

APPENDIX B

World Trade Center Health Effects Screening Criteria for Ambient Air

Introduction

Extensive air quality monitoring data have been collected at and around the World Trade Center (WTC) site since 9/11/01. Table 1 (Screening Criteria) is intended to provide health protective screening values for data evaluation. Analysis has been performed on an extensive list of potentially WTC-related contaminants. Many of the chemicals screened have demonstrated a consistently low (i.e., below detection limits or trace amounts) trend. Consequently, the list of contaminants in Table 1 represents those chemicals that, because of their intrinsic toxicity and frequency/magnitude-of -detection, pose the greatest potential hazard from exposure. This selection process (i.e., a toxicity/concentration analysis), although qualitative, reflects the contaminant-of-concern identification process recommended in the Risk Assessment Guidance for Superfund. Table 1 may be expanded as additional data analysis becomes available. Two populations have been identified for assessment: response/demolition (i.e., WTC site) workers; and residents living in Lower Manhattan (e.g., Battery Park City, Tribeca and other residential locations close to Ground Zero). Included in the resident category are all other workers located in Lower Manhattan with the exception of WTC site workers.

Relevant Standards

The following paradigm has been employed to develop screening values. For each of the two identified receptor populations (i.e., site workers and residents), existing standards are utilized where appropriate. Occupational standards (i.e., OSHA PELs) are used for all site workers conducting response/demolition activities covered by OSHA. Monitoring data from demolition areas are compared to OSHA PELs. (For example, the OSHA PEL of 1 ppm for benzene is used to evaluate benzene air samples taken directly from within the plume on the debris pile.) Environmental standards (e.g., NAAQS, AHERA) are utilized to evaluate monitoring data from the site perimeter and beyond where residents or non-WTC site workers may be exposed. (For example, lead air monitoring data from perimeter stations outside of the immediate work zone are evaluated against the NAAQS of 1.5 ug/m3.)

Risk-Based Screening Criteria

In cases where appropriate standards do not exist, risk-based screening criteria have been developed for residential (including the non-WTC site workers) receptors. (In the absence of OSHA standards, it is beyond the scope of EPA's mission to develop "occupational" screening values.) The risk assessment paradigm detailed in EPA's "Hazard Evaluation Handbook: A Guide to Removal Actions" (HEH) was employed for this initiative (except where otherwise noted in the Table 1 footnotes). Screening levels reflect the most current toxicity criteria (Slope Factors and RfCs) on EPA's IRIS database.

For carcinogenic compounds excess lifetime cancer risk was set at E-04 (one-in-ten thousand).

CONFIDENTIAL,

CITY_21MC100_003423728

SUBJECT TO PROTECTIVE ORDER NO. 2, SEPT. 2008

The residential exposure scenario in the HEH was modified for carcinogens from the default of 30 years (upper-bound estimate for residency in one dwelling) to 1 year (to reflect an upper bound estimate for the length of time a resident may be potentially exposed to WTC-related contaminants). In cases where the screening value based on a noncancer endpoint is more stringent, screening values for both cancer and noncancer endpoints are presented. It is also noted that the default 30 year exposure duration (and the 1 year site-specific adjustment) reflects an apportionment between child (20% of total exposure duration) and adult (80 % of total exposure duration) receptors. Because children have comparatively greater (as a function of body weight) respiration rates than adults, the screening values presented in Table 1 are marginally more stringent than values that would otherwise be derived by direct application of IRIS verified Unit Risk values.

For noncarcinogenic compounds, the Hazard Quotient (chronic daily intake/RfC) was set at 10. A Hazard Quotient of 10 is employed in the HEH to account for the fact that chronic toxicity criteria (RfDs/RfCs) are being applied to sub-chronic exposure scenarios that are not expected to exceed 6 months - 1 year in duration. Accordingly, a Hazard Quotient of 10 was utilized for non-carcinogens in Table 1 to reflect a similar (i.e., upper bound of 1 year) exposure duration. It is noted that contaminants (both non-carcinogens and carcinogens, alike) can exhibit acute effects from short-term, high-dose exposures. Because the screening values in Table 1 are based on subchronic exposure (i.e., 1 year), acute effects from exposures that are below the screening levels would be unlikely. Additionally, a review of California EPA's (CAL-EPA) Acute Risk Levels demonstrates that the screening criteria in Table 1 are categorically more stringent than the Cal-EPA's analogous acute levels.

