

VULNERABILITY ASSESSMENT - EXPOSURE LIMITS

Respirator Standards
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Art Stuempfle
OptiMetrics, Inc.



Objective

- ◆ Identify credible scenarios



Purpose

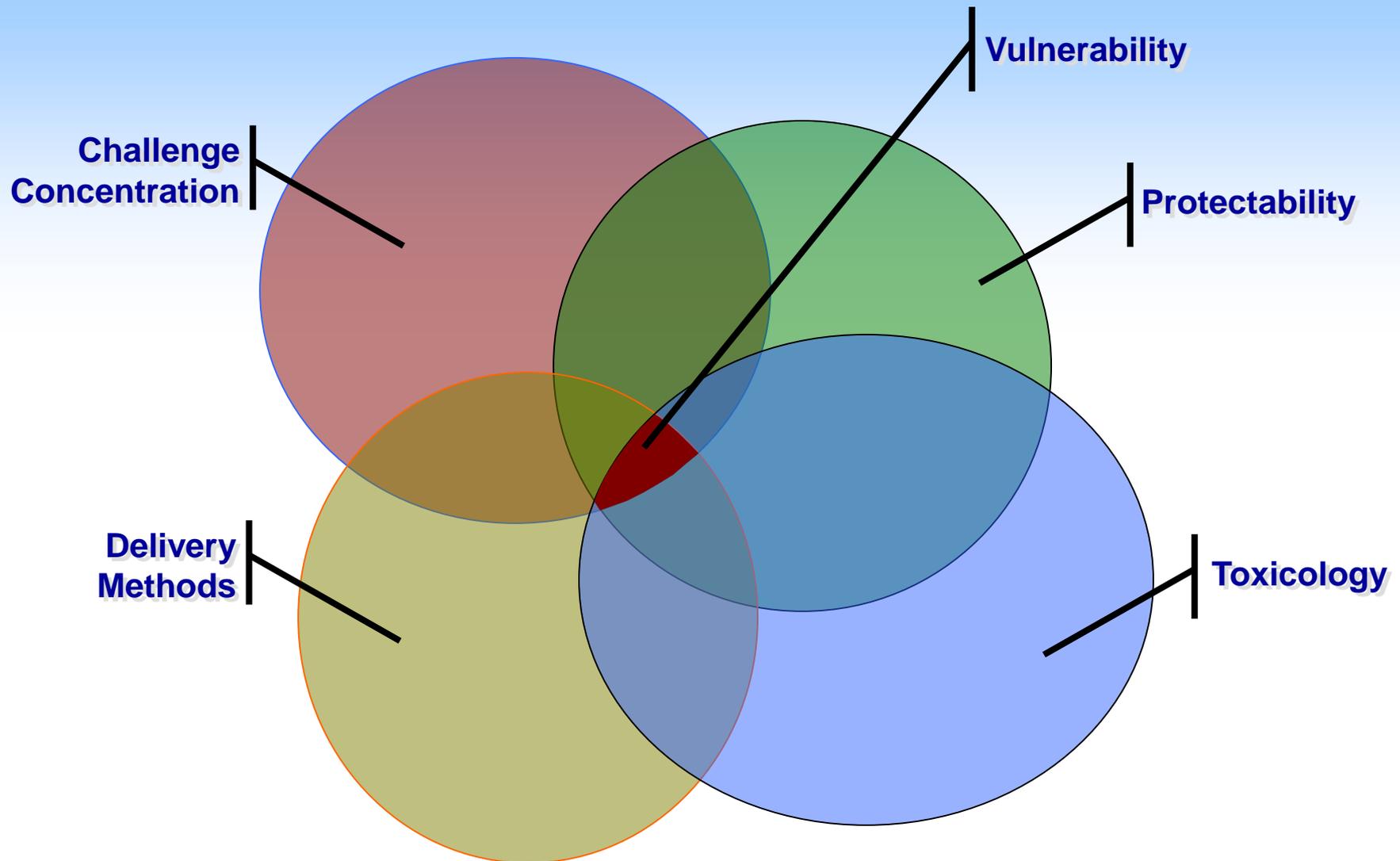
- ◆ Select likely Toxic Industrial Chemicals (TIC) and Chemical Warfare Agents (CWA) of use. Estimate vapor challenge levels



Why

- ◆ To establish rationale and reasonable/supportable test standards for NIOSH to certify performance of vendor respirators

VULNERABILITY ASSESSMENT



- ◆ **Reports/Articles Reviewed: 34**
- ◆ **Findings**
 - ◆ **90% of reports are non-specific regarding:**
 - ◆ **Scenario**
 - ◆ **Venue**
 - ◆ **Intent of incident**
 - ◆ **Probable dissemination devices**
 - ◆ **Type of material dispersed**

- ◆ 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

RELATIVE INHALATION TOXICITIES LCT50 (MG-MIN/M³)



VX	10
Soman (GD)	50
Sarin (GB)	100
Sulfur Mustard (HD)	1500
Hydrogen Cyanide (AC)	2500
Phosgene	3200
Methyl Isocyanate	>4600

