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Item ID Number 02210

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Report/Article Title Draft Report: Estimation of Risk to Human Health Associated with Exposures to Contaminated Surfaces in the Binghamton State Office Building and Proposed Reoccupancy Surface Standard

Journal/Book Title

Year 1982

Month/Day September 27

Color ☐

Number of Images 15

Descripton Notes Report is accompanied by letters introducing it. Also included is a sheet of handwritten notes by Alvin L. Young regarding a meeting on 22 December 1982.

Meeting

22 Dec 82

VAN KOZAK
Bob Westin } VERSAR INC.

- Efforts at clean-up are still continuing at the BSOB
- Partitions and sprayed-on fire proofing are now being cleaned.
- Will need to remove vinyl floor.

- By End of March - Preliminary Cleanup will be Completed.
  Probably will be a Public Meeting & meeting of the Expert Panel.

- Currently gathering data on Air Values using a Hi-Vol Sampler (16th Floor)

- Need to decide on whether to collect Wipe Samples from over wide areas.

These data impact level of cleaning ∴ State/EPA must establish safety levels.

$\mu g/m^3$ & $\mu g/m^2$

Kligman, 1968 concluded that 32 μg TCDD/volunteer did not cause chloracne but that 7600 μg/volunteer (skin patch) did cause chloracne.

VERSAR's exposure criteria would mean that individuals could safely be exposed to 27 picogram TCDD

= Ellen Silbergeld, EDF Toxicologist has been assigned to the Expert Panel.

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October 1, 1982

Dr. Alvin Young
Office of Environmental Medicine
Veterans Administration
810 Vermont Ave., N.W.
Washington, D.C. 20420

Dear Dr. Young:

Enclosed please find the proposed BSOB reoccupancy standard as we discussed. Although the approach is certainly not earth-shaking, New York State indicated that their initial reaction was favorable. I hope to have formal comments from them within the next week or so. As I mentioned in our phone conversation, I intend to adjust the standard appropriately for inaccessible areas of the building and for surfaces which are not likely to be contacted by BSOB employees. As one final point of interest, Versar has been authorized to pursue research on the two areas which I recommended in the document and I anticipate the generation of some truly fascinating new data over the next six months.

I hope your trip is both successful and pleasant and look forward to talking with you further on your return.

Sincerely

Van Kozak

Van Kozak
Senior Scientist

VK/sh
737C-129

Enclosures

P.O. BOX 1549 6621 ELECTRONIC DRIVE, SPRINGFIELD, VIRGINIA 22151 TELEPHONE: (703) 750-3000

September 27, 1982

Mr. Harry Stevens, Jr.
Director of Design and Construction
Office of General Services
State of New York
35th Floor, Tower Building
Empire State Plaza
Albany, New York 12242

Dear Mr. Stevens:

Enclosed please find five copies of a draft report proposing a reoccupancy surface standard for the Binghamton State Office Building. I look forward to meeting you and discussing this analysis and other matters in our Thursday meeting.

Sincerely,

Van P. Kozak

Van P. Kozak
Senior Scientist

VK/sh
737C-124

cc: Dr. R. Durfee
Dr. R. Ronan
Mr. R. Westin
Mr. J. Richards
Mr. C. Carter
Mr. J. Mayers

Versar New York inc.

DRAFT REPORT

Preliminry Draft: Do Not Cite or Quote

This document is a preliminry draft that was prepared by Versar New York Inc. for the purpose of facilitating discussions of policy issues. This document has not been formally released by the State of New York and should not at this stage by construed to represent the policy of the State or the final recommendations of Versar New York Inc. It is being circulated for comments on its technical merit and policy implications.

Estimation of Risk to Human Health Associated with Exposures to Contaminated Surfaces in the Binghamton State Office Building and Proposed Reoccupancy Surface Standard

Prepared for:

Office of General Services
State of New York
Albany, New York

Prepared by:

Versar New York Inc.
6621 Electronic Drive
Springfield, Virginia 22151

Versar New York inc.

