

*BUILDING DESIGN FOR HOMELAND SECURITY*

# Unit XII-B

## 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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# HAZARDCORP BUILDING

## Building

- Functions
- Infrastructure

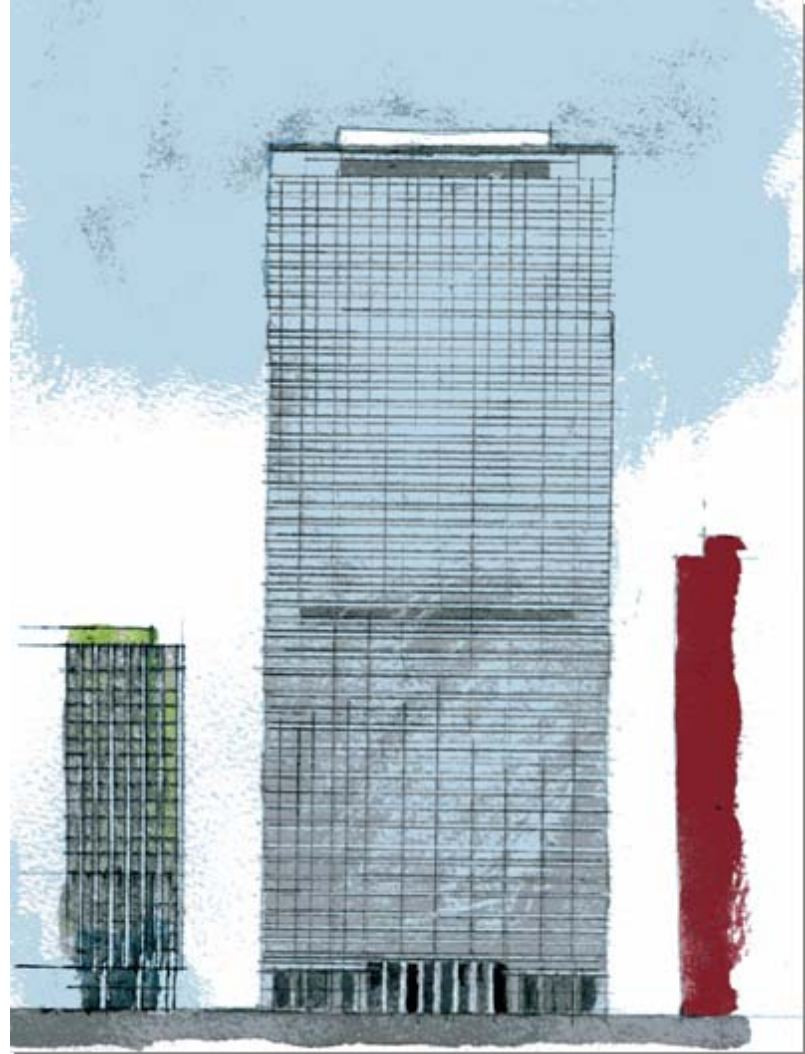
## Threats/Hazards

- Design Basis Threat
- Levels of Protection

## Vulnerabilities

- Impact
- Mitigation

## Report



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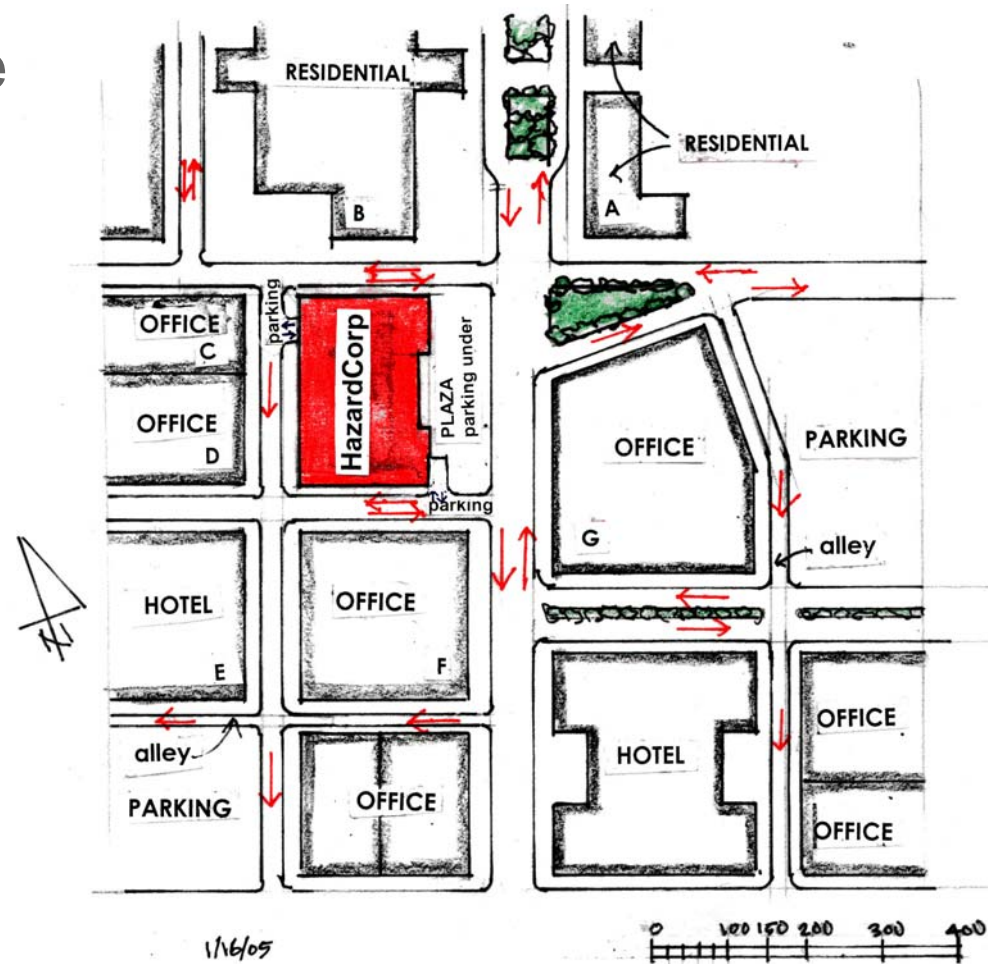
# HAZARDCORP

50-story mixed use high-rise office building

- 8,000 occupants
- 1,000 visitors
- Over 2,000,000 square feet of rentable space

“Neighbors” include:

- Offices
- Residential



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# 5-Mile Building Radius



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# Local Imagery



Local Imagery  
HazardCorp



1 meter Imagery



0 140 280 560 840 1,120 1,400 Feet



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# HazMat Sites



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# Emergency Response

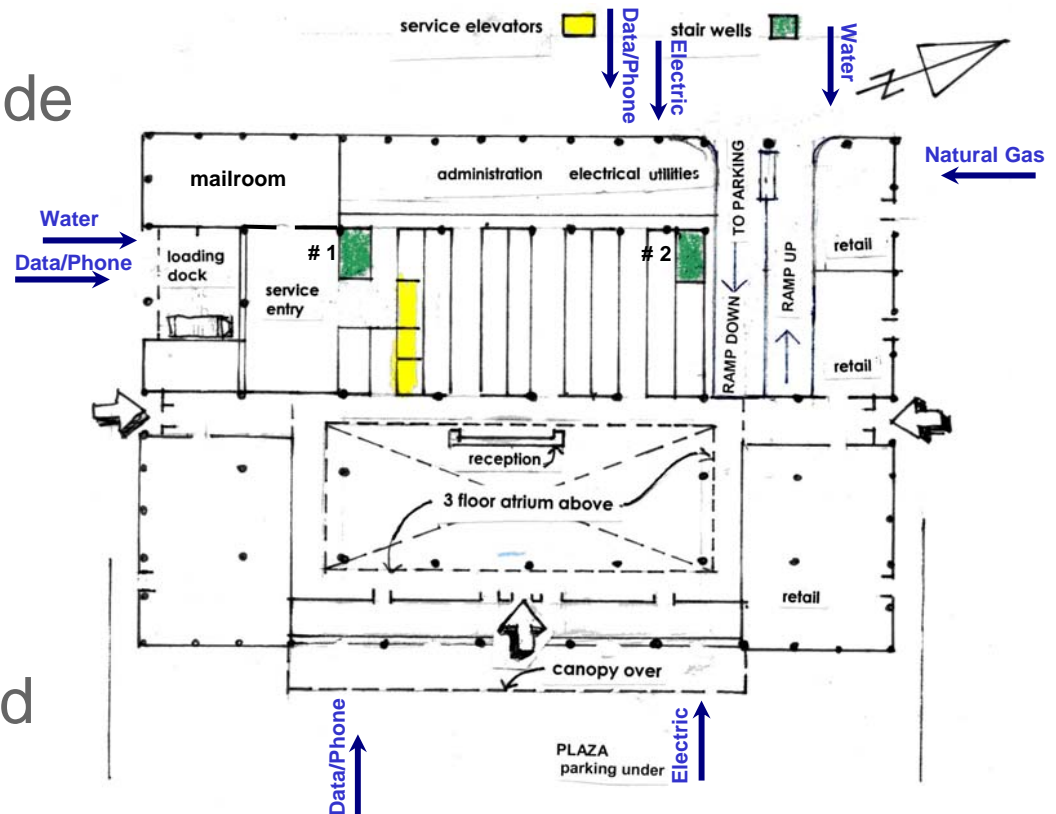


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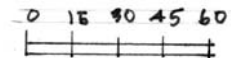


# Building Data

- 50-story building completed in 1987
- Loading dock on SW side
- Retail on lower level
- 8,000 occupants
- 1,000 visitors
- 3 levels of underground parking



