PB91-921314

OSWER DIRECTIVE: 9285.6-03

March 25, 1991

RISK ASSESSMENT GUIDANCE FOR SUPERFUND

VOLUME I: HUMAN HEALTH EVALUATION MANUAL

SUPPLEMENTAL GUIDANCE

"STANDARD DEFAULT EXPOSURE FACTORS"

INTERIM FINAL

Office of Emergency and Remedial Response
Toxics Integration Branch
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WASHINGTON, D.C. 20460

MAR 25 1991

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

OSWER Directive 9285.6-03

MEMORANDUM

SUBJECT: Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"

FROM: Timothy Fields, Jr., Acting Director
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TO: Director, Waste Management Division,
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Purpose

The purpose of this directive is to transmit the Interim Final Standard Exposure Factors guidance to be used in the remedial investigation and feasibility study process. This guidance supplements the Risk Assessment Guidance for Superfund: Human Health Evaluation Manual, Part A that was issued October 13, 1989.

Background

An intra-agency workgroup was formed in March 1990 to address concerns regarding inconsistencies among the exposure assumptions used in Superfund risk assessments. Its efforts resulted in a June 29, 1990, draft document entitled "Standard Exposure Assumptions". The draft was circulated to both technical and management staff across EPA Regional Offices and within Headquarters. It was also discussed at two EPA-sponsored meetings in the Washington, D.C., area. The attached interim final document reflects the comments received as well as the results of recent literature reviews addressing inhalation rates, soil ingestion rates and exposure frequency estimates.

Objective

This guidance has been developed to reduce unwarranted variability in the exposure assumptions used by Regional Superfund staff to characterize exposures to human populations in the baseline risk assessment.

Implementation

This guidance supplements the Risk Assessment Guidance for Superfund (RAGS): Human Health Evaluation Manual, Part A. Where numerical values differ from those presented in Part A, the factors presented in this guidance supersede those presented in Part A.

This guidance is being distributed as an additional interim final guidance in the RAGS series. As new data become available and the results of EPA-sponsored research projects are finalized, this guidance will be modified accordingly. We strongly urge Regional risk assessors to contact the Toxics Integration Branch of the Office of Emergency and Remedial Response (FTS 475-9486) with any suggestions for further improvement; as we will begin updating and consolidating the series of RAGS documents in 1992.

Attachment

cc: Regional Branch Chiefs
Regional Section Chiefs
Regional Toxics Integration Coordinators
Workgroup Members

* * * * NOTICE * * * *

The policies set out in this document are not final Agency action, but are intended solely as guidance. They are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of site-specific circumstances. The Agency also reserves the right to modify this guidance at any time without public notice.

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ACKNOWLEDGEMENTS

This guidance was developed by the Toxics Integration Branch (TIB) of EPA's Office of Emergency and Remedial Response, Hazardous Site Evaluation Division. Janine Dinan of TIB provided overall project management and technical coordination in the later stages of its development under the direction of Bruce Means, Chief of TIB's Health Effects Program.

TIB would like to acknowledge the efforts of the interagency work group chaired by Anne Sergeant of EPA's Exposure Assessment Group in the Office of Health and Environmental Assessment. Workgroup members, listed below, and Regional staff provided valuable input regarding the content and scope of the guidance.

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1.0 INTRODUCTION

The Risk Assessment Guidance for Superfund (RAGS) has been divided into several parts. Part A, of the Human Health Evaluation Manual (HHEM; U.S. EPA, 1989a), is the guidance for preparing baseline human health risk assessments at Superfund sites. Part B, now in draft form, will provide guidance on calculating risk-based clean-up goals. Part C, still in the early stages of development, will address the risks associated with various remedial actions.

The processes outlined in these guidance manuals are a positive step toward achieving national consistency in evaluating site risks and setting goals for site clean-up. However, the potential for inconsistency across Regions and among sites still remains; both in estimating contaminant concentrations in environmental media and in describing characteristics and behaviors of the exposed populations.

Separate guidance on calculating contaminant concentrations is currently being developed in response to a number of inquiries from both inside and outside the Agency. The best method for calculating the reasonable maximum exposure (RME) concentration for different media has been subject to a variety of interpretations and is considered an important area where further guidance is needed.