NOTE: Individual sampling results that exceed screening values should not be interpreted to represent the occurrence of an adverse health effect. Rather, such information indicates the need for careful monitoring and the assessment of longer-term data trends for evaluation against appropriate health criteria. That is, most of the screening levels have been developed to account for continuous one year average exposure durations. Because these screening levels assume continuous exposure for an extended duration, the average of the measured concentrations is more appropriate for evaluating risk than an individual measurement. Consequently, miscellaneous individual values above the screening level may not necessarily be indicative of potential for concern.

Table 1
World Trade Center Screening Criteria

Contaminant	Site Worker ⁽¹⁾	Resident ⁽²⁾
<u>Inorganics</u>		
Asbestos ⁽³⁾	.1 f/cc (PCM)	70 S/mm2 (TEM)

Contaminant	Site Worker ⁽¹⁾	Resident ⁽²⁾
Cadmium	5 ug/m3	.2 ug/m3 ⁽⁹⁾ 3 ug/m3 ⁽⁵⁾
Chromium ⁽⁴⁾	100 ug/m3	.6 ug/m3 ⁽⁵⁾
Lead	50 ug/m3	1.5 ug/m3 ⁽⁷⁾
Sulfur Dioxide	5 ppm	.14 ppm ⁽⁷⁾
<u>Particulates</u>		
Total	15,000 ug/m3	NA
Respirable	5,000 ug/m3	NA
PM _{2.5}	NA	40 ug/m3 ⁽⁸⁾ 65 ug/m3 ⁽⁷⁾
PM ₁₀	NA	150 ug/3 ^(7,8)
<u>Semivolatiles</u>		
Dioxin/Furans (TEQ)	NA	.162 ng/m3 ⁽⁵⁾
PCBs	1,000 ug/m3	.73 ug/m3 ⁽⁶⁾ 9 ug/m3 ⁽⁵⁾
PAHs ⁽¹⁶⁾	NA	6 ug/m3 ^(5, 17)
<u>Volatiles</u>		
Acetone	1,000 ppm	1.5 ppm ⁽⁶⁾
Benzaldehyde	NA	860 ppm
Benzene	1 ppm	.02 ppm ⁽⁹⁾ .21 ppm ⁽⁵⁾
Benzonitrile	NA	NA
1,3 Butadiene	1 ppm	.01 ppm ^(5, 15)
Chloromethane	100 ppm	.4 ppm ⁽⁶⁾ 2.6 ppm ⁽⁵⁾
1,4 Dioxane	100 ppm	.5 ppm ⁽⁵⁾
Ethanol	1,000 ppm	45 ppm ⁽¹⁰⁾

Contaminant	Site Worker ⁽¹⁾	Resident ⁽²⁾
Ethylbenzene	100 ppm	2.5 ppm ⁽⁶⁾
Freon 22	1,000 ppm ⁽¹⁴⁾	140 ppm
Propylene	LEL ⁽¹³⁾	simple asphyxiant
Styrene	100 ppm	2.3 ppm ⁽⁶⁾
alpha methylstyrene	100 ppm	.1 ppm ⁽⁶⁾
Tetrahydrofuran	200 ppm	.9 ppm ⁽⁵⁾
Toluene	200 ppm	1.1 ppm ⁽⁶⁾
Xylenes	100 ppm	1 ppm ⁽¹¹⁾
<u>Reactive Gases</u>		
Acetaldehyde	200 ppm	.05 ppm ⁽⁶⁾ 1.3 ppm ⁽⁵⁾
Formaldehyde	.75 ppm	.04 ppm ⁽¹²⁾ .35 ppm ⁽⁵⁾
Acrolein	.1 ppm	.0001 ppm ⁽⁶⁾

Units

f/cc = fibers (>5 um length) per cubic centimeter of air

S/mm2 = structures (>.5 um length) per square millimeter of filter paper

ppm = parts per million in air

ug/m3 = micrograms of contaminant per cubic meter of air

ng/m3 = nanograms of contaminant per cubic meter of air

NA - Not Applicable

Footnotes:

1. "Site Workers" refers to all workers involved in the response/demolition of the World Trade Center. Listed values are Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs), Time Weighted Averages (TWA) unless otherwise noted.