First floor plan



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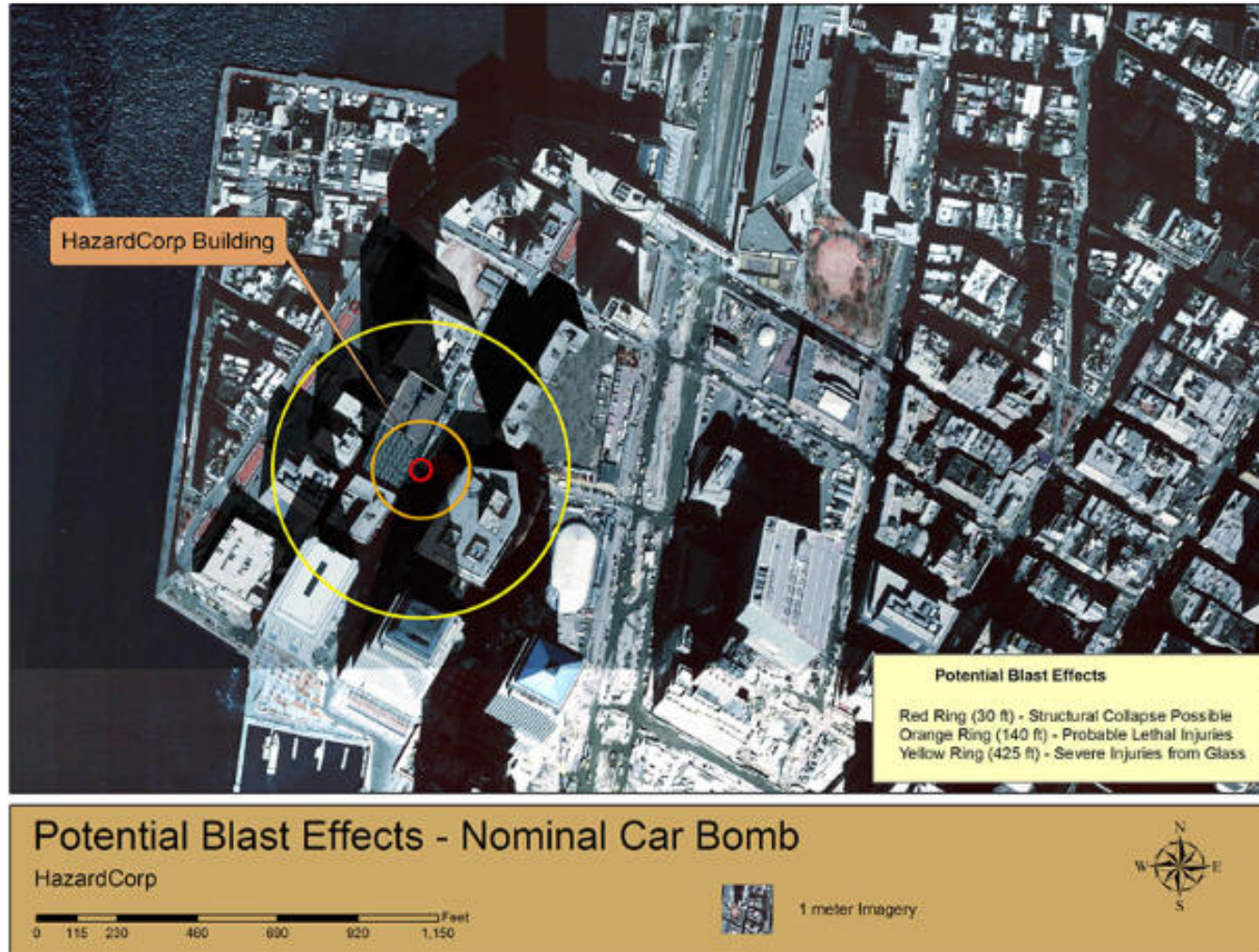
# HAZARDCORP Occupancy

| FLOOR | TENANT OCCUPANCY   |
|-------|--|
| 49-50 | Mechanical Floors  |
| 31-48 | National financial services company  |
| 29-30 | Bank offices   |
| 27-28 | Federal government offices (IRS, DOD, CIA)                                     |
| 26    | Mechanical room  |
| 25    | Office of Emergency Management   |
| 23-24 | Financial service company  |
| 20-22 | Insurance company  |
| 19    | State Employment Commission  |
| 15-18 | Vacant   |
| 14    | Financial management company   |
| 8-13  | Federal government offices (SEC, Secret Service)                               |
| 6-7   | Bank offices   |
| 4-5   | Storage, switch gear, generators, transformers                                 |
| 3     | Open to first floor lobby, rentable meeting space, building management         |
| 2     | Open to first floor lobby, rentable meeting space                              |
| 1     | Lobby, retail, fuel storage, switchgear, building administration, loading dock |
| UG1   | Parking  |
| UG2   | Parking  |
| UG3   | Parking  |



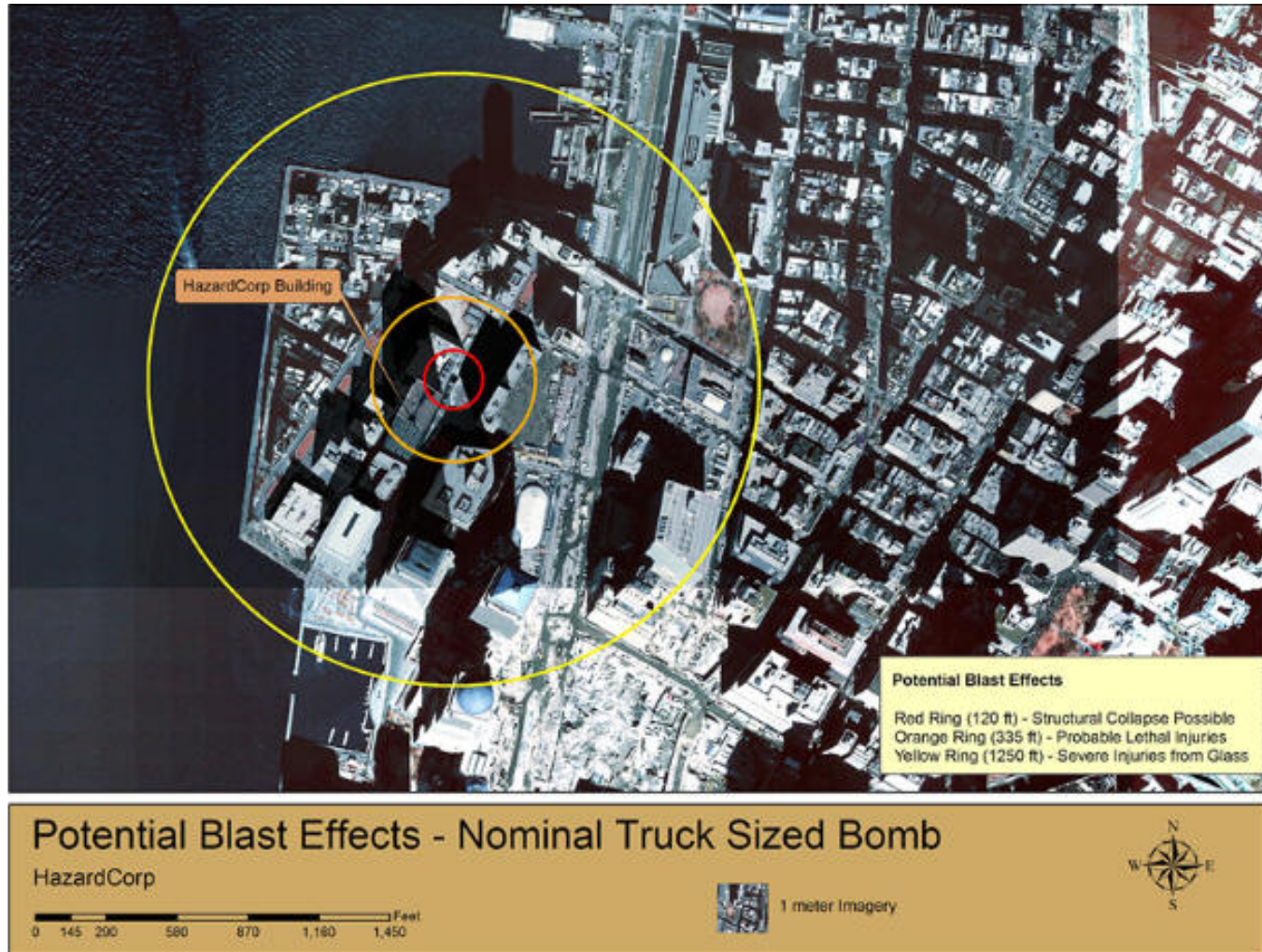
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# Car Bomb Blast Effects



