IMPACTS OF DIOXIN EMISSIONS FROM THE SHINKAMPO INCINERATOR TO THE UNITED STATES NAVAL AIR FACILITY AT ATSUGI, JAPAN. PART 1: SOIL IMPACTS

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Introduction

The United States Naval Air Facility at Atsugi, Japan (NAF Atsugi) is located in the Kanto Plain area on the island of Honshu, Japan. Directly to the south of the facility, in the Tade River Valley, was the Shinkampo Incinerator Complex (SIC). The Incinerator is no longer in operation, having closed in May of 2001. While operating, three incinerators were licensed by Japan to burn general industrial waste and infections industrial waste (medical), and were incinerating up to 90 tons a day. The pollution control devices included precipitators and scrubbers. The 4-5 acre facility was located in a small river valley, and the NAF Atsugi is positioned on a plateau at the end of the valley. While the incinerator stacks were about 25 m high from the valley base, they were only about 15 meters higher than the ground level of the NAF Atsugi. Further, these stacks were only 250 m away from the nearest high-rise housing unit and about 1000 m from a school and day care center. The predominant wind direction is from south to north during the spring and summer (conversely from north to south during the fall and winter). When blowing from south to north, the plume moves directly onto the base where exposures could occur . The NAF Atsugi was not permitted to test the stacks, and was not provided with stack test information by the owners of the facility. Subsequently, their evaluation of environmental impacts focused on environmental monitoring on NAF Atsugi, including a soil testing program and an extensive air monitoring program. Numerous organic and inorganic contaminants were measured in these programs. This paper focuses on the soil monitoring for polychlorinated dibenzo-*p*-dioxins (CDDs) and dibenzofurans (CDFs), and a companion paper focuses on the air monitoring program[1]. 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 soil sampling locations. The soil sampling program occurred during 1998. A total of 98 soil samples were taken and measured for CDD/Fs, including 73 surface samples (0-7.5 cm), and 25 subsurface samples (7.5-30 cm). The subsurface samples were taken below the surface samples. Sampling was conducted using stainless steel spoons, clearing the ground of debris and vegetation prior to sampling. Surface soil sampling sites were of three general types: 1) sampling in “areas of concern”, which included 12 samples in a residential tower complex, 8 samples at the elementary school, and 3 samples a the child development center, 2) sampling in 2 “reference” areas (6 samples in each area) initially speculated as least likely to be impacted by emissions based on their location in the western portion of the base; and 3) 33 dispersed "trend" samples located throughout the base. Subsurface samples include: 11 from the areas of concern, 6 from the reference areas, and 10 from the trend sites. In addition to chemical analysis, subsets of these soil samples were measured for texture (sand/silt/gravel/clay), moisture content, and pH.

In 1999, a second round of sampling included 29 samples taken to investigate issues which arose during analysis of the first round of sampling. Three of those samples were analyzed for CDD/CDFs. These included a soil sample taken at the ground level surface, but below a building which was erected at ground surface level prior to the time when the incinerator began operation in 1985, a surface soil sample near that building, and a surface soil sample in one of the two reference sites. Another program, which occurred in 1998, was a sampling of house dust. A total of 7 dust samples taken using a high volume (vacuum) dust sampler in 3 residences, the child development center, the elementary school, and a ground maintenance building. Only 2,3,7,8-TCDD was measured in these dust samples.

All samples were analyzed using EPA method 8290. Except for the single sample taken beneath the building in the second round, all samples contained detectable levels of CDD/Fs. Results reported below for dioxin toxic equivalent (TEQ) concentrations used the WHO 1998 TEF scheme. Further details of these studies can be found in Radian[2].

Results

Overall

Table 1 provides a summary breakdown of surface soil results in terms of TEQs. The exposure areas of concern and the reference study areas generally had comparable soil TEQ concentrations averaging about 15-30 ppt TEQ, ranging as high as 90 ppt TEQ. The trend samples were divided into two groups, based on an examination of the results and their locations. A set of 11 of the 33 trend samples, termed "downwind and impacted" was downwind generally within 500 meters of the incinerator stack; the remaining 22 were spread out on NAF Atsugi (see Figure 1). Clearly there is a distinction in the concentrations, with the impacted samples averaging 266 ppt TEQ and the unimpacted being similar in magnitude and range for all other base surface samples, with an average of 14 ppt and a range of 8-83 ppt TEQ

Surface vs. Subsurface

The dichotomy between surface and subsurface soil concentrations is to be expected, particularly if the source of surface dioxins is atmospheric deposition. The average TEQ concentration for the surface and subsurface soil samples is 61 and 12 ppt TEQ, respectively (n=25 for both sets).

Impact of sand content

Table 2 shows the results for samples in which sand content measurements were taken. The 12 samples were broken into logical groups corresponding to sand content. As seen, higher sand content resulted in lower dioxin concentrations. This is consistent with the findings of Brzuzy and Hites[3], who found the peak concentration of dioxin in sandy soils to occur at 30 cm in depth, in contrast to soils higher in silt and clay, where the peak concentrations were within the surface 5 cm.

Soil sample beneath the building

This sample, seemingly unimpacted by incinerator emissions but nonetheless a surface soil sample, had one of the lowest concentration of all the surface samples measured in this program - at 3 ppt TEQ. The sample taken outside this building had a higher concentration of 8 ppt TEQ, and the additional reference site sample was at a typical study concentration of 11 ppt TEQ.