2. "Residents" refers to people living in the vicinity of the World Trade Center as well as all other potentially exposed workers not involved in the response/demolition

3. Resident screening value is based on Asbestos Hazard Emergency Response Act (AHERA)

methodology which uses transmission electron microscopy (TEM), and because of its basis in "background" (vs a risk basis) includes all asbestos fibers greater than 0.5 microns in length. Worker values are based on phase contrast microscopy (PCM, - which doesn't distinguish asbestos from other fibers) or, for results above the PCM screening value, TEM to derive a PCM equivalence that includes all asbestos fibers greater than 5 microns in length.

4. Screening values for chromium were based on the most toxic form (hexavalent)
5. EPA - Hazard Evaluation Handbook (HEH) (carcinogen) > 1 year of continuous exposure equating to an excess lifetime cancer risk of one-in ten thousand
6. EPA - HEH (noncarcinogen) > Hazard Quotient (HQ) = 10
7. National Ambient Air Quality Standard (NAAQS)
 - Lead is a 3 month average
 - PM_{2.5} is a 24 hour average
 - Sulfur Dioxide is a 24 hour average primary standard
8. Air Quality Index (AQI)
9. Non cancer effects based on CAL-EPA toxicity studies
10. American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV)
11. Agency for Toxic Substances and Disease Registry (ATSDR) Inhalation minimum risk level (MRL) x 10
12. ATSDR acute MRL
13. Lower Explosive Limit (2 - 11 %)
14. National Institute of Occupational Safety and Health (NIOSH)
15. Proposed Reference Concentration (RfC) - HEH (noncancer) > Hazard Quotient (HQ) = 10
16. Based on Benzo(a)pyrene toxicity equivalency factor toxicity equivalency factor (TEF)
17. EPA National Center for Environmental Assessment (NCEA) provisional inhalation Slope Factor (3.1 E 00 mg/kg/day⁻¹)

Appendix C

Basis for Tier III screening level of 1 E-04

Defensible analytical methodology and sampling protocols are being chosen for future indoor sampling and analysis activities. The methods chosen are ones that have been published by reputable agencies and are in common practice among testing laboratories. In some cases, minor modifications may be made to the sampling and analytical protocols, but these will be modifications that are well established in the laboratory community.

All protocols chosen are designed to reach the lowest level of detection that is reasonable for the established methods. For Dioxin, Asbestos and PAHs, the sampling and analytical protocols are designed to reach detection limits that represent risk estimate levels of 1 E-04. To reach risk estimates of 1E-06, extraordinary modifications would have to be employed. These modifications would either have to be incorporated into the analytical protocols to increase the sensitivity of the required instrumentation, incorporated into the sampling protocols to achieve a larger sample, or a combination of both. For the Chemical of Potential Concern (COPC) list, the analytical protocols chosen are already incorporating the maximum sensitivity of the instrumentation. Therefore, the only legitimate mechanism to lower the overall limits of detection is to modify the sampling protocol. The two means of achieving this goal are to either run the sampling equipment (pumps) at a higher flow rate, or for longer periods of time. For the COPC list modifying flow rates would involve operating the equipment to achieve flow rates on the order of 500 to 1000 liters per minute. The only equipment available to operate at such flow rates are large units that can not be brought inside a resident. Rates this high also present problems with creating excessive negative pressure for indoor environments, plus flow rates this high have not been tested using the sampling protocols, and there is high likelihood of having analyte breakthrough on the collection filters. Therefore, this is not practical. The other option is to run the equipment for long periods of time. Again with the list of Chemicals of Potential Concern, sampling periods of up to 800 hours (33 days of continuous operation) would be needed to reach the E-06 risk detection levels.

For Silica, the analytical and sampling protocols chosen will give detection levels in the neighborhood of 5 ug/m³. Instrumental sensitivity can not be set any higher to reach lower detection levels. Also, the sampling protocols involved for this analysis have been thoroughly validated by NIOSH. Any change in pump flow rate or sampling duration beyond what is documented in the method will produce results that have not been validated. Therefore, the sampling protocol should not be changed from that which is documented.