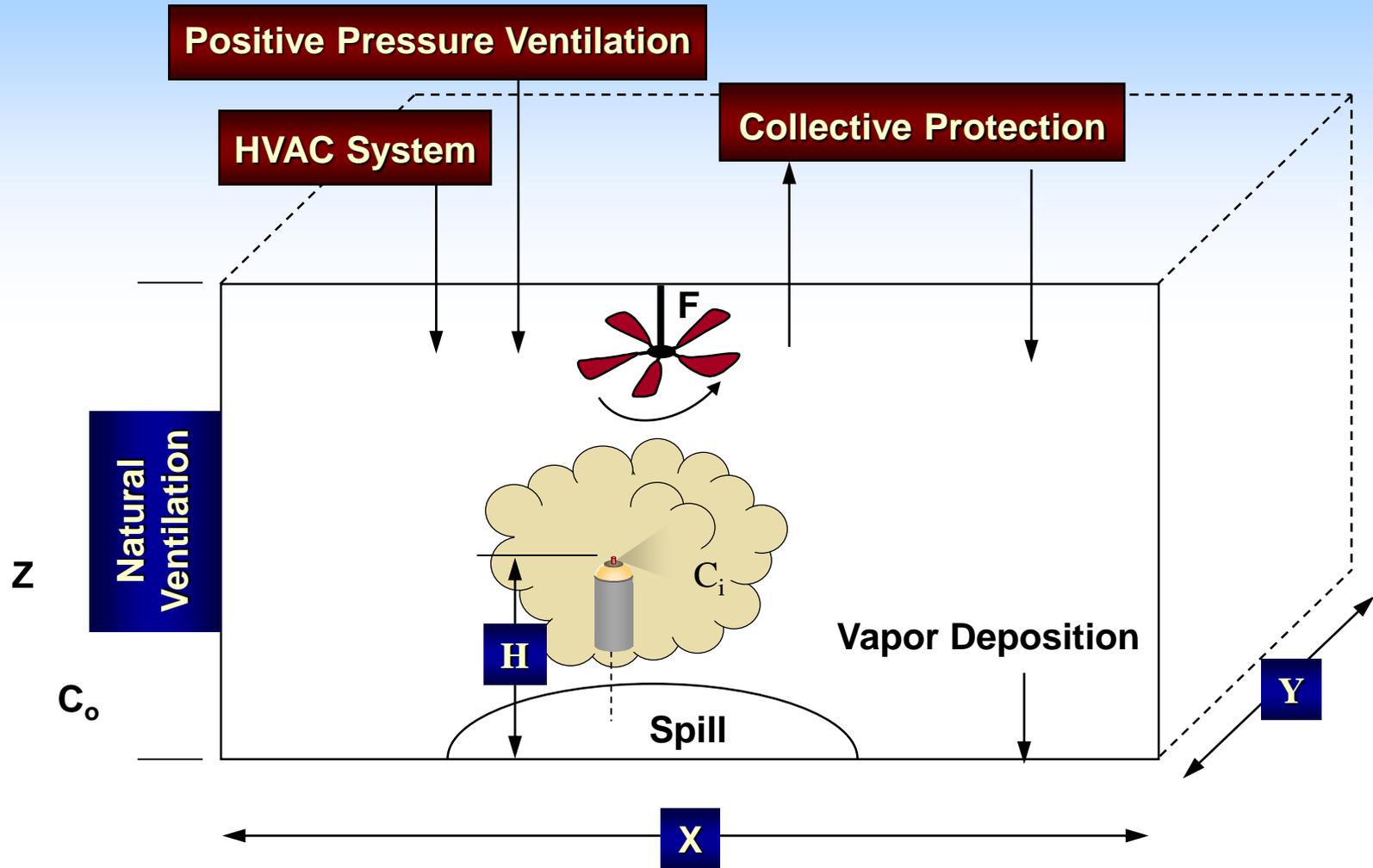
RELATIVE INHALATION TOXICITIES LCT50 (MG-MIN/M³) (CONT)