September 27, 1982

ESTIMATION OF RISK TO HUMAN HEALTH ASSOCIATED WITH EXPOSURES TO CONTAMINATED SURFACES IN THE BINGHAMTON STATE OFFICE BUILDING AND PROPOSED REOCCUPANCY SURFACE STANDARD

1.0 INTRODUCTION AND BACKGROUND

On February 5, 1981, an early morning electrical fire occurred in a basement mechanical room in the State Office Building in Binghamton, New York. The fire, believed to have originated in electrical switchgear,(1) was sufficiently intense to cause a coolant leak in an adjacent electrical transformer. The Askarel coolant was composed of about 65 percent Aroclor 1254 (PCBs) and roughly 35 percent trichlorobenzene and tetrachlorobenzene. Pyrolysis of the coolant and other organic materials by the intense heat resulted in the formation of a fine, oily soot which was found later to be present on virtually all surfaces within the building, presumably transported to upper floors via a ventilation shaft.(1) Cleanup activities were initiated but were terminated when chemical analysis of the soot by the New York State Department of Health laboratories revealed significant concentrations of not only PCBs, but also the much more toxic compounds 2,3,7,8-tetrachlorodibenzo-p-dioxin and 2,3,7,8-tetrachlorodibenzofuran.(1) These compounds apparently were produced by pyrolysis of the transformer coolant.

Available information on the nature and extent of contamination of the Binghamton State Office Building (BSOB) by toxic organic compounds indicates that a significant portion of the toxic material can be removed by removing the soot that is present on interior surfaces of the building. For example, analytical results from 12 wipe tests of desk tops on the Seventeenth Floor by the New York State Department of Health(1) indicated a geometric mean PCBs (as Aroclor 1254) area concentration of 11.35 $\mu g/m^2$ after vacuuming as compared to an average PCBs area concentration of 162 $\mu g/m^2$ reported on open, horizontal surfaces prior to cleaning.

The development of a reoccupancy surface standard for BSOB surfaces is important for at least three reasons. First, an appropriate standard must be established for the protection of human health. Second, the adoption of a standard will allow logical decisions to be made with respect to removal or encapsulation of building surfaces as opposed to cleaning and retention of the items and, finally, it may be possible to use surface sampling and an accepted standard as an alert system for the initiation of additional air monitoring or other appropriate action once the building is reoccupied.

2.0 INGESTION OF BSOB CONTAMINANTS

Based on an intensive review of available toxicological information, the State of New York has estimated a level of permissible human exposure to the BSOB contaminants and has proposed an air guideline for these compounds within the BSOB. Although inhalation is considered to be the most important exposure route, both ingestion and dermal absorption are potential routes for human exposure to BSOB contaminants. In all of the previous risk assessments conducted for the BSOB, the dermal absorption route has been considerd to be negligible when compared to inhalation and ingestion and, hence, has been neglected. Ingestion exposure might occur if particulate matter were to adhere to a worker's hands and eventually reach the mouth through a variety of activities such as smoking, nail biting, eating, or occasional hand-mouth contact. It is also possible that in rare instances, food would be placed directly on a work surface prior to consumption and, thereby, transfer contaminants from the surface directly to the mouth. This document presents an assessment of the risk to human health resulting from potential ingestion of BSOB contaminants and proposes a specific surface reoccupancy standard for the building.

The current scientific literature provides very little guidance which would assist in estimating the extent to which BSOB contaminants will be ingested by humans working in the building following cleanup. However, the need for a specific reoccupancy surface standard mandates that best estimates of this exposure route be made.

The general approach used in this document to assess the adequacy of a proposed surface standard has been to: Assume that ingestion is the only significant exposure route to contaminants on BSOB surfaces; Develop predictive estimates of the quantity of contaminants tranferred from surfaces to the hands and finally to the mouth; Add the total predicted ingestion exposure to inhalation levels estimated on the basis of the proposed air standard and; Compare the predicted total exposure to the no-observable-effect-level (NOEL) developed through animal toxicology experiments.