For fibrous glass the methodology is such that detection levels as low as 0.00001 f/cc can be achieved. This is well below required levels of detection for future indoor studies.

Another consideration in setting the target risk level involved the anticipated background level of contaminants such as asbestos, dioxin and PAHs in urban indoor environments. EPA is currently conducting a study to characterize background conditions for COPCs in New York City residential dwellings. In advance of this study, a literature review was conducted to provide a general estimate of background concentrations for carcinogenic COPCs in urban indoor environments. It should be noted that the literature is limited in this regard. For asbestos, ATSDR reports that "measured indoor air values range widely, depending on the amount, type, and condition (friability) of asbestos-containing materials used in the building" [ATSDR, 1995]. In its review ATSDR notes that the studies suffer from lack of common measurement reporting units. Study results have been reported as ng/m^3 , f/cc (TEM) and f/cc (PCM). Using unit conversion factors recommended by the National Research Council in 1984, ATSDR [1995] reports that the arithmetic mean concentrations of monitoring data from a variety of indoor locations ranged from .00003 - .006 f/cc (PCM). The proposed clearance level for WTC-impacted residential dwellings (.0009 PCM equivalents) is within this background range.

Appendix D

Wipe Sample Assessment Methodology

Introduction

There is no consistent, established national guidance for the estimation of risks from wipe samples. Indeed, even the literature is scant on this issue. Besides literature searches, the expertise of USEPA scientists throughout the country (specifically NCEA and Superfund Regional risk assessors) was sought. A discussion of the various methods that were considered follows.

Because of the uncertainties involved when estimating risks from wipe samples, this assessment was not performed in the usual manner; that is, with data assessment, exposure assessment, toxicity assessment, risk characterization, uncertainty analysis, in that order. Instead, the risk estimation methods are discussed, the toxicity of the chemicals of potential concern are addressed, the various possible exposure scenarios are discussed, and concentrations that are associated with certain levels of risk are derived. The site data are to be compared with these levels. Risk characterization and uncertainty analysis follow.

This approach (hereafter referred to as the "multiple risk-based level approach") was suggested during the consultations with NCEA and the USEPA Superfund risk assessors throughout the nation. It was adopted because it is felt that the risks and the uncertainties associated with the risks are most clearly and appropriately described in this fashion. All the elements of a standard risk assessment are incorporated, but are arranged to best represent the site-specific situation. This approach is also consistent with many wipe sample evaluations in the literature, which usually involve the derivation of "re-entry guidelines" (for buildings after spills or fires) or "cleanup levels," and which are followed by comparison of those levels to the site-specific levels.

The most commonly used estimation method involves treating wipe samples as indicative of the contaminant source, estimating exposure parameters to determine dose, and using this information to estimate risk. This is based on traditional risk assessment approaches seen in USEPA, 1989a.

More recently, the above method has been discussed as being over-conservative. A time-dependent transfer coefficient method, which assumes that duration of skin contact is more truly indicative than activity level of dermal uptake, has been proposed (Durkin et al, 1995). This

method is typically applied to pesticide-sprayed turf, but it is intended to relate dislodgeable residues of contaminated surfaces to dermal exposure. The main drawback to using this method for contaminated building surfaces is that information about duration of skin contact is no more available than information about frequency of skin contact for this scenario.

In at least one case, the traditional method was supplemented by consideration of conservation of mass using a mass-balance model (Michaud et al, 1994). The rationale to this approach was to avoid the overestimation of exposure by acknowledging that the reservoir of contaminants is necessarily limited. This approach may be more appropriate for short-term spills or fires than for surface contaminations that have built up over the long term and penetrated deeply into the surface. However, uncertainties related to this aspect of the risk assessment should be characterized.

In at least one case, an attempt was made to deal with the uncertainties involved in the contact rate and fraction transferred to skin by assuming that a certain percentage of contaminants present in the building material would ultimately be transferred to the receptor over the exposure duration. The drawback to this method is that there is little information available that could be used to estimate this total transfer percentage, and this approach found little favor among USEPA risk assessors. This method has not been pursued further in this risk assessment.

