

BUILDING DESIGN FOR HOMELAND SECURITY

Unit XII-A

Case Study



FEMA

Unit Objectives

Explain building security design issues to a building owner for consideration prior to a renovation or new construction.

Explain the identification process to arrive at the high risk asset-threat/hazard pairs of interest.

Justify the recommended mitigation measures, explaining the benefits in reducing the risk for the high risk situations of interest.



FEMA

Hazardville Information Company

Company

- Functions
- Infrastructure

Threats/Hazards

- Design Basis Threat
- Levels of Protection

Vulnerabilities

- Impact
- Mitigation

Report



Hazardville Information Company (HIC)



FEMA

Hazardville Information Company

IT services and support

- 130 employees

Two-story building in small corporate office park

Located in suburban area of major metropolitan city

“Neighbors” include:

- Offices
- Industry
- Road, Rail, Air traffic



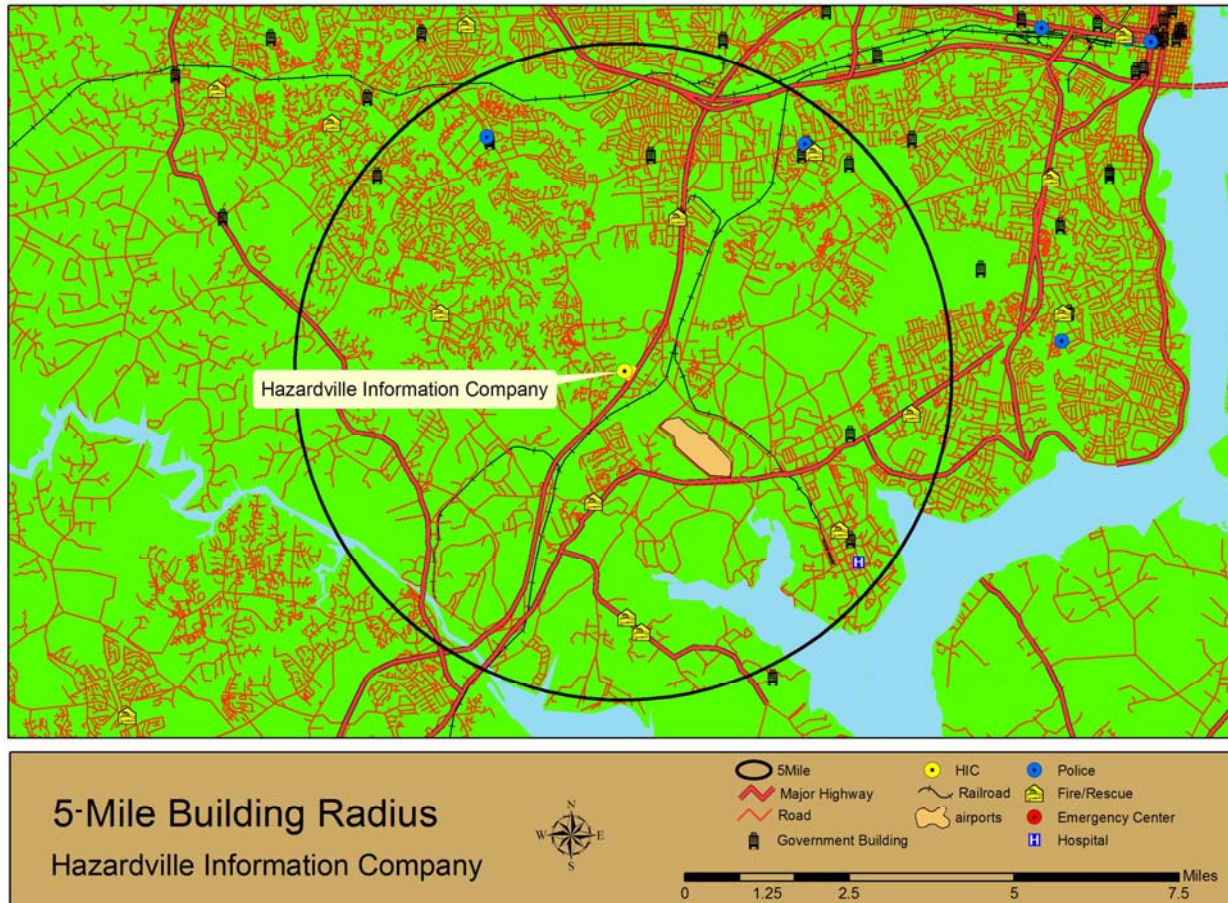
FEMA 426, Figure 2-1: Example of Using GIS to Identify Adjacent Hazards, p. 2-5

BUILDING DESIGN FOR HOMELAND SECURITY Unit XII-A-4



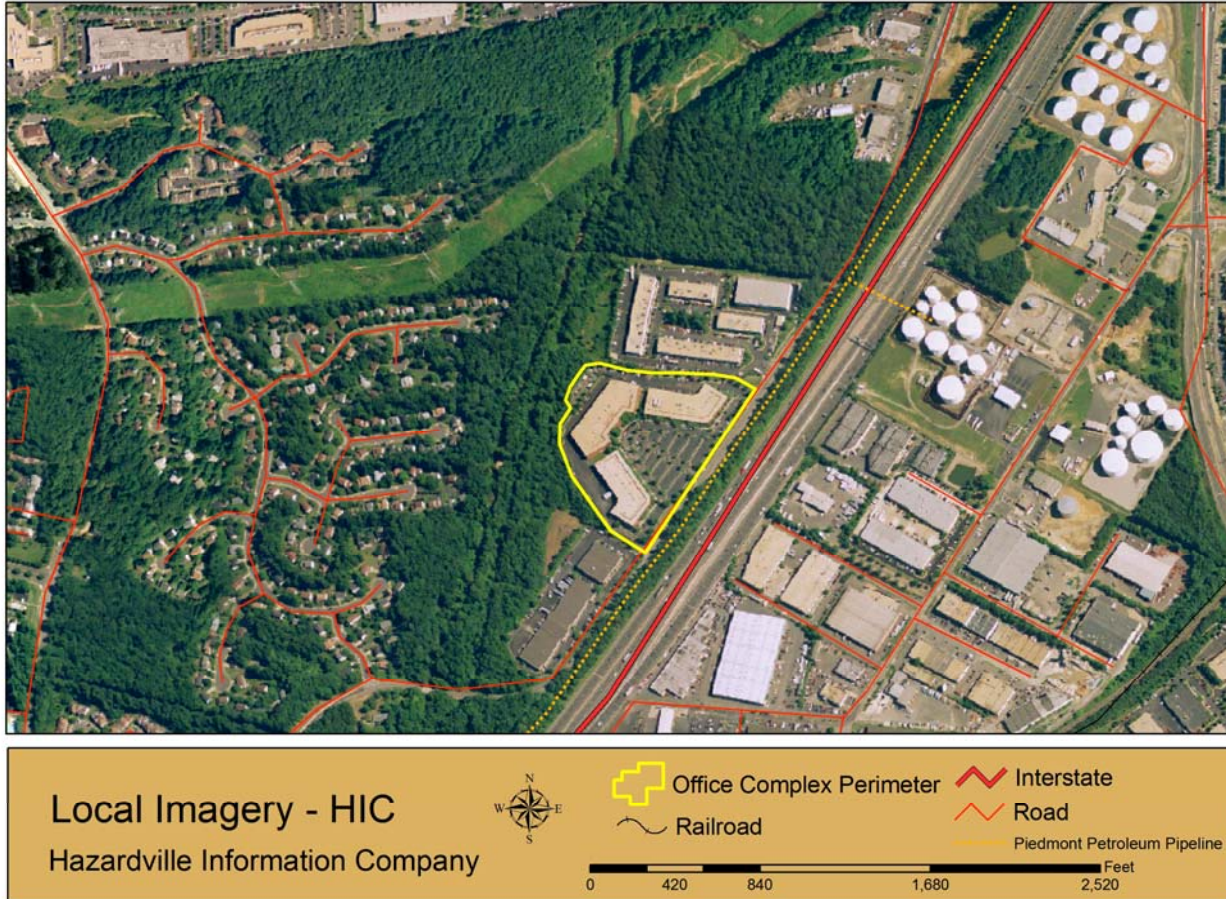
FEMA

5-Mile Building Radius



FEMA

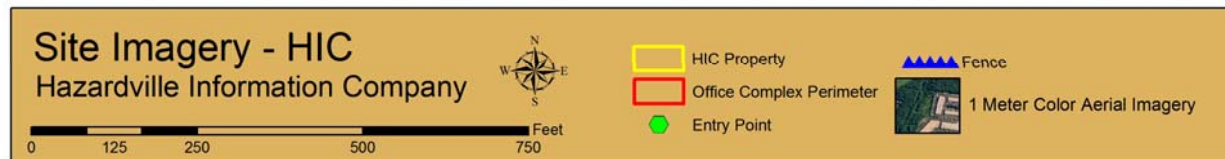
Local Imagery



FEMA

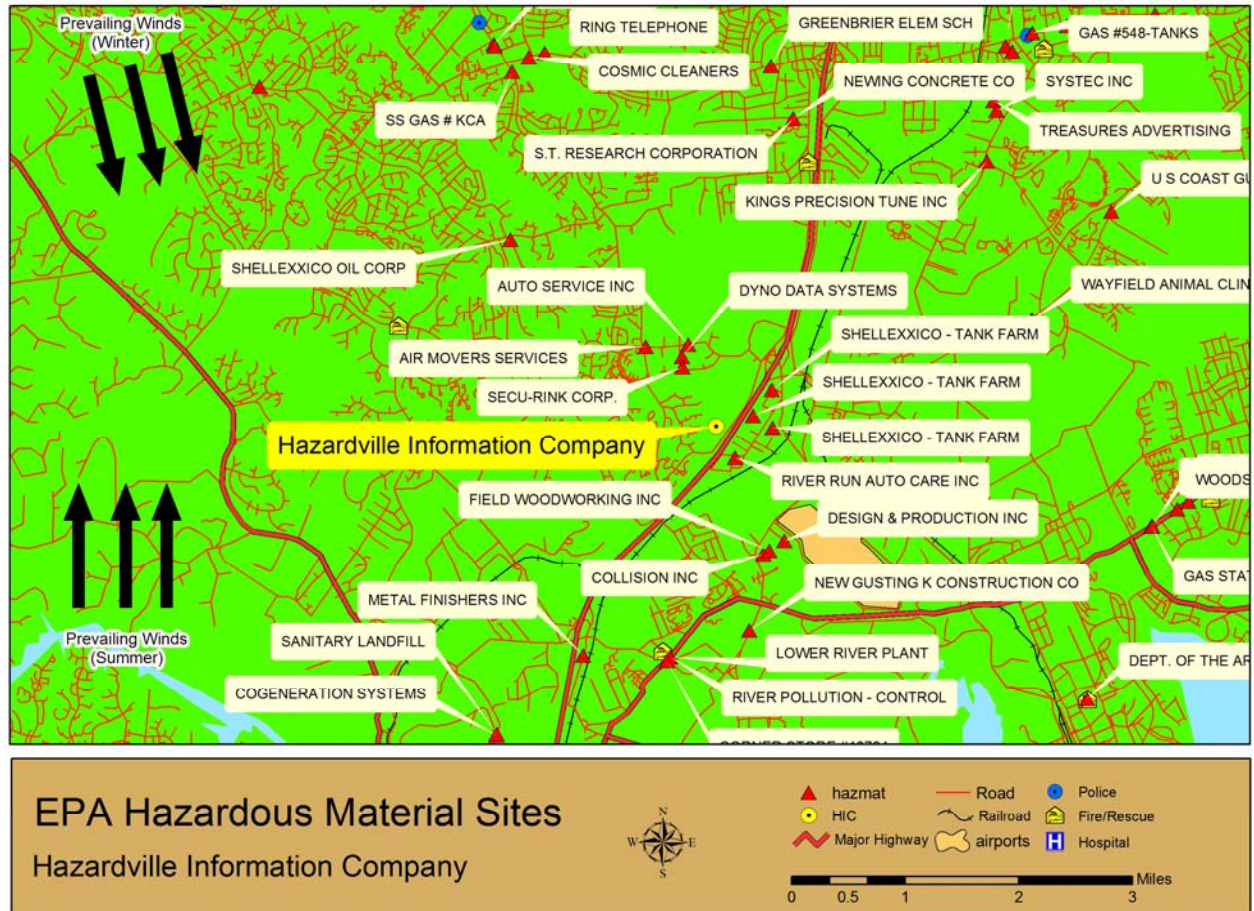
FEMA 426, Figure 2-1: Example of Using GIS to Identify Adjacent Hazards, p. 2-5
BUILDING DESIGN FOR HOMELAND SECURITY Unit XII-A-6

