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US ARMY PUBLIC HEALTH COMMAND

(Provisional)



WIPE SAMPLE INTERPRETATION

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Environmental Health Risk Assessment Program



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Purpose

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- Describe the rationale and logic used to assess health risks associated with chemical contamination on indoor surfaces
- USAPHC developed TG 312 for *office environments*
- Will not address issues related to collecting a “good” wipe sample



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Background and Scope

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- Few published health-based wipe sample standard/guidelines
- The development of TG 312 was an evolutionary process over time
- Guide is written in two parts;
 - First part basic concepts/explanation for general preventive medicine community
 - Second part detailed discussion of methodology for health risk assessors



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Evolution of Technical Guide 312

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- Pesticide residues at military housing
- Johnston Atoll Chemical Agent Disposal System (JACADS)
- Developed screening levels for construction/demolition workers
- Research laboratory converted to office
- Explosive residues in storage buildings
- Past herbicide research in laboratory



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- Contrast the health risk interpretation:
 - Drinking water
 - Food consumption
 - Surface wipe samples
- Basic EPA Risk Methodology equates health risk to magnitude of chemical intake.
- How to estimate an Average Daily Intake (ADI) from available environmental data?





EPA Health Risk Fundamentals

Health Effects	Human Health	Formula
Cancer risk	ILCR (Incremental Lifetime Cancer Risk)	$\text{ILCR} = \text{Chemical Intake} \times \text{Cancer Slope Factor}$
Noncancer	HQ (Hazard Quotient)	$\text{HQ} = \frac{\text{Chemical Intake}}{\text{Reference Dose}}$



Cancer Example

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ILCR = chemical intake X cancer slope factor

example:

A person incidentally ingesting sediment containing arsenic with a calculated intake of 7.23E-08 mg/kg-day



$$7.23\text{E-}08 \text{ mg/kg-d} \times 1.5 (\text{mg/kg-d})^{-1} = \mathbf{1.08\text{E-}07}$$



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Non Cancer Example- HQ

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example:

A worker incidentally ingests surface water with a calculated intake of $3.66\text{E-}07$ (mg/kg/day) of thallium



$$\text{HQ} = \frac{3.66\text{E-}07 \text{ (mg/kg/d)}}{7.00\text{E-}05 \text{ (mg/kg/d)}}$$

$$\text{HQ} = 5.2 \text{ E-}03$$



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Drinking Water Example

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- Measure chemical concentration
- Estimate daily water intake
- Concentration x consumption = mg



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Fish Consumption Example

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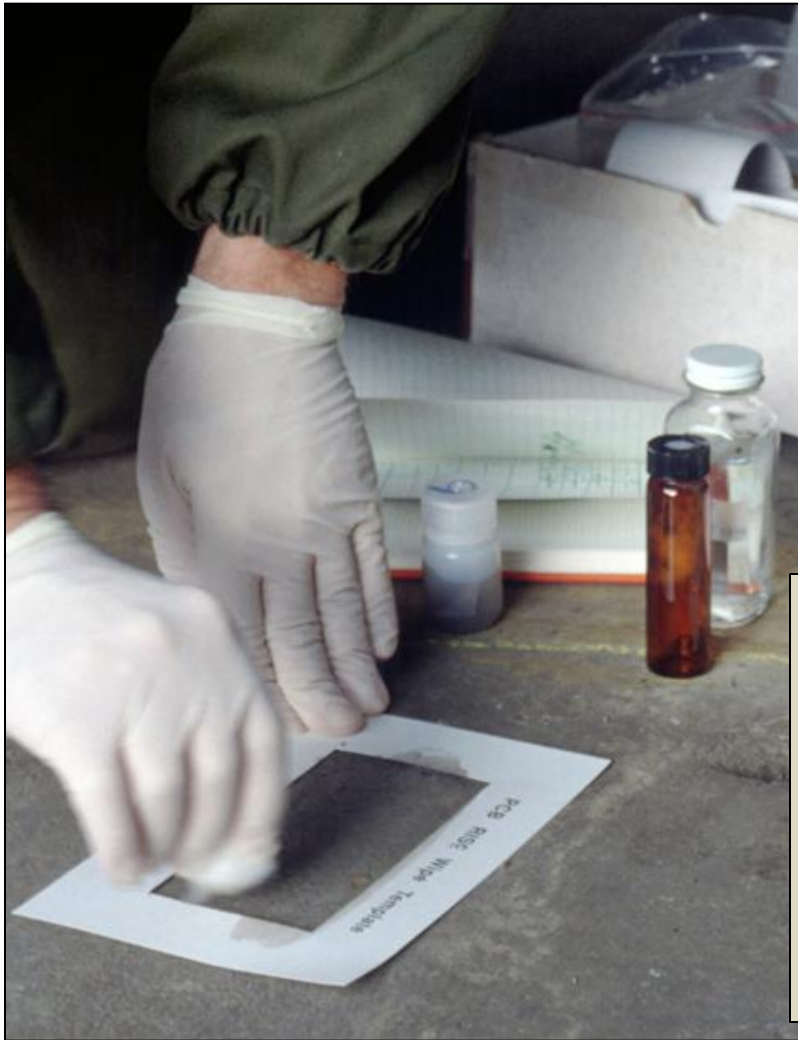


