Fire Protection Systems Evaluation
Office Building

Christine Newton
Agenda

• Prescriptive-based Evaluation
  • Building Overview
  • Structure
  • Occupancy
  • Egress
  • Detection and Suppression Systems

• Performance-based Evaluation
  • Fire Scenario 1
  • Fire Scenario 2
Building Overview

• Completed in 1991
• ~107,500 square feet total
• Four Story Building
  • 3 above ground floors
  • Basement with exterior access
  • 16’ between floors
  • 8’-10’ ceilings with space above ceiling used for services conveyance
• Mostly Office Space
• Automatic Wet Sprinkler System
• Fire Alarm and Detection System
Building Layout – First Floor

- Conference Rooms
- West Building Entrance
- Enclosed Atrium
- Kitchen and Cafeteria
- Convenience Store
- North Building Entrance
- Lobby Area
- Courtyard/Smoking Area Access
- Core Services Areas - Mechanical, Electrical, Communications rooms, Bathrooms

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Building Layout – Second Floor

Conference Rooms, Offices, Cubicle Space

Atrium

Core Services Areas
-Mechanical, Electrical, Communications rooms, Bathrooms
Building Layout – Third Floor

Conference Rooms, Offices, Cubicle Space

Core Services Areas
- Mechanical, Electrical, Communications rooms, Bathrooms
Structure
Building Occupancy Classification

- Mixed Occupancy Building
- Main Occupancy is Group B

<table>
<thead>
<tr>
<th>USE OF AREA</th>
<th>OCCUPANCY CLASSIFICATION</th>
<th>FLOOR</th>
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</thead>
<tbody>
<tr>
<td>Offices, Conference Rooms, Training Rooms</td>
<td>Business – Group B</td>
<td>All</td>
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<tr>
<td>Convenience Store</td>
<td>Mercantile – Group M</td>
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<tr>
<td>Kitchen &amp; Cafeteria</td>
<td>Assembly – Group A-2</td>
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<tr>
<td>Gym/Fitness Room</td>
<td>Accessory to Business – Group B</td>
<td>Basement</td>
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<td>Storage Rooms, Loading Dock</td>
<td>Accessory to Business – Group B</td>
<td>Basement</td>
</tr>
<tr>
<td>Mechanical/Electrical/Equipment Rooms</td>
<td>Accessory to Business – Group B</td>
<td>All</td>
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</tbody>
</table>
## Structure

### Construction Type

**Table 503 – 2012 IBC**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>TYPE OF CONSTRUCTION</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
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</tbody>
</table>
Structure

Building Elements

• Foundation
  • 6” concrete slab

• Primary Steel Support
  • Wide-flange columns, beams, girders, and joists

• Floor/Roof Assemblies
  • 16 or 18 gauge metal deck with 2.5”, 4”, or 5” concrete reinforced with welded-wire fabric

• Exterior Walls
  • Precast concrete panels supported with wide-flange steel beams

• Interior Walls
  • 3-5/8” steel studs @ 16” on-center with type x gypsum wall board on each side
## Occupancy

### Occupant Loads - Basement

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Calculated Occupant Load</th>
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<tbody>
<tr>
<td>Business</td>
<td>19</td>
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<td>Exercise Rm w/ Equip</td>
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<td>Kitchen Storage</td>
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<td>Accessory (Mech/Elec/Comm rms)</td>
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</tr>
<tr>
<td>Storage</td>
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</table>
## Occupancy

### Occupant Loads – First Floor

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Calculated Occupant Load</th>
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</thead>
<tbody>
<tr>
<td>Cafeteria</td>
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<td>Kitchen</td>
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<tr>
<td>Business</td>
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<td>Lobby</td>
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<td>Accessory (Mech/Elec/Comm rms)</td>
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<td>Mercantile</td>
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</table>
# Occupancy

## Occupant Loads – Second Floor

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Calculated Occupant Load</th>
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<tr>
<td>Business</td>
<td>218</td>
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<tr>
<td>Accessory (Mech/Elec/Comm rms)</td>
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## Occupancy

### Occupant Loads – Third Floor

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Calculated Occupant Load</th>
</tr>
</thead>
<tbody>
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<td>Business</td>
<td>224</td>
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<tr>
<td>Accessory (Mech/Elec/Comm rms)</td>
<td>N/A</td>
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</tbody>
</table>
## Occupancy
### Occupant Loads Summary

<table>
<thead>
<tr>
<th>Building Floor</th>
<th>Calculated Occupant Load</th>
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</thead>
<tbody>
<tr>
<td>Basement</td>
<td>80</td>
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<tr>
<td>First Floor</td>
<td>698</td>
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<tr>
<td>Second Floor</td>
<td>218</td>
</tr>
<tr>
<td>Third Floor</td>
<td>224</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1250</strong></td>
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</tbody>
</table>
Egress
Basement Exits

• Two stairways to the first floor
• One door to the exterior of the building
Egress
First Floor Exits

- Eight total exits from the first floor
Egress
Second and Third Floor Exits

- Two stairways to the first floor
Detection and Notification
FACP Location – First floor
Detection and Notification

- Smoke Detectors in elevator shafts, lobbies, and control rooms
- Thermal detectors in kitchen areas
- Duct detectors on HVAC components
- Manual pull stations throughout
Detection and Notification

- Speaker and/or Strobe devices used throughout
- Water flow devices on sprinkler piping
- Tamper devices and monitor modules throughout
Smoke Control

- Duct detectors within HVAC components will shut down air handling units
- Fire department will break windows in the building if smoke purging is needed
Suppression

