

BUILDING DESIGN FOR HOMELAND SECURITY COOP T-t-T

Unit XII

Case Study



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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.



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Cooperville Information / Business Center

Company

- Functions
- Infrastructure

Threats/Hazards

- Design Basis Threat
- Levels of Protection

Vulnerabilities

- Impact
- Mitigation

Report



Cooperville Information / Business Center (CI/BC)



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Coopersville Information / Business Center

IT services and support and temporary office facilities

- 75+ 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

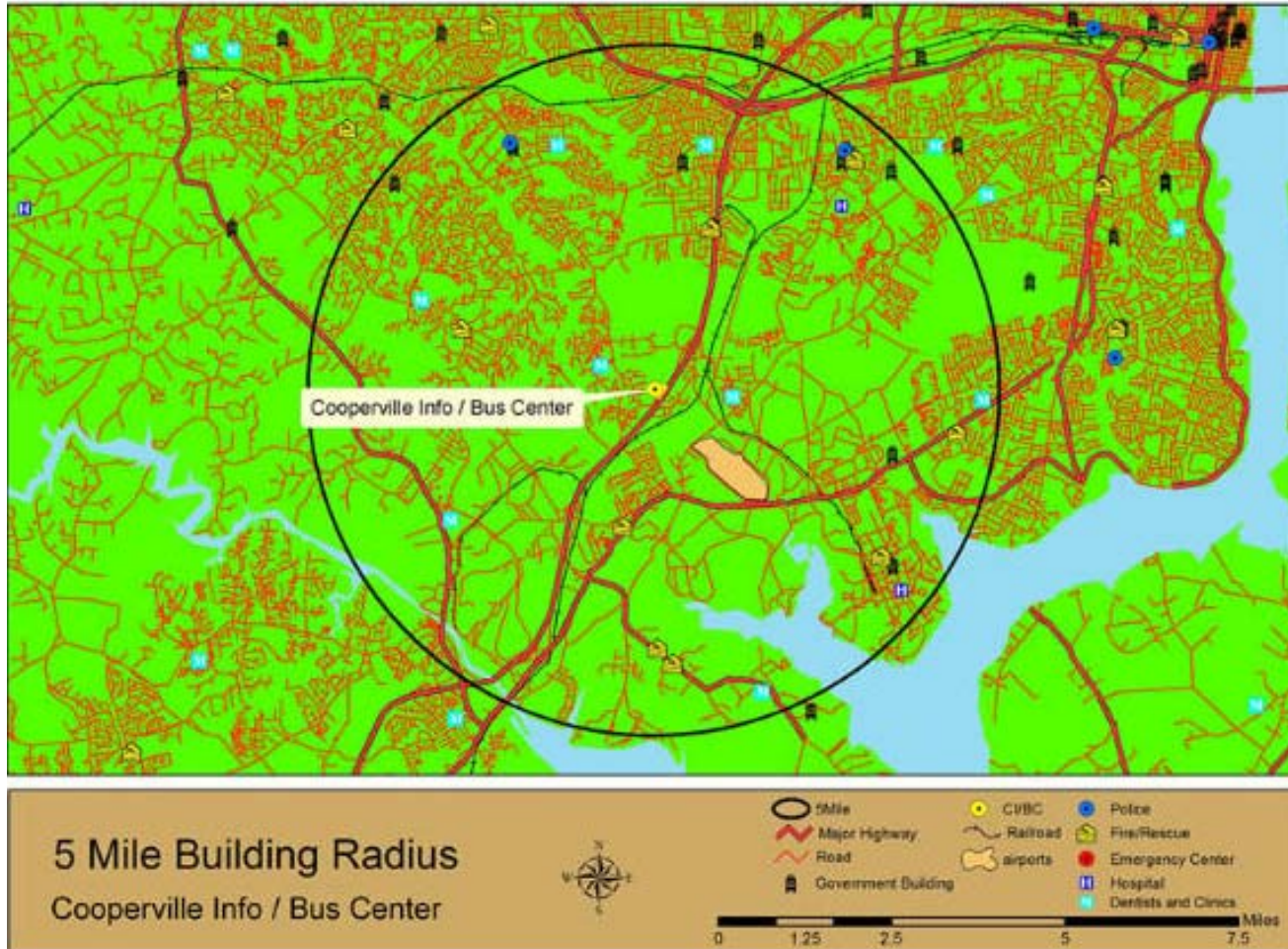
BUILDING DESIGN FOR HOMELAND SECURITY COOP T-t-T

Unit XII-C-4



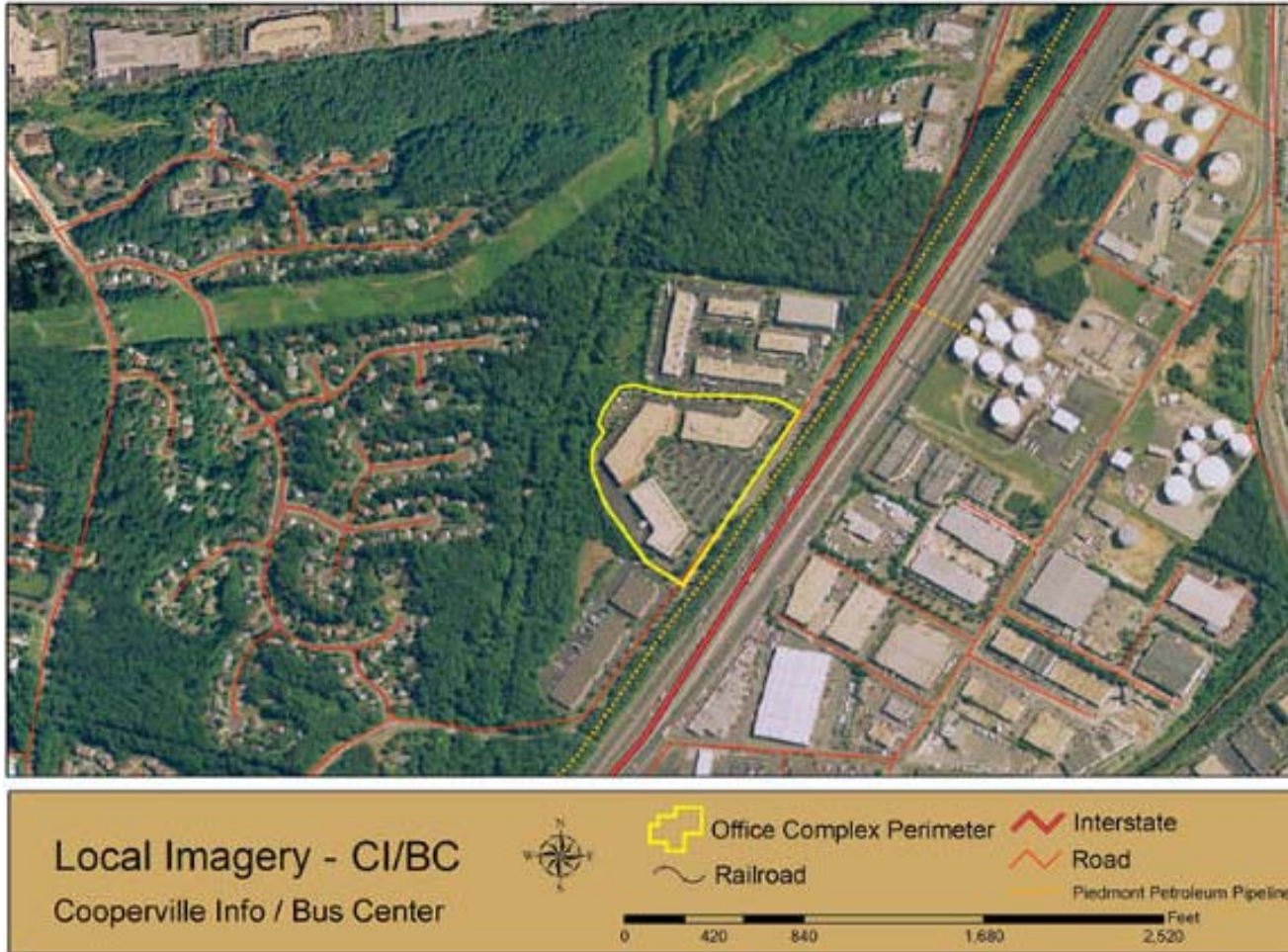
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5-Mile Building Radius



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Local Imagery



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

Site Imagery



Site Imagery - CI/BC
Cooperville Info / Bus Center

0 125 250 500 750 Feet

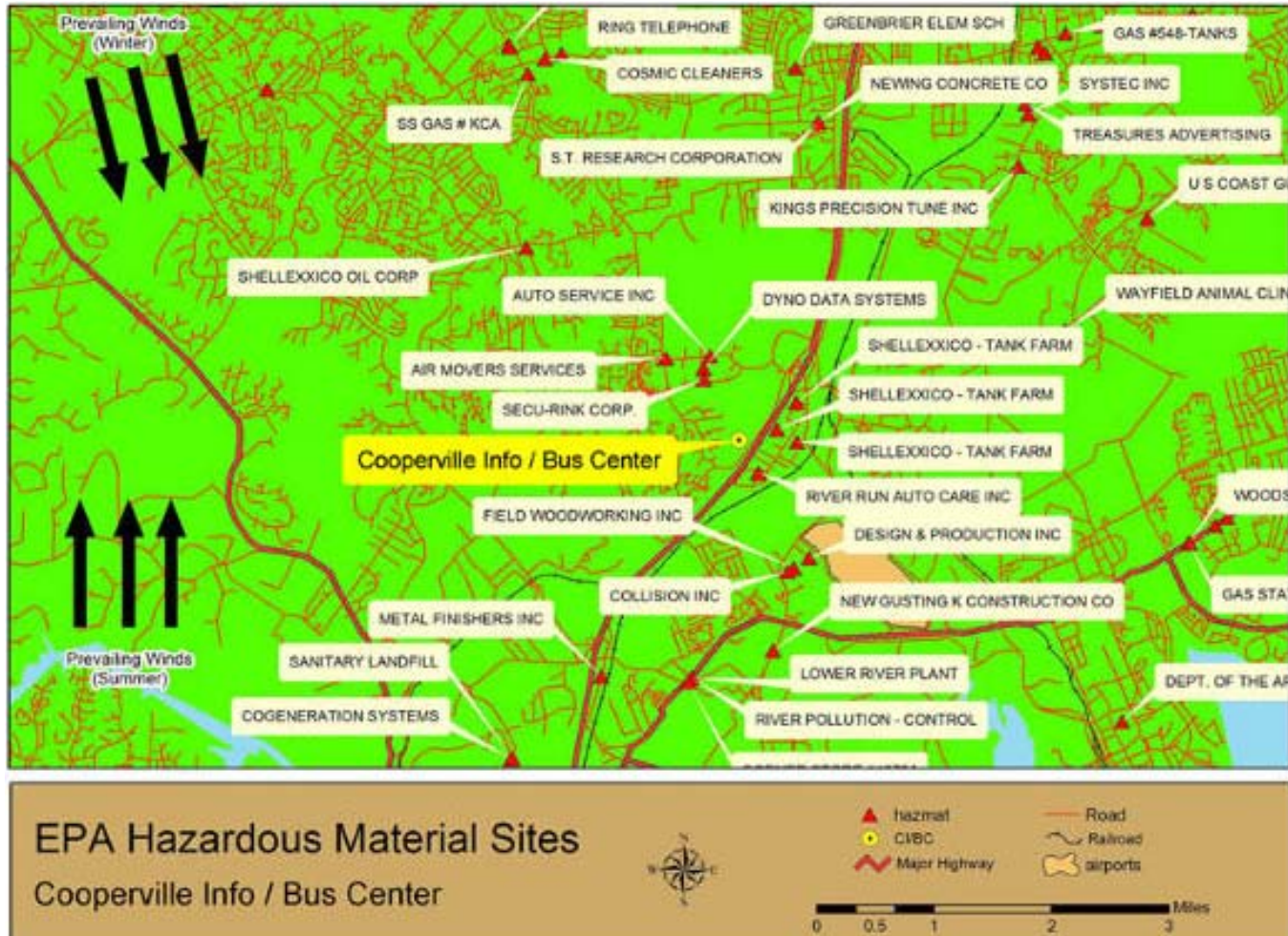
CI/BC Property
Office Complex Perimeter
Entry Point