Site Imagery



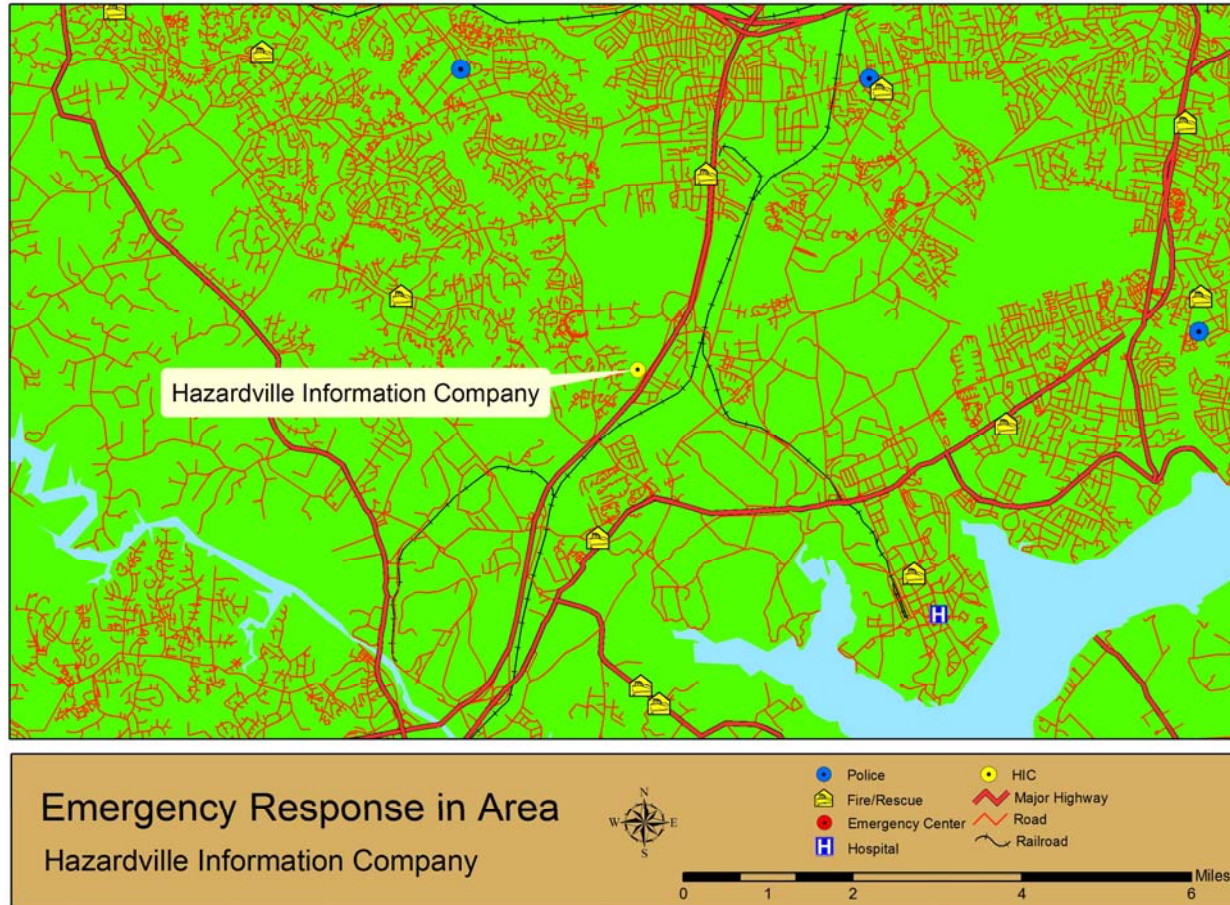
FEMA

HazMat Sites



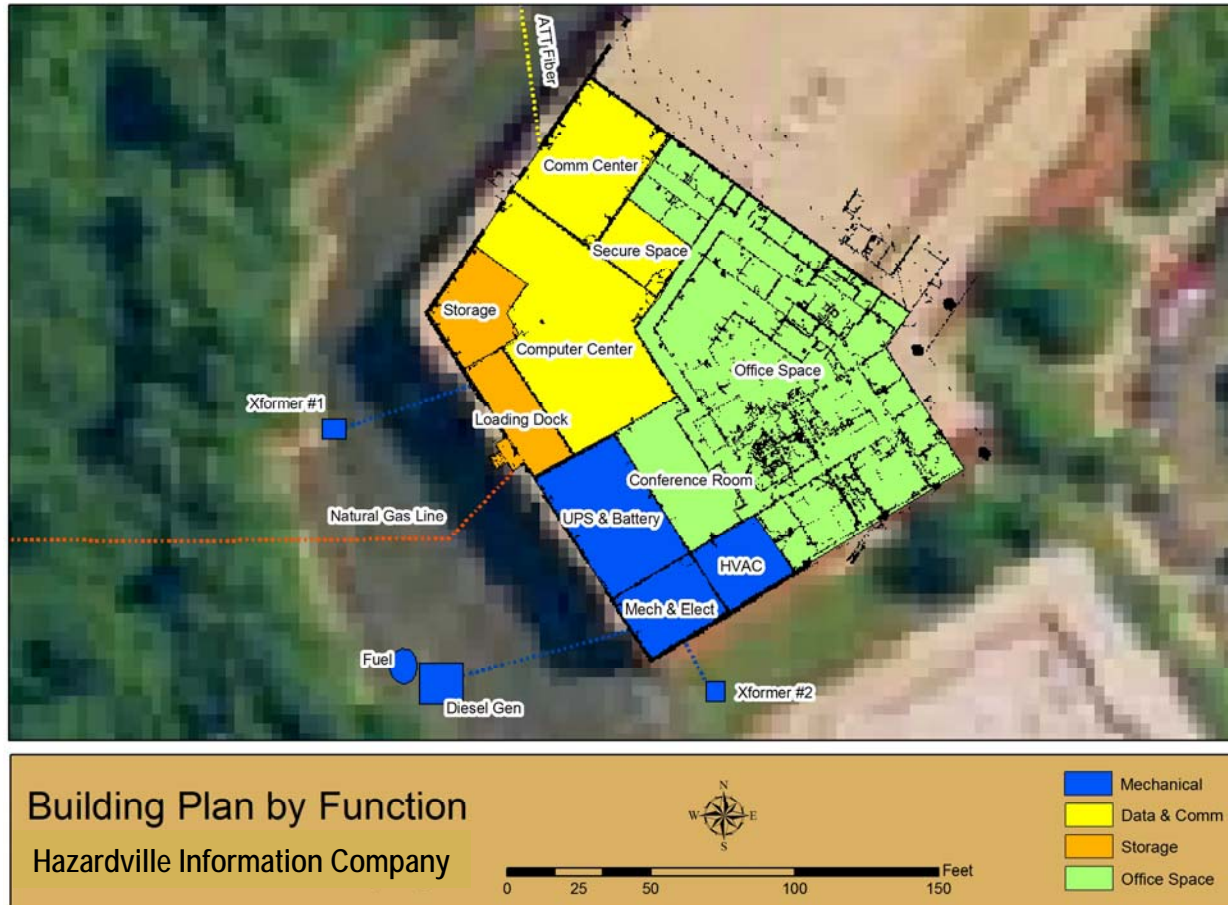
FEMA

Emergency Response



FEMA

Functional Layout

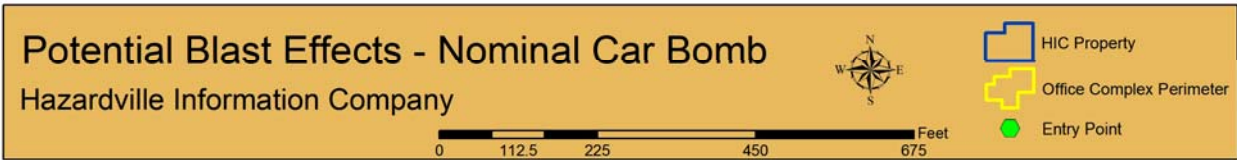
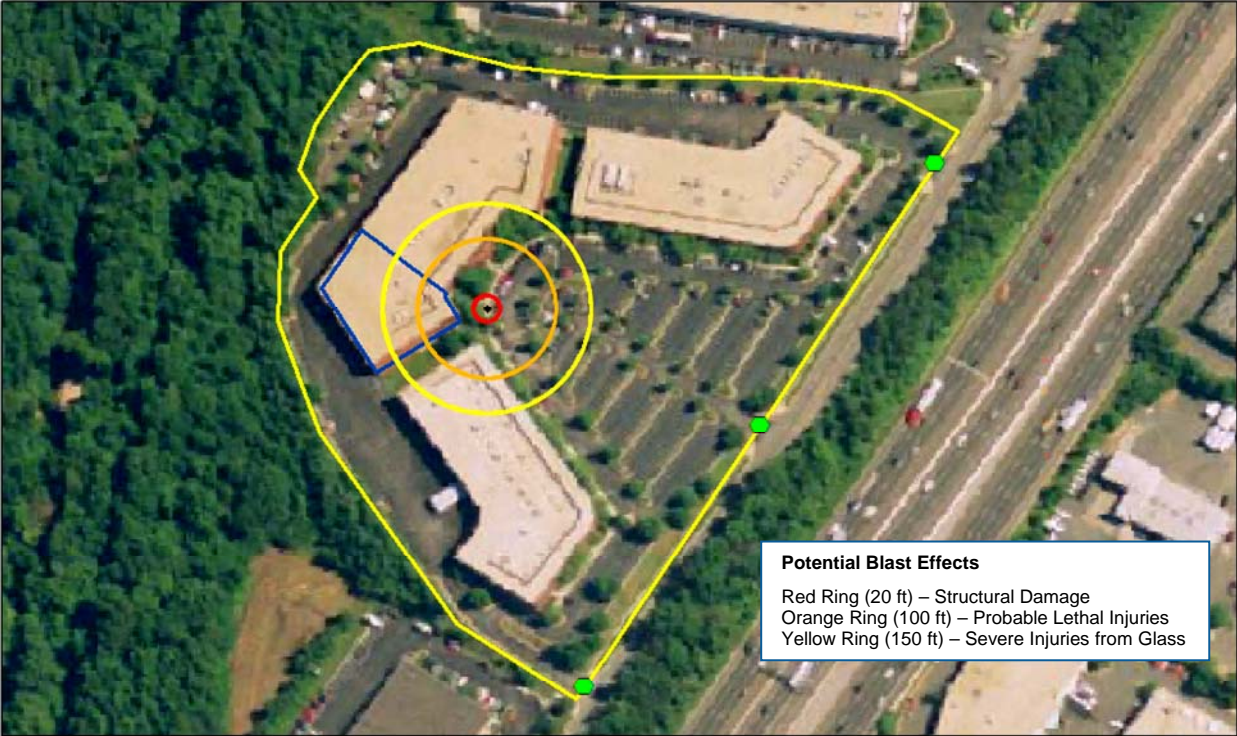