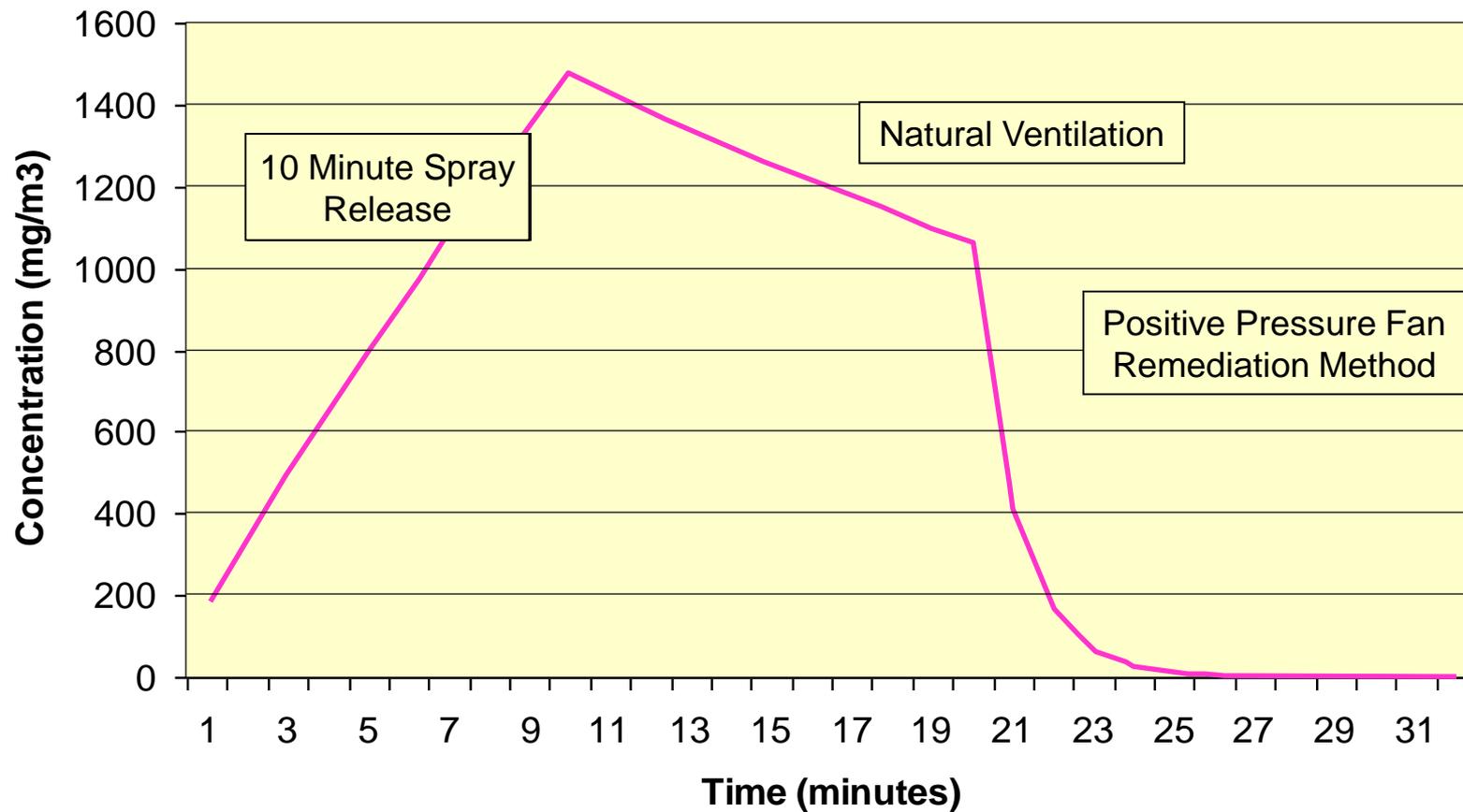
Sarin (GB)	100
Cyanogen Chloride (CK)	11,000
Hydrogen Sulfide	25,000
Chlorine	35,000
Bromine	45,000
Ethylene Oxide	420,000
Carbon Monoxide	~700,000

