COMPARISON OF PRE- AND POST-OPERATIONAL AMBIENT PCDDs/PCDFs LEVELS IN THE VICINITY OF MUNICIPAL SOLID WASTE (MSW) INCINERATORS

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ABSTRACT

Pre-operational and post-operational monitoring programs designed to determine levels of PCDDs/PCDFs in ambient air have been conducted in the vicinity of the Bridgeport, Connecticut MSW facility. Sampling and analytical methodology involved the use of high volume sorbent samplers in conjunction with high resolution (magnetic sector) mass spectrometry to determine ambient PCDDs/PCDFs concentrations in the 0.01-0.1 pg/m^3 range.

Comparison of pre- and post-operational ambient PCDDs/PCDFs concentrations measured in the vicinity this facility during wintertime show similar levels and profiles for both programs. Toxic equivalents calculations for the pre- and post-operational ambient PCDDs/PCDFs data show adherence to the 1.0 pg/m^3 ambient PCDDs/PCDFs standard established by the State of Connecticut.

INTRODUCTION

This paper focusses on ambient PCDDs/PCDFs data collected in the vicinity of the Bridgeport MSW facility on both a pre-operational and post-operational basis during the winters of 1987-88 (pre-operational) [1] and 1989-90 (post-operational). Average ambient PCDDs/PCDFs burdens for the two studies are presented and compared along with profiles for the tetra through octa PCDDs/PCDFs congener classes and individual 2,3,7,8-substituted PCDDs/PCDFs. In addition, the PCDDs/PCDFs data is applied to the US EPA and International Toxic Equivalency Factor (TEF) models to provide average atmospheric PCDDs/PCDFs burdens expressed as 2,3,7,8-TCDD equivalents on a pre- and post-operational basis. These values are then compared to the Connecticut ambient PCDDs/PCDFs standard of 1.0 pg/m^3 (expressed as 2,3,7,8-TCDD equivalents on an annualized basis) [2].

The objective for presenting the ambient PCDDs/PCDFs data herein, both on a pre- and post-operational basis, is two-fold; first, as a means to determine compliance with the established ambient standard for PCDDs/PCDFs and second, to assess the impacts, if any, of an operational MSW facility on nearby ambient PCDDs/PCDFs levels.

SAMPLING AND ANALYSIS METHODOLOGY

General Metal Works Polyurethane Foam (PUF) PS-1 samplers were used to collect the PCDDs/PCDFs isomers listed in Table 1. The samplers are essentially modified high volume air samplers employing a glass fiber filter in tandem with a sorbent trap to collect particulate-associated and vapor-phase PCDDs/PCDFs, respectively. Air flow rates between 140 and 220 lpm were utilized, in conjunction with 24 to 96 hour sample sessions to produce sample volumes between 350 m^3 and 950 m^3. All PS-1 samplers were calibrated prior to and at the conclusion of each sampling session using an NBS traceable calibrated orifice. Quality Assurance/Quality Control elements implemented for these programs included field blanks, method blanks, field surrogates, internal standards and collocated samples [3].

All program samples selected for analysis were prepared and analyzed based on the protocol outlined in EPA Methods 8280 and 8290. Native dioxins and furans collected from the ambient air were quantified against isotopically labelled internal standards added to each sample prior to extraction with toluene. Extracts were cleaned by column chromatography and subjected to complete PCDDs/PCDFs analyses by high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS). Detection limits of 10 to 50 fg/m^3 were achieved.

RESULTS AND DISCUSSION

Ambient air samples were collected as described above in the vicinity of Bridgeport MSW facility on both a pre- and post-operational basis for the target parameters listed in Table 1. An average concentration for each target parameter was calculated with non-detected values included into the database as one-half the reported detection limit. This treatment of non-detected observations has been discussed by others in the open literature [4, 5].

Table 2 provides average ambient PCDDs/PCDFs concentrations for the tetra through octa congener class sums measured during the pre-operational (n = 22) and post-operational (n = 7) Bridgeport monitoring programs. Total PCDDs/PCDFs burdens (Cl_4 through Cl_8) are also provided in this table. Congener profiles typical of combustion source influences are noted for both the pre- and post-operational program as characterized for PCDDs by higher concentrations as chlorine substitution increases. Average total PCDDs/PCDFs burdens for the pre-operational and post-operational are similar (7.1 pg/m^3 and 6.3 pg/m^3, respectively).

Table 3 provides average ambient concentrations for the fifteen 2,3,7,8-substituted PCDDs/PCDFs as measured for the pre- and post-operational Bridgeport monitoring programs. The 1,2,3,4,6,7,8-HpCDD and 1,2,3,4,6,7,8-HpCDF congeners predominate in both programs. As with the tetra through octa PCDD congener class totals, higher average ambient levels are noted for the 2,3,7,8-substituted PCDDs with increasing PCDD chlorine substitution.

Ambient PCDDs/PCDFs data gathered from the pre- and post-operational Bridgeport programs are presented in terms of 2,3,7,8-TCDD toxic equivalents in Table 5. This is accomplished by applying the US EPA and International Toxic Equivalency Factor models, contained in Table 4, to the ambient PCDDs/PCDFs database established through this study. The State of Connecticut has issued a standard for ambient PCDDs/PCDFs levels of 1.0 pg/m^3 expressed as EPA 2,3,7,8-TCDD toxic equivalents [2]. As noted in Table 5, neither the pre- or post-operational studies resulted in a toxic equivalents sum which exceeds this standard.

