UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10

August 21, 1985

REPLY TO ATTN OF: M/S 329

MEMORANDUM

SUBJECT: Dispersion Modeling of Fugitive Emissions Sources at Bunker Limited - Results of Model Evaluation

FROM: David C. Bray, Acting Chief and Robert B. Wilson
Air Programs Development Section Regional Meteorologist

TO: Joseph A. Tikvart, Chief
Source Receptor Analysis Branch, OAQPS (MD-14)

In our previous memos to you, we explained an alternative methodology we developed for modeling fugitive lead emissions from the Bunker Limited lead smelter in northern Idaho (July 29, 1985), and we proposed a protocol to evaluate whether or not this approach improves the model performance for predicting measured ambient concentrations (August 14, 1985). In this memo we present the results of our statistical evaluation and the implementation of the protocol in the attached three tables.

Table 1 lists the set of statistics for the paired data from all monitoring sites. This includes 36 data pairs: four quarters of data at nine monitoring stations. Table 2 lists the same statistics for the paired data from the maximum measured concentration (Silver King School) monitor. This includes only 4 data pairs: four quarters of data at one monitor station. This set of statistics is the same set that we used to compare the performances of the LONGZ and ISC Models in our original model selection process (see my memo to you of May 23, 1985).

Table 3 lists the results for the statistical parameters used in the model evaluation protocol. The single volume source method performed significantly better than the multiple volume source method for the average residuals at the SKS monitor, and for all the monitoring sites. The single volume source method also had a significantly lower variability among the data pairs over all the monitors. The variances for the SKS data set were not significantly different due to the small number of data pairs, so no points were awarded for this parameter. Also, the confidence intervals overlapped for the correlation, indicating no significant difference,and no points were awarded. Thus, the results of protocol indicate that the single volume source method is better than the multiple volume source method for modeling fugitive lead emissions from the Bunker Limited lead smelter. Since the single volume source method received more than 35 points, it will be used in the control strategy evaluation.

It is interesting to note (in Tables 1 and 2) that the confidence intervals for the average residuals of the single volume source method contained zero for both data sets. However, the confidence intervals for the multiple volume source method did not contain zero. Thus, the single volume source method would be considered unbiased (with 95% confidence) for these two data sets, while the multiple volume source method would be considered biased toward overprediction.

Attachments

cc: G. Abel

TABLE 1

Performance Statistics Over All Monitor Sites

STATISTIC	MULTIPLE VOLUME SOURCE METHOD	SINGLE VOLUME SOURCE METHOD
Average Observed	4.01	4.01
Average Predicted + Bkgrnd	7.75	4.53
Minimum Residual (O - P)	-31.80	-8.16
Maximum Residual	3.88	5.99
Average Residual	-3.74	-0.52
95% Confidence Interval	-6.55, -0.94	-1.39, 0.35
Median Residual	-0.37	-0.15
Signed Rank Test	2.54	1.00
Variance	66.83	6.43
95% Confidence Interval	44.00, 113.49	4.23, 10.91
Gross Variability	78.97	6.52
Average Absolute Residual	4.57	1.50
Correlation Coefficient	0.82	0.88
95% Confidence Interval	0.67, 0.90	0.78, 0.94

TABLE 2

Performance Statistics at the Maximum Observed Concentration Site
(Silver King School Monitor)

STATISTIC	MULTIPLE VOLUME SOURCE METHOD	SINGLE VOLUME SOURCE METHOD
Average Observed	10.72	10.72
Average Predicted + Bkgrnd	34.42	14.10
Minimum Residual (O - P)	-31.80	-6.38
Maximum Residual	-15.86	-0.76
Average Residual	-23.71	-3.39
95% Confidence Interval	-36.92, -10.50	-7.75, 0.97
Median Residual	-23.59	-3.21
Signed Rank Test	1.64	1.64
Variance	51.70	5.69
95% Confidence Interval	16.69, 705.00	1.82, 77.55
Gross Variability	600.80	15.74
Average Absolute Residual	23.71	3.39
Correlation Coefficient	0.88	0.91
95% Confidence Interval	-0.53, 0.997	-0.41, 0.998

