IMPACTS OF DIOXIN EMISSIONS FROM THE SHINKAMPO INCINERATOR TO THE UNITED STATES NAVAL AIR FACILITY AT ATSUGI, JAPAN. PART 2: AIR IMPACTS

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Introduction

Because of limited space for abstracts, the background on this site will not be presented here, but instead can be found in the companion abstract on soil testing at this site[1]. The NAF Atsugi was not permitted to test the stacks of the Shinkampo Incinerator Complex (SIC), and was not provided with stack test information by the owners of the facility. Subsequently, their evaluation of ambient and indoor air impacts focused on air monitoring on NAF Atsugi. Numerous organic and inorganic contaminants were measured in these programs. This paper focuses on the air monitoring for polychlorinated dibenzo-*p*-dioxins (CDDs) and dibenzofurans (CDFs). These monitoring programs were conducted by the Navy Environmental Health Center in support of a human health risk assessment designed to evaluate health risks for military and civilian personnel stationed at NAF Atsugi.

Methods

Figure 1 shows the boundaries of the NAF Atsugi, the location of the SIC, and the locations of the ambient (outdoor) and indoor air sampling locations. Five ambient sampler locations included: the ground electronics maintenance building (GEMB; directly north) the golf course (GC; directly east), an upwind criteria (CRIT; southeast corner, most upwind site at NAF Atsugi), on the roof of the Elementary school (ELEM; 700 m northwest), and on the roof of the residential tower, building 3102 (RT, 250 m northwest). Ambient samples were taken roughly six days apart between April, 1998 and June, 1999, for a total of 344 ambient samples. During each sampling event, wind speeds and directions were also taken in order to correlate this data with ambient air findings. Further, observations were made as to whether the SIC was operating or not. Seven indoor sampling locations included 4 concurrent indoor/ambient locations (at the GEMB, a corridor and a residential unit within building 3102 of the RT, and the cafeteria at the ELEM) and 3 additional exposure locations including residential building 3043, the child development center (CDC), and inside residential townhouse (TH) building 3025. The indoor sampling program included 67 total samples, of which 20 were taken at the same time as concurrent ambient sample. A high-volume filter/PUF sampler was used for all air samples. The filter and PUF were extracted together with benzene (so that vapor and particle fraction estimates are unavailable), and the extract analyzed using HRGC/HRMS in accordance with EPA Method SW8290.

Most results reported below for dioxin toxic equivalent (TEQ) concentrations used the International TEF scheme, although some TEQ concentrations generated for this paper used the newer 1998 WHO TEF scheme. A spot comparison suggests that WHO-TEQ concentrations are in the range of 5-10 %

higher than I-TEQ concentrations. Results will be characterized as I-TEQ or WHO-TEQ below. Further details of these studies can be found in Radian[2].

Results

Overall

Table 1 provides an overall summary of the sampling program for CDD/Fs. 2,3,7,8-TCDD was detected 71 % of the time, with an average concentration of 0.035 pg/m^3. Twelve of the remaining 16 congeners were detected 100 % of the time, and the other four congeners were non-detects in only one sample. The overall I-TEQ concentration from all 344 samples was 1.57 pg/m^3. This average concentration compares to average urban and rural ambient concentrations of about 0.12 and 0.017 pg WHO-TEQ/m^3 in the United States[3]. The GEMB was clearly the most impacted location, with a 3.49 pg I-TEQ/m^3 average concentration. At the exposure locations, ELEM and RT, average concentrations were closer to 1.0 pg I-TEQ/m^3.

Correlation with Wind Direction

Figure 2 shows a correlation analysis where I-TEQ concentration was plotted against the percent of time the wind was blowing in the direction of the sampler during the sampling event. The correlation for the GEMB is unambiguous – higher concentrations are associated with higher percent downwind. As also seen, there is not a strong correlation with wind direction when the SIC is not operating. Figure 2b shows a weak correlation with wind direction and the concentration at the ELEM sampler. The x-axis could not extend much beyond 30 % of the time because the wind blows only infrequently towards ELEM.

