EPA CERCLA Approach for Risk Assessment when Addressing Radioactive Contamination Indoors

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"Investigation of State Approaches to Assessing Indoor Contaminated Dust"
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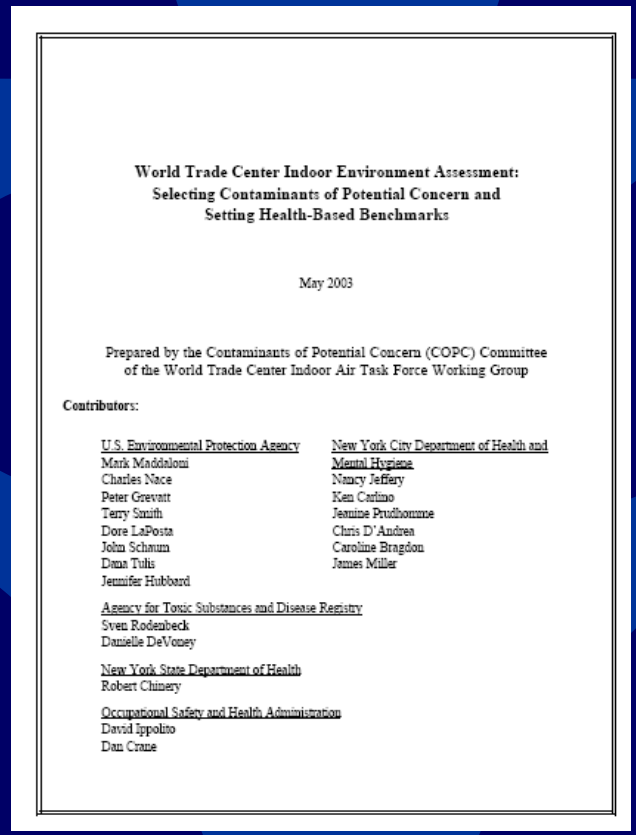
EPA

Purpose

- Provide overview and comparison of EPA CERCLA remedial program risk/dose assessment models for inside buildings and their chemical precursor document
- Provide need for intern research project

Guidance: World Trade Center (WTC) Benchmark

- Document issued 2003 and used to establish $1x10^{-4}$ risk based cleanup levels for the reuse of chemically contaminated buildings after the 9/11 attacks.
- Equations and parameters were the latest EPA chemical methodology
- Ingestion, inhalation, and dermal
  - » http://www.epa.gov/wtc/reports/contaminants_of_concern_benchmark_study.pdf



World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks

May 2003

Prepared by the Contaminants of Potential Concern (COPC) Committee of the World Trade Center Indoor Air Task Force Working Group

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Guidance: World Trade Center (WTC) Benchmark (continued)

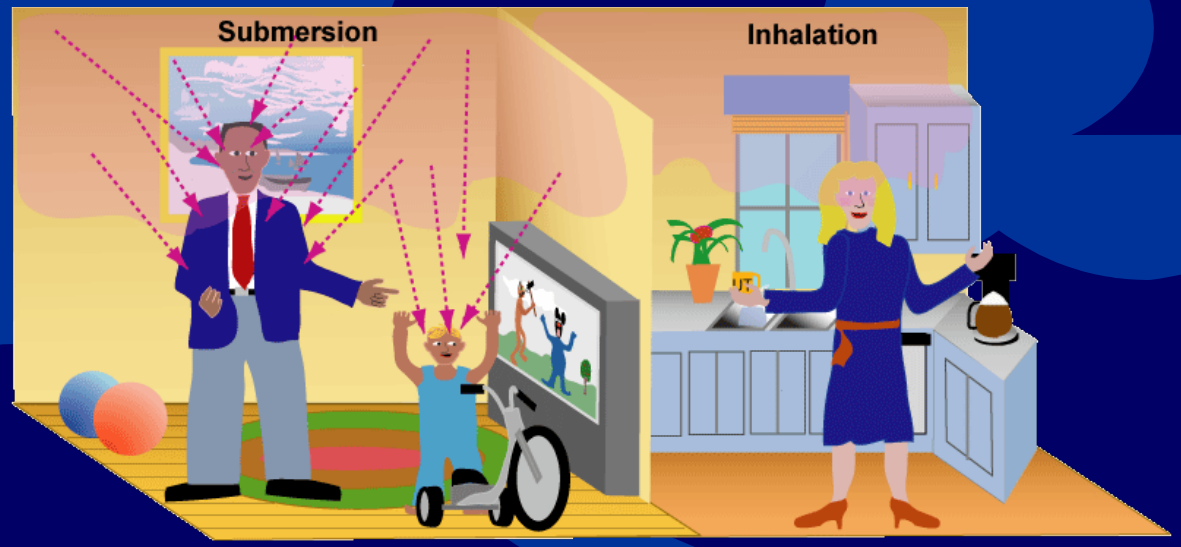
- WTC benchmark document includes 1 land use scenario
  - Residential
- This land use includes 2 exposure routes
  - Settled dust
  - Ambient air

