MEASURING AND EVALUATING IMPACTS OF DIOXIN-LIKE COMPOUNDS IN RESIDENTIAL APARTMENTS NEAR THE WORLD TRADE CENTER SITE

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Introduction

The World Trade Center (WTC) was subjected to a terrorist attack on September 11, 2001 which resulted in the collapse of both 110-story towers and multiple buildings located within the WTC complex. The collapse of the towers sent a large dust cloud across lower Manhattan and fires, initially fueled by jet fuel, burned for several months. The dust cloud consisted of pulverized building materials and the smoke consisted of combustion byproducts that originated from incomplete combustion of building materials, furniture, and office equipment. This resulted in a complex mixture of contaminants being deposited in and around lower Manhattan.

Monitoring the settled dust and ambient air quality was initiated following the collapse of the WTC by numerous government agencies, academic institutions, and private groups to determine the physical and chemical characteristics. Ambient monitoring indicated that polychlorinated dibenzodioxin (PCDD) and polychlorinated dibenzofurans (PCDF) were present in the air and settled dust in lower Manhattan[1,2,3]. Due to the force associated with the dispersal of the dust cloud, the length of time the fires burned, and the amount of dust disturbance during the removal of WTC-related debris from the site, the indoor environments of buildings in lower Manhattan were potentially impacted by WTC-related dust and fire-related particulate matter.

USEPA initiated a study in June of 2002 at a heavily impacted building (i.e., windows blown-in during WTC collapse and significant accumulation of dust) to determine the concentration of contaminants in indoor environments, before and after cleaning, and to determine if standard cleaning methods were able to reduce contaminants below health-based numeric criteria[4]. This paper presents the results of the dioxin wipe sampling from the USEPA study building.

Methods and Materials

This study was conducted in a five story building containing thirteen residential apartments and five commercial spaces. The building is located at 110 Liberty Street, New York, NY and is situated on the southern border of the World Trade Center site. Shortly after the collapse of the WTC, the owner had professional cleaners remove gross dust and debris from the residential spaces. Floors, walls and ceilings were cleaned using HEPA vacuums and wet wiping with soap and water. Personal items, such as furniture and clothing, were not cleaned. Although a cleaning event occurred prior to the implementation of this study, there was significant accumulation of dust in the building that resulted from redeposition of dust that had become airborne during activities associated with the recovery effort being conducted at the WTC site. The thirteen residential apartments range in size from 655 to 1,335 square feet with an open floor plan that contains a

kitchen, bathroom, and bedrooms. The five commercial spaces, consisting of two restaurants, a retail store, a medical office, and a barber shop, range in size from 716 to 2,451 square feet. Only two of the commercial spaces, the medical office and the retail store were included in this study.

Prior to cleaning events associated with this study, wipe samples were collected from each of the thirteen residential units and the two commercial units included in the study. Wipe samples were collected from 10 cm x 10 cm areas using 3 x 3 inch cotton gauze pads wetted with 2 milliliters of acetone. One sample was collected from the surface of each of the following three non-porous locations within each unit: wall, bare floor, and a horizontal surface (e.g., counters or tables). Following the cleaning activities, post-cleanup wipe samples were collected in the same manner as the pre-cleanup samples. The post-cleanup samples were collected adjacent to the pre-cleanup sampling locations whenever possible. All wipe samples were placed in amber glass jars or in glass jars wrapped in aluminum foil, and shipped via Federal Express to the laboratory. The analyses were provided by Paradigm Analytical, 2627 North Chase Parkway SE, Wilmington, NC. The samples were analyzed for dioxins/furans using USEPA method SW-846 8290[5].

Results and Discussion

The results indicate that furan congeners were detected more frequently than dioxin congeners. The more highly chlorinated congeners within each group (i.e., dioxin and furan) were also detected more frequently and generally at higher concentrations than less chlorinated congeners (Table 1). The mean detected values for the post-cleaning samples were lower than the pre-cleaning samples with the exception of two congeners (i.e., 2,3,7,8-TCDF and OCDF).

Comparison with literature values indicates that the mean pre-cleaning 2,3,7,8-TCDD concentration (0.414 ng/m^2) was lower than the mean calculated for samples with detected values collected adjacent to an incinerator in Atsugi, Japan (i.e., 0.086, 0.014, 0.200, 0.200, 0.210, 0.670, and 4.200 ng/m^2; mean = 0.815 ng/m^2)[6], while the mean post-cleaning TEQ (ND=½) concentration (0.703 ng/m^2) was slightly lower than the mean TEQ (ND=½) concentration (0.99 ng/m^2) reported after cleaning that occurred following a transformer fire in an office building [7]. This suggests that the pre-cleaning 2,3,7,8-TCDD concentrations were less than those found near an operating incinerator and that the post-cleaning dioxin concentrations were slightly less than post-cleaning samples collected from a building that was previously contaminated with dioxin.

The results also indicate that standard cleaning methods, which include vacuuming hard and porous surfaces and wet wiping horizontal surfaces, are effective at reducing total dioxin concentrations (Figure 1). A comparison of the pre-cleaning and post-cleaning dioxin TEQ concentrations shows a decrease in average concentration for the post-cleaning samples. The decrease is more noticeable when ½ of the detection limit is not used to calculate the TEQ. This is due to the results for both the pre-cleaning and post-cleaning samples being at or near the detection limits. The pre-cleaning data set contained three samples, with values of 5.54 ng/m^2, 2.47 ng/m^2, and 2.05 ng/m^2 that exceeded the health-based value of 2 ng/m^2. The remaining pre-cleaning samples, as well as all of the post-cleaning samples, were below the health-based value. The health-based value was developed using guidance documents from the USEPA Office of Pesticides and the USEPA Superfund Program and included parameters that accounted for transfer rates from hard and porous surfaces, exposure factors (e.g., skin surface area, body weight), and toxicity.