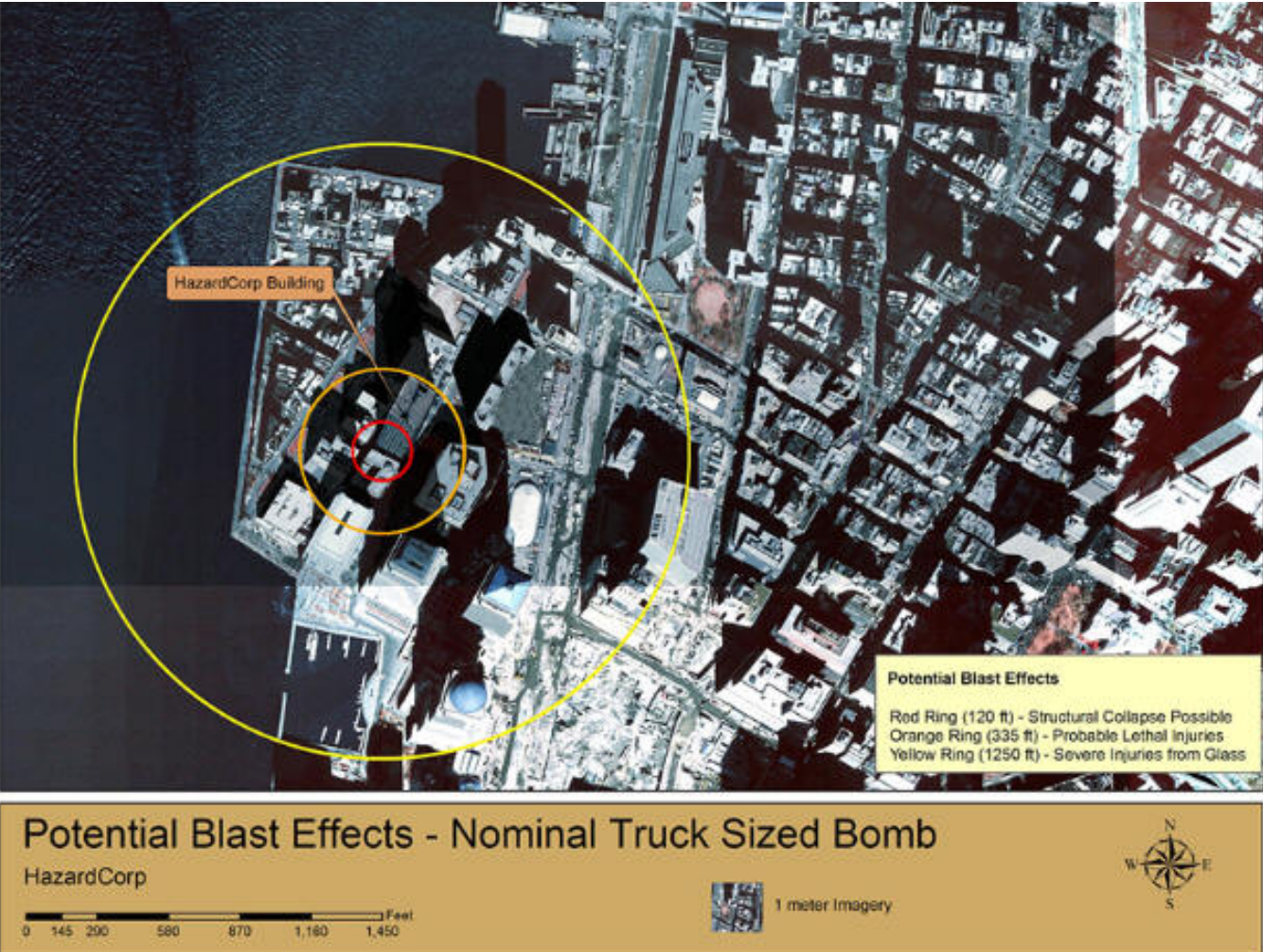
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# Truck Bomb Blast Effects-Collateral



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# Truck Bomb Blast Effects-Loading Dock

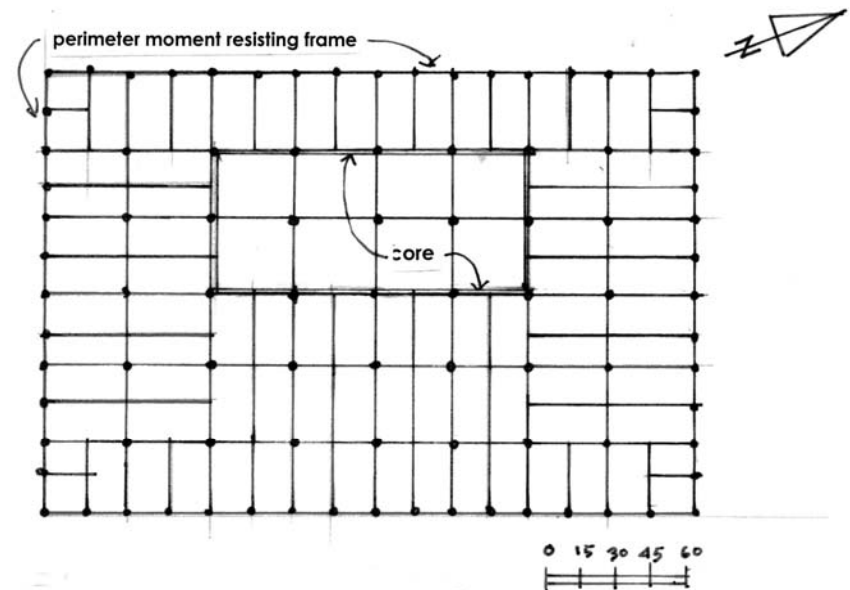


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# Building Data

## Structural / Envelope

- 4 perimeter moment frames
- Gravity framing composite steel beams
- Variety of framing connections
- Aluminum / Glass curtain wall exterior cladding
  - First three floors 3/8 inch thermally tempered glass
  - Other glazing 1/4 inch or 3/8 inch annealed single pane glass
- Discontinuous columns through the lobby area



Typical floor framing plan, 4<sup>th</sup> through 49<sup>th</sup> floor.



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# Building Infrastructure

## Fire Suppression

- Sprinklers on every floor of building
- Standpipes in every stairway, including building and plaza parking
- Yard main loops all around building
- Fire department connections – west and north side of building

## Electric Power

- 13,800 volt looped service feeds substation in building
- 4th floor transformers – 480/277 volt distribution



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# Building Infrastructure

## Generators/Fuel Systems

- Building management and tenant systems
- Located in various parts of building

## HVAC

- All air using heat pumps and supplemental electric heat (including lighting)
- Tied to fire suppression whereby floors above and below fire are overpressurized and fire floor is exhausted



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# Building Infrastructure

## Water

- Two feeds, one under loading dock
- Storage tanks on mechanical floors

## Natural Gas

- 4-inch main to first floor restaurants



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# Building Infrastructure

## Communications

- Three T-3 lines from three providers
- Empty conduits for expansion installed
- Tenants have additional services
- VOIP, satellite, and landline phones in building for outside communication
- Fire Watch phone in stairwells



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# Building Infrastructure

## Physical Security

### Security personnel

- 1 person -- Central Security
- 2 rovers

### Reception staff

- 2 persons 0600-1800 on business days
- 1 person 1800-0600 on business days or all day on non-business days

Lobby – access to atrium, mailroom, meeting rooms and retail space



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# Threats/Hazards

## Threats include:

### Terrorism

- No direct threat specifically identified for HazardCorp Building
- Government, military, finance, and banking tenants in building could be targeted if perceived as soft target
- Collateral damage potential due to nearby potential targets in the area

### Intelligence Collection, especially by cyber attack

- Government classified information
- Commercial information



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# Threats/Hazards

## Threats (continued):

### Crime

- City has much higher crime rate than national averages in most categories

### Natural Hazards

- Hurricanes and tornadoes – Almost 100 per year
- Evacuation zone for storm surges
- Earthquakes – Infrequent and low intensity -- old seismic zone 2A
- Lightning – 25 strikes/year on average



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# Threats/Hazards

## Threats (continued):

### HazMat

- Chemical and fuel tank farms across river
- Rail lines across river
- Shipping on river
- 2,000 trucks each day within city
- 100 spills and releases each year in city

### Other Technological Hazards

- 600 water main breaks per year in city



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# Design Basis Threat

**Explosive Blast:** Car Bomb 500 lb TNT equivalent. Truck Bomb 5,000 lb TNT equivalent (Murrah Federal Building class weapon)

**Chemical:** Large quantity petroleum fire toxic plume from tank farm. Large and small quantity HazMat release (chlorine) from tank farm, tanker truck, and rail car.

**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 HAZARDCORP building



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# Levels of Protection

## GSA Interagency Security Criteria

Level IV Building – over 450+ employees  
-- over 150,000 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  |
|---------------------|---|--|---|
| <b>Low</b>          | 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. |



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

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# 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 | Primary Gathering Building | Low   | 45 m   | 25 m                         | Car Bomb                     |
|   |                            |   | 148 ft                                       | 82 ft                        |                              |



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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

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



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# Levels of Protection (continued)

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

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, less urban canyon effect
- Additional Tier III analysis required inside building
  - Understand internal pressure changes during building operation
  - Understand on HVAC and other changes implemented in response plans affect the 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

- Plaza side barriers at property line to prevent direct approach into lobby – K12 rating / 408 LF
  - Planters - \$ 92K
  - Plinth walls - \$207K
  - Bollards - \$104K



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# Vulnerability/Mitigation

## Site / Vehicle Bomb

Maximize available stand-off

- Other three sides
  - Continue controlled parking on street
    - Signage - \$10K
  - Bollards if no controlled parking
    - K12 rating – North and South 340 LF - \$90K
    - K8 rating – West 248 LF - \$65K



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# Vulnerability/Mitigation

## Site / Vehicle Bomb

Protect loading dock / building

- Hardened vehicle barriers, K12 rating, 3 each
  - Pop-Up - \$405K
  - Drop Arm - \$150K



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# Vulnerability/Mitigation

## Site / Vehicle Bomb

### Reroute Traffic

- Traffic Study - \$20K
- MOUs with tenants / neighbors / police
- Variable road closure or area-wide access control based upon intelligence (Ring of Steel)
- Change west side alley to north travel direction to avoid queuing on main roads for entry to UG building parking



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# Vulnerability/Mitigation

## Site / Vehicle Bomb

Segregate UG parking for access control

- Controlled under building – tenants/vetted only
- Public under plaza (public parking is a premium in urban area)
- Hardened vehicle barriers at under building entrance / exit
  - Drop Arms K8 rating, 2 each - \$96K
- Signage to denote public and tenant/staff UG parking entrances - \$2K