Guidance: Building PRG (BPRG) Calculator

- Calculator issued 2007 to establish $1x10^{-6}$ risk based PRGs for the reuse of radioactively contaminated buildings.
- Equations and parameters are derived from latest EPA chemical methodology (e.g., assessment at WTC which used $1x10^{-4}$ cleanup level)
  - » Adjusted to account for technical differences posed by radiation
- EPA and ITRC Internet-based training on BPRG calculator and D&D
  - » http://www.clu-in.org/conf/itrc/radsdd_040308/

Guidance: Building PRG (BPRG) Calculator (continued)

- BPRG calculator includes 2 land use scenarios
  - » Residential
  - » Indoor worker
- Both land uses include 3 exposure routes
  - » Settled dust
  - » Ambient air
  - » Direct external exposure
    - —5 Room sizes and 4 receptor locations
    - —5 Room materials, and 2 composite rooms
    - —5 Source thickness



EPA

Building Dose Cleanup Concentrations (BDCC) ARAR Dose Calculator

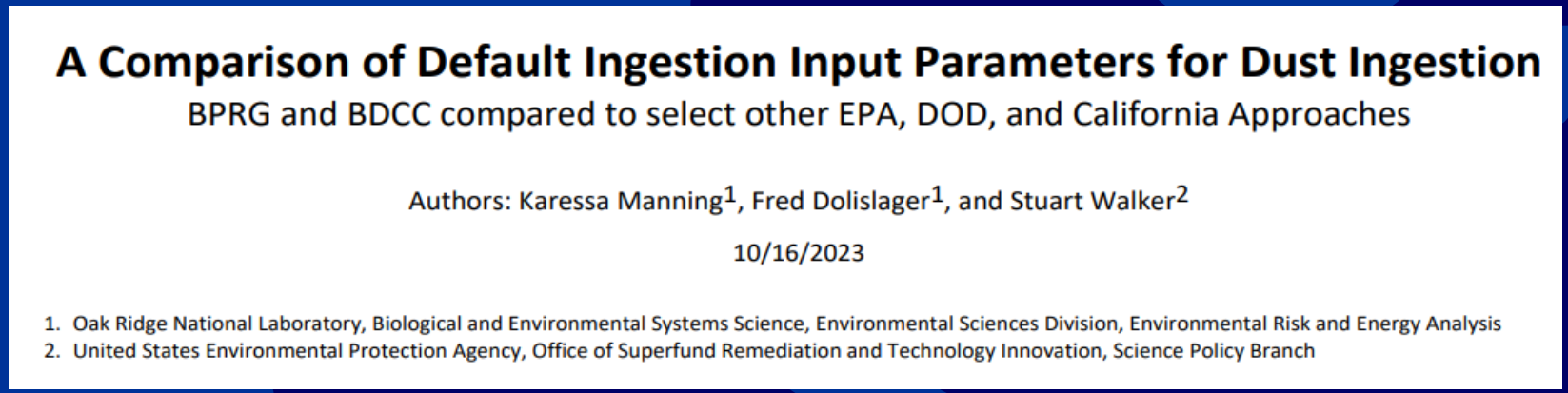
- BDCC Purpose: issued 2010 to establish BCCs for Inside Buildings for single dose limit ARARs (# mrem/yr)
- BDCC includes 2 land use scenarios (Residential, Indoor Worker)
- 2 land uses include 3 exposure routes (Settled dust, Fixed Direct External 3-D, Ambient Air)
- Equations are similar to those used for BPRG calculator, except dose conversion factors used instead of slope factors