Building Plan by Function
Hazardville Information Company



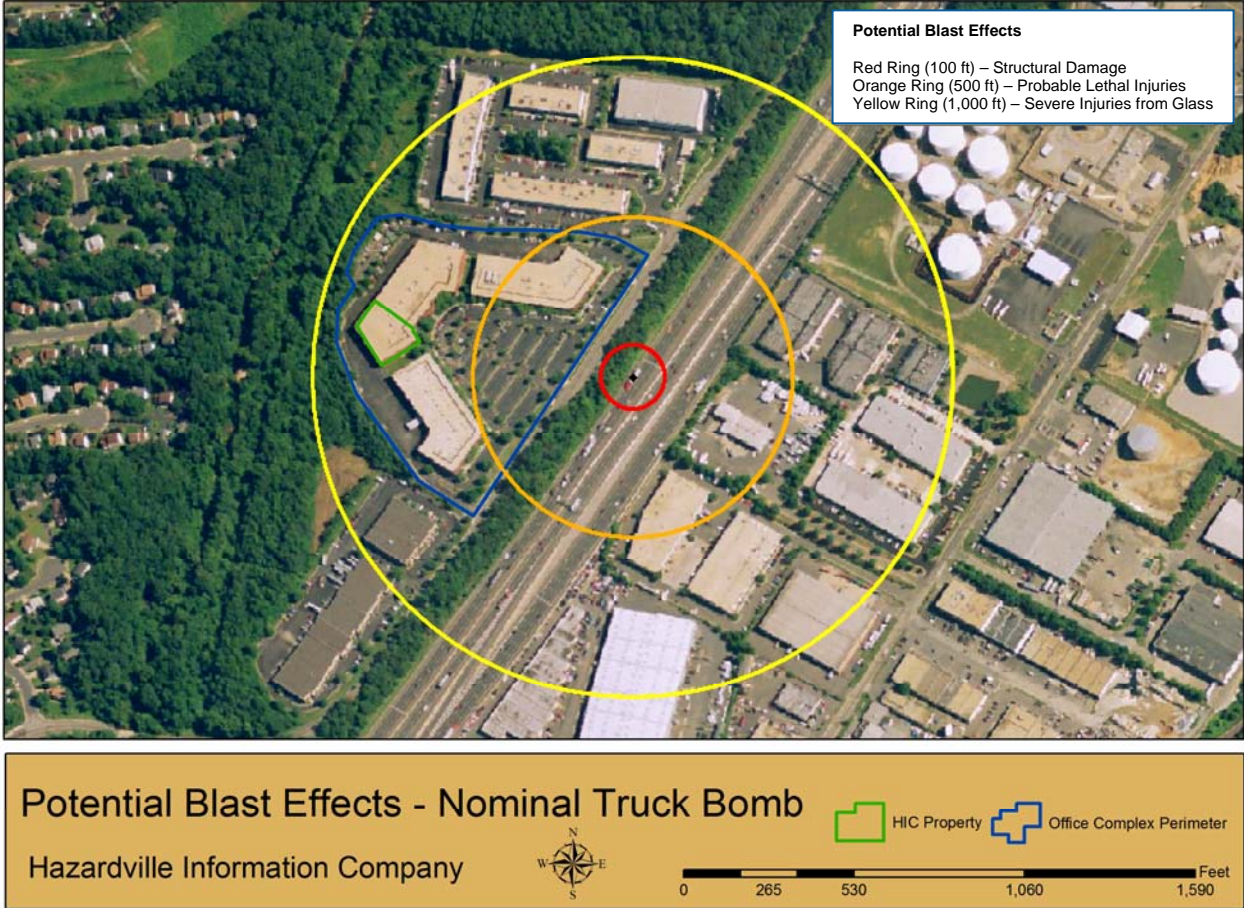
FEMA

Car Bomb Blast Effects



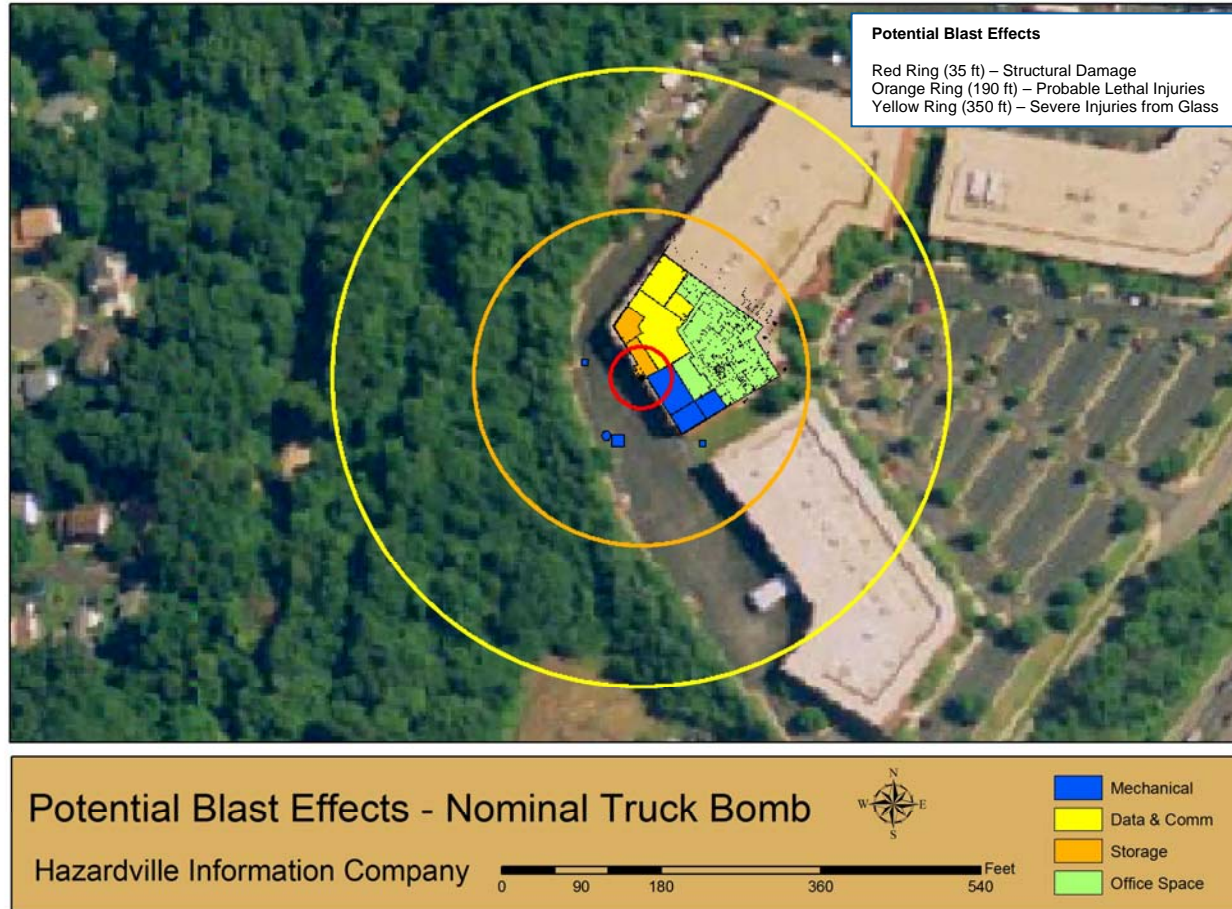
FEMA

Truck Bomb Blast Effects



FEMA

Truck Bomb Blast Effects



FEMA

Building Data

Infrastructure

Structural

- 2 Story steel frame with brick façade
- Annealed glass

Mechanical

- HVAC
- Gas
- Fire Systems

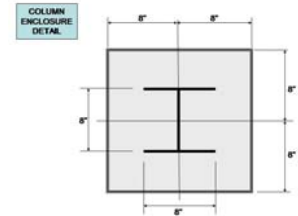
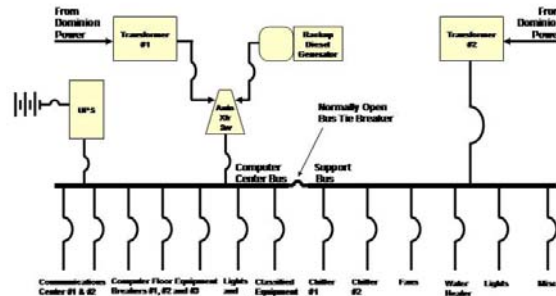
Electrical