Fence
1 Meter Color Aerial Imagery



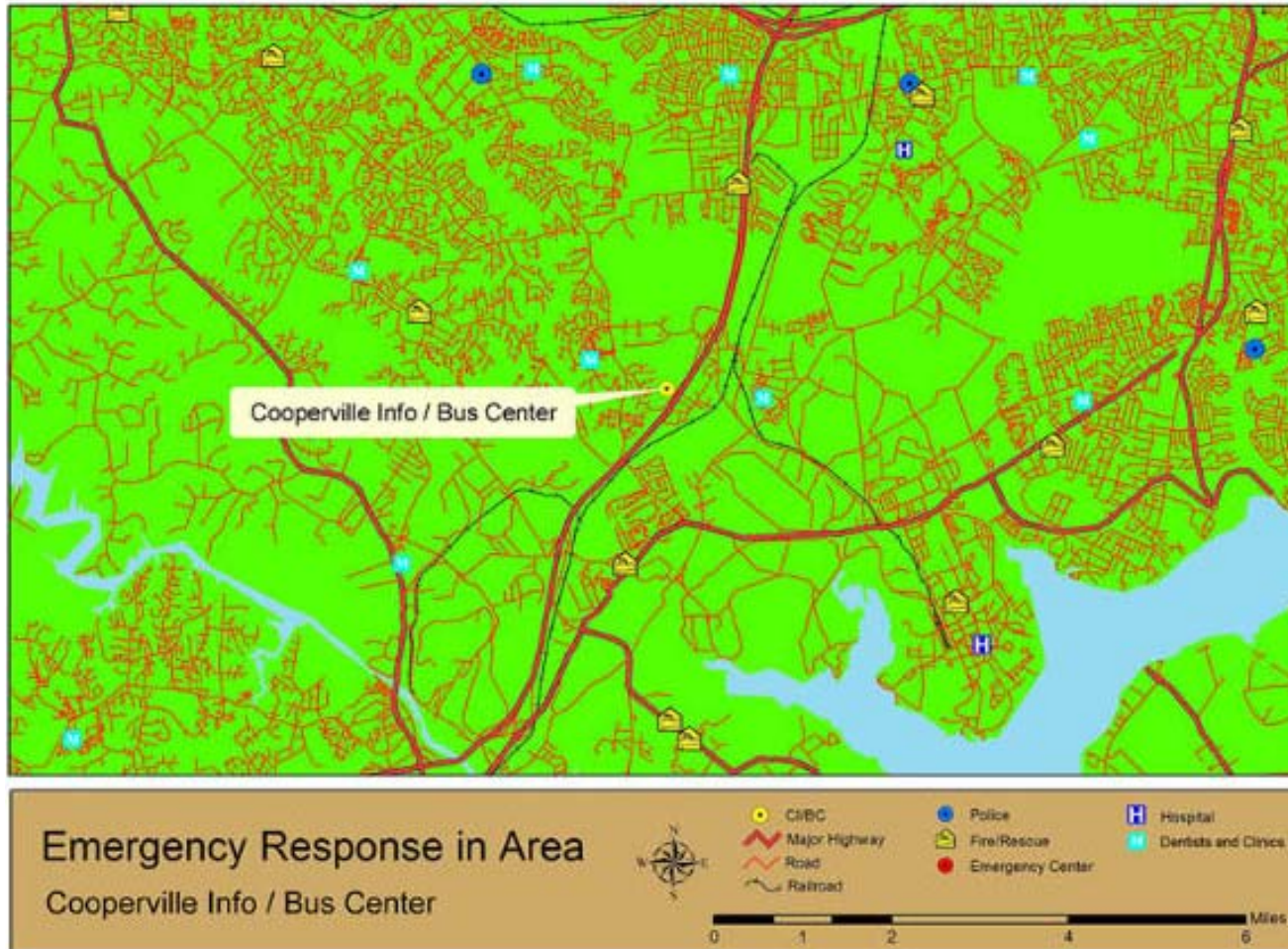
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HazMat Sites



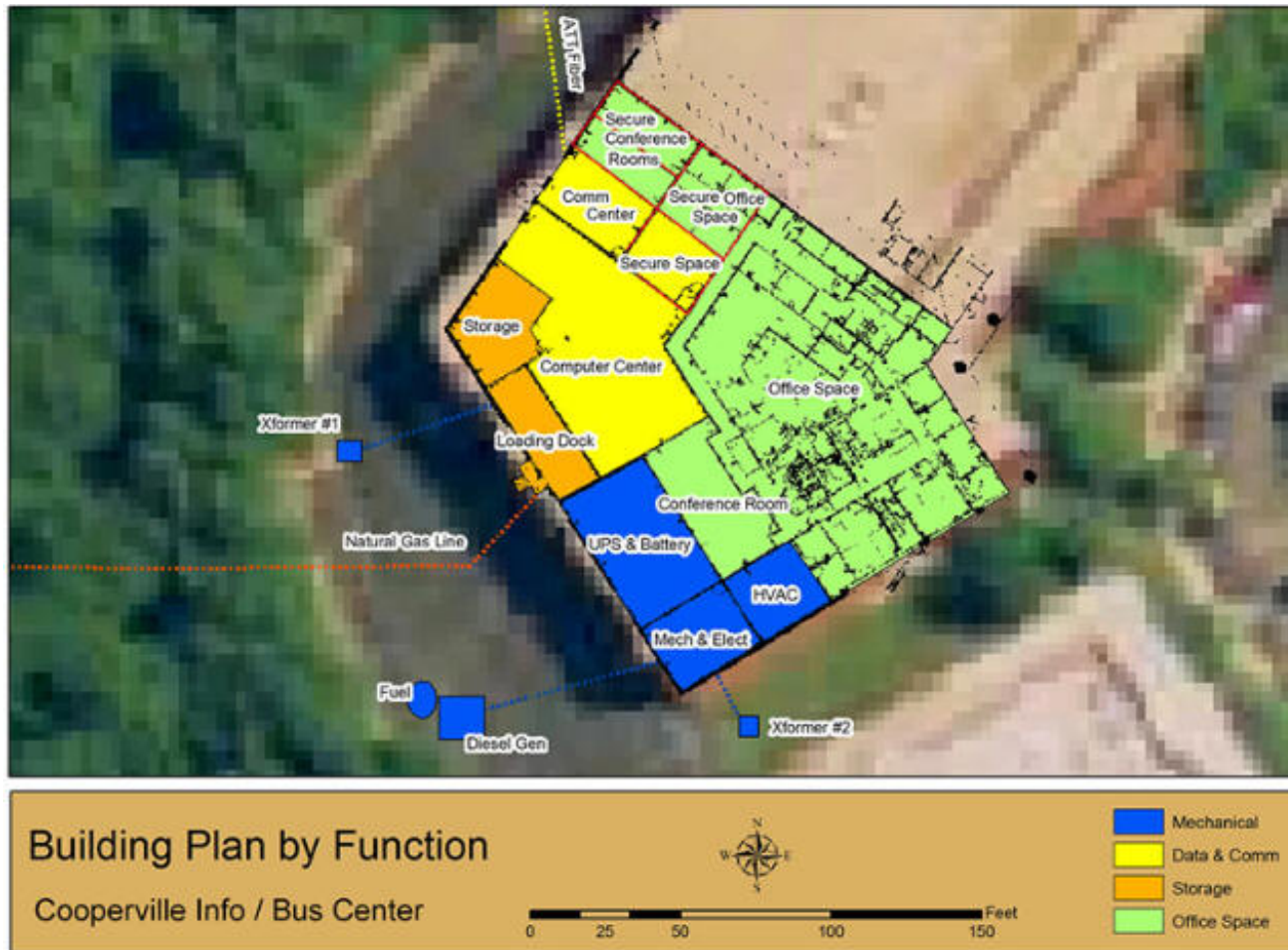
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Emergency Response