- Measure concentration in fish tissue
- Estimate fish consumption
- $\text{Concentration} \times \text{consumption} = \text{mg}$



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Wipe Sample Example



- Assume perfect sampling results of $50\mu\text{g}/100\text{ cm}^2$
- How do we use this surface sampling information to estimate intake?



Sampling Scenario

Child Day Care Center



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Sampling Scenario

Locked Mechanical Room



Potential Exposure Pathways



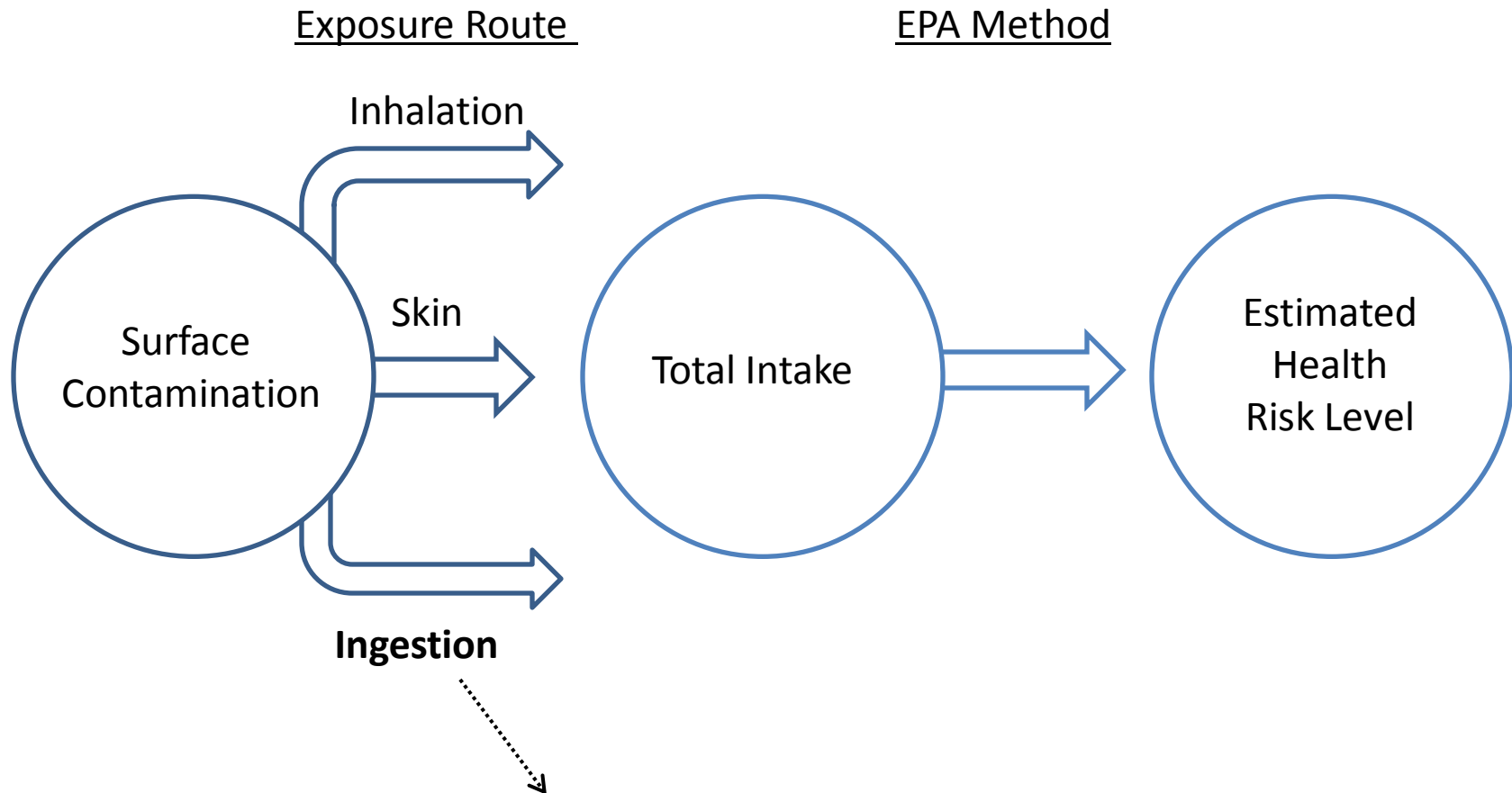
- ✓ Direct dermal contact
- ✓ Indirect ingestion from “mouthing behavior”
- ✓ Inhalation of settled particles resuspended from surface
- X Inhalation of semi-volatiles absorbed to surfaces (e.g., laminated, plastic)





