Objective

♦ Identify credible scenarios

Purpose

♦ Select likely Toxic Industrial Chemicals (TIC) and Chemical Warfare Agents (CWA) of use. Estimate vapor challenge levels

Why

♦ To establish rationale and reasonable/supportable test standards for NIOSH to certify performance of vendor respirators
Reports/Articles Reviewed: 34

Findings

90% of reports are non-specific regarding:

- Scenario
- Venue
- Intent of incident
- Probable dissemination devices
- Type of material dispersed
SCENARIOS CONSIDERED

- **Indoors**
  - Public Meeting Area
  - Entertainment Centers
  - Transportation Nodes
  - Public Office Building

- **Outdoors**
  - Town Center
  - Open-Air Stadium
  - Boardwalk at Beach
Selection Criteria:

- Toxicity and quantity required for desired effect
- Acquisition ease and availability of compound
- Dissemination properties and suitability for dispersion
- Handling requirements and transportability to proposed incident site
<table>
<thead>
<tr>
<th>Compound</th>
<th>LCT50 (mg-min/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VX</td>
<td>10</td>
</tr>
<tr>
<td>Soman (GD)</td>
<td>50</td>
</tr>
<tr>
<td>Sarin (GB)</td>
<td>100</td>
</tr>
<tr>
<td>Sulfur Mustard (HD)</td>
<td>1500</td>
</tr>
<tr>
<td>Hydrogen Cyanide (AC)</td>
<td>2500</td>
</tr>
<tr>
<td>Phosgene</td>
<td>3200</td>
</tr>
<tr>
<td>Methyl Isocyanate</td>
<td>&gt;4600</td>
</tr>
</tbody>
</table>
### Relative Inhalation Toxicities

**LCT50 (mg-min/m³) (Cont)**

<table>
<thead>
<tr>
<th>Substance</th>
<th>LCT50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarin (GB)</td>
<td>100</td>
</tr>
<tr>
<td>Cyanogen Chloride (CK)</td>
<td>11,000</td>
</tr>
<tr>
<td>Hydrogen Sulfide</td>
<td>25,000</td>
</tr>
<tr>
<td>Chlorine</td>
<td>35,000</td>
</tr>
<tr>
<td>Bromine</td>
<td>45,000</td>
</tr>
<tr>
<td>Ethylene Oxide</td>
<td>420,000</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>~700,000</td>
</tr>
</tbody>
</table>
Indoor Scenario Complexities

- Building Structure
- Compartmentalization
- Ventilation Characteristics
- Source Type and Location
- Remediation Techniques
Specific Incident
- Venue Description
- Source Term
  - Chemicals of Interest
  - Quantity of Chemical Released
  - Dissemination Method
Ventilation Kinetics

Positive Pressure Ventilation

HVAC System

Collective Protection

Natural Ventilation

Spill

Vapor Deposition

\( C_0 \)

\( Z \)

\( H \)

\( C_i \)
InDeVap Agent Profile

Typical Spray Release

- Natural Ventilation
- Positive Pressure Fan Remediation Method

Concentration (mg/m³) vs. Time (minutes)

10 Minute Spray Release

[Graph showing concentration over time for different remediation methods.]
Venues Considered

- Large Meeting Room
- Auditorium/Theater
- Office Building
- Airport Concourse
- Shopping Mall Store
- Shopping Mall Food Court
<table>
<thead>
<tr>
<th>Container</th>
<th>Method</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottle</td>
<td>Spill</td>
<td>1 Liter</td>
</tr>
<tr>
<td>Bottle</td>
<td>Spray</td>
<td>0.5-1 Liter</td>
</tr>
<tr>
<td>Bottle</td>
<td>Explosive</td>
<td>1-10 Liter</td>
</tr>
<tr>
<td>Knapsack</td>
<td>Explosive</td>
<td>25 lbs</td>
</tr>
<tr>
<td>Pull Luggage</td>
<td>Explosive</td>
<td>50 lbs</td>
</tr>
<tr>
<td>Luggage Cart</td>
<td>Explosive</td>
<td>200 lbs</td>
</tr>
</tbody>
</table>
GB - 1 Liter spill
room size: 68' x 51' x 11'

mg/m³

minutes

With AC
No AC
GB - 1 Liter pre-val spray, 2 minute discharge; room size: 68' x 51' x 11'
Concentration after 30 Minutes
1 liter, Meeting Room 1