This supplemental guidance attempts to reduce unwarranted variability in the exposure assumptions used to characterize potentially exposed populations in the baseline risk assessment. This guidance builds on the technical concepts discussed in HHEM Part A and should be used in conjunction with Part A. However, where exposure factors differ, values presented in this guidance supersede those presented in HHEM Part A.

Inconsistencies among exposure assumptions can arise from different sources: 1) where risk assessors use factors derived from site-specific data; 2) where assessors must use their best professional judgement to choose from a range of factors published in the open literature; and 3) where assessors must make assumptions (and choose values) based on extremely limited data. Part A encourages the use of site-specific data so that risks can be evaluated on a case-by-case basis. This supplemental guidance has been developed to encourage a consistent approach to assessing exposures when there is a lack of site-specific data or consensus on which parameter value to choose, given a range of possibilities. Accordingly, the exposure factors presented in this document are generally considered most appropriate and should be used in baseline risk assessments unless alternate or site-specific values can be clearly justified by supporting data.

Supporting data for many of the parameters presented in this guidance can be found in the Exposure Factors Handbook (EFH; U.S. EPA, 1990). In cases where parameter values are not available in EFH, this guidance adopts well-quantified or widely-accepted data from the open literature. Finally, for factors where there is a great deal of uncertainty, a rationally-derived, conservative estimate is developed and explained. As new data become available, this guidance will be modified to reflect them.

These standard factors are intended to be used for calculating reasonable maximum exposure (RME) estimates for each applicable scenario at a site. Readers are reminded that the goal of RME is to combine upper-bound and mid-range exposure factors in the following equation so that the result represents an exposure scenario that is both protective and reasonable; not the worst possible case:

$$\text{Intake} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

C = Concentration of the chemical in each medium (conservative estimate of the media average contacted over the exposure period)

IR = Intake/Contact Rate (upper-bound value)

EF = Exposure Frequency (upper-bound value)

ED = Exposure Duration (upper-bound value)

BW = Body Weight (average value)

AT = Averaging Time (equal to exposure duration for non-carcinogens and 70 years for carcinogens)

Please note that the Agency is presently evaluating methods for calculating conservative exposure estimates, such as RME, in terms of which parameters should be upper-bound or mid-range values. If warranted, this guidance will be modified accordingly.

1.1 BACKGROUND

An intra-agency workgroup was formed at the Superfund Health Risk Assessment meeting in Albuquerque, New Mexico (February 26 - March 1, 1990). Its efforts resulted in a June 29, 1990, draft document entitled “Standard Exposure Assumptions”. The draft was distributed to Superfund Regional Branch Chiefs, and members of other programs within the Agency, for their review and comment. It was also presented and discussed at two EPA/OERR sponsored meetings. The meetings, facilitated by Clean Sites, Inc., brought members of the "Superfund community" and the Agency together to focus on technical issues in risk assessment.

A final review draft was distributed on December 5, 1990, which reflected earlier comments received as well as the results of more recent literature reviews addressing inhalation rates, Soi1 ingestion rates and exposure frequency estimates (these being areas commented on most frequently).

1.2 PRESENT AND FUTURE LAND USE CONSIDERATIONS

The exposure scenarios, presented in this document, and their corresponding assumptions have been developed within the context of the following land use classifications: residential, commercial/industrial, agricultural or recreational. Unfortunately, it is not always easy to determine actual land use or predict future use: local zoning may not adequately describe land use; and unanticipated or even planned rezoning actions can be difficult to assess. Also, the definition of these zones can differ substantially from region to region. Thus, for the purposes of this document, the following definitions are used:

Residential

Residential exposure scenarios and assumptions should be used whenever there are or may be occupied residences on or adjacent to the site. Under this land use, residents are expected to be in frequent, repeated contact with contaminated media. The contamination may be on the site itself or may have migrated from it. The assumptions in this case account for daily exposure over the long term and generally result in the highest potential exposures and risk.

Commercial/Industrial

Under this type of land use, workers are exposed to contaminants within a commercial area or industrial site. These scenarios apply to those individuals who work on or near the site. Under this land use, workers are expected to be routinely exposed to contaminated media. Exposure may be lower than that under the residential scenarios, because it is generally assumed that exposure is limited to 8 hours a day for 250 days per year.