Wipe Sample Interpretation

Exposure Assessment



$$ADI_{ing} = \frac{(SA \times Fd \times FT_{ss} \times Cs \times Ff \times FT_{sm} \times EV_{ing}) \times EF \times ED \times 10^{-3}}{BW \times AT}$$



Incidental Ingestion (fingers)

$$PD_{\text{ingestion (fingertips)}} = SA \cdot Fd \cdot FT_{ss} \cdot C_s \cdot F_f \cdot FT_{sm}$$

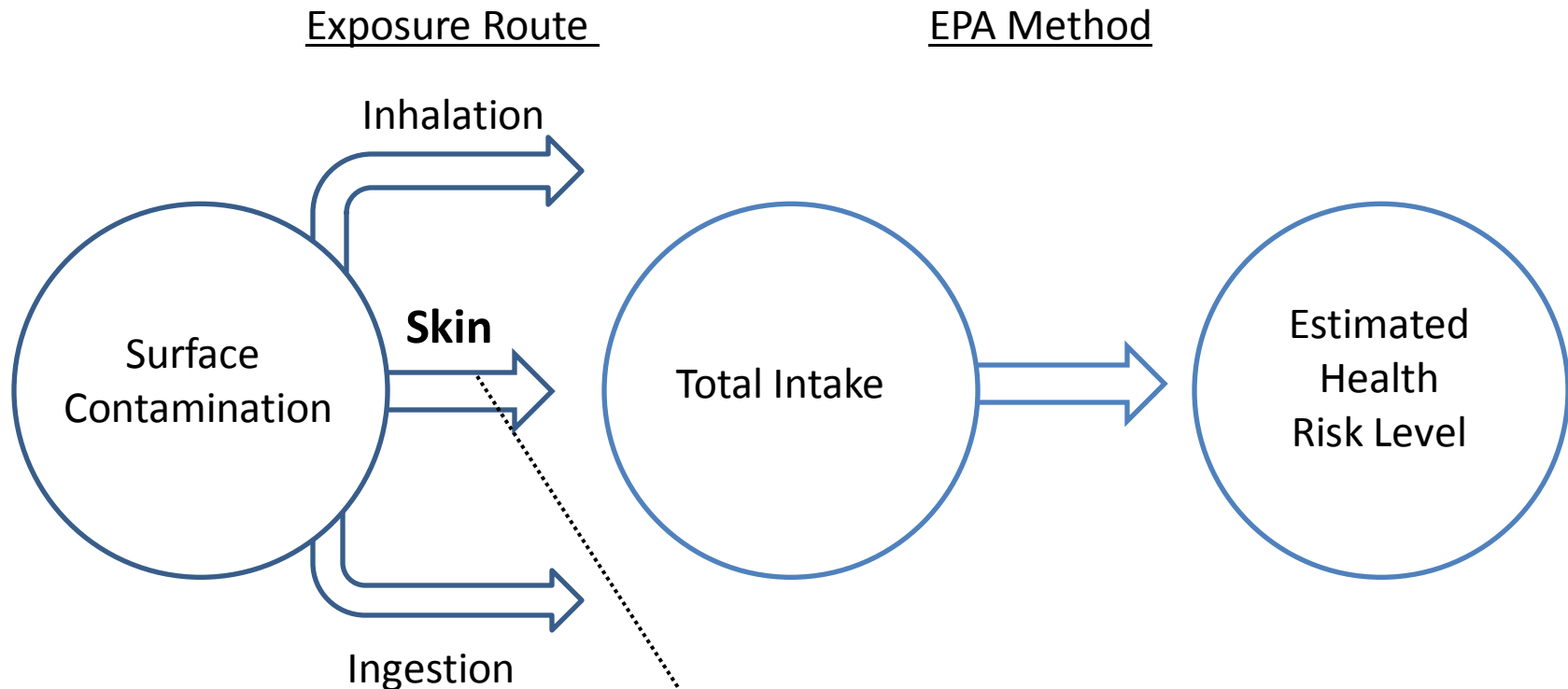
PD_{ingest}	Potential ingestion dose (mg/event)
SA	Exposed skin surface area per event (cm ² /event)
Fd	Fraction exposed skin surface area that actually contacts the surface (unitless)
FT_{ss}	Fraction transferred from surface to the skin (unitless)
C_s	Contaminant surface loading (mg/cm ²)
F_f	Fraction exposed skin area that contacts the mouth (unitless)
FT_{sm}	Fraction substance transferred from the skin to mouth (unitless)