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Functional Layout

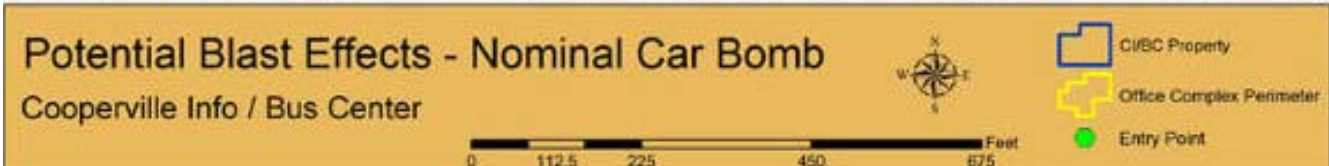


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Car Bomb Blast Effects

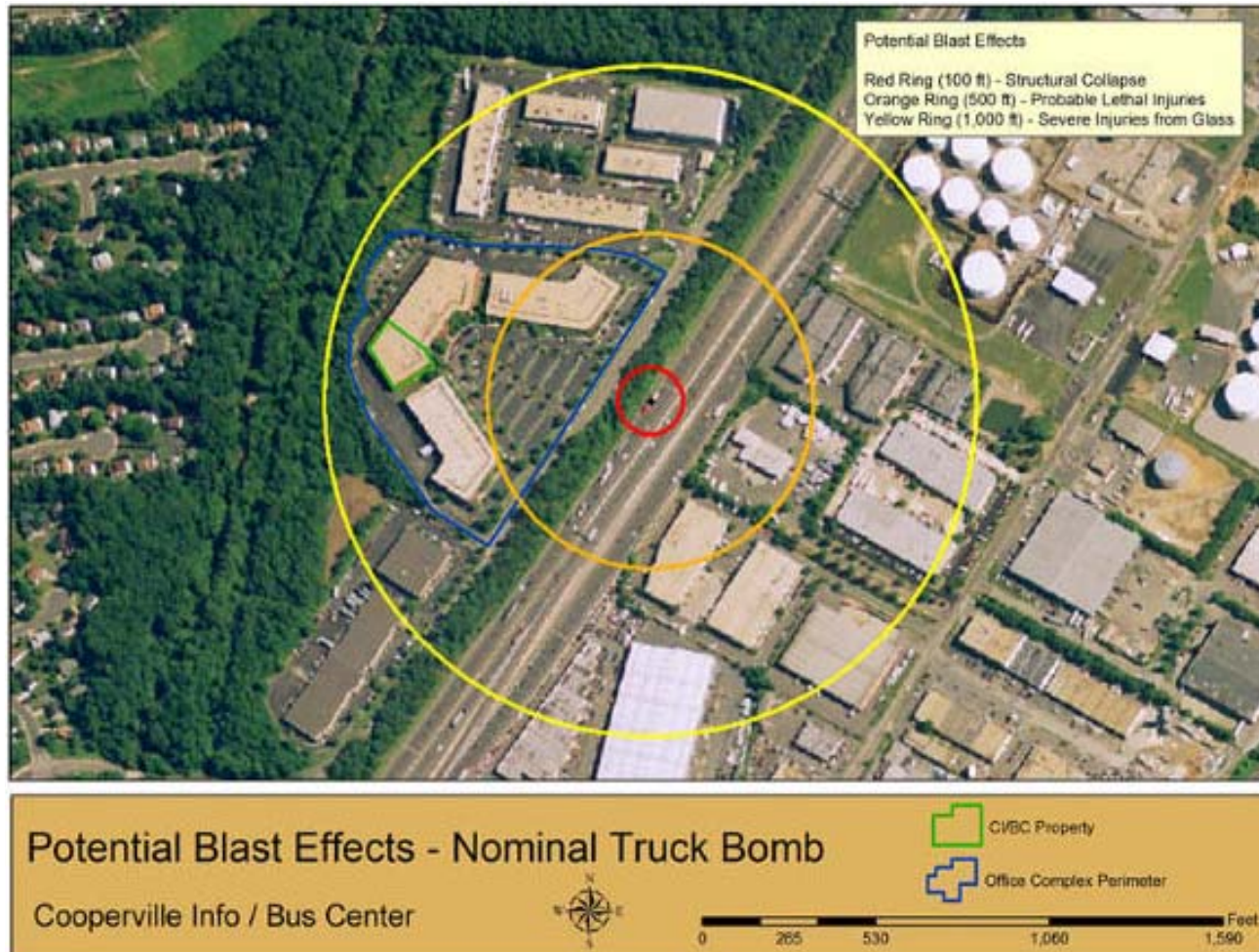


Potential Blast Effects
Red Ring (20 ft) – Structural Damage
Orange Ring (100 ft) – Probable Lethal Injuries
Yellow Ring (150 ft) – Severe Injuries from Glass



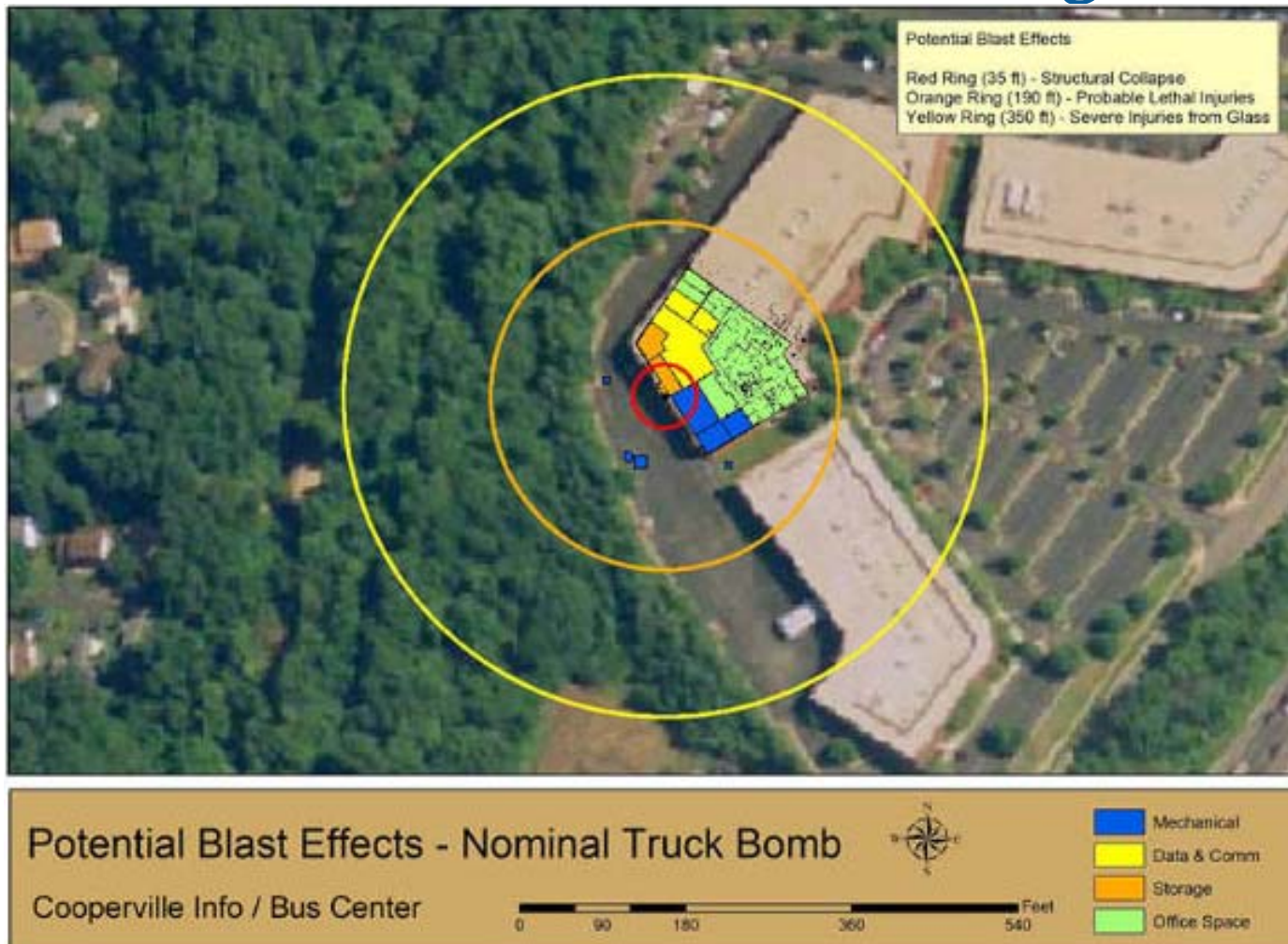
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Truck Bomb Blast Effects - Highway



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Truck Bomb Blast Effects – Loading Dock



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Building Data

Infrastructure

Structural

- 2 Story Steel Frame with brick façade
- Annealed glass

Mechanical

- HVAC
- Gas
- Fire Suppression

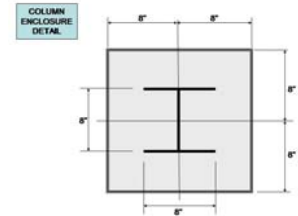
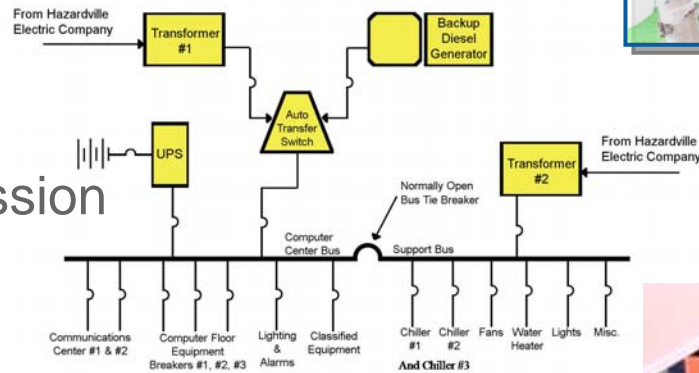
Electrical

