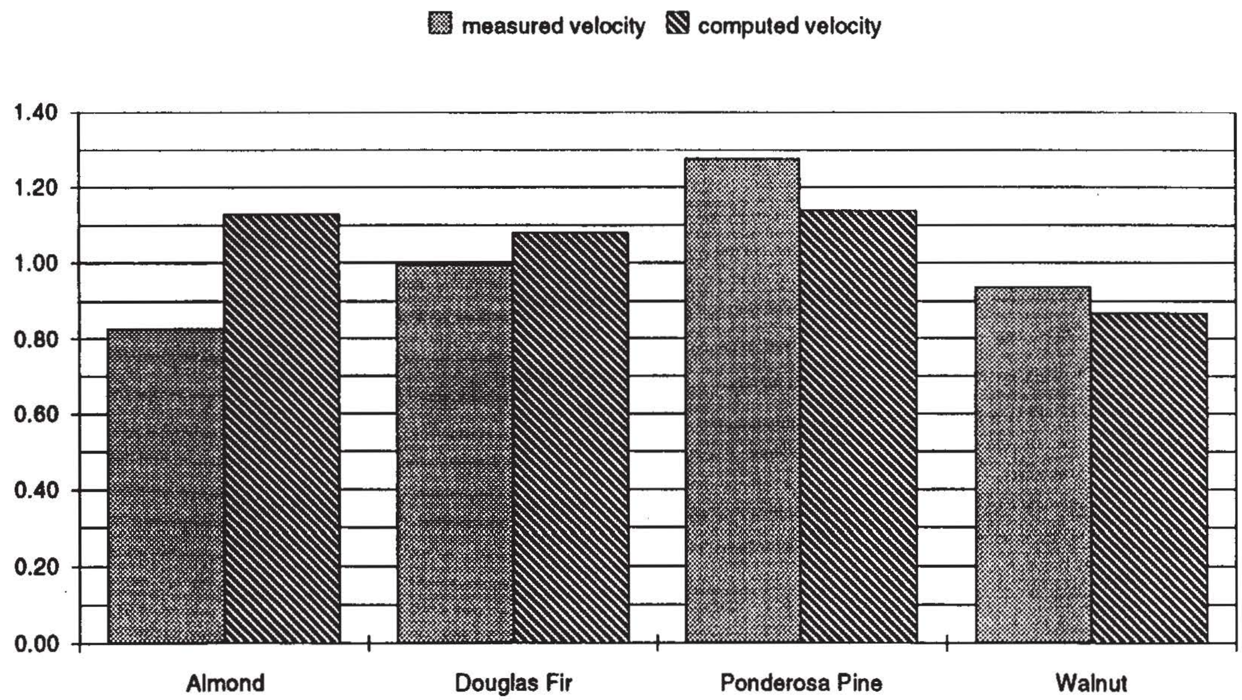


Figure 4.3.2.29. SO2/Total S - Pile Fires

Figure 4.3.2.30. Average PM emission factor (%) - Pile Fires

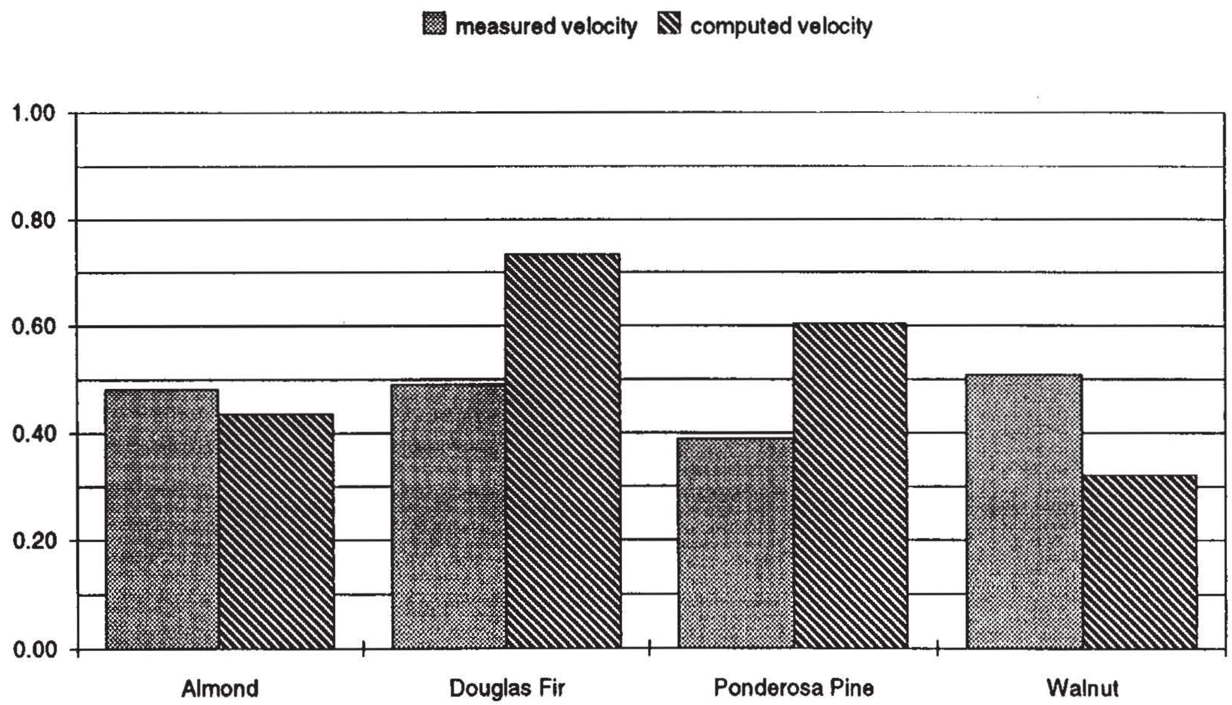


Figure 4.3.2.31. Average PM emission factors (%) - Pile Fires (measured velocity)

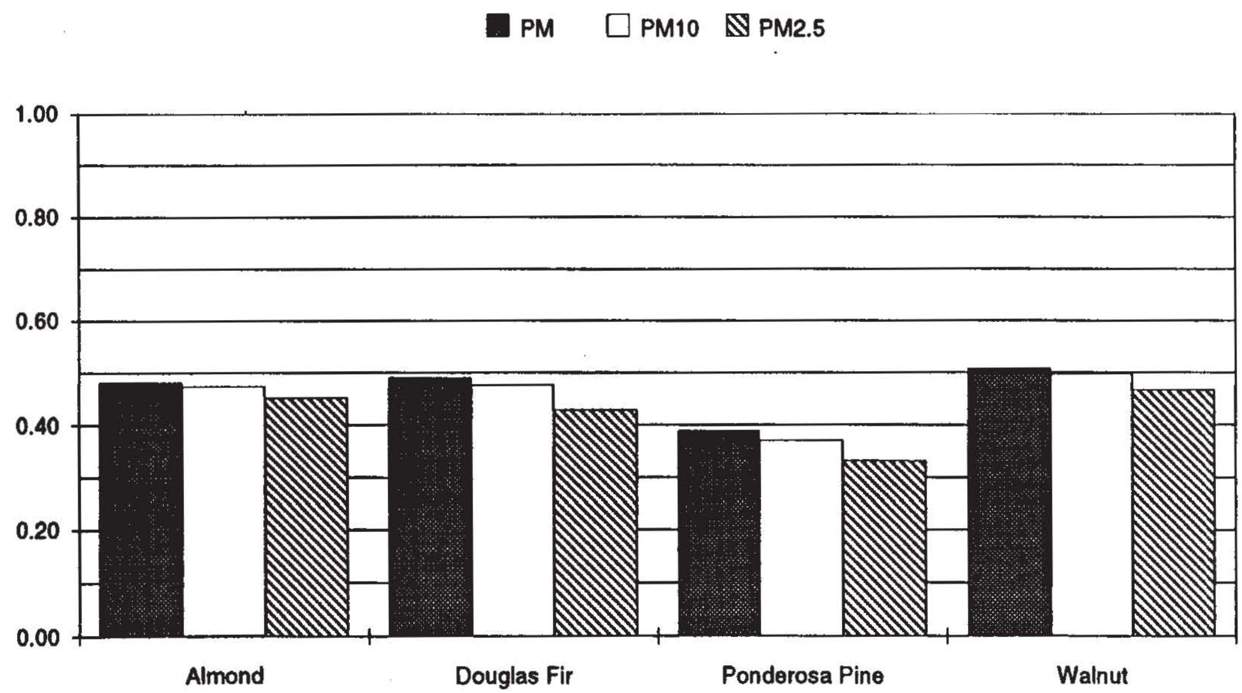


Figure 4.3.2.32. Average PM emission factors (%) - Pile Fires (computed velocity)

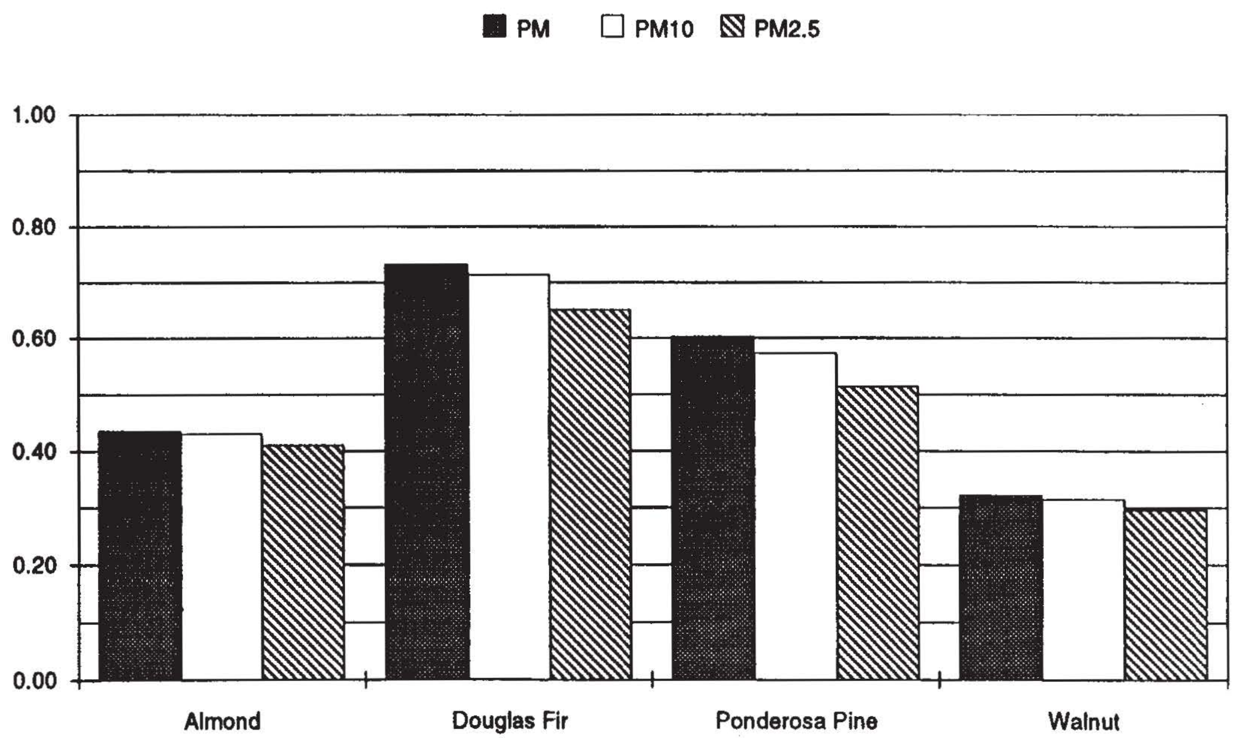


Figure 4.3.2.33. Average MMAD (μm) - Pile Fires

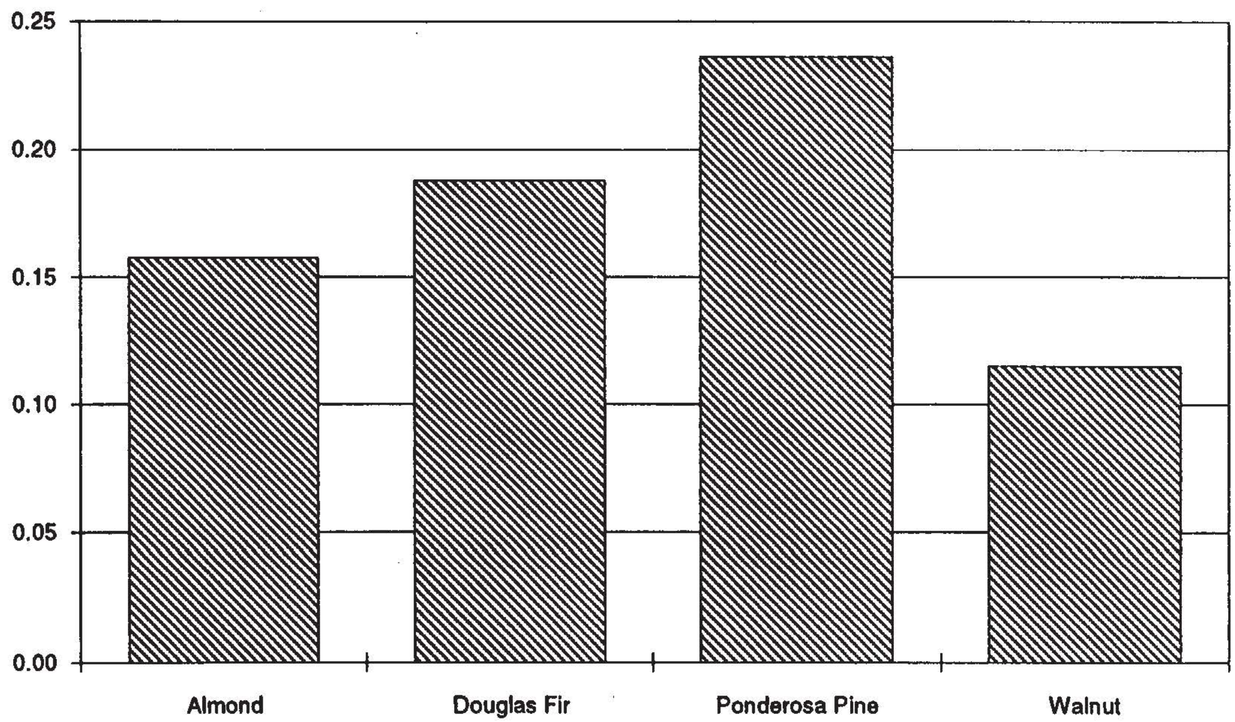


Table 4.4.1. Absorption coefficient B_{ap} by LIPM on CNL filter samples.

Date	Fuel		Time	Traverse	Filter ID	B_{ap} ($m^2\ g^{-1}$)
30-Apr-92	Rice	CRNF	13:27	1	17	2.44
30-Apr-92	Rice	CRNF	13:03	1	18	2.07
30-Apr-92	Rice	CRNF	14:03		20	1.82
30-Apr-92	Rice	CRNF	14:47		21	1.85
10-Jul-92	Rice	CEWF	10:15	1	28	1.79
10-Jul-92	Rice	CEWF	10:35	1	27	2.60
10-Jul-92	Rice	CEWF	10:54	1	25	2.57
10-Jul-92	Rice	CEWF	11:17		23	1.28
11-Aug-92	Wheat	CRNF	8:03	1	30	3.63
11-Aug-92	Wheat	CRNF	9:20	2	31	4.17
13-Aug-92	Wheat	CEWF	8:20	1	32	2.45
13-Aug-92	Wheat	CEWF	9:17	2	33	2.78
15-Sep-92	Barley	CEWF	NR	1	34	1.74
17-Sep-92	Barley	CRNF	9:19	1	37	3.11
17-Sep-92	Barley	CRNF	9:27	1	39	3.54
7-Oct-92	Corn	CRNF	NR	1	43	2.24
9-Oct-92	Corn	CEWF	8:37	1	44	2.26
9-Oct-92	Corn	CEWF	9:36	2	45	2.02
21-Oct-92	Rice	CEWF	14:39	1	46	0.90
21-Oct-92	Rice	CEWF	15:58	2	47	0.93
23-Oct-92	Rice	CRNF	15:20	1	48	0.78
12-Nov-92	Walnut	Pile	9:28	1	61	5.41
12-Nov-92	Walnut	Pile	11:12	2	62	4.49
12-Nov-92	Walnut	Pile	11:30	2	63	3.92
12-Nov-92	Walnut	Pile	12:50	2	64	3.74
6-Apr-93	Almond	Pile	10:16	1	68	2.99
6-Apr-93	Almond	Pile	11:54	2	69	4.14
6-Apr-93	Almond	Pile	12:12	2	70	4.99
29-Apr-93	Ponderosa Pine	Pile	10:56	1	BJ02	2.84
30-Apr-93	Douglas Fir	Pile	10:37	1	BJ03	1.99
30-Apr-93	Douglas Fir	Pile	12:02	2	BJ04	2.67
Global mean						2.71

NR = not recorded. Blank in traverse column indicates filter sample was collected at other time.

Figure 4.4.1. Comparison of PM analysis by PIXE and by XRF for four elements.

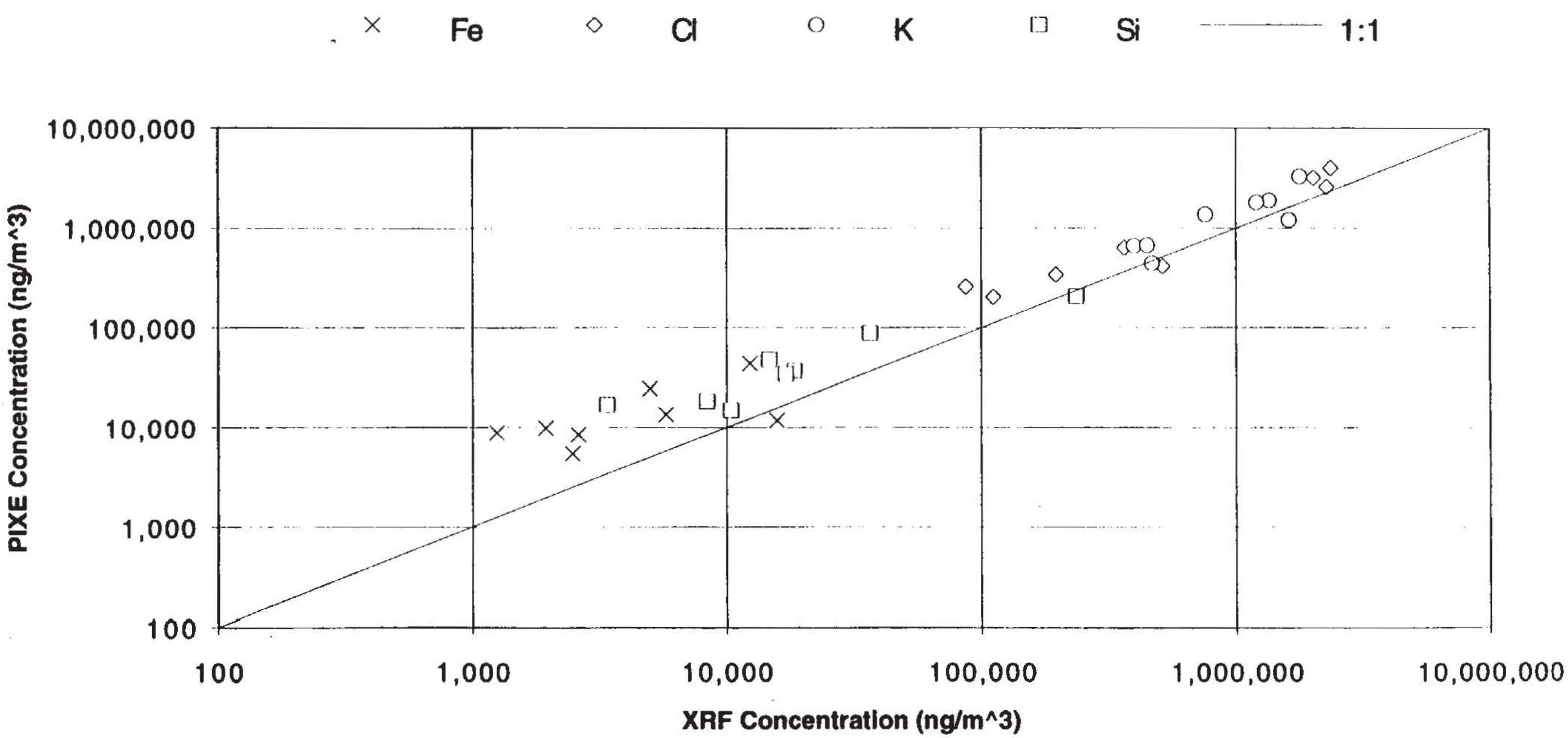


Figure 4.4.2. Barley straw: Average emission factors (mg/kg) for major species, DRI analysis

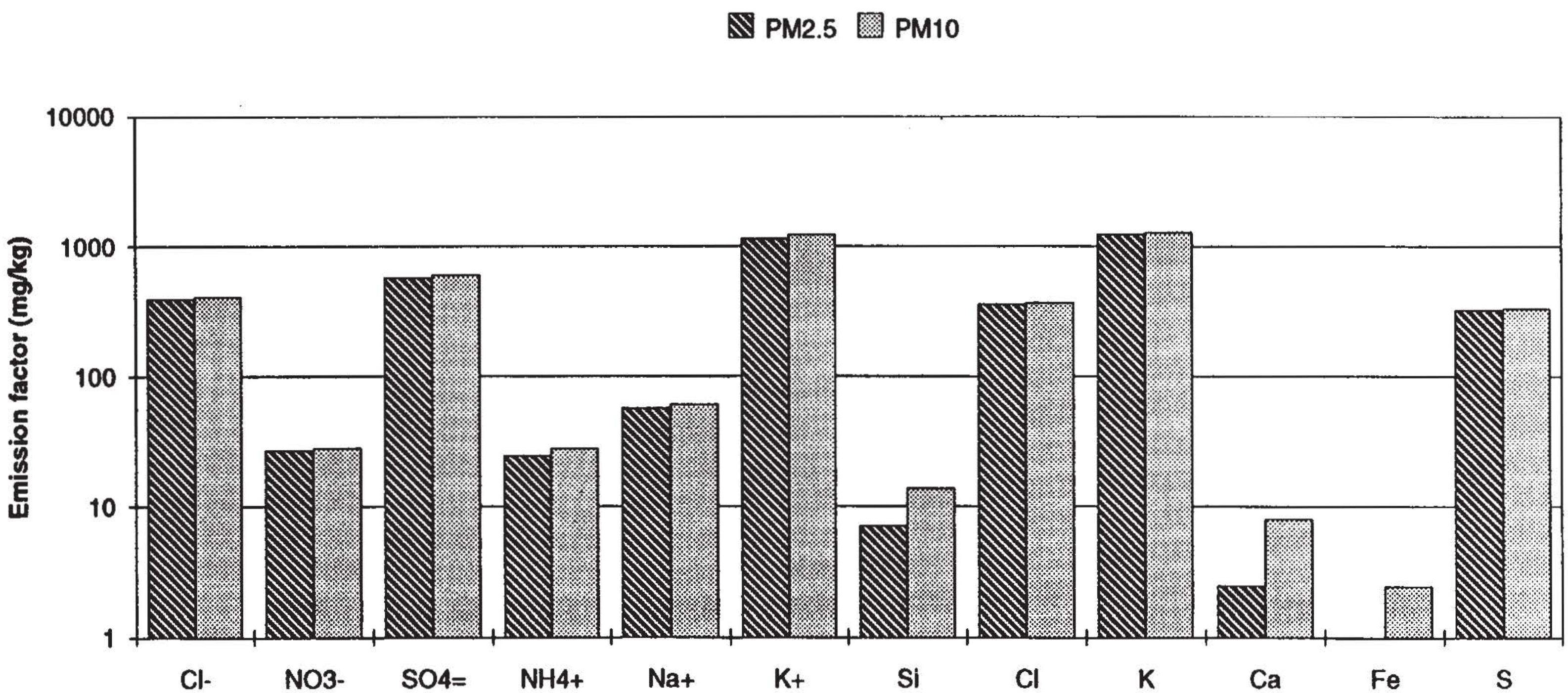


Figure 4.4.3. Corn stover: Average emission factors (mg/kg) for major species, DRI analysis

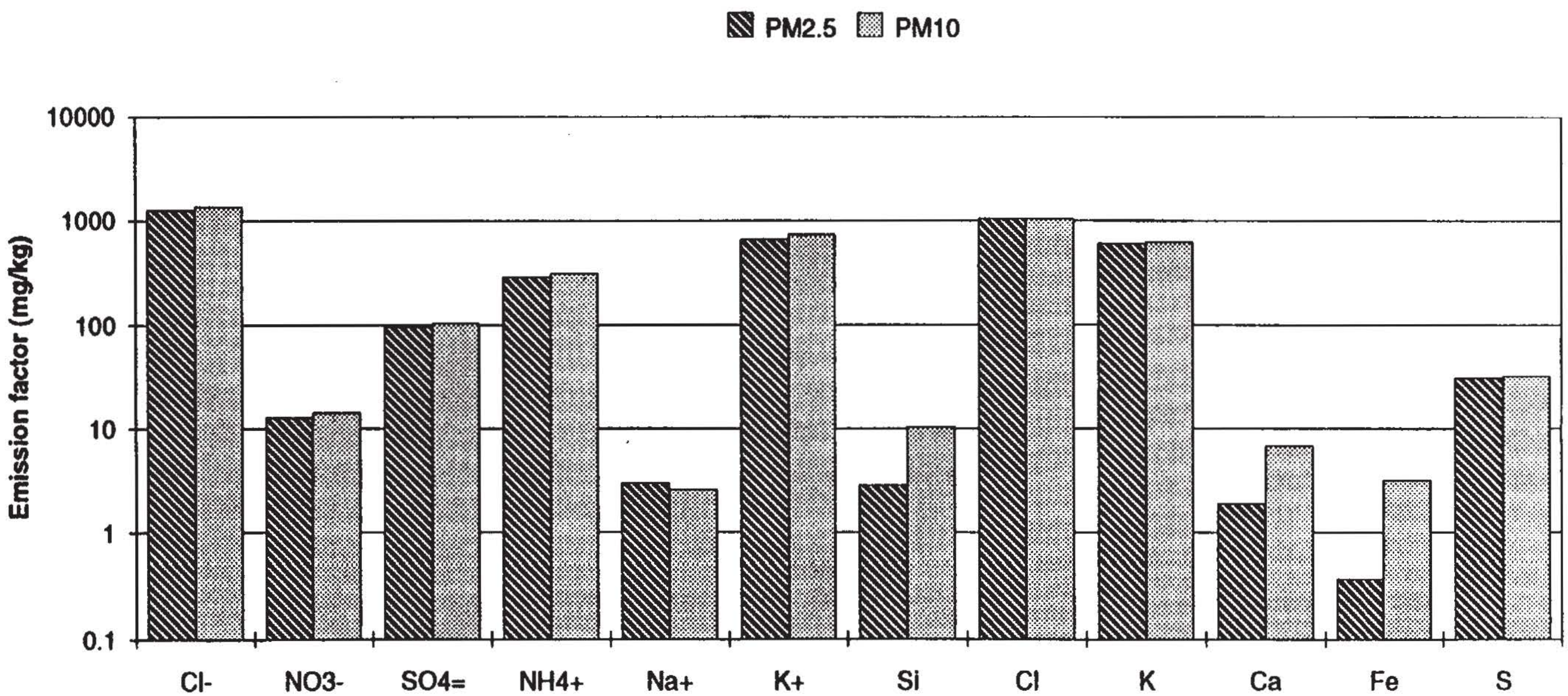


Figure 4.4.4. Rice straw: Average emission factors (mg/kg) for major species, DRI analysis

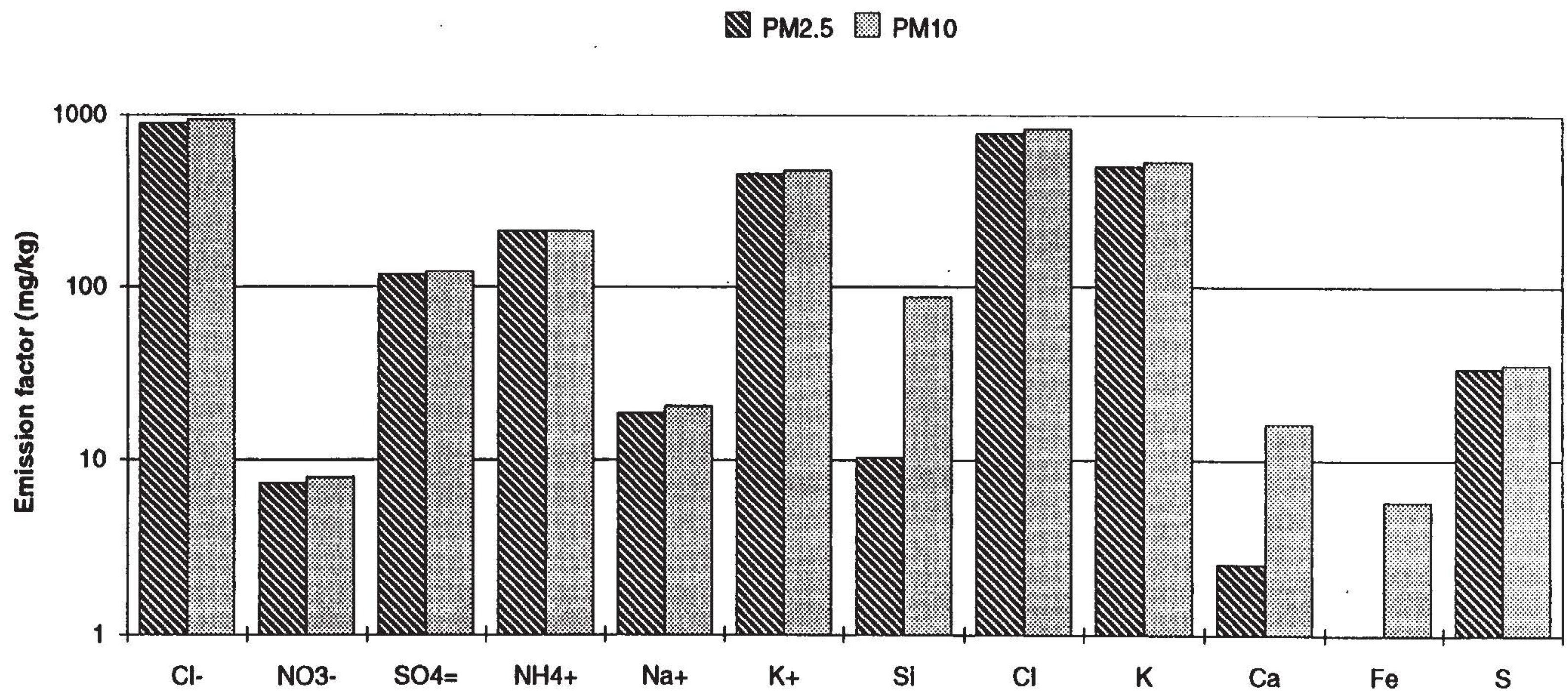


Figure 4.4.5. Wheat straw: Average emission factors (mg/kg) for major species, DRI analysis

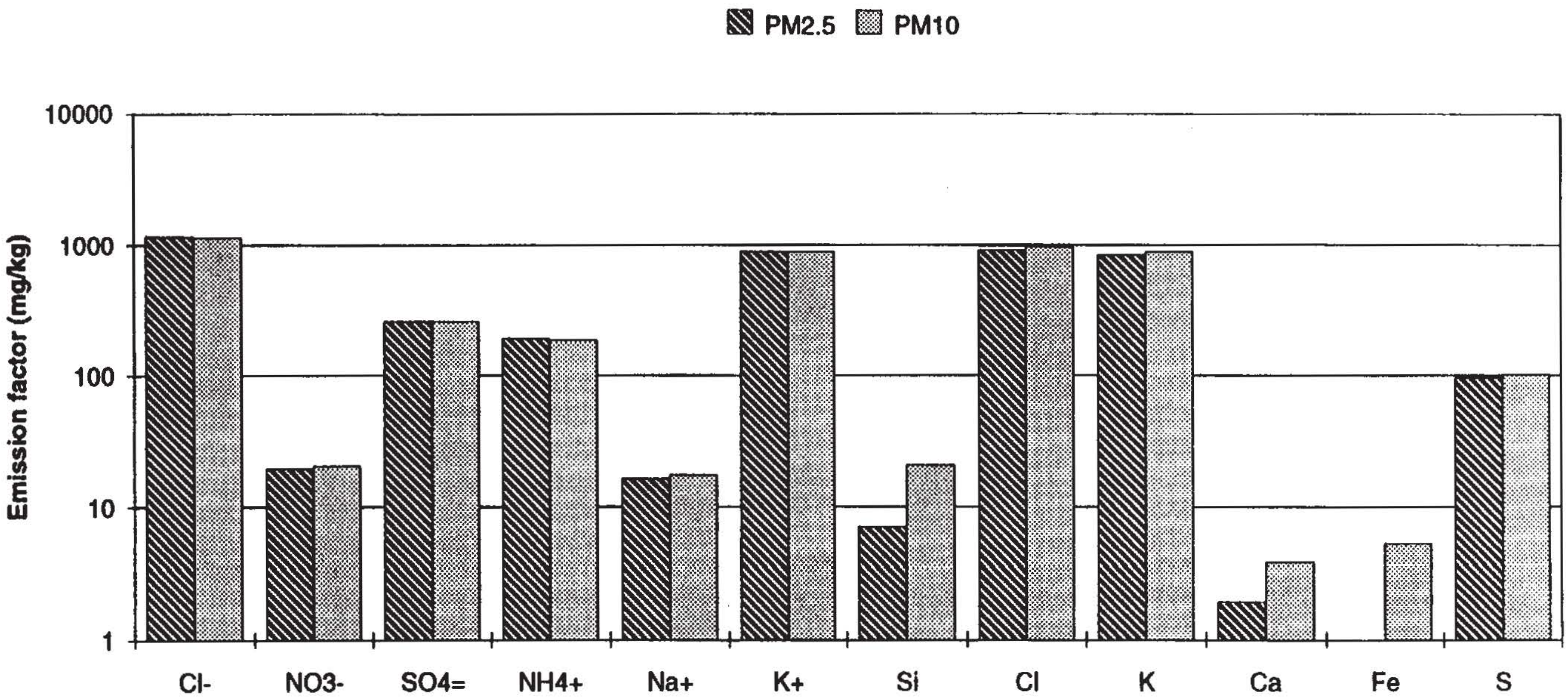


Figure 4.4.6. Almond prunings: Average emission factors (mg/kg) for major species, DRI analysis

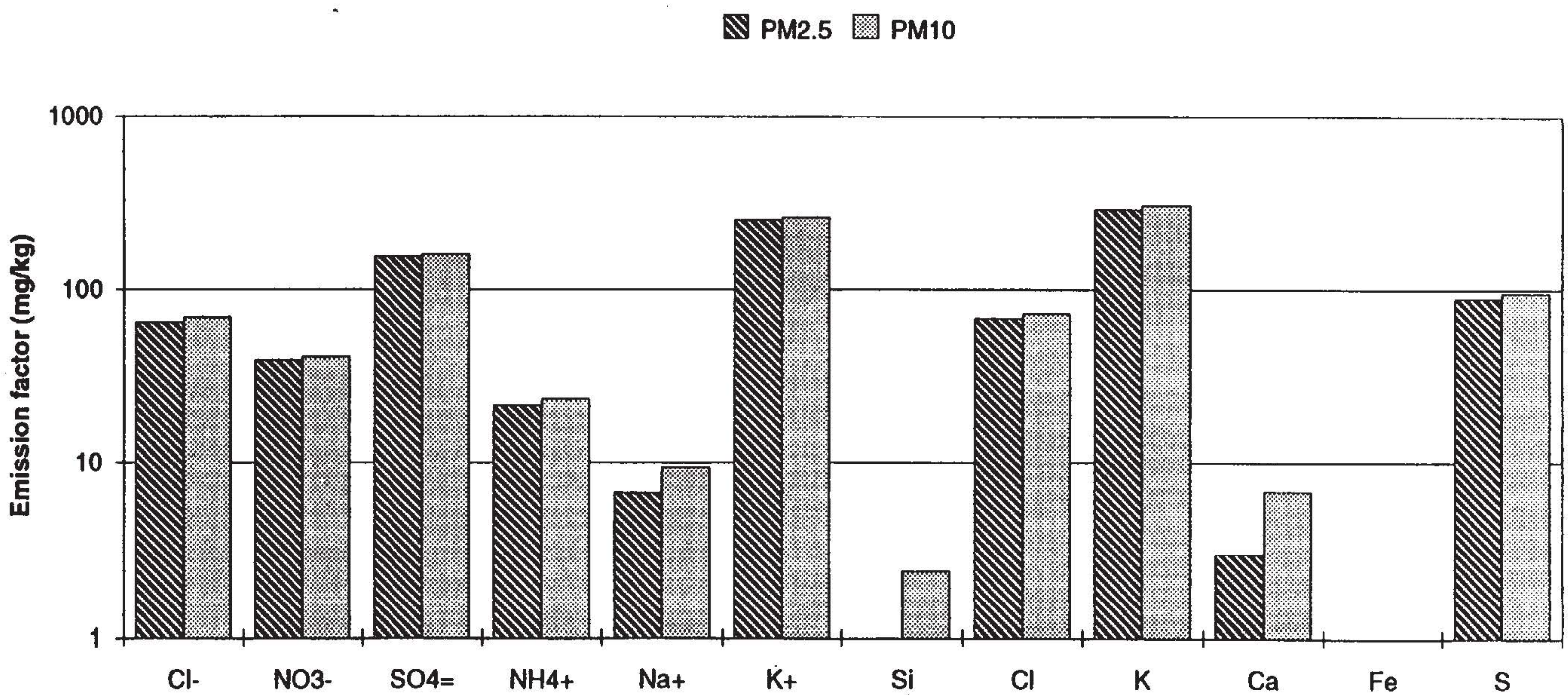


Figure 4.4.7. Douglas fir: Average emission factors (mg/kg) for major species, DRI analysis.