TABLE 3

Results of Model Evaluation Protocol

OBJECTIVE	PARAMETER	METHOD	STATISTIC	SIGNIFICANCE TEST	POINTS
1	$(\bar{d})_{SKS}$	Multiple	-23.71	[t_{SKS} = 5.365 [$t_{0.05}$ = 3.182, 3 dof	0
		Single	-3.39	[significant difference	35
1	$(s^2)_{SKS}$	Multiple	51.70	[F_{SKS} = 9.1 [F(3 dof) = 15.5	0 *
		Single	5.69	[no significant difference	0
2	$(\bar{d})_{ALL}$	Multiple	-3.74	[t_{ALL} = 2.253 [$t_{0.05}$ = 2.030	0
		Single	-0.52	[significant difference	25
2	$(s^2)_{ALL}$	Multiple	66.83	[F_{ALL} = 10.4 [F(35 dof) = 1.9	0
		Single	6.43	[significant difference	15
2	$(r)_{ALL}$	Multiple	0.82	[0.67, 0.90] [confid. intervals overlap	0 *
		Single	0.88	[0.78, 0.94]	0

	TOTAL POINTS
Multiple	0
Single	75

* Insignificant difference, no points awarded.

STATION	MEAS.	MULTIPLE BUILDINGS MOD+BACK	DIFF.	RATIO	ONE BUILDING 732 MAGL MOD+BACK	DIFF.	RATIO	MULT ABSRAT	732 ABSRAT	MULT Di-avD2	732 Di-avD2	MULT Di2	732 Di2	MULT ABS Di	732 ABS Di	MEAS MS-AVM	MULT C-AVGC	732 C-AVGC	MULT MD&CD	732 MD&CD	MEAS MD2	MULT CD2	732 CD2	CALC BACKGR	MULT MODELED	732 MODELED
					FIRST QUARTER																					
SKS	10.62	42.42	-31.80	0.250	17.00	-6.38	0.625	0.750	0.375	787.13	34.33	1011.05	40.67	31.80	6.38	6.61	34.67	12.47	229.26	82.47	43.73	1201.91	155.55	0.267	42.15	16.73
KMC	5.94	15.54	-9.60	0.382	12.21	-6.27	0.487	0.618	0.513	34.30	33.06	92.12	39.29	9.60	6.27	1.93	7.79	7.68	15.06	14.85	3.74	60.68	59.03	0.228	15.31	11.98
PIN	3.01	2.29	0.72	1.315	1.83	1.18	1.646	0.315	0.646	19.91	2.89	0.52	1.39	0.72	1.18	-1.00	-5.46	-2.70	5.44	2.69	0.99	29.81	7.27	0.209	2.08	1.62
OSB	1.72	4.72	-3.00	0.364	3.66	-1.94	0.470	0.636	0.530	0.54	2.03	9.02	3.78	3.00	1.94	-2.29	-3.03	-0.86	6.92	1.97	5.23	9.15	0.74	0.193	4.53	3.47
KCH	6.18	19.91	-13.73	0.310	14.34	-8.16	0.431	0.690	0.569	99.84	58.45	188.60	66.63	13.73	8.16	2.17	12.16	9.82	26.43	21.33	4.72	147.98	96.39	0.223	19.69	14.12
KIN	0.57	1.65	-1.08	0.346	1.33	-0.76	0.429	0.654	0.571	7.09	0.06	1.16	0.57	1.08	0.76	-3.44	-6.10	-3.20	20.97	10.99	11.81	37.22	10.22	0.198	1.45	1.13
WPO	0.89	0.61	0.29	1.471	0.55	0.35	1.633	0.471	0.633	16.21	0.74	0.08	0.12	0.29	0.35	-3.12	-7.14	-3.98	22.27	12.41	9.72	51.03	15.84	0.185	0.42	0.36
CAT	0.73	1.18	-0.45	0.617	0.97	-0.24	0.750	0.383	0.250	10.81	0.08	0.21	0.06	0.45	0.24	-3.28	-6.57	-3.55	21.52	11.64	10.74	43.10	12.62	0.193	0.99	0.78
SMV/OHD	7.58	12.47	-4.89	0.608	8.32	-0.74	0.911	0.392	0.089	1.32	0.05	23.92	0.55	4.89	0.74	3.57	4.72	3.80	16.87	13.56	12.76	22.30	14.41	0.241	12.23	8.08