- Primary
- Back-up

IT

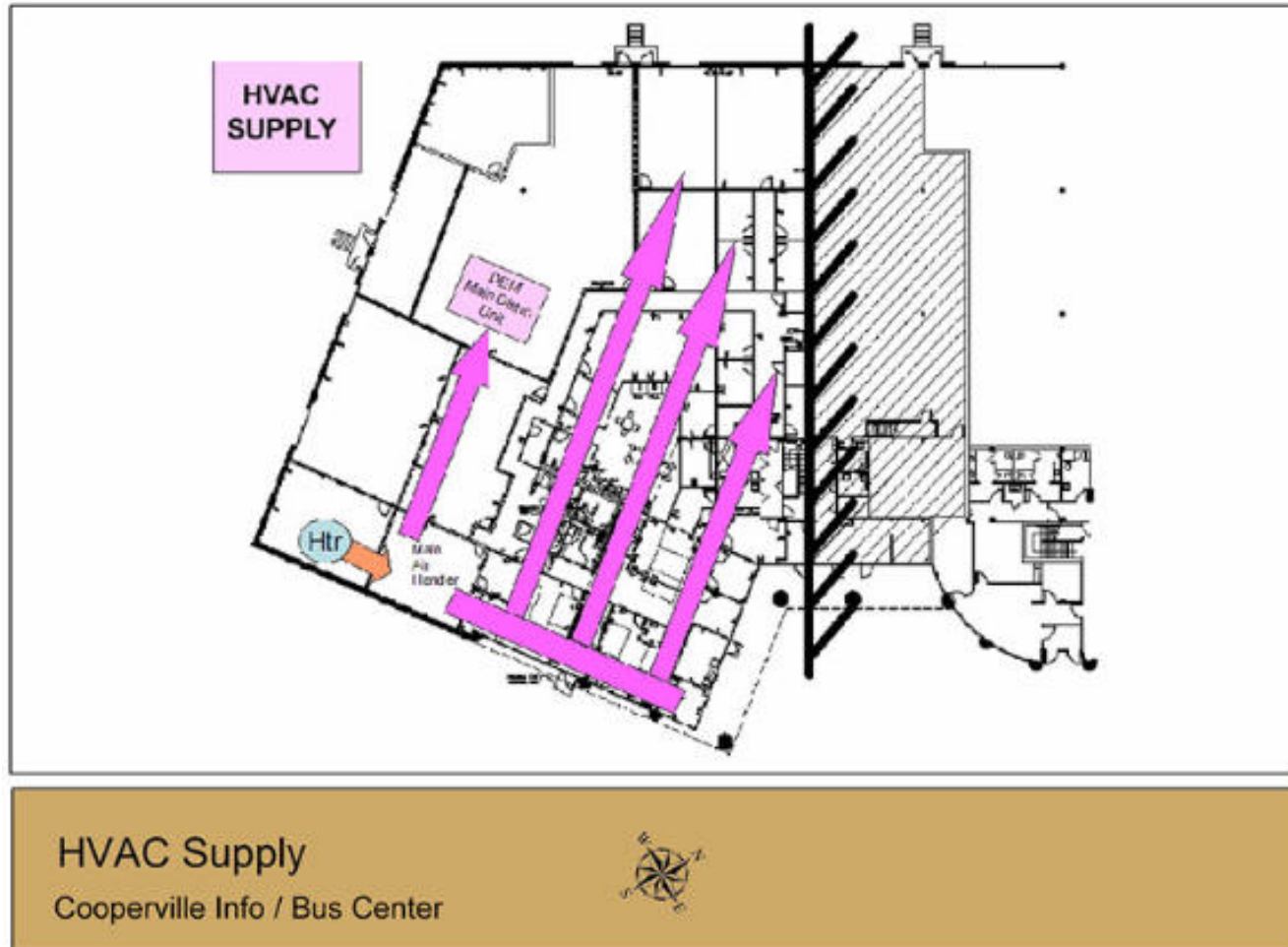
- Data Center
- Telecom

Physical Security



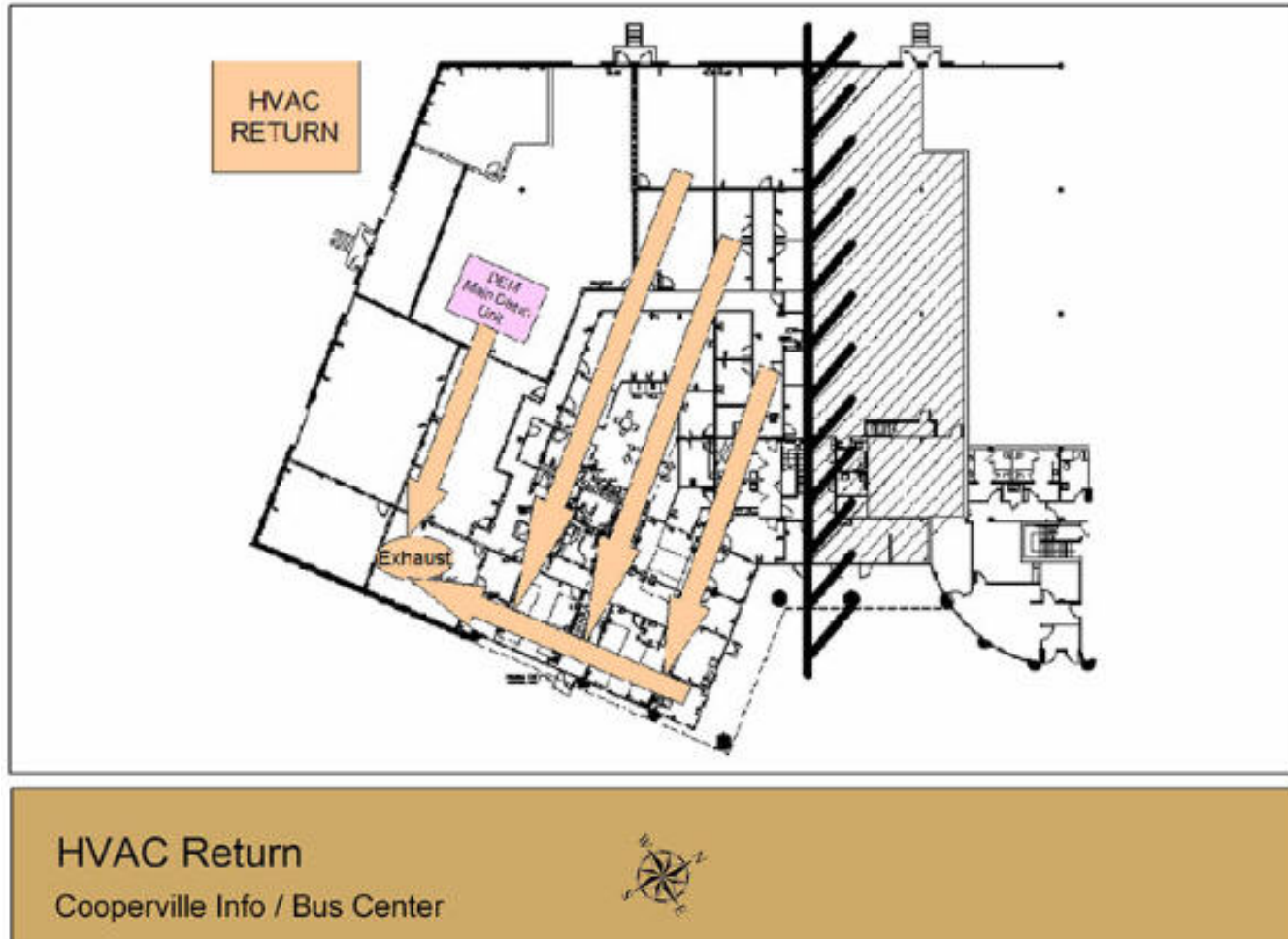
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Mechanical Systems



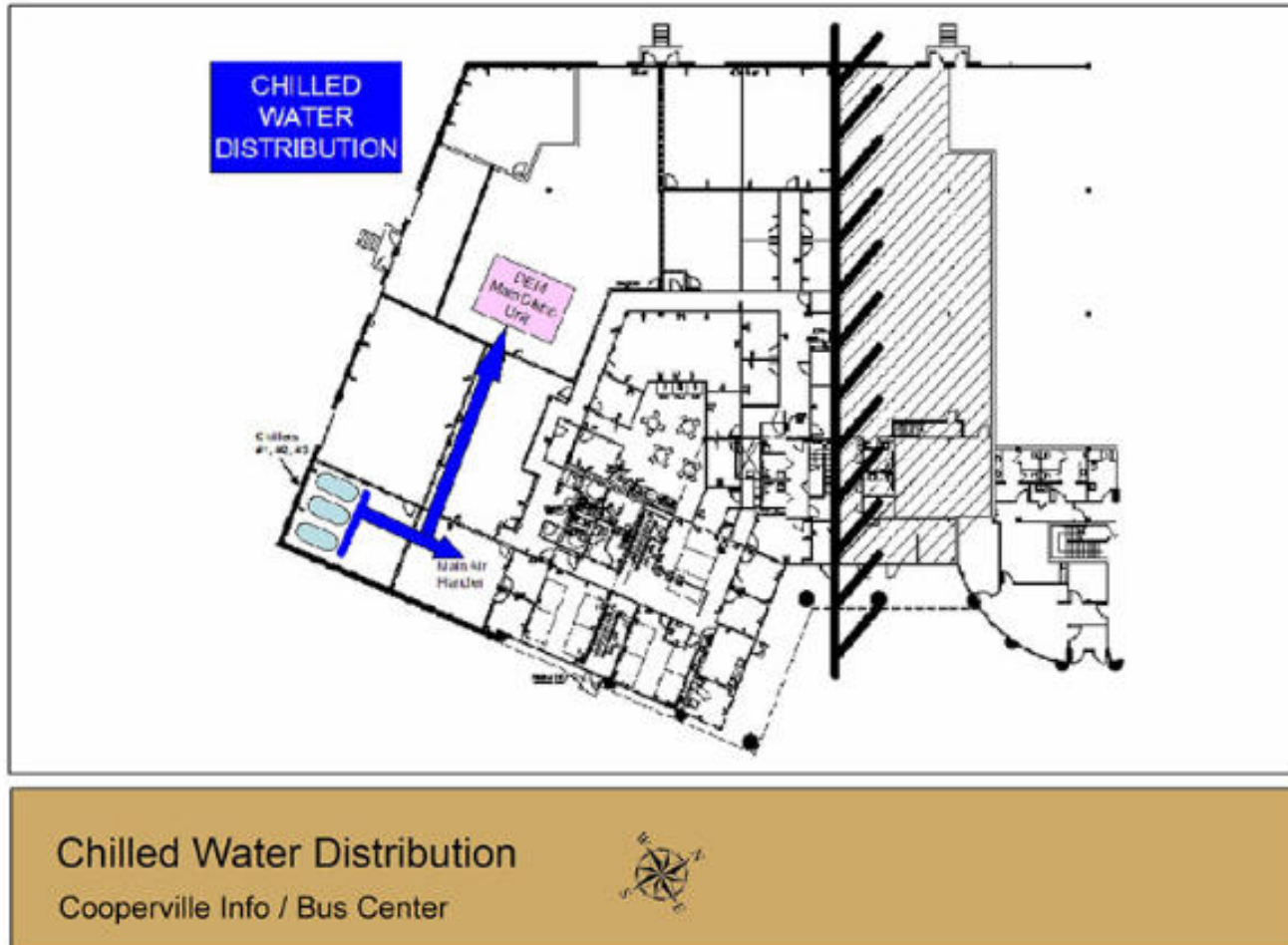
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Mechanical Systems