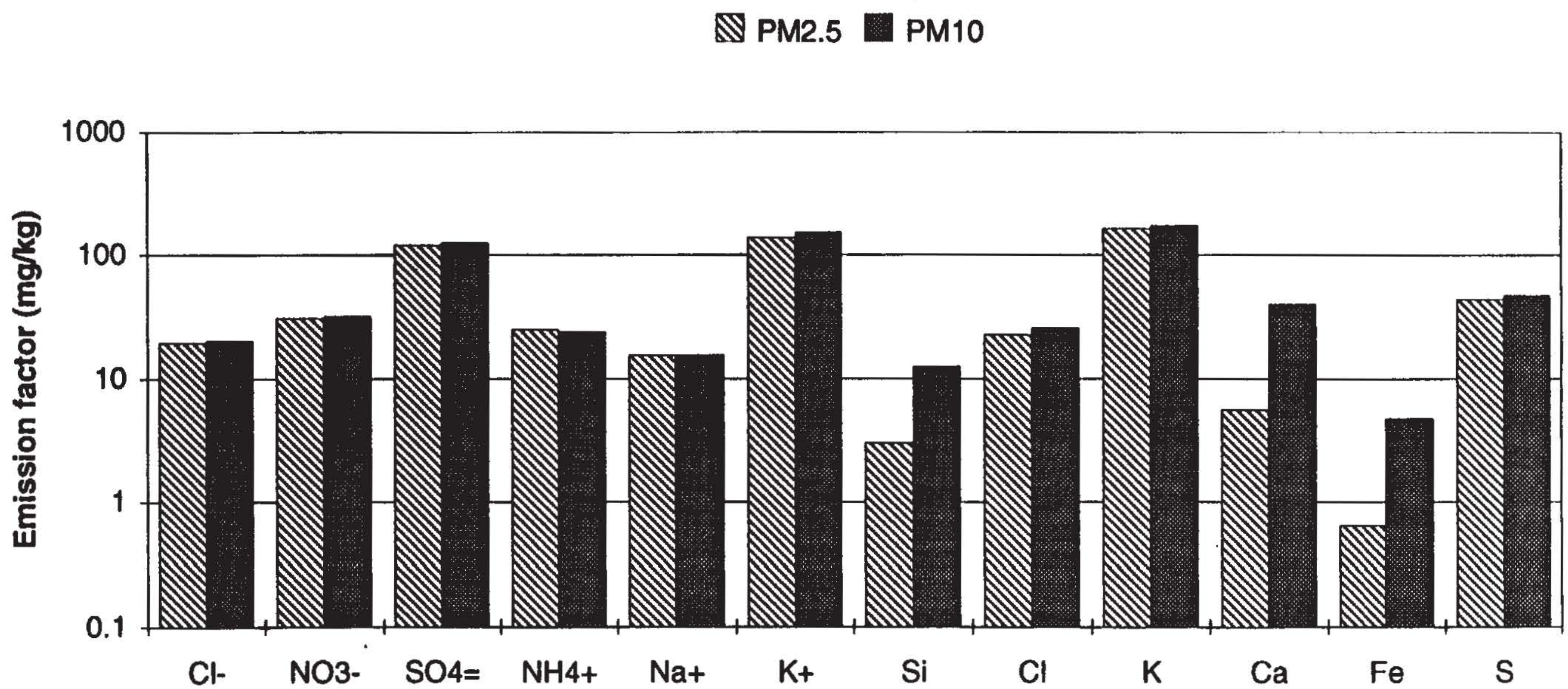


Figure 4.4.8. Ponderosa pine: Average emission factors (mg/kg) for major species, DRI analysis

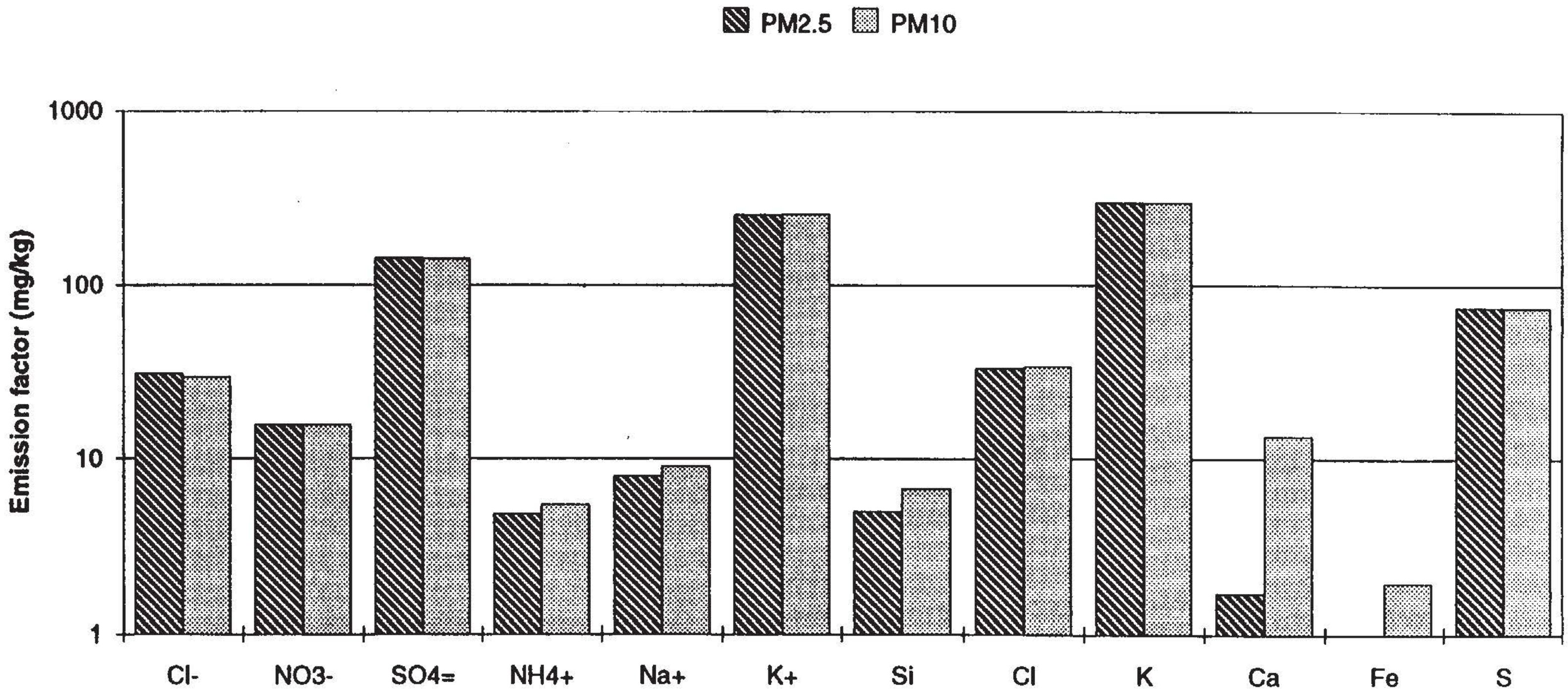


Figure 4.4.9. Walnut prunings: Average emission factors (mg/kg) for major species, DRI analysis

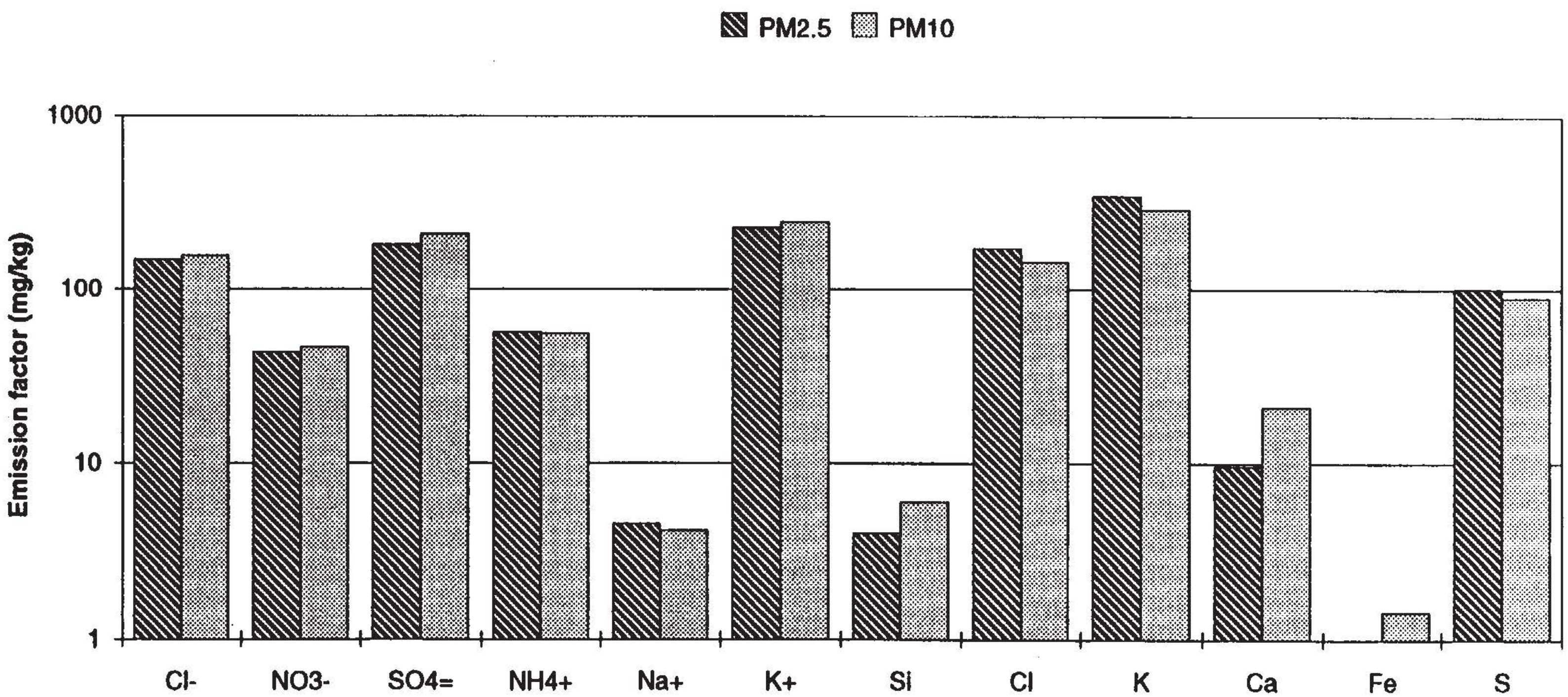


Figure 4.4.10. Si average emission factor in PM (mg/kg) by fuel type, DRI analysis.

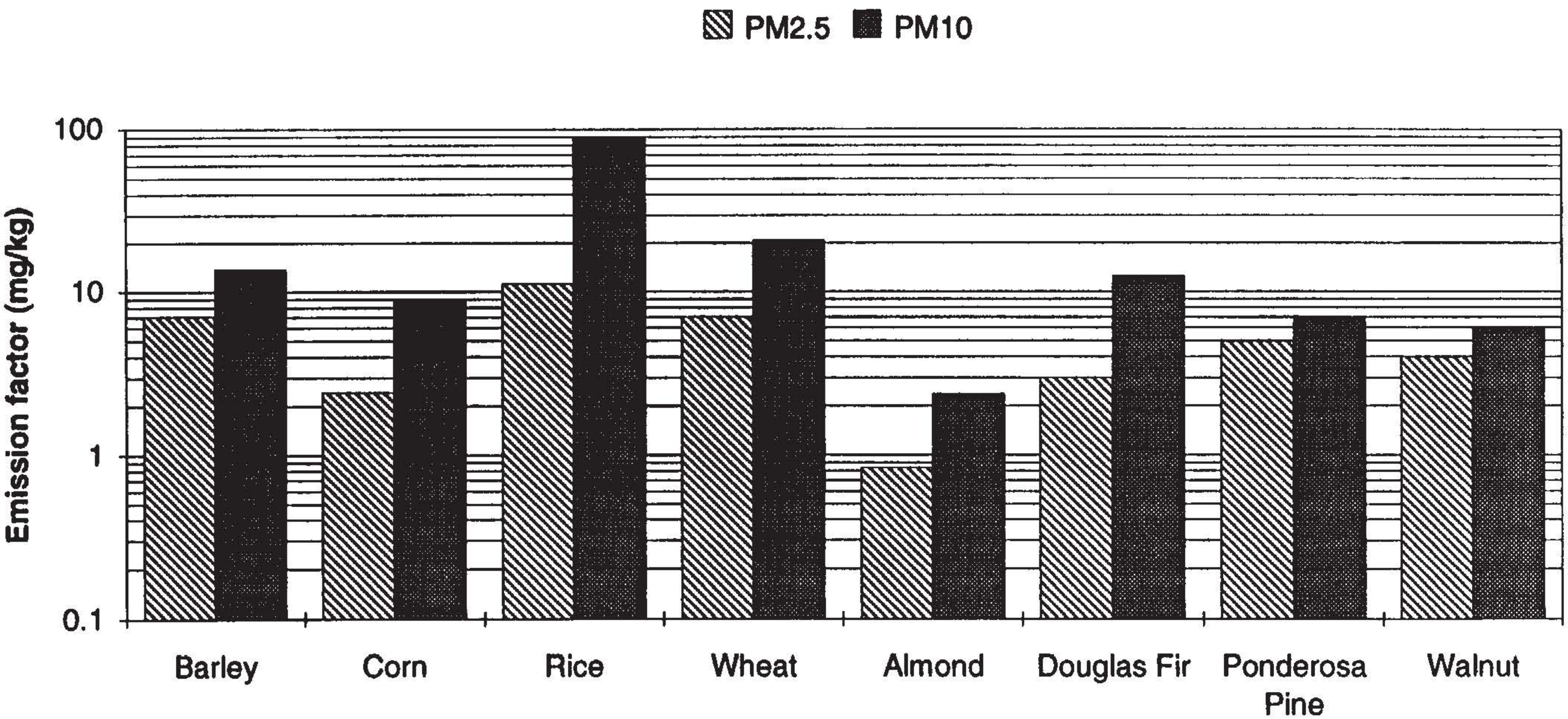


Figure 4.4.11. Cl average emission factor in PM (mg/kg) by fuel type, DRI analysis.

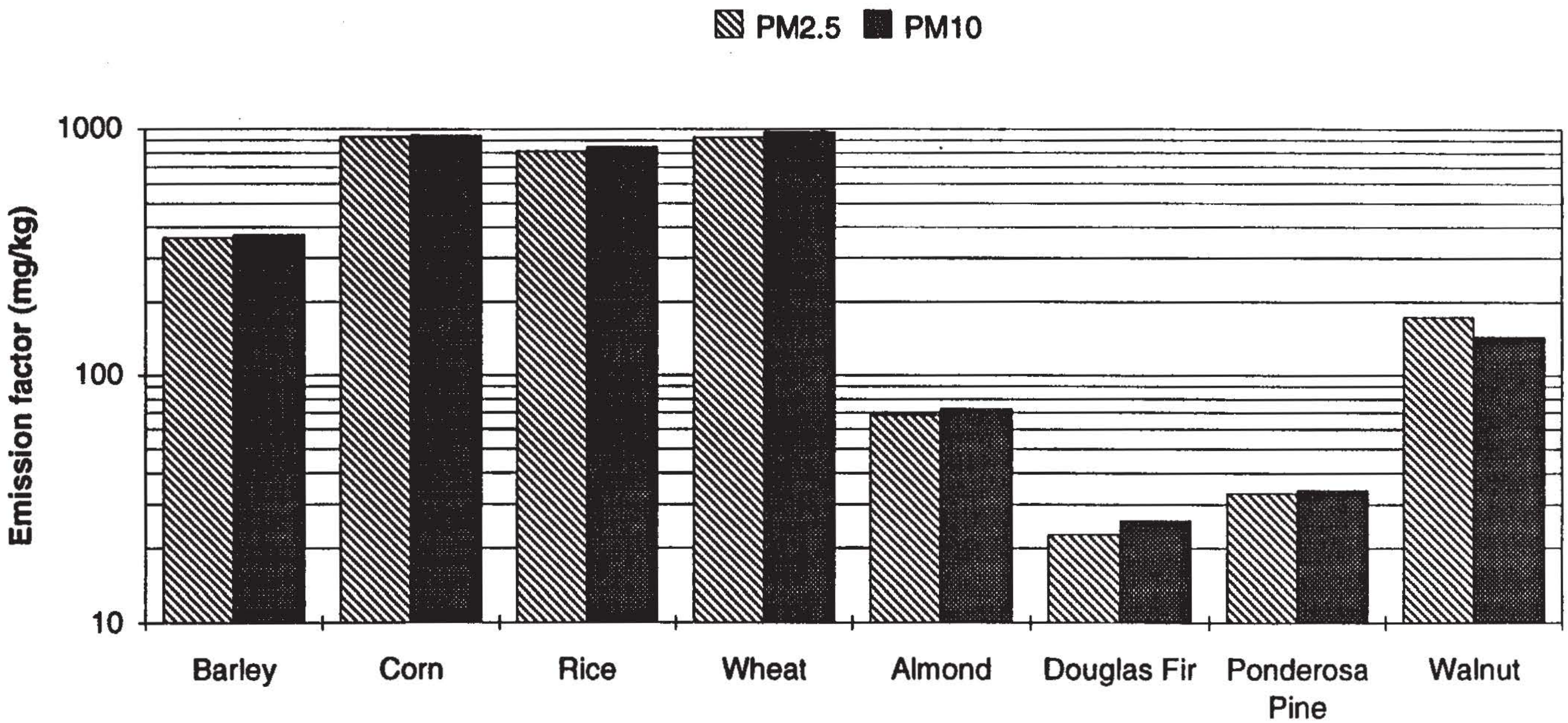


Figure 4.4.12. K average emission factor in PM (mg/kg) by fuel type, DRI analysis.

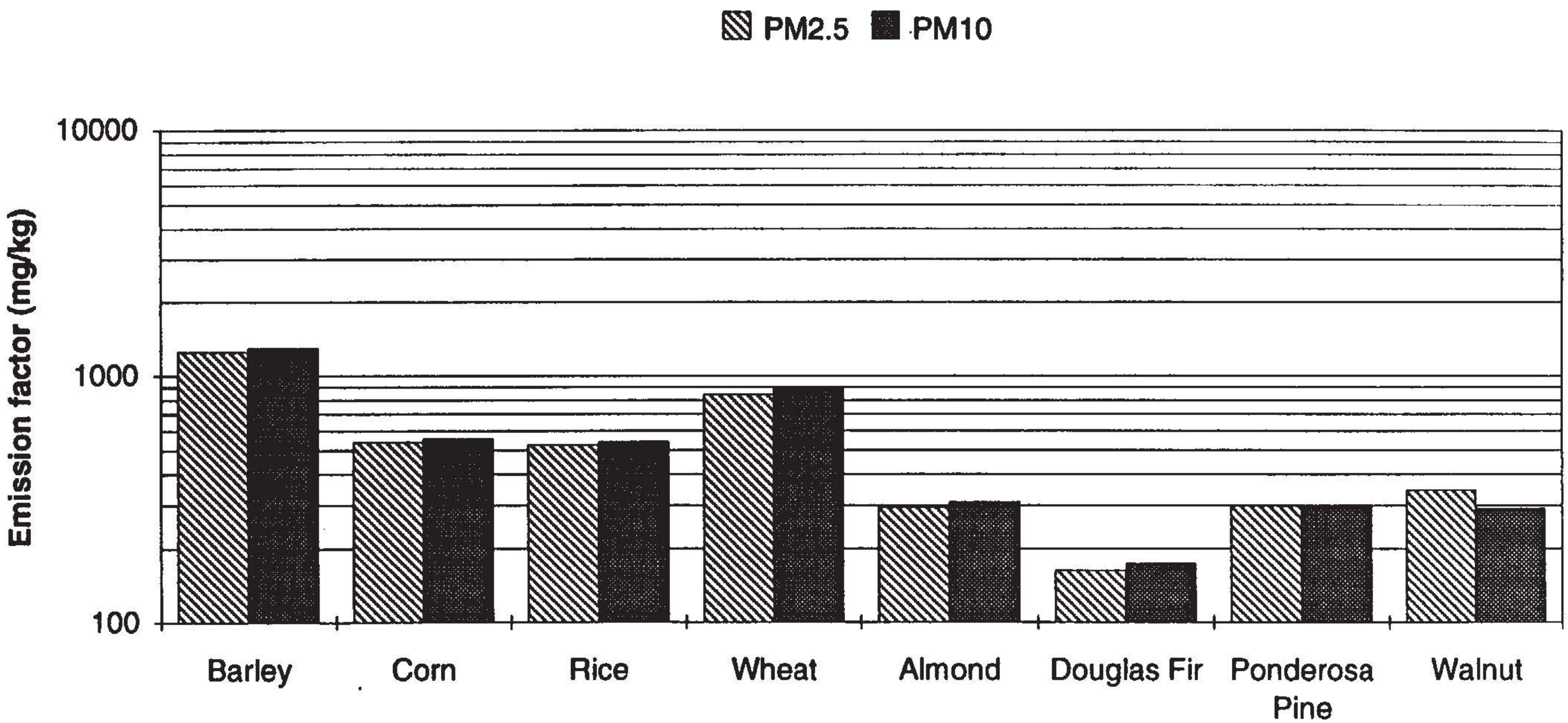


Figure 4.4.13. Ca average emission factor in PM (mg/kg) by fuel type, DRI analysis.

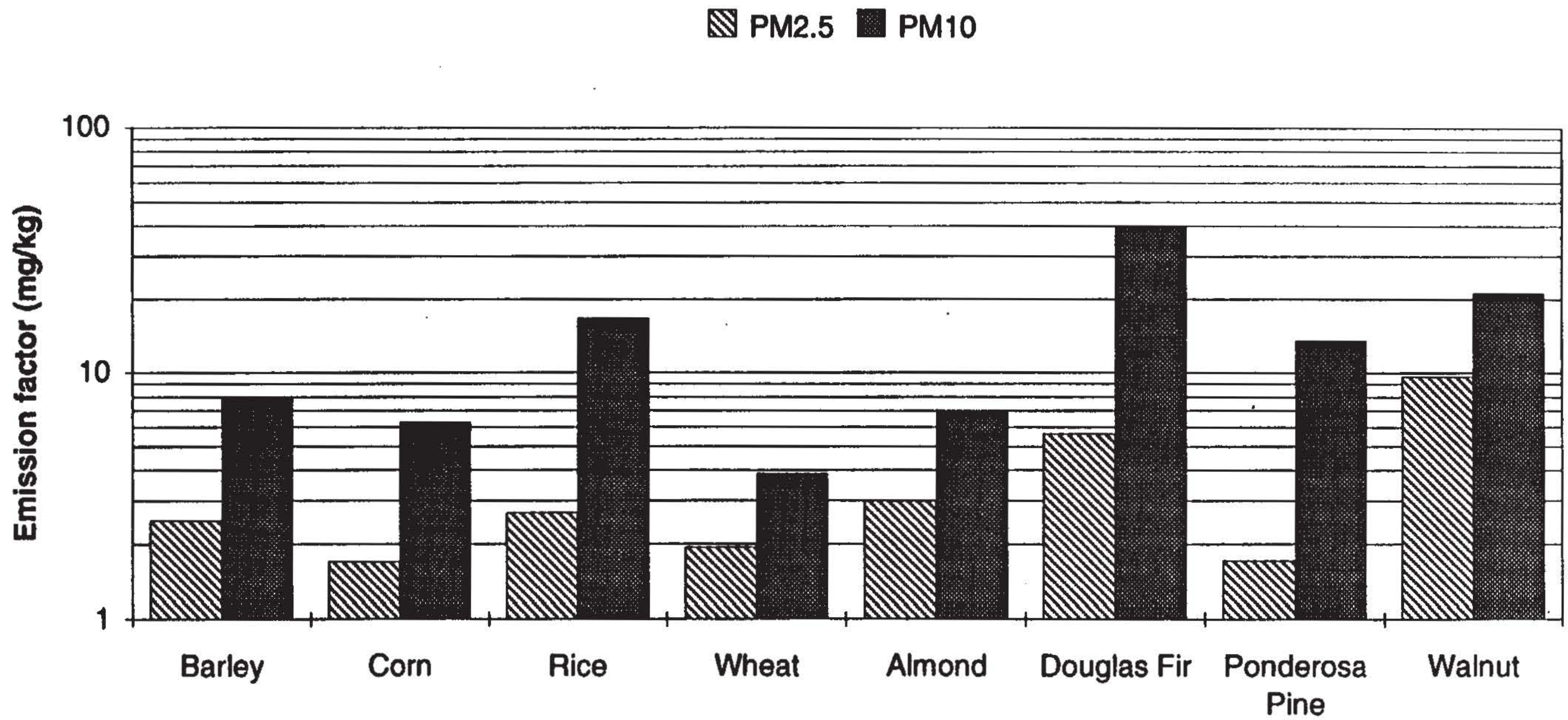


Figure 4.4.14. Fe average emission factor in PM (mg/kg) by fuel type, DRI analysis.

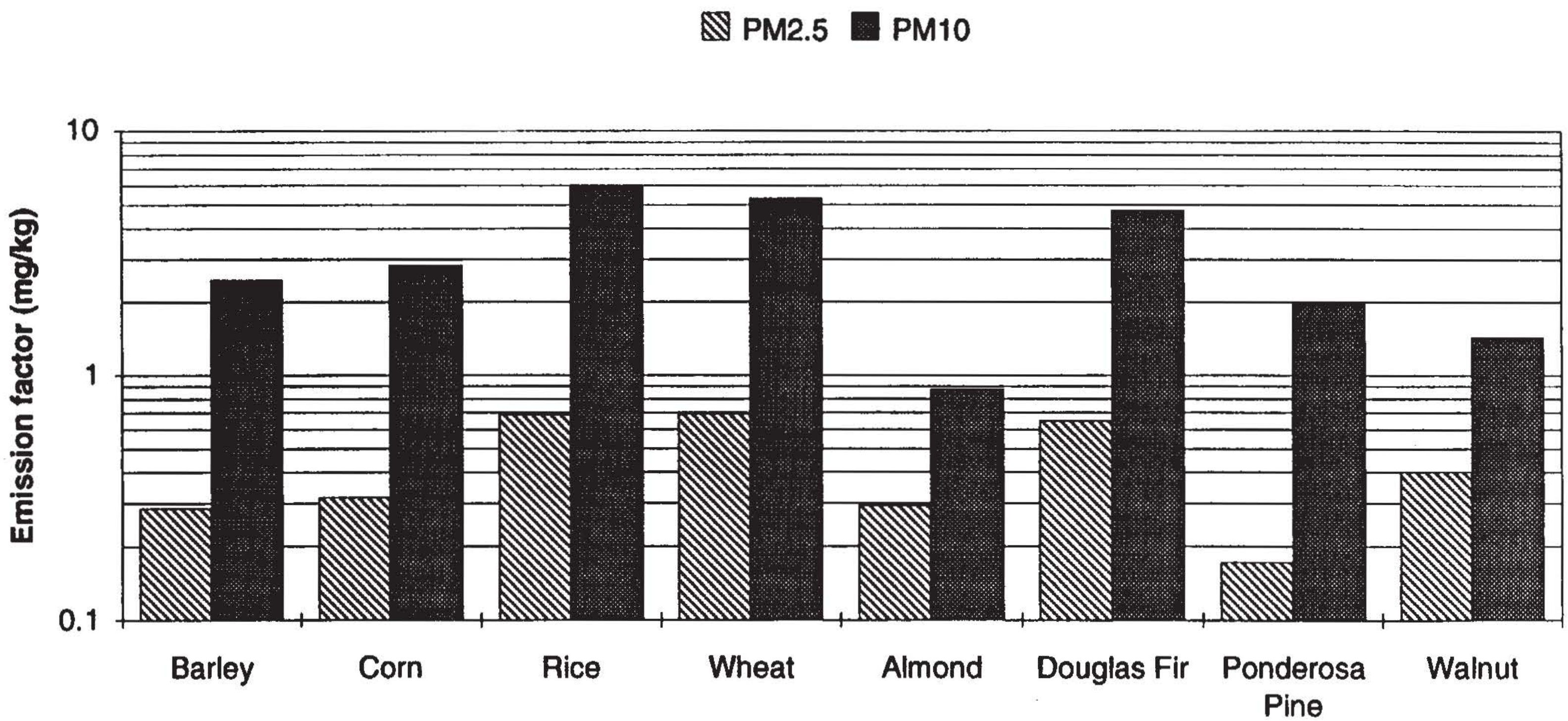


Figure 4.4.15. S average emission factor in PM (mg/kg) by fuel type, DRI analysis.

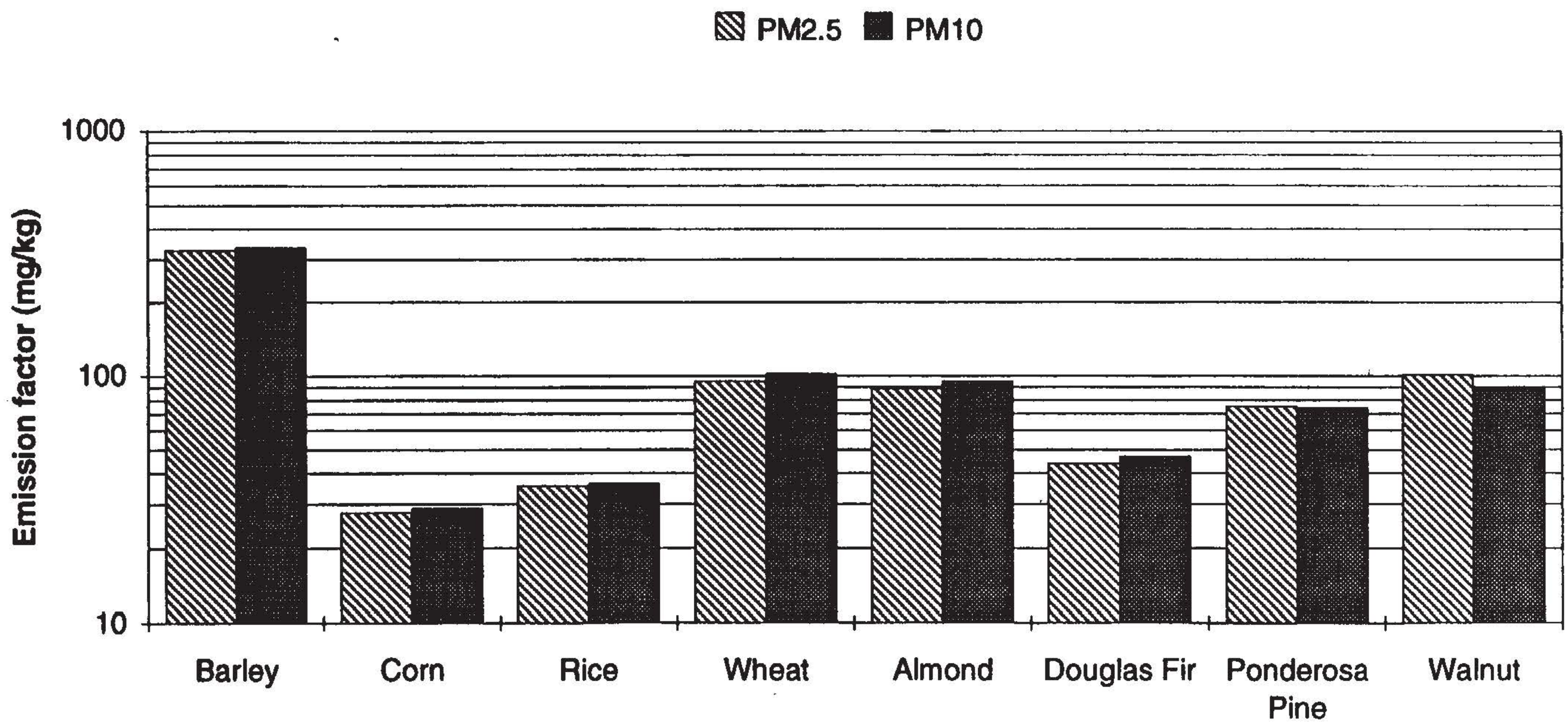


Figure 4.4.16. Cl- ion average emission factor (mg/kg) by fuel type, DRI analysis.

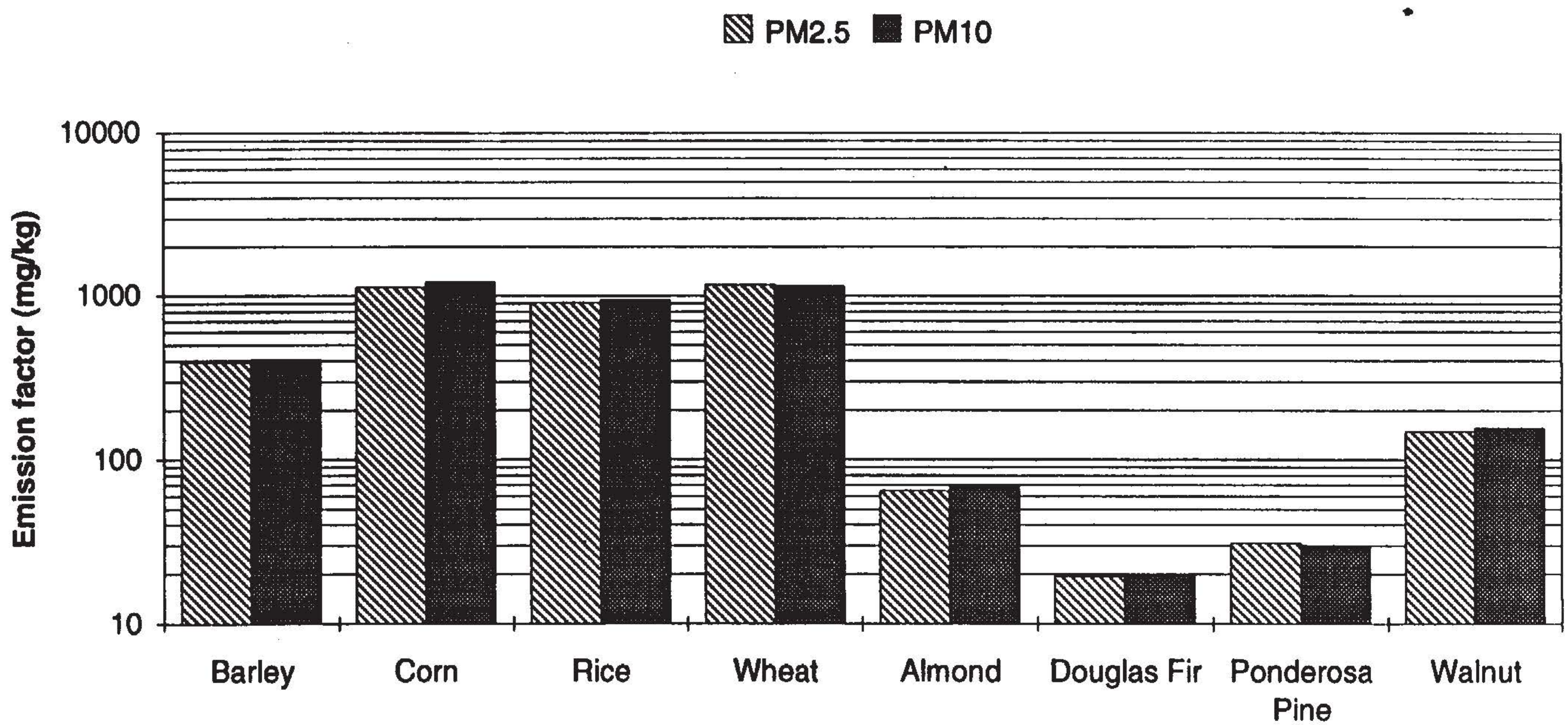


Figure 4.4.17. NO3- ion average emission factor (mg/kg) by fuel type, DRI analysis.

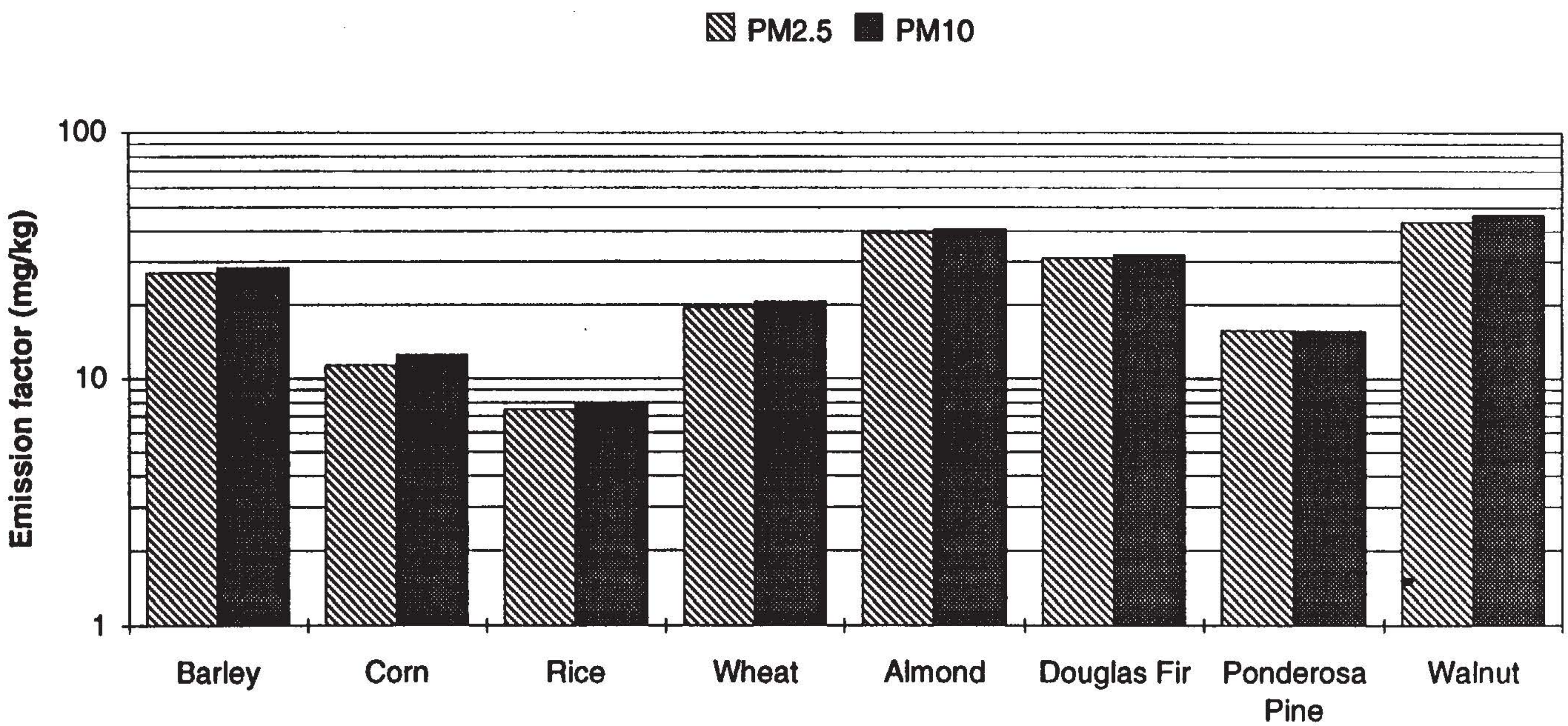


Figure 4.4.18. SO4= Ion average emission factor (mg/kg) by fuel type, DRI analysis.