Agricultural

These scenarios address exposure to people who live on the property (i.e., the farm family) and agricultural workers. Assumptions made for worker exposures under the commercial/industrial land use may not be applicable to agricultural workers due to differences in workday length, seasonal changes in work habits, and whether migrant workers are employed in the affected area. Finally, the farm family scenario should be evaluated only if it is known that such families reside in the area.

Recreational

This land use addresses exposure to people who spend a limited amount of time at or near a site while playing, fishing, hunting, hiking, or engaging in other outdoor activities. This includes what is often described as the 'Trespasser" or "site visitor" scenario. Because not all sites provide the same opportunities, recreational scenarios must be developed on a site-specific basis. Frequently, the community surrounding the site can be an excellent source of information regarding the current and potential recreational use of a site. The RPM/risk assessor is encouraged to consult with local groups to collect this type of information.

In the case of trespassers, current exposures are likely to be higher at inactive sites than at active sites because there is generally little supervision of abandoned facilities. At most active sites, security patrols and normal maintenance of barriers such as fences tend to limit (if not entirely prevent) trespassing. When modeling potential future exposures in the baseline risk assessment, however, existing fences should not be considered a deterrent to future site access.

Recreational exposure should account for hunting and fishing seasons where appropriate, but should not disregard local reports of species taken illegally. Other activities should also be scaled according to the amount of time they could actually occur; for children and teenagers, the length of the school year can provide a helpful limit when evaluating the frequency and duration of certain outdoor exposures.

2.0 RESIDENTIAL

Scenarios for this land use should be evaluated whenever there are homes on or near the site, or when residential development is reasonably expected in the future. In determining the potential for future residential land use, the RPM should consider: historical land use; suitability for residential development; local zoning; and land use trends. Exposure pathways evaluated under this scenario routinely include, but may not be limited to: ingestion of potable water; incidental ingestion of soil and dust; inhalation of contaminated air; and, where appropriate, consumption of home grown produce.

2.1 Ingestion of Potable Water

This pathway assumes that adult residents consume 2 liters of water per day, 350 days per year, for 30 years.

The value of 2 liters per day for drinking water is currently used by the Office of Water in setting drinking water standards. It was originally used by the military to calculate tank truck requirements. In addition, 2 liters happens to be quite close to the 90th percentile for drinking water ingestion (U.S. EPA, 1990), and is comparable to the 8 glasses of water per day historically recommended by health authorities.

The exposure frequency (EF) of 365 days/year for the residential setting used in RAGS Part A has been argued both inside and outside of the Agency as being too conservative for RME estimates. National travel data were reviewed to determine if an accurate number of “days spent at home” could be calculated. Unfortunately, conclusions could not be drawn from the available literature; as it presents data on the duration of trips taken for pleasure, but not the frequency of such trips (OECD, 1989; Goeldner and Duea, 1984; National Travel Survey, 1982-89). However, the Superfund program is committed to moving away from values that represent the "worst possible case". Thus, until better data become available, the common assumption that workers take two weeks of vacation per year can be used to support a value of 15 days per year spent away from home (i.e., 350 days/year spent at home).

In terms of exposure duration (ED), the resident is assumed to live in the same home for 30 years. In the EFH, this value is presented as the 90th-percentile for time spent at one residence. (Please note that in the intake equation, averaging time (AT) for exposure to non-carcinogenic compounds is always equal to ED; whereas, for carcinogens a

70 year AT is still used in order to compare to Agency slope factors typically based on that value).

2.2 Incidental ingestion of Soil and Dust

The combined soil and dust ingestion rates used in this document were presented in OSWER Directive 9850.4 (U.S. EPA, 1989b), which specifies 200 mg per day for children aged 1 thru 6 (6 years of exposure) and 100 mg per day for others. These factors account for ingestion of both outdoor soil and indoor dust and are believed to represent upper-bound values for soil and dust ingestion (Calabrese, et al., 1989; Calabrese, et al., 1990a,b; Davis, et al., 1990; Van Wijnen, et al., 1990). Presently, there is no widely accepted method for determining the relative contribution of each medium (i.e., soil vs. dust) to these daily totals, and the effect of climatic variations (e.g., snow cover) on these values has yet to be determined. Thus, a constant, year round exposure is assumed (i.e., 350 days/year).

Please note that the equation for calculating a 30-year residential exposure to soil/dust is divided into two parts. First, a six-year exposure duration is evaluated for young children which accounts for the period of highest soil ingestion (200 mg/day) and lowest body weight (15 kg). Second, a 24-year exposure duration is assessed for older children and adults by using a lower soil ingestion rate (100 mg/day) and an adult body weight (70 kg).