From a pragmatic standpoint, it seems unlikely that large amounts of the toxins will be removed from building surfaces and consumed by the average office worker. On the other hand, some degree of ingestion exposure will probably occur on an irregular basis. The extent of this exposure will be dependent on the extent to which contaminants are transferred from the building surfaces to the mouths of the employees. Although the mechanisms of transfer are speculative, it is reasonable to assume that the primary route of transfer will involve movement of the chemicals from the BSOB surfaces to the hands of the workers and then to the mouth. Activities which might facilitate this transfer include smoking, nail-biting, eating, or occasional hand-mouth contact. It is also possible that employees may occasionally place food directly on the surface of desks or tables prior to consumption and transfer contaminants directly to the mouth. This direct mechanism is considered less likely and has not been specifically addressed, since the analysis has been conducted on a reasonable worst-case basis and should allow for intermittent consumption of food which has been directly contaminated. Transfer of the BSOB contaminants from the hands of a worker to the mouth will likely involve contact with a relatively limited portion of the total hand skin area. It is reasonable to assume that the pads of the fingers and thumbs and some portion of the palm area will be preferentially involved in most hand mouth contact. These skin areas are believed to represent approximately 10% of the total surface area of the hands. Thus, for purposes of this analysis, it will be conservatively assumed that employees will ingest the total quantity of BSOB contaminants which cover 10% of the entire skin surface of both hands on a daily basis over a 30-year working lifetime.

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Although available information does not allow a reliable estimate of the extent to which these chemicals will adhere to human skin, there is no reason to expect that relatively dry skin in an air-conditioned environment will collect the contaminants at levels exceeding ambient surface concentrations. Contaminants will likely be in a dynamic interaction with the skin surface where accumulation will be countered by abrasion, wash-off, and transfer off the skin to other surfaces. Thus, the assumption will be made that skin levels of the contaminants are unlikely to exceed the ambient BSOB surface contamination level. These assumptions are believed to be quite conservative because most people wash their hands several times a day and employees will typically contact the same surfaces repeatedly. It is also likely that the contamination levels on such "frequently contacted" surfaces will decline at a rate exceeding the predictions used in this analysis (i.e., Scenario B - Kim and Hawley, 1982).

In order to calculate the human exposure based on the skin surface areas of the hands, it is necessary to develop estimates of skin area representative of the exposed population. Following the Binghamton State Office Building Expert Advisory Panel Meeting of March 29, 1982, a suggestion was made to use an average weight of less than 70 kg/person in the risk assessment. As a result of this suggestion, the current risk assessment has been revised to use a weight of 50 kg which is one standard deviation below the average weight for adult females. Assuming that the population at greatest risk is comprised of 50 kg women employees, an approximate hand surface area is calculated as shown below.

Based on an individual's height and weight, total body surface area can be estimated using the "Height-Weight Formula" for computing body surface area.[2,3,4] Given a person's height in centimeters (H) and weight in kilograms (W), the body surface area in square meters (S) is derived using the following formula:

$$S = 0.007184 \times W^{0.425} \times H^{0.725}$$

DuBois and DuBois[2] estimate the error in the "Height-Weight Formula" to be ±1.5% on the average, with a maximum of ±5%. These authors contend that maximum errors apply only to those of unusual shape; for those of average body form, the average error will seldom be exceeded.

An estimate of the average height of 50 kg woman can be derived using data compiled by the U.S. Department of Health, Education and Welfare (1979) National Center for Health Statistics.[5] This publication presents statistical values of height and weight characteristics for the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentile of a sample of the U.S. population at age intervals from birth to 74 years. According to this report, a 50 kg woman corresponds to the 10th percentile (equivalent to one standard deviation below the mean) of U.S. women 18-74 years of age. The corresponding height of women in this category is reported as 60.5 inches or 153.7 cm. Total body surface area may then be calculated from the "Height-Weight Formula" as:

$$S = 0.007184 \times 50^{0.425} \times 154^{0.725} = 1.46 \text{ m}^2$$

According to Berkow[6,7], the hands account for 4.5% of the total body surface area in humans 12-74 years of age. Hence, the skin surface area of the hands of a 50 kg woman is 14600 cm^2 x 0.045 = 657 or 329 cm^2 per hand.