- AC on
- AC off
- Spill
- Spray
- Explosive

Concentration values are as follows:
- AC on
  - Spill: 0
  - Spray: 300
  - Explosive: 400
- AC off
  - Spill: 100
  - Spray: 800
  - Explosive: 900
GB - 11.35 Liter explosive

room size: 68' x 51' x 11' with 3500 CFM AC
GB - 11.35 Liter explosive
room size: 128' x 160' x 33' with 9100 CFM AC
Practically any vapor concentration level is possible to achieve

Concentration-time profiles are situation dependent

Ventilation kinetics of facility critical

Concentration levels can exceed IDLH values for long times [IDLH = 0.1 mg/m3 for GB]
<table>
<thead>
<tr>
<th>Venue</th>
<th>Hazard</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Setting (Times Square)</td>
<td>Sarin (GB)</td>
<td>Knapsack (Explosive)</td>
</tr>
<tr>
<td>Open-Air Stadium</td>
<td>Nerve (VX)</td>
<td>Sprayer (Upper Deck)</td>
</tr>
<tr>
<td>Boardwalk At Beach</td>
<td>Mustard (HD)</td>
<td>Cropduster (Aircraft Spray)</td>
</tr>
</tbody>
</table>
### Outdoor

<table>
<thead>
<tr>
<th>Container</th>
<th>Method</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottle (GB)</td>
<td>Spill</td>
<td>5-55 Gallons</td>
</tr>
<tr>
<td>Bottle (VX)</td>
<td>Spray</td>
<td>0.5-1 Liter</td>
</tr>
<tr>
<td>Knapsack (VX)</td>
<td>Spray</td>
<td>25 Lbs</td>
</tr>
<tr>
<td>Knapsack (GB)</td>
<td>Explosive</td>
<td>25 Lbs</td>
</tr>
<tr>
<td>Cropduster (HD)</td>
<td>Spray</td>
<td>~1000 Liters</td>
</tr>
</tbody>
</table>
**Visual Comparison:**

**2000 Emergency Response Guidebook vs. Model Predictions of D2PCw (EMIS ver. 3.1)**

5 gallon GB spill, Stability ‘C’, Wind Speed 2mps

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1. Initial Isolation Zone: 155 meters
2. Daytime Protection Zone: 1,600 meters
3. Nighttime Protection Zone: 3,400 meters
4. Modeled Hazard: 635 meters (to no effects level)

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**Accumulated Dosage Values at ERG Zone Distances:**

<table>
<thead>
<tr>
<th>Zone</th>
<th>Dosage (mg-min/m³)</th>
<th>Cloud Arrival Time (min)</th>
<th>Cloud End Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation</td>
<td>6.669e+00</td>
<td>0.9</td>
<td>62</td>
</tr>
<tr>
<td>Day Protect</td>
<td>Less than Minimal</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Night Protect</td>
<td>Less than Minimal</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
**Visual Comparison:**

**2000 Emergency Response Guidebook vs. Model Predictions of D2PCw (EMIS ver. 3.1)**

55 gallon GB spill, Stability ‘C’, Wind Speed 2mps

1. Initial Isolation Zone: 155 meters
2. Daytime Protection Zone: 1,600 meters
3. Nighttime Protection Zone: 3,400 meters
4. Modeled Hazard: 1,976 meters (to minimal effects level)

Accumulated Dosage Values at ERG Zone Distances:

<table>
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<tr>
<th>Zone</th>
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<tr>
<td>Isolation</td>
<td>5.582e+01</td>
<td>0.9</td>
<td>62</td>
</tr>
<tr>
<td>Day Protect</td>
<td>7.336e-01</td>
<td>9.8</td>
<td>77</td>
</tr>
<tr>
<td>Night Protect</td>
<td>Less than Minimal</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

- > 1% Lethal Dose (max extent: 402 meters) (10 mg-min/m³)
- > No Deaths Dose (max extent: 528 meters) (6 mg-min/m³)
- > No Effects Dose (max extent: 1,976 meters) (0.5 mg-min/m³)
Observations: Outdoor Scenarios

- Large areas involved
- Meteorology dependent
Vulnerability Assessment Factors Involve
- Delivery Methods
- Toxicology
- Concentration Challenge
- Protectability

Toxicities of TIC and CWA Span Orders of Magnitude in Values

Challenge Levels are Venue Specific
Comments Requested

- Alternative Scenario Suggestions

- Hot Zone Entry/Exit Times for Responders (Police, HAZMAT, Firefighters, Cleanup Crews, Others)