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# Vulnerability/Mitigation

## Architectural / Vehicle Bomb

### Access control for loading dock

- Additional security at loading dock, includes screening at curb
  - 2 personnel, 8 hour shift – \$188K/year
- Pre-screening away from building
  - Pre-engineered bldg – \$ 36K
  - 2 personnel, 8 hour shift – \$188K/year
- Time of day access (2000 to 0400)
  - 4 personnel, 8 hour shift - \$376K/year
- Apply individually or collectively



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# Vulnerability/Mitigation

## Architectural / Vehicle Bomb

Segregate UG parking for access control

- Electronic or manned access control under building
  - Electronic (Card Scanner & PIN) – \$12K
  - Manned
    - Small Shelter - \$5K
    - 2 Personnel, 24/7 - \$790K/year



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# Vulnerability/Mitigation

## Architectural / Vehicle Bomb

Strengthen overhead anchorage elements

- HVAC diffusers, light fixtures, etc.
  - First three floors - \$950K
- Canopy at main entrance
  - Requires additional design information
  - \$950K



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# Vulnerability/Mitigation

## Architectural + Security / Vehicle Bomb

Move Security Control to 4<sup>th</sup> floor or install backup location on 4<sup>th</sup> floor

- >> \$1M
- Alarms, communications, CCTV, building operating systems (SCADA, EMCS), and Fire Control



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# Vulnerability/Mitigation

## Architectural / Access Control

### Lobby redesign

- Channel all entrances to screening location(s) with up to 12 checkpoints for throughput
- \$2.5M

### Close off retail space access to Lobby

- Convert to crash bar with alarm, 3 doors - \$1.5K
- Lobby redesign may overcome need

### Armed guards manning screening equipment in lobby

- Up to 36 guards with 3 guards per checkpoint at peak times based upon throughput
- \$8.7M/year



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# Vulnerability/Mitigation

## Structural Systems / Vehicle Bomb

Perform blast analysis – perimeter building columns

- Existing – W14x455 steel columns, 96 total
- Upgrade on Floors 1 and 2 – Encase in 4,000 psi concrete and ¼” steel wrap - \$980K

Harden loading dock to protect rest of building – below achieves low LOP

- 12” R/C, #8-4”O.C. both faces, ½” steel plate on ceiling and floor - \$510K
- Adds protection of fuel tanks under loading dock, evaluate need for additional measures



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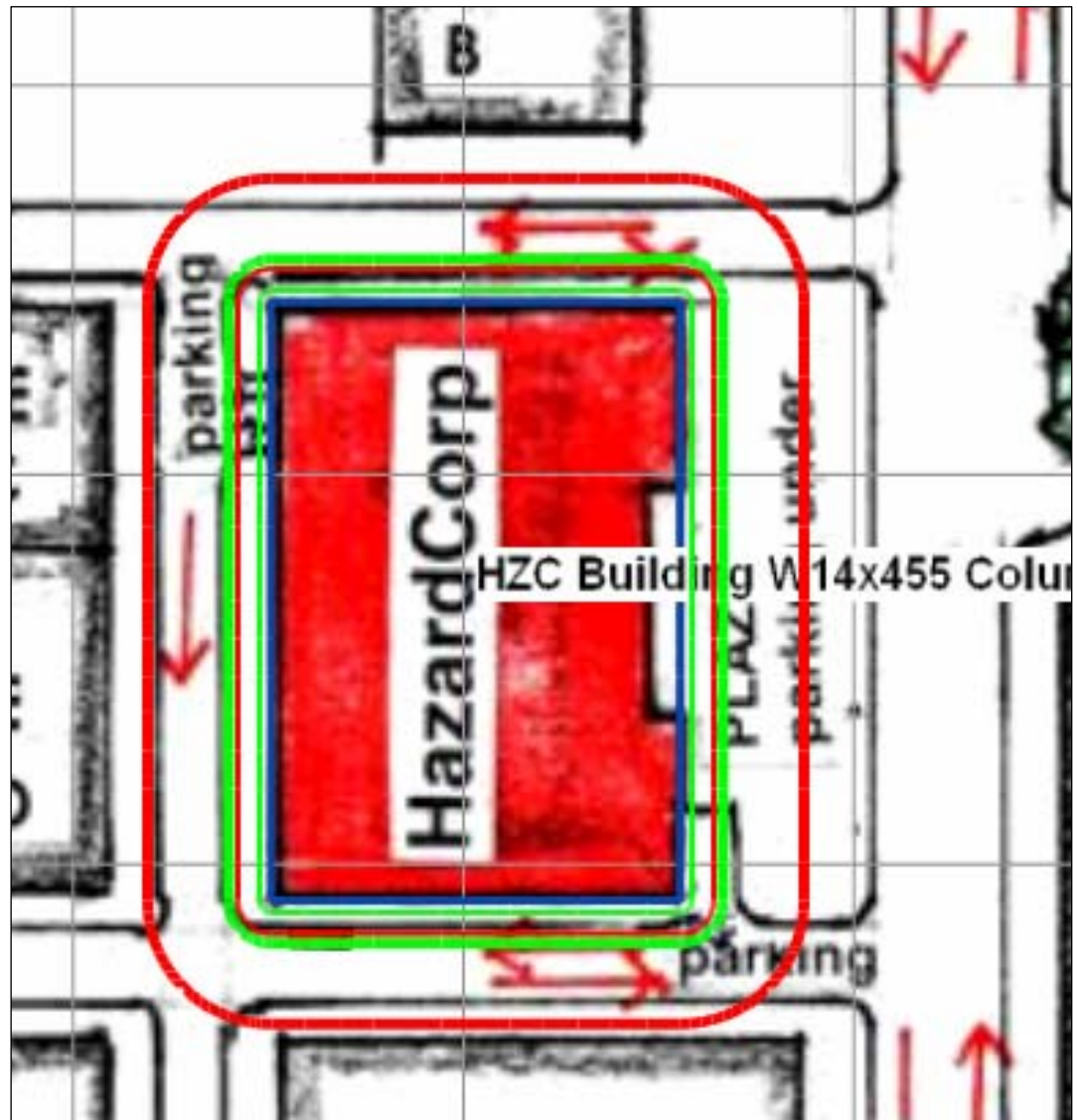
# Column Hardening

## Original Columns

- Large DBT – 52 ft
- Small DBT – 14 ft

## Hardened Columns

- Large DBT – 18 ft
- Small DBT -- 5 ft



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# Vulnerability/Mitigation

## Structural Systems / Vehicle Bomb

Segregate UG parking for access control

- Harden columns on all underground levels along first building line nearest public access
  - 4,000 PSI concrete and ¼” steel wrap, 21 columns
    - \$635K
  - Consider all columns at all UG parking levels under building based upon progressive collapse
    - Add \$2.6M to above



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# Vulnerability/Mitigation

## Structural Systems / Vehicle Bomb

Segregate UG parking for access control

- Hardened wall between vetted and public parking, 248 LF per level, 3 levels – totaled below
  - 12” R/C, #8-4”O.C., both faces - \$2.06M
  - One vehicle barrier per level, K8 rating - \$145K



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# Vulnerability/Mitigation

## Structural Systems / Vehicle Bomb

Perform blast analysis atrium columns – harden against progressive collapse

- Existing – W14x455 steel columns, 16 total
- Upgrade on Floor 1 only – Encase in 4,000 psi concrete and ¼” steel wrap - \$467K

Provide architectural stand-off around columns

- Gypsum board on metal studs
- 1’ off column (GSA 6” required)
- 16 columns, first floor only - \$50K



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# Vulnerability/Mitigation

## Building Envelope / Vehicle Bomb

Perform blast analysis – glazing and frame upgrades

- Existing 172 windows/floor, nominal 5' x 5'
  - Floors 1-3, 3/8" TTG SP
  - Floors 4-8, 1/4" DS SP
  - Floors 9-50, 3/8" DS SP
- Upgraded – Note Federal floors are 8-13 and 27-28
  - Floors 1-7, 1" TTG LAM SP – \$12M
  - Floor 8, 3/8" TTG SP from Floors 1-3 with 15 mil FRF – \$560K
  - Floors 9-13, 27-28 Existing with 15 mil FRF - \$710K



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# Window Hardening – Floor 1