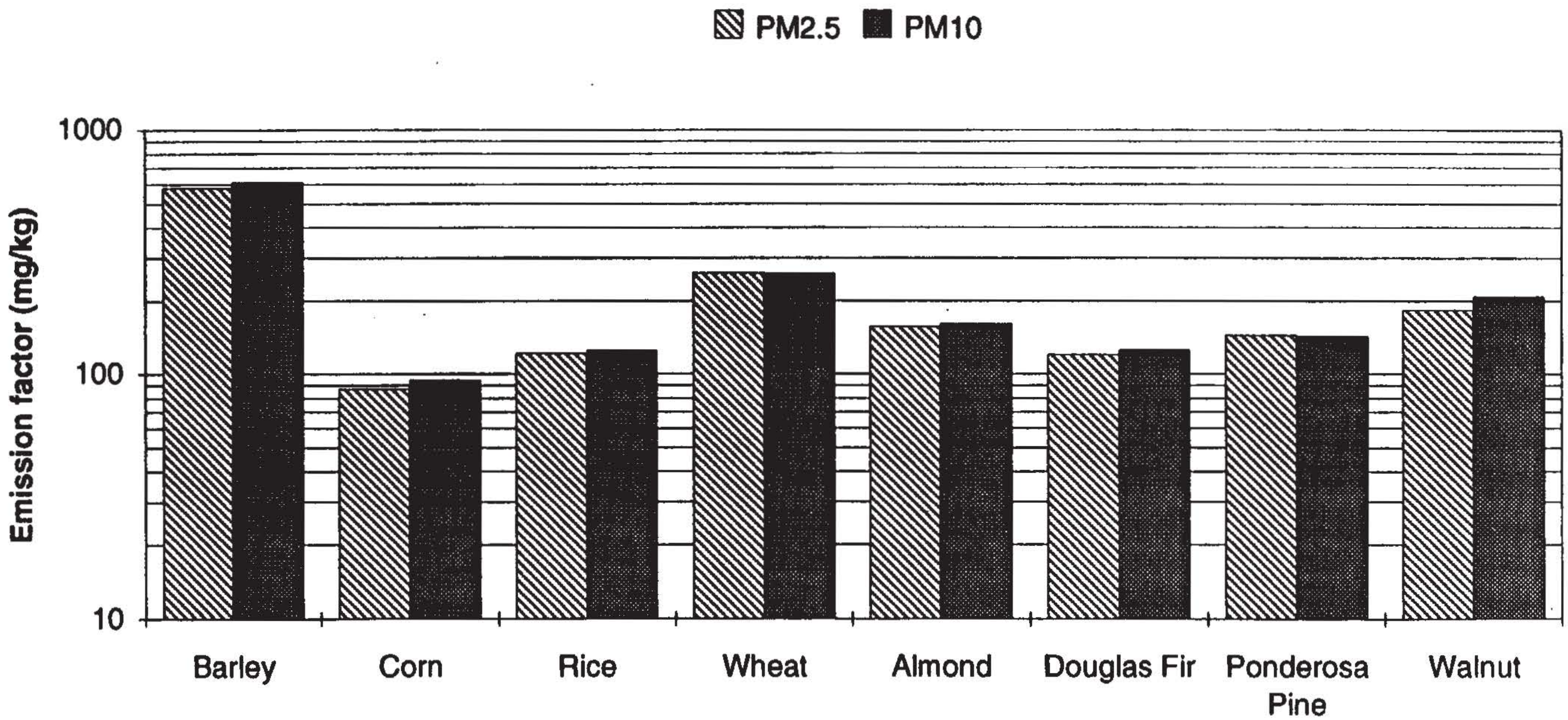


Figure 4.4.19. NH4+ ion average emission factor (mg/kg) by fuel type, DRI analysis.

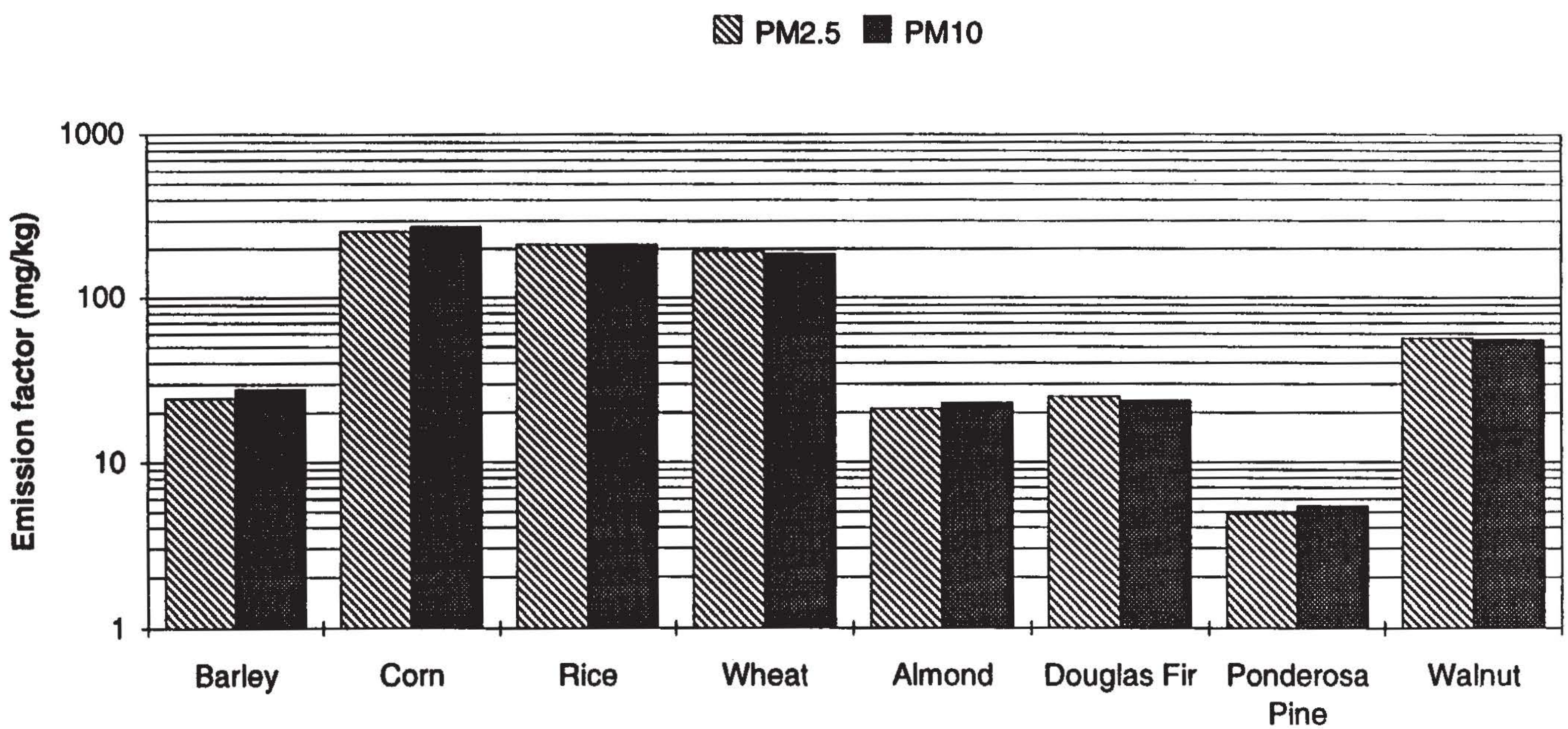


Figure 4.4.20. Na+ ion average emission factor (mg/kg) by fuel type, DRI analysis.

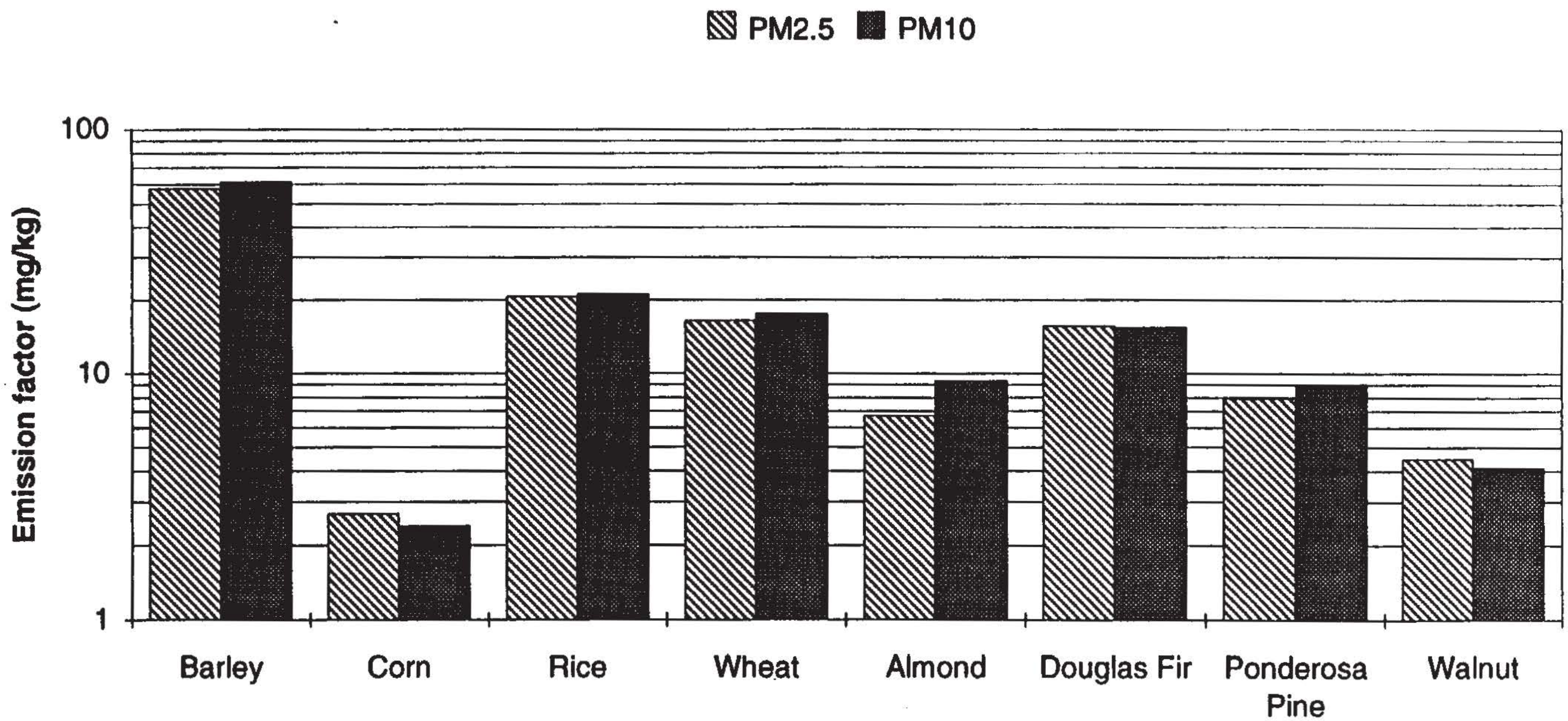


Figure 4.4.21. K+ Ion average emission factor (mg/kg) by fuel type, DRI analysis.

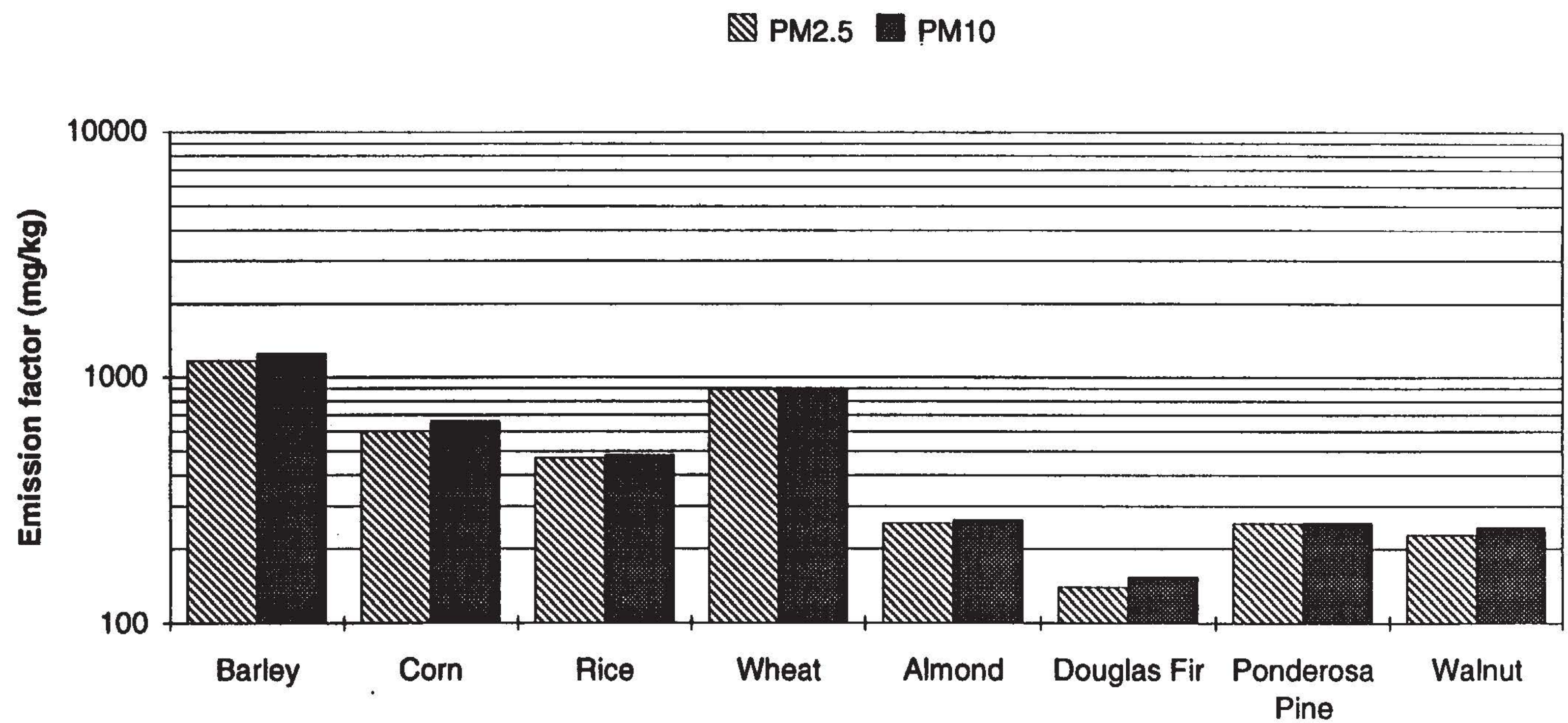


Table 4.5.1. Average concentrations (ppbv) for volatile organic compounds.

Fuel	Barley	Corn	Rice	Wheat	Almond	Douglas Fir	Ponderosa Pine	Walnut
Acetic acid							307	
Propanone (acetone)		77						8
Methyl ester acetic acid (methylacetate)								4
Butane			18					
Dimethyloxirane*			6					
Pentene			117					
Methylbutanone (isopropylmethyl ketone)								6
Furancarboxaldehyde (furfural)					12		246	10
Benzene	57	21	54	27	25	73	395	12
Dimethylbutane			49					
Hexane	61						1,793	
Phenol		25	62	7	7	32	166	
Dimethylfuran	16	50	113					
2-methyl 2-cyclopenten-1-one		10						
2-chloro phenol		9						
Toluene	26	25	46	8	14	50	235	7
Benzonitrile			1					
Benzaldehyde	10	10	12	5	5			4
Methylphenol (hydroxy toluene)					4		40	
Styrene	182	10	28	14	6	42	186	4
Xylene	5		9	5	2		36	1
Trimethylpentane	19							
Benzofuran	3		1	2	3			
Methoxymethylphenol (creosol)							62	
Naphthalene	5	5	7	6	5	56	63	1
C10H12†						30		
Alpha-pinene						50		
Camphene						93		
Δ3-Carene							203	
Limonene						169	208	
No match r.t. (6.7)		34						
No match r.t. (8.51)				10				
No match r.t. (8.71)			7					
No match r.t. (8.73)			11					
No match r.t.(6.4)			104					
No match r.t.(8.5)				11				

Table 4.5.2. Average emission factors (mg/kg) for volatile organic compounds.

Fuel	Barley	Corn	Rice	Wheat	Almond	Douglas Fir	Ponderosa Pine	Walnut
Fuel Consumption Rate (g/s d.b)	3.85	8.52	11.33	2.31	11.22	2.70	12.40	12.66
Stack Gas Mass Flow Rate (kg/s)	3.77	4.34	4.01	4.39	5.20	3.25	4.74	6.49
Acetic acid							321	
Propanone (acetone)		68						8
Methyl ester acetic acid (methylacetate)								5
Butane			11					
Dimethyloxirane*			6					
Pentene			208					
Methylbutanone (isopropylmethyl ketone)								8
Furancarboxaldehyde (furfural)					18		335	18
Benzene	149	35	75	145	30	196	444	16
Dimethylbutane			45					
Hexane	177						1,423	
Phenol		36	127	48	11	93	251	
Dimethylfuran	52	81	173					
2-methyl 2-cyclopenten-1-one		22						
2-chloro phenol		29						
Toluene	82	46	77	52	19	157	351	11
Benzonitrile			2					
Benzaldehyde	36	26	35	35	8			8
Methylphenol (hydroxy toluene)					9		202	
Styrene	652	16	55	91	10	137	271	7
Xylene	18		16	26	3		56	2
Trimethylpentane	72							
Benzofuran	13		2	13	5			
Methoxymethylphenol (creosol)							403	
Naphthalene	23	10	15	51	10	234	65	2
Unknown						141		
Alpha-pinene						210		
Camphene						393		
Δ3-Carene							224	
Limonene						713	372	

*Possible mismatch

Table 4.5.3. PAH emission factors by fuel type for individual tests.

Fuel	Configuration/Replicate		Total PAH (mg/kg)	PAH less naphthalenes (mg/kg)*
Barley Straw	CEWF	1	209.6	68.3
Barley Straw	CEWF	2	225.4	60.7
Barley Straw	CRNF	1	71.7	56.9
Barley Straw	CRNF	2	57.3	46.2
Corn Stover	CEWF	1	119.5	100.0
Corn Stover	CEWF	2	6.6	2.1
Corn Stover	CRNF	1	8.1	6.1
Corn Stover	CRNF	2	7.7	5.3
Rice Straw	CEWF	1	15.4	4.7
Rice Straw	CEWF	2	11.5	3.8
Rice Straw	CEWF	3	49.3	7.8
Rice Straw	CEWF	4	28.3	5.7
Rice Straw	CRNF	1	5.0	1.4
Rice Straw	CRNF	2	5.3	1.8
Rice Straw	CRNF	3	11.5	3.1
Rice Straw	CRNF	4	18.1	3.7
Rice Straw	CRNF	5	19.6	9.7
Rice Straw	CRNF	6	18.4	8.8
Wheat straw	CEWF	1	79.2	33.8
Wheat straw	CEWF	2	72.0	25.8
Wheat straw	CRNF	1	682.7	12.9
Wheat straw	CRNF	2	35.3	7.6
Almond Prunings	Pile	Flaming	16.2	8.0
Almond Prunings	Pile	Stoked/Flaming	12.3	5.6
Walnut Prunings	Pile	Flaming	27.9	9.9
Walnut Prunings	Pile	Stoked/Flaming	22.2	7.1
Douglas Fir Slash	Pile	Low flaming	48.8	23.4
Douglas Fir Slash	Pile	High flaming	12.4	5.4
Ponderosa Pine Slash	Pile	Flaming	16.7	6.5
Ponderosa Pine Slash	Pile	Late flame and smolder	69.7	20.6

*excludes naphthalene and 2-methylnaphthalene.

Table 4.5.4. Average PAH emission factors (μg/kg) for field crop residues.

Mol. Wt.		Barley Straw	Corn Stover	Corn Stover*	Rice Straw	Wheat Straw
128	Naphthalene	80,297	4,481	2,087	8,385	196,192
142	2-Methylnaphthalene	2,697	2,626	882	5,427	1,074
152	Acenaphthylene	11,747	402	351	1,058	1,504
154	Acenaphthene	9,313	660	428	306	170
166	Fluorene	2,702	121	73	363	318
178	Phenanthrene	17,346	1,606	1,424	1,541	4,093
178	Anthracene	3,000	189	241	271	1,073
202	Fluoranthene	2,302	801	717	451	3,929
202	Pyrene	3,577	766	675	347	2,471
228	Benz[a]anthracene	1,130	192	142	145	1,302
228	Chrysene	1,425	274	204	173	1,369
252	Benzo[b]fluoranthene	2,404	4,664	66	147	1,135
252	Benzo[k]fluoranthene	599	2,853	182	96	481
252	Benzo[a]pyrene	781	9,561	24	77	408
252	Benzo[e]pyrene	1,008	11,258	83	108	592
252	Perylene	231	2,081	4	19	438
276	Benzo[ghi]perylene	522	567		38	1,046
276	Indeno[1,2,3-cd]pyrene	592	9,672		62	673
278	Dibenz[a,h]anthracene	10	565			
	Total	141,683	53,339	7,582	19,013	218,268
	Total less naphthalenes	58,689	46,232	4,614	5,201	21,002

Blank indicates not detected. *Excludes CEWF-1.

Table 4.5.5. PAH emission factors (µg/kg) for agricultural wood fuels.

	Almond Prunings			Walnut Prunings		
	Flaming	Flaming Stoked	Flaming Average	Flaming	Flaming Stoked	Flaming Average
Naphthalene	8,025	6,590	7,307	15,846	13,279	14,563
2-Methylnaphthalene	161	128	145	2,203	1,757	1,980
Acenaphthylene	3,066	2,268	2,667	1,180	942	1,061
Acenaphthene	197	159	178	1,772	1,670	1,721
Fluorene	74	18	46	1,228	630	929
Phenanthrene	2,451	1,627	2,039	2,778	1,207	1,993
Anthracene	447	192	319	494	253	374
Fluoranthene	634	415	524	1,329	1,261	1,295
Pyrene	518	376	447	925	1,021	973
Benz[a]anthracene	243	185	214	54	66	60
Chrysene	165	248	206	80	77	78
Benzo[b]fluoranthene	59	27	43	0	0	0
Benzo[k]fluoranthene	56	45	50	0	0	0
Benzo[a]pyrene	38	18	28	12	0	6
Benzo[e]pyrene	24	10	17	30	7	18
Perylene						
Benzo[ghi]perylene	3		3			
Indeno[1,2,3-cd]pyrene						
Dibenz[a,h]anthracene						
Total	16,161	12,306	14,235	27,931	22,170	25,051
Total less naphthalenes	7,975	5,588	6,783	9,881	7,134	8,508

Blank indicates not detected.

Table 4.5.6. PAH emission factors (μg/kg) for forest wood fuels.

	Douglas Fir Slash			Ponderosa Pine Slash		
	Flaming Low Rate	Flaming High Rate	Flaming Average	Flaming	Late Flame and Smolder	Mass Average
Naphthalene	20,951	6,184	13,567	8,931	43,656	16,960
2-Methylnaphthalene	4,370	779	2,575	1,316	5,418	2,265
Acenaphthylene	3,607	1,229	2,418	775	3,521	1,410
Acenaphthene	3,650	1,387	2,518	1,224	4,007	1,868
Fluorene	1,427	288	857	428	1,521	680
Phenanthrene	6,967	908	3,938	1,934	4,789	2,594
Anthracene	1,271	175	723	325	772	429
Fluoranthene	2,859	673	1,766	843	3,039	1,351
Pyrene	2,413	525	1,469	613	2,574	1,066
Benz[a]anthracene	396	104	250	93	184	114
Chrysene	335	99	217	80	168	100
Benzo[b]fluoranthene	103	9	56	48		37
Benzo[k]fluoranthene	248	25	136	50		39
Benzo[a]pyrene	61	8	35	24		19
Benzo[e]pyrene	99	9	54	27	13	24
Perylene						
Benzo[ghi]perylene		5	5			
Indeno[1,2,3-cd]pyrene						
Dibenz[a,h]anthracene						
Total	48,755	12,406	30,583	16,711	69,663	28,955
Total less naphthalenes	23,434	5,443	14,441	6,464	20,589	9,730

Blank indicates not detected.

Table 4.5.7. PAH concentrations in particulate matter (mg/kg), agricultural field crops.

	Barley Straw	Corn Stover	Corn Stover*	Rice Straw	Wheat Straw
PM emission factor (% dry fuel)	0.78	0.63	0.45	0.38	0.58
Naphthalene	181.37	33.10	54.56	20.01	488.11
2-Methylnaphthalene	48.14	68.45	25.86	18.13	8.53
Acenaphthylene	102.35	29.51	13.49	3.14	13.84
Acenaphthene	109.87	41.28	7.32	2.91	7.66
Fluorene	8.60	0.39	0.31	0.49	3.16
Phenanthrene	206.13	29.59	48.16	11.10	86.49
Anthracene	40.00	10.39	10.05	2.17	24.55
Fluoranthene	197.56	80.04	132.58	11.93	260.09
Pyrene	381.71	80.03	131.10	14.47	234.77
Benz[a]anthracene	142.41	26.29	45.52	26.11	200.13
Chrysene	181.45	36.90	69.83	29.53	200.44
Benzo[b]fluoranthene	307.37	554.65	38.37	31.47	189.08
Benzo[k]fluoranthene	76.98	339.28	71.35	23.06	80.75
Benzo[a]pyrene	98.78	1,136.95	8.84	19.03	67.72
Benzo[e]pyrene	129.61	892.54	18.68	26.17	99.59
Perylene	13.89	164.99	0.87	4.84	56.47
Benzo[ghi]perylene	33.59	22.48		8.15	89.88
Indeno[1,2,3-cd]pyrene	38.15	383.39		14.46	57.85
Dibenz[a,h]anthracene		22.41			
Total	2,298	3,953	677	267	2,169
Total less naphthalenes	2,068	3,851	596	229	1,672

*Excludes CEWF-1.

Table 4.5.8. PAH concentrations in particulate matter (mg/kg), agricultural wood fuels.

	Almond Prunings			Walnut Prunings		
	Flaming	Flaming Stoked	Flaming Average	Flaming	Flaming Stoked	Flaming Average
	0.48	0.62	0.55	0.51	0.38	0.45
Naphthalene	17.42	10.34	13.88	2.10	2.75	2.43
2-Methylnaphthalene	2.85	1.73	2.29	1.89	1.57	1.73
Acenaphthylene	1.72		1.72	0.43	0.32	0.37
Acenaphthene						
Fluorene	0.07		0.07	1.41	0.26	0.84
Phenanthrene	24.26	12.16	18.21	18.96	22.74	20.85
Anthracene	4.54	2.70	3.62	1.44	3.06	2.25
Fluoranthene	49.32	26.68	38.00	94.37	87.42	90.89
Pyrene	44.87	25.82	35.34	80.19	86.16	83.17
Benz[a]anthracene	31.76	14.73	23.25	6.40	11.41	8.90
Chrysene	19.18	23.90	21.54	11.00	13.05	12.02
Benzo[b]fluoranthene	8.21	2.77	5.49		0.10	0.10
Benzo[k]fluoranthene	7.37	4.99	6.18			
Benzo[a]pyrene	2.70	0.39	1.55			
Benzo[e]pyrene	1.70		1.70			
Perylene						
Benzo[ghi]perylene	0.61		0.61			
Indeno[1,2,3-cd]pyrene						
Dibenz[a,h]anthracene						
Total	217	126	173	218	229	224
Total less naphthalenes	196	114	157	214	225	219

Table 4.5.9. PAH concentrations in particulate matter (mg/kg), forest wood fuels.

	Douglas Fir Slash			Ponderosa Pine Slash		
	Flaming Low Rate	Flaming High Rate	Flaming Average	Flaming	Late Flame and Smolder	Mass Average
	0.75	0.43	0.59	0.36	0.50	0.39
Naphthalene	23.94	18.24	21.09	19.55	4.46	16.06
2-Methylnaphthalene	5.12	3.98	4.55	4.48	1.20	3.72
Acenaphthylene	4.14	2.53	3.33	1.21	0.46	1.04
Acenaphthene						
Fluorene		0.14	0.14	0.66	0.28	0.57
Phenanthrene	68.05	29.26	48.65	25.27	23.88	24.95
Anthracene	13.64	5.66	9.65	4.63	6.45	5.05
Fluoranthene	171.06	52.01	111.53	105.21	59.30	94.59
Pyrene	141.69	32.05	86.87	79.55	47.68	72.18
Benz[a]anthracene	18.63	13.88	16.26	18.31	11.36	16.70
Chrysene	17.88	19.16	18.52	14.47	17.28	15.12
Benzo[b]fluoranthene		2.17	2.17	10.68		8.21
Benzo[k]fluoranthene	2.54	5.71	4.13	6.18		4.75
Benzo[a]pyrene	2.34	1.92	2.13	4.20		3.23
Benzo[e]pyrene	3.18	0.97	2.07	2.48		1.91
Perylene						
Benzo[ghi]perylene		1.08	1.08			
Indeno[1,2,3-cd]pyrene						
Dibenz[a,h]anthracene						
Total	472	189	332	297	172	268
Total less naphthalenes	443	167	307	273	167	248

Figure 4.5.1. Average emission factors for selected compounds.

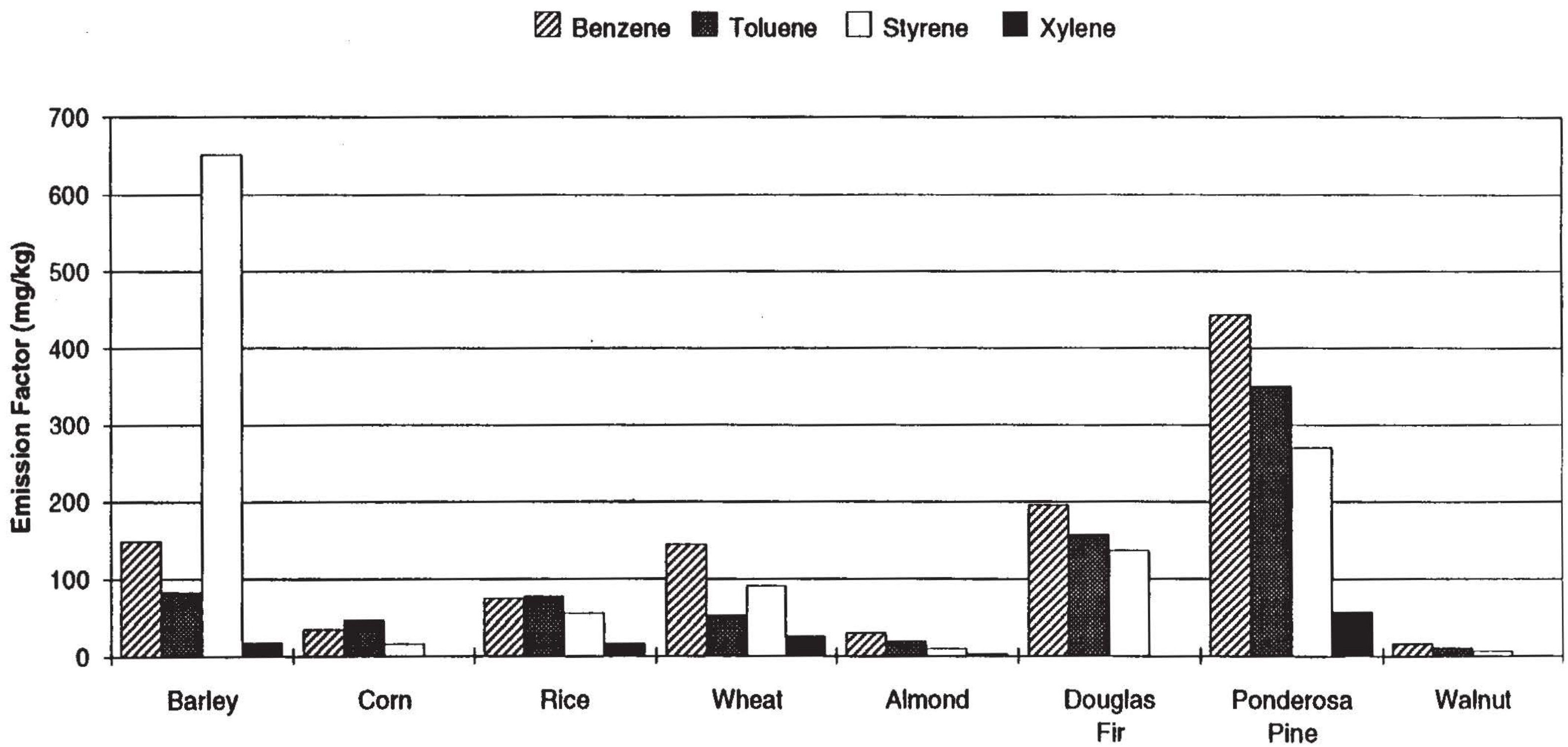


Figure 4.5.2. Average emission factors for selected compounds.

