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M E M O R A N D U M

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SUBJECT: EXPOSURES TO METHYL BROMIDE IN MONTEREY AND SANTA CRUZ COUNTIES BASED ON THE FALL 2001 MONITORING BY THE CALIFORNIA AIR RESOURCES BOARD

This memorandum gives inhalation exposures as average concentrations of methyl bromide in air for 24-hour, 1-week and 8-week averaging periods, based on monitoring done by the California Air Resources Board in Monterey and Santa Cruz Counties in Fall 2001 (ARB, 2002).

Methods

Following the practice of the Worker Health and Safety (WHS) Branch, this memorandum reports arithmetic mean concentrations and tolerance limits estimated using lognormal methods. Lognormality is assumed for environmental contaminants in most cases. DPR's experience with many large environmental datasets has shown that they are usually well described by the lognormal distribution. In addition, WHS prefers to avoid the inconsistency of using different exposure statistics based on sample characteristics. WHS uses the arithmetic mean concentration because the concentration of interest for exposure assessment is the overall concentration in all of the air that a person could breathe during the averaging period. The arithmetic mean concentration is the best estimate of the average mass of residue per unit of environmental medium; it is equivalent to compositing all of the samples and measuring the concentration of the mixture (Parkhurst, 1998). This is true regardless of the shape of the underlying distribution.

No samples below the detection limit of 0.002 ppbv (7.2 ng/m^3) were reported. Twenty samples with flow-rate deviations greater than 25% were not used in the analysis. There were ten cases where a site had usable samples for only two days in a week. The data were not adjusted for background levels (average 0.45 ppbv or 1737 ng/m^3 in 4 samples at a background site) or recovery (range 122% to 156% in laboratory, trip and field spikes).

24-hr exposure

For each monitoring site separately, the maximum observed and the 95% tolerance limit for 24-hr concentrations are given. The 95% tolerance limit is the concentration that, with given probability, will be exceeded in 5% of future samples (Hahn and Meeker, 1991). It is calculated using lognormal distribution methods:

$$95\% \text{ tolerance limit} = \exp\{\text{arithmetic mean of log concentrations} + g_{(..90;95;\,n)} * (\text{sd of logs})\}.$$

The multiplier g for 90% probability is tabled in Hahn and Meeker (1991).

1-week exposure

For each monitoring site separately, the maximum and the 95% tolerance limit for weekly mean concentrations are given. Each weekly mean is calculated as the arithmetic mean of the 24-hr samples taken at a site during the week (i.e., nonmonitoring days are ignored). The 95% tolerance limit for weekly mean concentrations is calculated using normal distribution methods:

$$95\% \text{ tolerance limit} = \text{arithmetic mean of week means} + g_{(.90;.95;\, n)} * (\text{sd of week means}).$$

Normal methods are used in this case because sample means from any distribution tend to be normally distributed.

8-week exposure

For each monitoring site separately, average exposure over the 8-week monitoring period is calculated as the arithmetic mean of the weekly means (calculated as above for 1-week exposure).

Results

Twenty-four-hour, 1-week and 8-week concentrations are presented in Table 1. Daily concentrations and intermediate calculations are shown in Tables 2 and 2a.

Table 1. Methyl bromide concentrations (ppbv) in Monterey and Santa Cruz Counties, 8 September – 7 November 2001, based on monitoring by the California Air Resources Board.

		Daily		1-week		8-week
Site [a]	N days	Maximum 24-hr	95% tolerance limit	Maximum weekly[b] mean	95% tolerance limit	Mean of weekly means
		ppbv				
CHU	29	1.84	2.08	1.16	1.40	0.56
LJE	32	14.49	21.72	8.99	11.29	2.82
MES	26	36.64	59.28	13.43	18.76	5.51
PMS	30	21.08	21.10	10.47	12.50	2.99
SAL	31	9.25	7.61	6.16	6.91	1.38
SES	30	5.31	7.53	2.54	3.32	1.22

a Monitoring sites described in ARB (2002).
b Each weekly mean is the arithmetic mean of the 24-hr samples (*n* ranged 2 - 4) in a calendar week.