Dust Ingestion Default Inputs

- The BPRG/BDCC method for handling dust ingestion was derived from WTC methodology
  - BPRG/BDCC did include gamma while WTC included dermal
  - BPRG/BDCC default to no dissipation rate (removal of source term) while WTC used a dissipation rate
- BPRG/BDCC default inputs have been updated with new information from:
  - 2011 EPA ORD Exposures Factor Handbook and 2014 EPA Superfund guidance on default inputs
  - 2018 EPA EFH dust chapter update

Precursor Studies

- EPA and ORNL staff conducted study of default dust ingestion parameters used by EPA and one other federal agency (DOD) and one state (California)



A Comparison of Default Ingestion Input Parameters for Dust Ingestion

BPRG and BDCC compared to select other EPA, DOD, and California Approaches

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- EPA had a previous study and webinar focused on default parameters for risk/dose assessment models addressing radioactively contaminated surfaces

Default Dust Ingestion Inputs from 2007 BPRG, 2014 BPRG, current BPRG and 2003 WTC

- Next slide shows table comparing the default dust ingestion Inputs from the 2003 WTC, 2007 BPRG, 2014 BPRG, and the current BPRG

Table Comparing Default Ingestion Input Parameters for Dust Ingestion

BPRG when issued (2007), update (2014), and current (2022) and World Trade Center 2009 guidance "World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks"

Variable	Description	WTC 2003	Units 2003	BPRG 2007	Units 2007	BPRG 2014	Units	Reference/Reason for change in 2014	BPRG 2022	Units	Reference/Reason for change in 2022
EDres	Exposure Duration - Resident	30	yrs	30	yrs	26	yrs	U.S. EPA 2014 (Attachment 1)	26	yrs	U.S. EPA 2014 (Attachment 1)
EDres-c	Exposure Duration - Resident Child	6	yrs	6	yrs	6	yrs	U.S. EPA 2014 (Attachment 1)	6	yrs	U.S. EPA 2014 (Attachment 1)
EDres-a	Exposure Duration - Resident Adult	24	yrs	24	yrs	20	yrs	U.S. EPA 2014 (Attachment 1)	20	yrs	U.S. EPA 2014 (Attachment 1)
EFres	Exposure Frequency - Resident	350	days/yr	350	days/yr	350	days/yr	U.S. EPA 2014 (Attachment 1)	350	days/yr	U.S. EPA 2014 (Attachment 1)
EFres-c	Exposure Frequency - Resident Child	350	days/yr	350	days/yr	350	days/yr	U.S. EPA 2014 (Attachment 1)	350	days/yr	U.S. EPA 2014 (Attachment 1)
EFres-a	Exposure Frequency - Resident Adult	350	days/yr	350	days/yr	350	days/yr	U.S. EPA 2014 (Attachment 1)	350	days/yr	U.S. EPA 2014 (Attachment 1)
ETres	Exposure Time - Resident	24	hr/day	24	hr/day	24	hr/day	U.S. EPA 2014 (Attachment 1)	24	hr/day	U.S. EPA 2014 (Attachment 1)
ETres-c	Exposure Time - Resident Child	24	hr/day	24	hr/day	24	hr/day	U.S. EPA 2014 (Attachment 1)	24	hr/day	U.S. EPA 2014 (Attachment 1)
ETres-a	Exposure Time - Resident Adult	24	hr/day	24	hr/day	24	hr/day	U.S. EPA 2014 (Attachment 1)	24	hr/day	U.S. EPA 2014 (Attachment 1)
ETres-c,h	Exposure Time - Resident Child Hard Surface	6	hr/day	6	hr/day	6	hr/day	WTC 2003	6	hr/day	WTC 2003
ETres-a,h	Exposure Time - Resident Adult Hard Surface	6	hr/day	6	hr/day	6	hr/day	WTC 2003	6	hr/day	WTC 2003
ETres-c,s	Exposure Time - Resident Child Soft Surface	10	hr/day	10	hr/day	10	hr/day	WTC 2003	10	hr/day	WTC 2003
ETres-a,s	Exposure Time - Resident Adult Soft Surface	10	hr/day	10	hr/day	10	hr/day	WTC 2003	10	hr/day	WTC 2003
FQres-c	Frequency of Hand to Mouth - child	9.5	event/hr	9.5	event/hr	17	event/hr	EPA 2011 Table 4.1	17.7	event/hr	EPA 2017 Table 5-13.[a]
FQres-a	Frequency of Hand to Mouth - adult	1	event/hr	1	event/hr	3	event/hr	EPA 2011 Table 4.1	3.025	event/hr	EPA 2017 Table 5-13.[b]
FTSSh	Fraction Transferred Surface to Skin - hard surface	0.5	unitless	0.5	unitless	0.5	unitless	WTC 2003			
FTSSs	Fraction Transferred Surface to Skin - soft surface	0.1	unitless	0.1	unitless	0.1	unitless	WTC 2003			
FTSSh-child	Fraction Transferred Surface to Skin - hard surface								0.64	unitless	EPA 2017 Table 5-13.[b]
FTSSs-child	Fraction Transferred Surface to Skin - soft surface								0.14	unitless	EPA 2017 Table 5-13.[b]
FTSSh-adult	Fraction Transferred Surface to Skin - hard surface								0.4	unitless	EPA 2017 Table 5-13.[a]
FTSSs-adult	Fraction Transferred Surface to Skin - soft surface								0.08	unitless	EPA 2017 Table 5-13.[a]
FSA-child	fractional surface area of hand mouthed child								0.1	unitless	EPA 2017 Table 5-13.[b]
FSA-adult	fractional surface area of hand mouthed adult								0.07	unitless	EPA 2017 Table 5-13.[a]
IFDres-adj	Age-Adjusted Resident Dust Ingestion Fraction			3870	cm^2-year/day	3200400	cm^2	Change in units because equation was rearranged to accommodate age adjustment (compare of BPRG age adjusted ingestion of dust equation to the 2007 ingestion of dust equation). Additionally, the value for FQ was updated.	3115591	cm^2	A factor called FSA (fraction of hand mouthed) has been incorporated that has not previously been used. In addition, the indoor worker IFD now includes EF and ED for consistency with resident IFD.
IFDiw	Indoor Worker Dust Ingestion Fraction			54	cm^2/day	54	cm^2/day		505659	cm^2	
k	Dissipation Rate Constant	0.38	yr^-1	0	yr^-1	0	yr^-1	WTC justified site-specific dissipation rate.	0	yr^-1	WTC justified site-specific dissipation rate.
SAres-a	Surface Area of Fingers - Resident Adult	45	cm^2	45	cm^2	49	cm^2	EPA 2011 Table 7.2	398	cm^2	EPA 2017 Table 5-13.[b]
SAres-c	Surface Area of Fingers - Resident Child	15	cm^2	15	cm^2	16	cm^2	EPA 2011 Table 7.2	223	cm^2	EPA 2017 Table 5-13.[a]
SE	Saliva Extraction Factor	0.5	unitless	0.5	unitless	0.5	unitless		0.5	unitless	WTC 2003
tres	Time - resident	30	yr	30	yr	26	yr	U.S. EPA 2014 (Attachment 1)	26	yr	U.S. EPA 2014 (Attachment 1)