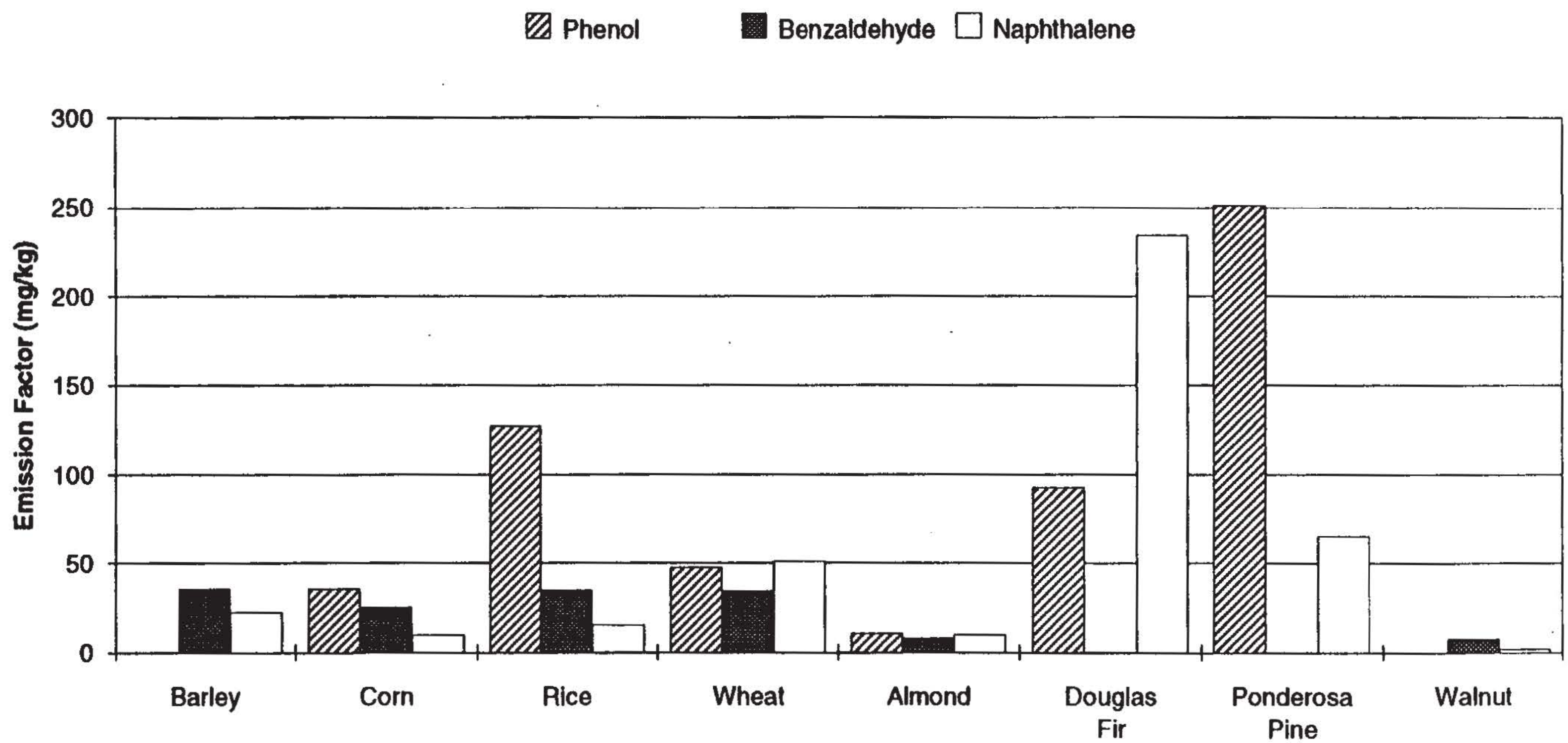


Figure 4.5.3. Average Benzene emission factors

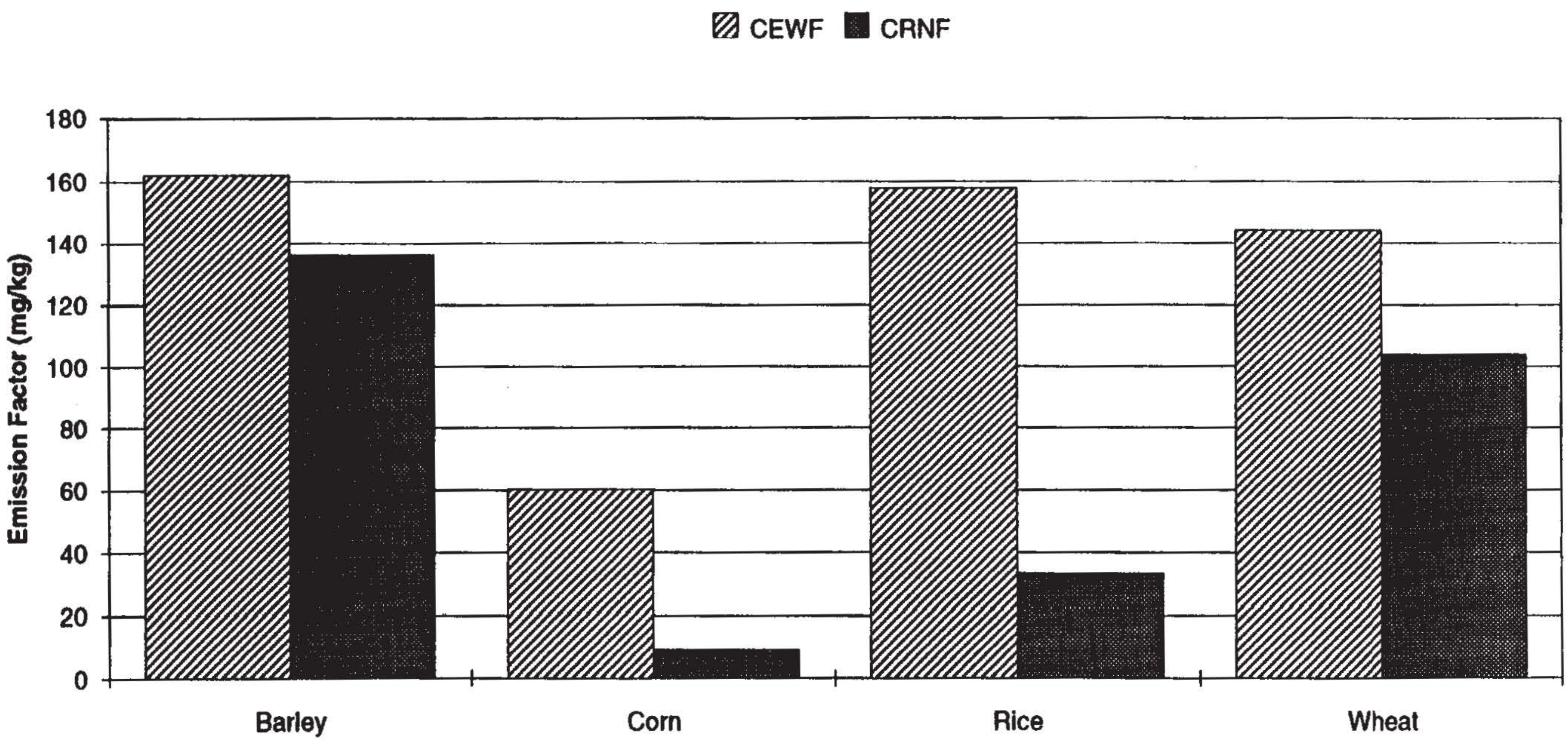


Figure 4.5.4. Average Phenol emission factors

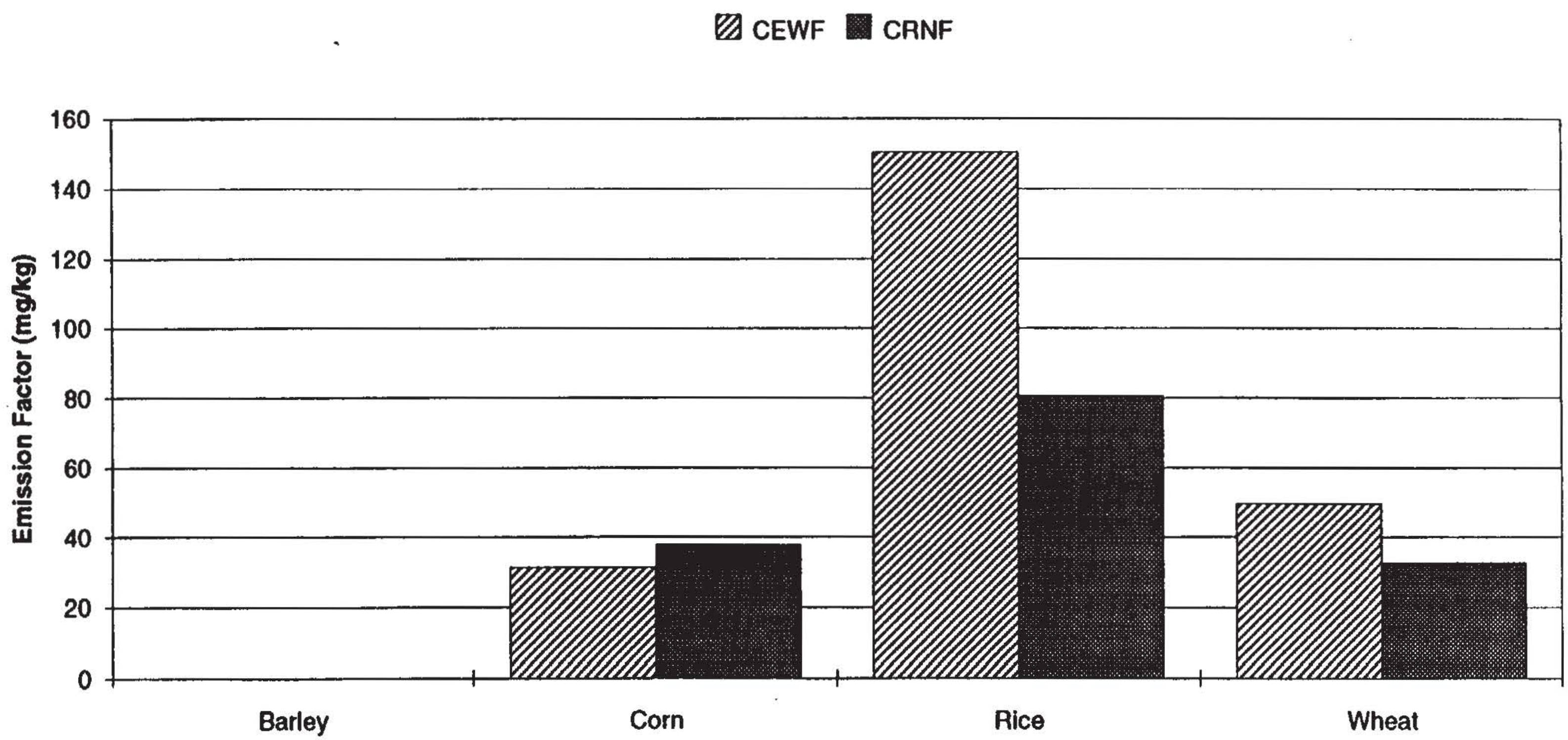


Figure 4.5.5. Average Naphthalene emission factors

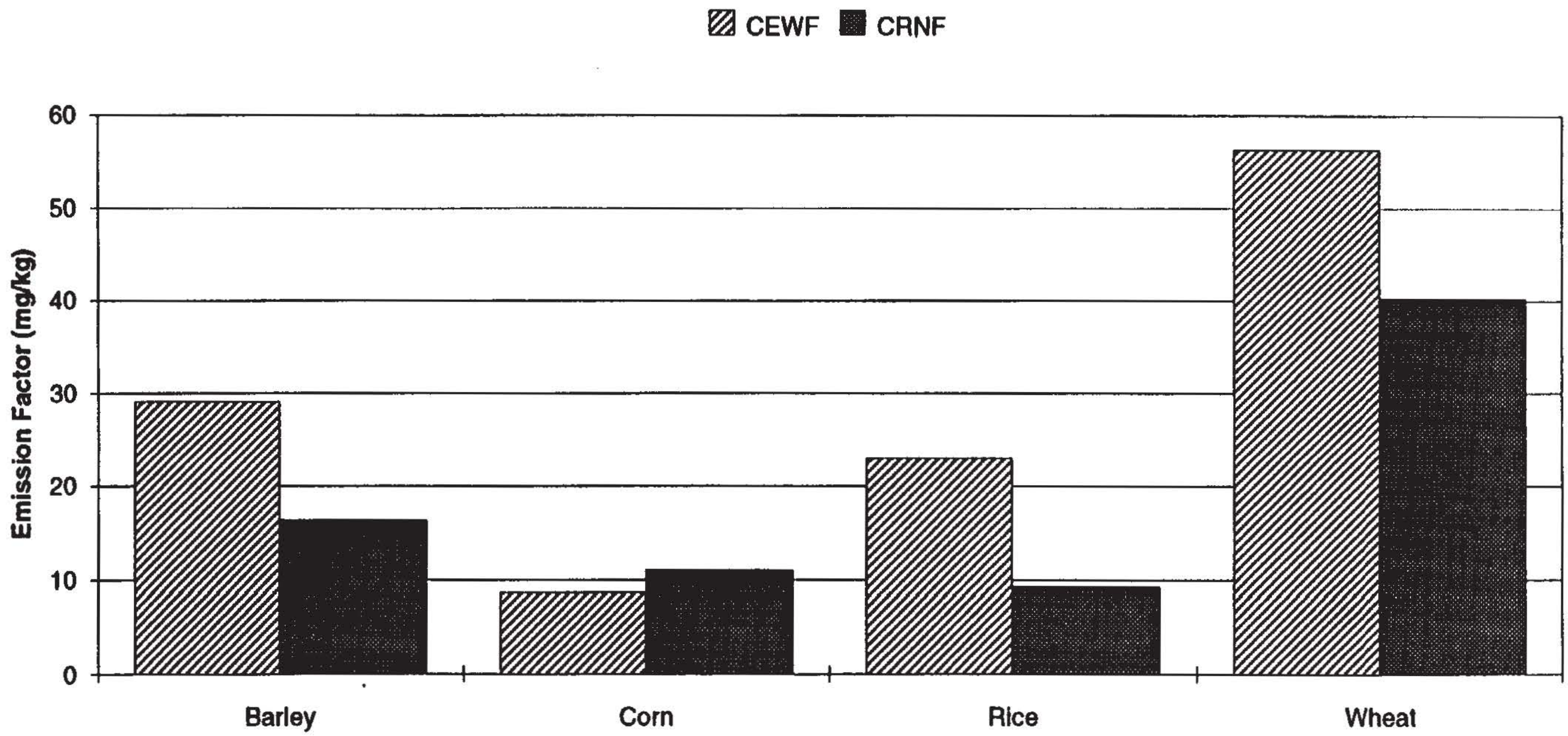


Figure 4.5.6. Average Styrene emission factors

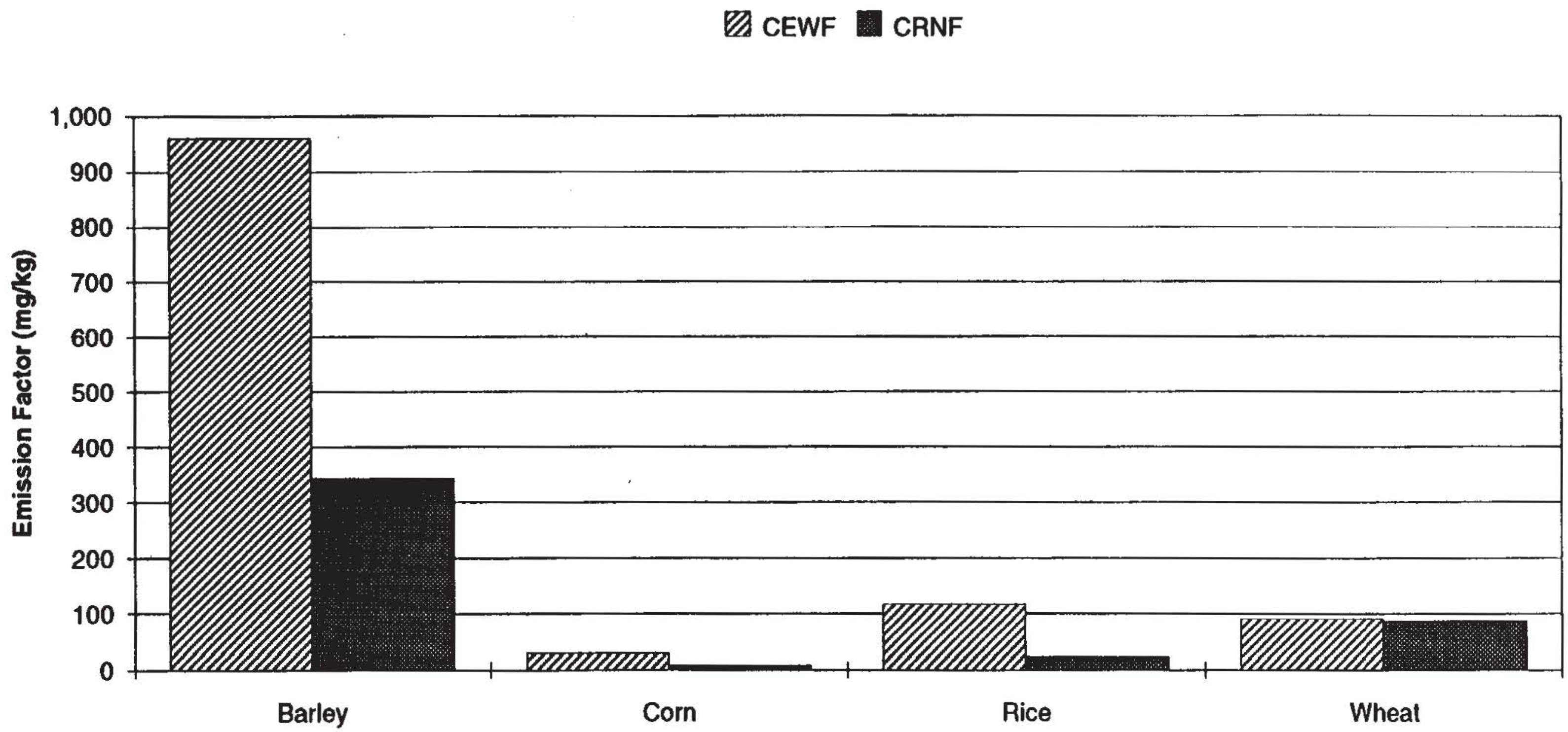


Figure 4.5.7. Average Toluene emission factors

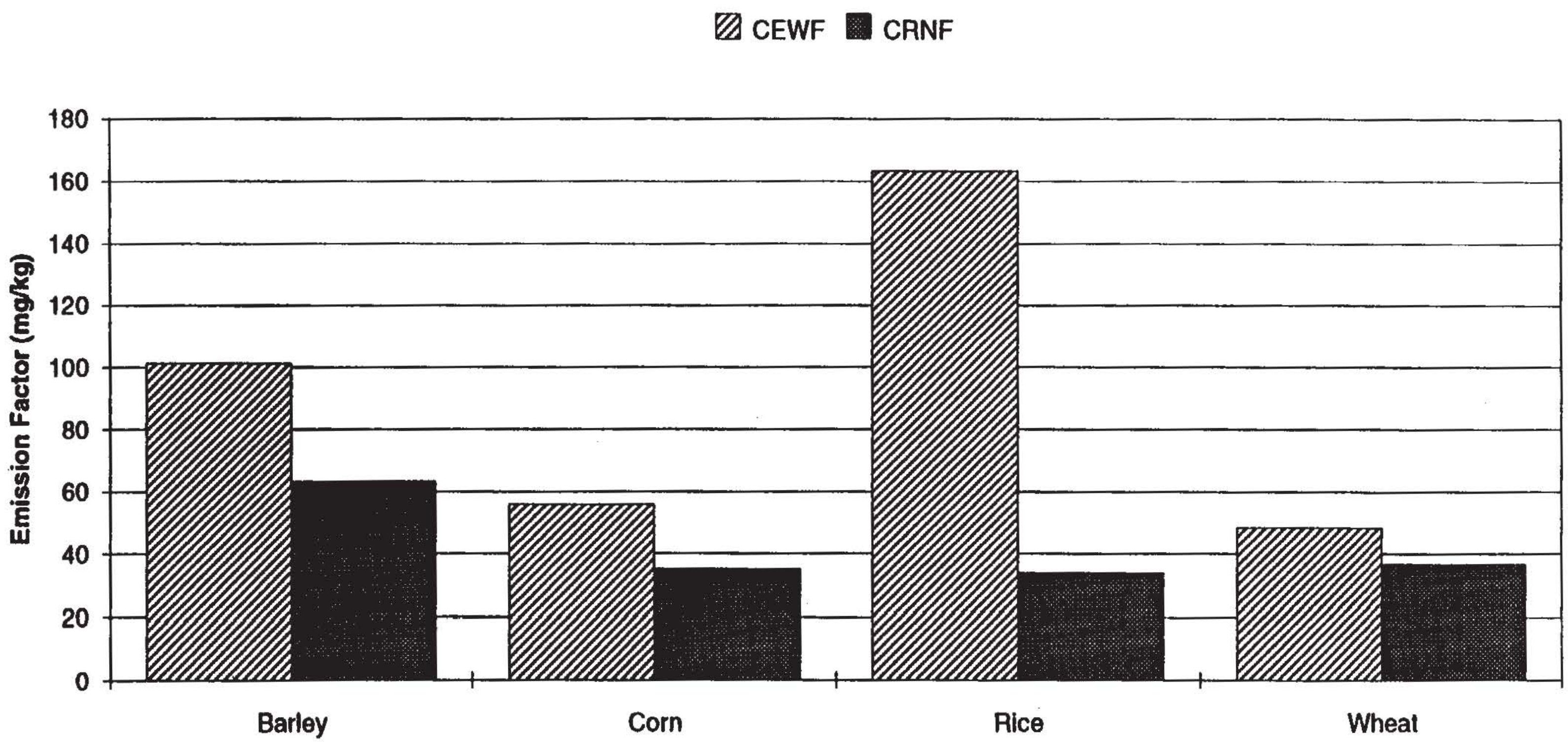


Figure 4.5.8. Average Xylene emission factors

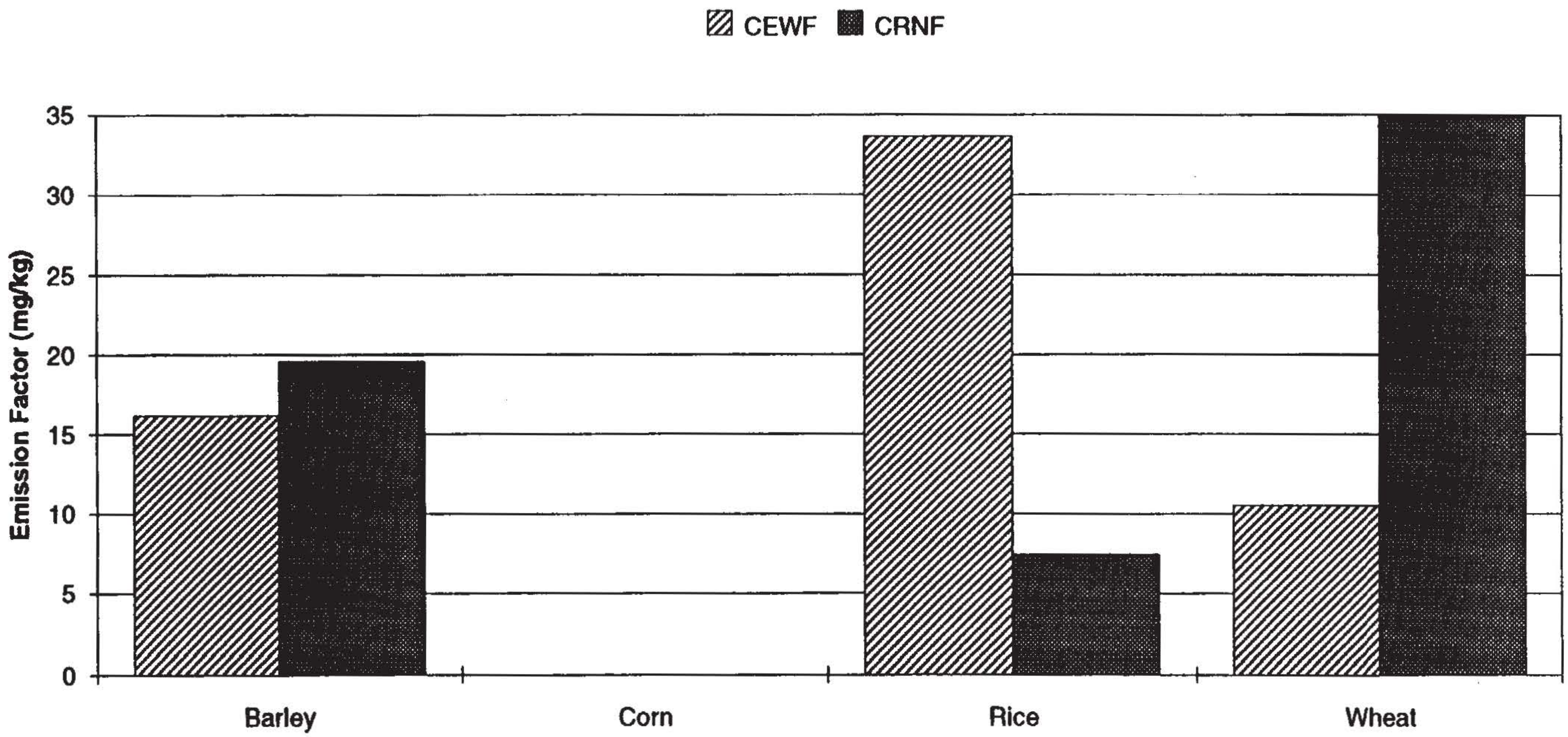


Figure 4.5.9. Average Benzene emission factors, flaming and smoldering stages, forest slash.

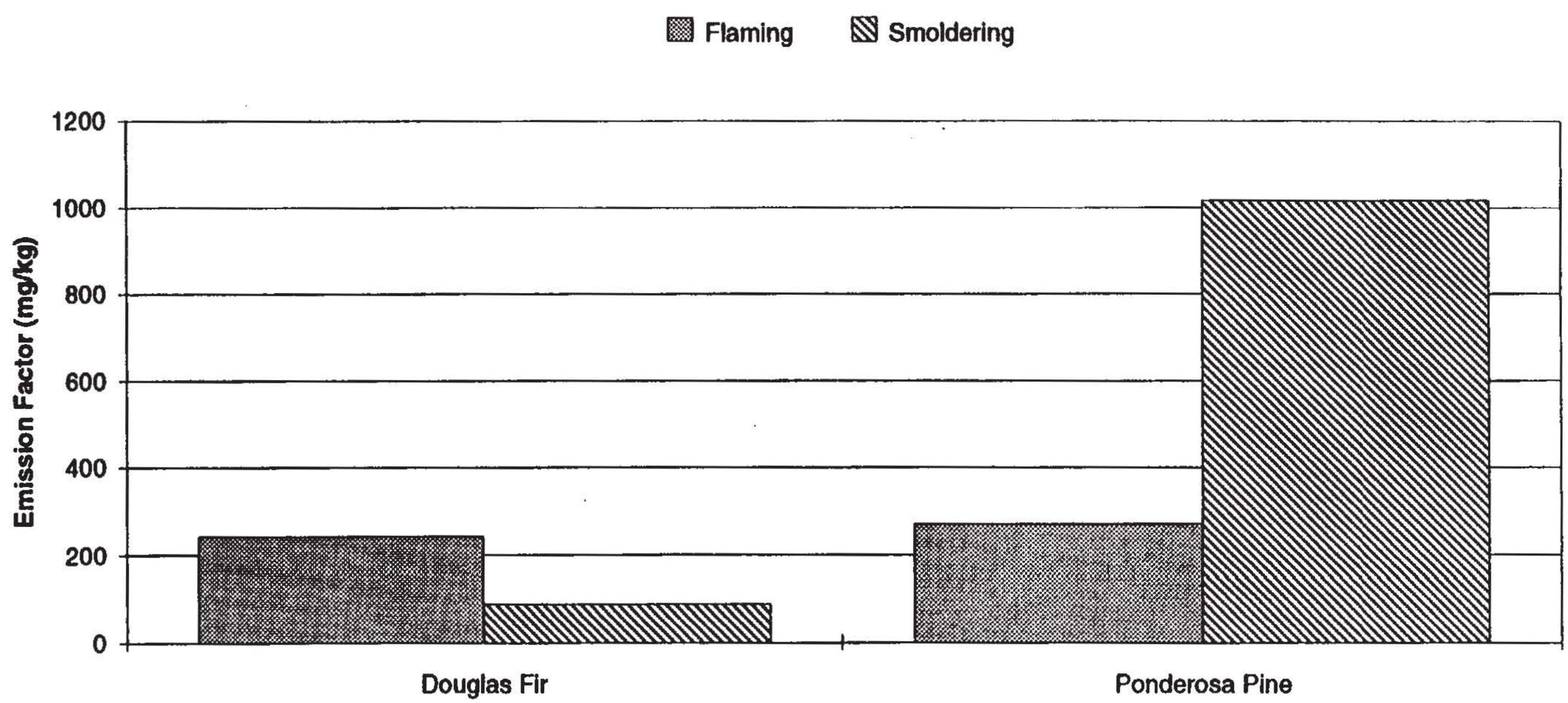


Figure 4.5.10. Average Styrene emission factors, flaming and smoldering stages, forest slash.

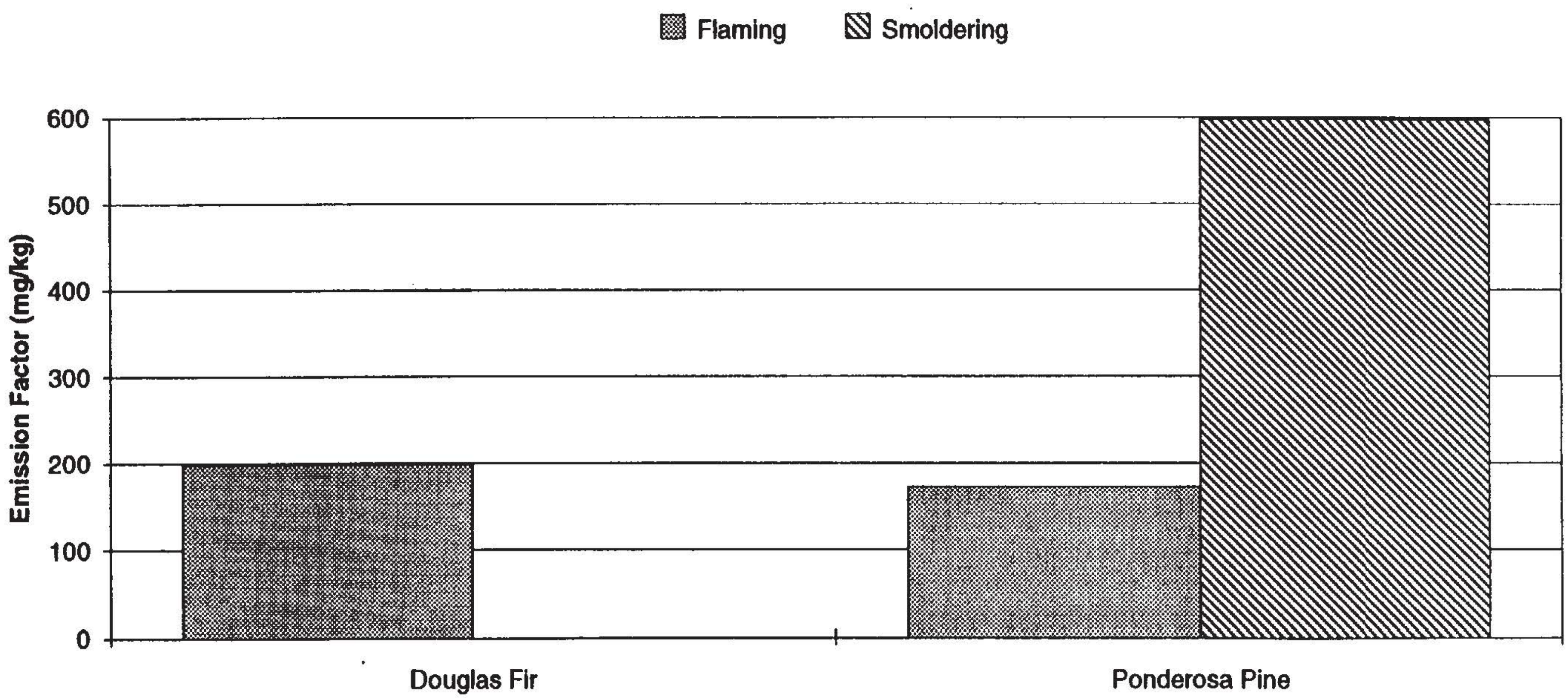


Figure 4.5.11. Average Naphthalene emission factors, flaming and smoldering stages, forest slash.

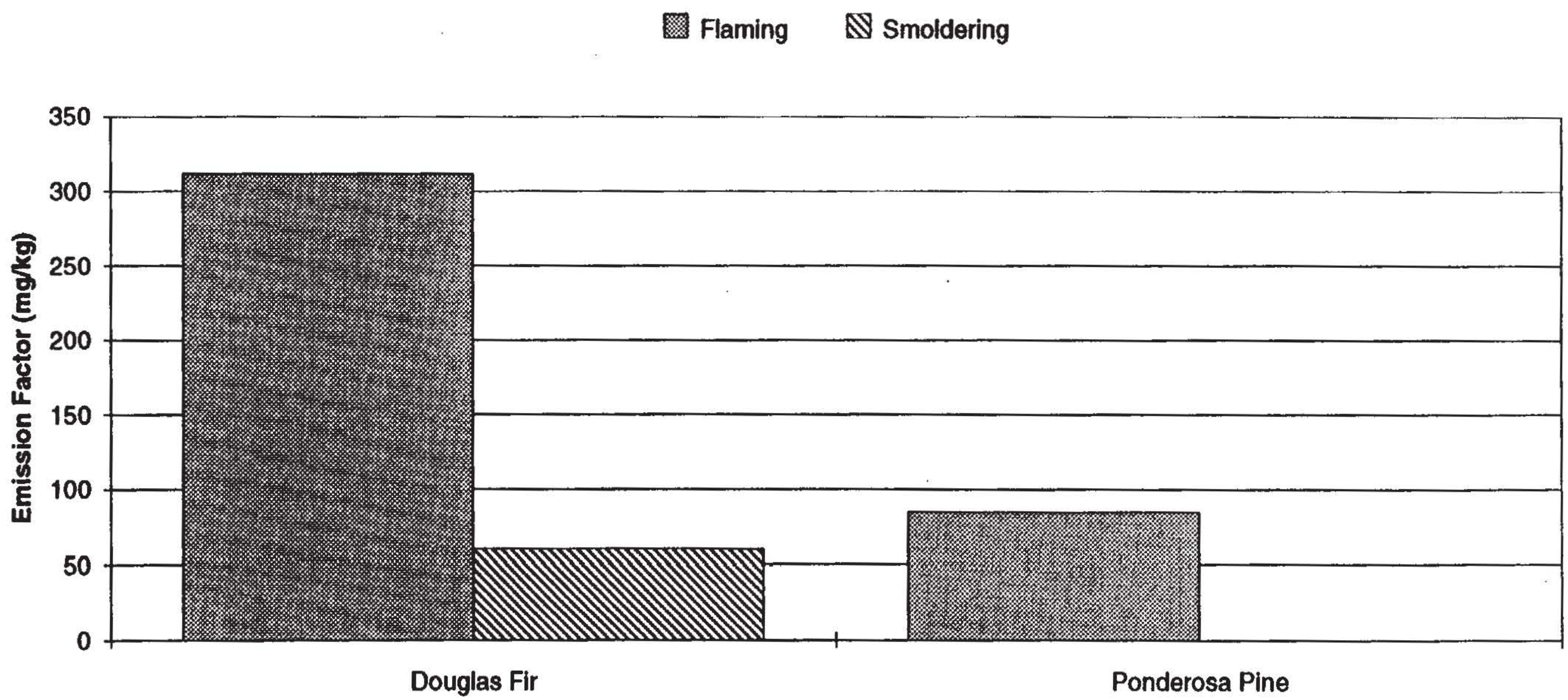


Figure 4.5.12. Emission factors for naphthalene as determined by VOC and PAH analyses (full range).

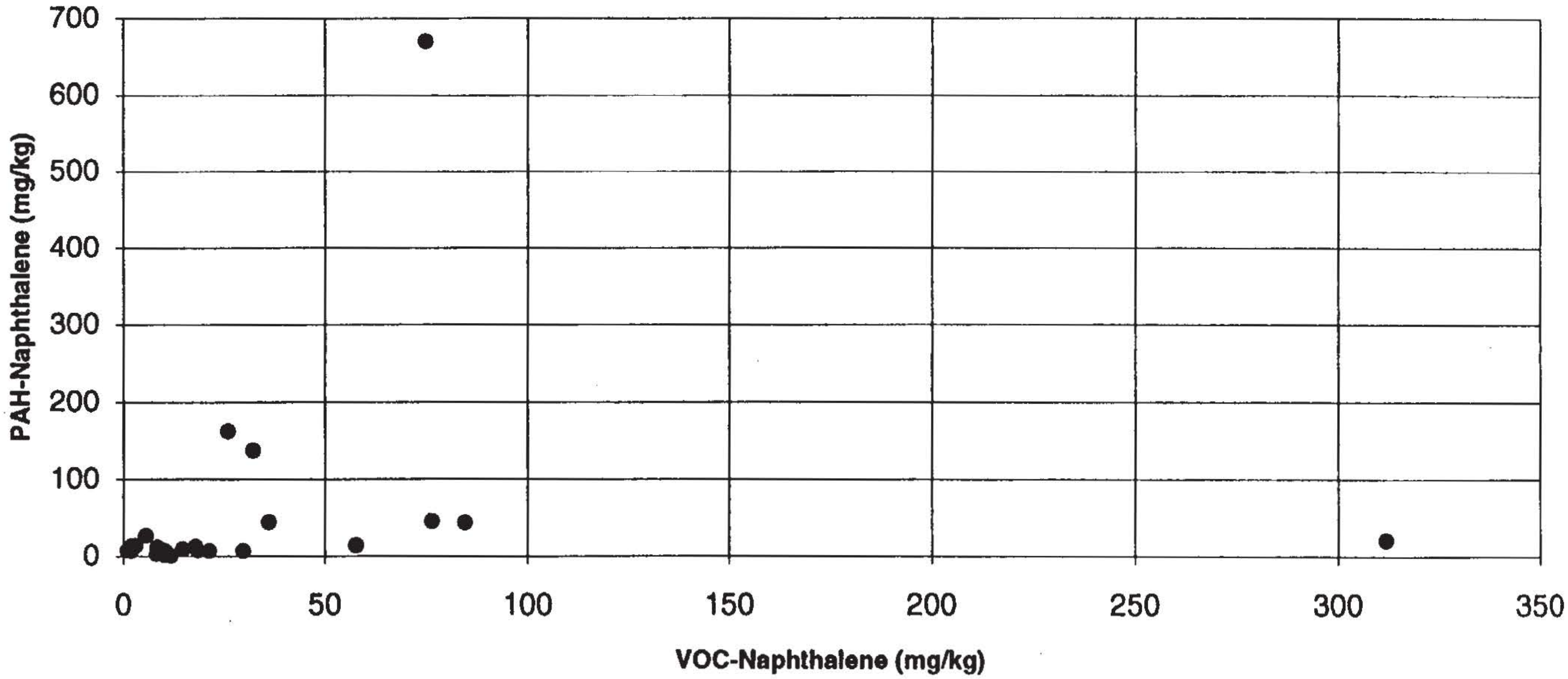


Figure 4.5.13. Emission factors for naphthalene as determined by VOC and PAH analyses (low range, line is 1:1).

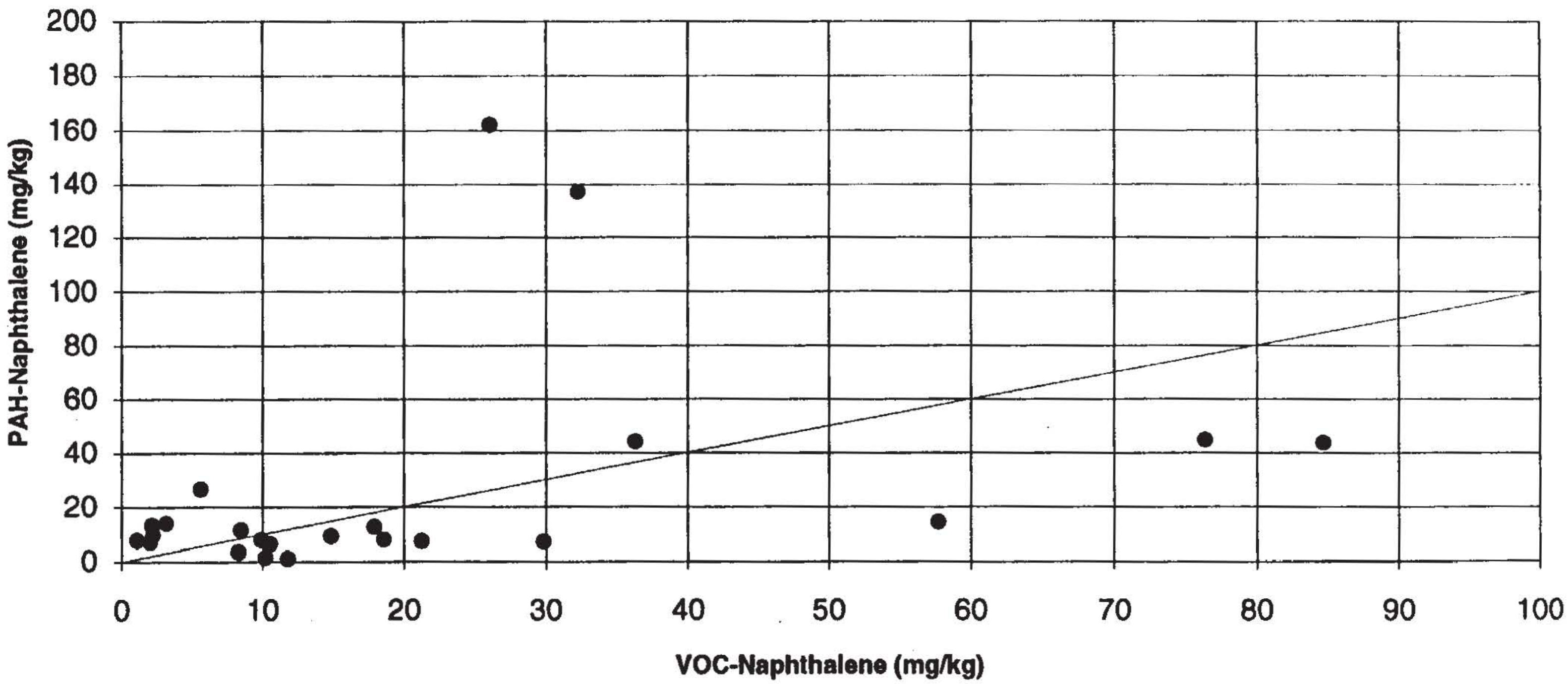


Figure 4.5.14. Fraction of PAH on primary filters against stack gas temperature.