- ◆ **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**



Typical Spray Release

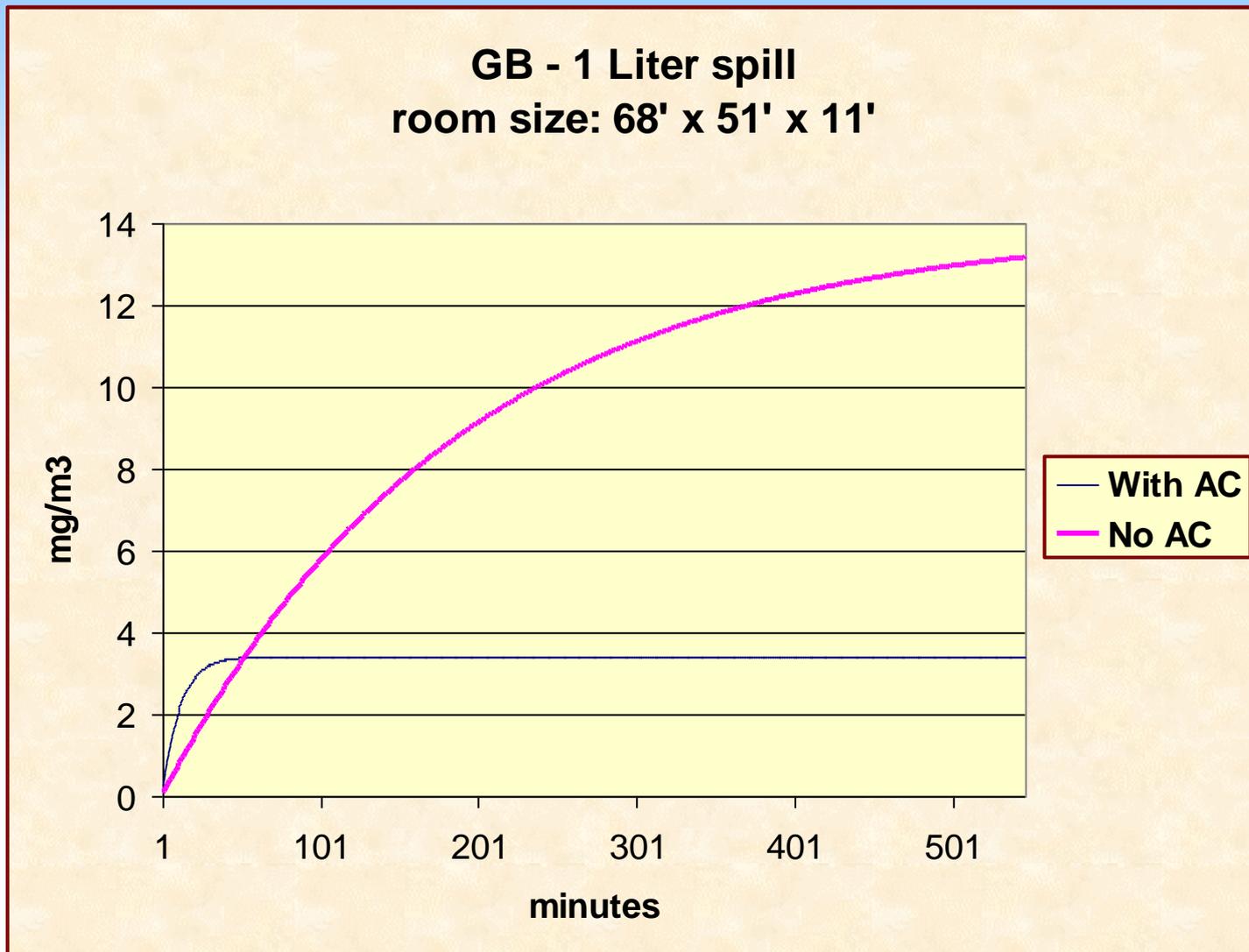


- ◆ **Large Meeting Room**
- ◆ Auditorium/Theater
- ◆ Office Building
- ◆ **Airport Concourse**
- ◆ Shopping Mall Store
- ◆ Shopping Mall Food Court