2.3 Inhalation of Contaminated Air

In response to a number of comments, the RME inhalation rate for adults of 30 m^3/day (presented in HHEM Part A) was re-evaluated. Activity-specific inhalation rates were combined with time-use/activity level data to derive daily inhalation rate values (see Attachment A). Our evaluation focused on the following population subgroups who would be expected to spend the majority of their time at home: housewives; service and household workers; retired people; and unemployed workers (U.S. EPA, 1985). An inhalation rate of 20 m^3/day was found to represent a reasonable upper-bound value for adults in these groups. This value was derived by combining inhalation rates for indoor and outdoor activities in the residential setting. This rate would be used in conjunction with ambient air levels measured at or downwind of the site. Although sampling data are preferred, procedures described in Hwang and Falco (1986) and Cowherd, et al. (1985) can be used to estimate volatile and dust-bound contaminant concentrations, respectively.

In cases where the residential water supply is contaminated with volatiles, the assessor needs to consider the potential for exposure during household water use (e.g., cooking, laundry, bathing and showering). Using the same time-use/activity level data described above, a total of 15 m^3/day was found to represent a reasonable upper-bound inhalation rate for daily, indoor, residential activities. Methods for modeling volatilization of contaminants in the household (including the shower) are currently being developed by J.B. Andelman and U.S. EPA's Exposure Assessment Group. Assessors should contact the Superfund Health Risk Assessment Technical Support Center for help with site-specific evaluations (FTS-684-7300).

2.4 Consumption of Home Grown Produce

This pathway need not be evaluated for all sites. It may only be relevant for a small number of compounds (e.g., some inorganic and pesticides) and should be evaluated when the assessor has site-specific information to support this as a pathway of concern for the residential setting.

The EFH presents figures for "typical" consumption of fruit (140 g/day) and vegetables (200 g/day) with the "reasonable worst case" proportion of produce that is homegrown as 30 and 40 percent, respectively. This corresponds to values of 42 g/day for consumption of homegrown fruit and 80 g/day for homegrown vegetables. They are derived from data in Pao, et al. (1982) and USDA (1980). EFH also provides data on consumption of specific homegrown fruits and vegetables that may be more appropriate for site-specific evaluations. Although sampling data are much preferred, in their absence plant uptake of certain organic compounds can be estimated using the procedure described in Briggs, et al. (1982). No particular procedure is recommended for quantitatively assessing inorganic uptake at this time; however, the following table developed by Sauerbeck (1988) provides a qualitative guide for assessing heavy metal uptake into a number of plants:

Plant Uptake of Heavy Metals

High	Moderate	Low	Very Low
lettuce	onion	corn	beans
spinach	mustard	cauliflower	peas
carrot	potato	asparagus	melon
endive	radish	celery	tomatoes
cress		berries	fruit
beet and beet leaves			

2.5 Subsistence Fishing

This pathway is not expected to be relevant for most sites. In order to add subsistence fishing as a pathway of concern among the residential scenarios, onsite contamination must have impacted a water body large enough to produce a consistent supply of edible fish, and there must be evidence that area residents regularly fish in this water body (e.g., interviews with local anglers). If these criteria are met, the 95th-percentile for daily fish consumption (132 g/day) from Pao, et al. (1982) should be used to represent the ingestion rate for subsistence fishermen. This value was derived from a 3-day study of people who ate fish, other than canned, dried, or raw. An example of this consumption rate is about four 8-ounce servings per week.
This consumption rate can also be used to evaluate exposures to non-residents who may also use the water body for subsistence fishing. In this case, the exposure estimate would not be added to estimates calculated for other residential pathways, but may be included in the risk assessment as an exposure pathway for a sensitive sub-population.

For further information regarding food chain contamination the assessor is directed to the following documents:

- Methodology for Assessing Health Risks Associated with Indirect Exposures to Combustor Emissions (PB-90-187055). Available through NTIS.

- Development of Risk Assessment Methodology for Land Application and Distribution and Marketing of Municipal Sludge (EPA/600/6-89/001). Available from OHEA/Technical Information at FTS 382-7326.

