The Changing Landscape of Chemical Toxicity Values and Possible Impacts to DoD Legacy Site Cleanup

Anita K. Meyer DABT
Environmental & Munitions CX
Huntsville Engineering and Support Center

SRA Annual Meeting
Charleston, SC
December 5, 2011
**Report Documentation Page**

**Title:** The Changing Landscape Of Chemical Toxicity Values And Possible Impacts To DoD Legacy Site Cleanup

**Performing Organization:** Environmental & Munitions CX, Huntsville Engineering and Support Center, Huntsville, AL, 35807

**Approved for public release; distribution unlimited**

**Presented at the Emerging Contaminants Program, 2011 Society for Risk Analysis Annual meeting, Charleston, SC, December 4-7, 2011**

**Security Classification:**
- **a. Report:** unclassified
- **b. Abstract:** unclassified
- **c. This Page:** unclassified

**Number of Pages:** 29

---

**Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.**
Emerging Contaminants (ECs)

- Are chemicals or materials of interest that are characterized by:
  - a perceived or real threat to human health or environment, and
  - there is no currently published health standard or there is an existing health standard, but the standard is evolving or being re-evaluated.

DoD’s Scan, Watch, Action Process: Identifying, Prioritizing & Pursuing Risk Management

**Scan**
- Over-the-horizon
- Review literature, periodicals, regulatory communications, etc.

**Watch**
- Possible DoD impacts
- Monitor events; Conduct Phase I qualitative impact assessment; Manage obvious risks.

**Action**
- Probable high DoD impacts
- Conduct Phase II quantitative impact assessment; Develop & rank risk management options (RMOs); Implement approved RMOs; Track implementation and reduce high risks; Revisit list annually for risk reduction

---

Risk Management Options to ECGC
- Approved RMOs become Risk Management Actions (RMAs)

BUILDING STRONG®
Trichloroethylene
Final Sept. 2011

- Kidney cancer in workers
  basis of cancer toxicity values, adjusted to include liver and non-Hodgkins lymphoma
  - Mutagenic mode of action adjustment applicable only for kidney cancer
- Current drinking water regulation of 5 µg/L used for most cleanups

<table>
<thead>
<tr>
<th></th>
<th>Risk-Based Screening Levels*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Res. Water (µg/L)</td>
</tr>
<tr>
<td>Non-Cancer Hazard of 1</td>
<td>3.4</td>
</tr>
<tr>
<td>10⁻⁶ Cancer Risk</td>
<td>0.65</td>
</tr>
</tbody>
</table>

*Using EPA Regional Screening Level Calculator
Tetrachloroethylene

- 1998 initiated
- Nat’l Academy Review Feb 2006
- June 2008 external review version released
- If present, common source was dry cleaning facilities

<table>
<thead>
<tr>
<th>Risk-Based Screening Levels*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Res. Soil (mg/kg)</td>
</tr>
<tr>
<td>Current</td>
</tr>
<tr>
<td>New (draft ‘08)</td>
</tr>
</tbody>
</table>

Sources of current toxicity values include EPA IRIS, ATSDR and CalEPA. Lowest RSL target risk = 10⁻⁶.

*Using EPA Regional Screening Level Calculator
Other Chemicals of DoD Interest Undergoing IRIS Reassessment

- 1,4-Dioxane
- Dioxin
- RDX
- Arsenic
- Benzo(a)pyrene
- Relative potency factors for PAHs
Shooting Trap and Skeet as Gunnery Training Component
Students, Using Shotguns Specially Mounted on Turrets, Learn How to Operate the Turrets as they Fire at Clay Pigeons Released from 40-foot High Towers

*Photos provided by: Kingman Army Airfield Historical Society*
Target Composition

- Clay and binder; ~30% composition is coal tar pitch especially during 1940s
  - Provided the right balance between surviving throw and shattering when hit with shot
- Less toxic and more degradable targets now being manufactured
  - Petroleum pitch, soy etc
    - PAHs ~ 75% lower in petroleum pitch than coal tar pitch
Coal Tar Pitch

- Coal tar pitch is a complex mixture of organic compounds
- Polycyclic aromatic hydrocarbons (PAHs) chemical class of most concern due to toxicity
- Benzo(a)pyrene most studied
  - Carcinogen
- Low soil screening level; 15 µg/kg

Source: EPA Regional Screening Level
Investigation Strategies

- Conceptual Site Model – consider past and subsequent site use
- PAHs in clay pigeons not highly mobile
  - Soil/sediment will be media of primary concern
- Consider ambient sources
  - Roadways
  - Runoff from surface sealant
  - Forensics may add value at some sites
1943 Aerial Photograph showing MRS03 – 15 Skeet Range
Flight paths of different materials resulting from clay target shooting (in meters, 1 m = 3.28 feet).