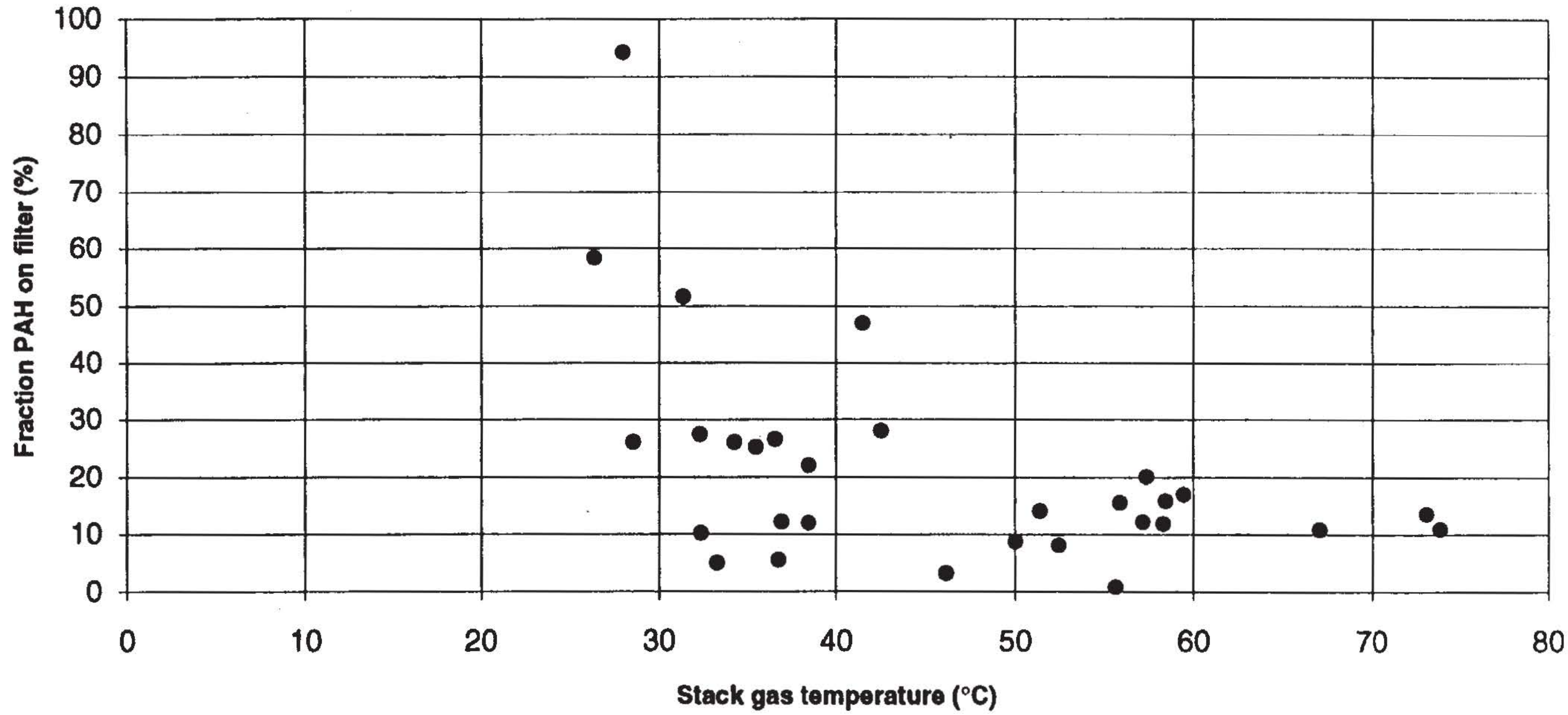


Figure 4.5.15. Emission factors for phenanthrene and fluoranthene.

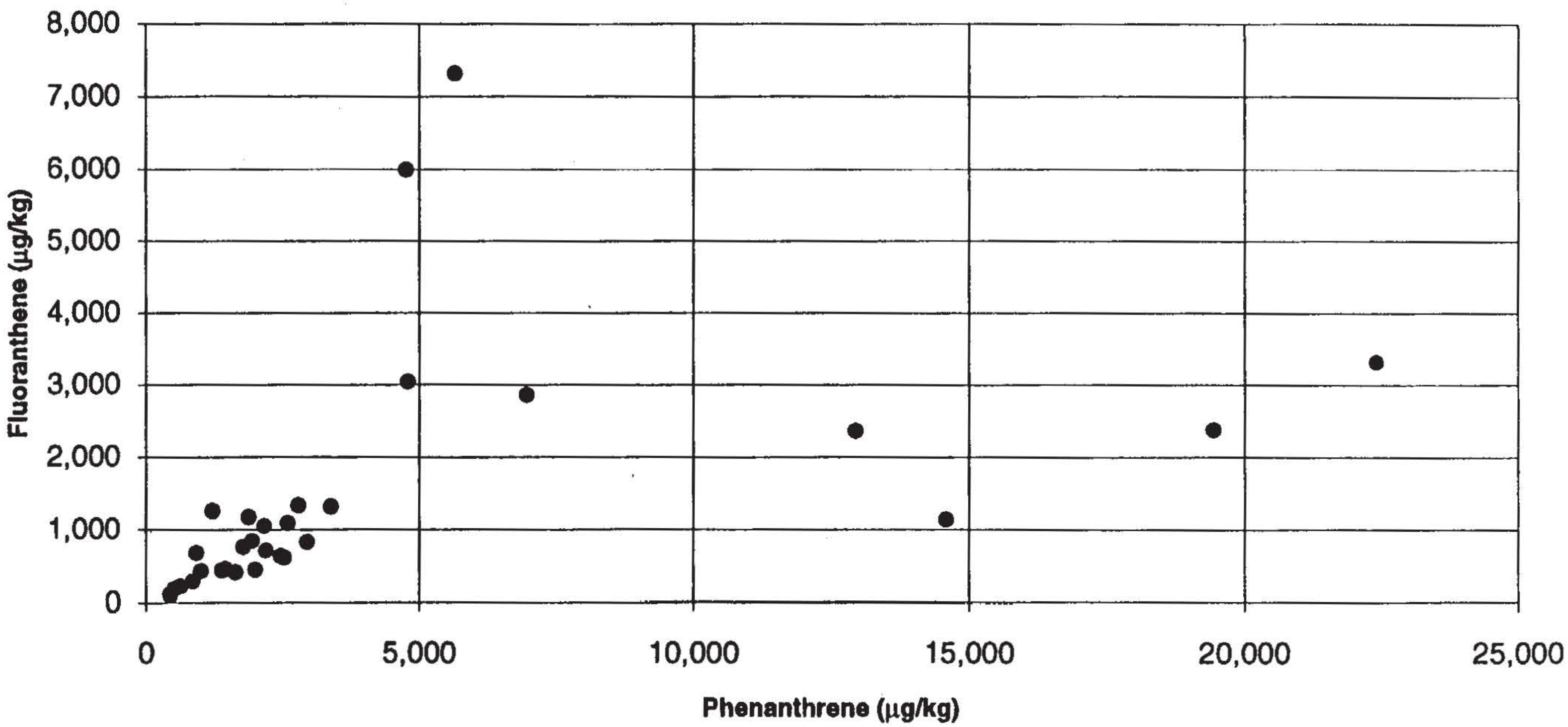


Figure 4.5.16. Emission factors for fluoranthene and pyrene.

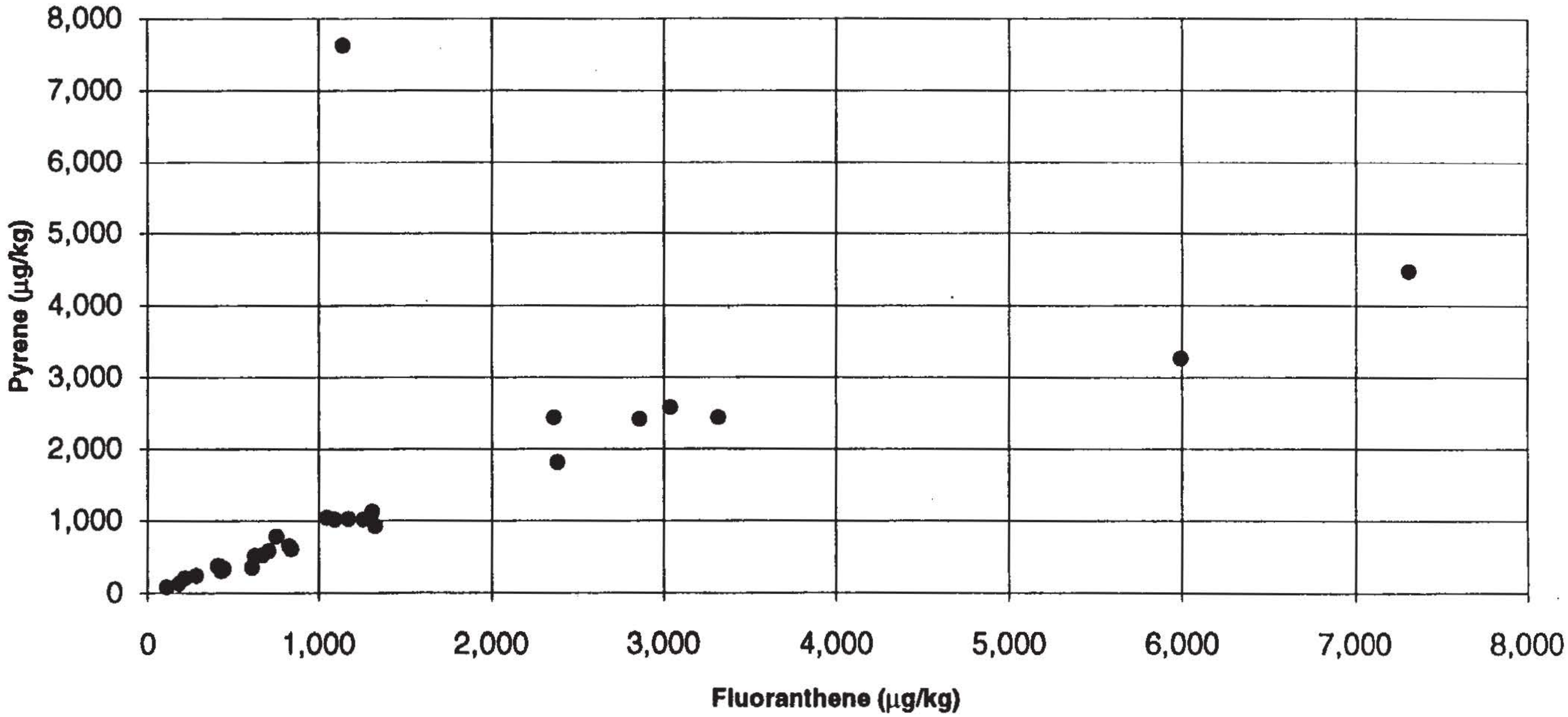


Figure 4.5.17. Emission factors for phenanthrene and anthracene.

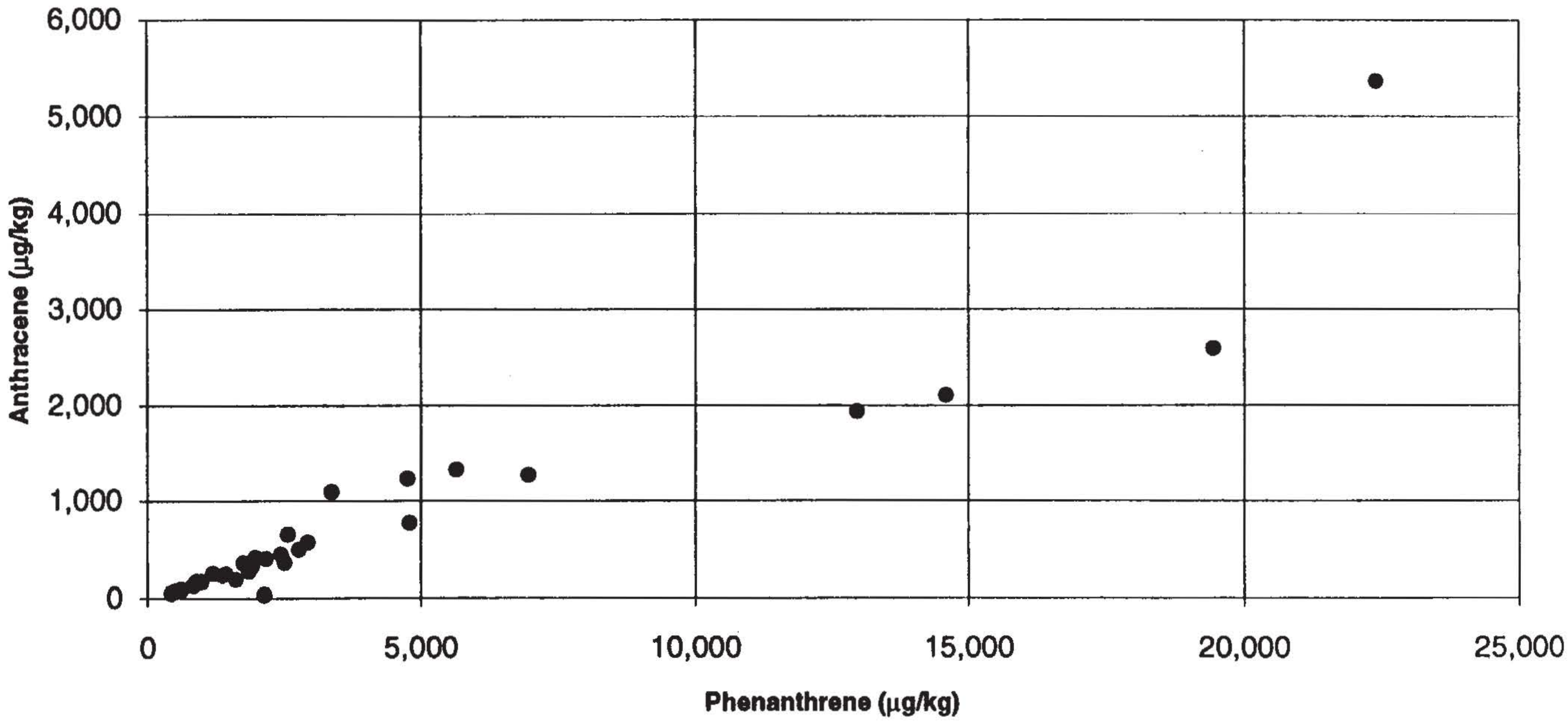


Figure 4.5.18. Emission factors for benzo[a]pyrene and benzo[e] pyrene.

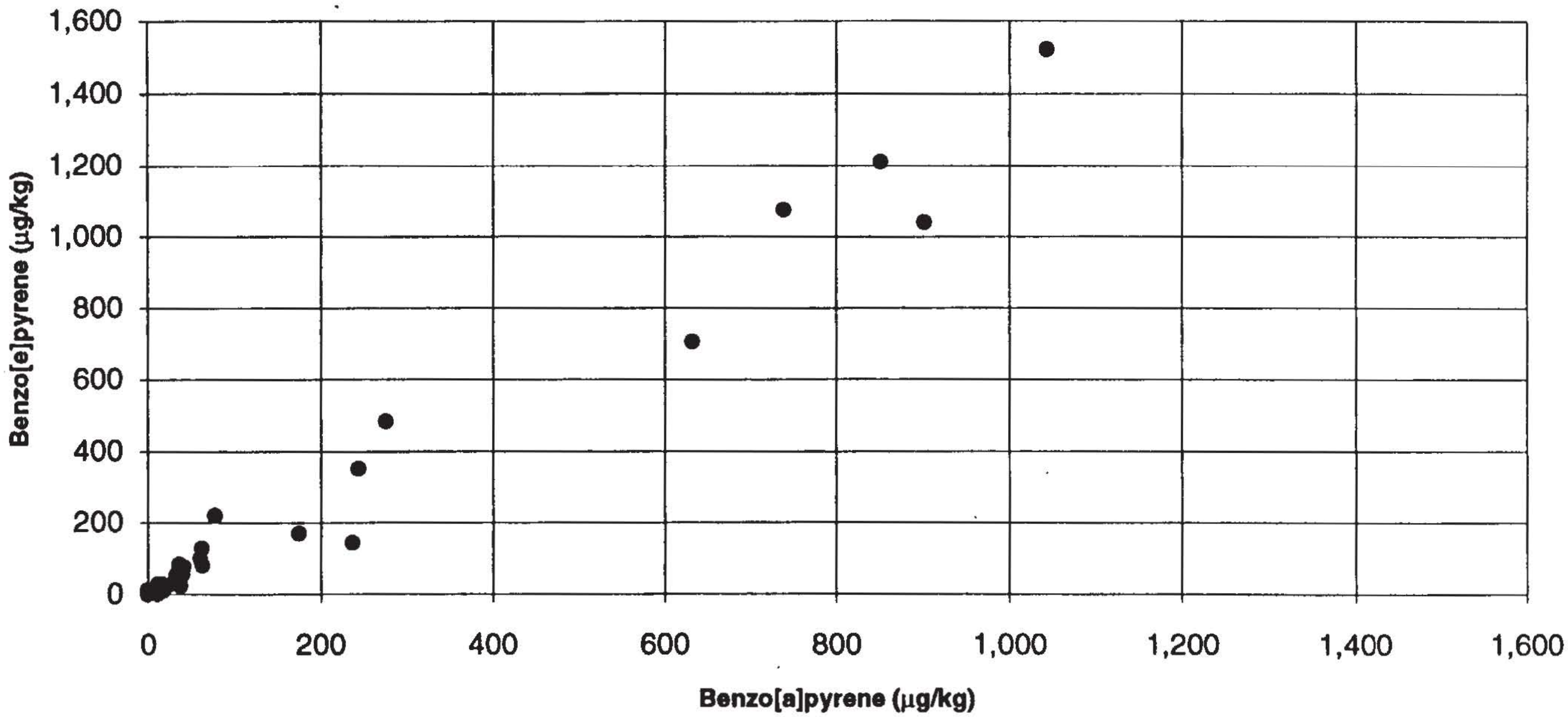


Figure 4.6.1. Carbon Balance-Spreading Fires

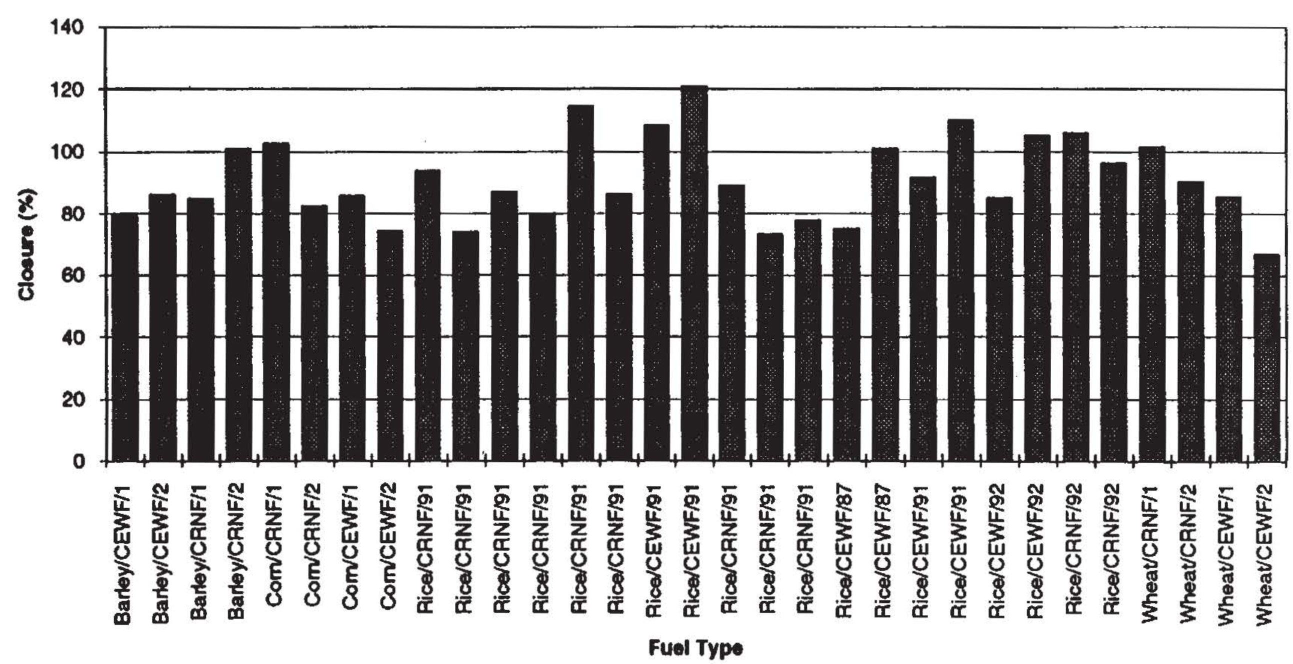


Figure 4.6.2. Carbon Balance - Pile Fires

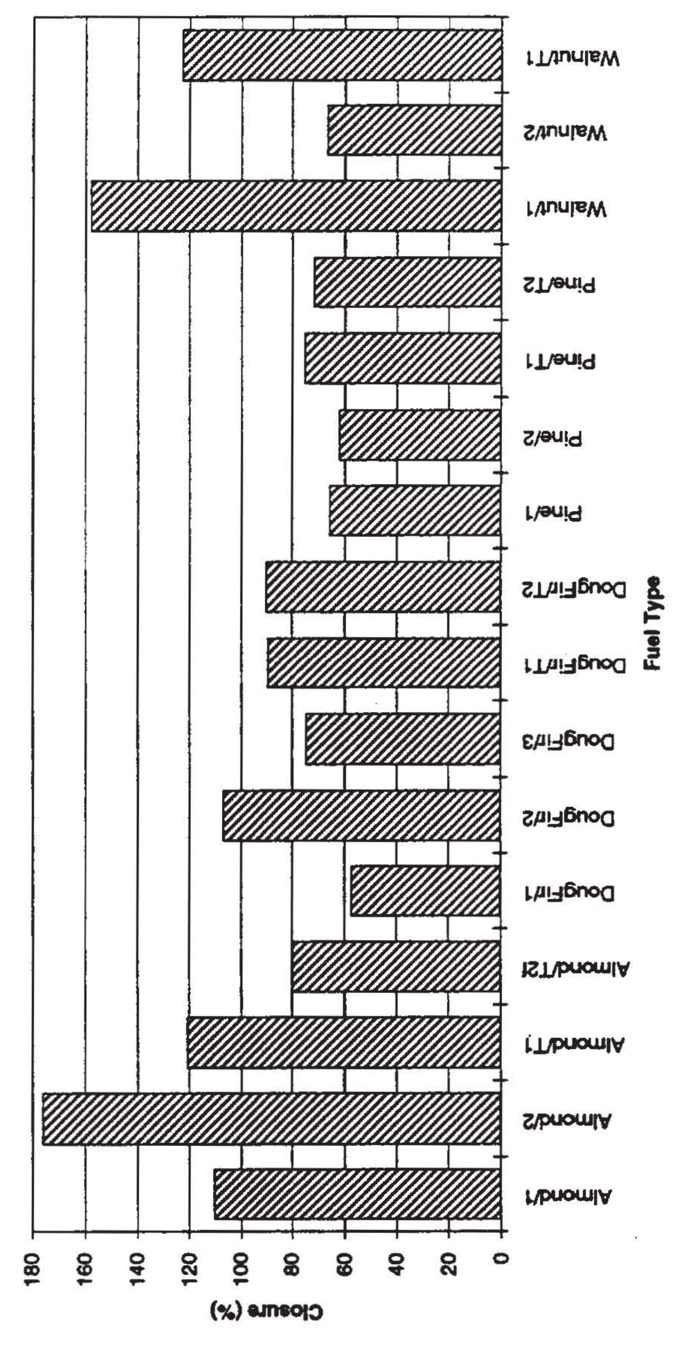


Figure 4.6.3. Nitrogen Balance-Spreading Fires

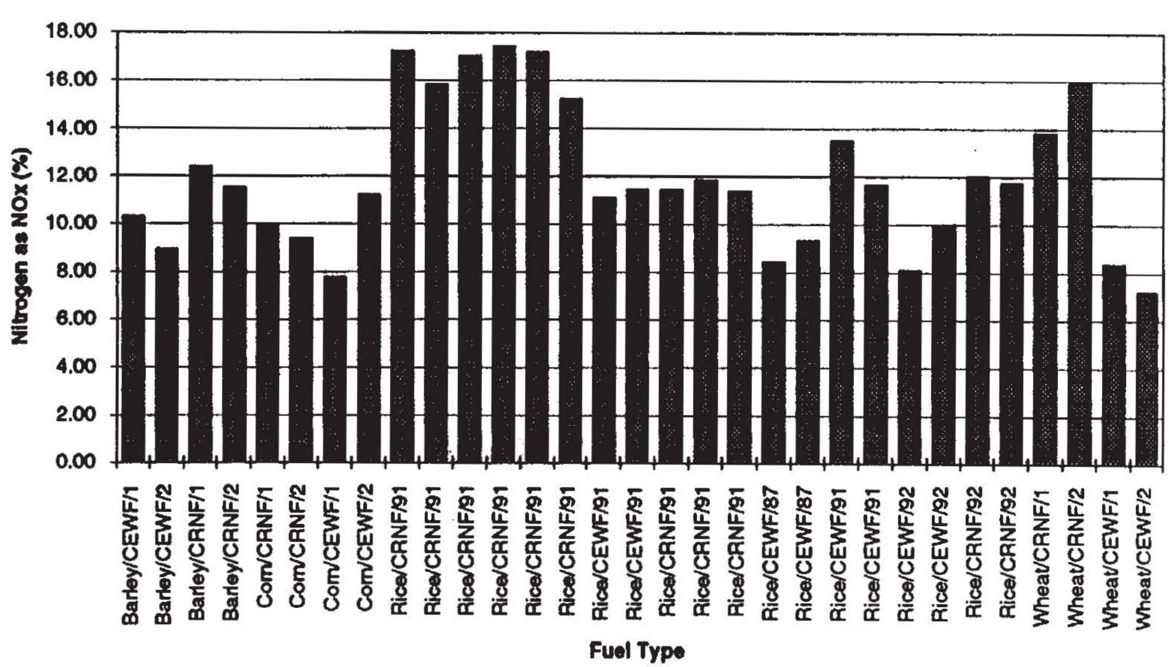


Figure 4.6.4. Nitrogen Balance - Pile Fires

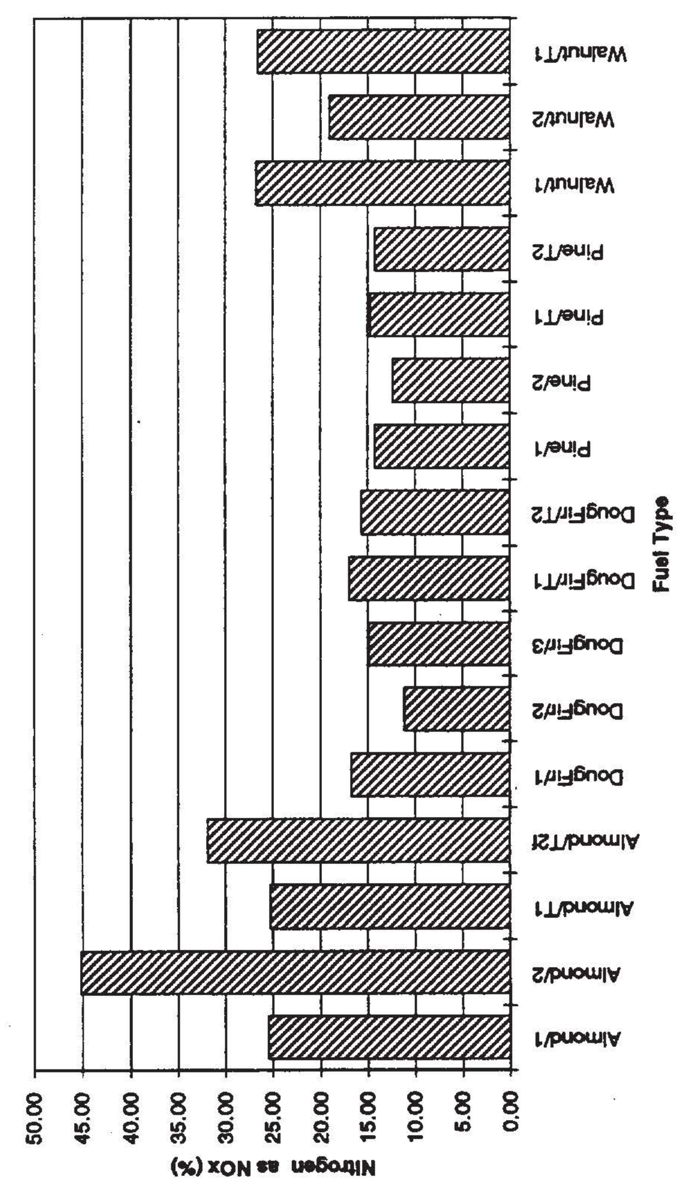


Figure 4.6.5. Results of nitrogen balances - spreading fires.

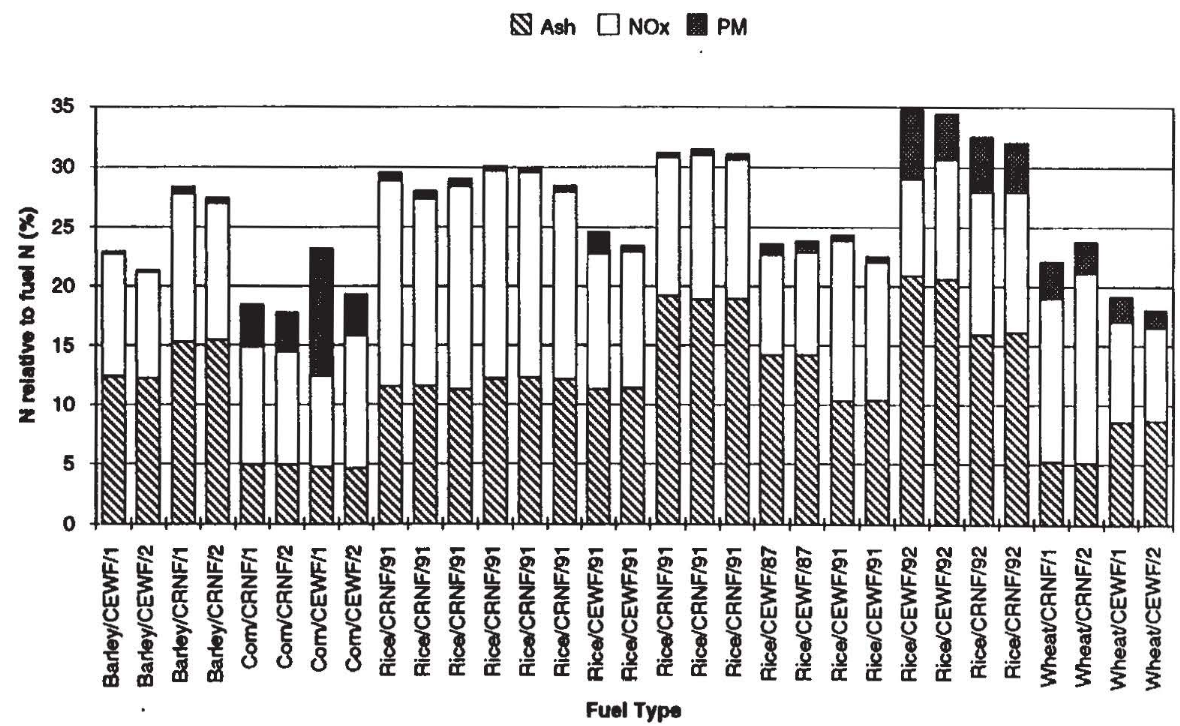


Figure 4.6.6. Normalized nitrogen distribution - spreading fires.

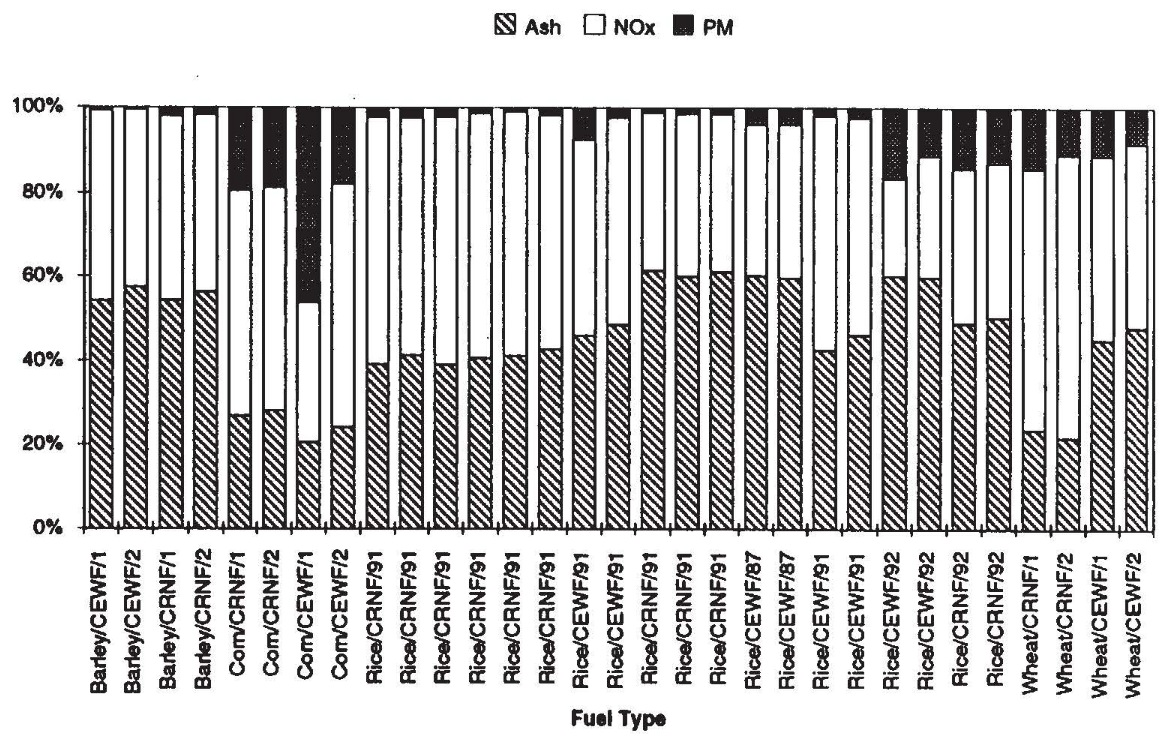


Figure 4.6.7. Results of nitrogen balances - pile fires.

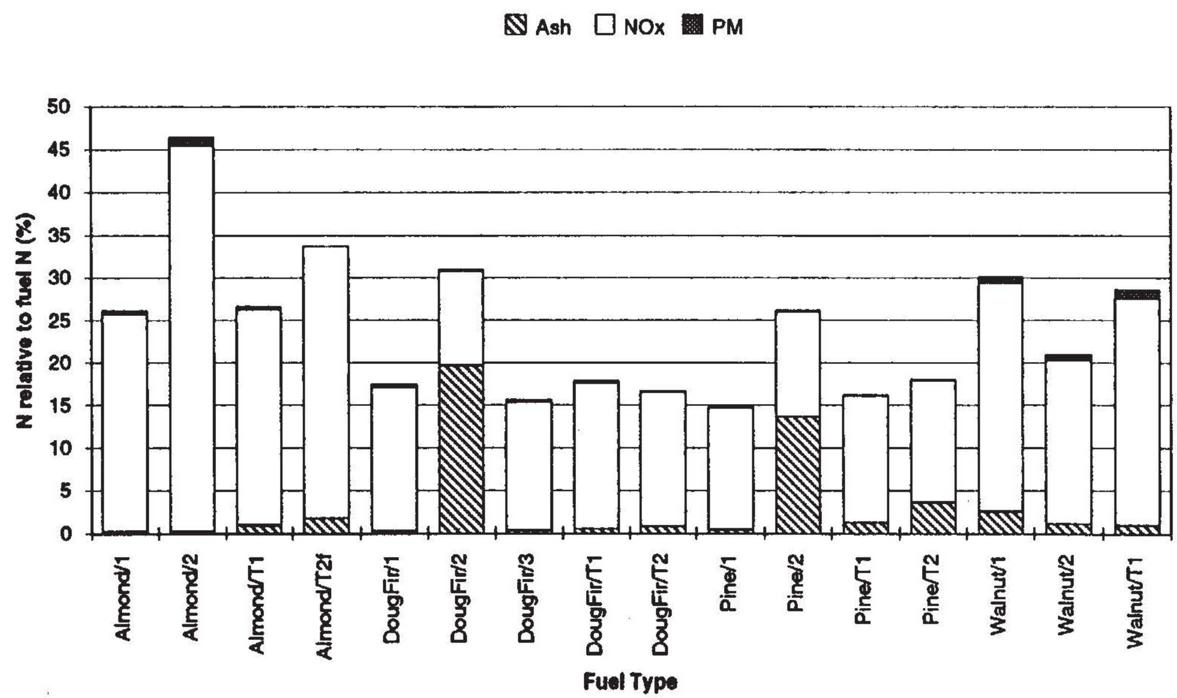


Figure 4.6.8. Normalized nitrogen distribution - pile fires.

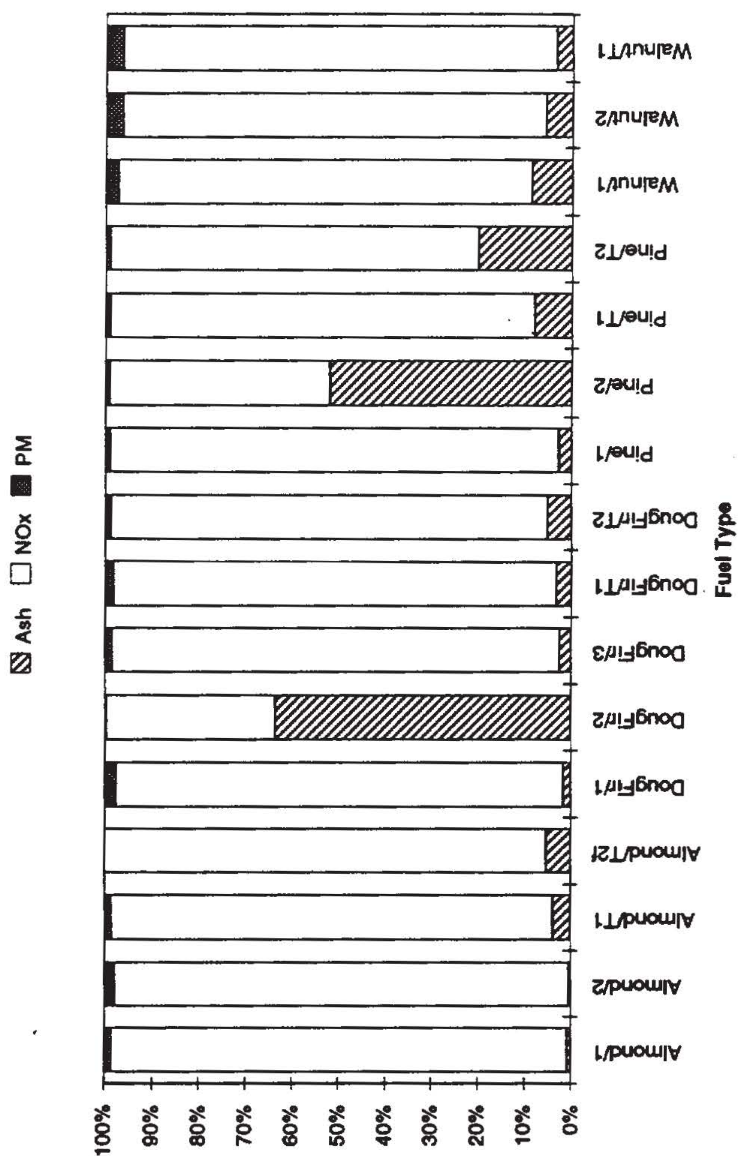


Figure 4.6.9. Fuel sulfur emitted as SO_2 - spreading fires.

