Sheraton Hotel in Downtown Phoenix
By: Raúl Farfán
Presentation Date: June 9th, 2016
Description of the Building

• Located in the Downtown area of Phoenix, Arizona
  • Construction started March 2006 and it was completed on September 2008

• The hotel has 31 floors which consists of
  • Various meeting places approximately 80,000 square feet
    • Master ballroom 29,000 square feet
    • Junior ballroom 15,000 square feet
  • 6,500 square feet - fitness center
  • 2,000 square feet - outdoor pool and sun deck
  • Restaurant: District American Kitchen and Wine Bar
  • Café shops
  • Lounges
  • Retail
General Construction Information

• The building is a Type I-A construction

• Fire Resistive Construction
  • Fire Resistance rating for the building elements reduced type I-B fire resistance elements with the exception of supporting columns. Per IBC 403.2.1.1
  • Structural members, components, opening and penetrations, and interior finish all comply with prescriptive code per the IBC.
Level 1 - Description of the Building
Level 1 - Description of the Building
Level 1 - Description of the Building
Level 1 - Description of the Building
Level 1 - Occupancy Classification

<table>
<thead>
<tr>
<th>IBC 2012 Classification</th>
<th>Example Color Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly Group A-2</td>
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<tr>
<td>Assembly Group A-3</td>
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Level 1 - Exit Location
Level 2 - Description of the Building

Second Floor
Level 2 - Description of the Building
Level 2 - Description of the Building
Level 2 - Description of the Building
Level 2 - Occupancy Classification

<table>
<thead>
<tr>
<th>Space Designation</th>
<th>Example Color Codes</th>
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<tbody>
<tr>
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<tr>
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IBC 2012 Classification

2006 391 231
136 173
64 162 173 69
371 207 83
175 192 92
Level 2 - Exit Location
Level 3 - Description of the Building
Level 3 - Description of the Building
Level 3 - Occupancy Classification

**IBC 2012 Classification**

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<th>Space Designation</th>
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</tr>
<tr>
<td>Storage Group S-2</td>
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</tr>
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</table>

**Assembly Group A-2**

- Code: 2
- Occupancy: 24
- Color: Green

**Assembly Group A-3**

- Code: 63
- Occupancy: 63
- Color: Pink

**Business Group B**

- Code: 119
- Occupancy: 119
- Color: Gray

**Mercantile Group M**

- Code: 2908
- Occupancy: 2908
- Color: Yellow

**Storage Group S-1**

- Code: 49
- Occupancy: 49
- Color: Blue

**Storage Group S-2**

- Code: 5
- Occupancy: 5
- Color: Teal
Level 3 - Exit Locations
Level 4 - Description of the Building
Level 4 - Description of the Building
Level 4 - Description of the Building
Level 4 - Occupancy Classification

<table>
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<th>IBC 2012 Classification</th>
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<tr>
<td>Storage Group S-2</td>
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</tr>
</tbody>
</table>

Space Designation Example Color Codes

- 648: Purple
- 74: Green
- 27: Blue
- 1326: Yellow
Level 4 - Exit Location
Egress of Building

• Egress sizing factor used are:
  • 0.2 inch per occupant load on stairways per IBC 1005.3.1
  • 0.15 inch per occupant load on doors and other egress components per IBC 1005.3.2
  • These exceptions were possible due to the building having a wet sprinkler systems per IBC 903.3.1.1

• Travel and common path of distances are in compliance

• Complies with majority of the egress requirements. There are two areas in the hotel that does not meet the requirements and needs to be reviewed
  • Terrace room on level 2 – exit separation non-conformity
  • Main Ballroom on level 3 – North egress doors encroachment non-conformity.
Egress of Building

• Terrace Room
  • Exit separation is not the minimum 1/3 of the maximum diagonal distance of the service area per IBC 1021.2.4 exception 2.
  • Two doors are needed because the occupant load is greater than 49 occupants.
  • It is recommended that the doors be separated 36’-8” from one another.
Egress of Building

• Main Ballroom
  • Encroachment per Section 1005.7 is not compliant with north egress doors in the Main Ballroom. The door swing obstruct the exit pathway of the vestibule by 55%.
  • Recommendation is to extend the vestibule to meet the code or to not use the north door as egress pathways. If the latter option is chose when the partition walls in the ballroom are used section B, E, and C will need to have less than 49 occupants.
Egress of Building

- **Egress Calculation**
  - Pathfinder was used to calculate the egress of level 1 to 4.
  - Pre-movement time was not placed in the model. However, it is assumed a maximum of 4 minute pre-movement time is needed.
    - Data used for pre-movement time was taken from the SFPE handbook.
  - Total Egress is 24 minutes and 32 seconds.
Egress of Building

• Illumination and Exit Signs
  • Meets IBC Section 1006 and 1011
    • 1 footcandle at the walking surface with 90 minutes emergency power
    • Signs mark direction of egress and sign does not exceed 100 feet
Fire Suppression Systems