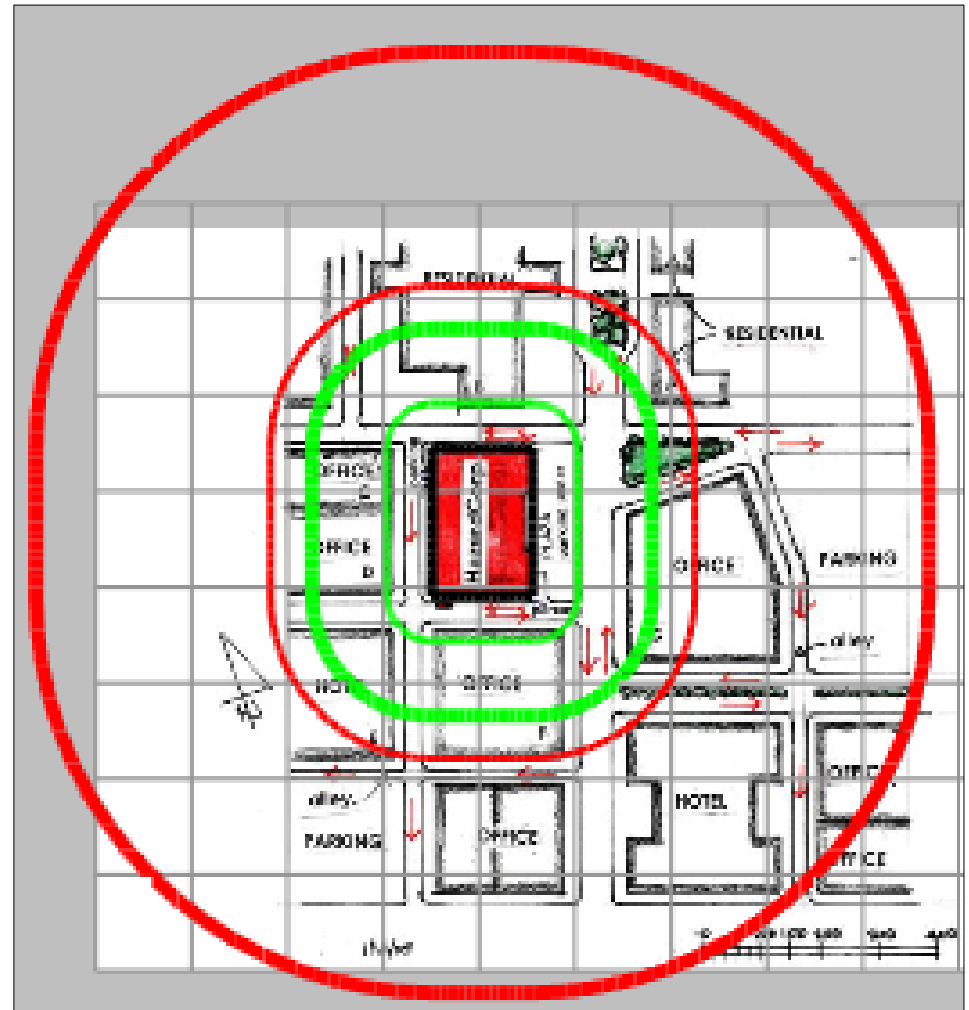
Original glazing meets  
GSA minimum

Original Glazing

- Large DBT– 678 ft
- Small DBT– 277 ft

Hardened Glazing

- Large DBT– 205 ft
- Small DBT– 77 ft



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# Window Hardening – Floor 7

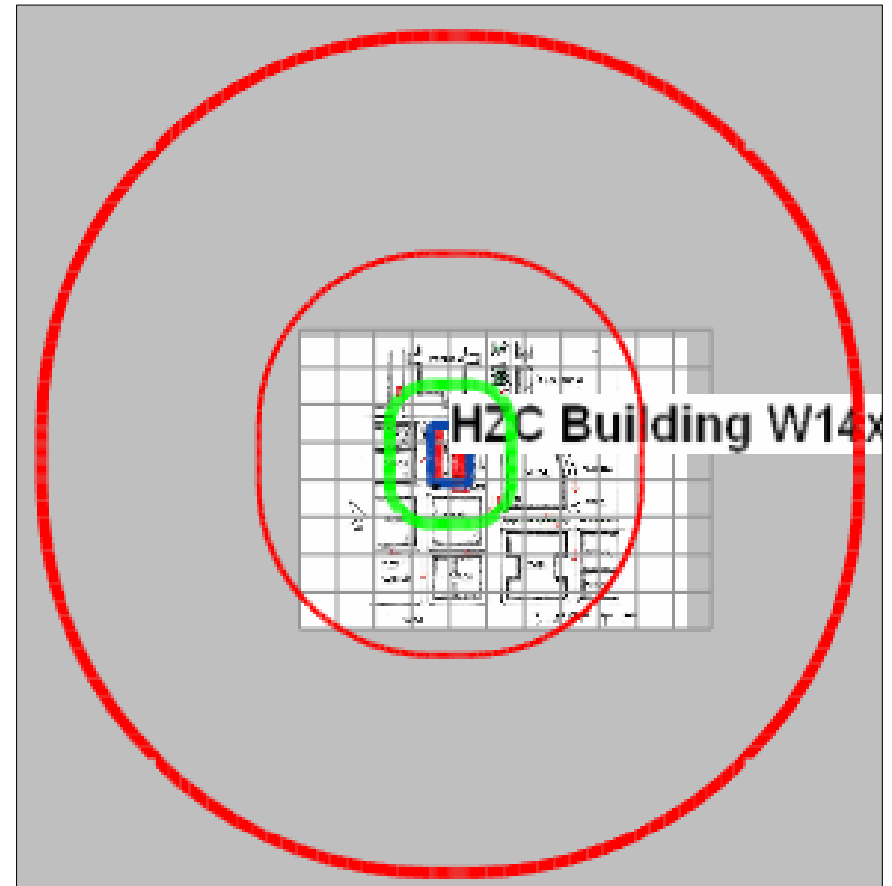
Original glazing requires 15-mil FRF to meet GSA minimum

## Original Glazing

- Large DBT– 1,707+ ft
- Small DBT– 755 ft

## Hardened Glazing

- Large DBT– 180 ft
- Small DBT– GSA 1 / 2



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# Window Hardening – Floor 8

Original glazing requires 15-mil FRF w/4-sided attachment to meet GSA minimum

## Original Glazing

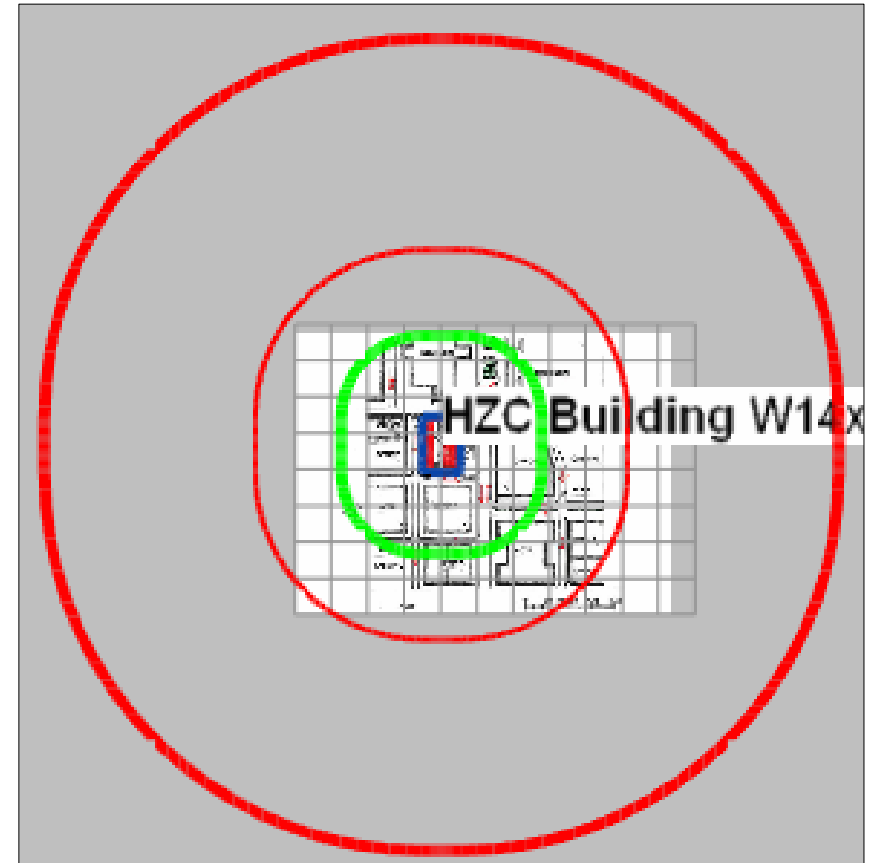
 Large DBT–1,707+ ft

 Small DBT– 755 ft

## Hardened Glazing

 Large DBT– 366 ft

 Small DBT– GSA 1 / 2



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# Window Hardening – Floor 9

Original glazing requires 15-mil FRF w/4-sided attachment to meet GSA minimum

## Original Glazing

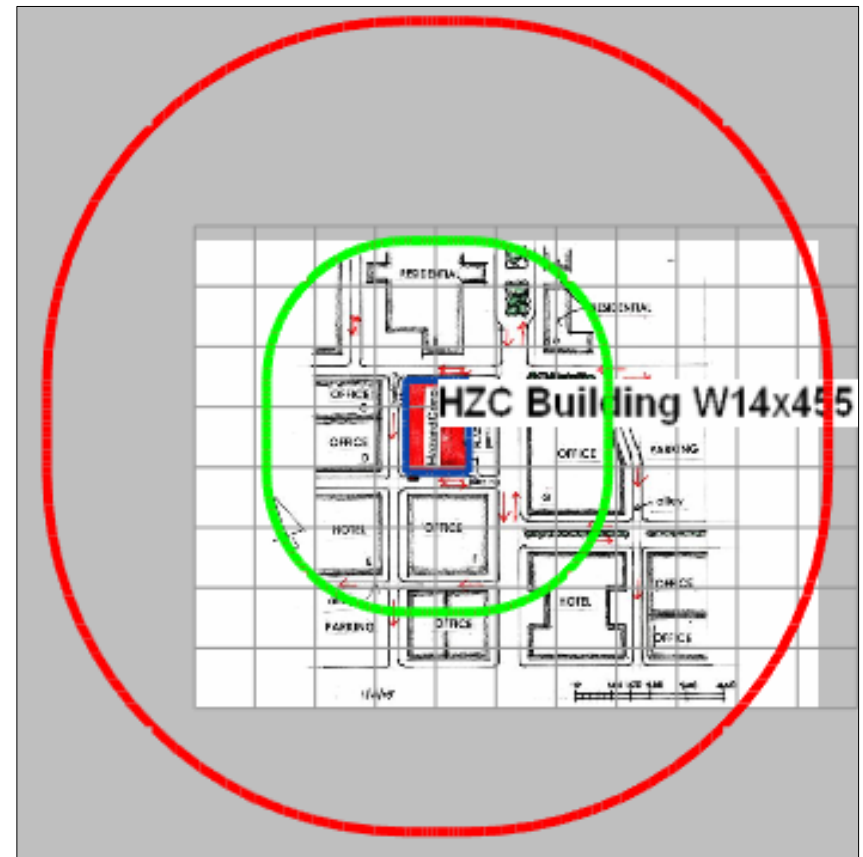
 Large DBT– 977 ft

 Small DBT– 380 ft

## Hardened Glazing

 Large DBT– 379 ft

 Small DBT– GSA 1 to 3b



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# Window Hardening – Floor 13