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Mechanical Systems

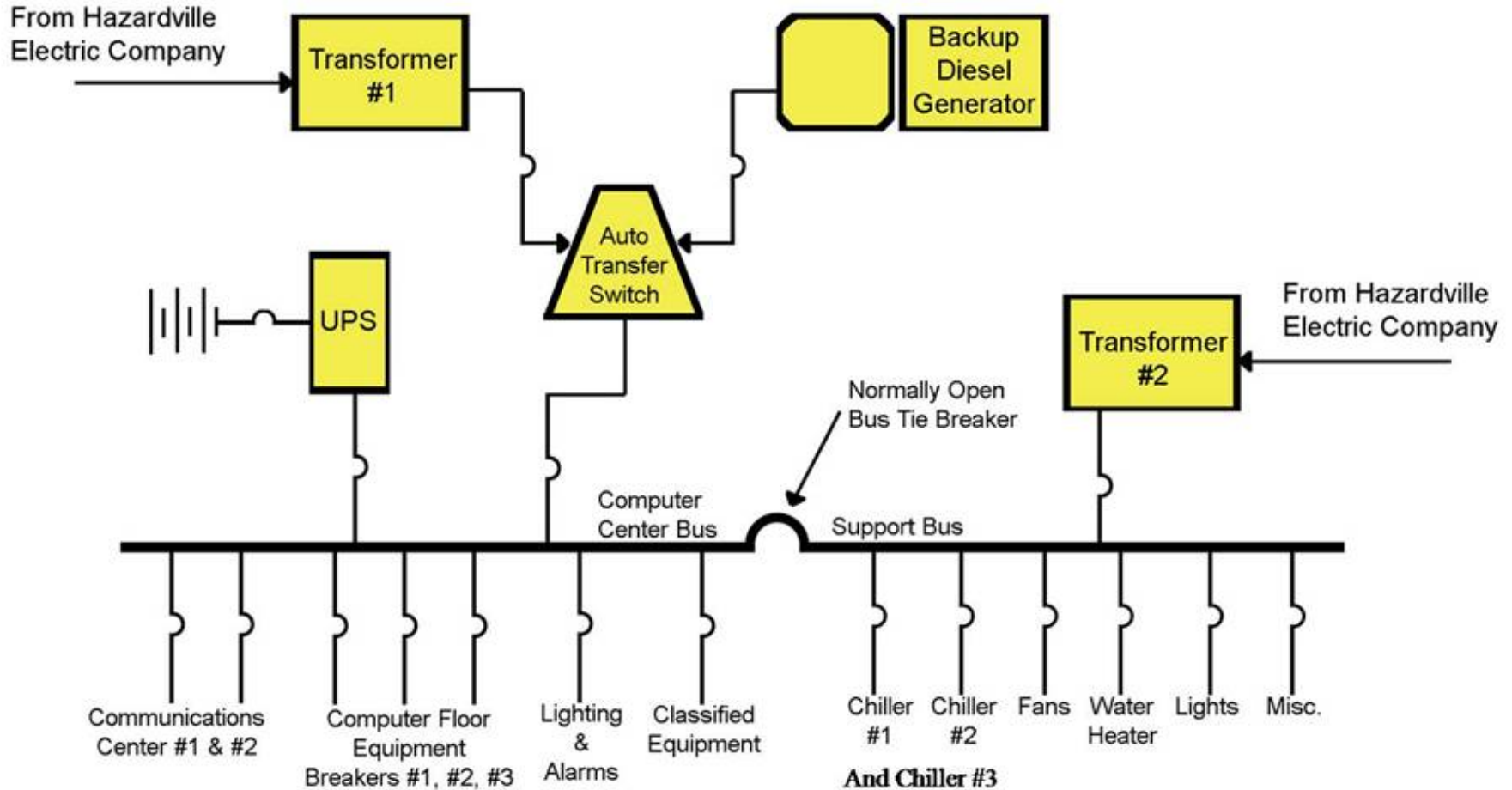


Chilled Water Distribution
Cooperville Info / Bus Center



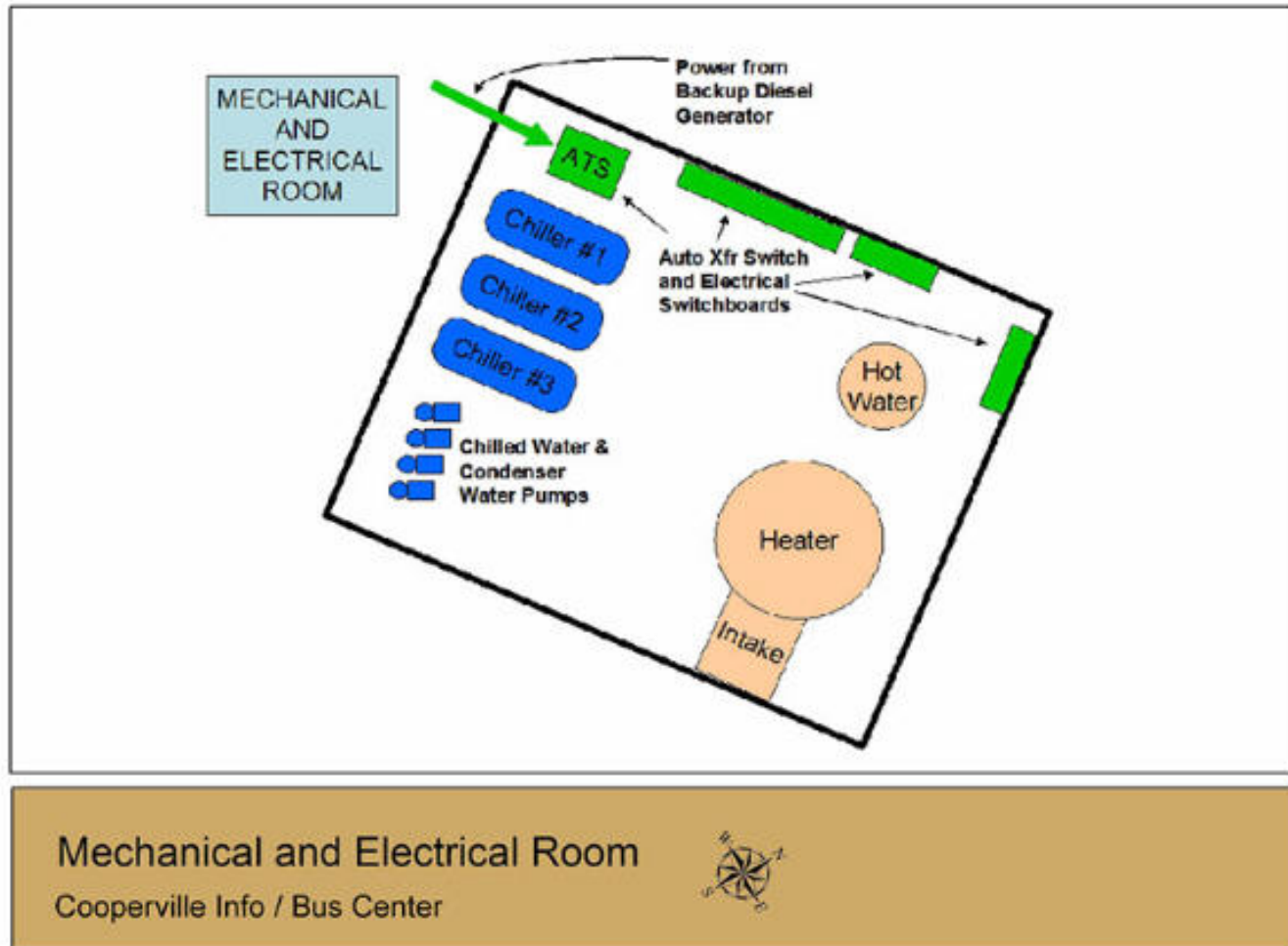
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Electrical Systems



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Mechanical and Electrical Room



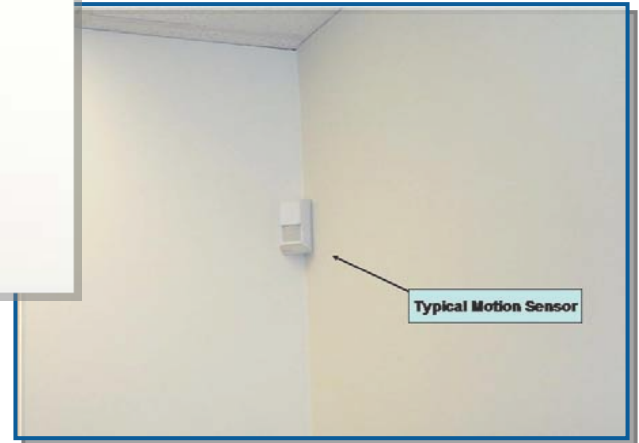
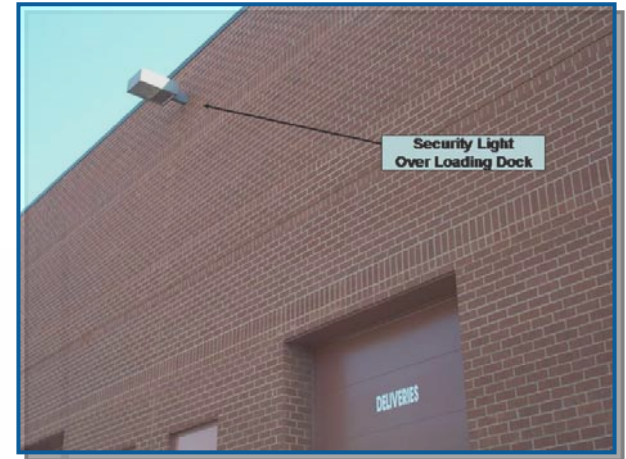
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Information Technology



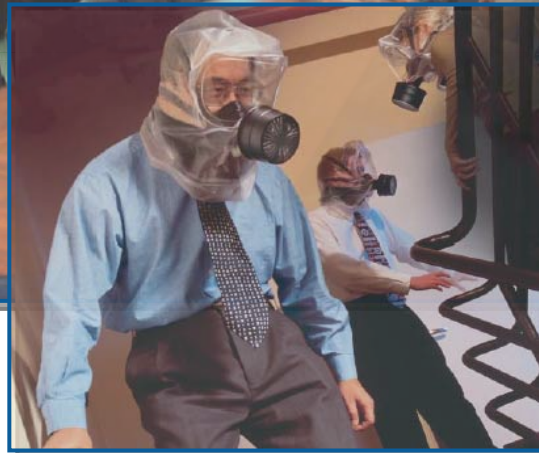
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Physical Security



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Emergency Response



Source: Mine Safety Appliances Company



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Threats/Hazards

Threats include:

Terrorism

- No direct threat to CI/BC
- Government, military, industry in the area

Intelligence Collection

Crime

- High threat in metro area, lower in suburbs



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Threats/Hazards

Threats (continued):

HazMat -- nearby facilities

- Fuel farm and pipeline
- Interstate highway
- Rail line

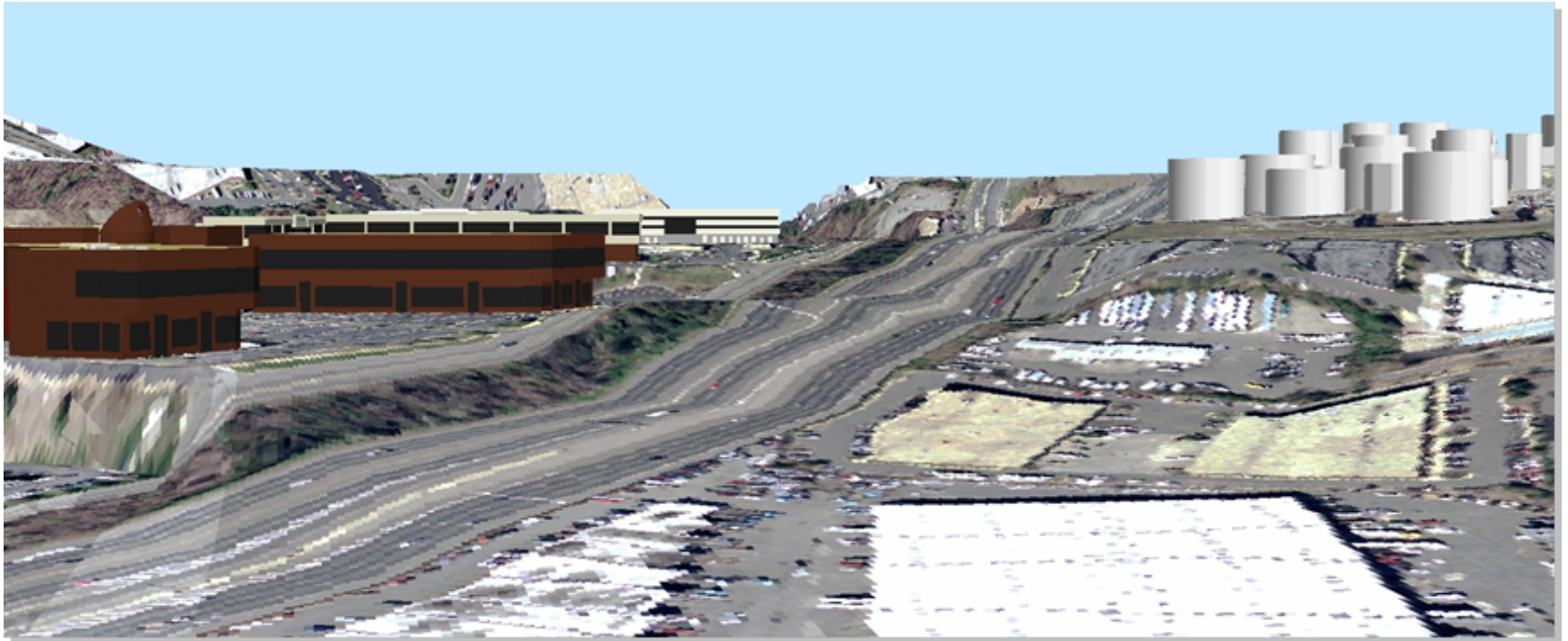
Natural Hazards

- Hurricanes – Infrequent
- Tornadoes – Almost every Spring
- Earthquakes – Low intensity and low probability
- Flooding – Not in 100 Yr Flood Plain
- Lightning - Frequent



