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
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
Means of Egress

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

Stair 1

Stair 3

Stair 4
Means of Egress

<table>
<thead>
<tr>
<th>Floor</th>
<th>Occupant Load</th>
<th>Occupant Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>552</td>
<td>2,340</td>
</tr>
<tr>
<td>2</td>
<td>515</td>
<td>540</td>
</tr>
<tr>
<td>3</td>
<td>331</td>
<td>390</td>
</tr>
</tbody>
</table>
Automatic Detection and Alarm

- Addressable FACP
- Tied to smoke control equivalencies

<table>
<thead>
<tr>
<th>FIRE ALARM SYSTEM SEQUENCE OF OPERATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual Pull Station</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Addressable Alarm Signal At FACP</td>
</tr>
<tr>
<td>Addressable Trouble Signal At FACP</td>
</tr>
<tr>
<td>Transmit Signal To Central Station Via Digital Communicator</td>
</tr>
<tr>
<td>Transmit Signal To BMS</td>
</tr>
<tr>
<td>Initiate Building Audible Alarm Signal</td>
</tr>
<tr>
<td>Initiate Building Visual Alarm Signal</td>
</tr>
<tr>
<td>Shutdown Associated Air Handling Systems</td>
</tr>
<tr>
<td>Activate Associated Fire Smoke Dampers</td>
</tr>
<tr>
<td>Recall Elevators To Designated Level</td>
</tr>
<tr>
<td>Recall Elevators To Alternate Level</td>
</tr>
<tr>
<td>Disconnect Power To Elevator Controllers</td>
</tr>
</tbody>
</table>

* 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

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Smoke Detector Activation</th>
<th>Sprinkler Activation</th>
<th>Smoke Layer &lt;6’</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50 sec</td>
<td>100 sec</td>
<td>480 sec (8 min)</td>
</tr>
<tr>
<td>2</td>
<td>47 sec</td>
<td>171 sec</td>
<td>850 sec (14 min 10 sec)</td>
</tr>
</tbody>
</table>
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 occupants

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

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Hand Calculations</th>
<th>Computer Modeling</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Steering Mode</td>
<td>SFPE Mode</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>6 min 30 sec</td>
<td>4 min 50 sec</td>
<td>5 min 52 sec</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>7 min 48 sec</td>
<td>5 min 51 sec</td>
<td>7 min 57 sec</td>
<td></td>
</tr>
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</table>
# ASET vs. RSET – Results

<table>
<thead>
<tr>
<th>Scenario</th>
<th>ASET</th>
<th>RSET (Largest Result)</th>
<th>Safety Margin</th>
<th>ASET/RSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8 min</td>
<td>6 min 30 sec</td>
<td>1 min 30 sec</td>
<td>1.2</td>
</tr>
<tr>
<td>2</td>
<td>14 min 10 sec</td>
<td>7 min 57 sec</td>
<td>6 min 13 sec</td>
<td>1.8</td>
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</tbody>
</table>
Conclusion

- Prescriptive requirements met
- PBA demonstrates adequate building performance