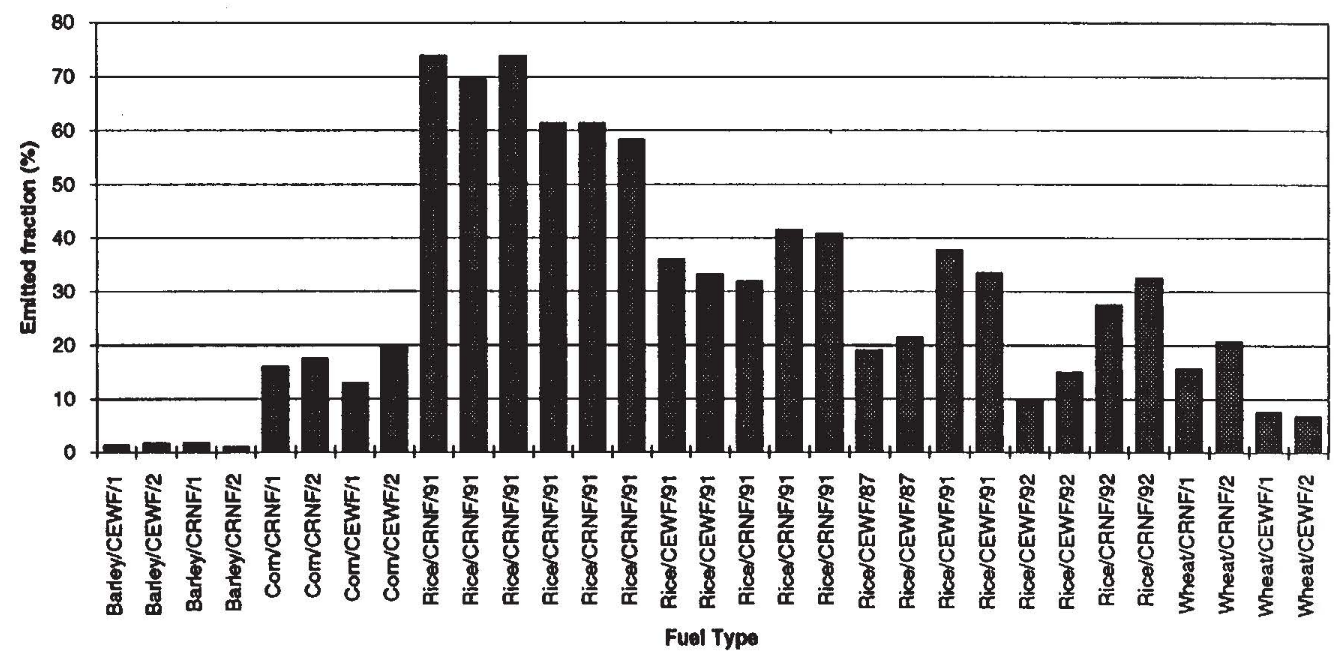
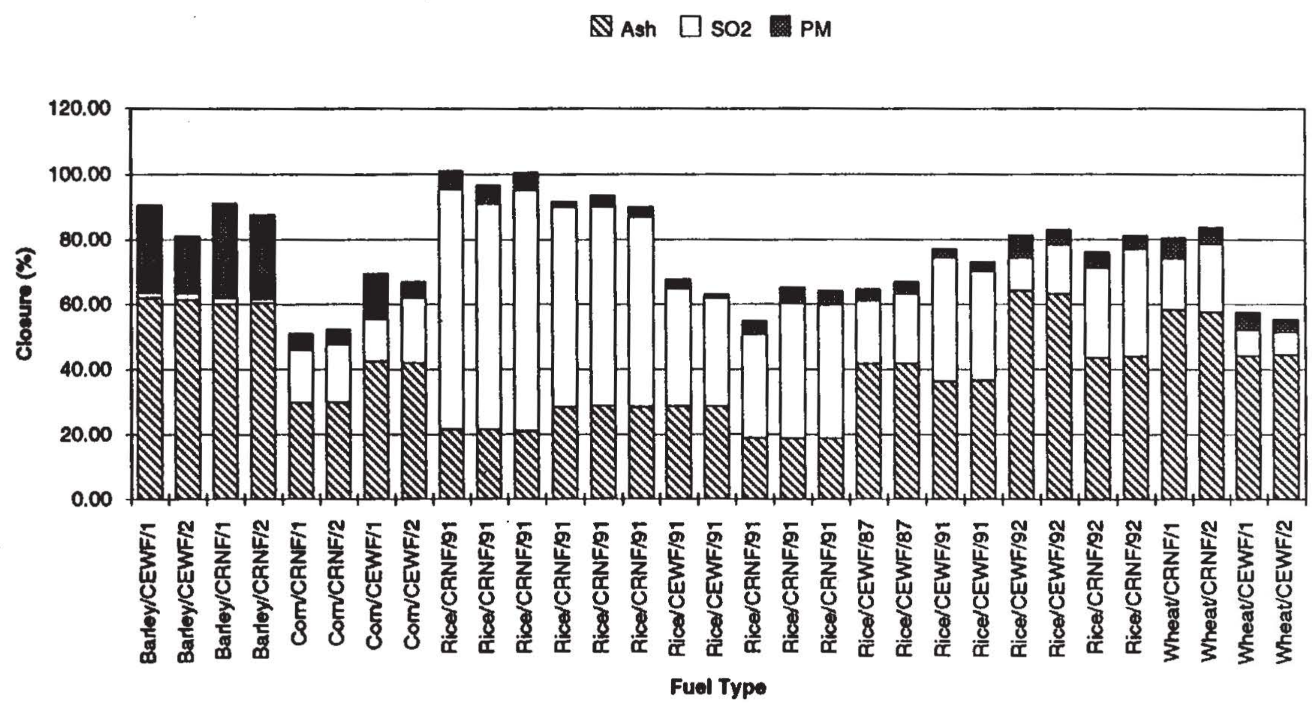


Figure 4.6.10. Sulfur balance - Spreading fires



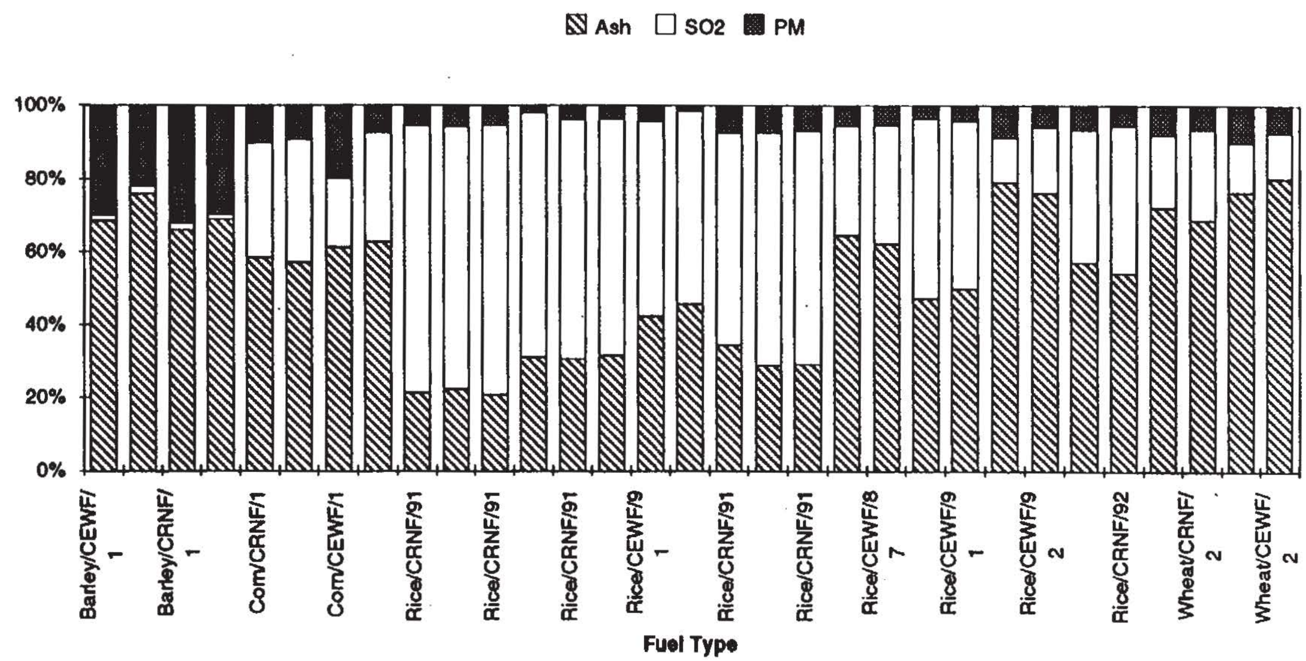
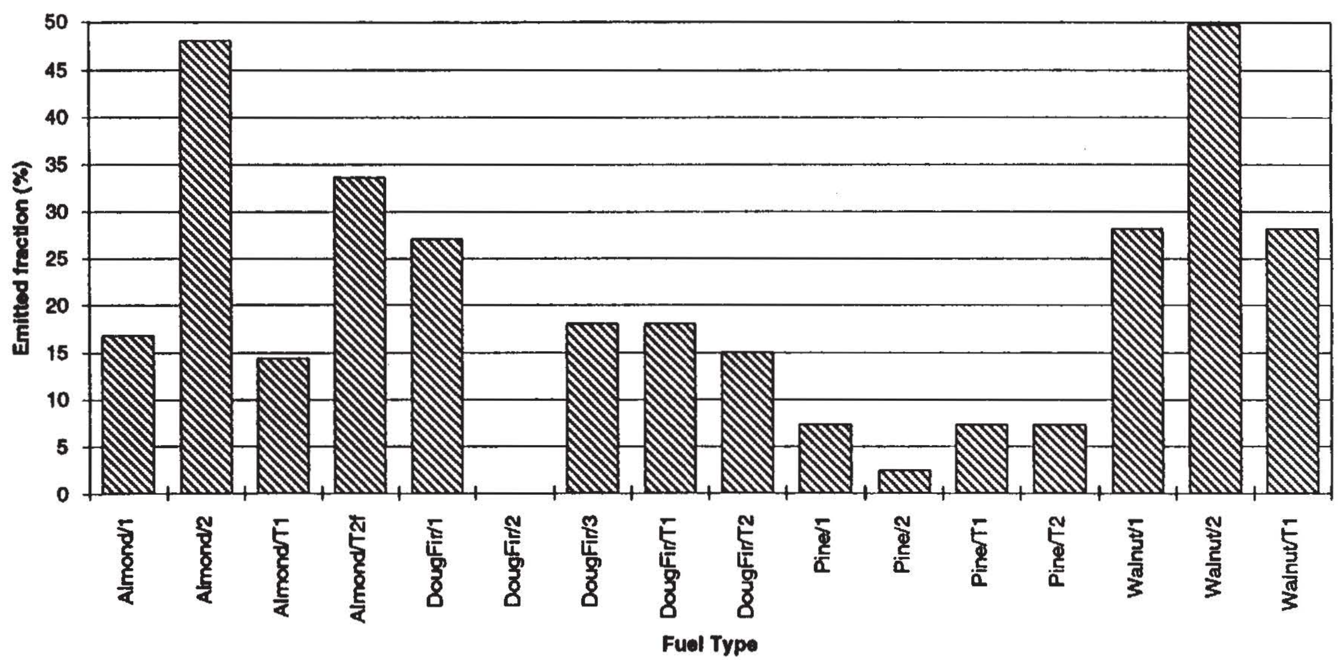


Figure 4.6.11. Normalized sulfur balance - Spreading fires.

Figure 4.6.12. Fuel sulfur emitted as SO2 - pile fires.



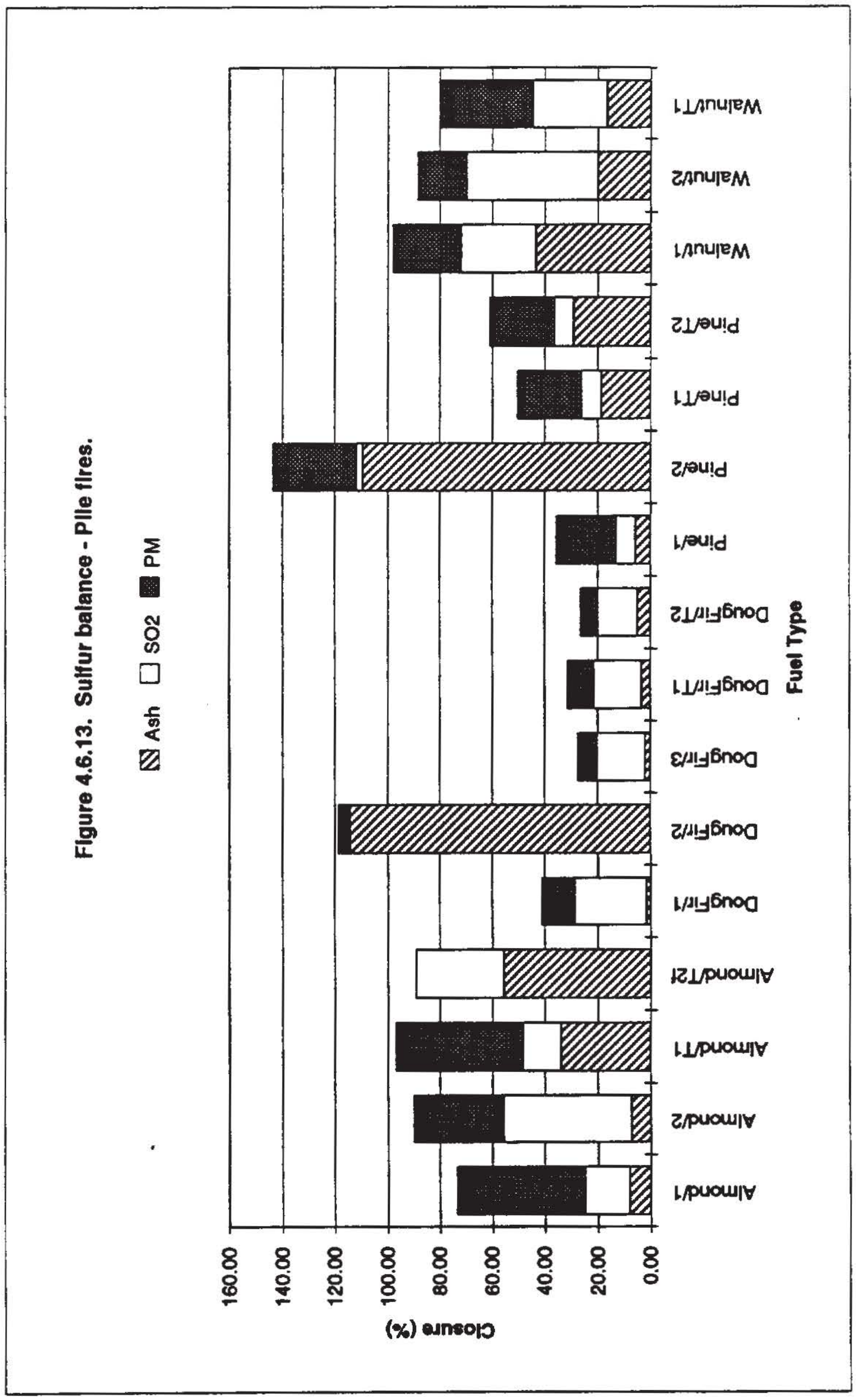


Figure 4.6.13. Sulfur balance - Pile fires.

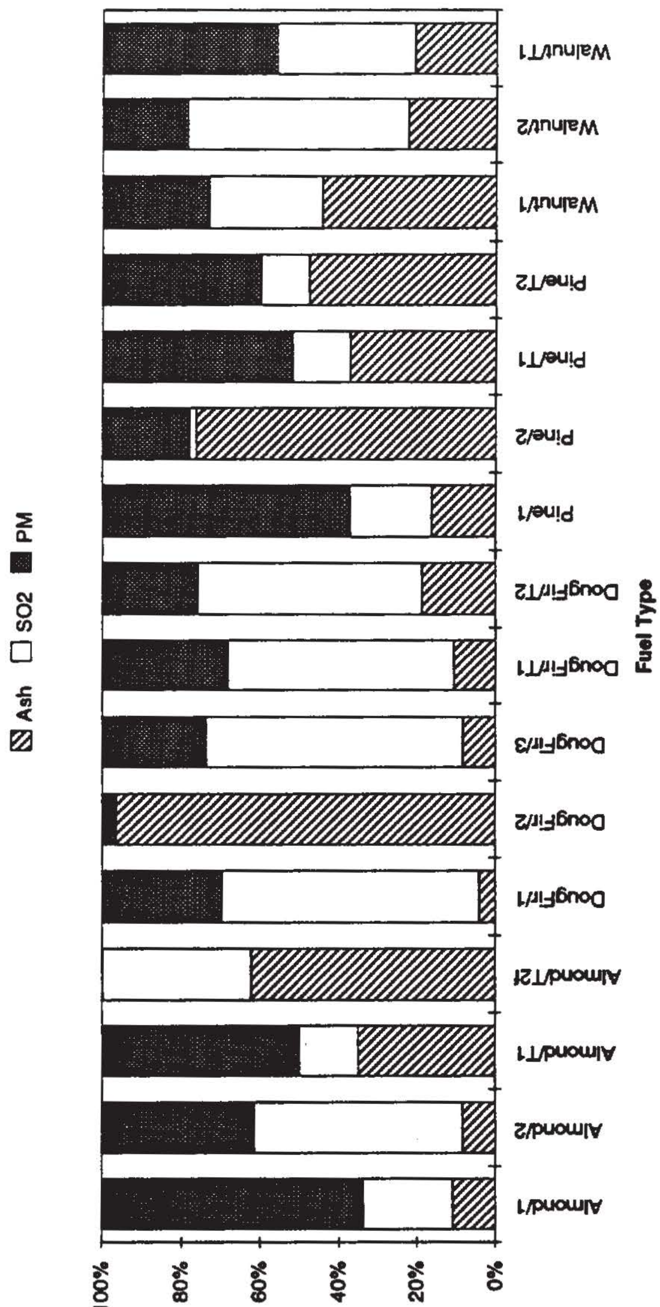


Figure 4.6.14. Normalized sulfur balance - Pile fires.

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Table 4.7.1. Regression statistics, predicted burning rate for spreading fires.

Regression Statistics	
Multiple R	0.91228728
R Square	0.83226808
Adjusted R Square	0.79872169
Standard Error	1.77577481
Observations	31

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	5	391.1679824	78.23359649	24.8094715	6.04524E-09
Residual	25	78.83440467	3.153376187		
Total	30	470.0023871			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-24.9384267	6.324926576	-3.942880026	0.00044664	-37.96484766	-11.9120057
Inlet Air Temperature (°C)	0.705807	0.093089573	7.582019913	1.8697E-08	0.514085567	0.89752843
Air Relative Humidity (%)	0.05365289	0.030710864	1.747033044	0.09086336	-0.00959727	0.11690306
Fuel Moisture Content (% w.b.)	0.33718816	0.412610898	0.81720615	0.42025348	-0.512599293	1.18697562
Inlet Air Mass Flow Rate (kg/s)	-0.29352361	0.381084437	-0.770232473	0.44718534	-1.078381149	0.49133393
Fuel Loading Rate (g/sq.m d.b.)	0.01381568	0.003458911	3.99422833	0.00038795	0.006691925	0.02093944

Table 4.7.2. Regression statistics for burning rate in rice straw.

Regression Statistics	
Multiple R	0.93309313
R Square	0.87066278
Adjusted R Square	0.8209177
Standard Error	1.3193924
Observations	19

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	5	152.3413428	30.46826855	17.5024892	2.28325E-05
Residual	13	22.63035198	1.740796306		
Total	18	174.9716947			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	30.7973549	18.16445115	1.695474011	0.10721363	-8.444548502	70.0392582
Inlet Air Temperature (°C)	0.63735668	0.105506404	6.040928822	1.0365E-05	0.409423994	0.86528936
Fuel Moisture Content (% w.b.)	-0.66315405	0.457832391	-1.448464675	0.16468356	-1.652240604	0.32593251
Inlet Air Mass Flow Rate (kg/s)	-1.37237957	0.489386531	-2.804285542	0.0117285	-2.429634692	-0.31512445
Fuel Loading Rate (g/sq.m d.b.)	-0.0521416	0.027185488	-1.917993705	0.07111756	-0.110872261	0.00658907
Air Relative Humidity (%)	0.03213202	0.025452353	1.262438147	0.22290278	-0.022854434	0.08711848

Table 4.7.3. Regression statistics from multiple linear regression of fire spreading rate, rice straw.

Regression Statistics	
Multiple R	0.92605643
R Square	0.85758051
Adjusted R Square	0.80280379
Standard Error	0.10881313
Observations	19

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	5	0.92685429	0.185370858	15.6559289	4.18977E-05
Residual	13	0.15392387	0.011840298		
Total	18	1.08077816			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	3.48297649	1.498061393	2.324989154	0.03196672	0.246612236	6.71934075
Inlet Air Temperature (°C)	0.05168906	0.00870134	5.940356096	1.2737E-05	0.032890961	0.07048716
Fuel Moisture Content (% w.b.)	-0.05350632	0.037758423	-1.417069823	0.17353901	-0.13507842	0.02806578
Inlet Air Mass Flow Rate (kg/s)	-0.11490271	0.040360761	-2.846891466	0.01070308	-0.202096811	-0.0277086
Fuel Loading Rate (g/sq.m d.b.)	-0.00581606	0.002242046	-2.594086588	0.01832572	-0.010659705	-0.00097242
Air Relative Humidity (%)	0.0021026	0.00209911	1.001663934	0.3297822	-0.002432248	0.00663745

Table 4.7.4. Regression statistics, fire spreading rate in rice straw from inlet air temperature.

Regression Statistics	
Multiple R	0.8586226
R Square	0.73723277
Adjusted R Square	0.72177588
Standard Error	0.12924966
Observations	19

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	0.796785081	0.796785081	47.6960441	2.54129E-06
Residual	17	0.283993078	0.016705475		
Total	18	1.08077816			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.65172592	0.212650465	-3.064775416	0.00667376	-1.10037981	-0.20307203
Inlet Air Temperature (°C)	0.04621813	0.006692236	6.906232263	1.8601E-06	0.032098731	0.06033754

Table 4.7.5. Emission factors (%) reported by Darley, 1977; 1979, for barley straw.

	Barley (backing fires)				
	15% slope			25% slope	
(Darley, 1977)					
Moisture (%)	10.5	8.7	10.1	10.0	10.0
Particulate matter	0.397	0.427	0.534	0.433	0.478
CO	4.492	5.613	6.157	6.294	6.261
HC	0.313	0.307	0.367	0.561	0.661
MMAD (μm)	0.03				
(Darley, 1979)					
Moisture (%)				13.4	12.7
Particulate matter				0.462	0.670
CO				8.788	8.843
HC				0.831	0.619
NO				0.167	
NO_2				0.058	
NO_x (as NO_2)				0.314	
SO_2 (by difference)				0.312	

Table 4.7.6. Emission factors (%) reported by Darley, 1977; 1979, for corn stover.

	Corn (backing fires)				
	15% slope			25% slope	
(Darley, 1977)					
Moisture (%)	16.9	10.8	14.1	7.6	11.7
Particulate matter	0.915	0.740	0.669	0.817	0.747
CO	6.534	5.359	5.693	5.969	5.798
HC	0.764	0.600	0.600	0.768	0.623
MMAD (μm)	0.12			0.07	
(Darley, 1979)					
Moisture (%)				15.4	14.5
Particulate matter				0.361	0.310
CO				5.508	5.930
HC				0.508	0.380
NO				0.160	
NO_2				0.018	
NO_x (as NO_2)				0.262	
SO_2 (by difference)				0.030	

Table 4.7.7. Emission factors (%) reported by Darley, 1977; 1979, for rice straw.

	Rice (backing fires)		
	15% slope	25% slope	
(Darley, 1977)			
Moisture (%)	11.7	10.2	
Particulate matter	0.470	0.351	
CO	4.196	4.866	
HC	0.311	0.445	
MMAD (µm)	0.07	0.10	
(Darley, 1979)			
Moisture (%)		14.7	15.1
Particulate matter		0.094	0.118
CO		-	-
HC		0.135	0.188
NO		0.188	
NO_2		0.064	
NO_x (as NO_2)		0.352	
SO_2 (by difference)		0.100	

Table 4.7.8. Emission factors (%) reported by Darley, 1977; 1979, for wheat straw.

	Wheat (backing fires)					
	15% slope				25% slope	
(Darley, 1977)						
Moisture (%)	7.8	8.6	8.5	9.7	7.5	6.6
Particulate matter	0.428	0.531	0.683	0.587	0.638	0.567
CO	4.452	5.246	4.863	5.576	5.989	5.926
HC	0.174	0.290	0.361	0.316	0.822	0.557
MMAD (µm)	0.05				0.06	
(Darley, 1979)						
Moisture (%)					14.9	14.3
Particulate matter					0.464	0.327
CO					7.503	7.707
HC					0.411	0.683
NO					0.123	
NO_2					0.047	
NO_x (as NO_2)					0.236	
SO_2 (by difference)					0.354	

Table 4.7.9. Emission factors (%) reported by Darley, 1977; 1979, for almond tree prunings.

	Almond tree prunings			
	Cold		Roll-on	
(Darley, 1977)				
Moisture (%)	38.9	26.3	38.9	26.3
Particulate matter	0.319	0.244	0.516	0.373
CO	3.061	1.364	4.116	2.476
HC	0.565	0.204	0.859	0.495
MMAD (μm)	0.08	0.07	0.08	0.13
(Darley, 1979)				
Moisture (%)	26.2	26.2		
Particulate matter	0.142	0.115		
CO	2.121	1.836		
HC	0.318	0.285		
NO	0.115			
NO_2	0.041			
NO_x (as NO_2)	0.217			
SO_2 (by difference)	0.020			

Table 4.7.10. Emission factors (%) reported by Darley, 1977, for walnut tree prunings.

	Walnut tree prunings			
	Cold		Roll-on	
(Darley, 1977)				
Moisture (%)	45.2	33.8	45.2	33.8
Particulate matter	0.575	0.415	0.757	0.408
CO	4.051	3.270	5.520	3.240
HC	0.675	0.476	1.086	0.483
MMAD (μm)	0.05	0.08	0.06	0.15

Table 4.7.11. Emission factors (%) reported by Ward, et al., 1989, for broadcast Douglas fir slash.

	Douglas fir (broadcast)		
	Flaming	Smoldering	Fire
CO	7.150	23.150	15.620
CO_2	169.230	140.180	154.100
CH_4	0.230	0.760	0.550
NMHC	0.210	0.420	0.360
PM	1.234	1.749	1.478
PM2.5	0.745	1.306	1.090

Table 4.7.12. Emission factors (%) reported by Ward, et al., 1989, for broadcast long needle pine slash.

	Long needle pine (broadcast)		
	Flaming	Smoldering	Fire
CO	4.450	14.240	8.920
CO_2	170.060	148.550	160.090
CH_4	0.150	0.730	0.410
NMHC	0.180	0.480	0.320
PM	0.940	2.430	1.980
PM2.5	0.500	1.710	1.100

Table 4.7.13. Emission factors (%) reported by Ward, et al., 1989, for tractor/dozer piled mixed conifer slash.

	Dozer piled mixed conifer slash		
	Flaming	Smoldering	Fire
CO	2.210	11.600	7.660
CO_2	174.600	156.180	163.560
CH_4	0.120	0.890	0.570
NMHC	0.110	0.610	0.400
PM	0.570	1.250	1.020
PM2.5	0.330	0.700	0.540

Table 4.7.14. Emission factors (%) reported by Ward, et al., 1989, for crane piled mixed conifer slash.

	Crane piled mixed conifer slash		
	Flaming	Smoldering	Fire
CO	5.030	11.610	9.270
CO_2	167.470	151.110	157.170
CH_4	0.470	1.500	1.086
NMHC	0.410	1.010	0.760
PM	1.130	2.210	1.820
PM2.5	0.590	1.550	1.170

Figure 4.7.1. Burning Rate (g/s dry fuel basis) - Spreading Fires.