One anomalous soil sample and soil profiles

The highest soil sample, at 642 ppt TEQ, was located on the NAF Atsugi golf course 300 m east of the incinerator. However, a close examination of the profile of dioxins and furans showed that this sample most likely came from a different source than the incinerator. Figure 2 shows the profile of this sample, along with three other CDD/F profiles. These profiles were constructed by adding the concentrations (not TEQ-adjusted) of the 17 CDD/F toxic congeners, and then simply dividing each concentration by this total. Two of the profiles were from the other impacted soil samples (n = 10, average = 226 ppt TEQ) and the unimpacted soil samples (n=22, average = 14 ppt TEQ). The third profile was from a profile of similarly “impacted” soil samples near a solid waste municipal incinerator in Ohio, US[4]. This very typical soil profile, found in areas of depositional impact as well as background, includes a high concentration of OCDD (50-60 % of total concentration), and noteworthy concentrations of the hepta dioxin congener, a hepta furan congener, and OCDF.

Indoor dust versus outdoor soil

The average 2,3,7,8-TCDD concentration in the 7 dust samples was 98 ppt, with a range of 17 to 210 ppt. The overall average of all the 2,3,7,8-TCDD surface samples was 0.8 ppt, with a maximum occurrence of 24 ppt. Only three surface samples, the ones located at the nearest downwind location, had concentrations above 10 ppt; all others were close to or below 1 ppt. One might surmise, or speculate on, a few conclusions from this finding: 1) with atmospheric depositions from a nearby source, clearly the very surface of the soil is most impacted, and even a 7.5 cm sample results in meaningful dilution, 2) an additional factor leading to higher indoor concentrations is possibly that only the lightest and finest soil particles – high in organic matter and enriched in dioxin, or the aerosol particles directly from stack emission, make it to the indoors.

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.

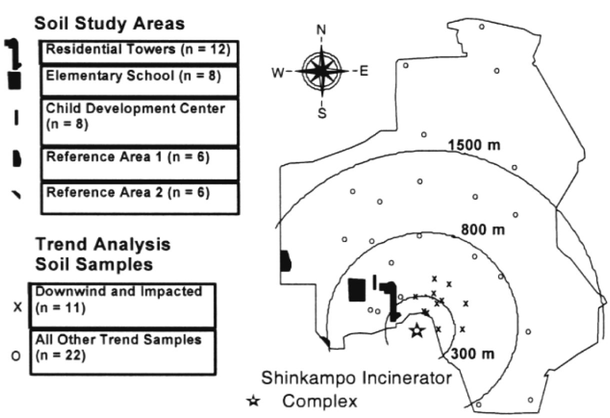

Figure 1. Depiction of the NAF Atsugi with respect to the Jinkampo Incinerator Complex, and the soil sampling locations.

References

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Table 1. Summary of TEQ results for the categories of soil samples.

Description	n	Total, pg/g	TEQ, pg/g	TEQ range
Exposure Study Areas	28	1071	15	<1 – 90
Reference Study Areas	12	1140	27	13 – 62
Trend – Downwind and Impacted	11	8800	266	66 – 642
Trend – All Other Samples	22	484	14	8 - 83

Table 2. Summary of 2,3,7,8-TCDD concentrations found in dust samples compared to the 2,3,7,8-TCDD found in the nearest cluster of samples.

Percent Sand	n	Mean TEQ, ppt	TEQ values, ppt
80 – 90	5	5	<1, <1, 7, 7, 10
60 – 80	4	38	9, 14, 62, 68
50 - 60	3	75	47, 87, 92

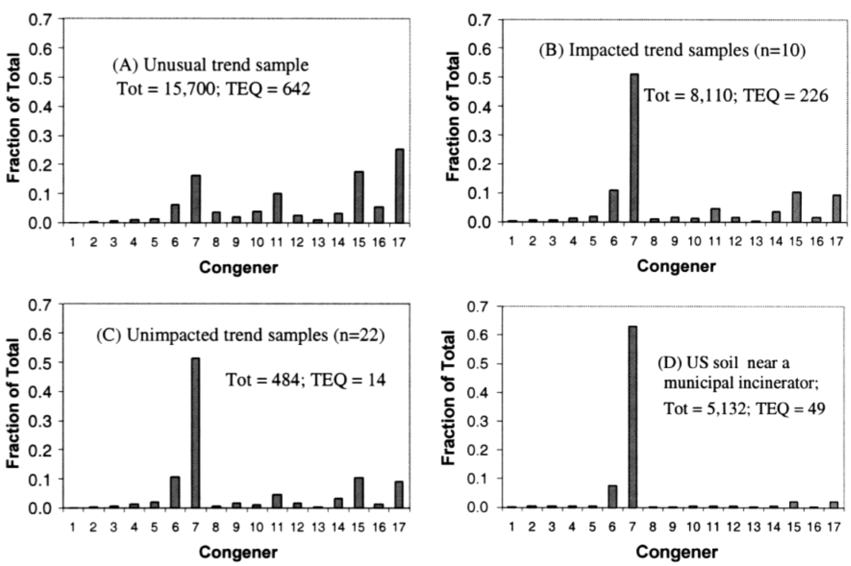

Figure 2. Congener profiles for the 17 CDD/F congeners for the anomalous soil sample (A), the average for the impacted trend samples (B), the average for the umimpacted trend samples (C), and for soil impacted by depositions from a US municipal waste incinerator (D) (key for congeners on x-axis: 1 = 2,3,7,8-TCDD, 7 = OCDD, 8 = 2,3,7,8-TCDF, 17 = OCDF)