Yellow highlighted BPRG defaults that differ from WTC defaults

WTC 2003 = World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks

U.S. EPA 2011 = 2011 Exposure Factors Handbook

U.S. EPA 2014 = 2014 Human Health Evaluation Manual: Update of Standard Exposure Factors (OSWER Directive 9200.1-120)

U.S. EPA 2017 = 2017 Exposure Factors Handbook, Chapter 5. Soil and Dust Ingestion Update

a; Average of all age groups from birth to 6 years.

b; Average of all age groups for ages 6+.

Similar Default Inputs in DOD and California guidance

- Both California and the DOD have risk assessment guidance for dust with similar defaults to those used in the WTC, BPRG, and BDCC.
  - California's Human and Ecological Risk Office (HERO), Human Health Risk Assessment (HHRA) for 2018 & 2020 Note Number 8 "Recommendations for Evaluating Polychlorinated Biphenyls (PCBs) at Contaminated Sites in California"
  - DOD's Center for Health Promotion and Preventative Medicine (CHPPM) 2009 Technical Guide "Health Risk Assessment Methods and Screening Levels for Evaluating Office Worker Exposures to Contaminants on Indoor Surfaces Using Surface Wipe Data"

Default Dust Ingestion Inputs from BPRG and California PCB guidance

- Next slide shows table of default dust ingestion Inputs from BPRG and California guidance for cleanup of PCBs in dust indoors

Table Comparing Default Ingestion Input Parameters for Dust Ingestion
Current BPRG (2022) and California's Human and Ecological Risk Office (HERO), Human Health Risk Assessment (HHRA) for 2018 & 2020 Note Number 8
"Recommendations for Evaluating Polychlorinated Biphenyls (PCBs) at Contaminated Sites in California"