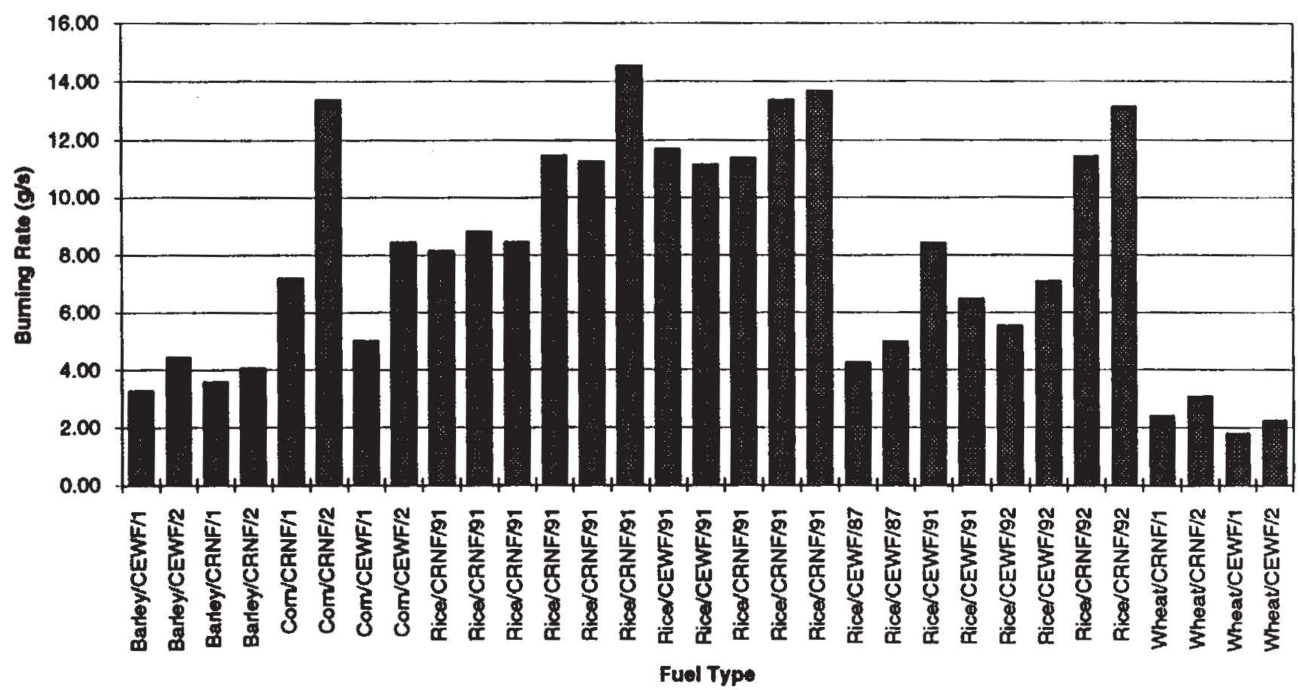

Figure 4.7.2. Burning Rate (g/s dry fuel basis)- Pile Fires

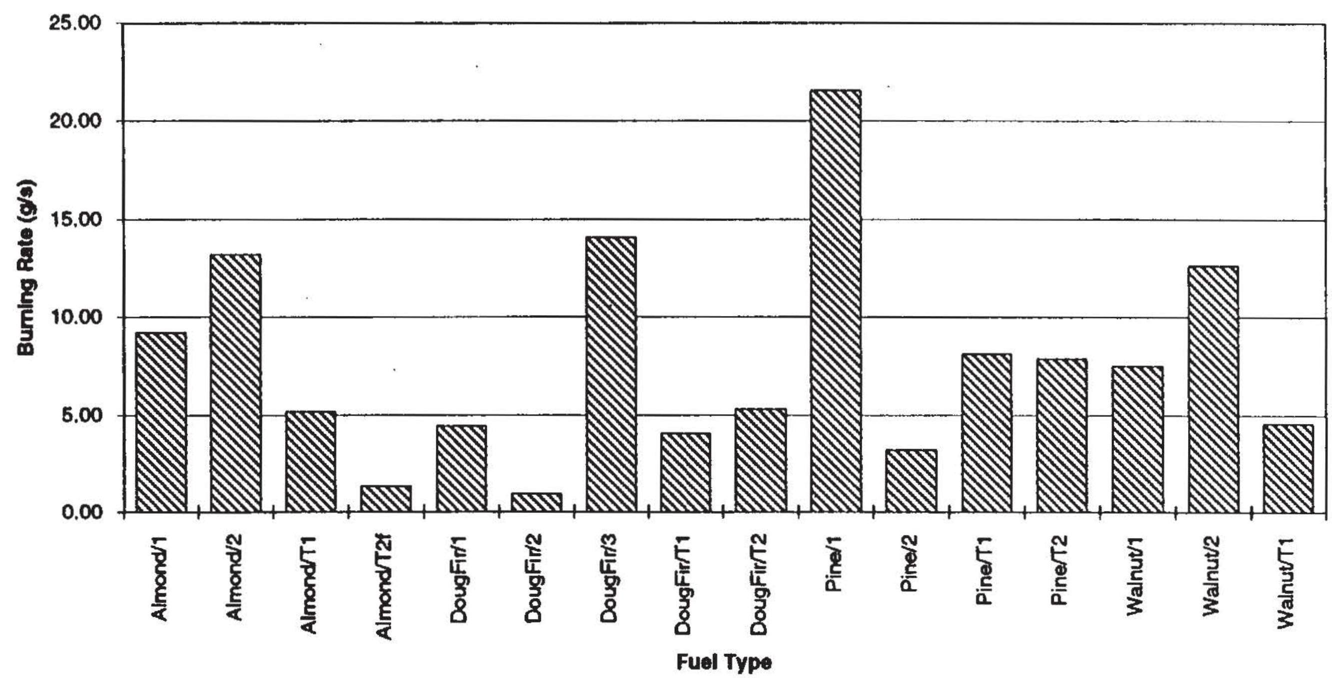

Figure 4.7.3. Heat Release Rate (kW) - Spreading Fires

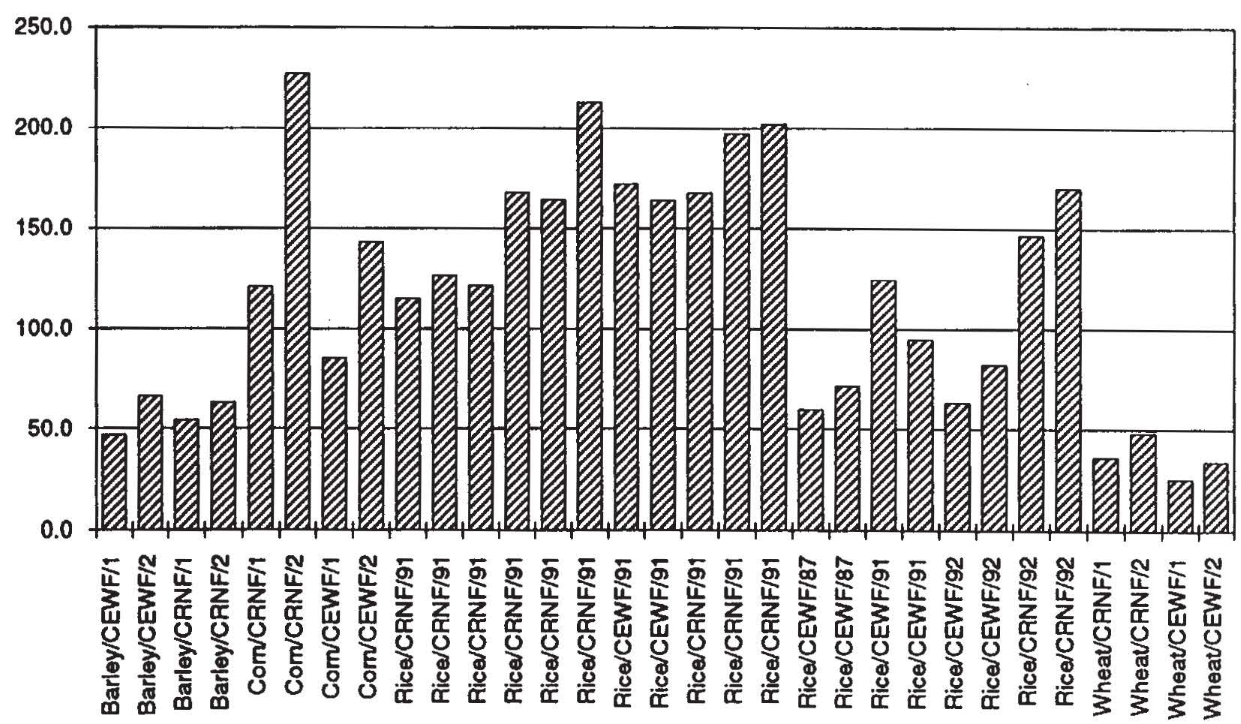

Figure 4.7.4. Heat Release Rate (kW) - Pile Fires

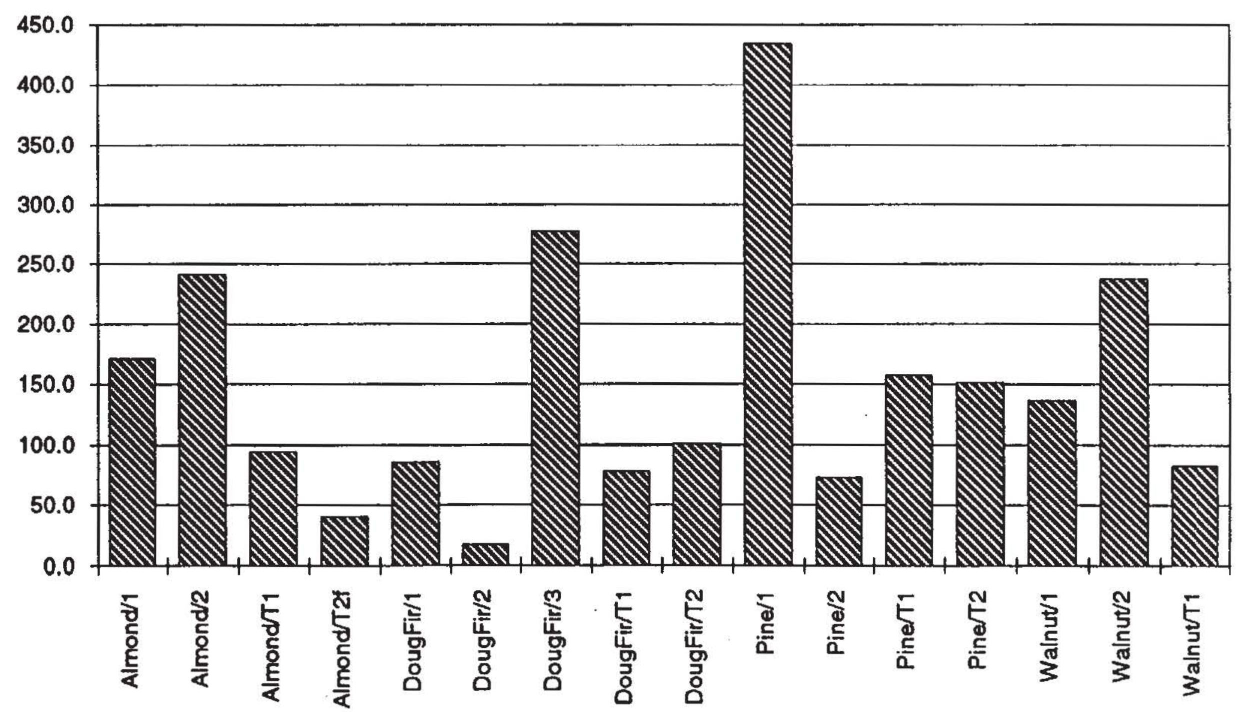

Figure 4.7.5. Burning Rate (g/s dry fuel basis) - All Fires

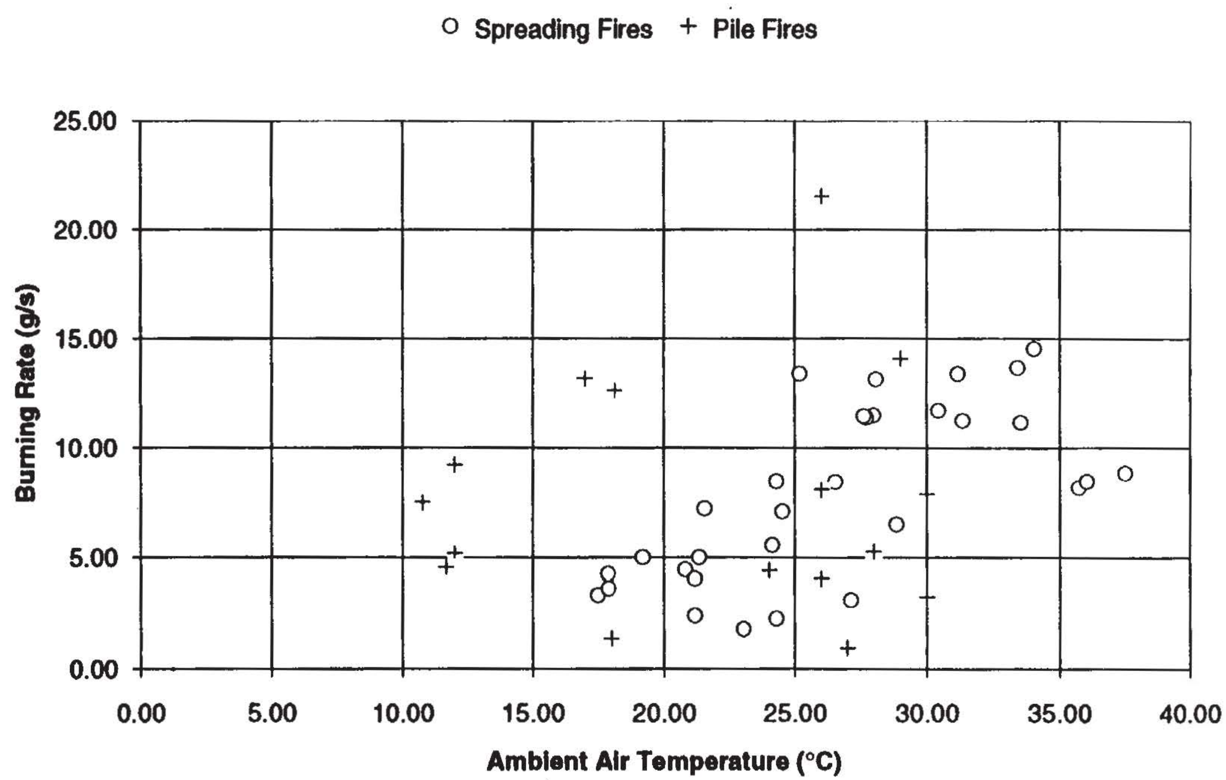

Figure 4.7.6. Burning Rate (g/s dry fuel basis) - All Fires

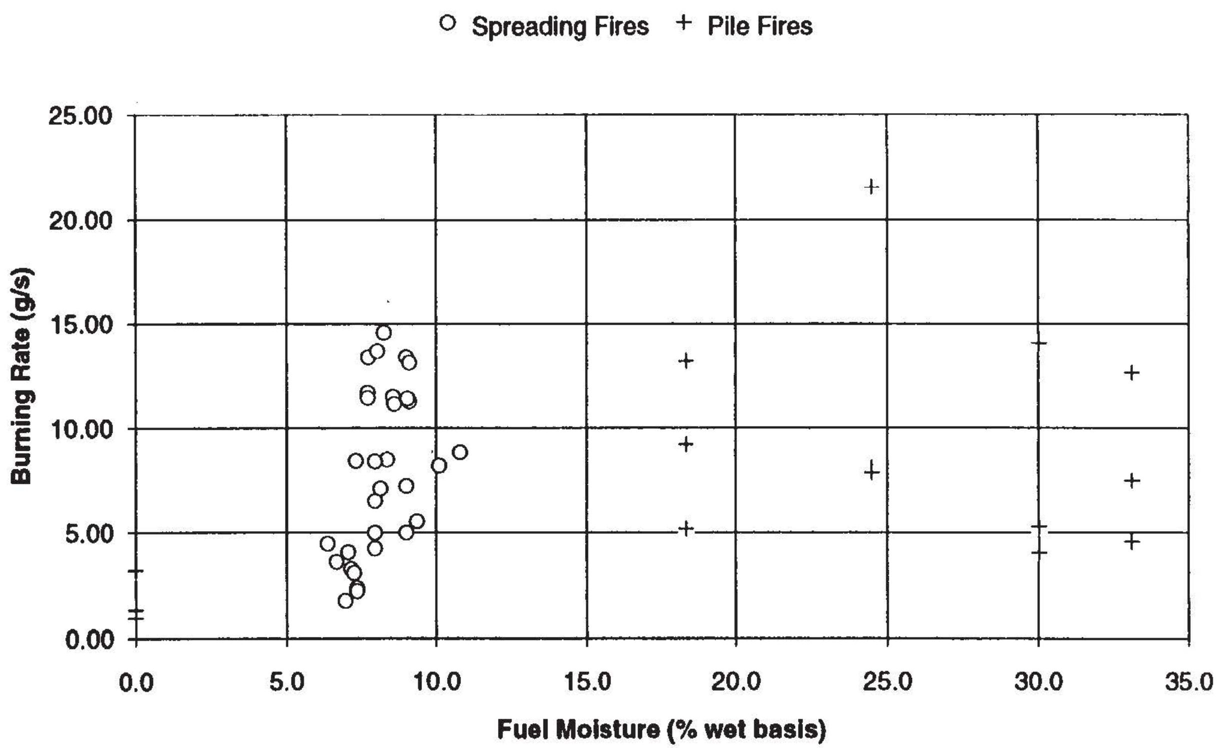

Figure 4.7.7. Predicted burning rate from multiple linear regression - spreading fires.

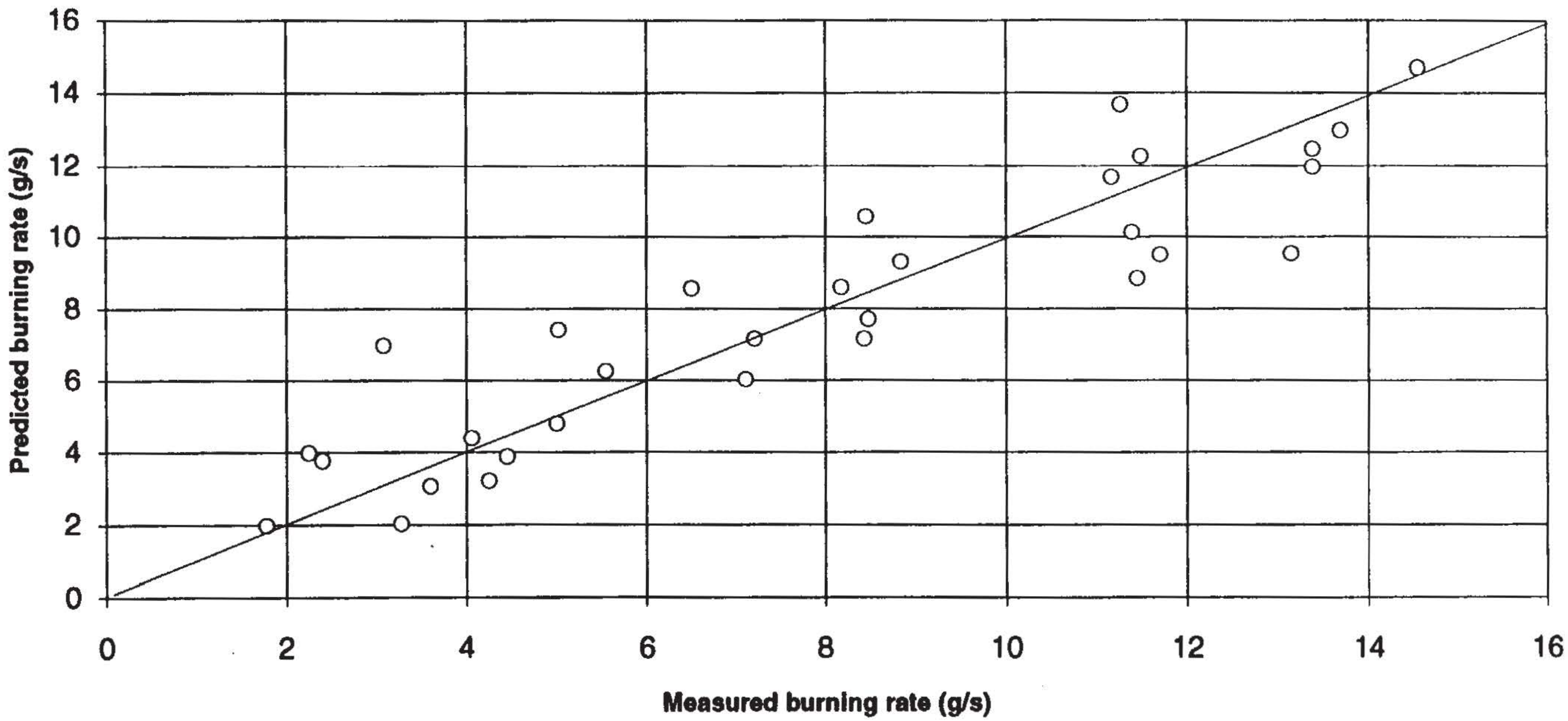

Figure 4.7.8. Predicted spreading rate for rice straw from multiple linear regression.

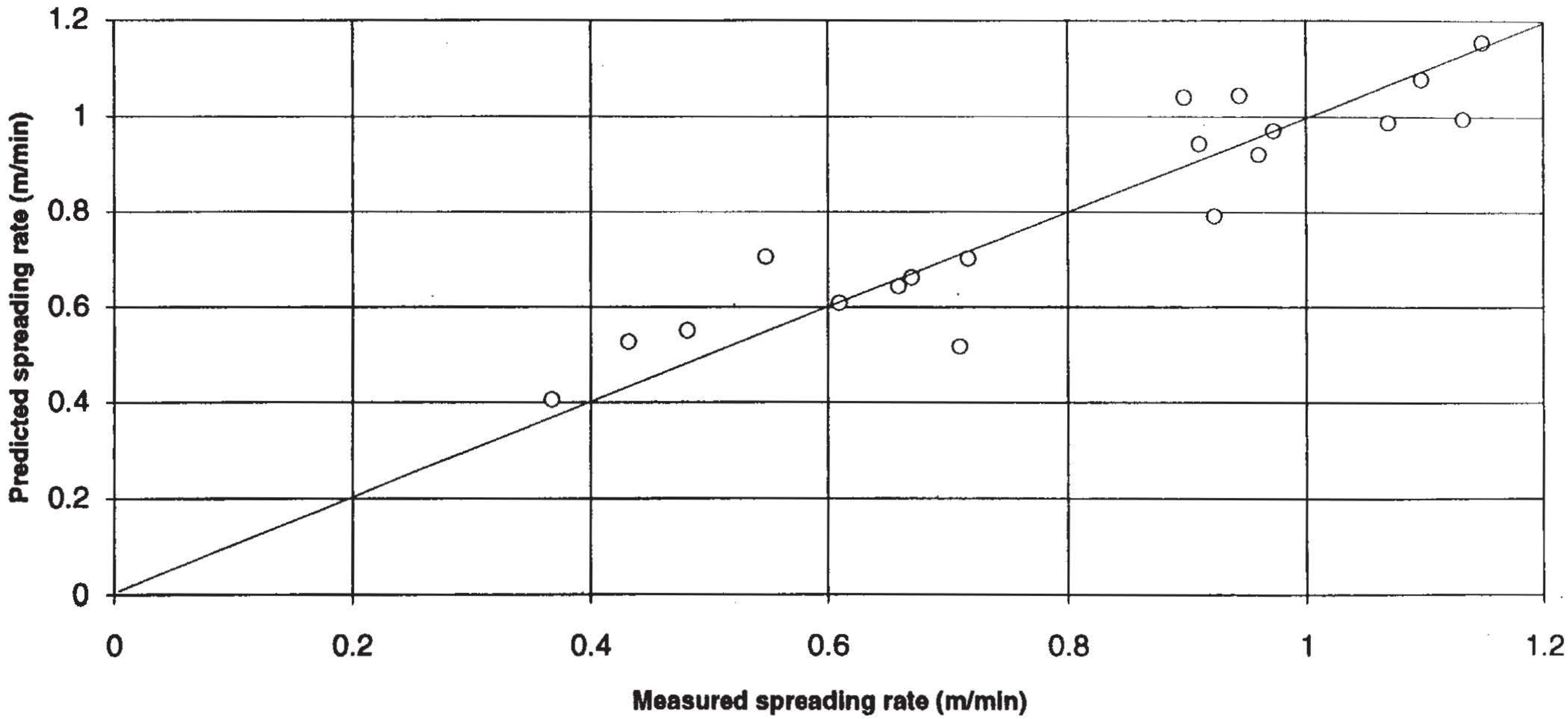

Figure 4.7.9. Predicted spreading rate for rice straw from inlet air temperature only.

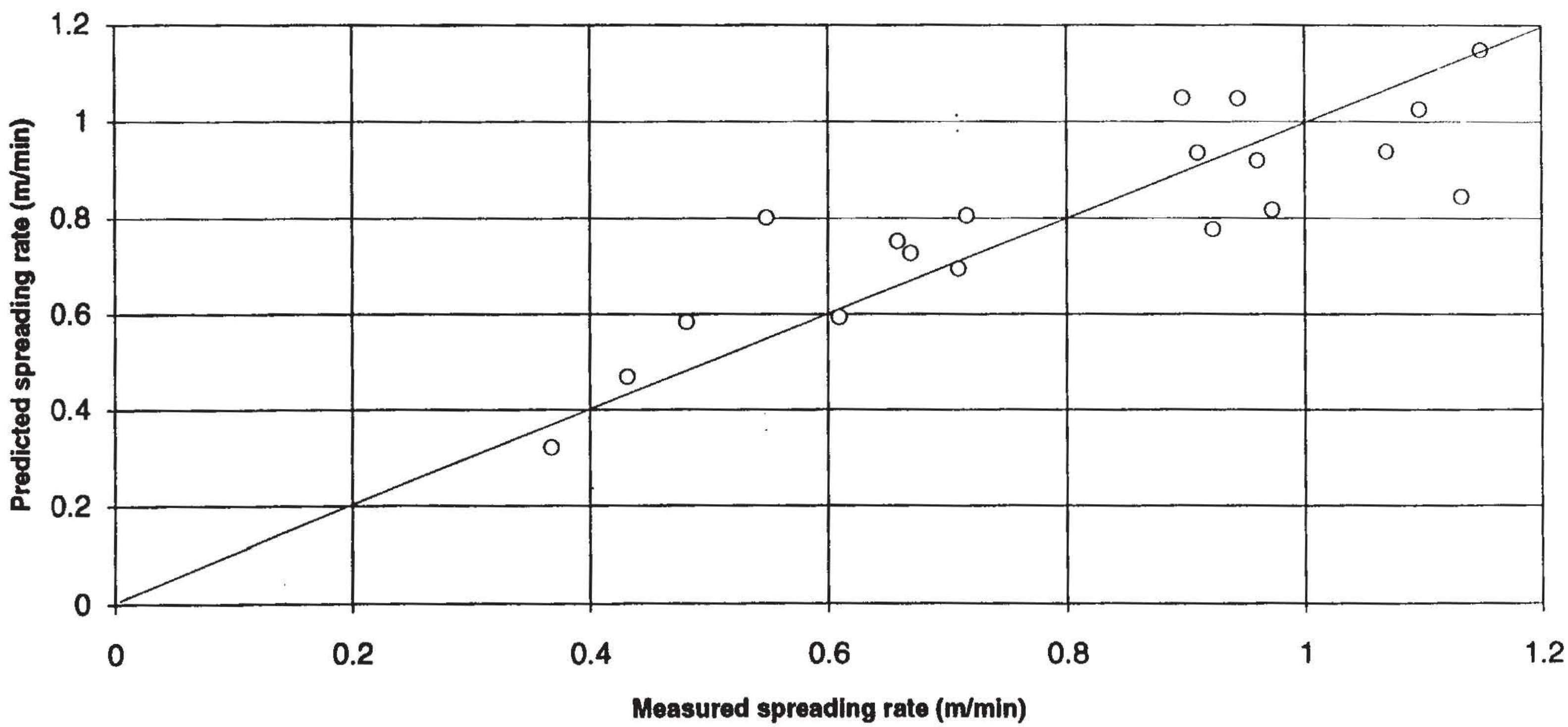

Figure 4.7.10. Emission factor for CO2 in relation to burning rate.

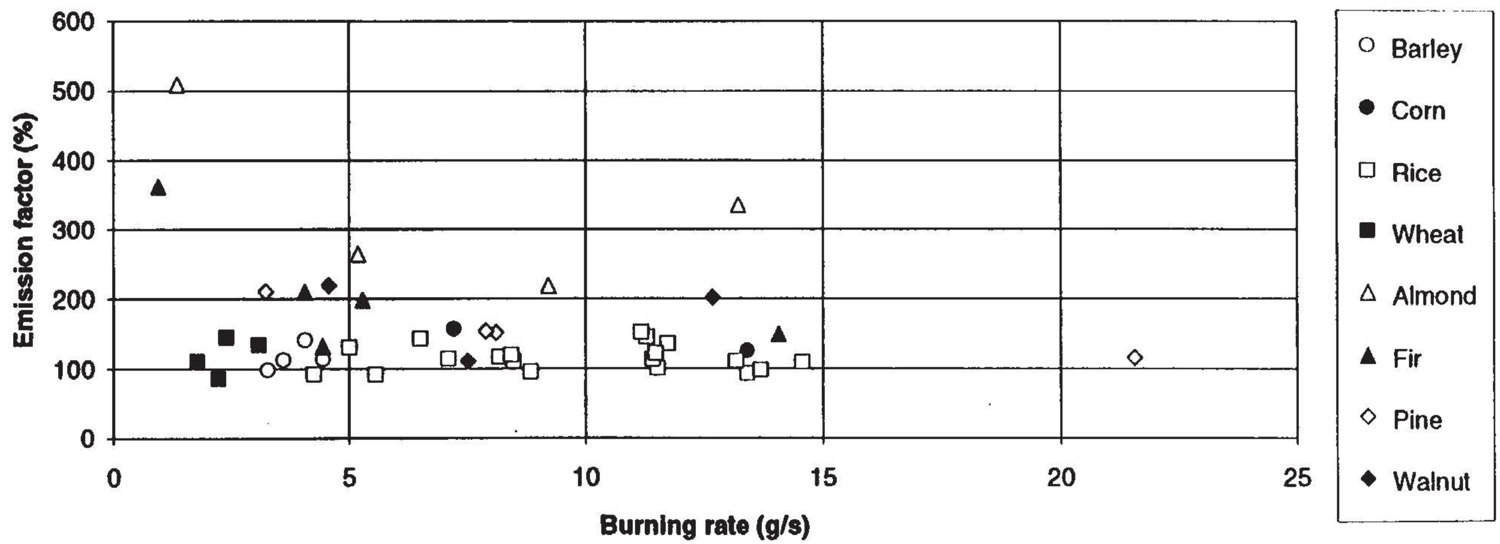

Figure 4.7.11. Emission factor for CO in relation to burning rate.

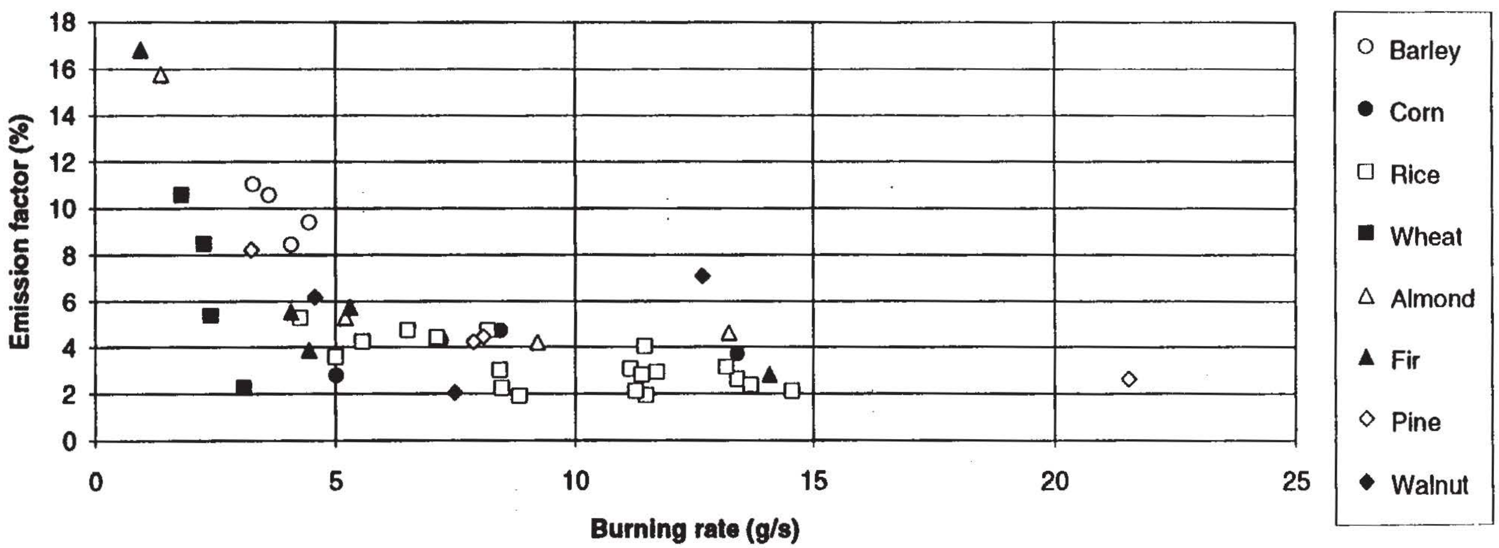

Figure 4.7.12. Emission factor for THC in relation to burning rate.

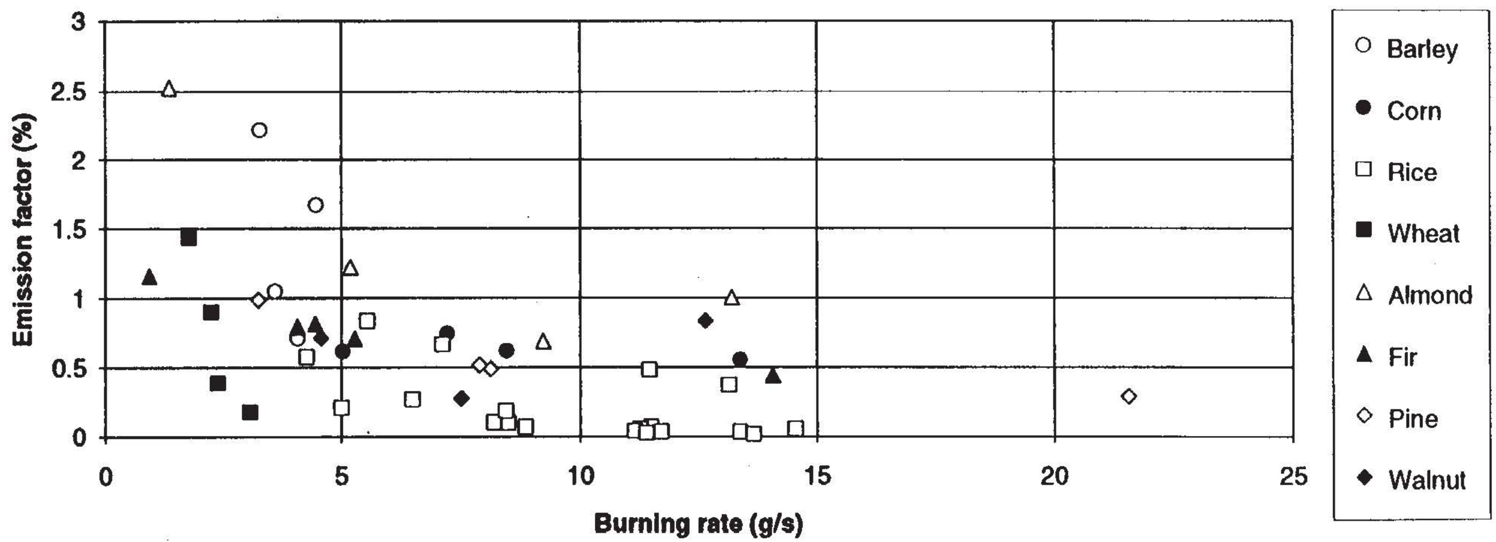

Figure 4.7.13. Emission factor for PM in relation to burning rate.

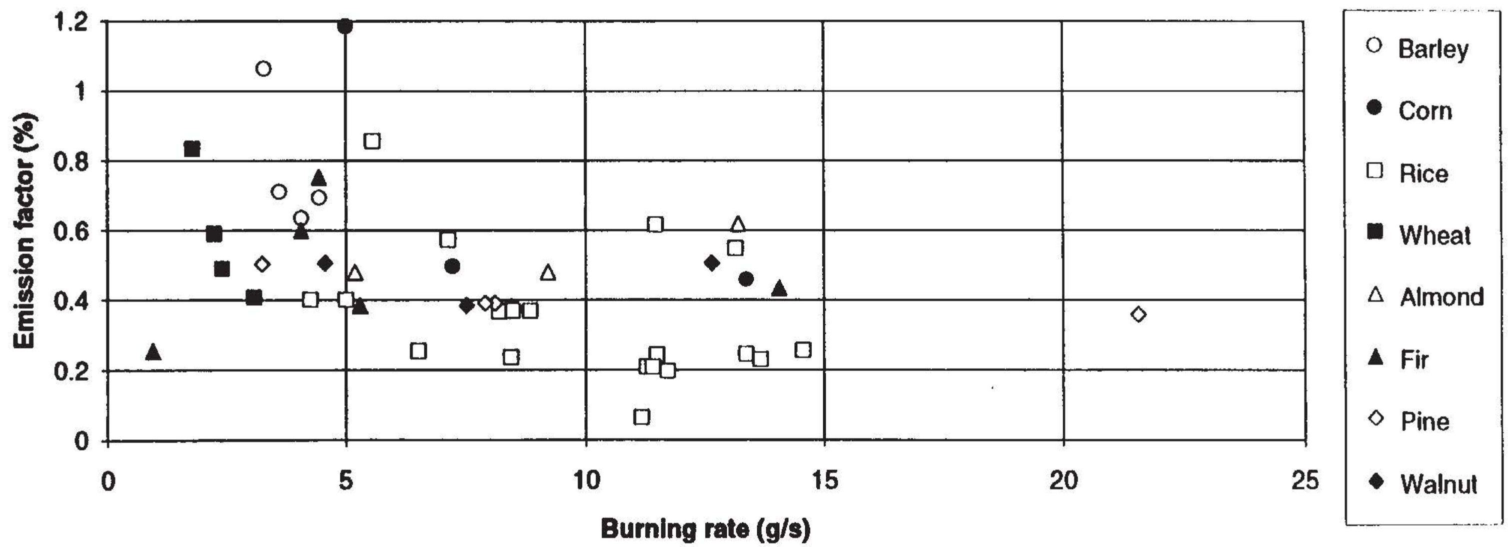

Figure 4.7.14. Emission factor for NOx in relation to burning rate.

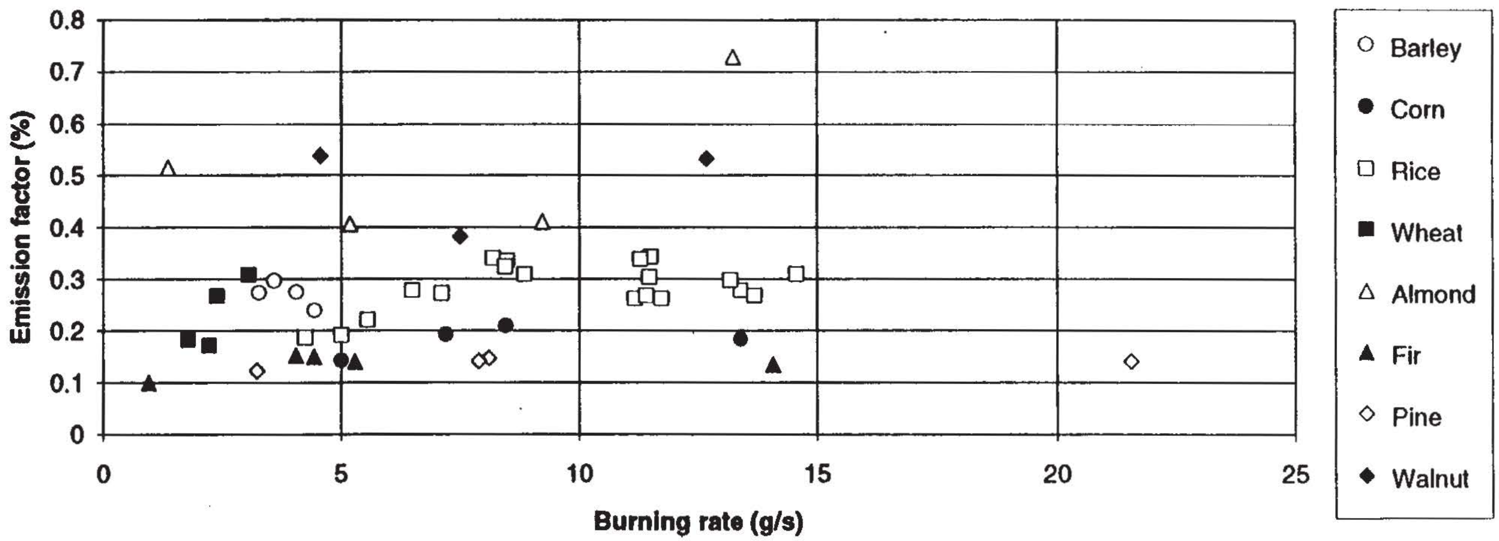

Figure 4.7.15. Emission factor for SO2 in relation to burning rate.

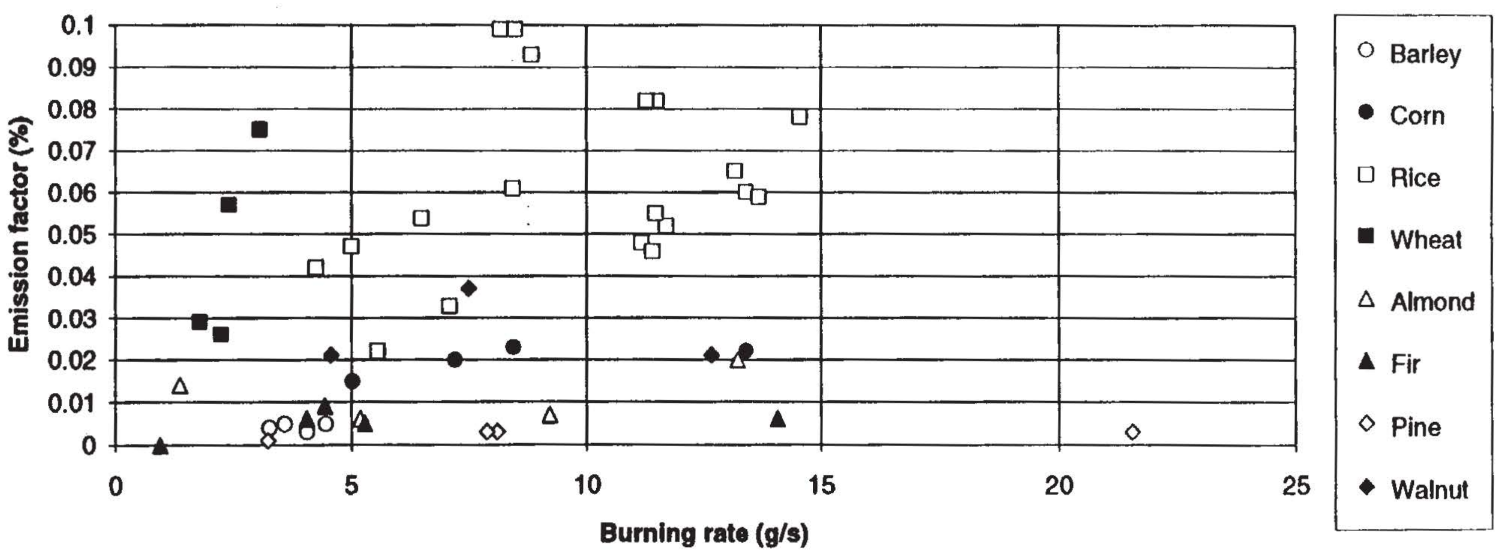

Figure 4.7.16. Measured combustion efficiency in comparison to combustion efficiency with closed carbon balance.

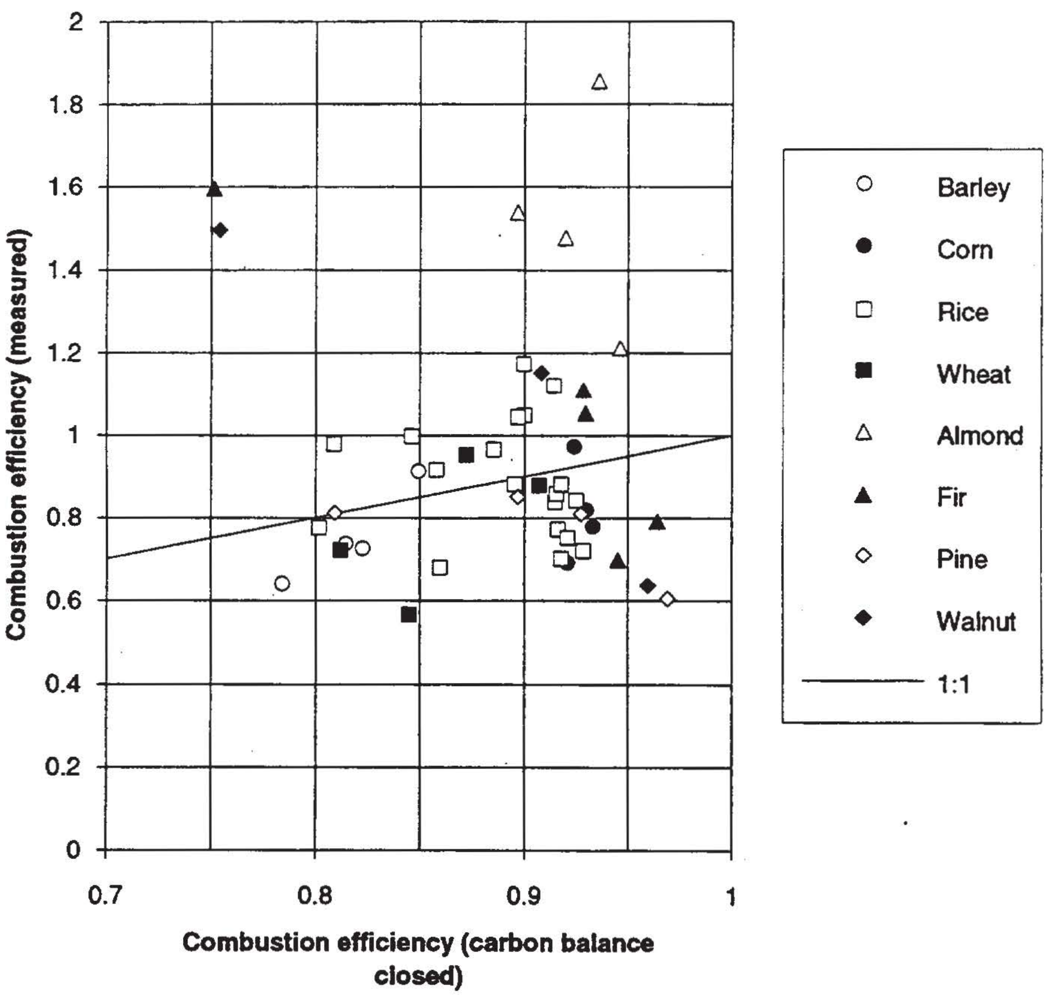

Figure 4.7.17. Stack carbon as CO2 in comparison to combustion efficiency.