Overview

- Automatic wet-pipe sprinkler system
- Double check valve at building entry point
- Victaulic fittings and black steel piping
- Standard temperature pendent and upright glass bulb sprinkler heads
Suppression
Hazard Classification

• Ordinary Hazard Group 1
  • Storage areas, kitchen, mechanical and electrical rooms
  • Max sprinkler spacing – 130 sqft
  • Sprinkler temp rating – 212 °F

• Light Hazard
  • All other areas
  • Max sprinkler spacing – 150 sqft
  • Sprinkler temp rating – 165 °F
Suppression
Supply Information

• Main sprinkler supply test last conducted in 2013 at a hydrant located off the south side of the building
  • Static Pressure = 95 psi
  • Residual Pressure = 87 psi
  • Flow = 1119 gpm
Suppression
Supply and FD Connection

- Supply main entry point on south end of basement
- Dry standpipes for FD connections enter on both north and south ends of the basement
Tenability Criteria

• Objective
  • Maintain tenable conditions during egress times

• Criteria
  • CO concentration: 1100 ppm for CO
  • Visibility: 6 meters
  • Temperature: 60°C
Fire Scenario 1
Office Workstation

- Cubicle furniture on the third floor
- Source: Space heater
- Area: 2887 ft$^2$
- 9’ false ceiling, 15’ to deck
Fire Scenario 1
Office Workstation

- Assume adjoining office doors are closed and both entrance doors are closed
- Assume supply air into the space is zero due to shut down of Air Handling Unit
- No detectors in the area
Fire Scenario 1
Office Workstation

- SFPE Handbook Data for HRR
- 2000 kW peak HRR at approximately 500 seconds
- Sprinkler activation at 415 seconds, HRR held constant at this time
Fire Scenario 1

RSET

Total RSET = 366 seconds
Fire Scenario 1
ASET – Carbon Monoxide (1100 ppm)

- CO concentration increases at 276 s
Fire Scenario 1
ASET – Visibility (4 meters)

• Visibility drops below 4 meters at 475 s
Fire Scenario 1
ASET – Temperature (60°C)

- Temperature at 60°C at 335s
Fire Scenario 1
ASET vs RSET

ASET - Office Workstation Fire

- Temperature Above 60 deg Celcius
- Visibility Drops Below 4 Meters
- CO Concentration Above 1100 ppm

- CO is the limiting factor
Fire Scenario 1
Summary/Recommendations

• CO is the limiting factor

• Recommendation:
  • Install smoke detectors in the space to try to reduce detection, alarm, and notification times and therefore reducing evacuation time
  • Use the HVAC system to purge smoke and toxic gases in the event of a fire
Fire Scenario 2
Convenience Store

- Display/storage unit in the convenience store
- Source: Electrical
- Store Area: 945 ft²
- Lobby Area: 8000 ft²
Fire Scenario 2
Convenience Store

- No detectors
- Fire occurs during normal business hours
- Occupants do not attempt to fight the fire

- 3 areas looked at
  - Small office/storage room
  - Store
  - Lobby
Fire Scenario 2
Convenience Store

• 6 MW peak HRR at approximately 300 seconds

• SFPE Handbook Data
  • Fire ramp information was altered to a maximum of 2000 kW due to the size of the area where the fire begins

• Sprinkler activation at 50 seconds

Figure 3-1.41. HRR of potato chips and cheese nibbles set up in a shop display unit.
Fire Scenario 2
RSET

**RSET - Convenience Store Fire**

- Ignition to Detection
- Detection Time to Initiation/Notification
- Notification to Egress Decision
- Egress Decision to Movement
- Initial Movement to Complete Evacuation

• Overall First Floor RSET = 158 seconds
Fire Scenario 2
ASET – Carbon Monoxide (1100ppm)

- CO level in storage room at 25 seconds
Fire Scenario 2
ASET – Carbon Monoxide (1100 ppm)

- CO level at 100 seconds
Fire Scenario 2
ASET – Carbon Monoxide (1100ppm)

• CO level at RSET (158 seconds)
Fire Scenario 2
ASET – Visibility (6 meters)

- Visibility at 45 seconds
Fire Scenario 2
ASET – Visibility (6 meters)

- Visibility at 85 seconds
Fire Scenario 2
ASET – Visibility (6 meters)

- Visibility at RSET (158 seconds)
Fire Scenario 2
ASET – Temperature (60°C)

- Temperature at 31 seconds
Fire Scenario 2
ASET – Temperature (60°C)

• Temperature at 45 seconds
Fire Scenario 2
ASET – Temperature (60°C)

• Temperature at RSET (158 seconds)
Fire Scenario 2
ASET vs RSET

ASET/RSET - Convenience Store Fire

- RSET
- Lobby
- Store
- Fire Location

- Temperature Above 60 deg Celcius
- Visibility Drops Below 6 Meters
- CO Conc Above 1100ppm

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Fire Scenario 2
Summary

• Small office/storage room
  • All conditions fail rapidly

• Store
  • Assumption is that personnel evacuate the store as they activate the pull station at 45 seconds
  • This is also when CO concentrations begin to enter the store area

• Lobby
  • CO concentration is the limiting factor for the lobby
  • Does not become widespread until well past RSET
Fire Scenario 2
Recommendations

• Same as Scenario 1
  • Install smoke detectors in the space to try to reduce detection, alarm, and notification times and therefore reducing evacuation time
  • Use the HVAC system to purge smoke and toxic gases in the event of a fire
Questions