AVERAGE	4.14	11.20	-7.06	0.629	6.69	-2.55	0.820	0.545	0.464																	
					SECOND QUARTER																					
SKS	6.23	22.09	-15.86	0.282	8.68	-2.45	0.718	0.718	0.282	146.82	3.73	251.48	5.99	15.86	2.45	2.22	14.34	4.15	31.87	9.23	4.94	205.62	17.25	0.258	21.83	8.42
KMC	2.37	1.87	0.50	1.265	1.56	0.81	1.516	0.265	0.516	17.96	1.76	0.25	0.65	0.50	0.81	-1.64	-5.88	-2.96	9.62	4.85	2.68	34.52	8.77	0.153	1.72	1.41
PIN	1.02	0.83	0.19	1.223	0.64	0.38	1.584	0.223	0.584	15.42	0.80	0.03	0.14	0.19	0.38	-2.99	-6.91	-3.88	20.65	11.59	8.92	47.81	15.06	0.114	0.72	0.53
OSB	0.67	0.81	-0.14	0.828	0.62	0.05	1.082	0.172	0.082	12.98	0.32	0.02	.00	0.14	0.05	-3.34	-6.94	-3.91	23.16	13.04	11.14	48.16	15.26	0.089	0.72	0.53
KCH	2.85	4.38	-1.53	0.651	3.02	-0.17	0.943	0.349	0.057	4.88	0.12	2.34	0.03	1.53	0.17	-1.16	-3.37	-1.50	3.90	1.74	1.34	11.34	2.26	0.141	4.24	2.88
KIN	0.35	0.66	-0.31	0.534	0.53	-0.18	0.667	0.466	0.333	11.81	0.12	0.09	0.03	0.31	0.18	-3.66	-7.09	-4.00	25.94	14.63	13.38	50.32	16.00	0.095	0.56	0.43
WPO	0.46	0.67	-0.21	0.690	0.53	-0.07	0.873	0.310	0.127	12.49	0.20	0.04	.00	0.21	0.07	-3.55	-7.08	-4.00	25.12	14.18	12.58	50.15	15.98	0.077	0.59	0.45
CAT	0.39	0.47	-0.08	0.833	0.38	0.01	1.032	0.167	0.032	13.42	0.28	0.01	.00	0.08	0.01	-3.62	-7.28	-4.15	26.33	15.00	13.08	53.00	17.20	0.088	0.38	0.29
SMV/OHD	3.83	7.10	-3.27	0.540	4.09	-0.26	0.938	0.460	0.062	0.23	0.07	10.66	0.07	3.27	0.26	-0.18	-0.65	-0.44	0.12	0.08	0.03	0.43	0.19	0.185	6.91	3.90
AVERAGE	2.02	4.32	-2.30	0.761	2.23	-0.21	1.039	0.348	0.231																	
					THIRD QUARTER																					
SKS	7.03	26.87	-19.84	0.262	10.99	-3.96	0.639	0.738	0.361	259.30	11.88	393.78	15.71	19.84	3.96	3.02	19.13	6.47	57.81	19.55	9.14	365.79	41.85	0.124	26.75	10.87
KMC	4.16	1.77	2.39	2.346	1.77	2.39	2.346	1.346	1.346	37.55	8.44	5.70	5.70	2.39	2.39	0.15	-5.98	-2.75	-0.91	-0.42	0.02	35.71	7.57	0.103	1.67	1.67
PIN	1.55	1.30	0.25	1.190	0.96	0.59	1.610	0.190	0.610	15.91	1.22	0.06	0.34	0.25	0.59	-2.46	-6.45	-3.56	15.84	8.75	6.04	41.54	12.69	0.093	1.21	0.87
OSB	0.87	1.30	-0.43	0.672	0.97	-0.10	0.902	0.328	0.098	11.00	0.18	0.18	0.01	0.43	0.10	-3.14	-6.45	-3.56	20.25	11.17	9.84	41.65	12.67	0.085	1.21	0.88
KCH	3.46	6.62	-3.16	0.523	4.58	-1.12	0.755	0.477	0.245	0.34	0.36	9.99	1.25	3.16	1.12	-0.55	-1.13	0.05	0.62	-0.03	0.30	1.27	.00	0.100	6.52	4.48