- Primary
- Back-up

IT

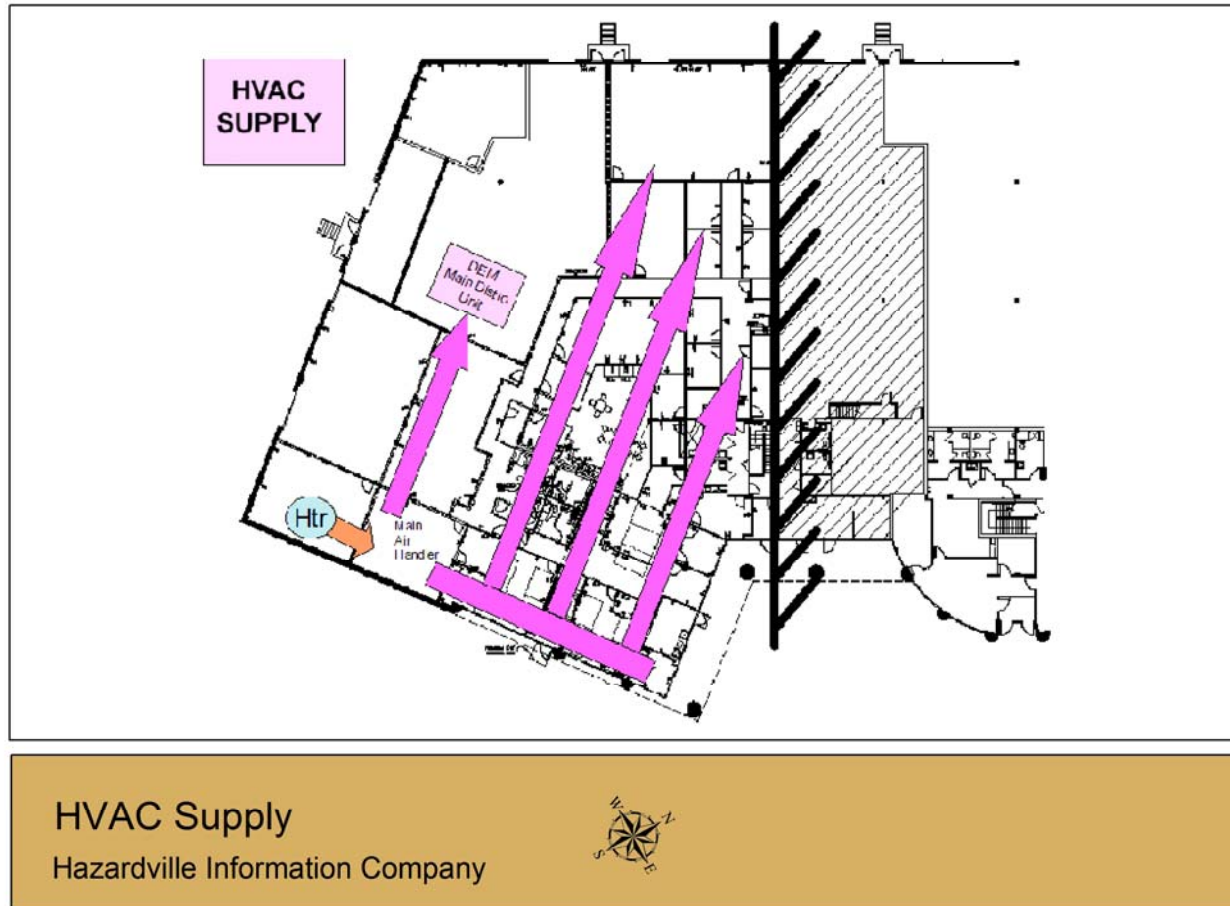
- Data Center
- Telecom

Physical Security



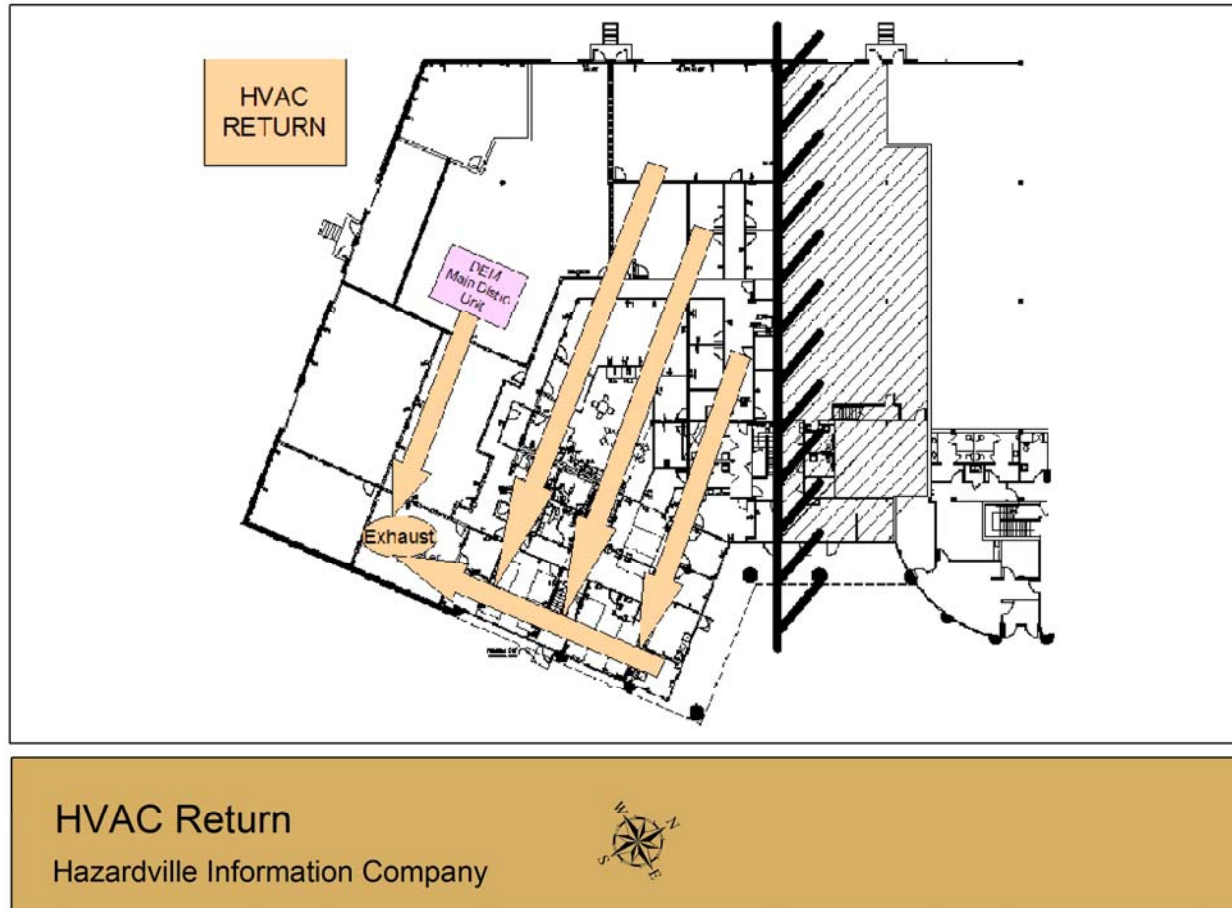
FEMA

Mechanical Systems



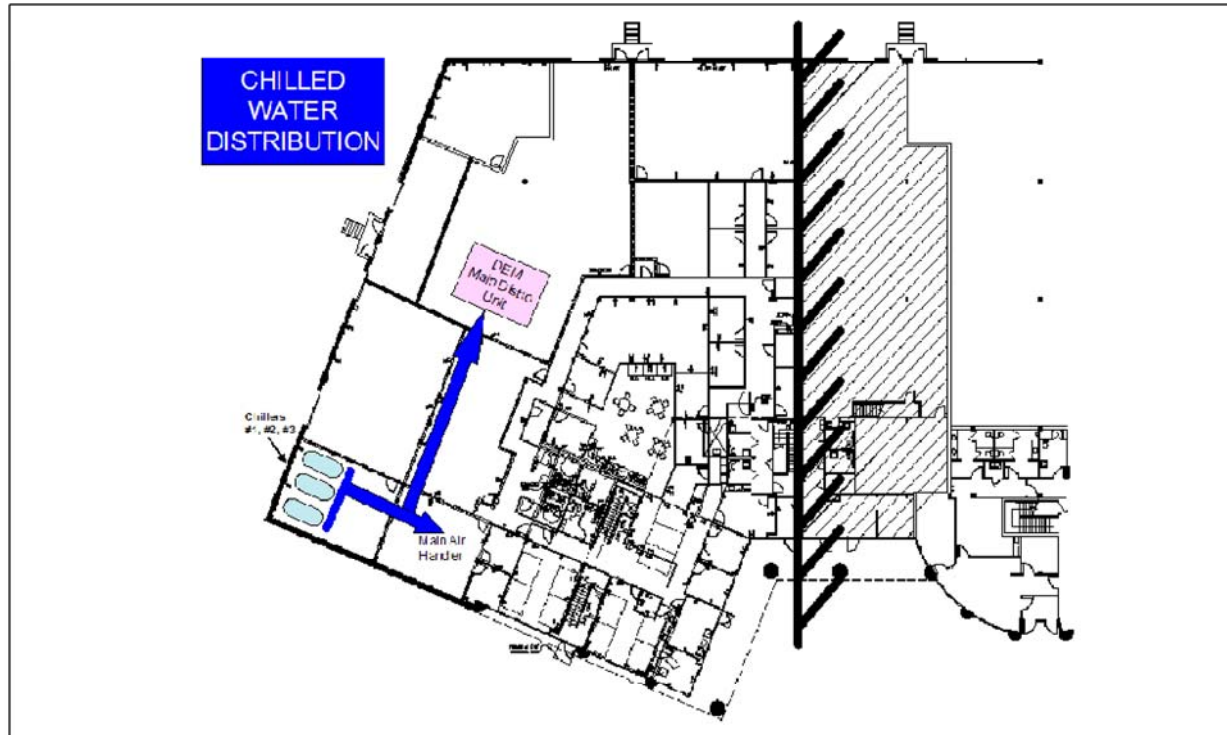
FEMA

Mechanical Systems



FEMA

Mechanical Systems

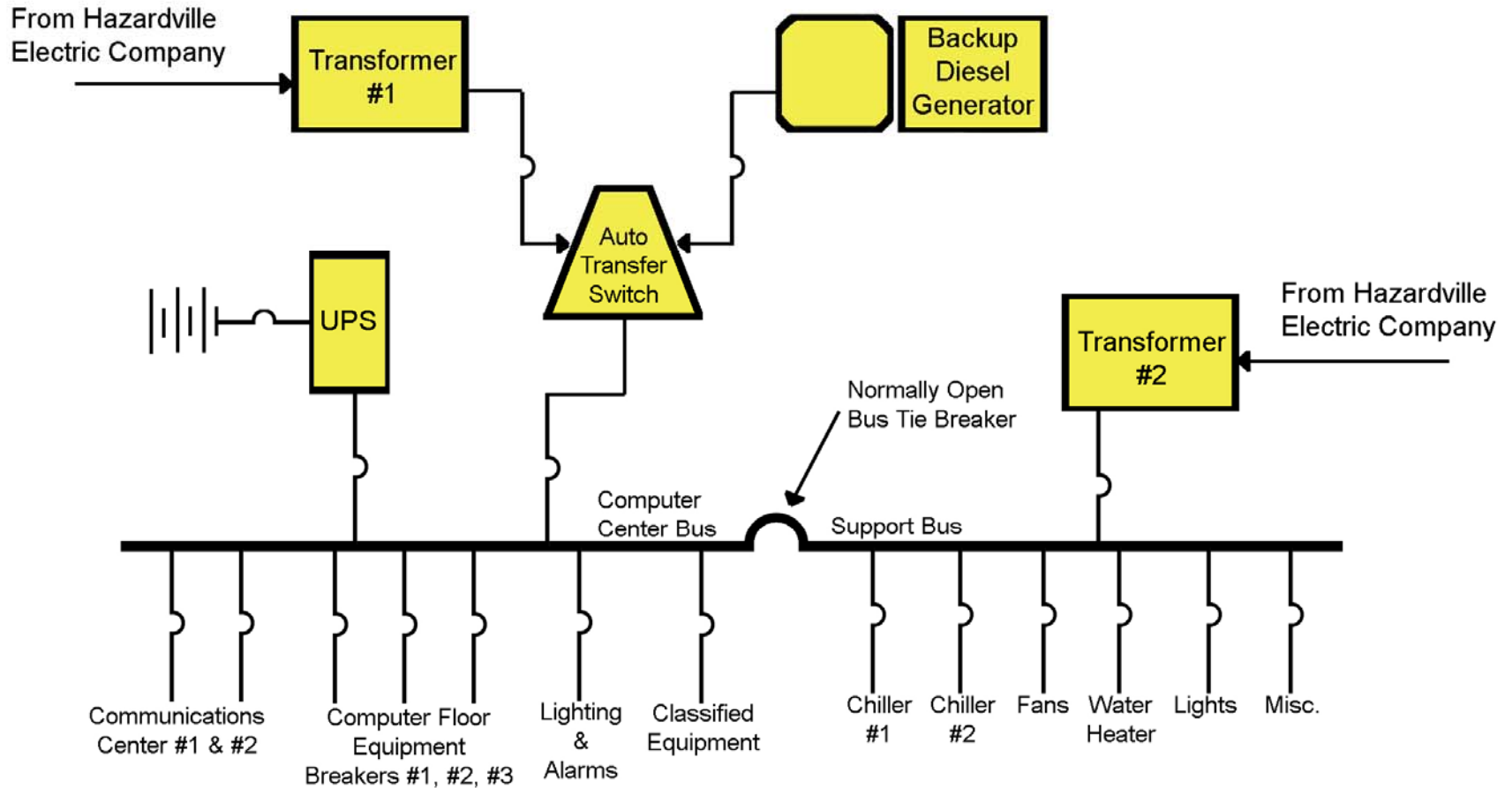


Chilled Water Distribution
Hazardville Information Company



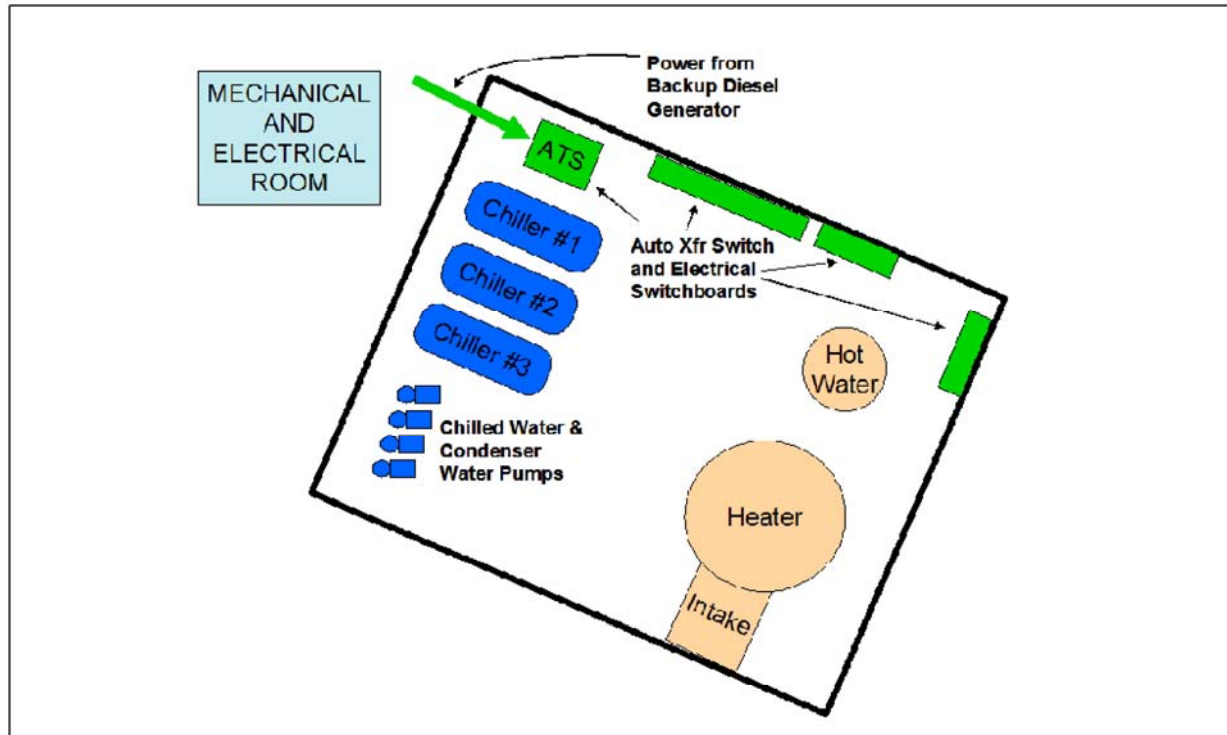
FEMA

Electrical Systems



FEMA

Mechanical and Electrical Room



Mechanical and Electrical Room
Hazardville Information Company



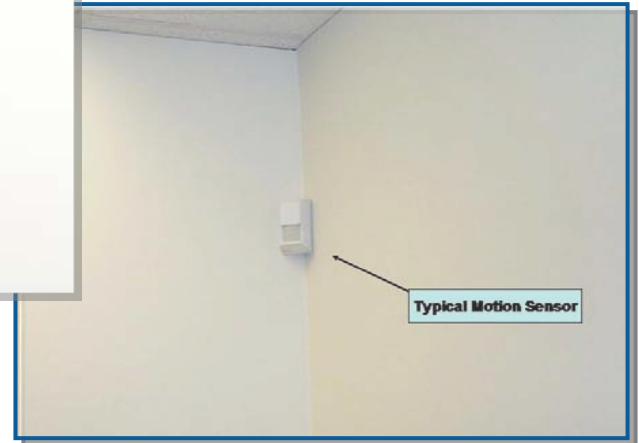
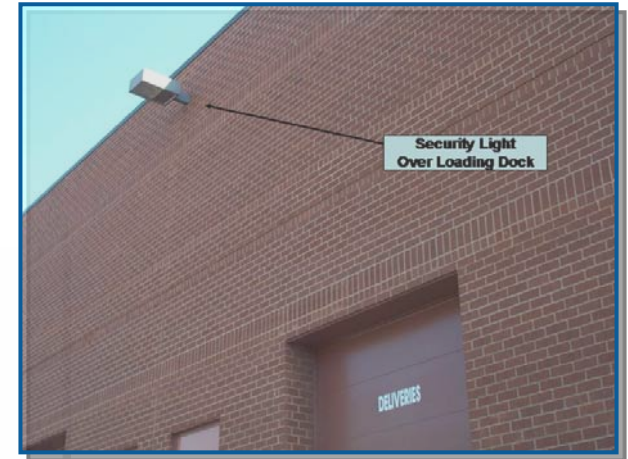
FEMA

Information Technology



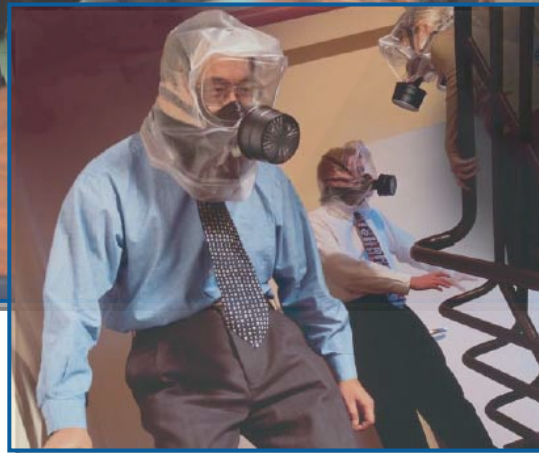
FEMA

Physical Security



FEMA

Emergency Response



Source: Mine Safety Appliances Company



FEMA

Threats/Hazards

Threats include:

Terrorism

- No direct threat to HIC
- Government, military, industry in the area

Intelligence Collection

Crime

- High threat in metro area, lower in suburbs



FEMA

Threats/Hazards

Threats (continued):

HazMat

- Many facilities nearby
 - Fuel farm and pipeline
 - Interstate highway
 - Rail line