Traditional Approach

Exposure to a contaminant on a building surface can be estimated as follows:

$$Ds = C \times SA \times CF \times FTSS \times EF \times ED$$

Ds = Amount of chemical deposited on skin (mg)

C = Concentration of chemical on contaminated surface (mg/cm²)

SA = Exposed skin surface area (cm²)

CF = Contact frequency of skin against surface (1/day)

FTSS = Fraction transferred from surface to skin

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

From Ds, oral and dermal exposure may be estimated:

$$Do = (Ds \times FTSM \times ABSO) / (BW \times AT)$$

Do = Oral dose (mg/kg/day)

FTSM = Fraction transferred from skin to mouth

ABSO = Oral absorption fraction

BW = Body weight (kilograms)

AT = Averaging time (days)

$$Dd = (Ds \times (1 - FTSM) \times ABSd) / (BW \times AT)$$

Dd = Dermal dose (mg/kg/day)

FTSM = Fraction transferred from skin to mouth

ABSd = Dermal absorption fraction

BW = Body weight (kilograms)

AT = Averaging time (days)

Several assumptions are incorporated into these equations. They assume that volatilization of the chemical on the surface is negligible, and that the chemical is available on the surface for the entire exposure duration (that is, that a previous transfer of contaminant from surface to skin would not deplete the amount of surface contamination). It is assumed that there is a "maximum Ds"; that is, that there would be a limit on how much contaminant could be transferred to the skin in a single day, but that maximum Ds is unknown. Therefore, this method tends to be conservatively biased with respect to oral and dermal exposure. If inhalation exposure is to be considered, the volatilized amount should be subtracted before estimating the amount available for dermal transfer.

Although these equations are limited by the above assumptions, they are basically sound in theory. The difficulty is in defining the specific inputs to the equations, since some of the input parameters have very little or no experimentally determined values in the literature. Previous assessments have usually relied upon professional judgment.

For that reason, it was felt that the multiple risk-based level approach, based on the range of possible inputs, was appropriate. RME assumptions were selected, along with "low-end" and "worst-case" values, in an attempt to bound the estimated RME risks.

Concentration of Chemical on Surface (C)

This is the parameter that was derived for each scenario, and is compared with the site data.

Exposed Skin Surface Area (SA)

Skin surface areas have been well-defined in the experimental literature. The Exposure Factors handbook is a good source. For adult workers, some percentage of the total surface area is usually appropriate. The use of protective gear by industrial and maintenance workers, such as masks and gloves, is possible, but it depends upon the specific type of work and is a case-by-case decision.

Contact Frequency (CF)

This parameter is one of the most difficult to estimate. Previous assessments have usually assumed 1 contact per day. Often, this assumption is made with little discussion, as if multiple contacts with the surface were not considered. Michaud et al (1994) assumed 8 contacts per day, apparently based on professional judgment. Low-end values of 1/day and "worst-case" rates of 24/day (3/hour) may be assumed as a matter of professional judgment; such exposure would obviously involve a very physical job with frequent contact with the walls and floor. If available, site-specific activity data should take precedence.

Fraction Transferred from Surface to Skin (FTSS)

This parameter is also difficult to estimate. Obviously, the worst-case assumption would be an FTSS of 1, or 100% transfer. However, for some chemicals, the range may be narrowed even beyond that. FTSS is assumed to be chemical-specific.

USEPA has previously assumed transfer of 0.5 for PCBs (USEPA, 1987) based on an Office of Toxic Substances (OTS) assessment. Michaud et al (1994) assumed 0.5 for PCBs and dioxins, but stated that 0.1 might be more realistic. In developing re-entry guidelines for an office building after a fire, a panel of assessors used ranges of 0.1, 0.25, and 0.5 of the arm surface area for PCBs and dioxins (New York State Dept. of Health, 1985). However, that actually assumed 100% transfer over a smaller surface area (that is, these percentages were technically used to adjust the exposed skin surface area rather than attempting to estimate a transfer rate).