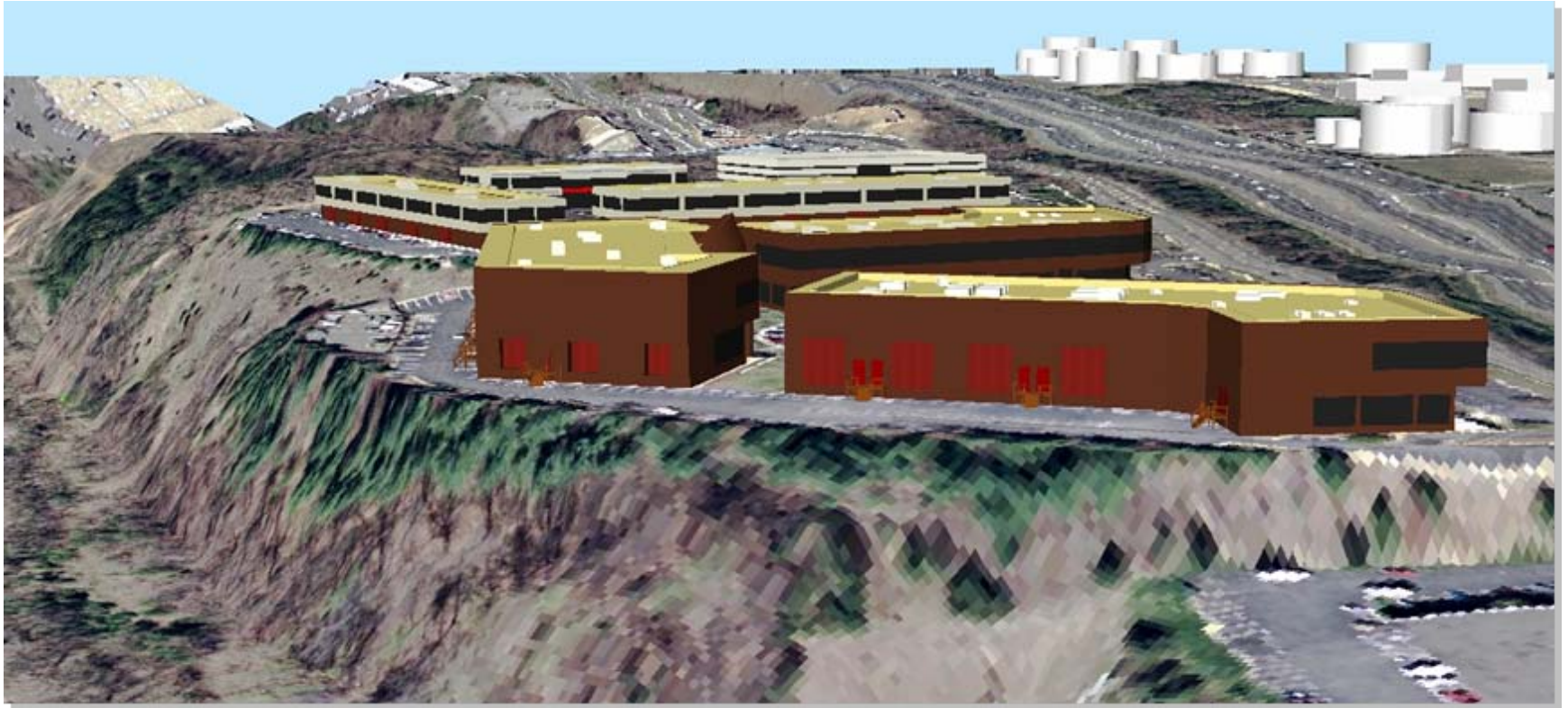
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Computerized Elevation Looking Northwest



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Computerized Elevation Looking Northeast



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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 CI/BC building



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Levels of Protection

DHS Interagency Security Committee 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



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Levels of Protection

DoD Antiterrorism Standards

| Level of Protection | Potential Structural Damage | Potential Door and Glazing Hazards | Potential Injury |
|---------------------|---|--|--|
| Low | <p>Moderate damage – Building damage will not be economically repairable.</p> <p>Progressive collapse will not occur.</p> <p>Space in and around damaged area will be unusable.</p> | <p>Glazing will fracture, potentially come out of the frame, but at a reduced velocity, does not present a significant injury hazard. (Very low hazard rating)</p> <p>Doors may fail, but they will rebound out of their frames, presenting minimal hazards.</p> | <p>Majority of personnel in damaged area suffer minor to moderate injuries with the potential for a few serious injuries, but fatalities are unlikely.</p> <p>Personnel in areas outside damaged areas will potentially experience minor to moderate injuries.</p> |



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FEMA 426, Adapted from Table 4-1: DoD Minimum Antiterrorism Standards for New Buildings, p. 4-9, updated for *UFC 4-010-01*, 22 Jan 2007

Levels of Protection

DoD Antiterrorism Standards

| Location | Building Category | Stand-off Distance or Separation Requirements | | | |
|---|----------------------------|---|--|----------------------------|------------------------------|
| | | Applicable Level of Protection | Conventional Construction Stand-off Distance | Minimum Stand-off Distance | Applicable Explosives Weight |
| Controlled Perimeter or Parking and Roadways without a Controlled Perimeter | Primary Gathering Building | Low | 45 m 148 ft | 25 m 82 ft | Car Bomb |



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Adapted from DoD Unified Facilities Criteria (UFC), “DoD Minimum Antiterrorism Standards for New Buildings”, UFC 4-010-01, 22 Jan 2007

Levels of Protection

UFC 4-010-01 APPENDIX B

DoD MINIMUM ANTITERRORISM STANDARDS FOR NEW AND EXISTING BUILDINGS

| | |
|--------------------|--|
| Standard 1 | 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 and Skylights |
| Standard 11 | Building Entrance Layout |
| Standard 12 | Exterior Doors |



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Levels of Protection (continued)

| UFC 4-010-01 APPENDIX B DoD MINIMUM ANTITERRORISM STANDARDS FOR NEW AND EXISTING BUILDINGS | |
|---|---|
| Standard 13 | Mail Rooms |
| Standard 14 | Roof Access |
| Standard 15 | Overhead Mounted Architectural Features |
| Standard 16 | Air Intakes |
| Standard 17 | Mail Room 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 |



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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, including COOP requirements not yet met

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



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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



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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



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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



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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



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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



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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



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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)



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Infill Hardening

Overhang Infill – Brick Only

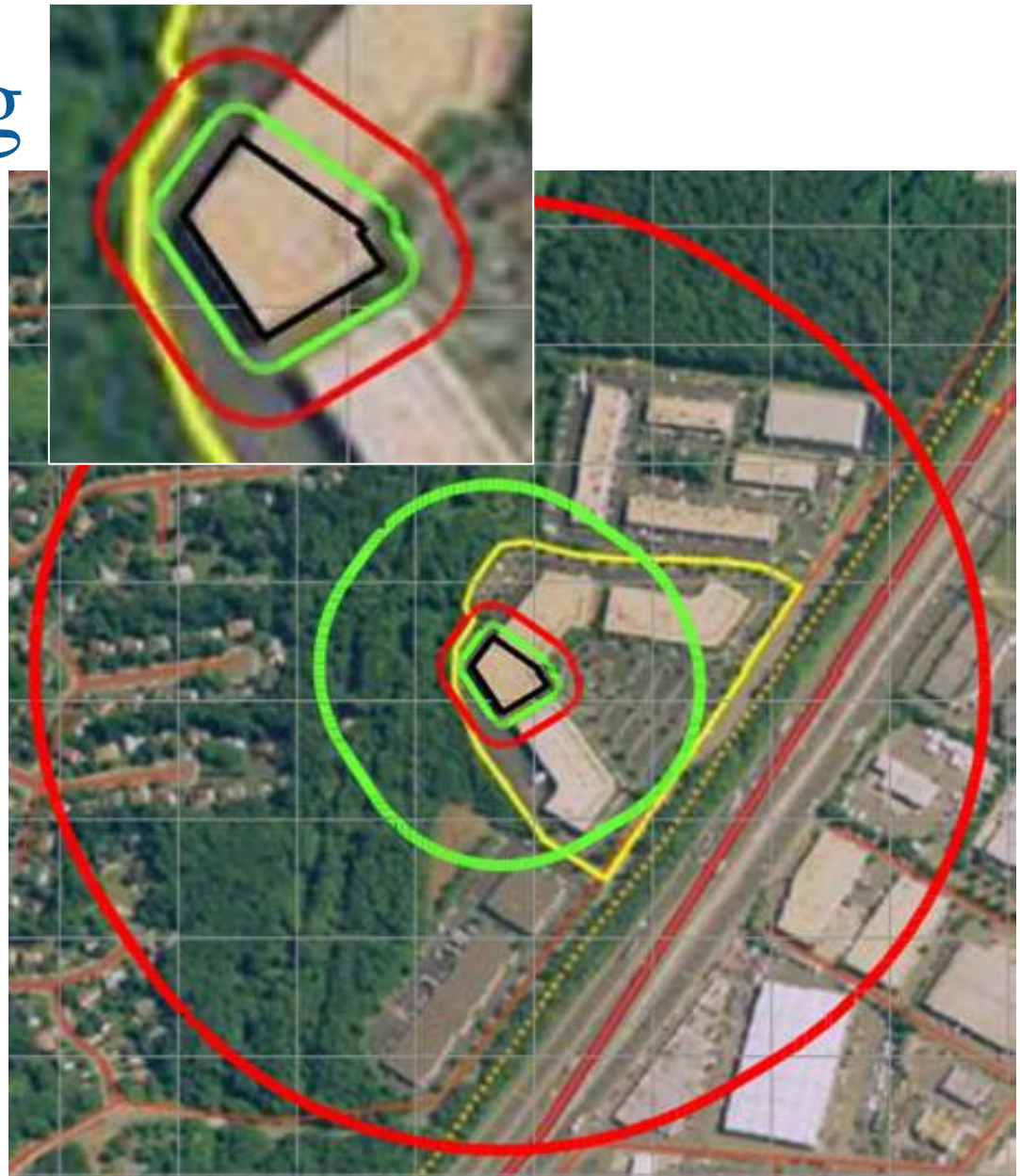
 Large DBT – 1,210 ft

 Small DBT – 88 ft

Hardened Overhang Infill
w/ R/C Backup Wall

 Large DBT – 422 ft

 Small DBT – 32 ft



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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



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Vulnerability/Mitigation

Building Envelope / Vehicle Bomb

Harden walls (balanced envelope)

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



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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



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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



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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



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Vulnerability/Mitigation

Architectural / Vehicle Bomb

Strengthen overhead anchorage elements

- Heaters - \$2.1K



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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



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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



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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