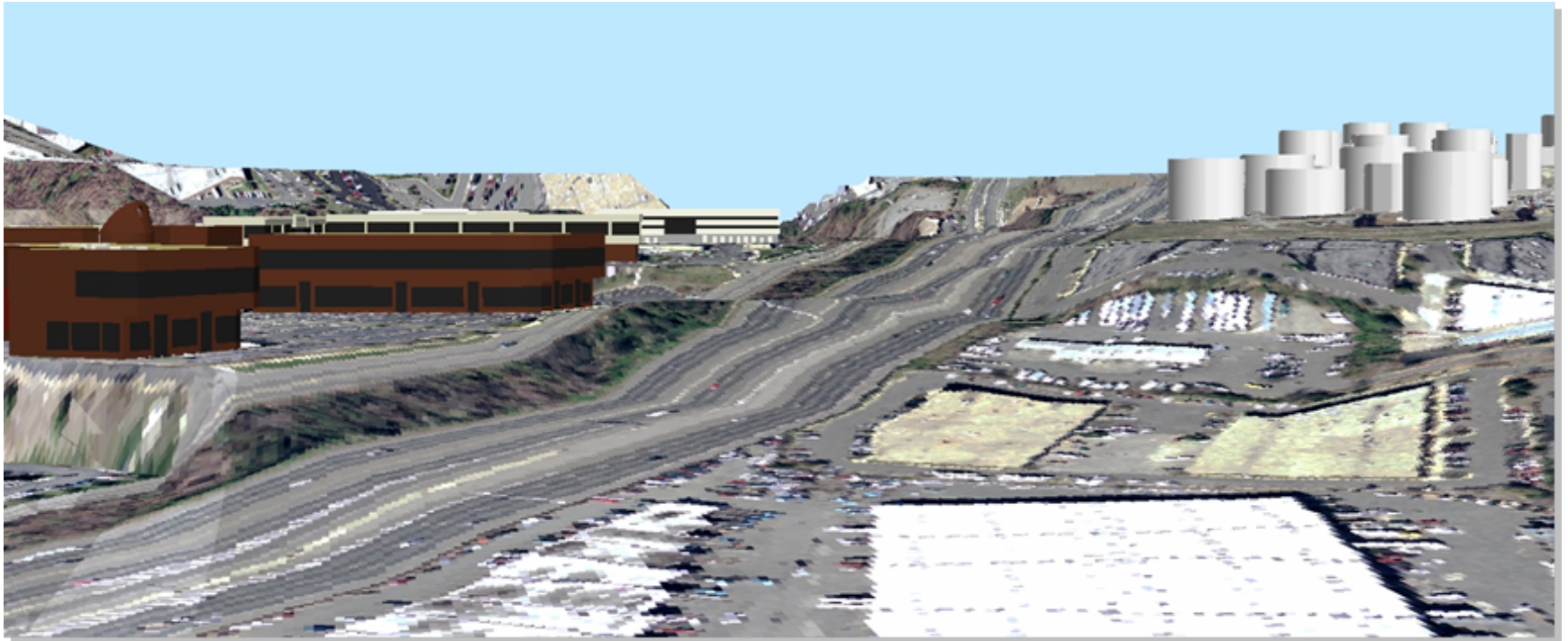
Natural Hazards

- Hurricanes – Infrequent
- Tornadoes – Almost every Spring
- Earthquakes – Infrequent
- Lightning - Frequent



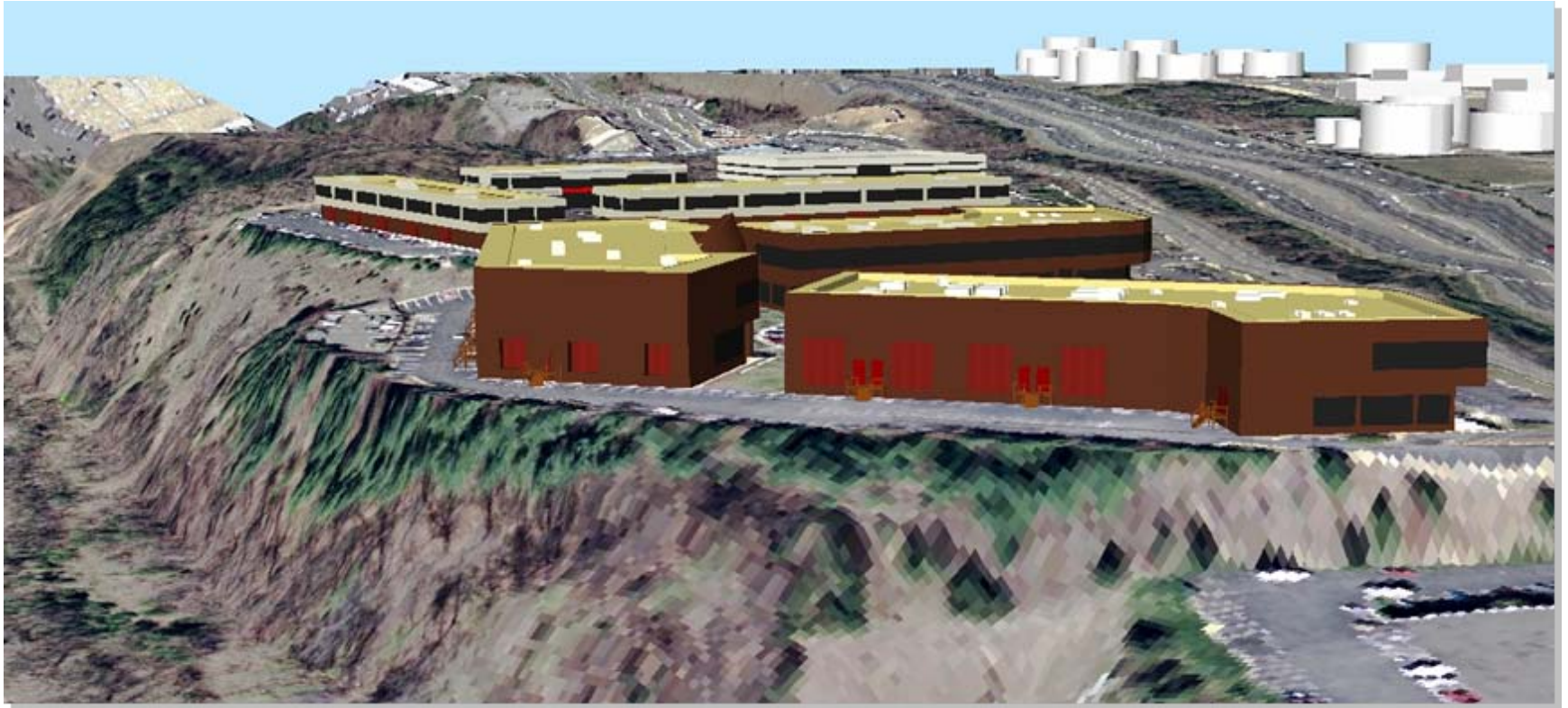
FEMA

Computerized Elevation Looking Northwest



FEMA

Computerized Elevation Looking Northeast



FEMA

Design Basis Threat

Explosive Blast: Car Bomb 250 lb TNT equivalent. Truck Bomb 5,000 lb TNT equivalent (Murrah Federal Building class weapon)

Chemical: Large quantity gasoline spill and toxic plume from the adjacent tank farm, small quantity (tanker truck and rail car size) spills of HazMat materials (chlorine)

Biological: Anthrax delivered by mail or in packages, smallpox distributed by spray mechanism mounted on truck or aircraft in metropolitan area

Radiological: Small “dirty” bomb detonation within the 10-mile radius of the HIC building



FEMA

Levels of Protection

GSA Interagency Security Criteria

Level II Building – between 11-150 employees; 2,500 to 80,000 sq ft

- Perimeter Security
- Entry Security
- Interior Security
- Administrative Procedures
- Blast/Setback Standards



FEMA

Levels of Protection

DoD Antiterrorism Standards

Level of Protection	Potential Structural Damage	Potential Door and Glazing Hazards	Potential Injury
Low	Damage – unrepairable. Major deformation of non-structural elements and secondary structural members and minor deformation of primary structural members, but progressive collapse is unlikely.	Glazing will break, but fall within 1 meter of the wall or otherwise not present a significant fragment hazard. Doors may fail, but they will rebound out of their frames, presenting minimal hazards.	Majority of personnel suffer significant injuries. There may be a few (<10 percent) fatalities.



FEMA

FEMA 426, Adapted from Table 4-1: DoD Minimum Antiterrorism Standards for New Buildings, p. 4-9

BUILDING DESIGN FOR HOMELAND SECURITY Unit XII-A-29

Levels of Protection

DoD Antiterrorism Standards

Location	Building Category	Stand-off Distance or Separation Requirements			
		Applicable Level of Protection	Conventional Construction Stand-off Distance	Effective Stand-off Distance	Applicable Explosives Weight
Controlled Perimeter or Parking and Roadways without a Controlled Perimeter	Inhabited Building	Very Low	25 m	10 m	Car Bomb
			82 ft	33 ft	



FEMA

Adapted from DoD Unified Facilities Criteria (UFC), “DoD Minimum Antiterrorism Standards for New Buildings”, UFC 4-010-01, 31 July 2002

Levels of Protection

UFC 4-010-01 APPENDIX B

DoD MINIMUM ANTITERRORISM STANDARDS FOR NEW AND EXISTING BUILDINGS

Standard 1	Minimum Stand-off Distances
Standard 2	Unobstructed Space
Standard 3	Drive-Up/Drop-Off Areas
Standard 4	Access Roads
Standard 5	Parking Beneath Buildings or on Rooftops
Standard 6	Progressive Collapse Avoidance
Standard 7	Structural Isolation
Standard 8	Building Overhangs
Standard 9	Exterior Masonry Walls
Standard 10	Windows, Skylights, and Glazed Doors
Standard 11	Building Entrance Layout
Standard 12	Exterior Doors



FEMA

Levels of Protection (continued)

UFC 4-010-01 APPENDIX B DoD MINIMUM ANTITERRORISM STANDARDS FOR NEW AND EXISTING BUILDINGS	
Standard 13	Mailrooms
Standard 14	Roof Access
Standard 15	Overhead Mounted Architectural Features
Standard 16	Air Intakes
Standard 17	Mailroom Ventilation
Standard 18	Emergency Air Distribution Shutoff
Standard 19	Utility Distribution and Installation
Standard 20	Equipment Bracing
Standard 21	Under Building Access
Standard 22	Mass Notification



FEMA

Unit XII Case Study Activity

Finalization and Presentation of Group Results

Purpose

- Groups finalize their assessments
- Decide on high priority risk concerns
- Determine appropriate mitigation measures
- Present findings to class

Requirements

Based on findings from previous activities, complete the worksheet table

Prepare to present conclusions and justify decisions to class in a 5- to 7-minute presentation



FEMA

Vulnerability/Mitigation

Basis of Mitigation Measures

Recommendations ultimately require an understanding of benefit (capability) versus cost to implement

Blast Modeling

- Various scenarios run at Tier III level for comparison using Design Basis Threats
 - Truck bomb is worst case
 - Car bomb also analyzed for comparison
 - Some interesting and unexpected results
- More analysis required for final design



FEMA

Vulnerability/Mitigation

Basis of Mitigation Measures

Plume Modeling (CBR or HazMat)

- Tier II / Tier III performed for selected Design Basis Threats external to building
- Additional Tier III analysis required inside building
 - Understand internal pressure changes during building operation
 - Understand how HVAC and other changes implemented in response plans affect building
 - Supports design of CBR measures



FEMA

Vulnerability/Mitigation

Basis of Mitigation Measures

Cost Estimates are ROM (Rough Order of Magnitude)

- Assumes 10% Overhead and 10% Profit
- Assumes Area Cost Factor of 1.0 (DoD) or 100 (RS Means)
 - DoD Range: **0.84** (Huntsville AL) to **1.67** (Anchorage AK)
 - RS Means Range: **82.5** (Baton Rouge LA) to **131.9** (New York NY)
 - Adjusted for July 2006
- Anti-Terrorism / Force Protection equipment and construction costing information is still immature



FEMA

Vulnerability/Mitigation

Site / Vehicle Bomb

Maximize available stand-off

- Front side along sidewalk to prevent direct approach into building and ensure stand-off – 100 LF
- Due to straightaways on front and back of building, need K12 stopping power
 - Planters - \$22.3K
 - Plinth wall - \$50.7K
 - Landscaping (boulders) - \$19.5K



FEMA

Vulnerability/Mitigation

Building Envelope / Vehicle Bomb

Harden windows (balanced envelope)

- Fragment Retention Film
 - Not costed -- could not meet performance required for upgraded stand-off
- Laminated glass -- 56 windows
 - 1/2" laminated interior pane with 0.060 PVB interlayer, air gap to 0.25 inches, and retention of exterior pane - \$170.8K