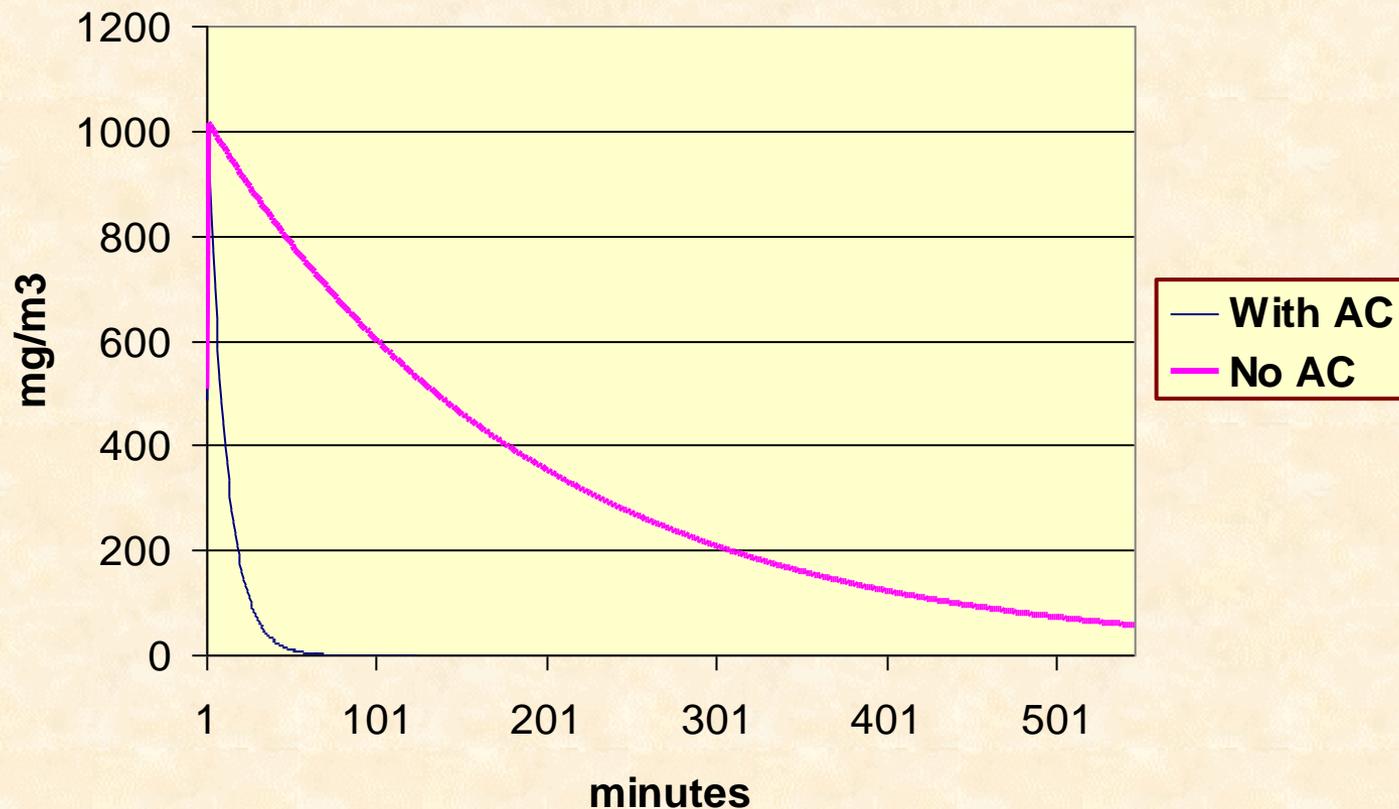
Indoor

<u>Container</u>	<u>Method</u>	<u>Amount</u>
Bottle	Spill	1 Liter
Bottle	Spray	0.5-1 Liter
Bottle	Explosive	1-10 Liter
Knapsack	Explosive	25 lbs
Pull Luggage	Explosive	50 lbs
Luggage Cart	Explosive	200 lbs

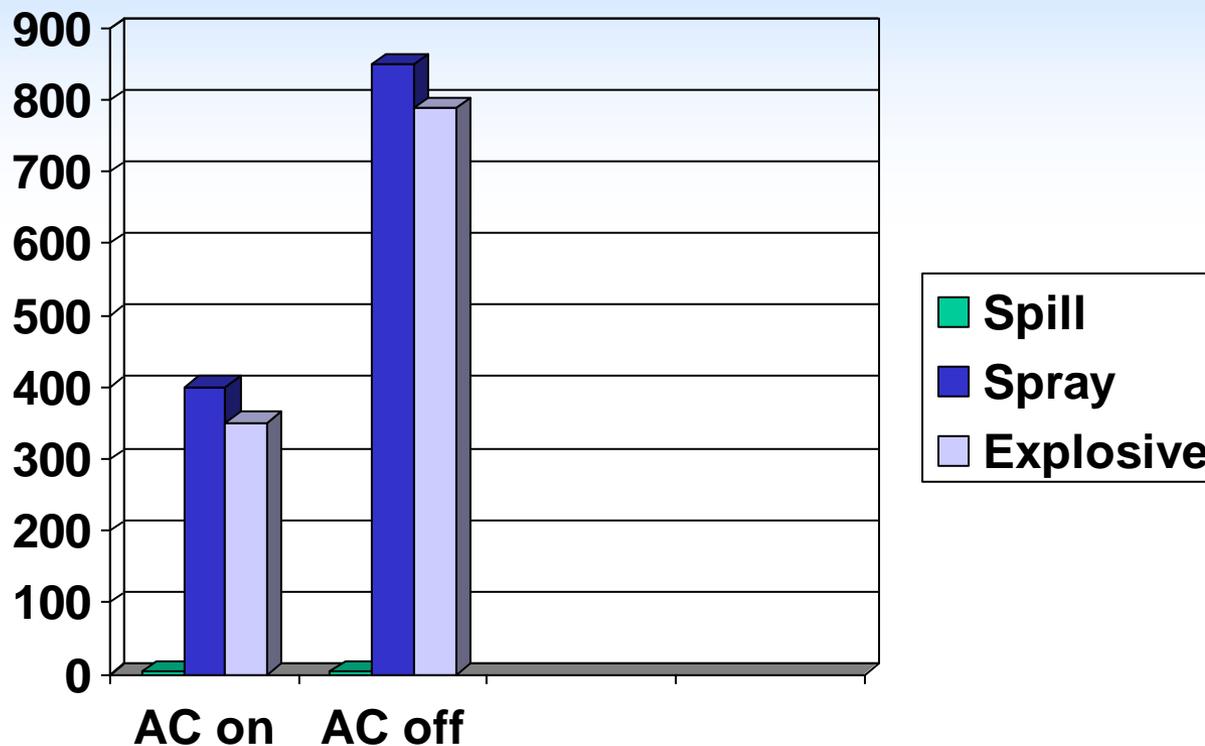
GB - 1 Liter spill room size: 68' x 51' x 11'