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Vulnerability/Mitigation

Mechanical Systems / Fire Alarm Systems / General Vulnerability – Redundancy

Fire Alarm / Suppression

- Install annunciator panel - \$3.5K
- Fire detection zones for CI/BC 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



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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



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Vulnerability/Mitigation

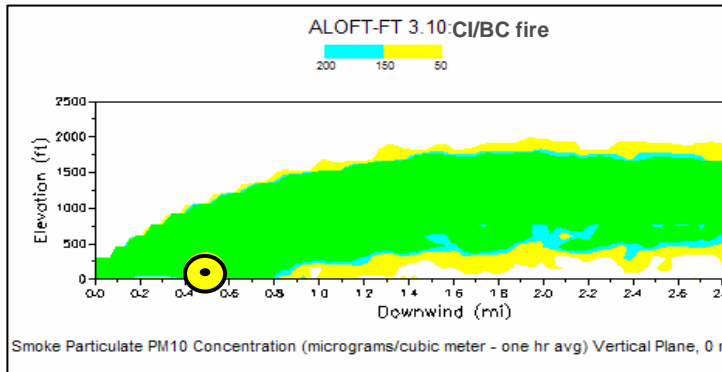
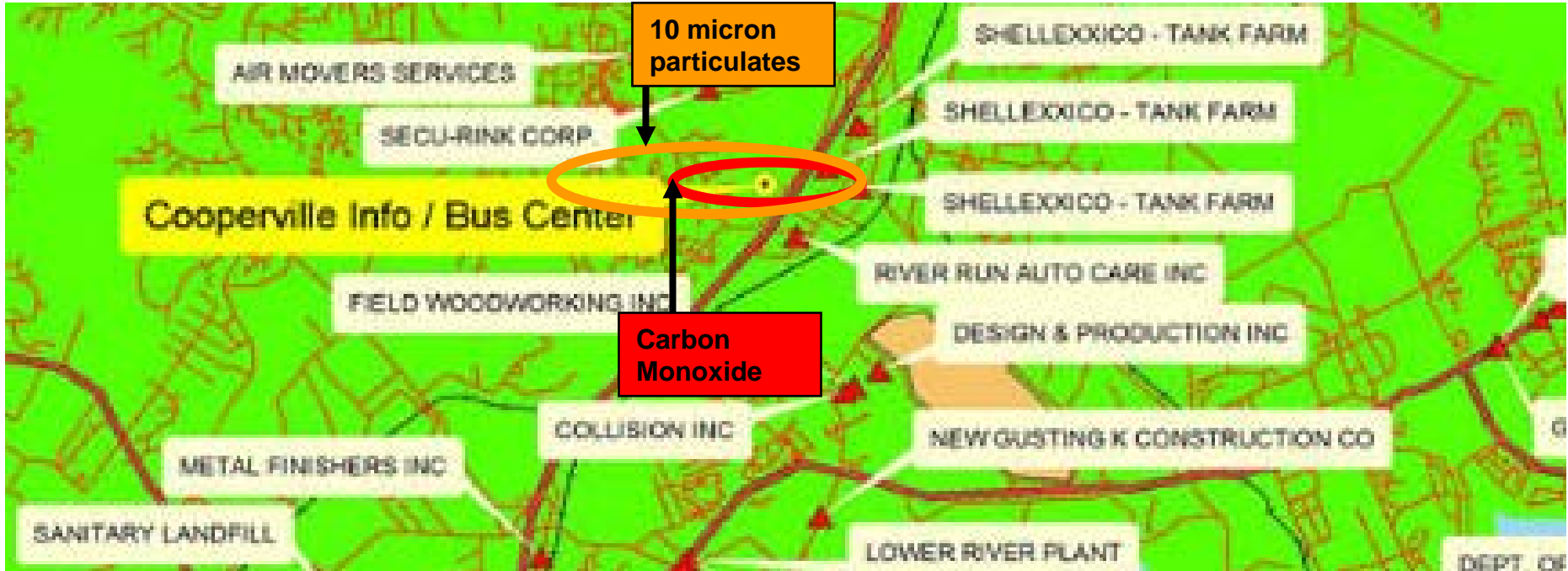
Mechanical Systems-HVAC / CBR Attack

- 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)

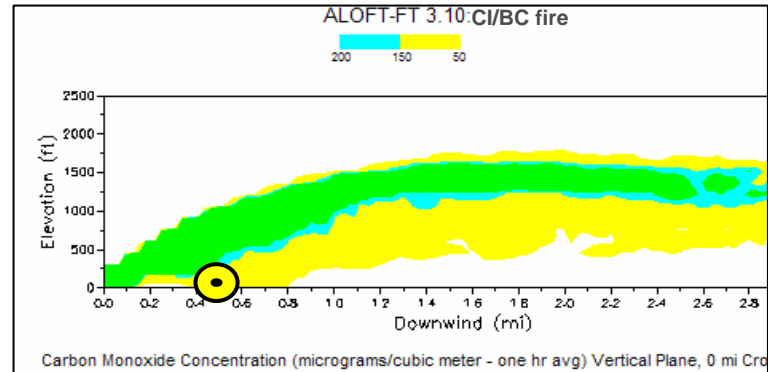


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Fire Plumes – Smoke & CO



Smoke Particles



Carbon Monoxide



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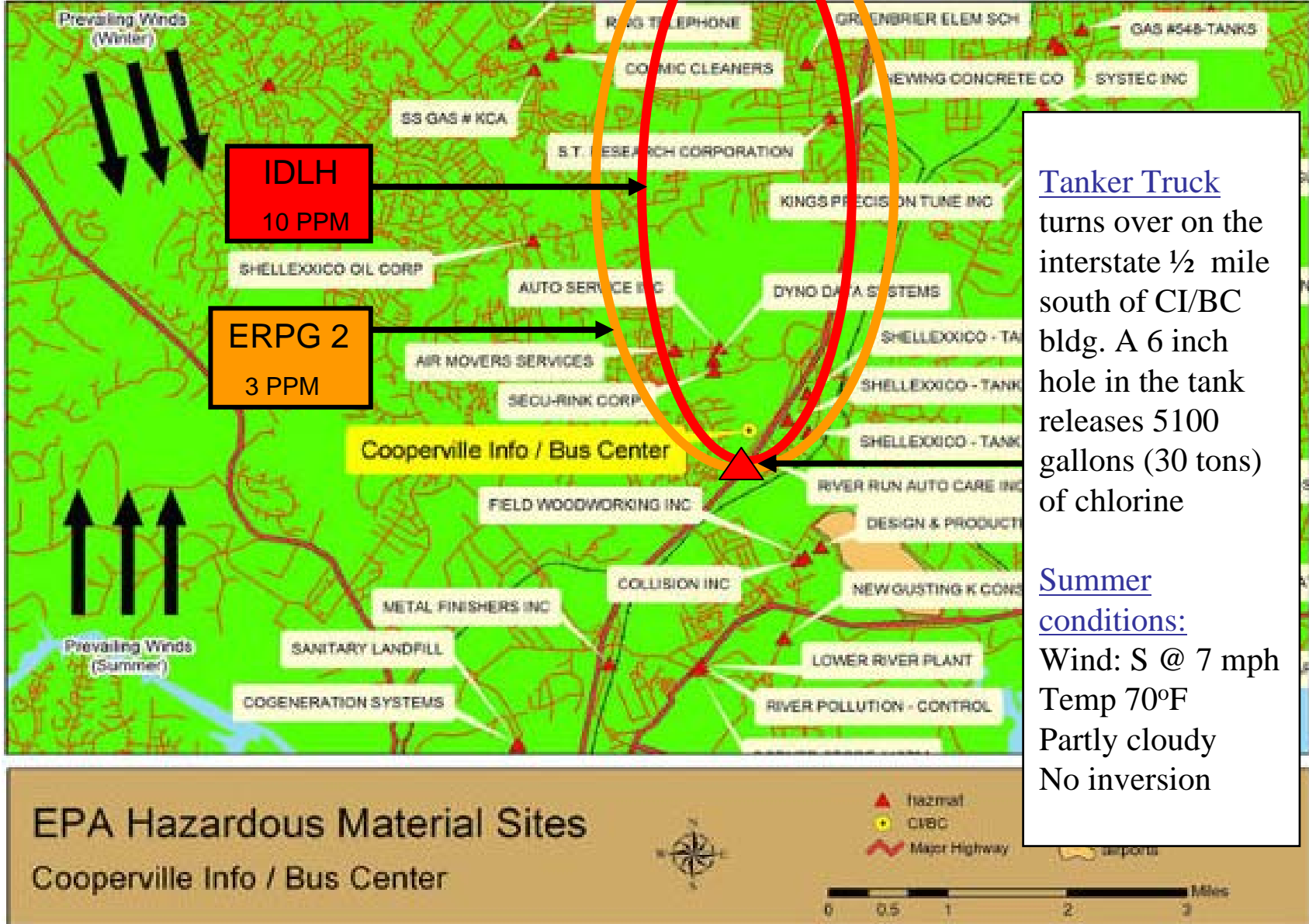
Vulnerability/Mitigation

Mechanical Systems-HVAC / CBR Attack

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



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Tanker Truck turns over on the interstate ½ mile south of CI/BC 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



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CI/BC 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