In a study of Malathion uptake from different surfaces, USEPA-EMSL found that FTSS of malathion from painted sheetrock to human hands was only 0.0003. (Mean transfer from vinyl flooring to hands was 0.0018, and from carpet to hands was 0.0152.) Malathion is a pesticide assumed to have lipophilicity more similar to PCBs than to volatiles or metals. However, the representativeness of such a number for PCBs and dioxins is unknown. PCBs are more lipophilic (have higher K_{ow}s) than malathion.

Exposure Frequency (EF)

The standard default factor for workplace EF is 250 days/year (USEPA, 1991). This represents days at work. The factor CF, discussed above, accounts for actual contacts with the contaminated surface during a working day.

Because central tendency estimations allow adjustment to 219 days/year (to account for all holidays, sick days, business trips, and vacation days), this factor may also be used for the low-end estimate for a full-time worker, in the absence of site-specific data (USEPA, 1993a).

Exposure Duration (ED)

The standard default factor for workplace ED is 25 years (USEPA, 1991).

The central tendency value of 5 years may be used as a low-end estimate (USEPA, 1993a).

Fraction Transferred from Skin to Mouth (FTSM)

This factor accounts for the apportionment between dermal and oral exposure. This factor must be greater than or equal to zero, and less than or equal to 1. In fact, the closer it is to 1, the greater the risk, since the oral route contributes relatively more than the dermal route to the overall risk.

Michaud et al (1994) assumed that the contamination that had been transferred to the surface area of the fingertips would be transferred to the mouth, twice per day. In the Binghamton reentry guideline derivation, a range of factors was used, which assumed 0.05, 0.1, and 0.25 of the hand surface area was transferred (New York State Dept. of Health, 1985).

It may be assumed that approximately 10% of the material on the hand surface area will be transferred to the mouth. Using the values of 200 to 400 cm² for total palm-side hand area (both hands), the area would be approximately 30 cm² (USEPA-EMSL; USEPA, 1989b; Michaud et al, 1994; New York State Dept. of Health, 1985). This must then be correlated to total SA in order to derive the FTSM fraction.

Oral Absorption Fraction (ABSO)

For chemicals whose dose-response parameters are based on orally administered doses, ABSO is assumed to be 1, and there is no need to adjust the RfD or CSF for absorption (which usually must be done when assessing dermal risks).

Body Weight (BW)

The standard default exposure factor for an adult worker's BW is 70 kilograms, which is an average (USEPA, 1991).

Averaging Time (AT)

For non-carcinogens, AT is the exposure duration expressed in days. For carcinogens, exposure is averaged over a 70-year lifetime (the factor on which the cancer slope factors are based), and the AT is 70 years, in days.

Dermal Absorption Fraction (ABSD)

This parameter is assumed to be chemical-specific. USEPA's dermal exposure assessment

document gives estimated ranges up to 0.06 for PCBs and 0.03 for dioxins from soil (USEPA, 1992b). Michaud et al (1994) used 0.02 for dioxins and 0.03 for PCBs uptake from a sooty surface, based on the ranges of estimated ABSD values for soil. The Binghamton panel used a range of values for PCBs (0.01, 0.1, and 0.5) and dioxins (0.01 and 0.1) (New York State Dept. of Health, 1985; Kim and Hawley, 1984).

Reported ranges for dermal uptake for PCBs in solvent vehicles are reported to range from 15 to 56%, with most of the values clustering around 20% (ATSDR, 1993). Reported ranges for 2,3,7,8-TCDD in solvent vehicles are reported to range from 1 to 40% (ATSDR, 1988). Therefore, it seems that even if absorption from the wall material might be enhanced by residual solvent, the maximum possible absorption of 100% would be unrealistic even for worst-case exposure.

References to Appendix D

Agency for Toxic Substances and Disease Registry (ATSDR). 1988. Toxicological Profile for 2,3,7,8-Tetrachlorodibenzo-p-dioxin. United States Public Health Service, ATSDR, Atlanta, GA.

ATSDR. 1993. Toxicological Profile Update for Polychlorinated Biphenyls. United States Public Health Service, ATSDR, Atlanta, GA.

Christiani, D.C., D. Kriebel, N.J. Fox, and E.L. Baker. 1986. Persistently elevated polychlorinated biphenyl levels form residual contamination of workplace surfaces. *American Journal of Industrial Medicine* 10:143-151.