Original glazing requires 15-mil FRF w/4-sided attachment to meet GSA minimum

## Original Glazing

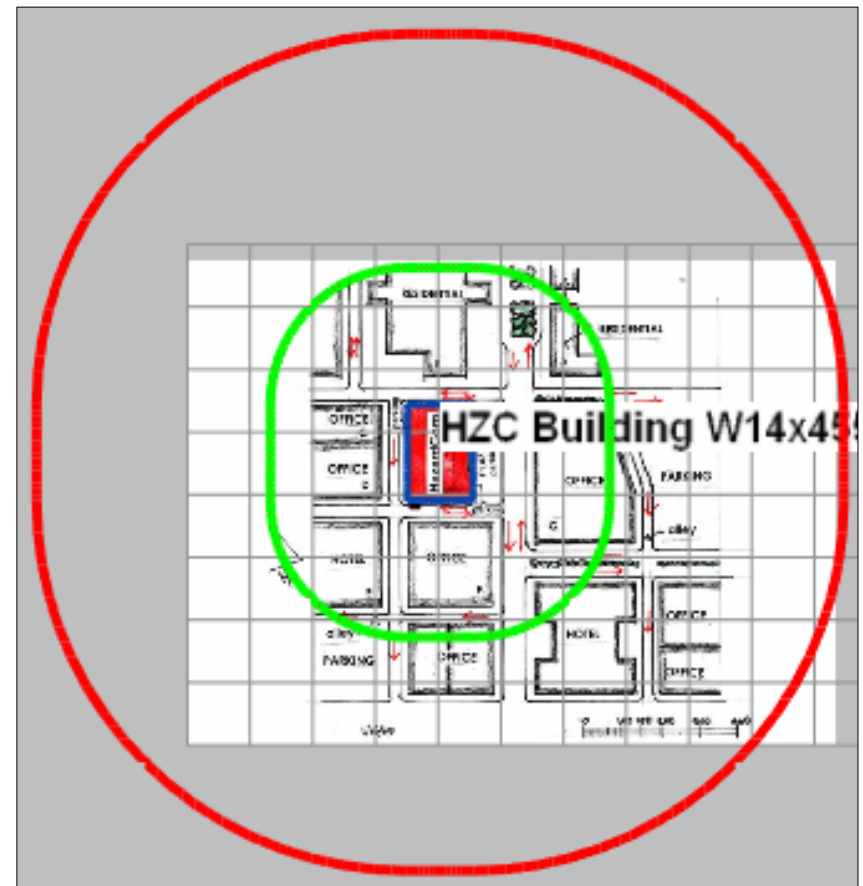
 Large DBT– 970 ft

 Small DBT– 359 ft

## Hardened Glazing

 Large DBT– 358 ft

 Small DBT– GSA 1 / 2



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# Window Hardening – Floor 27

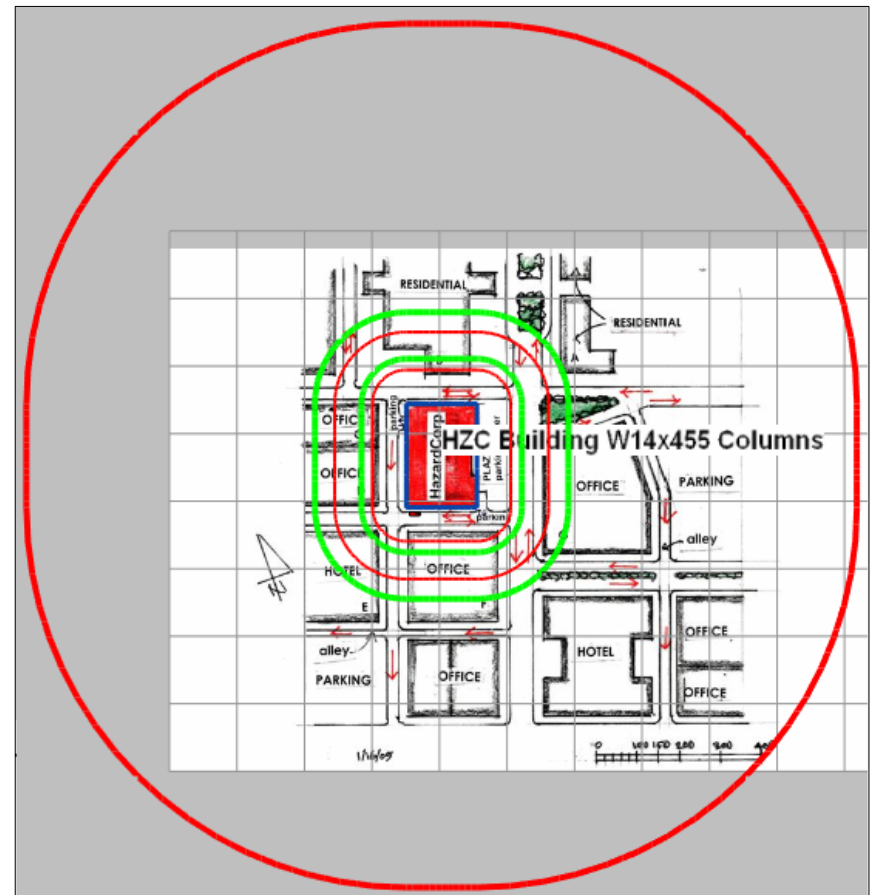
Original glazing requires 15-mil FRF w/4-sided attachment to meet GSA minimum

## Original Glazing

- Large DBT– 923 ft
- Small DBT– 82/174 ft

## Hardened Glazing

- Large DBT– 109/222 ft
- Small DBT– GSA 1 / 2



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# Vulnerability/Mitigation

## Utility Systems / Vehicle Bomb

Harden all utilities entering site as transiting UG parking, 1' x 1' cross section

- 3/8" steel plate welded with access panels and hangars - \$250/LF

Set up preplanned contingency fuel deliveries for emergency generators with other supplier(s)



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# Vulnerability/Mitigation

## Mechanical / CBR Attack

Install emergency shut down switches – all fans

- At each floor accessible to fire wardens - \$22K per floor
- Security Control and backup location - \$22K per floor in addition to fire warden capability
- Total for building: \$2.2M



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# Vulnerability/Mitigation

## Mechanical / CBR Attack

Install elevator controls in Security Control and backup location

- Evacuation support (up or down)
- Shut down to prevent pumping of contaminants throughout building
- Total for 31 elevators: \$775K



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# Vulnerability/Mitigation

## Mechanical / CBR Attack (Chemical and Radiological)

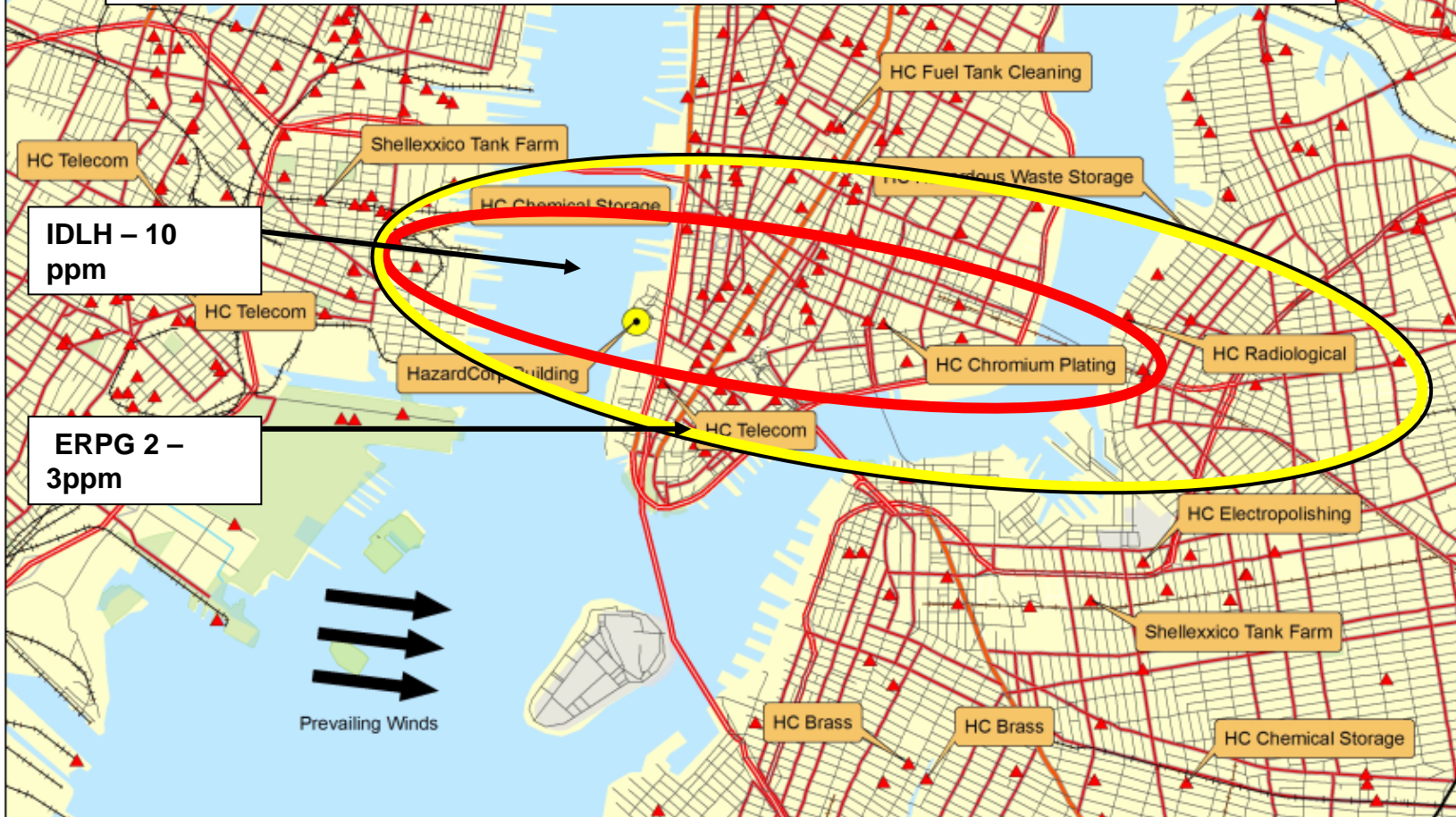
Evaluate carbon filters for chlorine-type spills