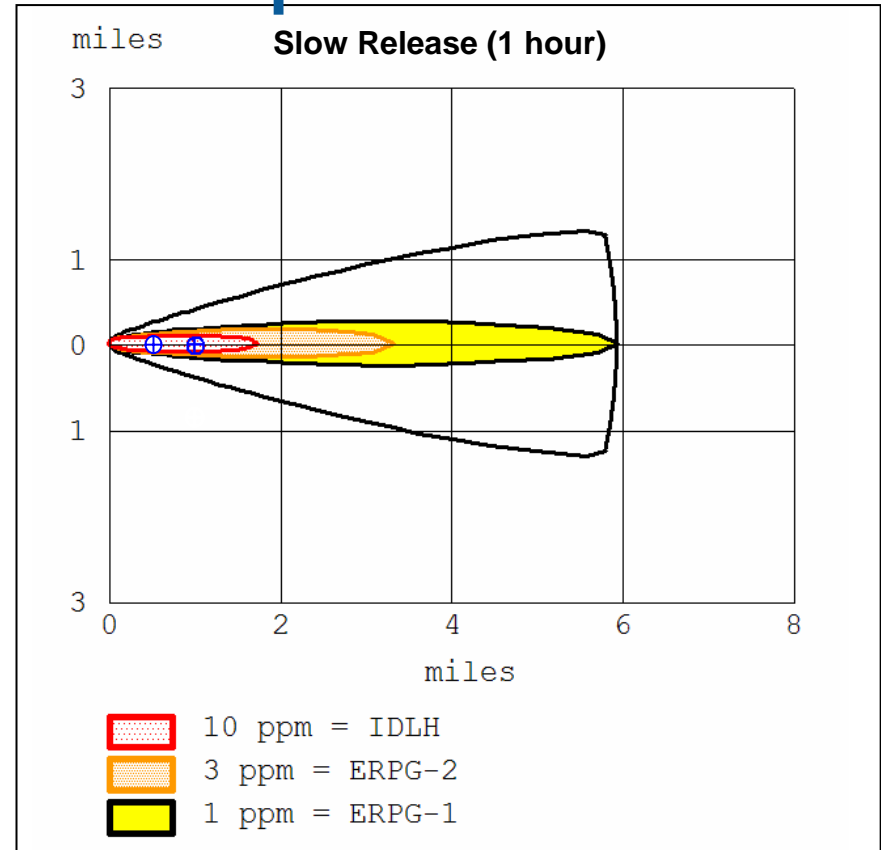
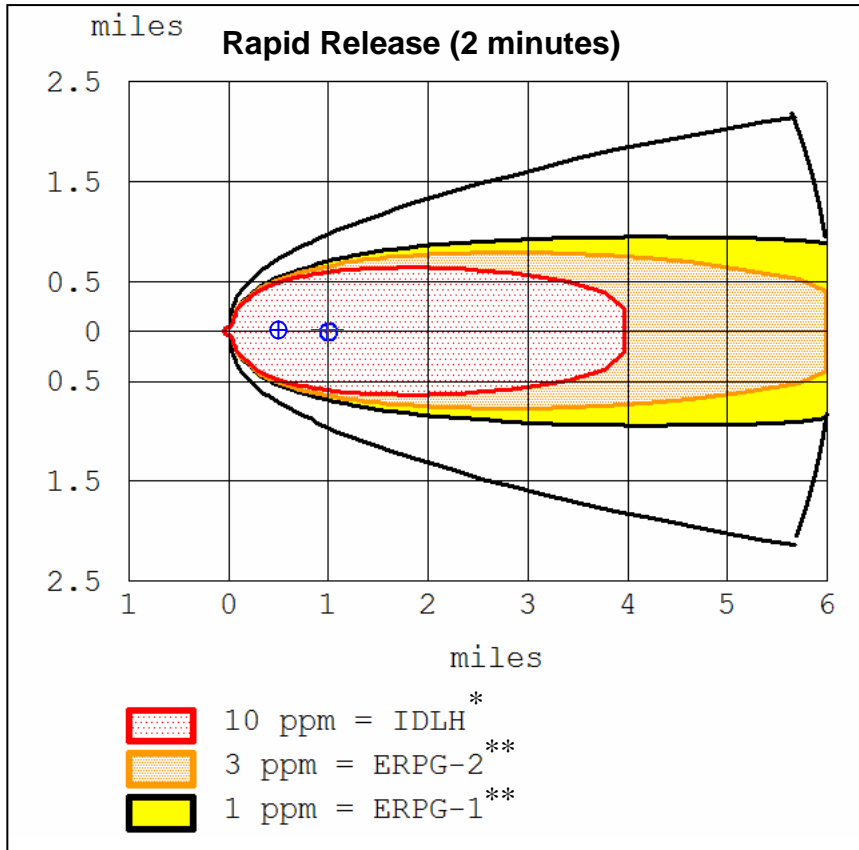
SOURCE STRENGTH INFORMATION:

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).



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Chlorine Release Footprints



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

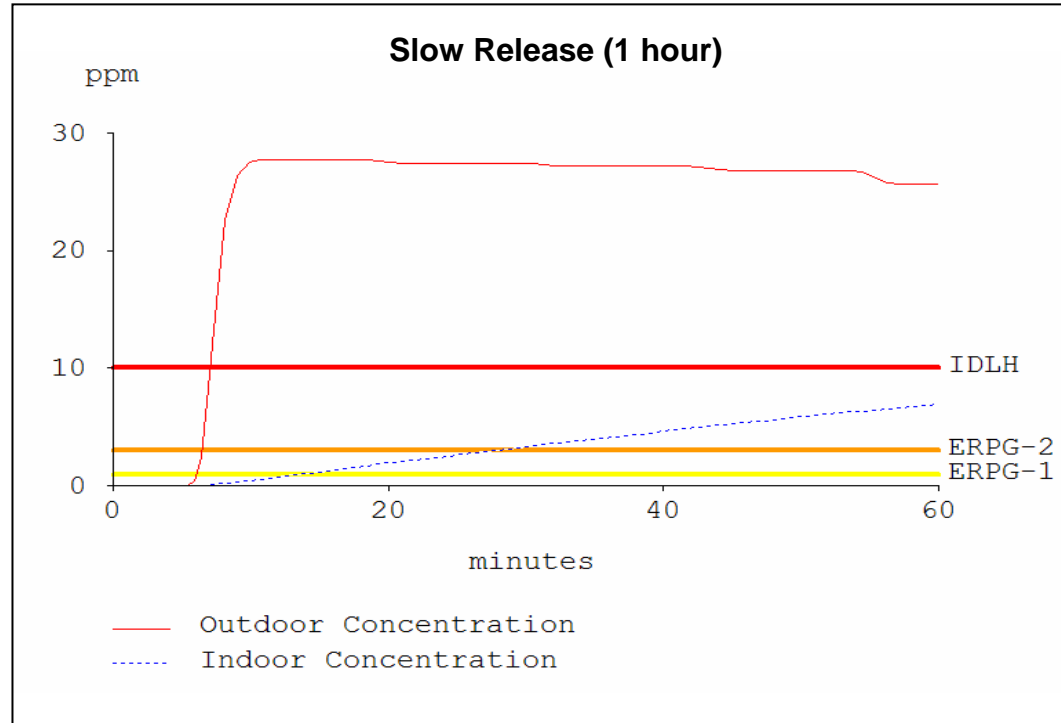
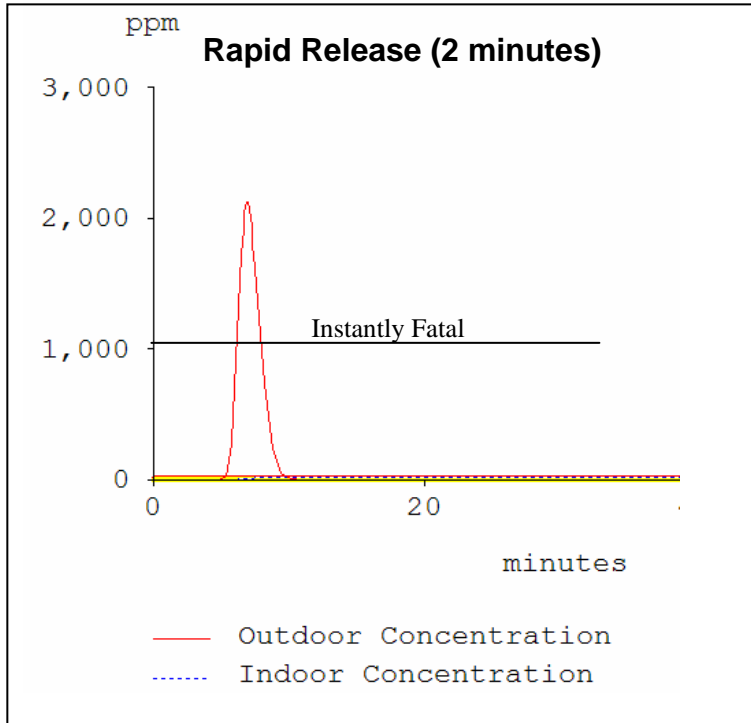
- Slow release reduces plume size
- IDLH less than 2 miles long and 0.5 miles wide

* 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



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Chlorine Concentrations at CI/BC



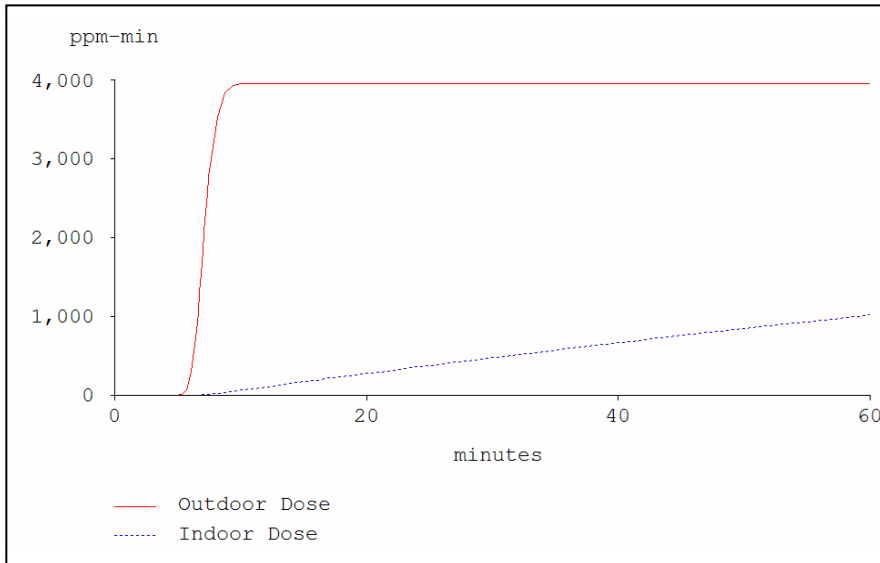
- Rapid spike outdoors at CI/BC from 6 –12 minutes later
- Instantly fatal concentration levels for this short period
- Indoor concentrations remain low during plume passage
- Evacuees likely to become fatalities from 0.5 to 4 miles downwind during typical evacuation times (5-30 minutes) particularly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

- Rapid spike outdoors at CI/BC 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



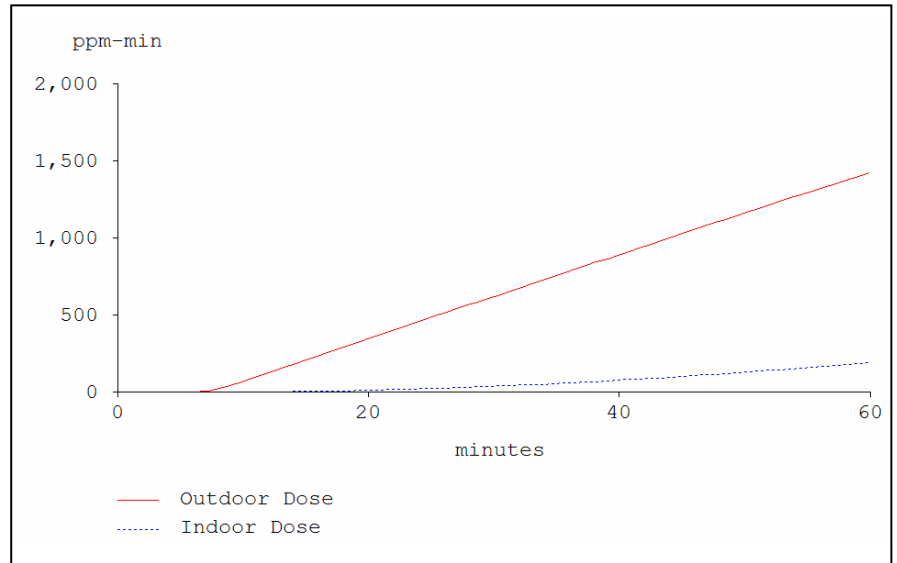
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Chlorine Dose at CI/BC



Rapid Release (2 minutes)

- Dose spikes rapidly outdoors at CI/BC 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 CI/BC 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



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Vulnerability/Mitigation

IT Communications Systems / Utility Systems / Cyber Attack - Redundancy

Identify alternate telecom carrier circuits and availability



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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



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