SUMMARY AND CONCLUSIONS

Ambient PCDDs/PCDFs data collected for these programs were applied to the US EPA and International Toxic Equivalency Factor (TEF) models to determine average concentration in terms of 2,3,7,8-TCDD toxic equivalents. Application of both TEF models showed that average ambient PCDDs/PCDFs levels expressed as toxic equivalents exist significantly below the Connecticut ambient PCDDs/PCDFs standard of 1.0 pg/m^3 (expressed as 2,3,7,8-TCDD equivalents on an annual basis) for both the pre- and post-operational programs.

In addition, comparison of average ambient PCDDs/PCDFs levels measured in the vicinity of the Bridgeport MSW incinerator on a pre-operational and post-operational basis during wintertime show no evidence of MSW facility influence on local ambient PCDDs/PCDFs levels. However, further study to more completely assess the impact of MSW facilities on ambient PCDDs/PCDFs levels should be conducted and include a comparison of post-operational ambient PCDDs/PCDFs data collected at sites located upwind and downwind to the facility, a comparison of an established MSW source PCDDs/PCDFs "fingerprint" using additional

PCDDs/PCDFs congeners to ambient PCDDs/PCDFs congener profiles, and further seasonal comparison of pre- and post-operational ambient PCDDs/PCDFs levels.

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Table 1. Target Parameter List.

PCDDs	PCDFs
2,3,7,8 – TCDD	2,3,7,8 – TCDF
1,2,3,7,8 – PeCDD	1,2,3,7,8 – PeCDF
1,2,3,4,7,8 – HxCDD	2,3,4,7,8 – PeCDF
1,2,3,6,7,8 – HxCDD	1,2,3,4,7,8 – HxCDF
1,2,3,7,8,9 – HxCDD	1,2,3,6,7,8 – HxCDF
1,2,3,4,6,7,8 – HpCDD	2,3,4,6,7,8 – HxCDF
OCDD	1,2,3,7,8,9 – HxCDF
	1,2,3,4,6,7,8 – HpCDF
(Also tetra through	1,2,3,4,7,8,9 – HpCDF
PCDDs/PCDFs congener class totals)	OCDF

Table 2
Average Ambient Levels of PCDDs/PCDFs
(tetra through octa) for the Pre- and Post-Operational
Bridgeport MSW Facility Monitoring Programs (Wintertime)

PCDDs/PCDFs Congener Class	Average Concentration (pg/m3)	
	Pre-Operational	Post-Operational
TCDD	0.19	0.089
PeCDD	0.24	0.16
HxCDD	0.71	0.54
HpCDD	1.0	1.0
OCDD	2.2	1.8
Total PCDDs (tetra through octa)	4.4	3.6
TCDF	0.91	0.55
PeCDF	0.62	0.64
HxCDF	0.56	0.59
HpCDF	0.38	0.52
OCDF	0.21	0.39
Total PCDFs (tetra through octa)	2.7	2.7
Total PCDDs/PCDFs Burden (tetra through octa)	7.1	6.3

Table 3
Average Ambient Levels of 2,3,7,8–Substituted PCDDs/PCDFs for the Pre– and Post–Operational Bridgeport MSW Facility Monitoring Programs (Wintertime)

Congener	Average Concentration (pg/m3)	
	Pre–Operational	Post–Operational
2,3,7,8–TCDD *	< 0.010	< 0.010
1,2,3,7,8–PeCDD	0.021	0.014
1,2,3,4,7,8–HxCDD	0.030	0.025
1,2,3,6,7,8–HxCDD	0.046	0.041
1,2,3,7,8,9–HxCDD	0.080	0.070
1,2,3,4,6,7,8,–HpCDD	0.47	0.54
2,3,7,8–TCDF	0.062	0.11
1,2,3,7,8–PeCDF	0.032	0.027
2,3,4,7,8–PeCDF	0.049	0.063
1,2,3,4,7,8–HxCDF	0.11	0.13
1,2,3,6,7,8–HxCDF	0.041	0.051
2,3,4,6,7,8–HxCDF	0.10	0.076
1,2,3,7,8,9–HxCDF *	< 0.010	< 0.010
1,2,3,4,6,7,8–HpCDF	0.22	0.28
1,2,3,4,7,8,9–HpCDF	0.031	0.015

* Greater than 50% of data points exist below the detection limit for this congener.

Table 4. Toxic Equivalency Factor (TEF) Models.

PCDDs	US EPA Model	International	PCDFs	US EPA Model	International
2,3,7,8 - TCDD	1	1	2,3,7,8 - TCDF	0.1	0.1
OTHER TCDD	0.01	0	OTHER TCDF	0.001	0
1,2,3,7,8 - PeCDD	0.5	0.5	1,2,3,7,8 - PeCDF	0.1	0.05
OTHER PeCDD	0.005	0	2,3,4,7,8 - PeCDF	0.1	0.5
1,2,3,4,7,8 - HxCDD	0.04	0.1	OTHER PeCDF	0.001	0
1,2,3,6,7,8 - HxCDD	0.04	0.1	1,2,3,4,7,8 - HxCDF	0.01	0.1
1,2,3,7,8,9 - HxCDD	0.04	0.1	1,2,3,6,7,8 - HxCDF	0.01	0.1
OTHER HxCDD	0.0004	0	2,3,4,6,7,8 - HxCDF	0.01	0.1
1,2,3,4,6,7,8 - HpCDD	0.001	0.01	1,2,3,7,8,9 - HxCDF	0.01	0.1
OTHER HpCDD	0.00001	0	OTHER HxCDF	0.0001	0
OCDD	0	0.001	1,2,3,4,6,7,8 - HpCDF	0.001	0.01
			1,2,3,4,7,8,9 - HpCDF	0.001	0.01
			OTHER HpCDF	0.00001	0
			OCDF	0	0.001

Table 5
Toxic Equivalents Determination

TEF Model	Toxic Equivalents (pg/m3) Pre-Operational	Post-Operational
US EPA	0.049	0.042
International	0.097	0.088