Assessing Public Health Risks from SRS Air Emissions

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Purpose

• To fulfill a 2016 Facilities Disposition and Site Remediation Committee Work Plan Commitment

• To provide the CAB and public the results from SRS Emissions Modeling performed as recommended by the 2014 Agency for Toxic Substances and Disease Registry (ATSDR) Public Health Assessment (PHA) for Off-Site Air Contamination from the Savannah River Site
Acronyms and Definitions

AERMOD - American Meteorological Society / Environmental Protection Agency Regulatory Model

ATDSR - Agency for Toxic Substances and Disease Registry

Acute toxicity - Adverse effects from a single exposure to a substance over a short period of time (usually less than 24 hours).

Chronic toxicity - Adverse affects caused by long-term exposure to a substance (months or years).

Carcinogen - Any substance capable of causing cancer in living tissue.

CREG - Cancer risk exposure guideline. Airborne concentration of a substance that is highly unlikely to result in an increase in cancer rates in the exposed population.

IUR - Inhalation unit risk. Estimate of the increased cancer risk from an individual’s continuous inhalation exposure to a 1 mg/m³ concentration of the chemical substance over a lifetime.

LOAEL - Lowest observable adverse effects level.

NOAEL - No observable adverse effects level.

RfC - Inhalation reference concentration. Estimated airborne concentration of a chemical for which continuous inhalation exposure is likely to be without risk of deleterious non-cancer effects over a lifetime.

SCDHEC - South Carolina Department of Health and Environmental Control

TCE - Trichloroethylene
SRNL Atmospheric Technologies Group Overview

• Comprehensive meteorological monitoring program, supporting:
  - Real-time emergency response.
  - Long-term data sets used in environmental impacts studies and design safety.
  - Safe facility operations.

• Modeling releases of air and waterborne contaminants
  - ATG’s WIND System for emergency response.
  - International non-proliferation emissions attribution.

• Applied Studies
  - Weather forecasting for operations planning, severe weather response, wildfire management.
  - Occurrence frequencies of extreme weather events for nuclear facility design.
  - Air quality modeling for regulatory compliance, i.e., DHEC air permits applications, and workplace chemical exposures.
Three primary findings from the 2014 CDC Agency for Toxic Substances and Disease Registry (ATSDR) Evaluation of Off-Site Air Contamination from SRS:

- Emissions of radioactivity and criteria air pollutants (SO2, CO, NOx, PM, ozone, and lead) were unlikely to cause adverse health effects in the general population.

- There was insufficient data to evaluate non-cancer effects from trichloroethylene (TCE) emissions
  - **Recommendation:** short & long term air modeling based on actual emissions

- There was insufficient data to evaluate cancer effects from emissions of toxic air pollutants (i.e., SCDHEC Standard 8 pollutants).
  - **Recommendation:** long term modeling for all carcinogens on site
Background: Toxicity

- **Toxicity**: acute/chronic, cancer/non-cancer
  - For TCE we assess both acute and chronic exposure for non-cancer effects
  - For all others, only chronic exposure posing a cancer risk is examined

- Guidelines for sensitive groups

**Toxicity Testing, Epidemiological Studies** → **Effects levels: NOAEL, LOAEL** → **Exposure Concentration Thresholds: MRL, Rfc, CREG** → **RISK?**
Risk Analysis: Chronic Exposure

- Reference concentration (RfC) for non-cancer health effects = NOAEL/UF x MF
- Inhalation unit cancer risk factor (IUR) for cancer effects - extrapolated from testing.
- Cancer risk evaluation guide (CREG) a cancer screening level = 1 x 10^{-6}/IUR
- Increased Cancer Risk = Air concentration (µg/m³) x IUR

**Target risk**: 1.0 x 10^{-6} = 0.000001
or, 1 excess cancer per one million people

**Current baseline values:**
- National: 5.0 x 10^{-5}
- South Carolina: 4.2 x 10^{-5}
- Aiken County: 4.8 x 10^{-5}

**Assumes a** 70 year lifetime exposure

*Note that the ATSDR considers a risk of 1.0 x 10^{-4} (one in 10,000 people) as unlikely to produce a health concern*
Pollutant Screening Process

- SRS emits 43 of 256 SCDHEC Standard 8 Toxic Pollutants
  - 18 are listed by EPA carcinogens including TCE

1. **24 hr max**: Title V modeling max permitted emissions (SRNL-L2200-2014-00006)