FEMA

Window Hardening

Original Glazing

 Large DBT – 1,136 ft

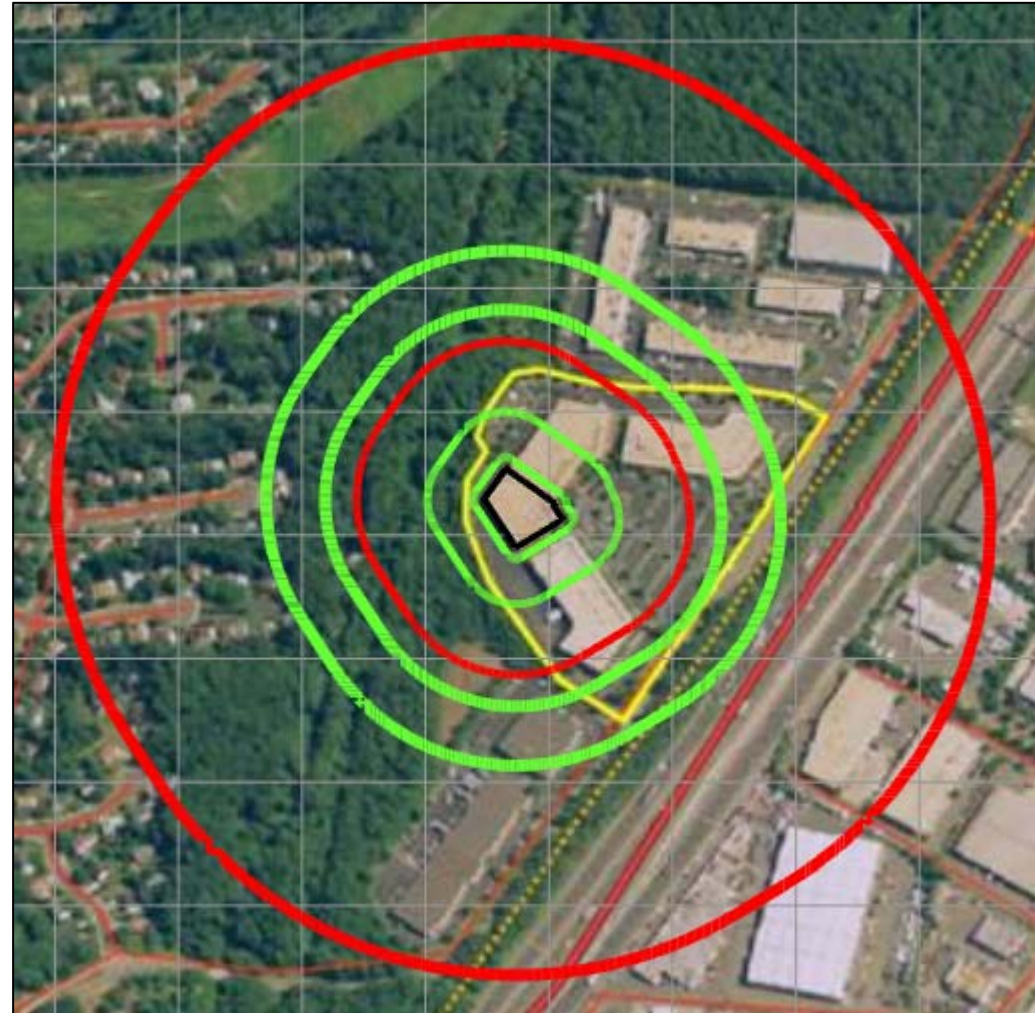
 Small DBT – 338 ft

Hardened Glazing

 Large DBT – 422 / 579 ft

 Small DBT – 29 / 150 ft

Between the two hardened glazing distances glass blows OUT of building



FEMA

Vulnerability/Mitigation

Building Envelope / Vehicle Bomb

Harden exterior -- Close in overhang

- Brick bonded to 4" Reinforced Concrete Wall, #3 rebar @12 inches each way - \$64.2K
- Brick backed with truck bed liner - \$34.6K
- Deduct window hardening if overhang enclosed – (\$85.4K)



FEMA

Infill Hardening

Overhang Infill – Brick Only

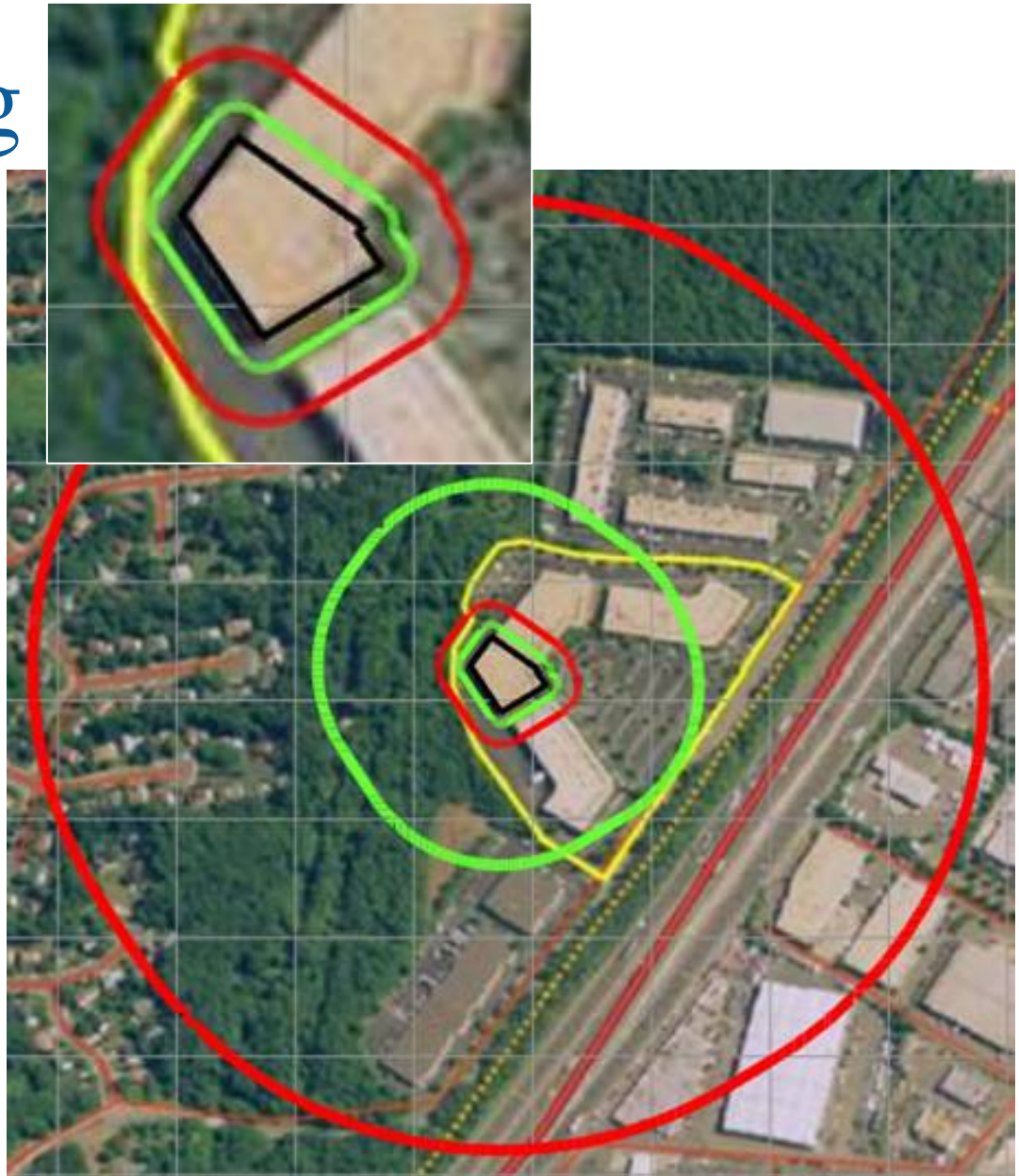
■ Large DBT – 1,210 ft

■ Small DBT – 88 ft

Hardened Overhang Infill
w/ R/C Backup Wall

■ Large DBT – 422 ft

■ Small DBT – 32 ft



FEMA

Infill Hardening

Overhang Infill – Brick Only

 Large DBT – 1,210 ft

 Small DBT – 88 ft

Hardened Overhang Infill
w/ Spray-On Liner

 Large DBT – 213 ft

 Small DBT – 17 ft



FEMA

Vulnerability/Mitigation

Building Envelope / Vehicle Bomb

Harden walls (balanced envelope)

- Vermiculite in wall cavity - \$23.5K
- Spray on truck bed liner - \$43.4K



FEMA

Wall Hardening

Cavity Wall – CMU Only

■ Large DBT – 1,022 ft

■ Small DBT – 230 ft

Hardened Cavity Walls
w/ Vermiculite in gap

■ Large DBT – 371 ft

■ Small DBT – 31 ft



FEMA

Wall Hardening

Cavity Wall – CMU Only

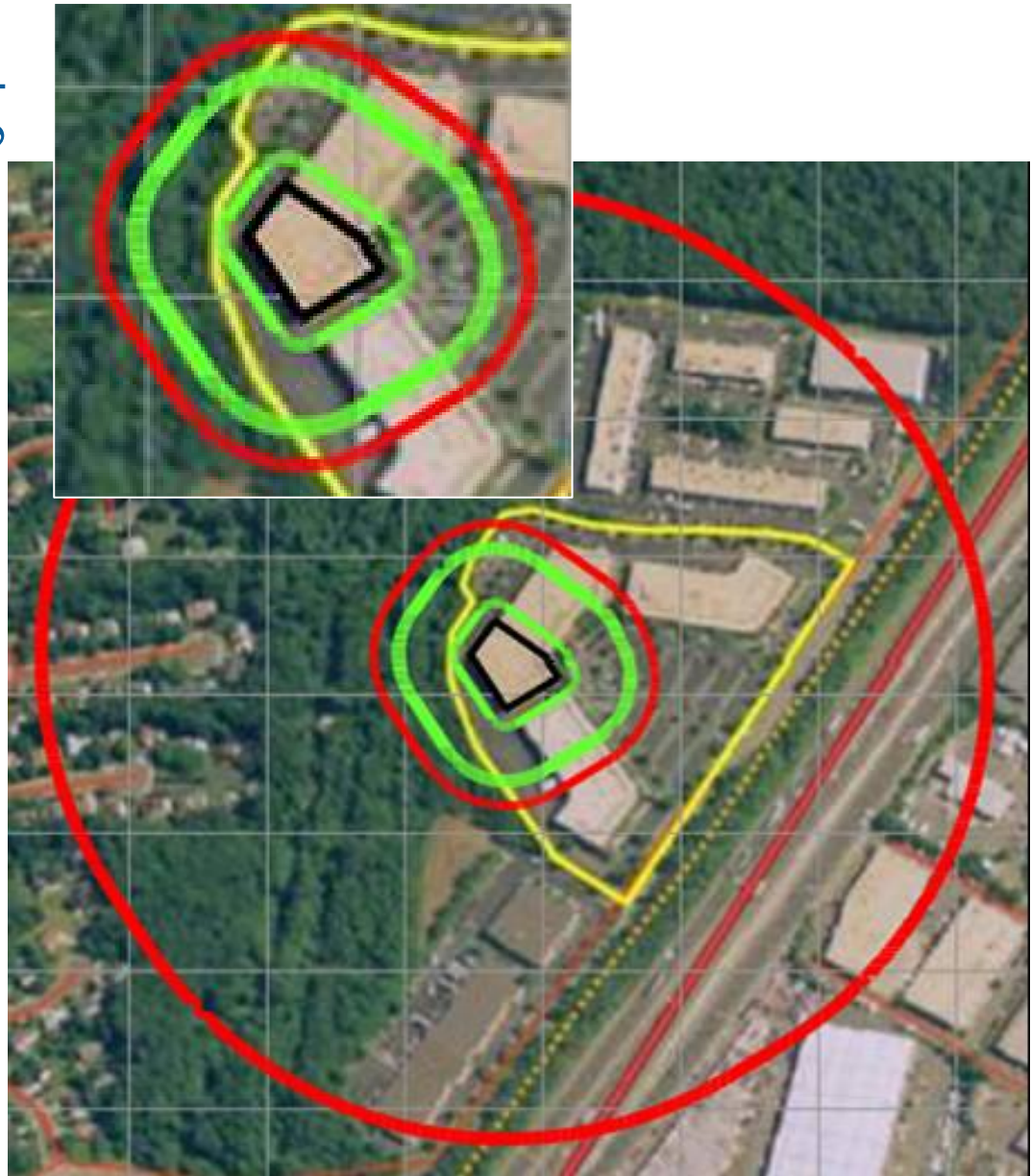
 Large DBT – 1,022 ft

 Small DBT – 230 ft

Hardened Cavity Walls
w/ Spray-On Liner

 Large DBT – 171 ft

 Small DBT – 42 ft



FEMA

Vulnerability/Mitigation

Site / Vehicle Bomb

Protect site from truck bomb by establishing controlled perimeter

- Chain link fencing along main road – K8 with two aircraft cables - \$50,500
- Vehicle pop-up barriers – K8, 3 entrances - \$181.7K
- Pre-screening away from building
 - Facility (Pre-Engineering Building) - \$35,000
 - Manpower/year - \$187.2K



FEMA

Vulnerability/Mitigation

Architectural / Vehicle Bomb

Strengthen overhead anchorage elements

- Heaters - \$2.1K



FEMA

Vulnerability/Mitigation

Site / Armed Attack (Physical Security)

Controlled Perimeter

- Fencing on three sides of site not on main road - \$66.0K
- Upgrade Security Ops Center (security managers office) – digital CCTV, digital video recording (DVR), and cameras for complete building coverage - \$55.0K



FEMA

Vulnerability/Mitigation

Architectural / Mailroom

Separate front lobby from interior office space

- Harden wall between lobby and office space - \$22.9K
- Harden door between lobby and office space - \$4.4K
- Separate HVAC system - \$4.4K
- Total \$31.7K

Separate Mailroom, hardened with separate HVAC - \$40.0K



FEMA

Vulnerability/Mitigation

Utilities / Mechanical Systems / Vehicle Bomb

Natural gas meters / pressure regulators

- Bollards, K12, 3 total - \$2.3K
- Fencing (access control) - \$0.20K

Utilities / Electrical Systems / Vehicle Bomb

Electrical transformers

- Bollards, K12, 6 total – \$4.6K



FEMA

Vulnerability/Mitigation

Mechanical Systems / Fire Alarm Systems / General Vulnerability – Redundancy

Fire Alarm / Suppression

- Install annunciator panel - \$3.5K
- Fire detection zones for HIC corporate space with dual detection in Data Center - \$81.0K
- Convert Data Center to clean agent to supplement water (check local code) - \$137.5K