KIN	0.42	1.05	-0.63	0.401	0.79	-0.37	0.534	0.599	0.466	9.70	0.02	0.39	0.13	0.63	0.37	-3.59	-6.70	-3.74	24.04	13.41	12.87	44.91	13.97	0.087	0.96	0.70
WPO	0.61	0.50	0.11	1.218	0.43	0.18	1.415	0.218	0.415	14.82	0.49	0.01	0.03	0.11	0.18	-3.40	-7.25	-4.09	24.62	13.91	11.54	52.53	16.76	0.081	0.42	0.35
CAT	0.43	0.72	-0.29	0.601	0.55	-0.12	0.789	0.399	0.211	11.95	0.16	0.08	0.01	0.29	0.12	-3.58	-7.03	-3.98	25.16	14.24	12.80	49.47	15.84	0.085	0.63	0.46
SMV/OHD	4.77	9.03	-4.26	0.528	5.47	-0.70	0.872	0.472	0.128	0.27	0.03	18.15	0.49	4.26	0.70	0.76	1.28	0.94	0.98	0.72	0.58	1.64	0.89	0.110	8.92	5.36
AVERAGE	2.59	5.46	-2.87	0.860	2.95	-0.36	1.096	0.530	0.431																	
					FOURTH QUARTER																					
SKS	18.99	46.32	-27.33	0.410	19.75	-0.76	0.962	0.590	0.038	556.38	0.06	746.87	0.58	27.33	0.76	14.98	38.57	15.22	577.89	228.10	224.48	1487.69	231.77	0.199	46.12	19.55
KMC	9.20	6.11	3.09	1.505	8.45	0.75	1.088	0.505	0.088	46.61	1.60	9.52	0.56	3.09	0.75	5.19	-1.63	3.93	-8.49	20.40	26.96	2.67	15.44	0.164	5.95	8.29
PIN	5.08	2.35	2.73	2.164	1.77	3.31	2.875	1.164	1.875	41.92	14.68	7.47	10.98	2.73	3.31	1.07	-5.40	-2.76	-5.79	-2.96	1.15	29.18	7.61	0.147	2.20	1.62
OSB	2.58	3.82	-1.24	0.675	2.83	-0.25	0.910	0.325	0.090	6.24	0.07	1.55	0.06	1.24	0.25	-1.43	-3.92	-1.69	5.60	2.41	2.04	15.40	2.86	0.134	3.69	2.70
KCH	10.28	16.78	-6.50	0.613	11.60	-1.32	0.886	0.387	0.114	7.61	0.64	42.24	1.74	6.50	1.32	6.27	9.03	7.07	56.65	44.37	39.33	81.55	50.04	0.159	16.62	11.44
KIN	2.05	1.67	0.38	1.230	1.25	0.80	1.644	0.230	0.644	17.01	1.74	0.15	0.64	0.38	0.80	-1.96	-6.08	-3.28	11.90	6.42	3.83	36.98	10.75	0.137	1.53	1.11
WPO	1.31	1.19	0.12	1.104	0.99	0.32	1.327	0.104	0.327	14.93	0.71	0.02	0.10	0.12	0.32	-2.70	-6.56	-3.54	17.70	9.54	7.28	43.05	12.52	0.127	1.06	0.86
CAT	1.41	1.12	0.29	1.256	0.85	0.56	1.653	0.256	0.653	16.23	1.16	0.08	0.31	0.29	0.56	-2.60	-6.63	-3.67	17.21	9.54	6.75	43.90	13.48	0.133	0.99	0.72
SMV/OHD	14.65	10.77	3.88	1.361	8.66	5.99	1.692	0.361	0.692	58.11	42.38	15.07	35.90	3.88	5.99	10.64	3.02	4.13	32.14	43.99	113.27	9.12	17.08	0.178	10.59	8.48
AVERAGE	7.28	10.01	-2.73	1.146	6.24	1.04	1.449	0.436	0.502																	
AVERAGE	4.01	7.75	-3.74	0.849	4.53	-0.52	1.101	0.465	0.407	64.97	6.25	78.97	6.52	4.57	1.50	.00	.00	.00	39.02	19.43	18.33	124.68	26.77			
SUM										2339.03	224.89	2842.91	234.54	164.54	53.96	.00	.00	.00	1404.65	699.36	659.77	4488.56	963.84			