Doull, J., C.D. Klaassen, and M.O. Amdur. 1986. Casarett and Doull's Toxicology: The Basic Science of Poisons. Third Edition. MacMillan Publishing Company, New York.

Durkin, P.R., L. Rubin, J. Withey, and W. Meylan. 1995. Methods of assessing dermal absorption with emphasis on uptake from contaminated vegetation. *Toxicology and Industrial Health* 11(1):63-79.

Environmental Criteria and Assessment Office (ECAO). 1992. Risk Assessment Issue Paper for: Evaluation of Feasibility of Oral-to-Dermal Extrapolation for PCBS. United States Environmental Protection Agency, ECAO, Cincinnati, OH. July 31.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Co., New York.

Kim N.K. and J. Hawley. 1984. Re-Entry Guidelines: Binghamton State Office Building. Draft. New York State Dept. of Health, Bureau of Toxic Substances Assessment, Division of Health Risk Control. Albany, NY. August. Document 0549P.

Lees, P.S.J., M. Corn, and P.N. Breyse. 1987. Evidence for dermal absorption as the major route of body entry during exposure of transformer maintenance and repairmen to PCBS. *American Industrial Hygiene Association Journal* 48(3):257-264.

Michaud, J.M., S.L. Huntley, R.A. Sherer, M.N. Gray, and D.J. Paustenbach. 1994. PCB and dioxin re-entry criteria for building surfaces and air. *Journal of Exposure Analysis and Environmental Epidemiology* 4(2):197-227.

New York State Department of Health. 1985. PCB Re-Entry Guidelines. New York State Dept. of Health, Bureau of Toxic Substances Assessment, Division of Environmental Health Assessment. Albany, NY. July 17. Document 1330P.

Sittig, M. 1985. Handbook of Toxic and Hazardous Chemicals and Carcinogens. Second Edition. Noyes Publications, Park Ridge, New Jersey.

Sittig, Marshall. 1991. Handbook of Toxic and Hazardous Chemicals and Carcinogens. Third Edition. Noyes Publications, Park Ridge, New Jersey.

United States Environmental Protection Agency (USEPA)-Environmental Monitoring Systems Laboratory. Surface to Skin/Suit Transfer Studies; Transferability of Malathion Surface Residues Studies. USEPA-EMSL, Analytical Sciences Division, Las Vegas, NV.

USEPA. 1986. Air Quality Criteria for Lead. Environmental Criteria and Assessment Office. Research Triangle Park, North Carolina.

USEPA. 1987. Polychlorinated Biphenyls: Spill Cleanup Policy. Final Rule. Federal Register, Volume 52, Number 63. April 2.

USEPA. 1989a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response, Washington, D.C. December.

USEPA. 1989b. Exposure Factors Handbook. Exposure Assessment Group, Office of Health and Environmental Assessment, Washington, D.C. May. EPA/600/8-89/043.

USEPA. 1989c. Interim procedures for estimating risks associated with exposures to mixtures of chlorinated dibenzo-p-dioxins and -dibenzofurans (CDDs and CDFS) and 1989 update. Risk Assessment Forum, Washington, DC. EPA/625/3-89/016.

USEPA. 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03. Office of Solid Waste and Emergency Response, Washington, D.C. March 25.

USEPA. 1992a. Supplemental Guidance to RAGS: Calculating the Concentration Term. Office of Solid Waste and Emergency Response, Washington, D.C. May. Publication 9285.7-081.

USEPA. 1992b. Dermal Exposure Assessment: Principles and Applications. Interim Report. Office of Health and Environmental Assessment, Washington, D.C. January. EPA/600/891/011/B.

USEPA, 1993a.. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure. Draft. November.

USEPA, 1993b. 40 Code of Federal Regulations 300.430.

USEPA. 1994. Health Effects Assessment Summary Tables; Annual FY94. Office of Emergency and Remedial Response, Washington, D.C.

USEPA. 1995. Integrated Risk Information System (IRIS). Records for 2,3,7,8-TCDD and polychlorinated biphenyls.

Versar, Inc. for USEPA. 1979 : Water-Related Fate of 129 Priority Pollutants. Monitoring and Data Support Division, Washington, D.C. EPA 440/4-79-029.