BPRG Variable	BPRG Description	BPRG 2022	Units 2022	BPRG Ref	HERO HHRA Variable	HERO HHRA Description	HERO HHRA 2018	Units 2018	Reference 2018	HERO HHRA Variable	HERO HHRA Description	HERO HHRA 2020	Units 2020	Reference 2020
EDres-c	Exposure Duration - Resident Child	6	yrs	U.S. EPA 2014 (Attachment 1)	ED	Exposure Duration - student	6	yrs	conservative assumption based on years in school	ED	Exposure Duration - student	6	yrs	conservative assumption based on years in school
EDres-a	Exposure Duration - Resident Adult	20	yrs	U.S. EPA 2014 (Attachment 1)	ED	Exposure Duration - teacher	25	yrs	conservative assumption based on years in school	ED	Exposure Duration - teacher	25	yrs	conservative assumption based on years in school
EFres-c	Exposure Frequency - Resident Child	350	days/yr	U.S. EPA 2014 (Attachment 1)	EF	Exposure Frequency - student	230	days/yr	conservative assumption based on length of school year	EF	Exposure Frequency - student	230	days/yr	conservative assumption based on length of school year
EFres-a	Exposure Frequency - Resident Adult	350	days/yr	U.S. EPA 2014 (Attachment 1)	EF	Exposure Frequency - teacher	230	days/yr	conservative assumption based on length of school year	EF	Exposure Frequency - teacher	230	days/yr	conservative assumption based on length of school year
FQres-c	Frequency of Hand to Mouth - child	17.7	event/hr	EPA 2011 Table 4.1	CF	Contact Frequency - student	6	events/day	conservative assumption based on classes per day	CF	Contact Frequency - student	6	events/day	conservative assumption based on classes per day
FQres-a	Frequency of Hand to Mouth - adult	3.025	event/hr	EPA 2011 Table 4.1	CF	Contact Frequency - teacher	6	events/day	conservative assumption based on classes per day	CF	Contact Frequency - teacher	6	events/day	conservative assumption based on classes per day
SE	Saliva Extraction Factor	0.5	unitless	WTC 2003	fdo	skin to mouth transfer efficiency	0.04	unitless	Michaud, et. al. (1994).	fdo	skin to mouth transfer efficiency	0.04	unitless	Michaud, et. al. (1994).
FTSSh FTSSs	Fraction Transferred Surface to Skin - hard or soft surface				TE	surface to skin transfer efficiency	0.1	unitless	DiBiasio, et. al. (2003)	TE	surface to skin transfer efficiency	0.1	unitless	DiBiasio, et. al. (2003)
FTSSh-child	Fraction Transferred Surface to Skin - hard surface	0.64	unitless	EPA 2017 Table 5-13.[b]										
FTSSs-child	Fraction Transferred Surface to Skin - soft surface	0.14	unitless	EPA 2017 Table 5-13.[b]										
FTSSh-adult	Fraction Transferred Surface to Skin - hard surface	0.4	unitless	EPA 2017 Table 5-13.[a]										
FTSSs-adult	Fraction Transferred Surface to Skin - soft surface	0.08	unitless	EPA 2017 Table 5-13.[a]										
IFDres-adj	Age-Adjusted Resident Dust Ingestion Fraction	NA	NA	NA	Intake Factor	Intake Factor - student	0.014	cm^2/kg-day	calculated from other inputs	Intake Factor	Intake Factor - student	0.014	cm^2/kg-day	calculated from other inputs
		NA	NA	NA	Intake Factor	Intake Factor - teacher	0.044	cm^2/kg-day	calculated from other inputs	Intake Factor	Intake Factor - teacher	0.044	cm^2/kg-day	calculated from other inputs
SAres-c	Surface Area of Fingers - Resident Child	223	cm^2	EPA 2017 Table 5-13.[b]	CA	Surface Area of Fingers - Resident Child	372	cm^2/event	50% of the recommended surface areas for the hands and forearms on pages 7-40 and 7-41 of the Exposure Factors Handbook (USEPA 2011)	CA	Surface Area of Fingers - Resident Child	372	cm^2/event	50% of the recommended surface areas for the hands and forearms on pages 7-40 and 7-41 of the Exposure Factors Handbook (USEPA 2011)
SAres-a	Surface Area of Fingers - Resident Adult	398	cm^2	EPA 2017 Table 5-13.[a]	CA	Surface Area of Fingers - Resident Adult	647	cm^2/event	50% of the recommended surface areas for the hands and forearms on pages 7-40 and 7-41 of the Exposure Factors Handbook (USEPA 2011)	CA	Surface Area of Fingers - Resident Adult	647	cm^2/event	50% of the recommended surface areas for the hands and forearms on pages 7-40 and 7-41 of the Exposure Factors Handbook (USEPA 2011)