All Monitors

MULTIPLE 732 MAGL

AVG DIFF	-3.74	-0.52
VARIANCE	66.83	6.43
GROSS VAR	78.97	6.52
AV AB RES	4.57	1.50
CORRELATE	0.82	0.88
MIN DIFF	-31.80	-8.16
MAX DIFF	3.88	5.99
AVG MEAS	4.01	4.01
AVG CALC	7.75	4.53
MIN RATIO	0.25	0.43
MAX RATIO	2.35	2.87
AVG RATIO	0.85	1.10

STATION	MEAS.	MULTIPLE BUILDINGS MOD+BACK	DIFF.	RATIO	ONE BUILDING 732 MAGL MOD+BACK	DIFF.	RATIO	MULT ABSRAT	732 ABSRAT	MULT Di-avD2	732 Di-avD2	MULT Di2	732 Di2	MULT ABS Di	732 ABS Di	MEAS MS-AVM	MULT C-AVGC	732 C-AVGC	MULT MD*CD	732 MD*CD	MEAS MD2	MULT CD2	732 CD2	CALC BACKGR	MULT MODELED	732 MODELED
					FIRST QUARTER																					
SKS	10.62	42.42	-31.80	0.250	17.00	-6.38	0.625	0.750	0.375	65.45	8.94	1011.05	40.67	31.80	6.38	-0.10	7.99	2.89	-0.78	-0.28	0.01	63.88	8.37	0.267	42.15	16.73
					SECOND QUARTER																					
SKS	6.23	22.09	-15.86	0.282	8.68	-2.45	0.718	0.718	0.282	61.61	0.88	251.48	5.99	15.86	2.45	-4.49	-12.34	-5.43	55.36	24.35	20.14	152.19	29.45	0.258	21.83	8.42
					THIRD QUARTER																					
SKS	7.03	26.87	-19.84	0.262	10.99	-3.96	0.639	0.738	0.361	14.92	0.33	393.78	15.71	19.84	3.96	-3.69	-7.55	-3.11	27.84	11.47	13.60	57.01	9.68	0.124	26.75	10.87
					FOURTH QUARTER																					
SKS	18.99	46.32	-27.33	0.410	19.75	-0.76	0.962	0.590	0.038	13.12	6.91	746.87	0.58	27.33	0.76	8.27	11.89	5.64	98.40	46.69	68.43	141.48	31.86	0.199	46.12	19.55
AVERAGE	10.72	34.42	-23.71	0.30	14.10	-3.39	0.74	0.70	0.26	38.77	4.27	600.80	15.74	23.71	3.39	.00	.00	.00	45.21	20.56	25.54	103.64	19.84			
SUM										155.10	17.06	2403.18	62.95	94.83	13.55	.00	.00	.00	180.82	82.23	102.18	414.56	79.35			

Silver King School Only

	MULTIPLE	732 MAGL
AVG DIFF	-23.71	-3.39
VARIANCE	51.70	5.69
GROSS VAR	600.80	15.74
AV AB RES	23.71	3.39
CORRELATE	0.88	0.91
MIN DIFF	-31.80	-6.38
MAX DIFF	-15.86	-0.76
AVG MEAS	10.72	10.72
AVG CALC	34.42	14.10
MIN RATIO	0.25	0.62
MAX RATIO	0.41	0.96
AVG RATIO	0.30	0.74