Exposure appraisal

The average concentrations presented here are based on limited monitoring data and must be considered as having some degree of uncertainty. The representativeness of the six monitoring sites is unknown. Each site was monitored only 2 - 4 days per week for a relatively short (8-week) period. Weekend days were not monitored. It is unknown whether weekdays and weekends differ systematically in numbers of methyl bromide fumigations.

References

ARB. 2002. Ambient air monitoring for methyl bromide and 1,3-dichloropropene in Monterey and Santa Cruz Counties, Fall 2001. Report dated Mar. 29, Project No. P-01-004. Sacramento, CA: Quality Management Branch, Monitoring and Laboratory Division, Air Resources Board, California Environmental Protection Agency.

Hahn, G.J., and Meeker, W.Q. 1991. *Statistical Intervals: A Guide for Practitioners*. New York, John Wiley & Sons, Inc.

Parkhurst, D.F. 1998. Arithmetic versus geometric means for environmental concentration data. *Environmental Science and Technology News.* Feb. 1.

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Table 2. Daily concentrations and intermediate calculations for Monterey/Santa Cruz County sites.

Sample		CHU		LJE		MES		PMS		SAL		SES	
Start Date	Week	(ng/m3)	(pptv)	(ng/m3)	(pptv)	(ng/m3)	(pptv)	(ng/m3)	(pptv)	(ng/m3)	(pptv)	(ng/m3)	(pptv)
8-Sep-01	1	1293	333	2143	552	256	66	1514	390	1843	475	494	127
9-Sep-01	1	3638	938	24132	6219	14710	3791	16274	4194	3831	987	6000	1546
10-Sep-01	1	2881	742	18744	4830					16739	4314		
11-Sep-01	1			20895	5385								
	1 Average	2604	671	16478	4246	7483	1928	8894	2292	7471	1925	3247	837
17-Sep-01	2	935	241	1198	309	4123	1063	4145	1068	624	161	4388	1131
18-Sep-01	2	793	204	941	243	2959	763	2890	745	811	209	3893	1003
	2 Average	864	223	1070	276	3541	913	3517	906	717	185	4140	1067
22-Sep-01	3	1857	478	4629	1193	3911	1008	6650	1714	2133	550	10980	2830
23-Sep-01	3	974	251	2033	524	2697	695	4408	1136	1259	325	4021	1036
24-Sep-01	3	1283	331	2963	764	25511	6574	9946	2563	1786	460	6005	1548
25-Sep-01	3	5526	1424	2694	694	73909	19046	51028	13150	4698	1211	1936	499
26-Sep-01	3	1852	477	1016	262	41809	10774	12611	3250	1068	275	8998	2319
27-Sep-01	3	1885	486	870	224	72565	18700	50866	13108	1193	307	4388	1131
	3 Average	2229	575	2368	610	36734	9466	22585	5820	2023	521	6055	1560
3-Oct-01	4	1297	334	1632	420	1417	365	2158	556	1277	329	1646	424
4-Oct-01	4			655	169	7364	1898	3103	800	469	121	3000	773
5-Oct-01	4	942	243	1251	322	8306	2140	6262	1614	1176	303	4215	1086
6-Oct-01	4	2816	726	1515	390	142190	36642	11366	2929	9400	2422	1237	319
	4 Average	1685	434	1263	326	39819	10261	5722	1475	3080	794	2524	651
11-Oct-01	5	3735	963	5526	1424	86617	22321	10979	2829	9151	2358	5301	1366
12-Oct-01	5	4583	1181	11240	2897			81818	21084	34582	8912	16357	4215
13-Oct-01	5	7123	1836	28732	7404			38822	10004	35899	9251	15562	4010
14-Oct-01	5	2579	665	24962	6433	17600	4536	30832	7945	16062	4139	2260	582
	5 Average	4505	1161	17615	4539	52109	13428	40613	10466	23923	6165	9870	2544
19-Oct-01	6	3120	804	10049	2590	9933	2560	7803	2011	4803	1238	7891	2034
20-Oct-01	6			1683	434	1345	347	1462	377	1387	357	948	244
21-Oct-01	6	974	251	534	138	6638	1711	1463	377	552	142	2215	571
22-Oct-01	6	3921	1010	35847	9238	29689	7651	7994	2060	3156	813	20621	5314
	6 Average	2671	688	12028	3100	11901	3067	4680	1206	2475	638	7918	2041

Continued

Table 2. Continued.