Wipe Sample Interpretation

Exposure Assessment

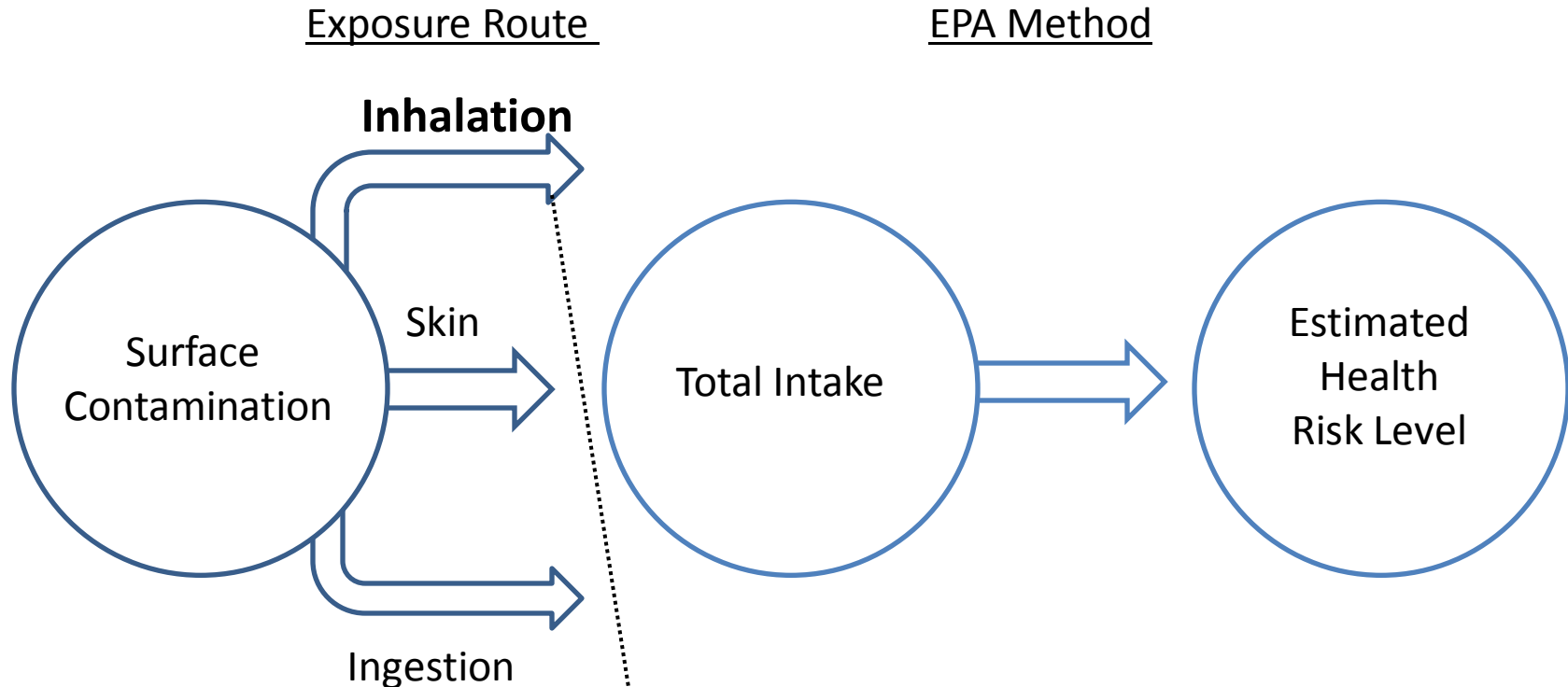


$$ADI_{derm} = \frac{\sum (SA_i \times Fd_i) \times FTss \times Cs \times ABS \times EV_{derm} \times EF \times ED \times 10^{-3}}{BW \times AT}$$



Wipe Sample Interpretation

Exposure Assessment