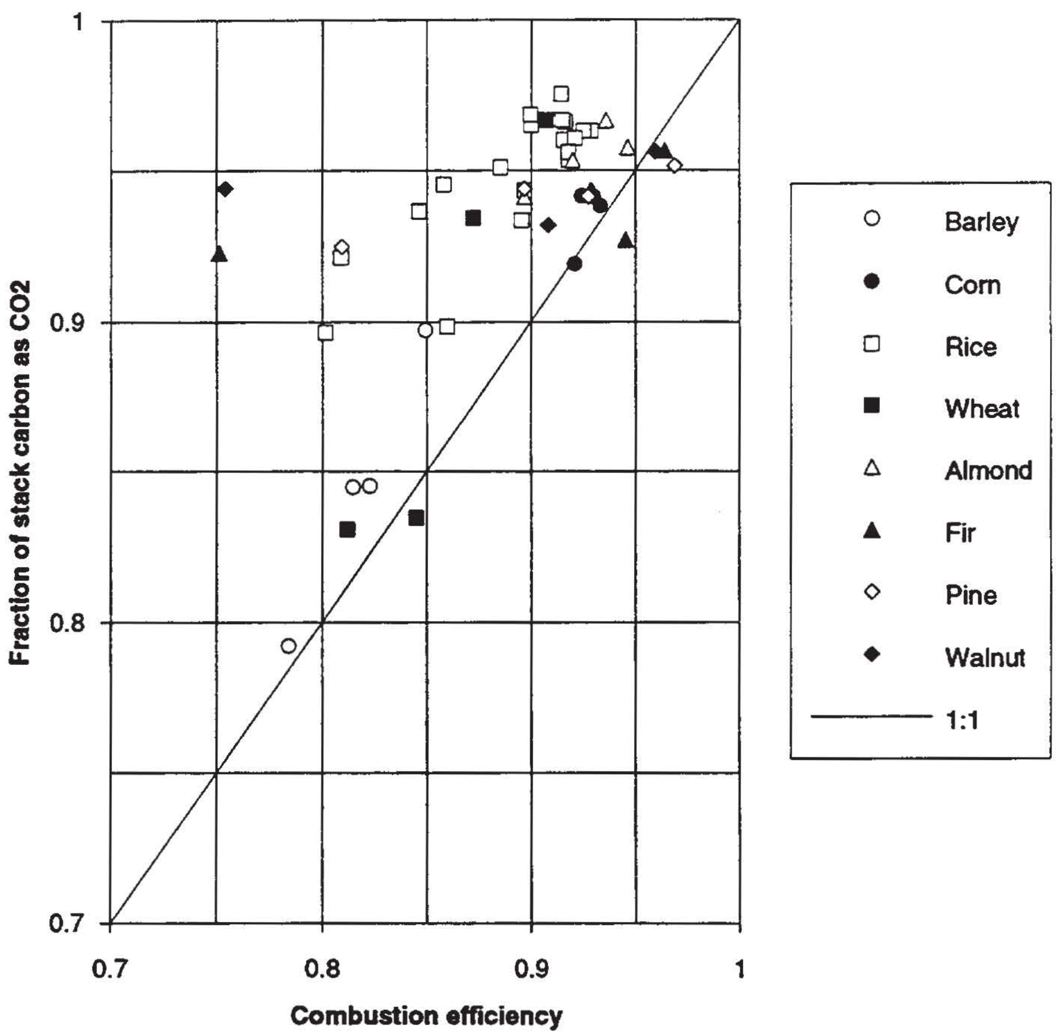

Figure 4.7.18. Emission factor for CO against combustion efficiency.
Symbols: actual. Lines: CO sensitivity only.

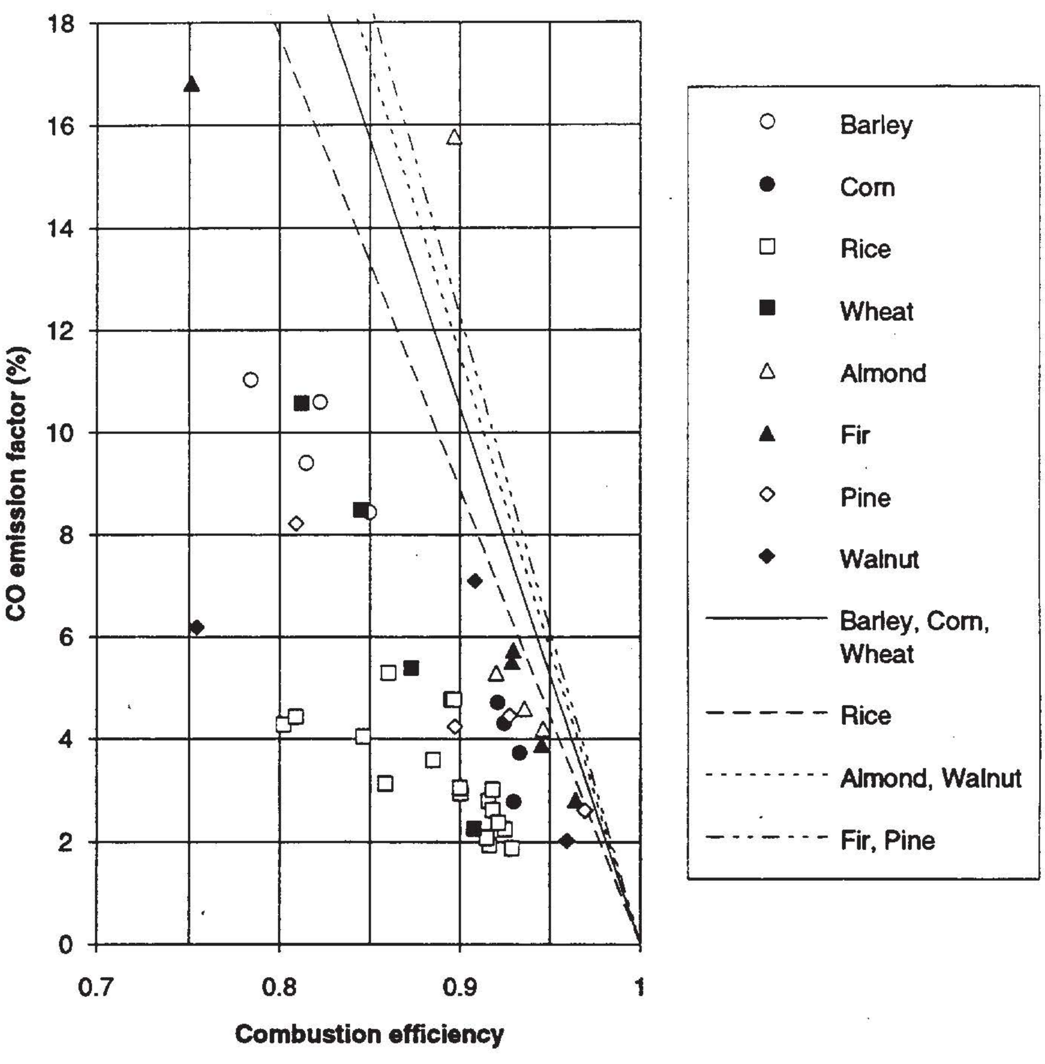

Figure 4.7.19. Emission factor for THC against combustion efficiency.

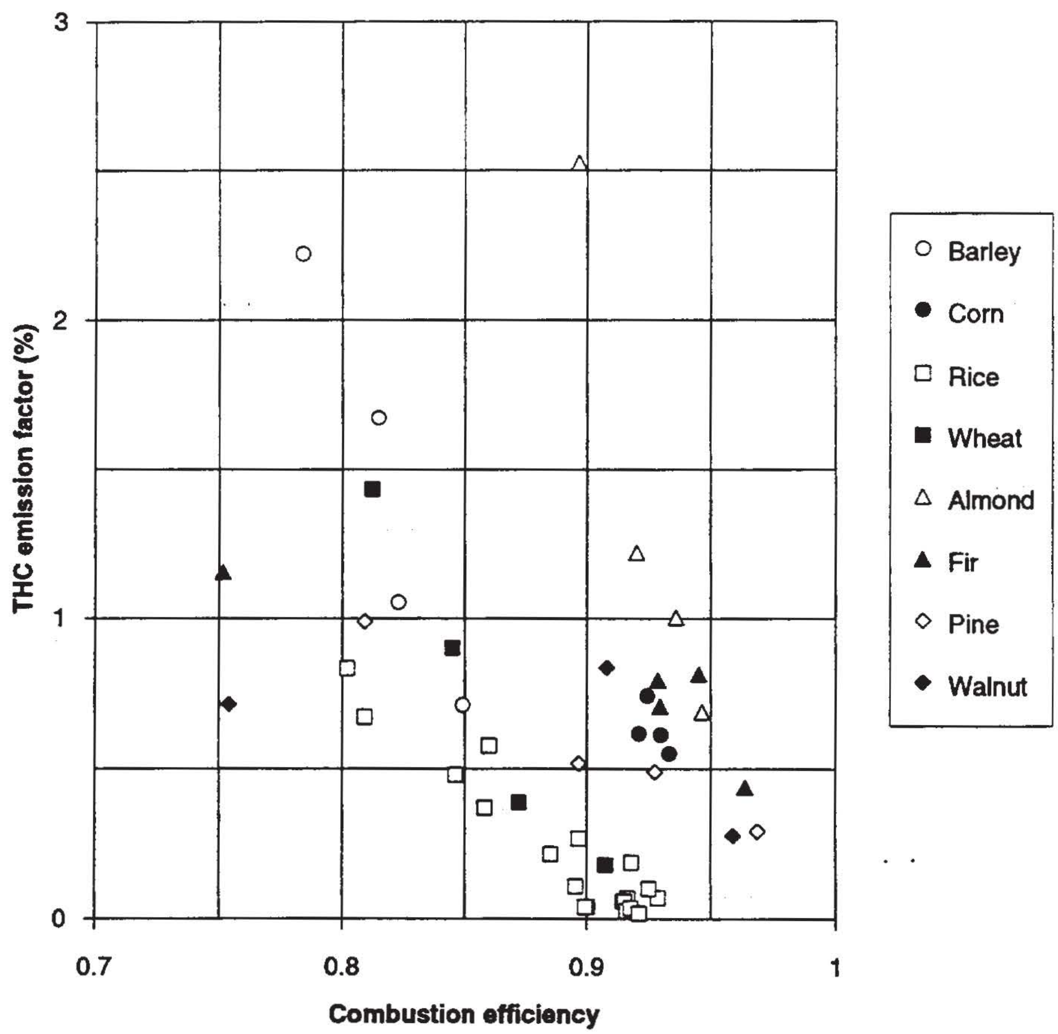

Figure 4.7.20. Emission factor for particulate matter against combustion efficiency.

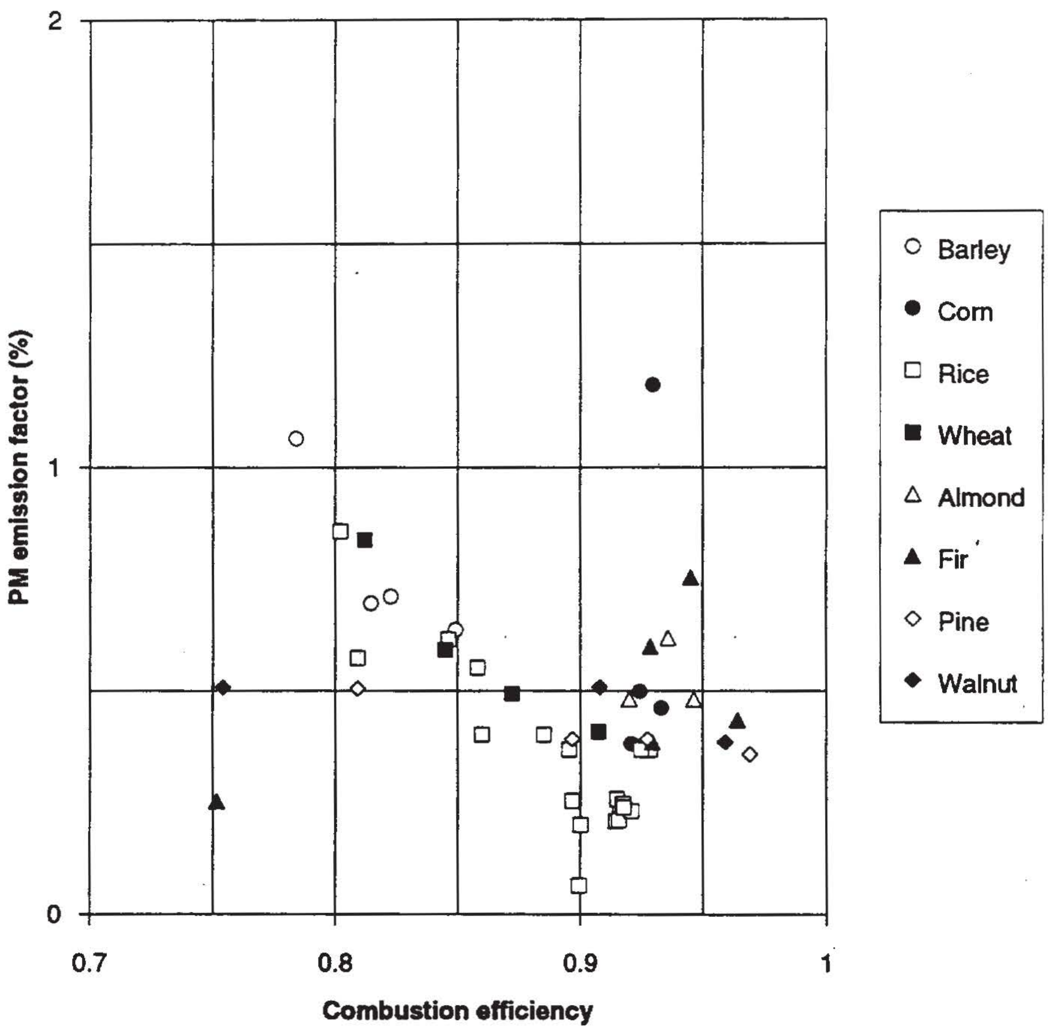

Figure 4.7.21. Emission factor for NOx against combustion efficiency.

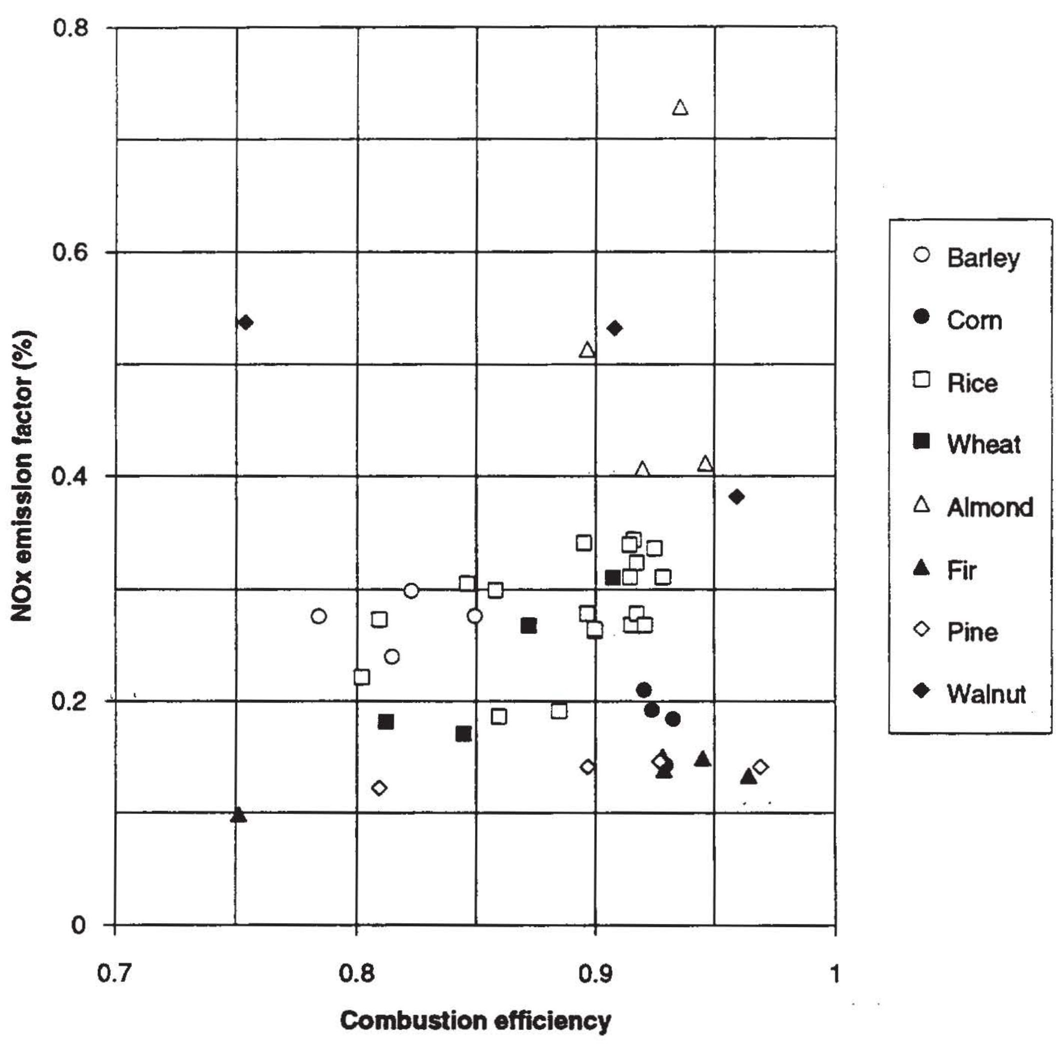

Figure 4.7.22. Emission factor for SO2 against combustion efficiency.

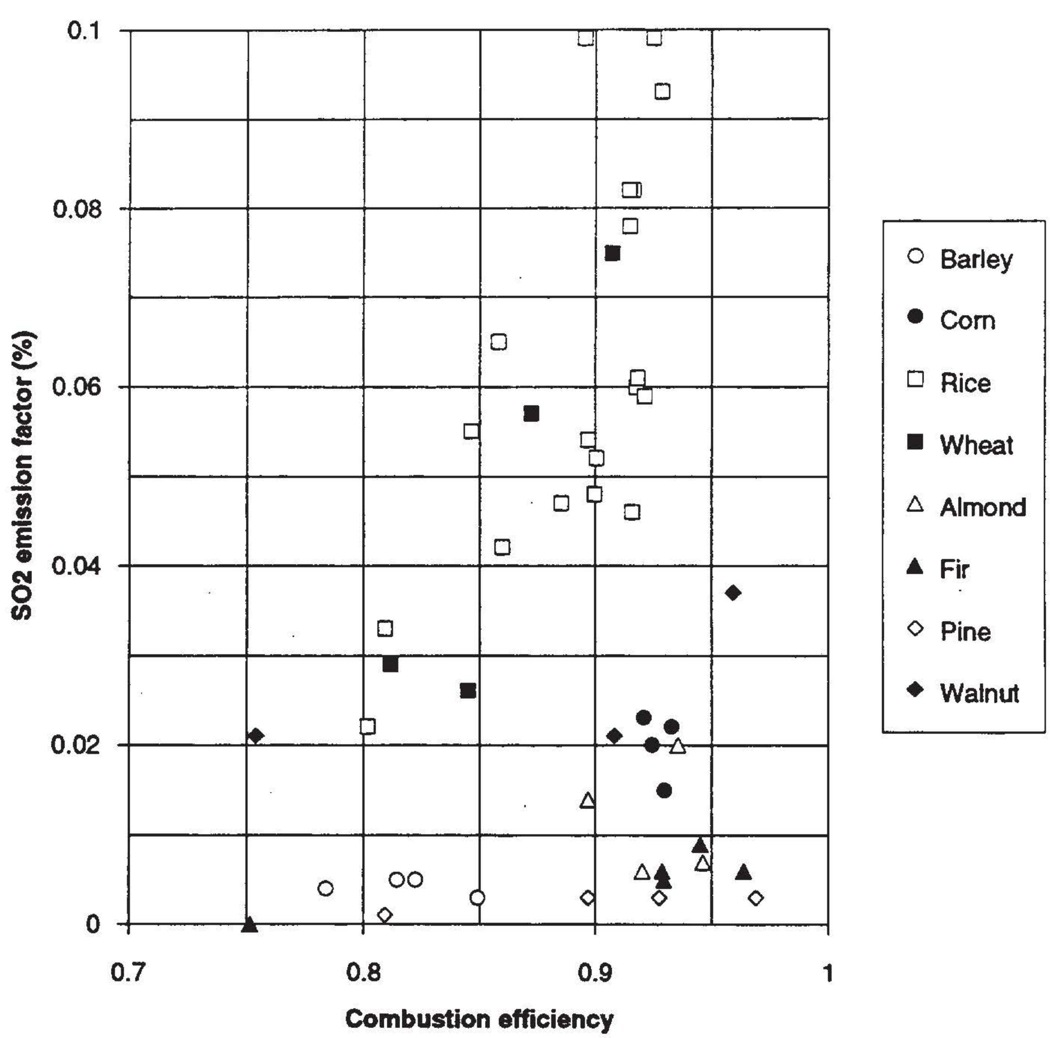

Figure 4.7.23. PAH emission factor (less naphthalenes) in relation to stack gas temperature.

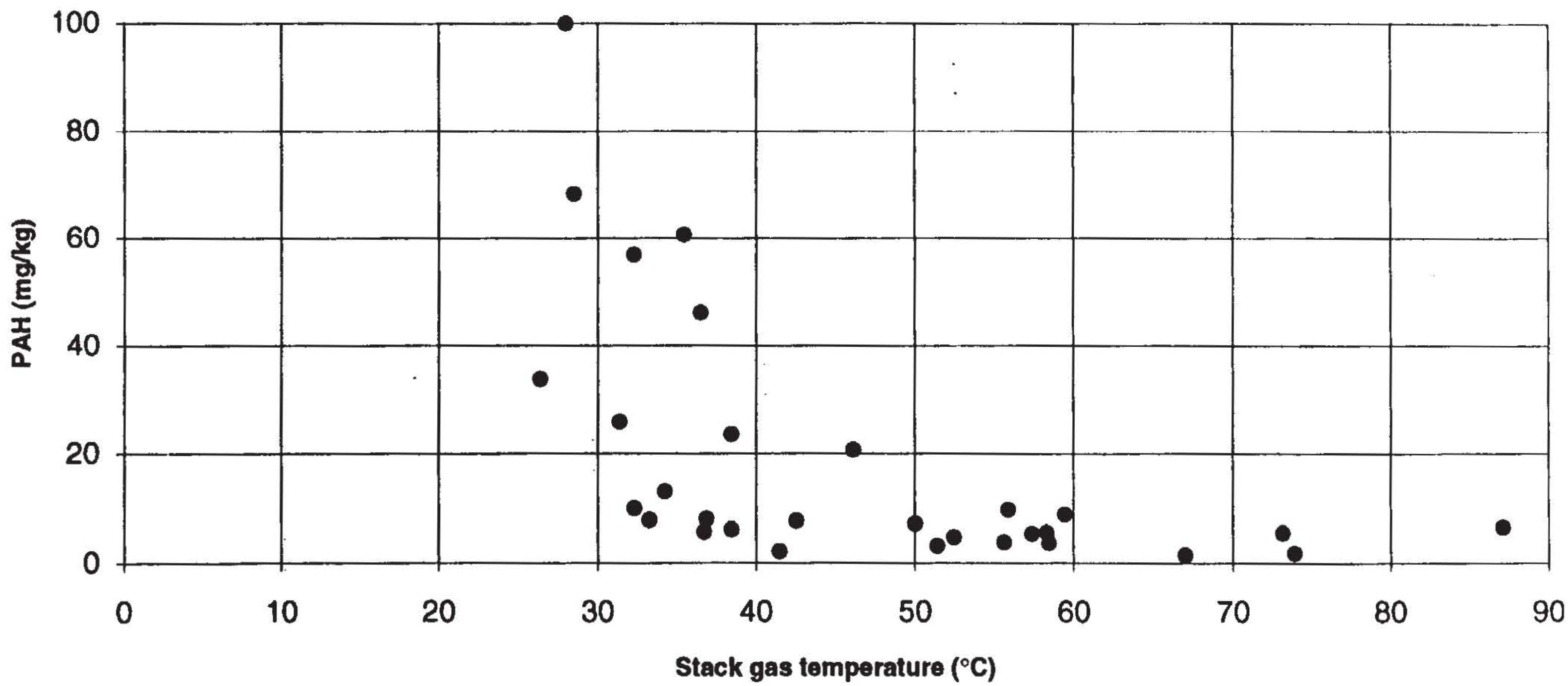

Figure 4.7.24. PAH emission factor (less naphthalenes) against burning rate.

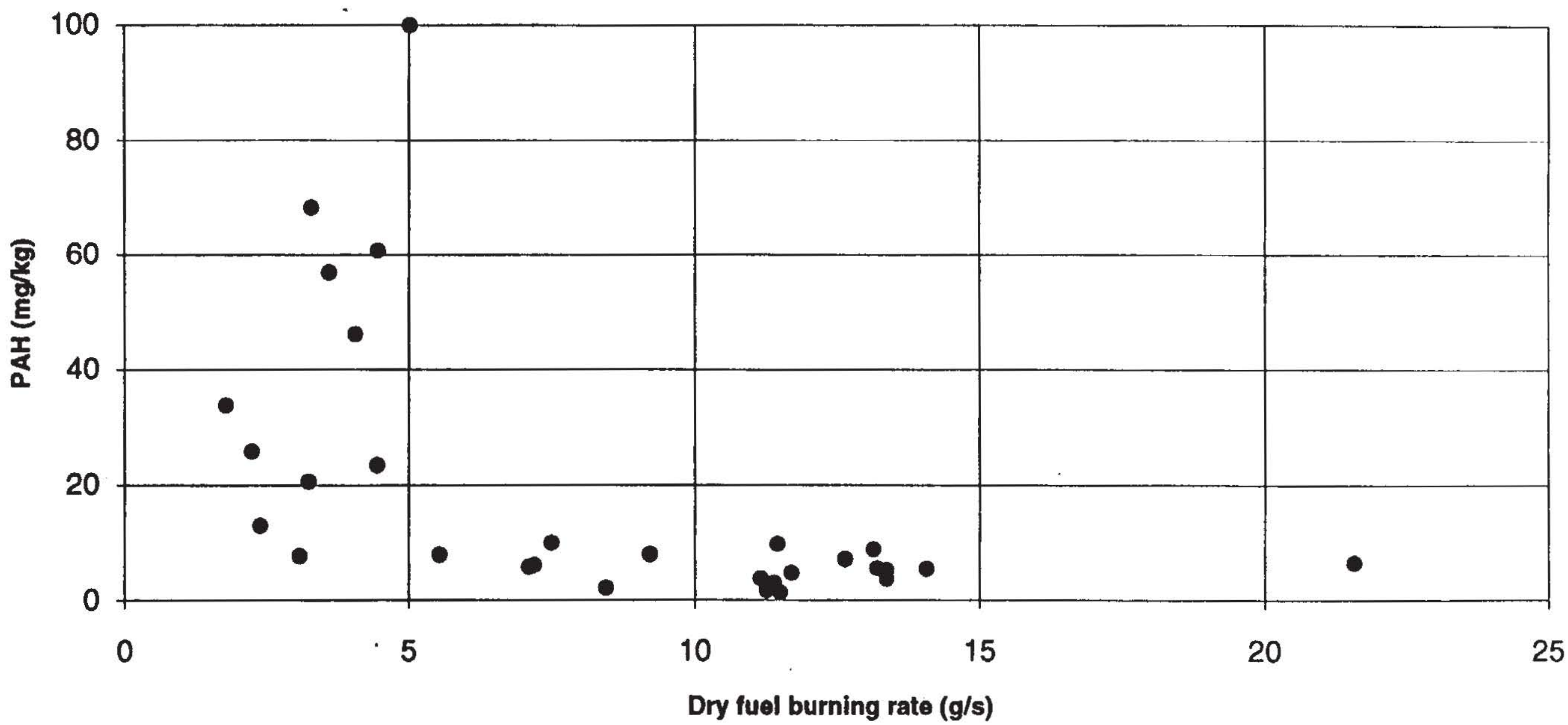

Figure 4.7.25. Combustion efficiency for all tests against burning rate.

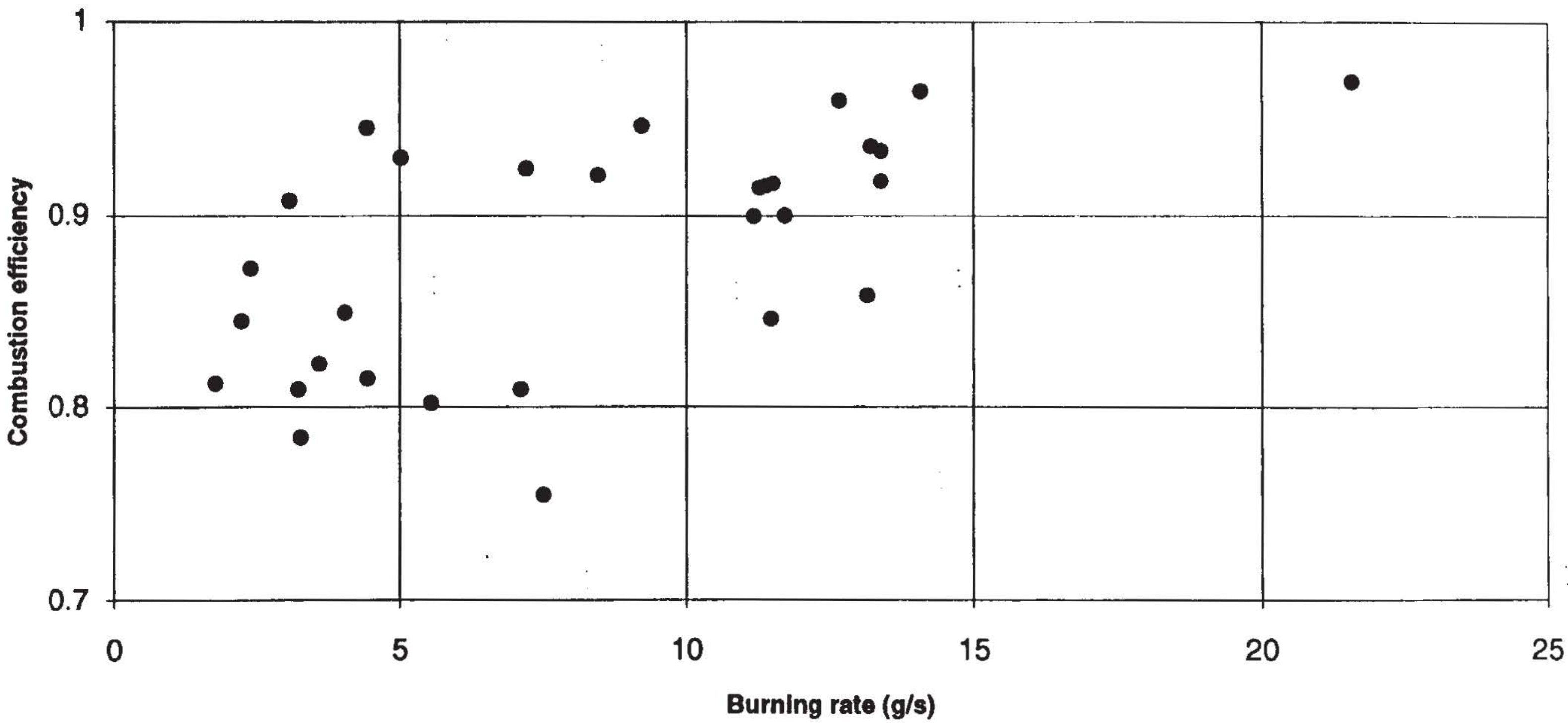

Figure 4.7.26. PAH emission factor (less naphthalene) against combustion efficiency.

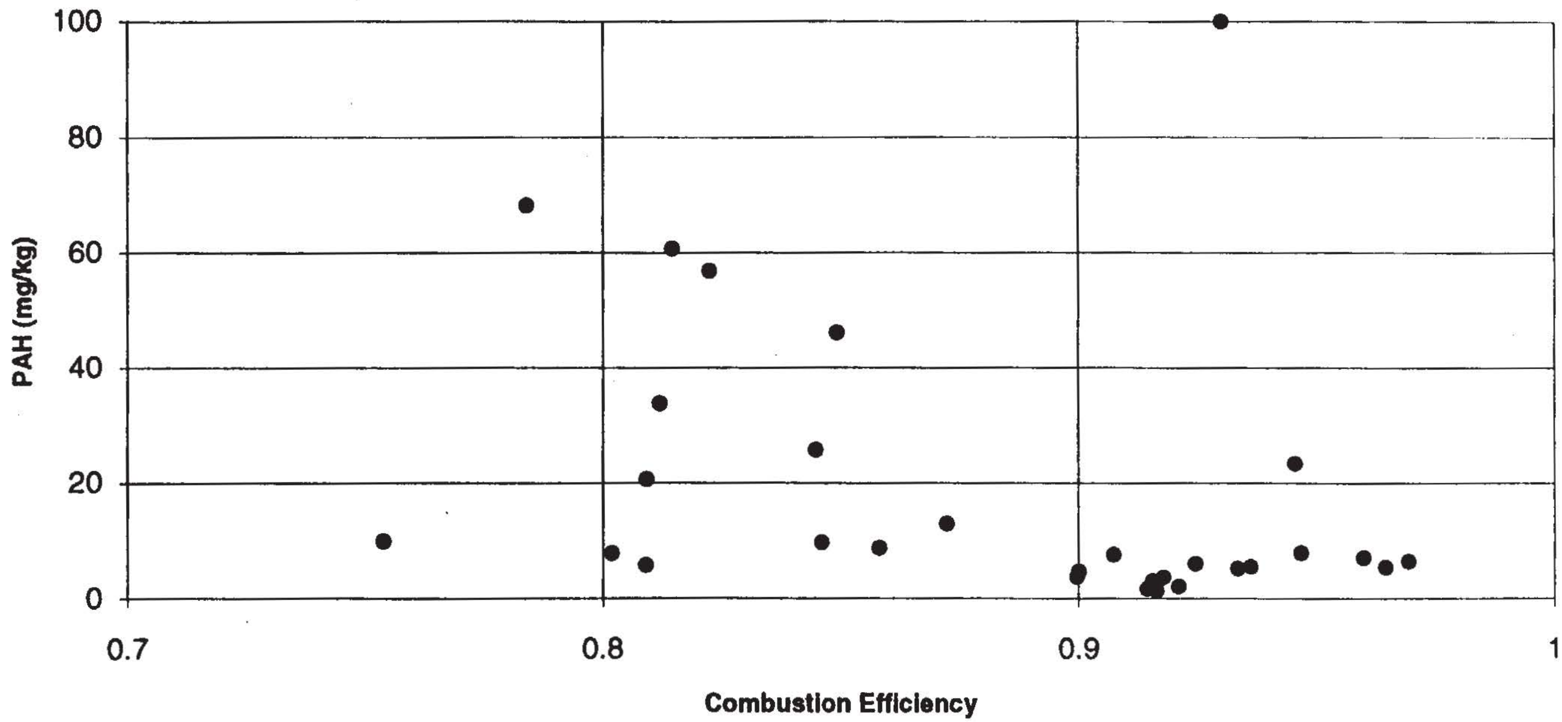

Figure 4.7.27. PAH in relation to the fraction of stack carbon in the form of CO2.

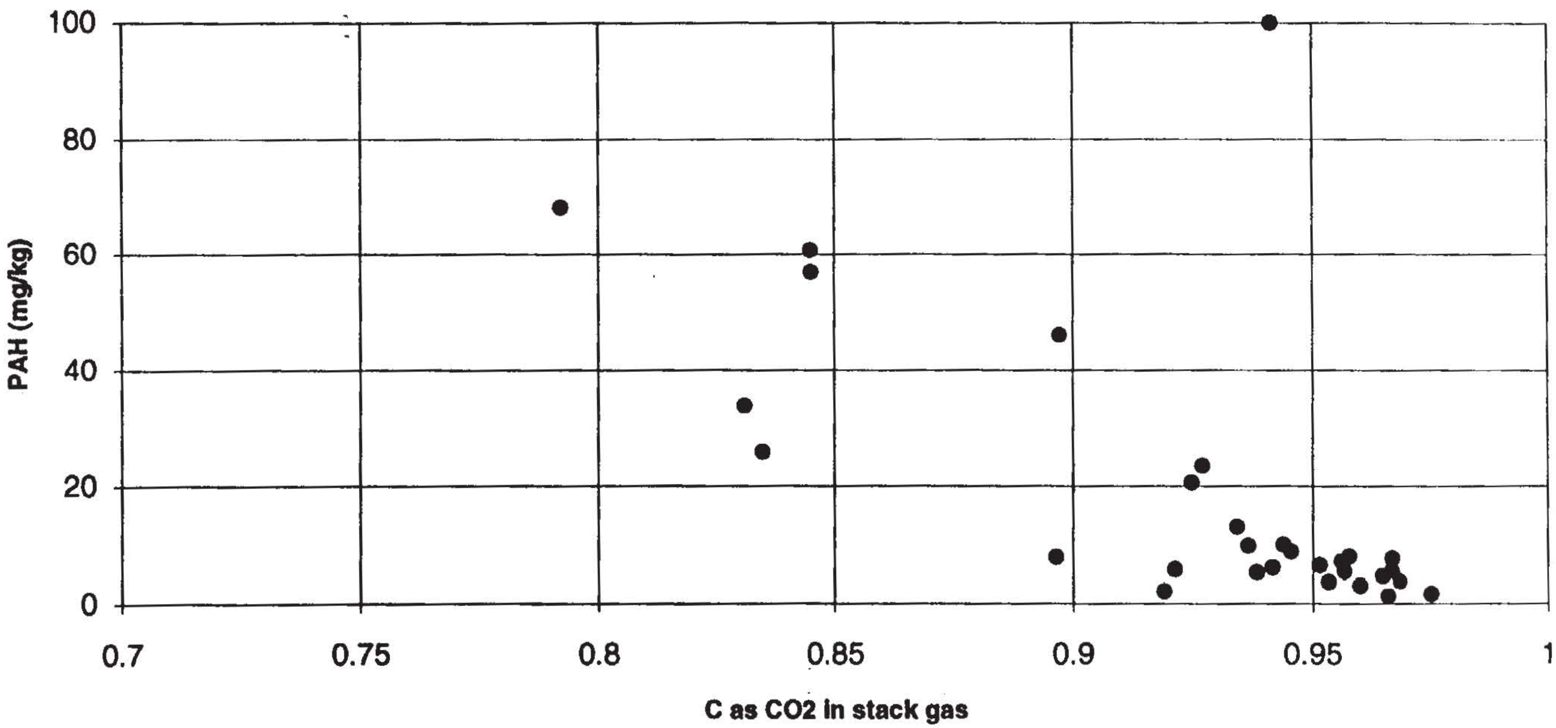

Figure 4.7.28. Total VOC emission factor against combustion efficiency.