27-Oct-01	7	2228	574	15531	4002	17007	4383	9457	2437	3909	1007	1310	338
28-Oct-01	7	2779	716	51795	13348	12121	3124	2063	532	2254	581	1434	369
29-Oct-01	7	2240	577	56236	14492	15002	3866	6036	1555	2221	572	1871	482
30-Oct-01	7	1080	278	16007	4125			1334	344	1879	484	274	71
	7 Average	2082	536	34892	8992	14710	3791	4722	1217	2566	661	1222	315
4-Nov-01	8	1115	287	3076	793			586	151	1182	305	442	114
5-Nov-01	8	409	105	1357	350	3681	948	1372	353	607	156	736	190
6-Nov-01	8	392	101	1478	381	9614	2477	4628	1193	370	95	3498	901
7-Nov-01	8	1040	268	1342	346	1013	261	1591	410	672	173	7200	1856
	8 Average	739	190	1814	467	4769	1229	2044	527	708	182	2969	765
	Mean of week means	**2172**	**560**	**10941**	**2819**	**21383**	**5510**	**11597**	**2989**	**5370**	**1384**	**4743**	**1222**
	SD of week means	1189	306	11940	3077	18676	4813	13396	3452	7789	2007	2956	762
	Max of week means	**4505**	**1161**	**34892**	**8992**	**52109**	**13428**	**40613**	**10466**	**23923**	**6165**	**9870**	**2544**
	n weeks	8	8	8	8	8	8	8	8	8	8	8	8
	95th %ile of week means	4425	1140	33562	8649	56767	14629	36976	9529	20128	5187	10343	2665
	90% tol limit on 95th%	**5446**	**1404**	**43824**	**11293**	**72817**	**18765**	**48489**	**12496**	**26822**	**6912**	**12884**	**3320**
	Max of days	**7123**	**1836**	**56236**	**14492**	**142190**	**36642**	**81818**	**21084**	**35899**	**9251**	**20621**	**5314**

Table 2a. Natural logarithms of daily concentrations and intermediate calculations for Monterey/Santa Cruz County sites.