- Analysis of heavier or lighter than air contaminants
- \$135K per air handler (two to four air handlers per floor)



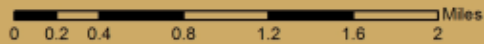
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5,000 gallons of chlorine released 1.5 miles upwind of HZC Bldg



### EPA Hazardous Material Sites

HazardCorp



- ▲ HazMat
- HazardCorp
- ⚡ Interstate
- ⚡ Highway
- 🚊 Railroad
- 🚙 Major Road
- 🛣 Local Road



(Note - HC is Hazard City)



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# HZC Chlorine Release Parameters

## SITE DATA INFORMATION:

Location: JERSEY CITY, NEW JERSEY  
Building Air Exchanges Per Hour: 0.50 (enclosed office)  
Time: June 30, 2005 0937 hours EDT (user specified)

## 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: -29.3° 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 280° true at 3 meters  
No Inversion Height  
Stability Class: C      Air Temperature: 70° F  
Relative Humidity: 50%      Ground Roughness: open country  
Cloud Cover: 5 tenths

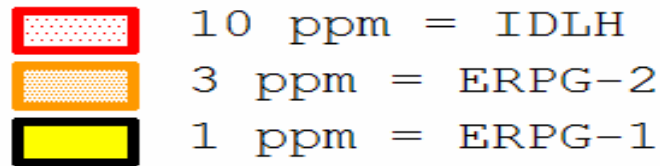
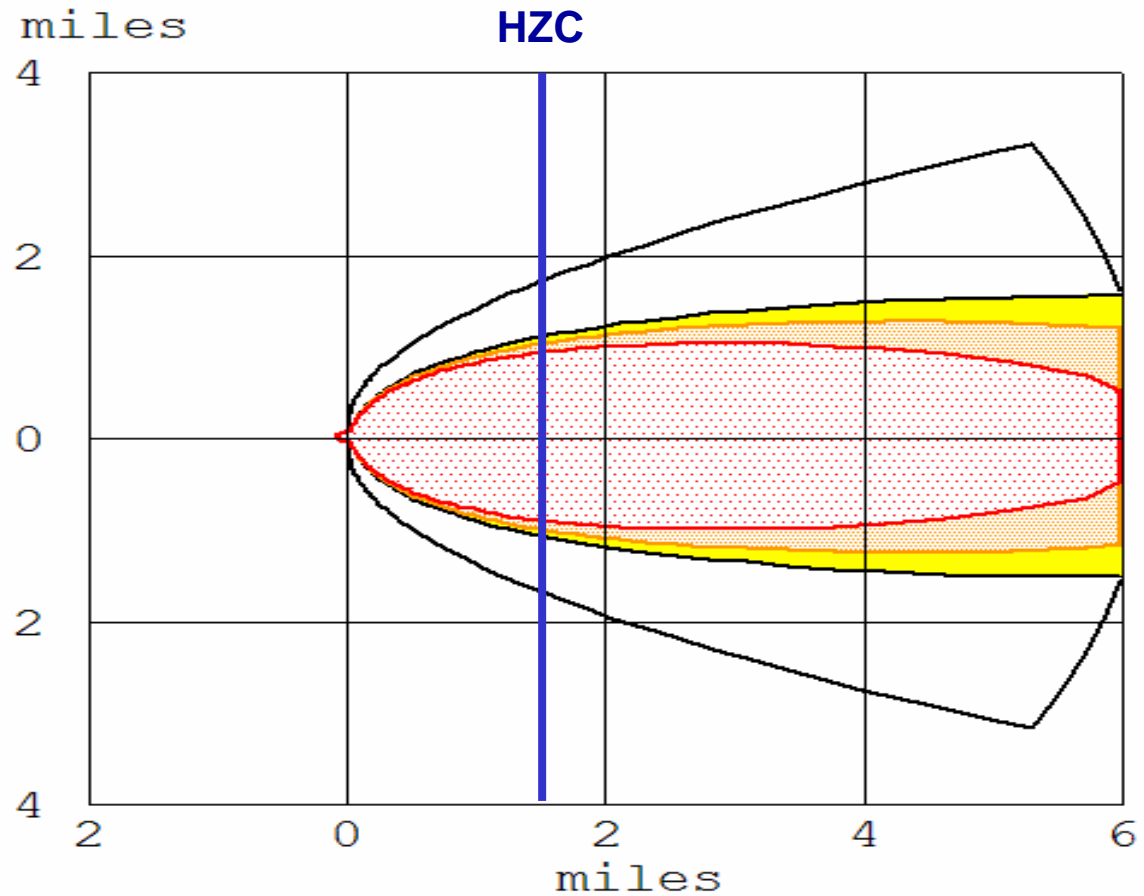
## SOURCE STRENGTH INFORMATION:

Leak from hole in horizontal cylindrical tank  
Tank Diameter: 8 feet      Tank Length: 39.9 feet  
Tank Volume: 15000 gallons      Tank contains liquid  
Internal Temperature: 70° F      Tank is 100% full  
Chemical Mass in Tank: 88.0 tons  
Circular Opening Diameter: 6 inches  
Opening is 6 inches from tank bottom  
Release Duration: 5 minutes  
Max Average Sustained Release Rate: 60,900 pounds/min  
(averaged over a minute or more)  
Total Amount Released: 174,826 pounds  
Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).



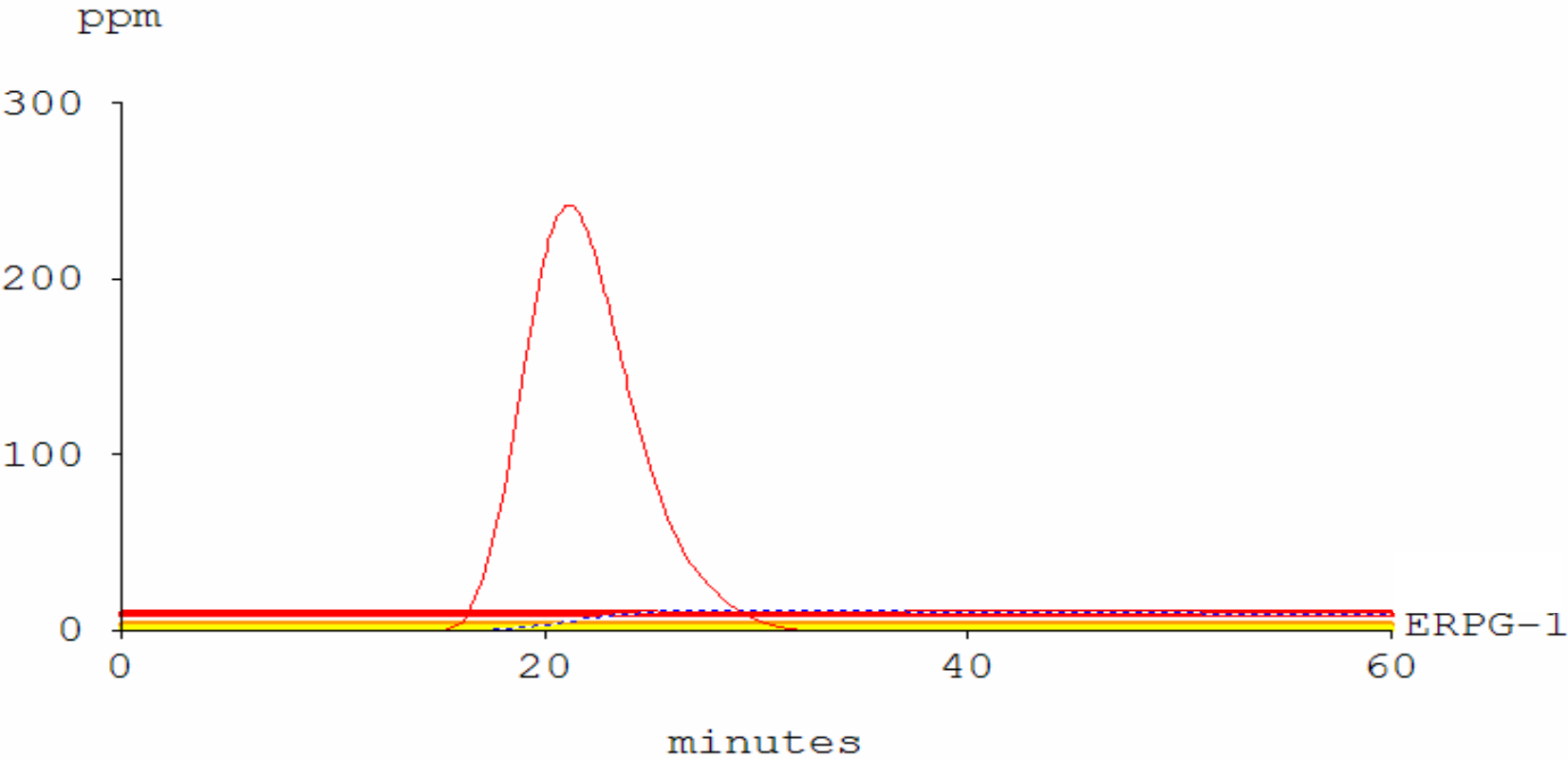
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# Railroad Tanker Chlorine Release