WTC 2003 = World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks
U.S. EPA 2011 = 2011 Exposure Factors Handbook
U.S. EPA 2014 = 2014 Human Health Evaluation Manual: Update of Standard Exposure Factors (OSWER Directive 9200.1-120)
U.S. EPA 2017 = 2017 Exposure Factors Handbook, Chapter 5. Soil and Dust Ingestion Update
Michaud, et. al. (1994).
DiBiasio, et. al. (2003)
a; Average of all age groups from birth to 6 years.
b; Average of all age groups for ages 6+.

Default Dust Ingestion Inputs from BPRG and DOD chemicals in dust guidance

- Next slide shows table of default dust ingestion Inputs from BPRG and DOD guidance for cleanup of chemically contaminated dust indoors

Table Comparing Default Ingestion Input Parameters for Dust Ingestion
Current BPRG (2022) and Deparment of Defense's (DOD) Center for Health Promotion and Preventative Medicine (CHPPM) 2009 Technical Guide
"Health Risk Assessment Methods and Screening Levels for Evaluating Office Worker Exposures to Contaminants on Indoor Surfaces Using Surface Wipe Data"

BPRG Variable	BPRG Description	BPRG 2022	Units 2022	BPRG Ref	CHPPM Parameter	CHPPM Definition	CHPPM Value or Equation No.	CHPPM Reference	CHPPM Important Notes	CHPPM Limitations
NA	NA	NA	NA	NA	Fd	Fraction of exposed skin surface area that actually contacts the contaminated surface (unitless)	Forearm: 1 Hand (palmar side): 0.30	Zainudin and Semple 2005 (fraction of forearm and hand surface area that actually has contact with smooth, nonporous surfaces in an office setting)	Fd values provided are limited to fine particles and should not be used for direct contact with liquids on the surface.	
FSAind	Fractional surface area of hand mouthed adult	0.07	unitless	EPA 2017 Table 5-13 [a]	Ff	Fraction of exposed skin that contacts the mouth (unitless)	0.08	Estimated using professional judgment. The following assumptions were used to estimate the fingertip fraction of 0.08 that contacts the mouth: • Total finger area is one-half the hand area (0.5). • The joint at the distal end of the finger is one-third of each finger (0.33). • One-half of the joint at the distal end of the finger contacts the mouth (0.5).	A fraction of this area that contacts the mouth during adult mouthing behaviors such as nail biting or placing the fingertips in the mouth.	
SE	Saliva Extraction Factor	0.5	unitless	WTC 2003	FTsm	Fraction of substance transferred from skin to mouth (unitless)	0.4	Rusin et al. (2002)	The data from Rusin et al. is more representative of office worker exposures. USEPA uses Kissel et al. 1998 which accounts for a three different activities: thumb sucking, finger mouthing ("mouthing three fingers above the first knuckle"), and palm licking ("three swipes with the tongue"). These activities are not appropriate for office worker exposure.	
FTSSind-h FTSSind-s	Fraction Transferred Surface to Skin	hard surfaces = 0.4 soft surfaces = 0.08	unitless	EPA 2017 Table 5-13 [a]	FTss	Fraction transferred from the surface to the skin (unitless)	0.063	Calculating the fraction transferred using the Brouwer et al. assumption—that the transfer surface area is similar to the exposed hand area—estimated FTss would be 6.3 percent and 0.5 percent at surface loadings of 6 µg/cm2 and 177 µg/cm2, respectively. (Note: This value is based on results reported by Brouwer et al. for six repeated contacts at a low surface loading of 6 µg/cm2.)	For office workers, FTss values should reflect casual contact with the surface; therefore, experimental values derived from vigorous rubbing are probably not appropriate. In addition, although not explicitly stated, many studies focused on a crawling infant as the likely receptor. Studies designed to mimic exposures to a crawling infant applied forces not normally associated with casual surface contacts.	The default FTss was selected using office worker exposure assumptions and should not be applied to other exposure scenarios without considering additional factors for those scenarios. For example, children are more likely to contact surfaces with wet hands than adults, and experimental data show moisture can increase the amount transferred from the surface to the skin.