* ITRC, 2005
Select PAHs from Sampled Areas

mg/kg

BaP
Chrysene
Fluoranthene
Benzo (g,h,i)pery
Benzo(b)fl
Detected PAHs (Low Density Area)
Emerging Contaminant Issue

- Benzo(a)pyrene under reevaluation by EPA IRIS program
  - EPA Science Advisory Board review complete
  - RPF approach retained but updated by new data/science
## Carcinogenic PAHs and Relative Potency Factors

<table>
<thead>
<tr>
<th>Compound</th>
<th>Current RPF</th>
<th>Draft RPF</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzo(a)pyrene</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Benz(a)anthracene</td>
<td>0.1</td>
<td>0.2</td>
<td>2x</td>
</tr>
<tr>
<td>Benzo(b)fluoranthene</td>
<td>0.1</td>
<td>0.8</td>
<td>8x</td>
</tr>
<tr>
<td>Benzo(k)Fluoranthene</td>
<td>0.01</td>
<td>0.03</td>
<td>3x</td>
</tr>
<tr>
<td>Chrysene</td>
<td>0.001</td>
<td>0.1</td>
<td>100x</td>
</tr>
<tr>
<td>Dibenz(a,h)anthracene</td>
<td>1</td>
<td>10</td>
<td>10x</td>
</tr>
<tr>
<td>Indeno(1,2,3-c,d)pyrene</td>
<td>0.1</td>
<td>0.07</td>
<td></td>
</tr>
</tbody>
</table>
Additional PAHs from 2010 RPF Assessment

- Anthanthrene
- Benzo[g,h,i]perylene
- Benzo[j]fluoranthenes
- Cyclopenta[c,d]pyrene
- Dibenzo[a,e]fluoranthenes
- Dibenzo[a,e]pyrene
- Dibenzo[a,h]pyrene
- Dibenzo[a,i]pyrene
- Dibenzo[a,l]pyrene
- Fluoranthene
- Benz[b,c]aceanthrylene
- Benz[e]aceanthrylene
- Benz[j]aceanthrylene (60x)
- Benz[l]aceanthrylene
- Cyclopenta[d,e,f]chrysene
- Naphtho[2,3-e]pyrene
Select PAHs from Sampled Areas

mg/kg

BaP  Chrysene  Fluoranthene  Benzo(g,h,i)pery  Benzo(b)fl

0  20  40  60  80  100  120  140
# Potential Impacts

<table>
<thead>
<tr>
<th>Analyte</th>
<th>High</th>
<th>Med</th>
<th>Low</th>
<th>Current RSL</th>
<th>Draft RSL</th>
<th>$10^{-4}$ RSL</th>
<th>Bkg</th>
</tr>
</thead>
<tbody>
<tr>
<td>BaP</td>
<td>76.4</td>
<td>5.5</td>
<td>1.6</td>
<td>0.015</td>
<td>0.015</td>
<td>1.5</td>
<td>0.014</td>
</tr>
<tr>
<td>Chrysene</td>
<td>77.8</td>
<td>5.9</td>
<td>1.7</td>
<td>15</td>
<td>0.15</td>
<td>15</td>
<td>0.012</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>9.5</td>
<td>6.7</td>
<td>2.6</td>
<td>0.188</td>
<td>18.8</td>
<td>0.018</td>
<td></td>
</tr>
<tr>
<td>Benzo-(g,h,i)perylene</td>
<td>64.4</td>
<td>5</td>
<td>1.5</td>
<td>1.67</td>
<td>167</td>
<td>0.032</td>
<td></td>
</tr>
<tr>
<td>Benzo(b) fluoranthene</td>
<td>128</td>
<td>11.5</td>
<td>3.3</td>
<td>0.15</td>
<td>0.019</td>
<td>1.9</td>
<td>0.027</td>
</tr>
</tbody>
</table>
Investigation Strategies

- Reduce uncertainty in CSM and in risk assessment; better informed decisions
  - Location/size of fragments? Likelihood of exposure?
  - Are risk assessment assumptions valid and representative of exposure?
  - Fragment size
  - Relative bioavailability
Are PAHs bioaccessible and bioavailable in weathered clay targets?
Risk Management Strategies

- Draft plan for relative bioavailability study planned for Formerly Used Defense Site in TX
DoD Funded Project

PAH Bioavailability from Soils—Schematic of Project Tasks

Select soil characteristics to evaluate

Review/confirm exposure pathways of interest and PAH mixtures relevant to DOD sites

Construct research soils (spiked soils)

Soil characterization of PAH—soil interactions
  Characterize PAH “releasable fractions” for different soil characteristics and PAH mixtures
  Characterize stability/permanence of non-bioavailable fraction

Initial physiologically-based extraction testing
  Establish range of anticipated RBA values

Statistical modeling of factors controlling bioaccessibility

Select research substrates for oral (and dermal) research

Feeding studies oral RBA evaluation (2 time points)

Dermal absorption studies (optional)

In vitro method development and validation against feeding studies

Assess potential to support default absorption rates for PAH in soil
Acknowledgments

Brian Jordan - USACE
Glenn Hoeger – Arcadis
Yvette Lowney and
Mike Ruby - Exponent