$$ADI_{inh} = \left(\frac{f_{resp} \times Cs \times 10^4 \times As \times R}{V(\lambda_{dep} \times \lambda_a)} \right) \times \frac{IR_{inh} \times ET \times EF \times ED \times 10^{-3}}{BW \times AT}$$

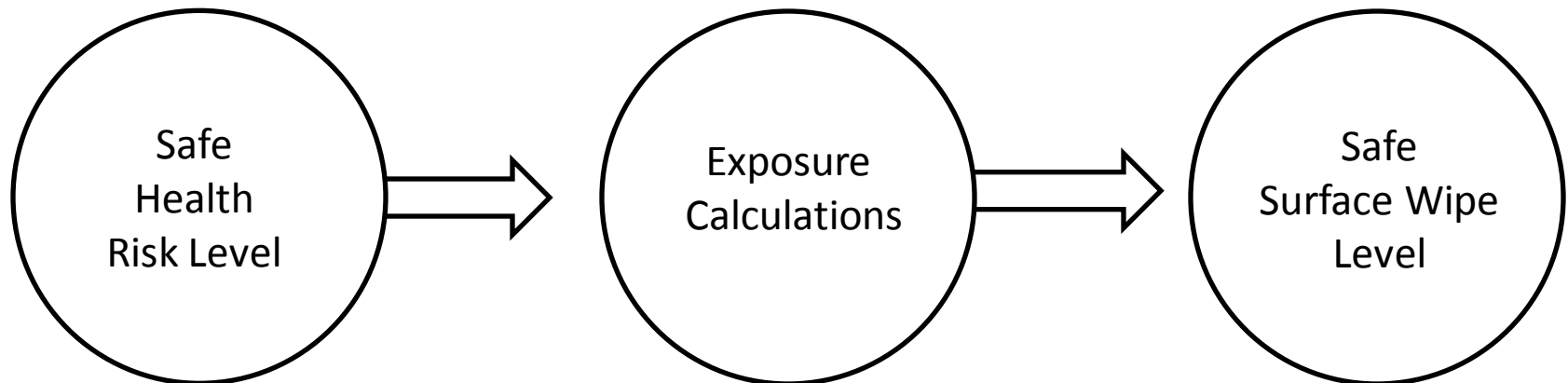
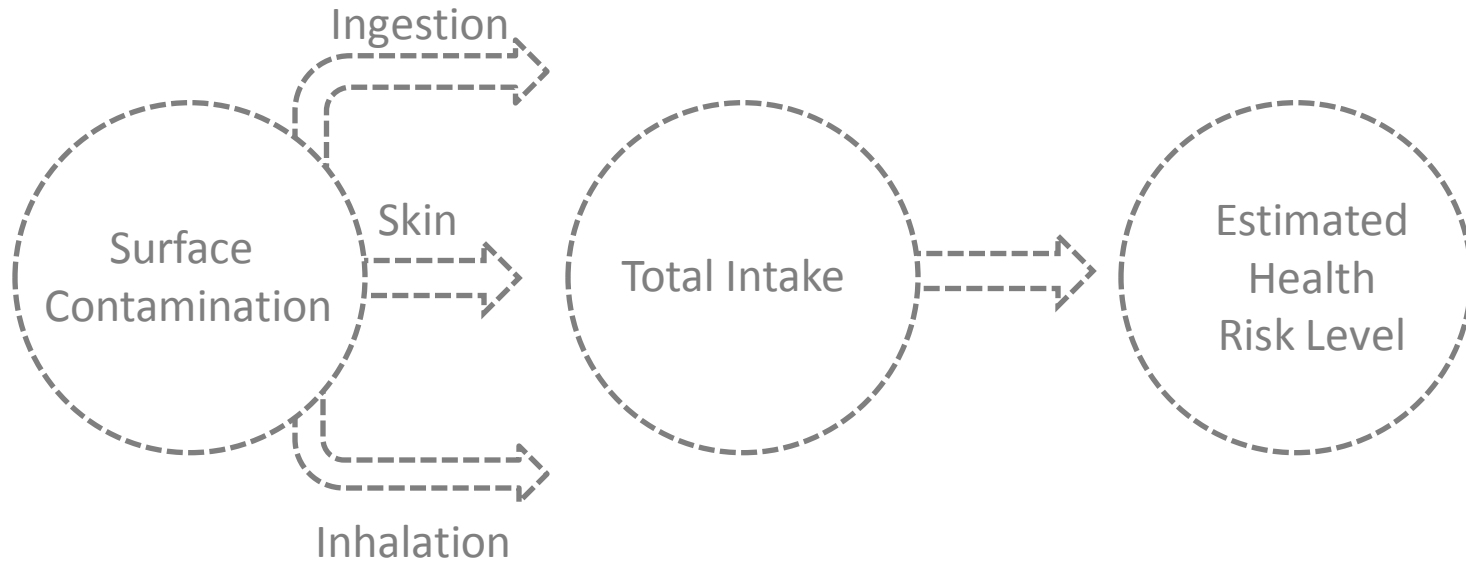