Chilled Water

- Install backup piping to primary air handling units - \$26.0K



FEMA

Vulnerability/Mitigation

Electrical Systems / General Vulnerability – Redundancy

Increase size of generator fuel tank

- 2,000 to 3,000 gallons (30 hours at full output) - \$17.0K
- 3,000 gallons of diesel fuel - \$8.7K
- Total \$25.7K
- Arrange multiple suppliers for daily deliveries under worst case conditions

Conduct full and extended load test of emergency generator and UPS system to confirm performance



FEMA

Vulnerability/Mitigation

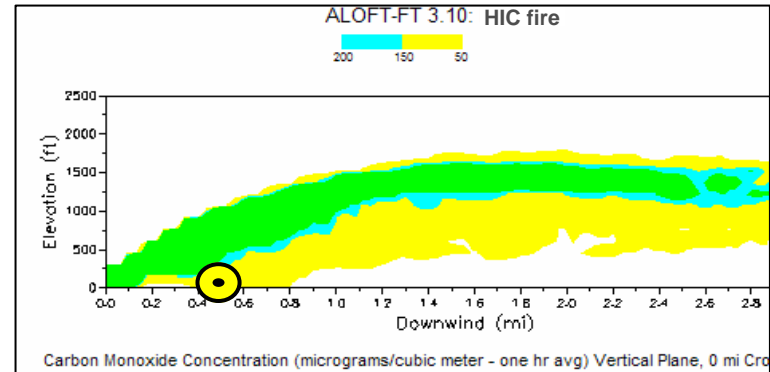
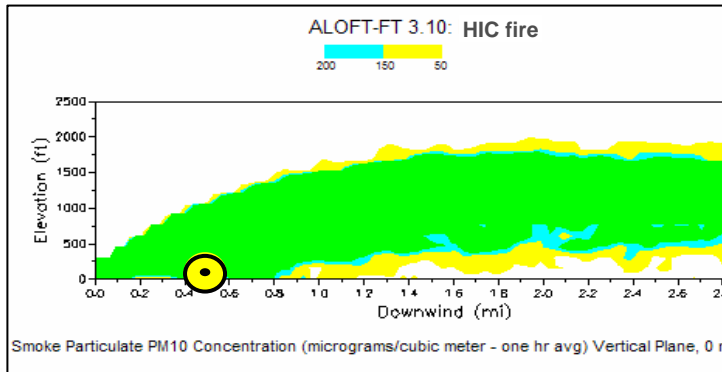
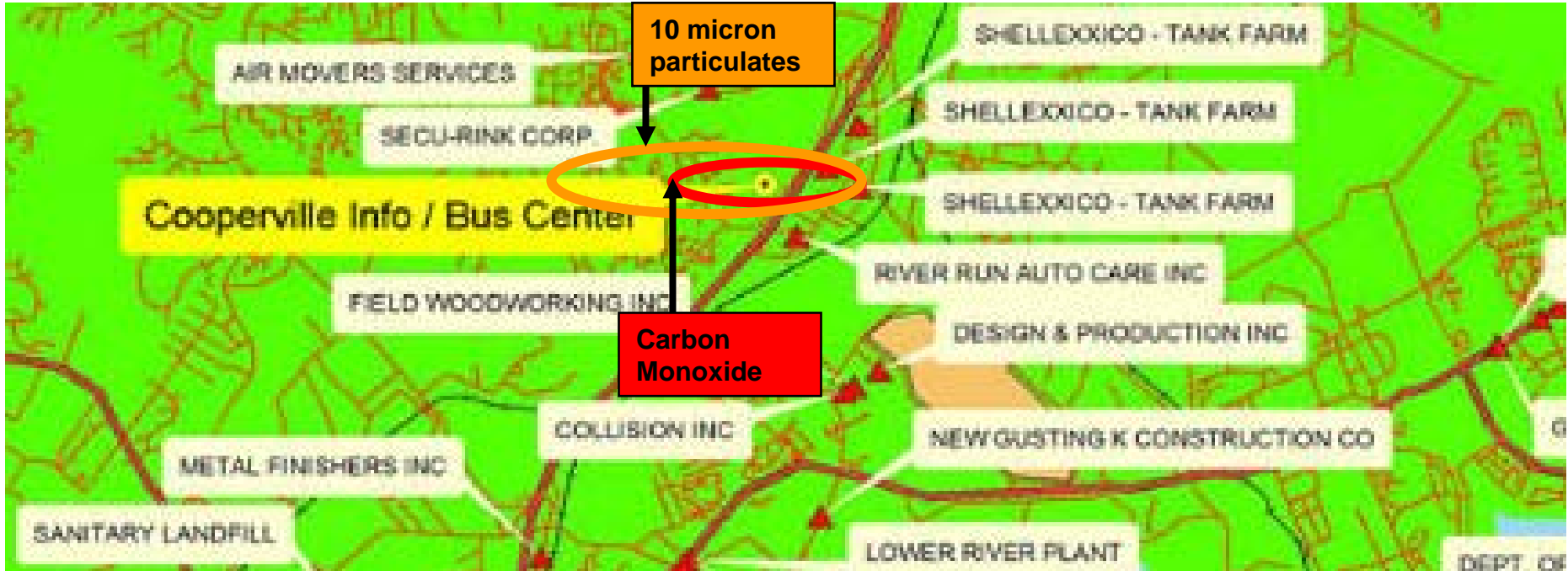
Mechanical Systems-HVAC / CBR Attack

- Protect outside air intake - \$21.0K
(architecturally compatible)
- Emergency shut down switch - \$10.0K
- Upgrade filters to MERV 11/13 (gasoline plume and radioactive particulates)
 - \$25.0K (filter assembly only) to
 - \$500.0K (upgraded air handling)



FEMA

Fire Plumes – Smoke & CO



Smoke Particles
FEMA

Carbon Monoxide

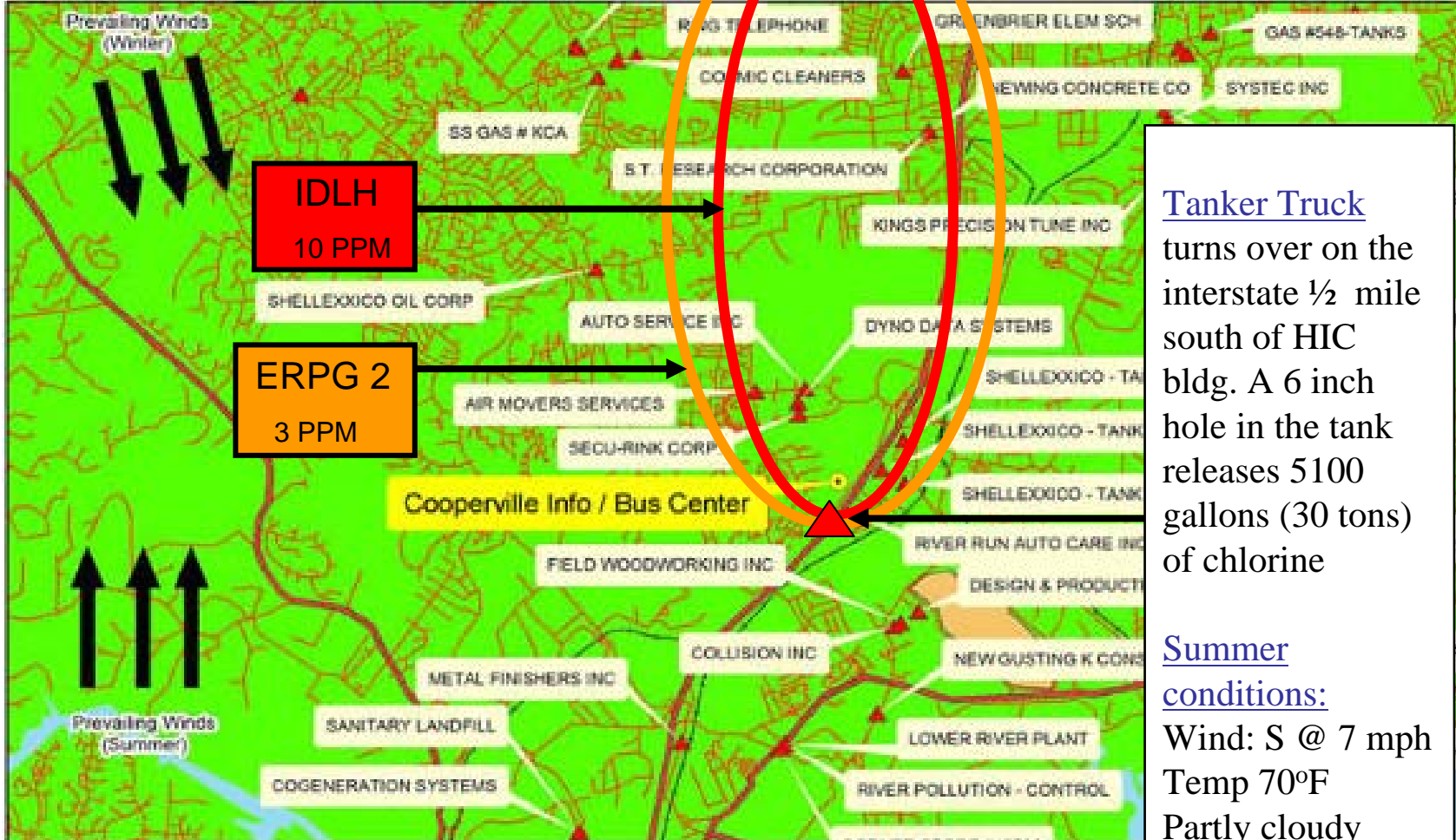
Vulnerability/Mitigation

Mechanical Systems-HVAC / CBR Attack

- Evaluate carbon filters for chlorine type spills
- \$130.0K
- Evaluate UVGI - \$8.0K



FEMA



Tanker Truck turns over on the interstate ½ mile south of HIC bldg. A 6 inch hole in the tank releases 5100 gallons (30 tons) of chlorine

Summer conditions:
 Wind: S @ 7 mph
 Temp 70°F
 Partly cloudy
 No inversion

EPA Hazardous Material Sites
 Cooperville Info / Bus Center

0 0.5 1 2 3 Miles



FEMA

HIC Chlorine Release Parameters

SITE DATA INFORMATION:

Location: FAIRFAX, VIRGINIA
Building Air Exchanges Per Hour: 0.34 (sheltered double storied)
Time: November 29, 2005 1111 hours EST (using computer's clock)

CHEMICAL INFORMATION:

Chemical Name: CHLORINE
Molecular Weight: 70.91 g/mol
ERPG-3: 20 ppm ERPG-2: 3 ppm ERPG-1: 1 ppm
IDLH: 10 ppm
Carcinogenic risk - see CAMEO
Normal Boiling Point: -29.3° F Ambient Boiling Point: -29.7° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC INFORMATION: (MANUAL INPUT OF DATA)

Wind: 7 mph from 180° true at 3 meters
No Inversion Height
Stability Class: D Air Temperature: 70° F
Relative Humidity: 50% Ground Roughness: urban or forest
Cloud Cover: 5 tenths