- Estimating Exposure to 2,3,7,8-TCDD (EPA/600/6-88/005A). Available from OHEA/Technical Information at FTS 382-7326.

3.0 COMMERCIAL/INDUSTRIAL

Occupational scenarios should be evaluated when land use is (or is expected to be) commercial/industrial. In general, these scenarios address a 70-kg adult who is at work 5 days a week for 50 weeks per year (250 days total). The individual is assumed to work 25 years at the same location (95th-percentile; Bureau of Labor Statistics, 1990]. This scenario also considers ingestion of potable water, incidental ingestion of soil and dust, and inhalation of contaminated air.

Please note that under mixed-use zoning (e.g., apartments above storefronts), certain pathways described for the residential setting should also be evaluated.

3.1 Ingestion of Potable Water

Until data become available for this pathway, it will be assumed that half of an individual's daily water intake (1 liter out of 2) occurs at work. All water ingested is assumed to come from the contaminated drinking water source (i.e., bottled water is not considered). For site-specific-cases where workers are known to consume considerably more water (e.g., those who work outdoors in hot weather or in other high-activity/stress environments), it may be necessary to adjust this figure.

A lower ingestion rate is used in this pathway so that a more reasonable exposure estimate may be made for workers ingesting contaminated water. However, it is important to remember that remedial actions are often based on returning the contaminated aquifer to maximum beneficial use; which generally means achieving levels suitable for residential use.

3.2 Incidental Ingestion of Soil and Dust

In the occupational setting, incidental ingestion of soil and dust is highly dependent on the type of work being performed. Office workers would be expected to contact much less soil and dust than someone engaged in outdoor work such as construction or landscaping. Although no studies were found that specifically measured the amount of soil ingested by workers in the occupational setting, the one study that measured adult soil ingestion included subjects that worked outside of the home (Calabrese, et al., 1990a). Although the study had a limited number of subjects (n=6) and did not associate the findings with any particular activity pattern, it is the only study that did not rely on modeling to estimate adult soil ingestion. Thus, the Calabrese, et al. (1990a) estimate of 50 mg/day is selected as an interim default for adult ingestion of soil and dust in the "typical" workplace. Please be aware that this value may change when the results of ongoing soil ingestion studies sponsored by EPA's Exposure Assessment Group are finalized in 1991.

Attachment B presents modeled rates for adult soil ingestion that should be used to estimate exposures for certain workplace activities where much greater soil contact is anticipated, but with limited exposure frequency and/or duration.

3.3 Inhalation of Contaminated Air

As in the previous discussion regarding inhalation rates for the residential setting, specific time-use/activity level data were used to estimate inhalation rates for various occupational activities. The results indicate that 20 m^3 per 8-hour workday represents a reasonable upper-bound inhalation rate for the occupational setting (see Attachment A). Although analytical data are much preferred, procedures described in Hwang and Falco (1986) and Cowherd, et al. (1985) can be used to estimate volatile and dust-bound contaminant concentrations, respectively.

4.0 AGRICULTURAL

These land use scenarios include potential exposures for farm families living and working on the site, as well as, individuals who may only be employed as farm workers.

4.1 Farm Family Scenario

This scenario should be evaluated only if it is known or suspected that there are farm families in the area. The animal products pathway should not be used for areas zoned residential, because such regulations generally prohibit the keeping of livestock. Farm family members are assumed to have most of the same characteristics as people in the residential setting; the only difference is that consumption of homegrown produce will <u>always</u> be evaluated. Thus, default values for the soil ingestion, drinking water, and inhalation pathways would be the same as those in the residential setting.

4.1.1 Consumption of Homegrown Produce

The values used in evaluating this pathway are the same as those presented in Section 2.4. While it is more likely for farm families to cultivate fruits and vegetables, it is not necessarily true that they would be able to grow a sufficient variety to meet all their dietary needs and tastes. Thus, the consumption rate default values will be 42 g/day and 80 g/day for fruits and vegetables, respectively. Again, EFH presents consumption rates for specific homegrown fruits and vegetables. The assessor is reminded that the plant uptake pathway is not relevant for all contaminants and sampling of fruits and vegetables is highly recommended. However, in the absence of analytical data, plant uptake of organic chemicals can be estimated using the procedure described in Briggs, et al. (1982). No particular procedure is recommended for quantitatively assessing inorganic uptake at this time; however, the table (presented in Section 2.4) developed by Sauerbeck (1988) provides a qualitative guide for assessing heavy metal uptake into a number of plants.