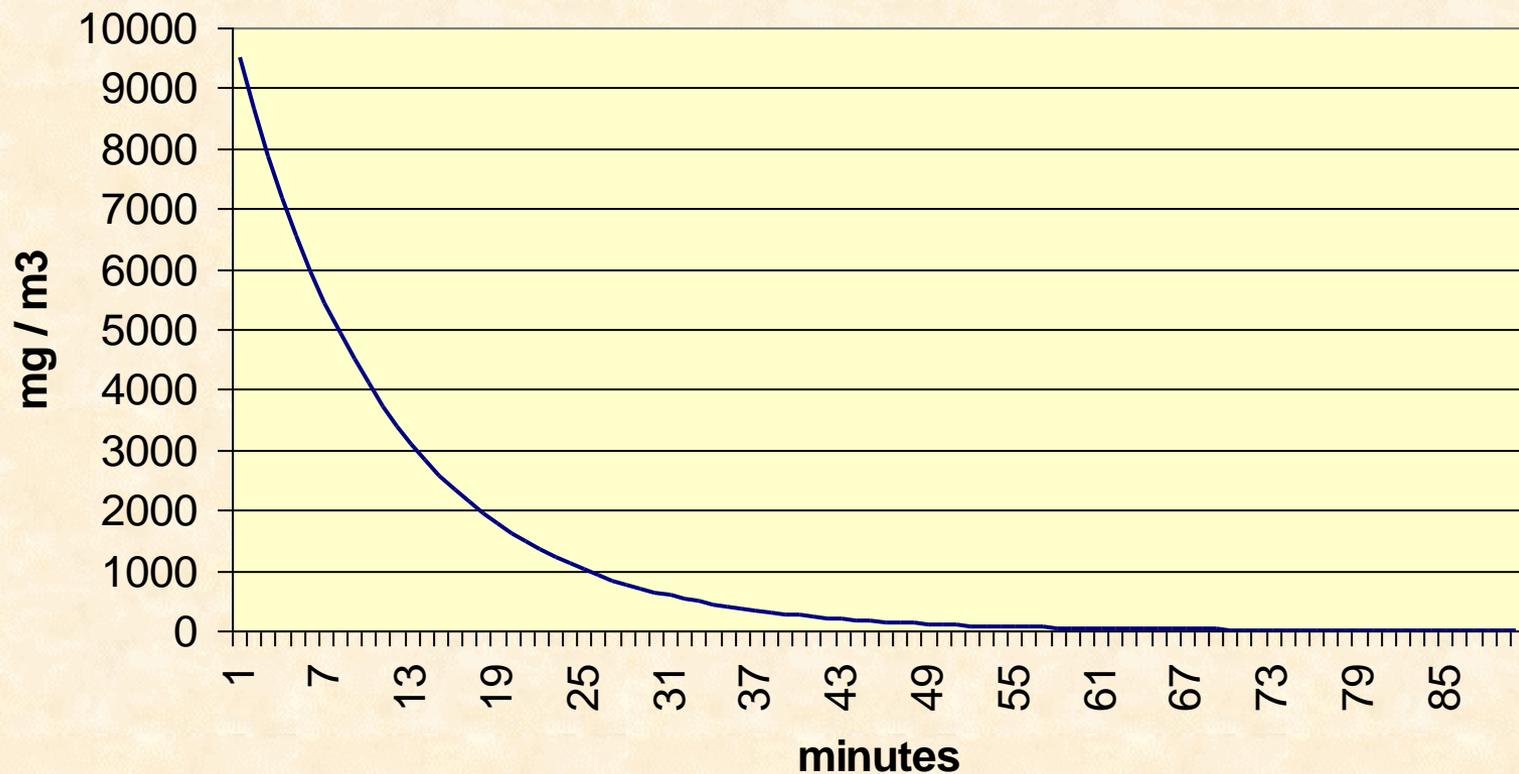
GB - 1 Liter pre-val spray, 2 minute discharge; room size: 68' x 51' x 11'