Wipe Sample Interpretation

Safe Wipe Level Calculation

Exposure Route

EPA Method





Wipe Sample Interpretation

Example Comparisons

Substance	Source	Safe level (ug/100 cm ²)
Beryllium	DOE	3 and 0.2
	TG 312	4.7
PCB	TSCA EPA	10
	TG312	1.60 and 9.04
	Michaud et al.	7.5
2,3,7,8 TCDD	EPA WTC	0.00002
	TG312	0.0000354
	Michaud et al.	0.00125





Wipe Sample Interpretation

References

Michaud, et al (1994) "PCB and Dioxin Re-Entry Criteria for Building Surfaces and Air", Journal of Exposure Analysis and Environmental Epidemiology, Vol 4, No. 2.

Contaminants of Potential Concern Committee (2003) "World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks".

USACHPPM, (2009) Technical Guide 312 Health Risk Assessment Methods and Screening Levels for Evaluating Office Worker Exposures to Contaminants on Indoor Surfaces Using Surface Wipe Data.





Wipe Sample Interpretation

References (cont)

Department of Energy, 10 CFR Part 850, Chronic Beryllium Disease Prevention Program; Final Rule

Toxic Substance Control Act, PCB Regulations: 40 CFR Part 761.61, PCB remediation waste.

Nicas, M Et al (2008) “A Study Quantifying the Hand-to-Face Contact Rate and Its Potential Application to Predicting Respiratory Tract Infection”, Journal of Occupational and Environmental Health.





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Backup Slides



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Inhalation of Resuspended Surface Particles

$$C_{air} = \frac{f_{resp} \cdot C_s \cdot 10^4 \cdot A_s \cdot R}{V \cdot \lambda_{dep} + V \cdot \lambda_a}$$

C_{air}	Resuspended air concentration (mg/m ³)
C_s	Contaminant surface loading (mg/cm ²)
f_{resp}	Fraction respirable (unitless)
10^4	Units conversion, cm ² to m ²
A_s	Source area (m ²)
V	Room volume (m ³)
R	Resuspension rate (1/hr)
λ_{dep}	Deposition loss rate (1/hr)
λ_a	Air exchange rate (air changes per hour [ACH])





Direct Dermal Contact

$$PD_{dermal} = \left[\sum_{i=1}^n SA_i \cdot Fd_i \right] \cdot FT_{ss} \cdot C_s$$

PD_{dermal}	Potential dermal dose (mg/event)
SA_i	Exposed skin surface area per event (cm ² /event)
Fd_i	Fraction exposed skin surface area that actually contacts the surface (unitless)
i	Body part in contact with the surface (e.g., hand, forearm)
n	Total number of body parts in contact with the surface
FT_{ss}	Fraction transferred from surface to the skin (unitless)
C_s	Contaminant surface loading (mg/cm ²)