Congener Profile Analysis

In order to better describe the difference between the CDD/Fs in the plume in contrast to background conditions, a small number of samples were isolated for congener profile analysis. Specifically, 10 downwind very high samples (average I-TEQ = 13.9 pg/m^3) from the GEMB and 10 very low upwind samples from the CRIT (0.22 pg TEQ/m^3) were obtained. The average congener profile for these two sets are shown in (A) and (B) of Figure 3. The profile was constructed by summing the concentrations (not TEQ-adjusted) of the 17 CDD/F congeners, and then dividing the concentration of each congener by that total. Figures (C) and (D) are similarly constructed congener profiles for air known to be downwind and impacted from a municipal solid waste incinerator in Ohio, USA (C) and background air (D) from the city where the incinerator is located[5]. The similarities in the profiles are striking. The background air profiles, (B) and (D), are virtually identical despite the 4-fold difference in air concentration. The plume profiles, (A) and (C), also share important similarities in that the hepta and octa furan congeners, and even the other furans, are more predominant as compared to the background profiles, and by contrast, the OCDD is less predominant in the plume profile, comprising only 20-35 % of the total profile, rather than 50-60 % as in background conditions.

Indoor Air

Table 1 provides a summary of the indoor air sampling program, including a comparison of indoor and ambient air samples when both were taken simultaneously. As expected, the indoor air at the GEMB site was the highest, averaging 1.15 pg WHO-TEQ/m^3, with other locations showing a range of 0.2 to 0.6 pg WHO-TEQ/m^3. The most important trend to observe is that the indoor air appears to be lower on average than the outdoor air, less than 50 % of the outdoor air on average. The paired sample comparison between simultaneous indoor and outdoor concentrations provides some insight into this trend. Overall, the averages for this simultaneous set also suggest that indoor air is a bit less than 50 %

of outdoor air. However, the difference is most striking for the GEMB, where indoor air was 20 % of outdoor air. When outdoor air was lower and perhaps typical of NAF Atsugi "background", as it appears to be with the RT and ELEM sites, than indoor air was only slightly lower than outdoor air. This suggests that the ventilation systems are effective at keeping out the higher plume-related concentrations, but for more typical background conditions, indoor air appears similar to outdoor air.

Disclaimer

The views expressed in this article are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.

References

1. Lorber M., Wang V, Walker Y, Gillooly P. 2002. Impacts of Dioxin Emissions from the Shinkampo Incinerator to the US Naval Air Facility at Atsugi, Japan. Part 1: Soil Impacts. This conference.
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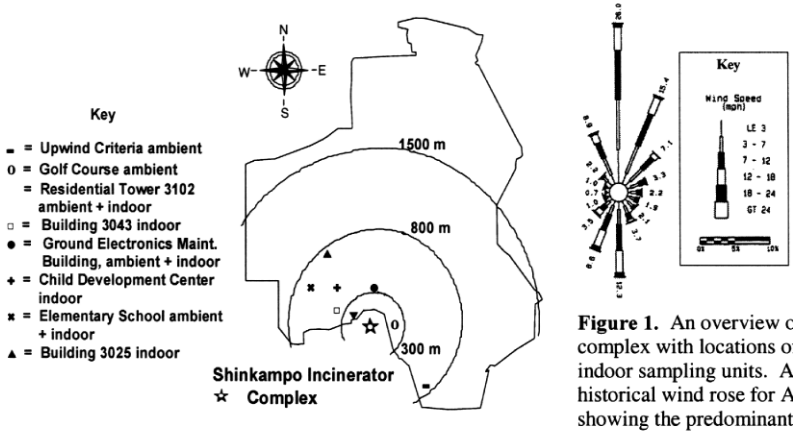

Figure 1. An overview of the SIC complex with locations of the ambient and indoor sampling units. Also shown is the historical wind rose for Atsugi, Japan showing the predominant north and south wind direction.