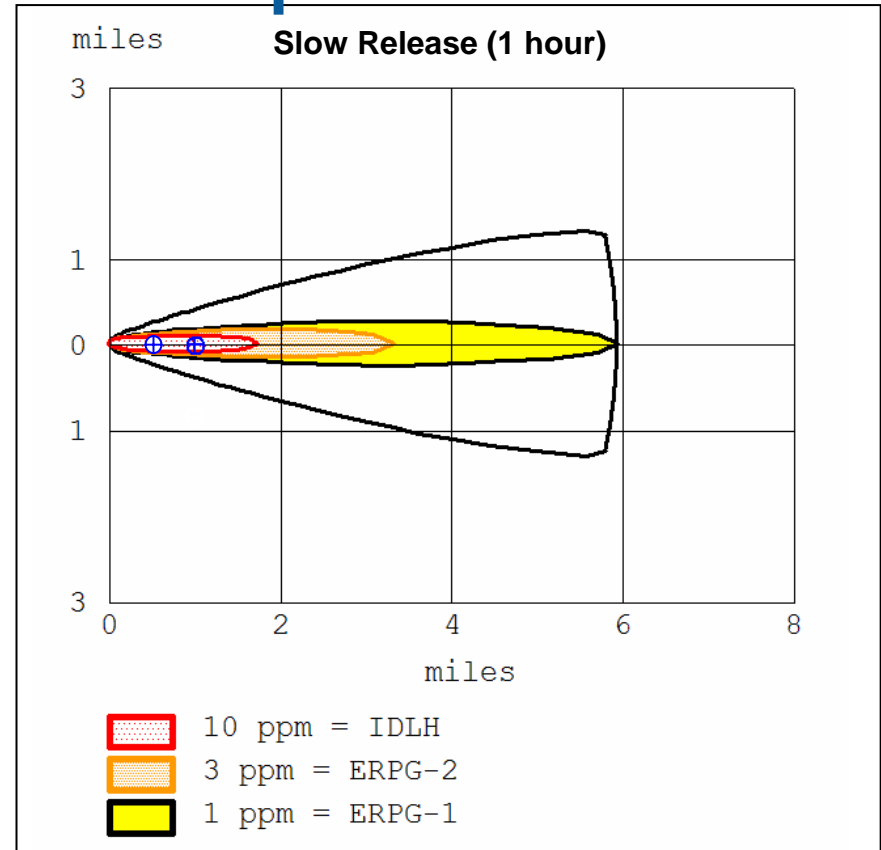
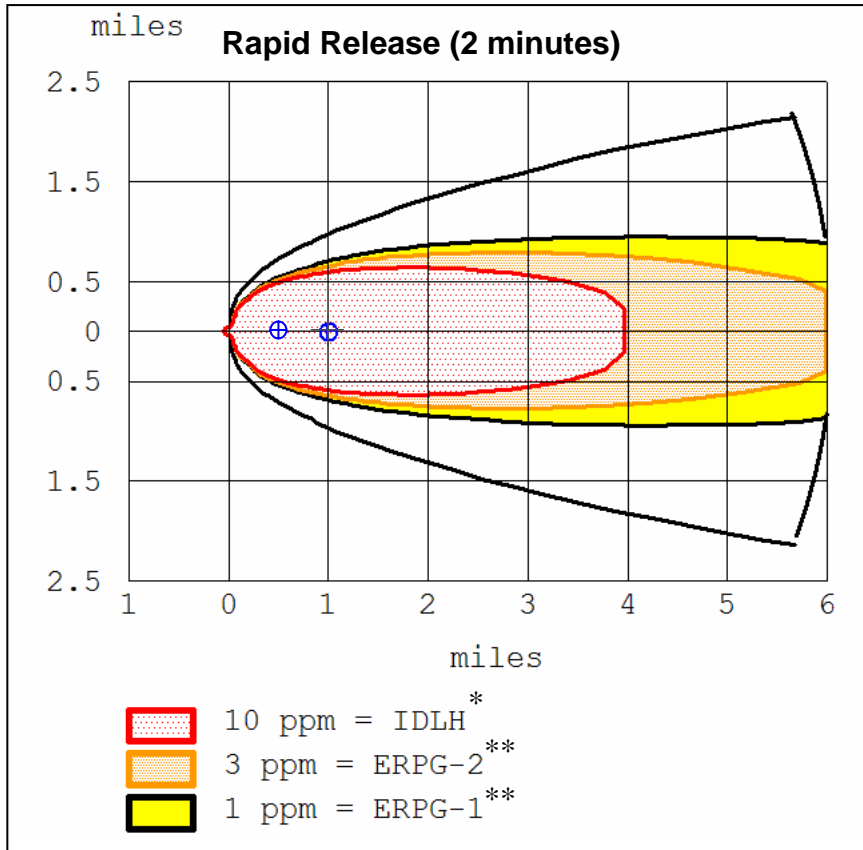
SOURCE STRENGTH INFORMATION:

Leak from hole in horizontal cylindrical tank
Tank Diameter: 6 feet Tank Length: 24.1 feet
Tank Volume: 5100 gallons Tank contains liquid
Internal Temperature: 70° F
Chemical Mass in Tank: 30 tons Tank is 100% full
Circular Opening Diameter: 6 inches
Opening is 6 inches from tank bottom
Release Duration: 2 minutes
Max Average Sustained Release Rate: 57,700 pounds/min
(averaged over a minute or more)
Total Amount Released: 59,200 pounds
Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).



FEMA

Chlorine Release Footprints



- Rapid release yields a large plume
- IDLH four miles long and over 1 mile wide

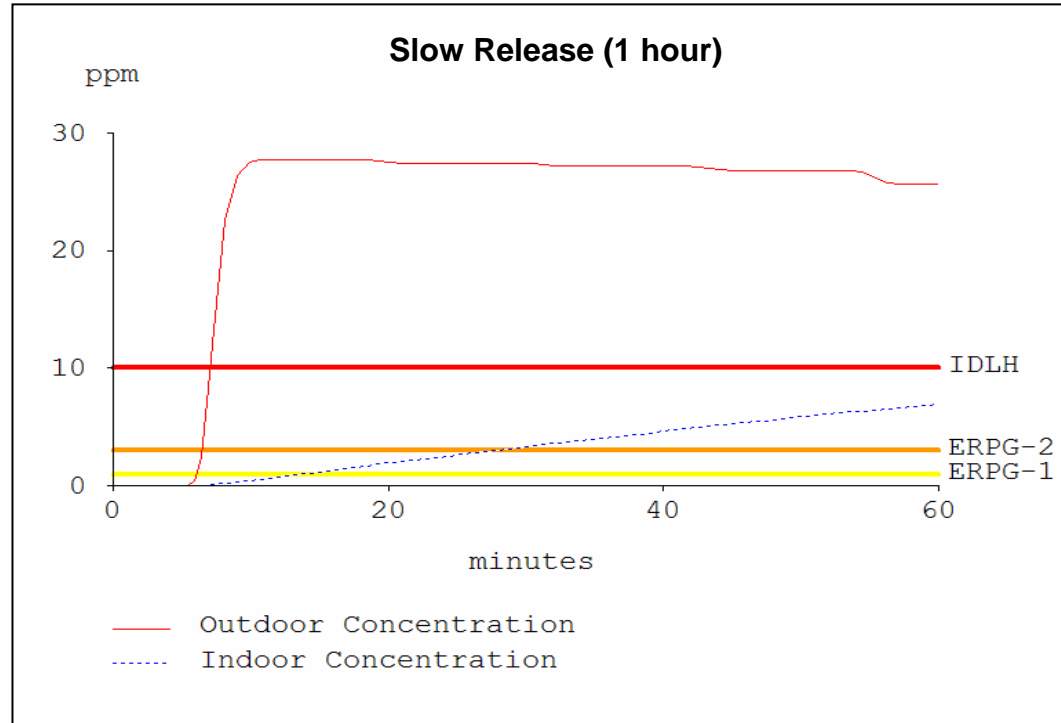
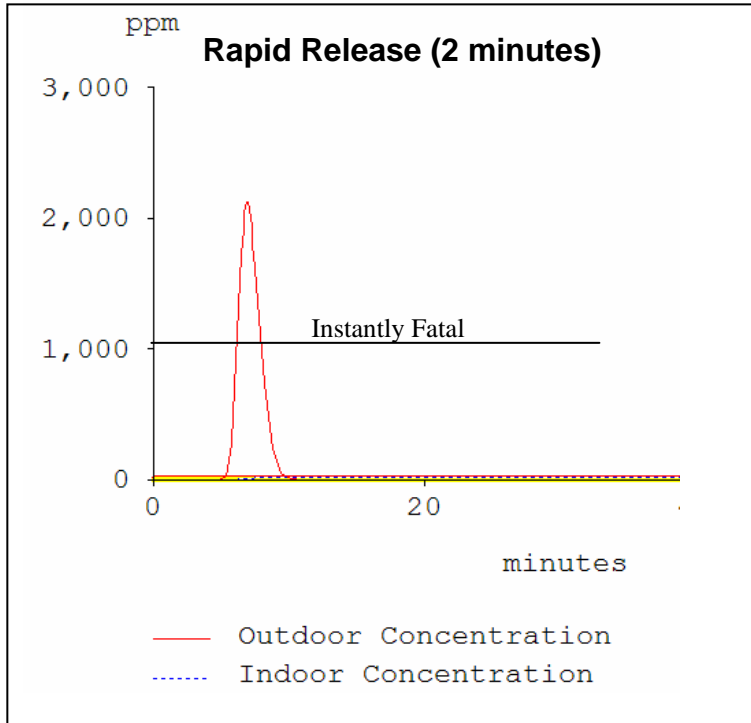
- Slow release reduces plume size
- IDLH less than 2 miles long and 0.5 miles wide

* Immediately Dangerous to Life or Health – maximum concentration that allows 30 minutes exposure without serious or irreversible health risk
 ** Emergency Response Planning Guide (1 hour exposure guidelines) 1 = mild symptoms, 2 = moderate symptoms, but without irreversible damage and not incapacitating



FEMA

Chlorine Concentrations at HIC



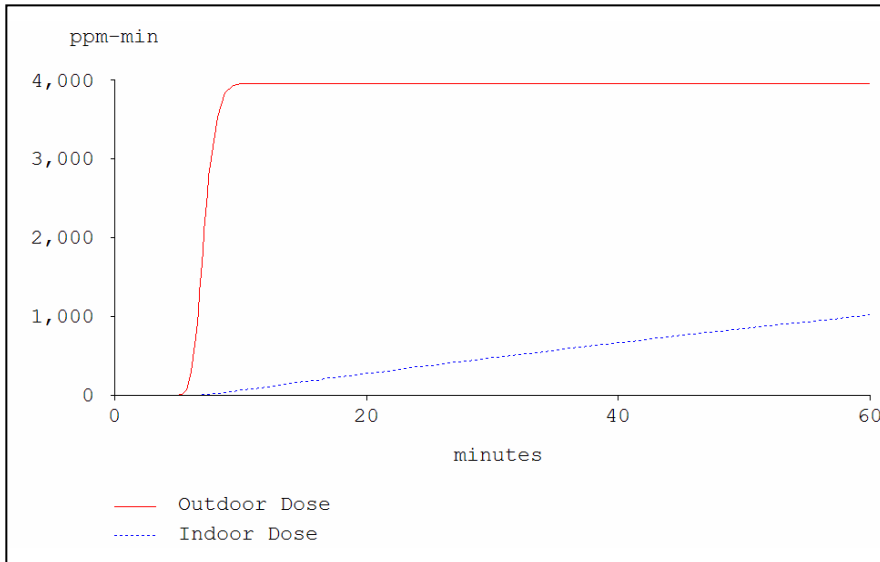
- Rapid spike outdoors at HIC from 6 –12 minutes later
- Instantly fatal concentration levels for this short period
- Indoor concentrations remain low during plume passage
- Evacuees likely to become fatalities from 0.5 to 4 miles downwind during typical evacuation times (5-30 minutes) particularly absent clear/proper evacuation instructions

- Rapid spike outdoors at HIC begins at 6 minutes and continues for over an hour but at 100x lower levels
- Short exposures at 20-30 ppm (2xIDLH) for any lengthy period could cause serious or irreversible health problems
- Indoor concentrations remain below IDLH for > 1 hour and below ERPG 2 for > 0.5 hours



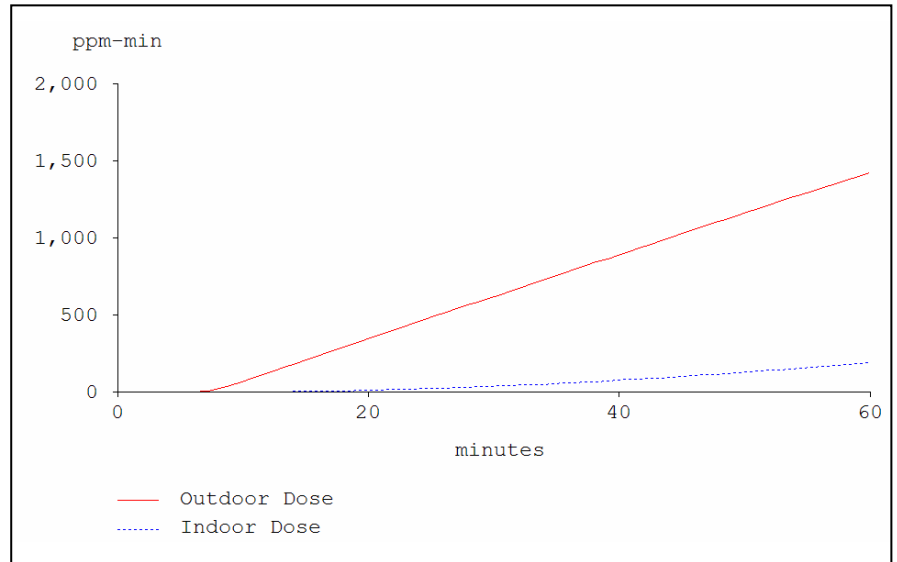
FEMA

Chlorine Dose at HIC



Rapid Release (2 minutes)

- Dose spikes rapidly outdoors at HIC at 6 minutes
- Lethal dose at 6 minutes but no increase in dose after the plume passes (~12 minutes post release)
- Indoor concentrations increase at about 16 ppm 1000ppm-min/60 min. Health problems are likely in less than 30 minutes (IDLH - 10 ppm).



Slow Release (1 hour)

- Dose increases gradually outdoors at HIC beginning at 6 minutes and continues for over an hour but at a rate not much greater than the indoor rates for a rapid release (1 hour dose = 1500 ppm vs 1000 ppm (rapid release))
- Indoor dose remains very low throughout the full hour



FEMA

Vulnerability/Mitigation

IT Communications Systems / Utility Systems / Cyber Attack - Redundancy

Identify alternate telecom carrier circuits and availability



FEMA

Vulnerability/Mitigation

Emergency Operations & Response

Post shelter and evacuation procedures - \$900

Identify rally points (A, B, C) at sites away from building - \$900

Conference Room for shelter-in-place (130 people)
[Sealing and Overpressurization] –\$177.4K

Personal protective evacuation hoods - \$180 / person - \$23.4K



FEMA