The current state-of-the-art with respect to sampling and analytical methodology should allow the quantification of PCB surface levels as low as 1 to 5 $\mu g/m^2$. If it is assumed that the ratios of the highly toxic contaminants (e.g., TCDD, TCDF, etc.) to PCB levels in the BSOB remain equal to previously reported values, then it is possible to predict the level of human exposure and risk resulting from ingestion of these contaminants from surfaces within the building. The following risk assessment assumes that, following the final cleanup of the building, PCB's will not exceed 5 $\mu g/m^2$ on surfaces which employees will contact on a regular basis.

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Key assumptions used in the analysis are as follows:

- o Skin levels of contaminants will not exceed ambient BSOB surface levels.
- o Employees will ingest the total quantity of BSOB contaminants which cover 10% of the skin surface of both hands on a daily basis for a 30-year working lifetime.
- o The skin surface area of both hands of a member of the working population most at risk (i.e., 50 kg women) is 657 cm^2.
- o Dermal absorption is negligible and will not contribute to the risk.
- o Over a 30-year period, surface contamination levels in the BSOB will decline to one percent of the initial values when the building is reoccupied (i.e., Scenario B).
- o BSOB soot contains 30,000 µg PCB/g, 1.2 µg TCDD/g and 48 µg TCDF/g and the ratios between contaminants remains the same on contaminated surfaces.
- o The ratio $\frac{58}{1.2}$ accurately represents the increased toxicity of the contaminant mixture when it is first calculated on the basis of 2,3,7,8-TCDD concentration alone.

2.1 Residue Analysis

Previous experiments suggests that typical BSOB soot contains 3% PCB's (30,000 µg PCB/g soot), 1.2 µg TCDD/g soot and 48 µg TCDF/g soot. For purposes of this analysis, it is assumed that the ratios between contaminants (which may be easily derived from these figures) will apply to all relevant surfaces in the building. Further analytical work may refine these values and modify any subsequent exposure analyses.

(1) Based on these assumptions, BSOB surfaces contaminated by 5 µg PCB/m^2 would also contain 200 pg TCDD/m^2 $\left(\text{i.e., } 5\ \mu g/m^2 \times \frac{1.2}{30000}\right)$ and 8.0 ng TCDF/m^2 $\left(\text{i.e., } 5\ \mu g/m^2 \times \frac{48}{30000}\right)$

This analysis assumes that BSOB employees are exposed to the contaminants on a daily basis over a 30-year working lifetime. If one assumes that over a 30-year period contamination levels drop to one percent of the initial values when the building is reoccupied per Scenario B - developed by N. Kim and J. Hawley,[1], the initial surface levels may be adjusted to reflect average values more appropriate for the estimate of human exposure:

(a) $5\,\mu g\ PCB/m^2 \times \frac{6.4}{30} = 1.1\,\mu g\ PCB/m^2$

(b) $200\ pg\ TCDD/m^2 \times \frac{6.4}{30} = 43\ pg\ TCDD/m^2$

(c) $8.0\ ng\ TCDF/m^2 \times \frac{6.4}{30} = 1.7\ ng\ TCDF/m^2$

These average values will be used to derive an estimate of human risk based on an initial reoccupany standard of $5\,\mu g\ PCB/m^2$.

2.2 Exposure/Risk Analysis

Assuming that the hands of a 50 kg female BSOB employee become contaminated with the compounds of interest at levels equivalent to the surface reoccupancy standard and that the total quantity of these compounds covering 10% of the entire skin surface of both hands is ingested each working day, the following exposure results:

Skin surface area = 10% of 657 cm^2 = 66 cm^2

Average Daily Ingestion Exposure:

PCB $\frac{(1.1\,\mu g/cm^2) \times (66\ cm^2)}{(10000\ cm^2/m^2)} = 6.9\ ng/day$

TCDD $\frac{(43\ pg/m^2) \times (66\ cm^2)}{(10000\ cm^2/m^2)} = 0.28\ pg/day$

TCDF $\frac{(1.7\ ng/m^2) \times (66\ cm^2)}{(10000\ cm^2/m^2)} = 0.011\ ng/day$

It is known that soot from the building has an acute toxicity equivalent to a 2,3,7,8-TCDD concentration of 58 µg/g of soot despite the fact that the actual 2,3,7,8-TCDD content is 1.2 µg/g of soot.[8] The difference is presumably attributable to other compounds in the soot.

