WIPE SAMPLE INTERPRETATION

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George Murnyak, CIH
USAPHC

Environmental Health Risk Assessment Program
• 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
Background and Scope

• 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
Evolution of Technical Guide 312

- 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
Problem

• 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

<table>
<thead>
<tr>
<th>Health Effects</th>
<th>Human Health</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer risk</td>
<td>ILCR (Incremental Lifetime Cancer Risk)</td>
<td>ILCR = Chemical Intake $\times$ Cancer Slope Factor</td>
</tr>
<tr>
<td>Noncancer</td>
<td>HQ (Hazard Quotient)</td>
<td>HQ = Chemical Intake Reference Dose</td>
</tr>
</tbody>
</table>
Cancer Example

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

\[
7.23E-08 \text{ mg/kg-d} \times 1.5 \text{ (mg/kg-d)}^{-1} = 1.08E-07
\]
example:
A worker incidentally ingests surface water with a calculated intake of 3.66E-07 (mg/kg/day) of thallium

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

HQ = 5.2 E-03
Drinking Water Example

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

Example

- Measure concentration in fish tissue
- Estimate fish consumption
- Concentration x consumption = mg
Wipe Sample Example

- Assume perfect sampling results of 50ug/100 cm²
- How do we use this surface sampling information to estimate intake?
Sampling Scenario
Child Day Care Center
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

Exposure Route
- Inhalation
- Skin
- Ingestion

EPA Method
- Total Intake
- Estimated Health Risk Level

ADI ing = \( \frac{(SA \times Fd \times FTss \times Cs \times Ff \times FTsm \times EVing)}{BW \times AT} \) \( \times EF \times ED \times 10^{-3} \)
Incidental Ingestion (fingers)

\[
PD_{\text{ingest (fingertips)}} = (SA \cdot Fd \cdot FT_{SS} \cdot Cs) \sum (Ff \cdot FT_{SM})
\]

<table>
<thead>
<tr>
<th>PD_{\text{ingest}}</th>
<th>Potential ingestion dose (mg/event)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA</td>
<td>Exposed skin surface area per event (cm(^2)/event)</td>
</tr>
<tr>
<td>Fd</td>
<td>Fraction exposed skin surface area that actually contacts the surface (unitless)</td>
</tr>
<tr>
<td>FT_{SS}</td>
<td>Fraction transferred from surface to the skin (unitless)</td>
</tr>
<tr>
<td>Cs</td>
<td>Contaminant surface loading (mg/cm(^2))</td>
</tr>
<tr>
<td>Ff</td>
<td>Fraction exposed skin area that contacts the mouth (unitless)</td>
</tr>
<tr>
<td>FT_{SM}</td>
<td>Fraction substance transferred from the skin to mouth (unitless)</td>
</tr>
</tbody>
</table>
Wipe Sample Interpretation

Exposure Assessment

Exposure Route

- Inhalation
- Ingestion

Skin

Surface Contamination

Total Intake

EPA Method

Estimated Health Risk Level

\[
\text{ADI derm} = \sum (SA_i \times Fd_i) \times FTss \times Cs \times ABS \times EVderm \times EF \times ED \times 10^{-3} \times \frac{BW \times AT}{BW \times AT}
\]
Wipe Sample Interpretation

Exposure Assessment

Exposure Route

Inhalation

Surface Contamination

Skin

Ingestion

EPA Method

Total Intake

Estimated Health Risk Level

\[
ADI \text{ inh} = \left( \frac{f_{\text{resp}} \times Cs \times 10^4 \times As \times R}{V(\lambda_{\text{dep}} \times \lambda_a)} \right) \times \frac{IR_{\text{inh}} \times ET \times EF \times ED \times 10^{-3}}{BW \times AT}
\]
Wipe Sample Interpretation

Safe Wipe Level Calculation

Exposure Route
- Ingestion
- Skin
- Inhalation

EPA Method

Surface Contamination

Total Intake

Estimated Health Risk Level

Safe Wipe Level Calculation

Safe Health Risk Level

Exposure Calculations

Safe Surface Wipe Level
## Wipe Sample Interpretation

### Example Comparisons

<table>
<thead>
<tr>
<th>Substance</th>
<th>Source</th>
<th>Safe level (ug/100 cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beryllium</td>
<td>DOE</td>
<td>3 and 0.2</td>
</tr>
<tr>
<td></td>
<td>TG 312</td>
<td>4.7</td>
</tr>
<tr>
<td>PCB</td>
<td>TSCA EPA</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>TG312</td>
<td>1.60 and 9.04</td>
</tr>
<tr>
<td></td>
<td>Michaud et al.</td>
<td>7.5</td>
</tr>
<tr>
<td>2,3,7,8 TCDD</td>
<td>EPA WTC</td>
<td>0.00002</td>
</tr>
<tr>
<td></td>
<td>TG312</td>
<td>0.0000354</td>
</tr>
<tr>
<td></td>
<td>Michaud et al.</td>
<td>0.00125</td>
</tr>
</tbody>
</table>
Wipe Sample Interpretation

References


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.

Acknowledgements

• Ms. Hsieng-Ye Chang, MS, JD, PE
  DuPont de Nemours

• Ms. Ronie Shackelford, BA, MA
  USAPHC (Provisional)
Inhalation of Resuspended Surface Particles

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C_{\text{air}})</td>
<td>Resuspended air concentration (mg/m(^3))</td>
</tr>
<tr>
<td>(C_s)</td>
<td>Contaminant surface loading (mg/cm(^2))</td>
</tr>
<tr>
<td>(f_{\text{resp}})</td>
<td>Fraction respirable (unitless)</td>
</tr>
<tr>
<td>(10^4)</td>
<td>Units conversion, cm(^2) to m(^2)</td>
</tr>
<tr>
<td>(A_s)</td>
<td>Source area (m(^2))</td>
</tr>
<tr>
<td>(V)</td>
<td>Room volume (m(^3))</td>
</tr>
<tr>
<td>(R)</td>
<td>Resuspension rate (1/hr)</td>
</tr>
<tr>
<td>(\lambda_{\text{dep}})</td>
<td>Deposition loss rate (1/hr)</td>
</tr>
<tr>
<td>(\lambda_a)</td>
<td>Air exchange rate (air changes per hour [ACH])</td>
</tr>
</tbody>
</table>
Direct Dermal Contact

\[ PD_{\text{dermal}} = \left[ \sum_{i=1}^{n} (SA_i \cdot Fd_i) \right] \cdot FT_{SS} \cdot C_s \]

<table>
<thead>
<tr>
<th><strong>PD_{\text{dermal}}</strong></th>
<th>Potential dermal dose (mg/event)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SA_i</strong></td>
<td>Exposed skin surface area per event (cm(^2)/event)</td>
</tr>
<tr>
<td><strong>Fd_i</strong></td>
<td>Fraction exposed skin surface area that actually contacts the surface (unitless)</td>
</tr>
<tr>
<td><strong>i</strong></td>
<td>Body part in contact with the surface (e.g., hand, forearm)</td>
</tr>
<tr>
<td><strong>n</strong></td>
<td>Total number of body parts in contact with the surface</td>
</tr>
<tr>
<td><strong>FT_{SS}</strong></td>
<td>Fraction transferred from surface to the skin (unitless)</td>
</tr>
<tr>
<td><strong>C_s</strong></td>
<td>Contaminant surface loading (mg/cm(^2))</td>
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