	ln values											
	CHU		LJE		MES		PMS		SAL		SES	
	(ng/m3)	*(pptv)	(ng/m3)	*(pptv)	(ng/m3)	*(pptv)	(ng/m3)	*(pptv)	(ng/m3)	*(pptv)	(ng/m3)	*(pptv)
8-Sep-01	7.165	5.809	7.670	6.314	5.544	4.188	7.322	5.966	7.519	6.163	6.203	4.847
9-Sep-01	8.199	6.843	10.091	8.735	9.596	8.240	9.697	8.341	8.251	6.895	8.700	7.344
10-Sep-01	7.966	6.610	9.839	8.483					9.725	8.370		
11-Sep-01			9.947	8.591								
17-Sep-01	6.841	5.485	7.088	5.732	8.324	6.968	8.330	6.974	6.436	5.080	8.387	7.031
18-Sep-01	6.676	5.320	6.847	5.491	7.993	6.637	7.969	6.613	6.698	5.342	8.267	6.911
22-Sep-01	7.526	6.170	8.440	7.084	8.272	6.916	8.802	7.446	7.665	6.309	9.304	7.948
23-Sep-01	6.881	5.525	7.617	6.262	7.900	6.544	8.391	7.035	7.138	5.782	8.299	6.943
24-Sep-01	7.157	5.801	7.994	6.638	10.147	8.791	9.205	7.849	7.488	6.132	8.700	7.344
25-Sep-01	8.617	7.261	7.899	6.543	11.211	9.855	10.840	9.484	8.455	7.099	7.568	6.213
26-Sep-01	7.524	6.168	6.923	5.567	10.641	9.285	9.442	8.086	6.973	5.617	9.105	7.749
27-Sep-01	7.541	6.186	6.768	5.412	11.192	9.836	10.837	9.481	7.084	5.728	8.387	7.031
3-Oct-01	7.167	5.811	7.397	6.041	7.256	5.900	7.677	6.321	7.152	5.796	7.406	6.050
4-Oct-01			6.485	5.129	8.904	7.548	8.040	6.684	6.150	4.794	8.006	6.650
5-Oct-01	6.848	5.492	7.132	5.776	9.025	7.669	8.742	7.386	7.070	5.714	8.346	6.990
6-Oct-01	7.943	6.587	7.323	5.967	11.865	10.509	9.338	7.982	9.148	7.792	7.120	5.764
11-Oct-01	8.226	6.870	8.617	7.261	11.369	10.013	9.304	7.948	9.122	7.766	8.576	7.220
12-Oct-01	8.430	7.074	9.327	7.971			11.312	9.956	10.451	9.095	9.702	8.346
13-Oct-01	8.871	7.515	10.266	8.910			10.567	9.211	10.488	9.132	9.653	8.297
14-Oct-01	7.855	6.499	10.125	8.769	9.776	8.420	10.336	8.980	9.684	8.328	7.723	6.367
19-Oct-01	8.046	6.690	9.215	7.859	9.204	7.848	8.962	7.606	8.477	7.121	8.973	7.618
20-Oct-01			7.429	6.073	7.204	5.848	7.287	5.931	7.235	5.879	6.854	5.498
21-Oct-01	6.881	5.525	6.280	4.924	8.801	7.445	7.288	5.932	6.314	4.958	7.703	6.347
22-Oct-01	8.274	6.918	10.487	9.131	10.299	8.943	8.986	7.631	8.057	6.701	9.934	8.578
Continued												

Table 2a. Continued.

27-Oct-01	7.709	6.353	9.651	8.295	9.741	8.385	9.154	7.798	8.271	6.915	7.178	5.822
28-Oct-01	7.930	6.574	10.855	9.499	9.403	8.047	7.632	6.276	7.721	6.365	7.268	5.912
29-Oct-01	7.714	6.358	10.937	9.581	9.616	8.260	8.705	7.350	7.706	6.350	7.534	6.178
30-Oct-01	6.985	5.629	9.681	8.325			7.196	5.840	7.538	6.182	5.612	4.256
4-Nov-01	7.017	5.661	8.032	6.676			6.374	5.018	7.075	5.719	6.091	4.735
5-Nov-01	6.014	4.658	7.213	5.857	8.211	6.855	7.224	5.868	6.408	5.052	6.601	5.245
6-Nov-01	5.971	4.616	7.299	5.943	9.171	7.815	8.440	7.084	5.913	4.557	8.160	6.804
7-Nov-01	6.946	5.591	7.202	5.846	6.920	5.565	7.372	6.016	6.510	5.154	8.882	7.526
Overall mean of days	7.48	6.12	8.38	7.02	9.14	7.78	8.69	7.34	7.74	6.38	8.01	6.65
Overall SD of days	0.72	0.72	1.43	1.43	1.51	1.51	1.26	1.26	1.23	1.23	1.09	1.09
n days	29	29	32	32	26	26	30	30	31	31	30	30
95th % ile of days	**6081**	**1567**	**48725**	**12556**	**123345**	**31786**	**50677**	**13060**	**18459**	**4757**	**19269**	**4966**
90% tol limit on 95th	**8054**	**2076**	**84282**	**21719**	**230039**	**59281**	**81887**	**21102**	**29532**	**7610**	**29225**	**7531**