Fire and Life Safety Analysis

Engineering IV

Cal Poly, San Luis Obispo

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Engineering IV – General Info

- Group II-FR (UBC)/Group IB (IBC)
 - Steel frame
 - 3 Stories, 15' Tall Each
 - Classrooms, offices, labs
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Unique Features and Hazards

- “Open Architecture”
 - Atrium
 - Light wells
- High-occupancy labs
- Labs with hazardous materials

Prescriptive Analysis

- Means of egress
- Automatic detection and alarm system
- Smoke control equivalency
- Automatic sprinkler system

Means of Egress

Color Key
Business (B) Occupancy
Assembly (A-3) Occupancy
Vertical Exits

Means of Egress

Color Key
Business (B) Occupancy
Assembly (A-3) Occupancy
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Means of Egress

Color Key
Business (B) Occupancy
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Means of Egress

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Floor	Occupant Load	Occupant Capacity
1	552	2,340
2	515	540
3	331	390

Automatic Detection and Alarm

- Addressable FACP
- Tied to smoke control equivalencies

FIRE ALARM SYSTEM SEQUENCE OF OPERATION

	Manual Pull Station	Area Smoke Detector	Area Heat Detector	Duct Smoke Detector	*Elevator Smoke Detectors	**Elevator Heat Detectors	Sprinkler Flow Switch	Sprinkler Tamper Switch	Interruption Of Normal Power
Annunciate Alarm Signal At FACP	YES	YES	YES	YES	YES	YES	YES	NO	NO
Annunciate Trouble Signal At FACP	YES	YES	YES	YES	YES	YES	YES	YES	YES
Transmit Signal To Central Station Via Digital Communicator	YES	YES	YES	YES	YES	YES	YES	YES	YES
Transmit Signal To BMS	YES	YES	YES	YES	YES	YES	YES	YES	YES
Initiate Building Audible Alarm Signal	YES	YES	YES	YES	YES	YES	YES	NO	NO
Initiate Building Visual Alarm Signal	YES	YES	YES	YES	YES	YES	YES	NO	NO
Shutdown Associated Air Handling Systems	NO	YES	YES	YES	YES	YES	YES	NO	NO
Activate Associated Fire Smoke Dampers	NO	YES	YES	YES	YES	YES	YES	NO	NO
Recall Elevators To Designated Level	NO	NO	NO	NO	YES	NO	NO	NO	NO
Recall Elevators To Alternate Level	NO	NO	NO	NO	YES	NO	NO	NO	NO
Disconnect Power To Elevator Controllers	NO	NO	NO	NO	NO	YES	NO	NO	NO

* Photoelectric Type Smoke Detector Located in Elevator Lobbies and Machine Rooms

** Combination Rate of Rise/135 Degree Fixed Temperature Heat Detector Located in Elevator Hoistways and Machine Rooms

Smoke Control Equivalencies

- Fire shutters over light wells
- Smoke enclosure

Sprinkler System

- Wet-pipe system
- Fully sprinklered
- Design Criteria
 - Light hazard (offices, classrooms)
 - OH-1 (labs)

Performance-Based Analysis

- ASET vs. RSET

ASET

- Performance Criteria
 - Smoke layer < 6' (NFPA 101, Method 2)
- Two Design Fires
- Computer Modeling
 - FDS
 - CFAST

ASET – Design Fire 1

- Light well fire
 - Delayed sprinkler and smoke detector activation
 - Bypass smoke control measures

ASET – Design Fire 1

- Base HRR Curve

ASET – Design Fire 1

FDS Model

CFAST Model

ASET – Design Fire 2

- Room 225 Fire
 - Proximity to dead-end corridors
 - Blocked building exit

ASET – Design Fire 2

- Base HRR Curve

ASET – Design Fire 2

FDS Model

CFAST Model

ASET – Results

Scenario	Smoke Detector Activation	Sprinkler Activation	Smoke Layer <6'
1	50 sec	100 sec	480 sec (8 min)
2	47 sec	171 sec	850 sec (14 min 10 sec)

RSET

- Time to evacuate while fully occupied
 - Detection time (RSET)
 - Pre-movement time
 - Evacuation time

RSET – Pre-Movement Time

- Wide range of times possible
- 50 seconds typical for offices with trained occupants¹

1. Chapter 3-12: “Evacuation Time”, SFPE Handbook, 4th Edition

RSET – Evacuation Time

- Hand calculations
 - NFPA Handbook method
- Pathfinder 2011 model
- For both models...
 - Building is fully occupied
 - For Design Fire 1: all exits available
 - For Design Fire 2: one second floor exit removed

RSET – Results

Scenario	Hand Calculations	Computer Modeling	
		Steering Mode	SFPE Mode
1	6 min 30 sec	4 min 50 sec	5 min 52 sec
2	7 min 48 sec	5 min 51 sec	7 min 57 sec

ASET vs. RSET – Results

Scenario	ASET	RSET (Largest Result)	Safety Margin	ASET/RSET
1	8 min	6 min 30 sec	1 min 30 sec	1.2
2	14 min 10 sec	7 min 57 sec	6 min 13 sec	1.8

Conclusion

- Prescriptive requirements met
- PBA demonstrates adequate building performance