Although the reoccupancy standard will probably be based on actual analytical measurements of PCB, TCDD, TCDF or other contaminants (where appropriate ratios are established), risk is a function of the toxicity of the contaminated mixture to which humans are exposed. Thus, a surface standard based on actual residue analysis of one of these compounds must be adjusted to reflect the actual toxicity of the mixture. As noted above, ingestion exposure at levels predicted by this analysis will result in a dose of "TCDD-equivalent" which is significantly greater than exposure to TCDD alone. Based on the predicted Average Daily/Ingestion Exposure to TCDD of 0.28 pg/day, the dose of "TCDD - equivalent toxicant" is 0.28 pg/day x $\frac{58}{1.2}$ = 13.5 pg/day.

For a 50 kg BSOB employee, the dose may be expressed as

$$\frac{13.5 \text{ pg/day}}{50 \text{ kg body weight}} = 0.27 \text{ pg/kg/day.}$$

Based on a no-observed-effect level of 1 ng/kg/day, an uncertainty factor of 3703 $\left(\text{i.e., } \frac{1000 \text{ pg/kg/day}}{0.27 \text{ pg/kg/day}}\right)$ would exist if ingestion were the sole source of human exposure within the BSOB. To look at it another way, if the inhalation standard (i.e., 2 pg/kg/day) is based on a safety factor of 500 the addition of 0.27 pg/kg/day ingestion exposure would reduce the safety factor from 500 to 440 i.e., $\left(\frac{1000}{2.27} = 440\right)$

3.0 CONCLUSIONS AND RECOMMENDATIONS

It appears that based on practical limitations of current analytical methodology and a conservative estimate of ingestion exposure, a reoccupancy surface standard for the BSOB of 5 $\mu g/m^2$ PCB (200 pg $TCDD/m^2$ or 8 ng $TCDF/m^2$) would ensure an adequate margin of safety for the health of workers in the building.

It is important to recognize that the methodology used in this report is quite flexible and may be easily modified should new data become available in the future. For example, the analysis is highly sensitive to both the levels of contaminants and their ratios in the soot and on BSOB surfaces. In a similar fashion, the rate of contaminant degradation in the building determines the appropriate initial reoccupancy surface standard. This assessment has utilized Scenario B of Kim and Hawley since according to the Summary Conclusions of the Binghamton State Office Building Expert Advisory Panel Meeting of March 29, 1982: "Scenario B in the risk assessment paper is the most appropriate decontamination scenario for inhalation exposures (Surface contamination and the resulting dermal exposure may decrease more rapidly than assumed in Scenario B)." (Emphasis added). Scenario B has been utilized in this risk assessment because: (1) Scenario B has been acknowledged as an appropriate scenario for inhalation exposure, (2) it is recognized that Scenario B is probably a conservative estimate for dermal and subsequent ingestion exposure, and (3) available data do not permit development of a more reliable decontamination prediction for the ingestion situation. The decline in BSOB surface contamination levels will depend on the degree of degradation and removal from surfaces (or the building as a whole) on the one hand, and deposition on surfaces following atmospheric transfer from other areas of the building on the other. At present, data are unavailable to permit an adequate evaluation of the dynamics of the contaminants within the building. We recommend that such data be collected in order to further substantiate or appropriately modify the proposed surface standard. Another important consideration from the standpoint of the reoccupancy surface standard is the method used to sample BSOB surface contamination levels. Available information suggests that the two methods currently used (i.e., dry wipes and hexane saturated wipes) provide widely different results, and it is believed that neither method adequately simulates the contact between human skin and building surfaces. Further testing in this area is also recommended.

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