4.1.2 Consumption of Animal Products

Animal products should only be addressed if it is known that local residents produce them for home consumption or are expected to do so in the future. The best way to determine which items are produced is by interviews or consultation with the local County Extension Service which usually has data on the type and quantity of local farm products.

EFH provides average ingestion rates for beef and dairy products and assumes that the farm family produces 75 percent of what it consumes from these categories. This corresponds to a "reasonable worst case" consumption rate of 75 g/day for beef and 300 g/day for dairy products. Although sampling data are much preferred, in their absence the procedure described in Travis and Arms (1988) may be used to estimate organic contaminant concentrations in beef and milk. This procedure does not provide transfer coefficients for poultry and eggs. Thus, the latter two pathways can be evaluated only if site-specific concentrations for poultry and eggs are available, or if transfer coefficients can be obtained from the literature.

Additional references addressing potential exposures from contaminated foods are listed in Section 2.0.

4.2 Farm Worker

Many farm activities, such as plowing and harrowing, can generate a great deal of dust. The risk assessor should consider the effects of observed (or expected) agricultural practices when using the fugitive dust model suggested under the residential scenario. Note that soil ingestion rate may be similar to the outdoor yardwork scenario discussed in Attachment B, although it will be necessary to modify the exposure frequency and duration to account for climate and length of employment. The local County Extension Service should be able to provide information on agricultural practices around a site. In addition, the Biological and Economic Analysis Division in the Office of Pesticide Programs maintains a database of the usual planting and harvesting dates for a number of crops in most U.S. states. This information may be very helpful for estimating times of peak exposure for farm workers, and, if needed, can be obtained through the Superfund Health Risk Assessment Technical Support Center (FTS 684-7300).

5.0 RECREATIONAL

As stated previously, sites present different opportunities for recreational activities. The RPM or risk assessor is encouraged to consult with the local community to determine whether there is or could be recreational use of the property along with the likely frequency and duration of any activities.

5.1 Consumption of Locally Caught Fish

This pathway should be evaluated when there is access to a contaminated water body large enough to produce a consistent supply of edible-sized fish over the anticipated exposure period. Although the local authorities should know if the water body is used for fishing, illegal access (trespassing) and deliberate disregard of fishing bans should not necessarily be ruled out; the risk assessor should check for evidence of these activities. If required, the scenario can be modified to account for fishing season, type of edible fish available, consumption habits, etc.

For recreational fishing, the average consumption rate of 54 g/day from Pao, et al. (1982) is used. This value is derived from a 3-day study of people who ate finfish, other than canned, dried or raw. An example of this consumption rate is about two 8-ounce servings per week. Other values presented in EFH, for consumption of recreationally caught fish, are from limited studies of fishermen on the west coast and may not be applicable to catches in other areas.

When evaluating this pathway please consider the possibility of subsistence fishing. Unlike the residential scenario, exposure estimates from this pathway would not necessarily be added to any other exposure estimates (see Section 2.5). Instead, it would be included as an estimate of exposure for a sensitive sub-population.

5.2 Additional Recreational Scenarios

A number of commentors requested standard default values for the following recreational scenarios: hunting, dirtbiking, swimming and wading. One approach to address exposure during swimming and wading is presented in HHEM Part A. The Agency is currently involved in research projects designed to estimate dermal uptake of contaminants from soil, water and sediment. Results of these studies will be used to update the swimming and wading scenarios as well as other scenarios that rely on estimates of dermal absorption. Unfortunately, lack of data and problems in estimating exposure frequencies and durations based on regional variations in climate have precluded the standardization of other recreational scenarios at this time. Additional guidance will be developed as data become available.

6.0 SUMMARY

This supplemental guidance has been developed to provide a standard set of default values for use in exposure assessments when site-specific data are lacking. These standard factors are intended to be used for calculating reasonable maximum exposure (RME) levels for each applicable land use scenario at a site.

Supporting data for many of the assumptions can be found in the Exposure Factors Handbook (EFH; U.S. EPA, 1990). When supporting information was not available in EFH, well-quantified or widely-accepted data from the open literature were adopted. Finally, for factors where there is a great deal of uncertainty, a rationally conservative estimate was developed and explained.