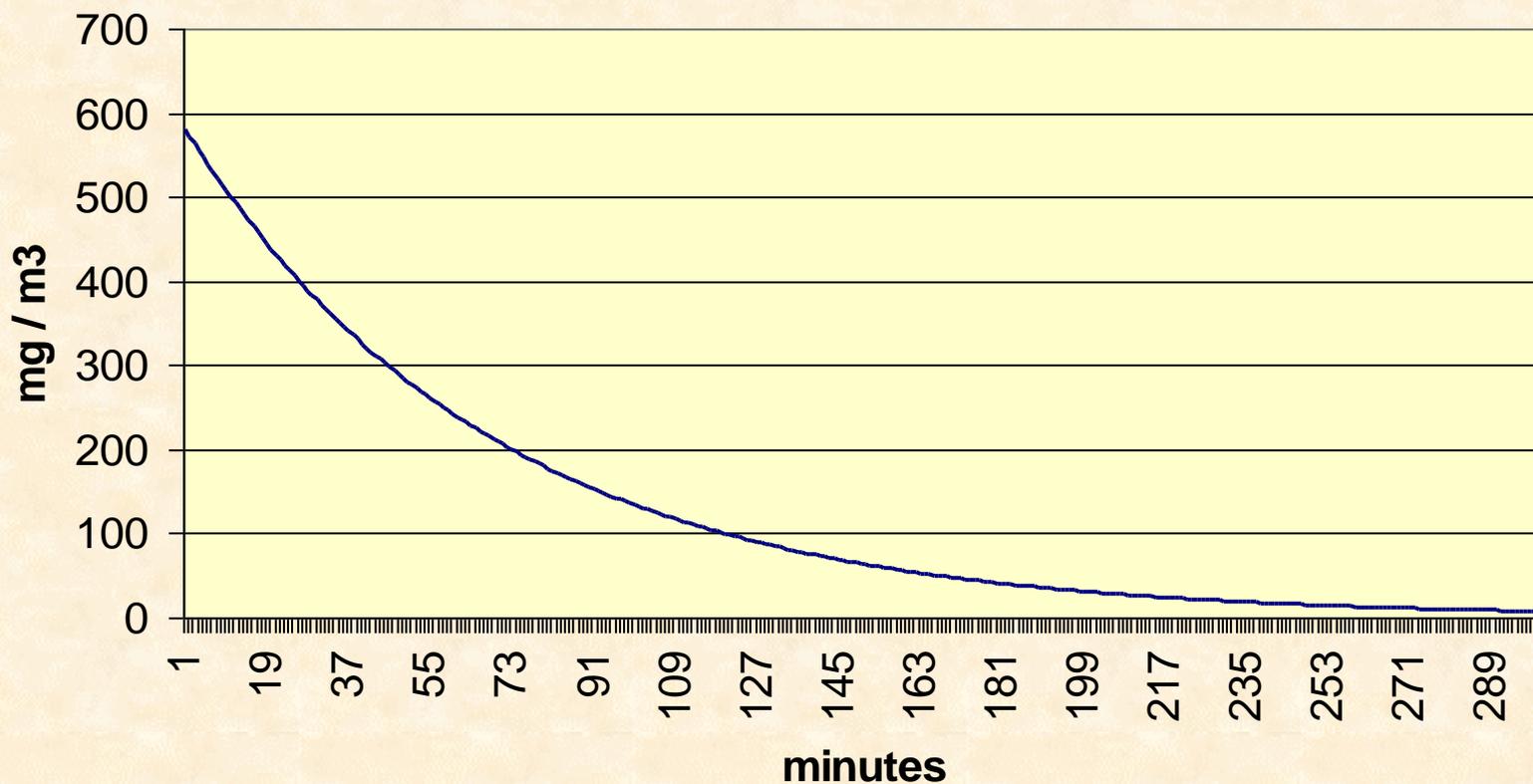
Concentration after 30 Minutes 1 liter, Meeting Room 1



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]**

<u>Venue</u>	<u>Hazard</u>	<u>Source</u>
Urban Setting (Times Square)	Sarin (GB)	Knapsack (Explosive)
Open-Air Stadium	Nerve (VX)	Sprayer (Upper Deck)
Boardwalk At Beach	Mustard (HD)	Cropduster (Aircraft Spray)

Outdoor

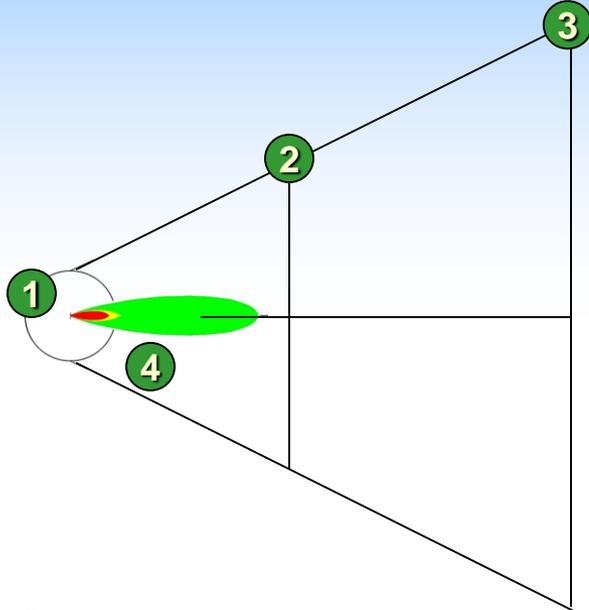
<u>Container</u>	<u>Method</u>	<u>Amount</u>
Bottle (GB)	Spill	5-55 Gallons
Bottle (VX)	Spray	0.5-1 Liter
Knapsack (VX)	Spray	25 Lbs
Knapsack (GB)	Explosive	25 Lbs
Cropduster (HD)	Spray	~1000 Liters