EDiw	Exposure Duration - Indoor Worker	25	yrs	U.S. EPA 2014 (Attachment 1)	ED	Exposure duration (year)	10	Based on the mass balance analysis, an ED of 10 years is recommended for evaluating office worker exposures.	The mass balance analysis is assumes that the initial contamination is not the level at which a worker would be exposed for the duration of employment. (essentially, they are applying k (dissipation rate) to ED)	USEPA (1991) recommends using a 95th percentile ED of 25 years, which is based on 1990 BLS data.
EFiw	Exposure Frequency - Indoor Worker	250	days/yr	U.S. EPA 2014 (Attachment 1)	EF	Exposure frequency (days/year)	250	USEPA recommendation		
ETiw	Exposure Time - Indoor Worker	8	hr/day	U.S. EPA 2014 (Attachment 1)	ET	Exposure time (hours/day)	8	(BLS 2007)		
FQiw	Frequency of Hand to Mouth - Indoor Worker	3.025	events/hr	EPA 2017 Table 5-13 a	EVderm	Event frequency for estimating the dermal dose (events/day)	4	selected using professional judgment	The default value should not be used for exposure scenarios that are significantly different from these considerations. (i.e. office workers)	Examples are computer work (includes typing, working in front of the computer); talking on the phone; and working at a desk away from the computer (for example, writing, reading, attending meetings). When a break occurs, an activity is considered a new event even when the office worker resumes the same activity.
					EVing	Event frequency for estimating intake from incidental ingestion (events/day)	27 (fingertip/nail biting)	Zainudin and Semple (2005)	For the purposes of estimating office worker exposure from incidental ingestion, Zainudin's observation of 3.4 hand-to-perioral area contacts per hour was used to estimate EVing for fingertip/fingernail biting habits. Multiplying this by a typical 8-hour workday results in a total EVing of 27 events/day.	
SAiw	Surface Area of Fingers - Indoor Worker	398	cm^2	EPA 2017 Table 5-13 [a]	SA	Exposed skin surface area per event (cm2)	Forearms: 873 Hands (palmar side): 326	Forearm surface areas were obtained from the Exposure Factors Handbook (USEPA 1997c). Palmar surface areas (wrist crease to fingertips) were obtained from the open literature Edwards and Lioy (1999). (Value was doubled to account for SA on both hands)	As the Exposure Factors Handbook provides only whole forearm surface area values, an adjustment factor of 66.7 percent, or two-thirds of the whole forearm surface area, was used to modify the forearm surface area. This adjustment factor accounts for the underside of the forearm as well as the "spread-out" effect of the arm when it is laid on a flat surface. As discussed in paragraph 9.1, residents are expected to have a larger exposed skin area available for contact with surfaces than office workers.	Paragraph 9.1: Residents are more likely to come in contact with a greater variety of indoor surfaces and from different parts of the home. In addition, due to the more relaxed atmosphere of a home as compared to that of an office, residents of a home tend to dress more casually, resulting in a greater skin surface area available for contact. Residents are also more apt to engage in activities that involve direct contact with floor surfaces. Some examples include walking barefooted or sitting on the floor. This is especially true of children and infants, with the latter group spending most of their time close to the floor.

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U.S. EPA 2011 = 2011 Exposure Factors Handbook
U.S. EPA 2014 = 2014 Human Health Evaluation Manual: Update of Standard Exposure Factors (OSWER Directive 9200.1-120)
U.S. EPA 2017 = 2017 Exposure Factors Handbook, Chapter 5. Soil and Dust Ingestion Update
Zainudin and Semple (2005)
Rusin et al. (2002)
(BLS 2007)
Edwards and Lioy (1999)
a; Average of all age groups from birth to 6 years.