As new data become available, either for the factors themselves or for calculating RME, this guidance will be modified accordingly.

The following table summarizes the exposure pathways that will be evaluated on a <u>routine</u> basis for each land use, and the current default values for each exposure parameter in the standard intake equation presented below (refer to HHEM: Part A, U.S. EPA, 1989a for a more detailed discussion of each exposure parameter):

$$\text{Intake} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

c = Concentration of the chemical in each medium

IR = Intake/Contact Rate

EF = Exposure Frequency

ED = Exposure Duration

BW = Body Weight

AT = Averaging Time

SUMMARY OF STANDARD DEFAULT EXPOSURE FACTORS (1)

Land Use	Exposure Pathway (2)	Daily Intake Rate	Exposure Frequency	Exposure Duration	Body Weight
Residential					
	Ingestion of Potable Water	2 liters	350 days/year	30 years	70 kg
	Ingestion of Soil and Dust	200 mg (child) 100 mg (adult)	350 days/year	6 years 24 years	15 kg (child) 70 kg (adult)
	Inhalation of Contaminants	20 cum (total) 15 cum (indoor)	350 days/year	30 years	70 kg
Commercial/ Industrial					
	Ingestion of Potable Water	1 liter	250 days/year	25 years	70 kg
	Ingestion of Soil and Dust	50 mg	250 days/year	25 years	70 kg
	Inhalation of Contaminants	20 cum/workday	250 days/year	25 years	70 kg
Agricultural					
	Ingestion of Potable Water	2 liters	350 days/year	30 years	70 kg
	Ingestion of Soil and Dust	200 mg (child) 100 mg (adult)	350 days/year	6 years 24 years	15 kg (child) 70 kg (adult)
	Inhalation of Contaminants	20 cum (total) 15 cum (indoor)	350 days/year	30 years	70 kg
	Consumption of Homegrown Produce	42 g (fruit) 80 g (veg.)	350 days/year	30 years	70 kg
Recreational					
	Consumption of Locally Caught Fish	54 g	350 days/year	30 years	70 kg

(1) - Factors presented are those that should generally be used to assess exposures associated with a designated land use. Site-specific data may warrant deviation from these values; however, use of alternate values should be justified and documented in the risk assessment report.

(2) - Listed pathways may not be relevant for all sites and, other exposure pathways may need to be evaluated due to site conditions. Additional pathways and applicable default values are provided in the text of this guidance.

7.0 REFERENCES

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ATTACHMENT A

ACTIVITY SPECIFIC INHALATION RATES

Background

The standard default value of 20 m^3/day has been used by EPA to represent an average daily inhalation rate for adults. According to EFH, this value was developed by the International Commission on Radiologic Protection (ICRP) to represent a daily inhalation rate for "reference man" engaged in 16 hours of "light activity" and 8 hours of "rest". EPA (1985) reported on a similar study that indicated the average inhalation rate or a man engaged in the same activities would be closer to 13 m^3/day. EFH, in turn, reiterated the findings of ICRP and EPA (1985) then calculated a "reasonable worst case" inhalation rate of 30 m^3/day. This reasonable worst case value was used in Part A of the Human Health Evaluation Manual as the RME inhalation rate for residential exposures.

Commentors from both inside and outside the Agency expressed concerns that this value may be too conservative. Many also added their concern that exposure values calculated using this inhalation rate would not be comparable to reference doses (RfD) and cancer potency factors (ql*) values based on an inhalation rate of 20 m^3/day. Thus, the Toxics Integration Branch of Superfund (TIB) conducted a review of the literature to determine the validity of using 30 m^3/day as the RME inhalation rate for adults. Members of EPA's Environmental Criteria Assessment Office-Research Triangle Park (A. Jarabek, 9/20/90) and the Science Advisory Board (10/26/90) have suggested that inhalation rates could be calculated using time-use/activity level data reported in the "Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessments" (OHEA; U.S. EPA, 1985). Thus, TIB used this data to calculate an RME inhalation rate for both the residential and occupational settings, as follows.