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# Chlorine Concentration at HZC

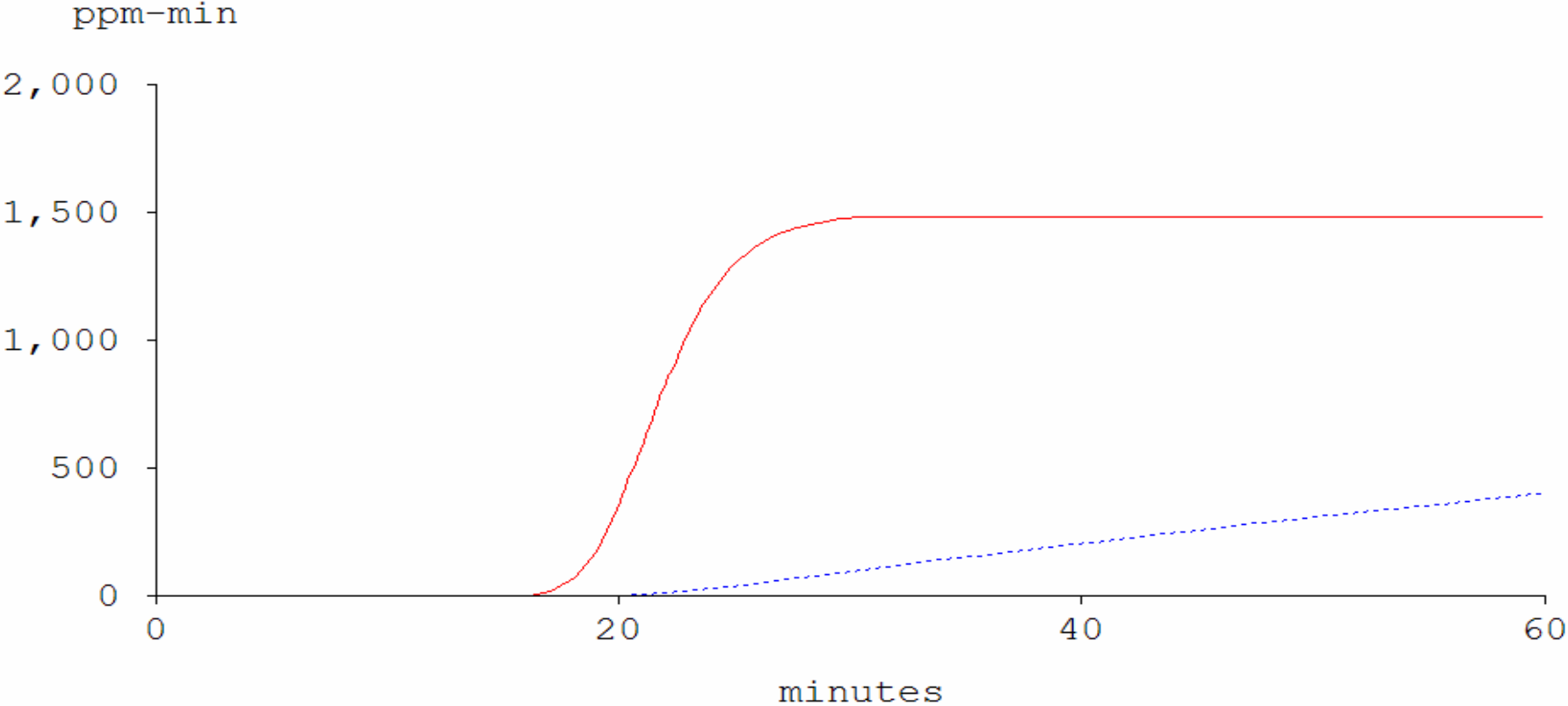


— Outdoor Concentration  
- - - Indoor Concentration



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# Chlorine Dose at HZC



— Outdoor Dose  
- - - Indoor Dose



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# Vulnerability/Mitigation

## **Mechanical / CBR Attack (Chemical and Radiological)**

Upgrade filters to MERV 11, 12 or 13 to remove particulates / CBR

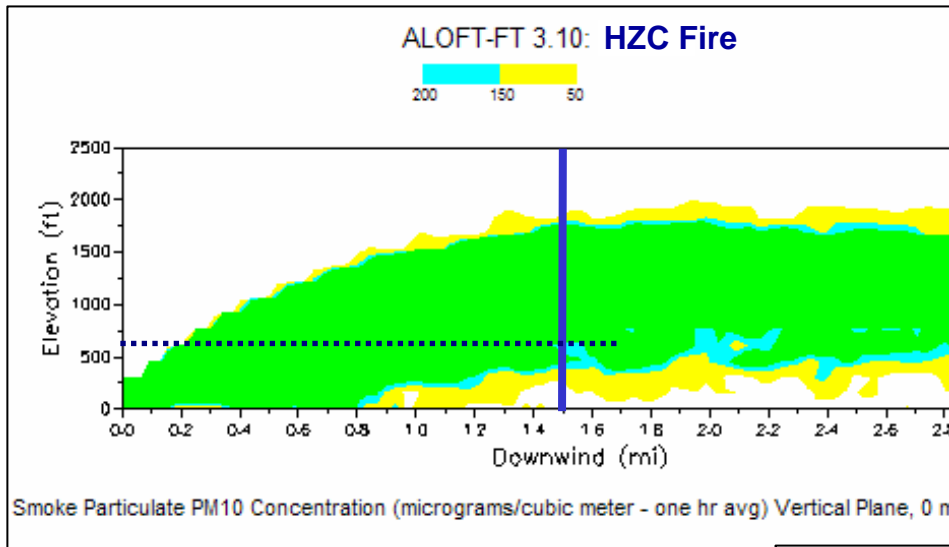
- Confirm pressure drop can be handled or upgrade fan equipment
- \$50K to \$1.2M+ per floor



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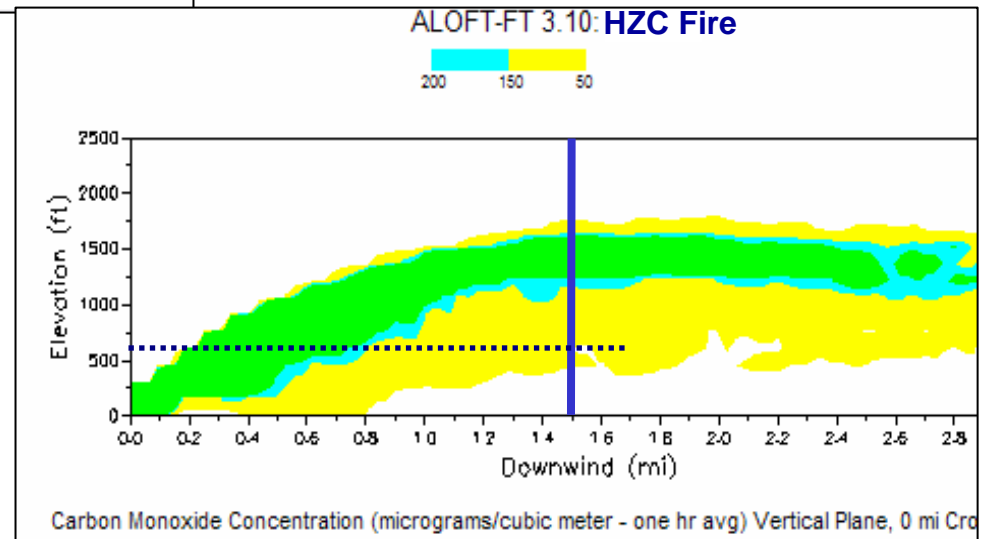


# Fire Plumes – Smoke & CO



Smoke

Carbon Monoxide  
IDLH for CO is 1,200 ppm



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# Vulnerability/Mitigation

## **Mechanical / CBR Attack (Chemical and Radiological)**

Install chemical/radiological detectors

- Activate HVAC shutdown and alarm
- \$15K to \$100K per floor for each type, with radiological less expensive



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# Vulnerability/Mitigation

## Mechanical / CBR Attack

Redesign HVAC for lobby

- Separate system, like mailroom - \$620K

Design safe rooms / shelter-in-place locations with filtered air units operated when shelter activated

- \$200K per floor for 170 people



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# Vulnerability/Mitigation

## **Mechanical / CBR Attack (Biological)**

Evaluate Ultraviolet Germicidal Irradiation (UVGI)

- \$4.9M for complete facility

## **CBR General**

Establish Occupant Emergency Plans for CBR external and internal releases

- Part of Building Management overhead



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# Vulnerability/Mitigation

## Security Systems / Generic Measures

Expanded and upgraded CCTV coverage

- Perimeter - \$415K
- Stairwells (not pan/tilt/zoom) - \$800K
  - UG Parking, Lobby, Federal Floors
  - Include coverage of access keypads
- UG parking - \$555K
- With appropriate sensors (motion, noise, door contact) to aid monitoring



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# Vulnerability/Mitigation

## Security Systems / Generic Measures

Panic / duress alarms – for general public

- Place sign at each keypad
- Reprogram system to indicate duress/problem by pressing 911\*
- Keypads linked to CCTV monitoring system for alarm
- Keypads added to plaza UG parking levels with CCTV coverage



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# Vulnerability/Mitigation

## Equipment Ops and Maintenance / Vehicle Bomb or Armed attack

Confirm sufficient fuel capacity for emergency generators to cover longest historical outage

- Starting estimate: 0.08 gal/KW/hr
- Once per year measure consumption at normal to high load
- Coordinate timely resupply



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