Default Dust Ingestion Inputs from BPRG and EPA pesticide guidance

- Next slide shows table of default dust ingestion Inputs from BPRG and EPA guidance for risk assessment of pesticides in dust indoors

Table Comparing Default Ingestion Input Parameters for Dust Ingestion
Current BPRG (2022) and EPA Office of Pesiticide Programs (OPP) 2012 guidance

BPRG Variable	BPRG Description	BPRG 2022	BPRG Units	BPRG Reference	OPP Variable	OPP Description	OPP 2020	OPP Units	OPP Reference
ETres-c,h	Exposure Time - Resident Child Hard Surface	6	hr/day	WTC 2003	ET	Exposure time	2	hr/day	EPA, 2011; Tables 16-15 and 16-25
ETres-c,s	Exposure Time - Resident Child Soft Surface	10	hr/day	WTC 2003	ET	Exposure time	4	hr/day	EPA, 2011; Tables 16-15 and 16-25
FQres-c	Frequency of Hand to Mouth - child	17	event/hr	EPA 2011 Table 4.1	Freq_HtM	Hand-to-mouth events per hour	20	event/hr	Xue et al. (2007)
FTSSh-child	Fraction Transferred Surface to Skin - hard surface	0.64	unitless	EPA 2017 Table 5-13.[b]	Fai-hands	Fraction of ai on hands	0.15	unitless	Krieger, 2000 and Selim, 2004
FTSSs-child	Fraction Transferred Surface to Skin - soft surface	0.14	unitless	EPA 2017 Table 5-13.[b]					
FTSSh-adult	Fraction Transferred Surface to Skin - hard surface	0.4	unitless	EPA 2017 Table 5-13.[a]					
FTSSs-adult	Fraction Transferred Surface to Skin - soft surface	0.08	unitless	EPA 2017 Table 5-13.[a]					
SAres-c	Surface Area of Fingers - Resident Child	223	cm^2	EPA 2017 Table 5-13.[b]	SAH	Surface area of one hand	150	cm^2	U.S. EPA, 2011; Table 7-2
SE	Saliva Extraction Factor	0.5	unitless	WTC 2003	SE	Saliva Extraction Factor	0.48	unitless	Camann et al. (1996)
FSA-child	fractional surface area of hand mouthed child	0.1	unitless	EPA 2017 Table 5-13.[b]	Fm	Fraction of hand mouthed per event	0.13	fraction/event	Zartarian et al. (2005).
FSA-adult	fractional surface area of hand mouthed adult	0.07	unitless	EPA 2017 Table 5-13.[a]					

Yellow highlighted BRPG defaults that differ from WTC defaults

WTC 2003 = World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks

U.S. EPA 2011 = 2011 Exposure Factors Handbook

U.S. EPA 2014 = 2014 Human Health Evaluation Manual: Update of Standard Exposure Factors (OSWER Directive 9200.1-120)

U.S. EPA 2017 = 2017 Exposure Factors Handbook, Chapter 5. Soil and Dust Ingestion Update

Xue et al. (2007) = A Meta-Analysis of Children's Hand-to-Mouth Frequency Data for Estimating Nondietary Ingestion Exposure. Risk Analysis, 27(2):411-420.

Krieger, 2000 = Biomonitoring and Whole Body Cotton Dosimetry to Estimate Potential Human Dermal Exposure to Semivolatile Chemicals. J. Exposure Analysis & Environ. Epidemiol. 10: 50-57.

Camann et al. (1996) = Comparison of Methods to Determine Dislodgeable Residue Transfer from Floors (EPA/600/R96/089) United States Environmental Protection Agency, Research Triangle Park, NC.

Zartarian et al. (2005). = A Probabilistic Exposure Assessment for Children Who Contact CCA-treated Playsets and Decks Using the Stochastic Human Exposure and Dose Simulation Model for the Wood Preservative Scenario (SHEDS-WOOD). Final Report. U.S.

Selim, 2004 = Measurement of Transfer of Deltamethrin Residues from Vinyl and Carpet flooring Treated with a Fogger Formulation Following a Single Hand Press. Unpublished study prepared by Non-Dietary Exposure Task Force. (MRID 46297602).

a; Average of all age groups from birth to 6 years.

b; Average of all age groups for ages 6+.

Need for Intern Study

- Limited reviews by EPA staff indicated state and federal agencies when assessing risks of contaminated dust used either an:
  - » NRC/DOE approach, or an
  - » EPA approach
- EPA wanted to survey additional states to confirm if this is true
- Also to then study default dust ingestion parameters to determine if there are any defaults parameters being used that differ from the NRC/DOE and EPA approach that EPA should consider adopting in the BPRB/BDCC calculators