In summary, the study demonstrated that there were dioxin-like compounds present in the indoor environment and that standard cleaning techniques were effective at reducing dioxin-like compounds in the indoor environment.

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Table 1. Analytical results for the pre- and post-cleaning sampling. Mean and standard deviation were calculated using only samples which were above the detection limit (DL) for the specific congener. Bold values indicate that the post-cleaning mean was higher than the pre-cleaning mean.

PCDD/PCDF	Pre-Cleaning (n = 56)			Post-Cleaning (n = 74)		
	% Samples Above DL	Mean (ng/m^2)	STD	% Samples Above DL	Mean (ng/m^2)	STD
2,3,7,8-TCDD	9	0.414	0.155	3	0.310	0.110
1,2,3,7,8-PeCDD	27	0.383	0.296	4	0.251	0.216
1,2,3,4,7,8-HxCDD	20	0.382	0.361	0	na	na
1,2,3,6,7,8-HxCDD	41	0.516	0.521	1	na	na
1,2,3,7,8,9-HxCDD	32	0.426	0.419	0	na	na
1,2,3,4,6,7,8-HpCDD	89	1.671	2.687	81	0.609	0.383
OCDD	96	8.255	13.608	99	4.272	4.697
2,3,7,8-TCDF	59	0.512	0.475	14	**0.692**	0.999
1,2,3,7,8-PeCDF	84	0.405	0.454	30	0.210	0.184
2,3,4,7,8-PeCDF	89	0.593	0.663	47	0.257	0.220
1,2,3,4,7,8-HxCDF	82	0.479	0.654	20	0.182	0.099
1,2,3,6,7,8-HxCDF	82	0.415	0.496	22	0.185	0.094
2,3,4,6,7,8-HxCDF	70	0.477	0.663	16	0.191	0.073
1,2,3,7,8,9-HxCDF	11	0.431	0.367	0	na	na
1,2,3,4,6,7,8-HpCDF	84	1.115	1.966	46	0.264	0.141
1,2,3,4,7,8,9-HpCDF	16	0.458	0.365	0	na	na
OCDF	66	1.077	1.599	8	**1.255**	1.266

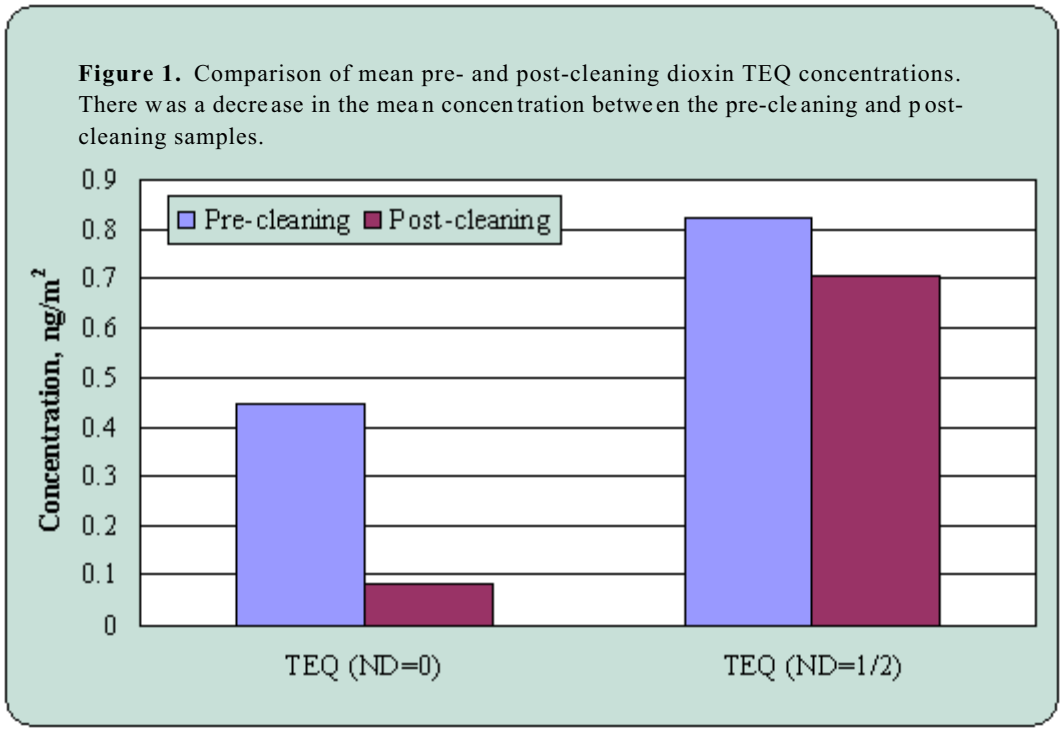

Figure 1. Comparison of mean pre- and post-cleaning dioxin TEQ concentrations. There was a decrease in the mean concentration between the pre-cleaning and post-cleaning samples.

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