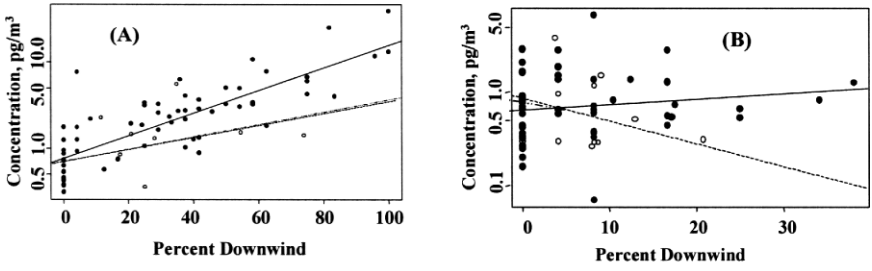

Figure 2. Correlation of I-TEQ concentration (pg/m^3) with percent wind was blowing in the direction of the sampler for the GEMB (A) and the ELEM (B) (solid lines and closed circles correspond to when the SIC was on, and dashed lines and open circles for when the SIC was off).

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Table 1. Summary statistics for ambient and indoor sampling program .

Description	GC	GEMB	RT		ELEM	3043	TH	CDC	CRIT	OVERALL
I. 2,3,7,8-TCDD Ambient Sampling Results										
n	62	76	70		63				73	344
% detected	74	91	73		57				56	71
minimum	0.01	0.01	0.009		0.01				0.01	0.009
maximum	0.12	0.59	0.20		0.18				0.07	0.59
mean	0.026	0.08	0.027		0.018				0.016	0.035
II. I-TEQ Ambient Sampling Results (same n as 2,3,7,8-TCDD)										
minimum	0.24	0.31	0.15		0.07				0.15	0.07
maximum	4.34	39.4	7.29		6.73				6.44	39.4
mean	1.09	3.49	1.19		0.98				0.85	1.57
III. Indoor I-TEQ Sampling Results										
			C	R						
n		19	8	8	8	8	8	8		67
minimum		0.15	0.11	0.22	0.06	0.13	0.10	0.05		0.05
maximum		9.05	2.07	0.69	1.38	1.42	0.88	0.40		9.05
mean		1.15	0.59	0.53	0.42	0.66	0.43	0.18		0.60
IV. Mean Concentrations of Simultaneous Indoor and Outdoor I-TEQ Measurements										
n		6	7		7					20
indoor		0.51	0.52		0.26					0.42
outdoor		2.48	0.66		0.34					1.09

Key: GC = golf course; GEMB = ground electronics maintenance building; RT = residential tower (C=corridor; R=Residence); ELEM = elementary school; CRIT = upwind criteria site; CDC = child development center, TH = townhouse indoor sampling; OVERALL = study summary totals (number of samples) and averages (concentrations).

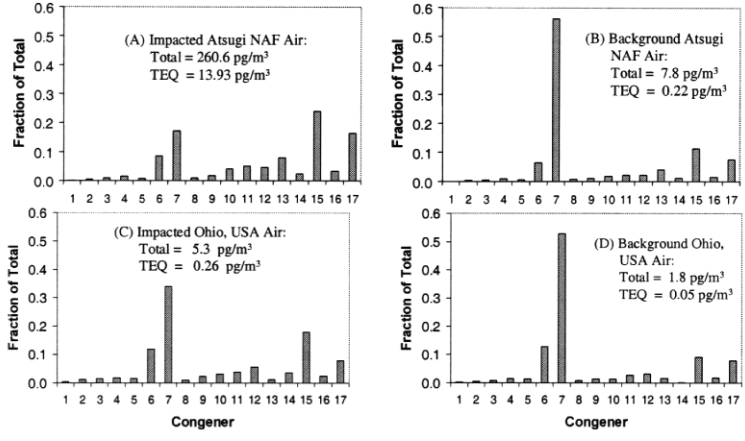

Figure 3. Comparison of congener profiles for plume air (A) and background air (B) at NAF Atsugi with similar plume air (C) and background air (D) for an urban city in Columbus, OH, USA.