

ASSESSMENT OF HUMAN EXPOSURE TO POLYCHLORINATED
DIBENZOFURANS AND DIOXINS

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ABSTRACT

Fires, explosions and other accidents in PCB filled equipment can result in possible exposure of firemen, cleaning personnel and the normal workers. Inhalation, dermal exposure and ingestion are the possible routes of exposure. An indirect assessment of the exposure can be made by analyses of wipes, air and water samples and clothes. A direct assessment of exposure can be made by analyses of blood samples, adipose and other tissue samples, feces and bile.

Key words: PCB
 PCB Fires
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 Exposure

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GENP 010652

INTRODUCTION

The PCB accidents discussed in Ref. 1 resulted in a possible exposure of firemen, cleaning personnel and partly also the normal workers. The possible routes of exposure are

Inhalation

Ingestion

Dermal

The assessment of exposure can be made from the analyses of a variety of samples like wipes, air, water samples and clothes. These assessments are indirect as the amount absorbed through the skin is 1-10%, via inhalation 50-70% and via ingestion 50-90% is taken up. A direct assessment of the exposure can be made by analyses of samples taken from the exposed persons like blood, adipose and other tissues, feces and bile.

INDIRECT ASSESSMENTS OF EXPOSURE

The most important samples for the indirect assessment of exposure are wipe tests. The results from the recent Scandinavian PCB accidents discussed in Reference 1 indicate a large variation in the levels of PCDDs and PCBPs. The isomeric pattern are almost identical in these samples consequently the risk of exposure is parallel to the levels found for PCDFs and PCBPs, see Table 1.

Water is used to extinguish the fire and for washing. Water samples from the Surahammar fire were analyzed, see Table 2. A series of PCDFs could be identified in a water sample from the high pressure washing also containing suspended soot particles. However, when the soot particles had sedimented, the supernatant water phase contained less than 0.1 pg/ml of each PCDF isomer including 2,3,7,8-tetra-CDF. No solubility studies

GENP 010653

783464

of PCDFs can be found in the literature, but in laboratory experiments the solubility of 2,3,7,8-tetra-CDD has been found to be 200 pg/ml (2). It can be assumed that the solubility of PCDDs and PCDFs is quite similar, consequently the solubility in the washing water is highly reduced possibly due to the adsorption of PCDFs on soot particles.

Air samples have been collected and analyzed in order to estimate the amount of exposure via inhalation. The cartridges used in this study consisted of a filter and a XAD-2 layer, both were analyzed together. Samples were taken during and after the cleaning operations at the Surahammar steel mill and during the cleaning operations of the railway locomotive (1), see Table 3. In Surahammar the levels were below the detection level, 2 pg/m³ for each isomer. In a sample collected close to the exploded capacitor of the railway locomotive, the level of 2,3,7,8-tetra-CDF was 50 pg/m³. No soot was found in this accident.

From the Surahammar fire we have analyzed overalls and underwear. The overalls were washed after use every day. After being used for 14 days an overall was found to have 28 ng 2,3,7,8-tetra-CDF/m² and about 100 ng of all tetra-CDFs/m². Another overall used and washed for one month followed by dry cleaning had almost the same levels. A set of underwear also used for one month had less than 5 ng 2,3,7,8-tetra-CDF/m². In order to avoid dermal exposure the workers should be protected by double layers of protective clothings.

DIRECT ASSESSMENT OF EXPOSURE

Blood samples have been collected from more than forty firemen and analyzed by a method earlier described in Reference 3. No PCDFs were detected in these samples at a detection level of 0.1 pg/ml blood serum for the toxic 2,3,7,8-tetra-CDF and 1,2,3,7,8- and 2,3,4,7,8-penta-CDFs.

GENP 010654

783465

We have analyzed a sample of adipose tissue from a man engaged in the clean-up operations in the Binghamton State Office Building. The levels found were 8 ppt of 2,3,7,8-tetra-CDF and 9 ppt for 2,3,4,7,8-penta-CDF, which is close to background levels found in the general population (4).

CHECKING LIST AFTER PCB ACCIDENTS

<u>Information:</u>	Workers Industrial hygienists Authorities: Occupational Environmental Local medical Press, TV
<u>Coordination:</u>	Local coordinator for sampling and cleaning
<u>Sampling:</u>	Areas (indoor and outdoor) Exposed personnel (blood) Air Water
<u>Analyses:</u>	PCBs; Levels and isomeric pattern PCDFs, PCBPs, PCDDs; Isomer specific
<u>Contact:</u>	Cleaning firm
<u>Cleaning firm:</u>	Experienced Good protection of workers Good equipment Vacuum cleaning - high pressure washing

GENP 010655

783466

Resampling:

Contaminated areas - Analyses

Waste:

Controlled degradation

GENP 010656

783467

GENP 010657

783468

Table 1. Comparison of PCDF levels in wipe samples

Sample	Type	Levels	Other Constituents
Skövde	PCB + oil fire	1 $\mu\text{g}/\text{m}^2$	
Surahammar	"	1 - 10 "	
Stockholm	PCB Explosion	1.5 "	+ PCBPs (major)
Hallstahammar	"	1 - 10 "	
Imatra	"	1 - 3 "	+ PCBPs (minor)
Railway locomotive	"	1 - 100 "	
Kisa	"	1 - 1000 "	+ PCBPs (minor)
Halmstad	"	0.1 - 500 "	+ PCBPs (minor)

Table 2. Analyses of PCDFs in water samples, Surahammar (pg/ml)

Sample	ΣCl_4	2378-	ΣCl_5	ΣCl_6	ΣCl_7	Cl_8
High pressure washing (incl. soot)	4500	1500	2000	500	15	15
High pressure washing (after sedimentation)	< 2.5 ^x	< 0.1	< 2.5 ^x	< 1.5 ^x	< 2.5	< 2.5

^x < 0.1 pg each isomer

GENP 010658

783469

GENP 010659

783470

Table 3. Analyses of PCDFs in air samples (pg/m³)

Sample	ΣCl_4	2378-	ΣCl_5	ΣCl_6	ΣCl_7	Cl_8
Surahammar During cleaning	< 20	< 2	< 10	< 10	< 10	< 10
Surahammar After cleaning	< 10	< 2.5	< 10	< 10	< 10	< 10
Railway locomotive During cleaning	500	50	50	30	20	20

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