Fire Protection Systems Evaluation

Office Building

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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 – Basement

Building Layout – First Floor

Building Layout – Second Floor

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

USE OF AREA	OCCUPANCY CLASSIFICATION	FLOOR
Offices, Conference Rooms, Training Rooms	Business – Group B	All
Convenience Store	Mercantile – Group M	First
Kitchen & Cafeteria	Assembly – Group A-2	First
Gym/Fitness Room	Accessory to Business – Group B	Basement
Storage Rooms, Loading Dock	Accessory to Business – Group B	Basement
Mechanical/Electrical/Equipment Rooms	Accessory to Business – Group B	All

Structure

Construction Type

Table 503 – 2012 IBC

GROUP		TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
	HEIGHT (feet)	UL	160	65	55	65	55	65	50	40
A-2	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
B	S	UL	11	5	3	5	3	5	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
M	S	UL	11	4	2	4	2	4	3	1
	A	UL	UL	21,500	12,500	18,500	12,500	20,500	14,000	9,000
S-2	S	UL	11	5	3	4	3	5	4	2
	A	UL	79,000	39,000	26,000	39,000	26,000	38,500	21,000	13,500
U	S	UL	5	4	2	3	2	4	2	1
	A	UL	35,500	19,000	8,500	14,000	8,500	18,000	9,000	5,500

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

Occupancy	Calculated Occupant Load
Business	19
Exercise Rm w/Equip	42
Kitchen Storage	19
Accessory (Mech/Elec/Comm rms)	N/A
Storage	N/A

Occupancy

Occupant Loads – First Floor

Occupancy	Calculated Occupant Load
Cafeteria	450
Kitchen	94
Business	42
Lobby	77
Accessory (Mech/Elec/Comm rms)	N/A
Mercantile	35

Occupancy

Occupant Loads – Second Floor

Occupancy	Calculated Occupant Load
Business	218
Accessory (Mech/Elec/Comm rms)	N/A

Occupancy

Occupant Loads – Third Floor

Occupancy	Calculated Occupant Load
Business	224
Accessory (Mech/Elec/Comm rms)	N/A

Occupancy

Occupant Loads Summary

Building Floor	Calculated Occupant Load
Basement	80
First Floor	698
Second Floor	218
Third Floor	224
<i>Total</i>	<i>1250</i>

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

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 ft²
- 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

Figure 3-1.61. HRR of four unit workstations tested at NRIFD.

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

- 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

Fire Scenario 2

RSET

- Overall First Floor RSET = 158 seconds

ASET – Carbon Monoxide (1100ppm)

- CO level in storage room at 25 seconds

Fire Scenario 2

ASET – Carbon Monoxide (1100ppm)

- 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)

ASET – Temperature (60°C)

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

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