Methodology

- o The time-use/activity level data reported by OHEA (1985) were analyzed for each occupation subgroup;
- o The data were divided into hours spent at home vs. hours spent at the workplace (lunch hours spent outside of work and hours spent in transit were excluded);
- o The hourly data were subdivided into hours spent indoors vs. outdoors (to allow for estimating exposures to volatile contaminants during indoor use of potable water);

- The corresponding activity level was assigned to each hour and the total number of hours spent at each activity level was calculated;

- For time spent inside the home, 8 hours per day were assumed to be spent at rest; and

- The total number of hours spent at each activity level was multiplied by average inhalation rates reported in the EFH. <u>Note</u>: average values were used since only minimum, maximum and average values were reported. The use of maximum values would have to be considered "worst case". Values for average adults were applied to all but the housewife data (where average rates for women were applied).

The results showed that the highest weekly inhalation rate was 18.3 m^3 /day for the residential setting and 18 m^3/day for the workplace. These values represent the highest among the weekly averages and were derived from coupling “worst case” activity patterns with “average“ adult inhalation rates. It was concluded from these data that 30 m^3 /day may in fact be too conservative and that 20 m^3/day would be more representative of a reasonably conservative inhalation rate for total (i.e., indoor plus outdoor) exposures at home and in the workplace.

RAGS Part B will specifically model exposure to volatile organics via indoor use of potable water. Using the method described previously, it was determined that 15 m^3/day would represent a reasonably conservative inhalation rate for indoor residential exposures.

ATTACHMENT B

ESTIMATING ADULT SOIL INGESTION IN THE COMMERCIAL/INDUSTRIAL SETTING

Most of the available soil ingestion studies focus on children in the residential setting; however, two studies were found that address adult soil ingestion that also have application to the commercial/industrial setting (Hawley, 1985; Calabrese, et al., 1990).

Hawley (1985) used a number of assumptions for contact rates and body surface area to estimate the amount of soil and dust adults may ingest during a variety of residential activities. For indoor exposures, Hawley estimated levels based on contact with soil/dust in two different household areas, as follows: 0.5 mg/day for daily exposure in the “living space”; and 110 mg/day for cleaning dusty areas such as attics or basements. For outdoor exposures, Hawley estimated a soil ingestion rate during yardwork of 480 mg/day. The assumptions used to model exposures in the residential setting may also be applied to similar situations in the workplace. The amount of soil and dust adults contact in their houses may be similar to the amount an office or indoor maintenance worker would be expected to contact. Likewise, the amount of soil contacted by someone engaged in construction or landscaping may be more analogous to a resident doing outdoor yardwork.

Calabrese, et al. (1990) conducted a pilot study that measured adult soil ingestion at 50 mg/day. Although the study has several drawbacks (e.g., a limited number of participants and no information on the participants daily work activities), it included subjects that worked outside the home. It is also interesting to note that this measured value falls within the range Hawley (1985) estimated for adult soil ingestion during indoor activities.

From these studies, 50 mg/day was chosen as the standard default value for adult soil ingestion in the workplace. It was chosen primarily because it is a measured value but also because it falls within the range of modeled values representing two widely different indoor exposure scenarios. The 50 mg/day value is to be used in conjunction with an exposure frequency of 250 days/year and an exposure duration of 25 years. For certain outdoor activities in the commercial/industrial setting (e.g., construction or landscaping), a soil ingestion rate of 480 mg/day may be used; however, this type of work is usually short-term and is often dictated by the weather. Thus, exposure frequency would generally be less than one year and exposure duration would vary according to site-specific construction/maintenance plans.

- The corresponding activity-level was assigned to each hour and the total number of hours spent at each activity level was calculated;

- For time spent inside the home, 8 hours per day were assumed to be spent at rest; and

- The total number of hours spent at each activity level was multiplied by average inhalation rates reported in the EFH. Note: average values were used since only minimum, maximum and average values were reported. The use of maximum values would have to be considered "worst case". Values for average adults were applied to all but the housewife data (where average rates for women were applied).

The results showed that the highest weekly inhalation rate was 18.3 m^3/day for the residential setting and 18 m^3/day for the workplace. These values represent the highest among the weekly averages and were derived from coupling “worst case” activity patterns with “average" adult inhalation rates. It was concluded from these data that 30 m^3/day may in fact be too conservative and that 20 m^3/day would be more representative of a reasonably conservative inhalation rate for total (i.e., indoor plus outdoor) exposures at home and in the workplace.

RAGS Part B will specifically model exposure to volatile organics via indoor use of potable water. Using the method described previously, it was determined that 15 m^3/day would represent a reasonably conservative inhalation rate for indoor residential exposures.