2. Estimate annual max: \( C_{\text{annual}} = C_{24\text{hr}} \cdot (8760/24)^{-0.3} \)

3. Compare to RfC, CREG

4. If either is within 50% of RfC, select for modeling using actual emissions

5. If annual max > CREG, calculate risk

6. If risk > $10^{-6}$, select for modeling using actual emissions
## Screening Results

<table>
<thead>
<tr>
<th>Chemical</th>
<th>No. Sources</th>
<th>Title V 24 hr Max (µg/m³)</th>
<th>Estimated Annual Max (µg/m³)*</th>
<th>RfC (µg/m³)</th>
<th>CREG (µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Tetrachloride (CCl₄)</td>
<td>20</td>
<td>11.3</td>
<td>2.28</td>
<td>100</td>
<td>0.167</td>
</tr>
<tr>
<td>Chloroform</td>
<td>6</td>
<td>44.6</td>
<td>9.34</td>
<td>100</td>
<td>0.0435</td>
</tr>
<tr>
<td>Chromium (Cr) Compounds</td>
<td>2</td>
<td>0.0145</td>
<td>0.00142</td>
<td>0.008</td>
<td>8.33x10⁻⁵</td>
</tr>
<tr>
<td>1,1-Dichloroethylene</td>
<td>3</td>
<td>7.50</td>
<td>1.50</td>
<td>200</td>
<td>0.02</td>
</tr>
<tr>
<td>Manganese (Mn) Compounds</td>
<td>5</td>
<td>0.0254</td>
<td>0.0246</td>
<td>0.05</td>
<td>-</td>
</tr>
<tr>
<td>Tetrachloroethylene (PCE)</td>
<td>53</td>
<td>1320</td>
<td>284</td>
<td>40</td>
<td>3.85</td>
</tr>
<tr>
<td>Trichloroethylene (TCE)</td>
<td>62</td>
<td>315</td>
<td>68</td>
<td>2</td>
<td>0.244</td>
</tr>
</tbody>
</table>

*estimated
Air Dispersion Modeling: AERMOD

- **EPA** model recommended for regulatory air quality applications
- Pollutant diffusion as a Gaussian process using hourly meteorological data (wind, **turbulence**, temperature, boundary layer)
- Processors for topography, met data, buildings
- **Flexible configuration**
  - Multiple emission sources
  - Averaging times: 1hr – **annual**
  - Plume rise due to momentum and buoyancy
  - Elevated **receptor** grid arrays
  - Transport & dispersion around buildings
Data Collection & Model Setup

- 7 toxics exceed screening guidelines using **maximum permitted** modeling data
- **Actual emissions** modeled with corresponding annual met data
- **2002-2010** meteorology from SRS Central Climatology Site and National Weather Service
- 1344 **boundary receptors**
- Max emissions years modeled for most recent 5 years of weather
- **Assume** continuous emissions

Source: SRNL ATG
Results: Non-Cancer Impacts from TCE

- **24 hr** Maxima consistently > RfC, but less than EPA’s LOAEL of 21 µg/m³
- Annual Max > RfC in **2006 only**

![Graph showing TCE concentration over years](image)

Emissions plateau upon reduction of source term from remediation projects
Results: Carcinogens

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Daily Max (µg m⁻³)</th>
<th>Annual Max (µg m⁻³)</th>
<th>Increased Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon tetrachloride</td>
<td>1.1</td>
<td>0.030</td>
<td>1.8 x 10⁻⁷</td>
</tr>
<tr>
<td>Chloroform</td>
<td>0.063</td>
<td>0.0089</td>
<td>1.6 x 10⁻⁷</td>
</tr>
<tr>
<td>Chromium</td>
<td>0.005</td>
<td>0.00025</td>
<td>3.0 x 10⁻⁶</td>
</tr>
<tr>
<td>1,1-Dichloroethylene</td>
<td>0.044</td>
<td>0.0034</td>
<td>1.7 x 10⁻⁷</td>
</tr>
<tr>
<td>PCE</td>
<td>52</td>
<td>7.9</td>
<td>2.1 x 10⁻⁶</td>
</tr>
<tr>
<td>TCE</td>
<td>16</td>
<td>2.7</td>
<td>1.1 x 10⁻⁵</td>
</tr>
</tbody>
</table>

- **Chromium compounds**
  - Maximum excess cancer risk associated with 2006 emissions
  - No screening level exceedances since

- **Trichloroethylene (TCE)**
  - 2002 through 2010: annual max > CREG
  - Maximum risk in 2006
  - No other years with > 10⁻⁶ risk

Total Excess Cancer Risk = 1.4 x 10⁻⁵

This value is less than the national average risk of 5.0 x 10⁻⁵
Conclusions

TCE (non-cancer)

- **Chronic** impacts unlikely: Annual maximum concentrations < RfC.
- **Acute** impacts unlikely: 24-hr maximum > RfC, but < EPA’s LOAEL and all occupational standards.

Carcinogens

- Target Risk \((10^{-6})\) < **Total Risk** < National Average \(5 \times 10^{-5}\)
- ASTDR considers risks less than \(10^{-4}\) as unlikely to pose a health concern.
- Emissions of compounds of concern have decreased upon reduction of source term from remediation projects.
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