2000 EMERGENCY RESPONSE GUIDEBOOK

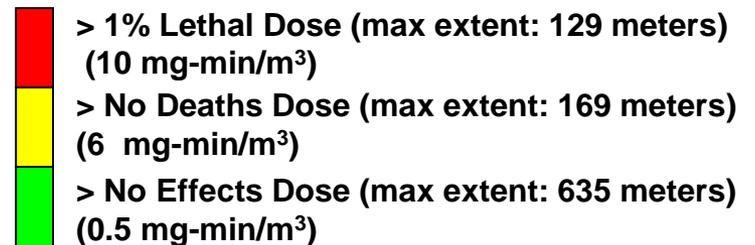
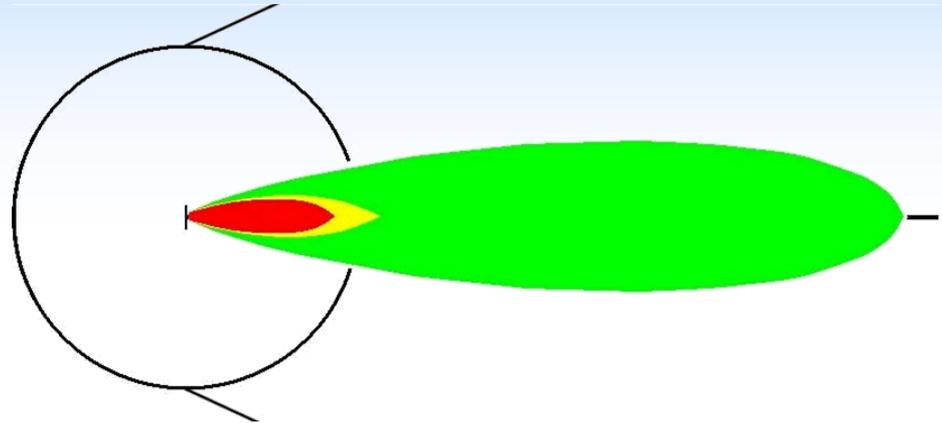
vs.

MODEL PREDICTIONS OF D2PCW (EMIS VER. 3.1)

5 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: 635 meters (to no effects level)



Accumulated Dosage Values at ERG Zone Distances:

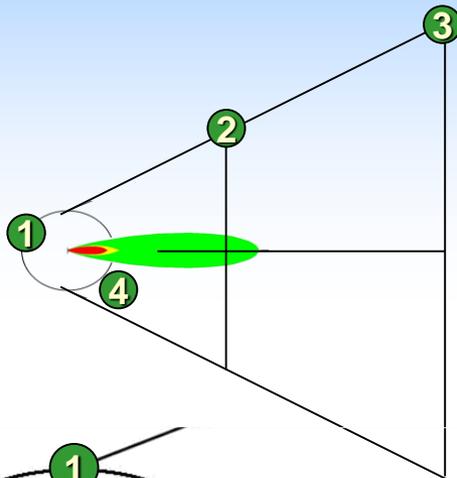
<u>Zone</u>	<u>Dosage (mg-min/m³)</u>	<u>Cloud Arrival Time (min)</u>	<u>Cloud End Time (min)</u>
Isolation	6.669e+00	0.9	62
Day Protect	Less than Minimal	N/A	N/A
Night Protect	Less than Minimal	N/A	N/A

2000 EMERGENCY RESPONSE GUIDEBOOK

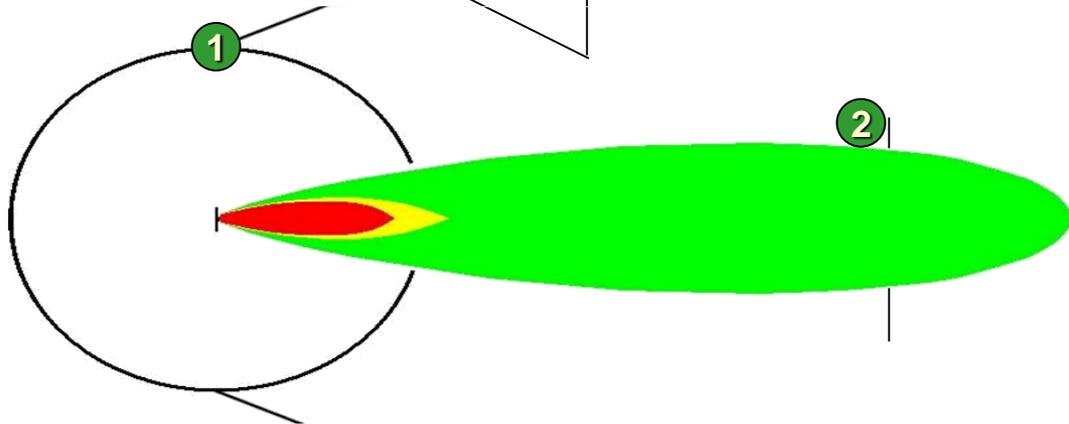
VS.

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)



- █ > 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)

Accumulated Dosage Values at ERG Zone Distances:

<u>Zone</u>	<u>Dosage (mg-min/m³)</u>	<u>Cloud Arrival Time (min)</u>	<u>Cloud End Time (min)</u>
Isolation	5.582e+01	0.9	62
Day Protect	7.336e-01	9.8	77
Night Protect	Less than Minimal	N/A	N/A



- ◆ 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**

- ◆ **Alternative Scenario Suggestions**
- ◆ **Hot Zone Entry/Exit Times for Responders
(Police, HAZMAT, Firefighters, Cleanup Crews,
Others)**