• Wet Sprinklered System
  • Installed per IBC 903.3.1.1 and NFPA 13
  • Light Hazard, Ordinary Hazards I and II
  • Typical 5.6 K factor sprinklers
    • Light Hazard Areas are quick response sprinklers
  • Flow Control System with every floor

• Ansul Kitchen System
  • Installed per NFPA 96 and 17a

• Suppression system in the hotel is determined to be compliant
Alarm and Detection Systems

- Fire Panel per NFPA 72
  - Edwards Fire Panel model E-FSA250 Series
  - Power Boosters S85005-0125
- Detection per NFPA 72
  - Smoke detectors
  - Duct Smoke Detectors
  - Flow Switch on the main standpipe
  - Detector located on the elevator lobbies, guest rooms, ducts, and near the stairwells.
Alarm and Detection Systems

• Alarms per NFPA 72
  • Strobe Lights
  • Audible Alarms
  • Horn/Strobe Alarms

• Smoke Control System
  • System is compliant with the IBC Section 909
  • Since this is a high rise building a smoke control system is required on the stairwells. Section 909.20 Smoke Proof Enclosures
  • No smoke control system required for the 2 stories atrium per Section 404.5. This atrium is located on the ground floor in the lobby area.
Performance Based Analysis

• Fire Scenarios
  • Lobby couch fire (level 1)
  • Tradeshow fire, modeled as a kiosk fire on the main ballroom (level 3)

• Objectives
  • Fire Scenario 1 is to verify the tenability criteria is met during the egress time of the pre-function area on level 2. Although the fire is on level 1 the atrium exposes occupants on level 2 to temperature, smoke, and toxicity from the fire.
  • Fire Scenario 2 is to verify tenability criteria is met during egress time of the main ballroom and to show if fire spread is a concern in the ballroom.
Performance Based Analysis

• Tenability
  • Temperature Limit: < 140°F (60°C) at 6 ft.
    • Thermal Tolerance for unprotected skin is 240°F (120°C), to keep a safe value the thermal tolerance was reduced by half. (Found in the Handbook of Smoke Control Engineering)
  • Visibility: 50 ft. (approx. 15 m)
    • The exit signs are located at a maximum of 100 ft. (approx. 30 m).
  • Toxicity: FED value of < 0.5
    • A 0.5 value is considered an incapacitating dose
    • \[ FED_{max} = \frac{Kt}{2.303 \delta_m S_c L C t_{50}} \] taken from the Handbook of Smoke Control Engineering
      • K = Proportionality constant (3 or 8)
      • t = Exposure time (min)
      • \( \delta_m \) = Mass Optical Density (SF/lb or sm/g)
      • \( S_c \) = Visibility criterion (ft or m)
      • \( L C t_{50} \) = Lethal exposure dose from test data, (lb*min/cu. ft or g*min/cu. m.)
Fire Scenario 1

• Couch Fire in the main lobby 1st Floor
  • Atriums do not allow high fire loads per Section 404, unless there is a suppression system installed per Section 903.1.1. The Hotel does have a sprinklered system and this is the reason why upholstered couches are located in level 1.
  • Pendants are set up 15 ft. apart around the couch fire. Area coverage is the maximum 225 sq. ft. (RTI value: 50, Activation Temp. 155°F)
Fire Scenario 1

• Egress time for the pre-function area is approximately 800 seconds

• This will be time frame tenability must be maintained in the pre-function area in level 2
Fire Scenario 1

• Heat Release Input Parameters
  • Peak HRR is 3447 kW at 400 seconds
  • Soot Yield 0.129
  • The fire HRR and soot are from Barbrauskas, Upholstered Furniture Room Fires and the SFPE handbook of Fire Protection Engineering.

• Assumed that if sprinkler activation time is activated before peak then couch will be suppress and allowed to burn out.

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Qdot (kW)</th>
<th>CO Yield</th>
<th>Soot Yield</th>
</tr>
</thead>
<tbody>
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<td>0</td>
<td>0</td>
<td>0.0187</td>
<td>0.129</td>
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<tr>
<td>100</td>
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</table>
Fire Scenario 1

- HRR output with Sprinklered Activation
  - Pendant activation at 328 seconds, 72 seconds before peak HRR
Fire Scenario 1

- Tenability at 800 seconds
- Temperature passed, 49°C
Fire Scenario 1

- Tenability at 800 seconds
- Visibility failed, 1 meter visibility
Fire Scenario 1

• Tenability at 800 seconds
  • FED failed, 0.7

\[ FED_{max} = \frac{Kt}{2.303 \delta_m S_c LCT_{50}} \]

• \( K \) = Proportionality constant (8, exit sign illuminated)
• \( t \) = Exposure time (13.3 minutes)
• \( \delta_m \) = Mass Optical Density (1600 sq. ft./lbs - 0.33 sq. m./g)
• \( S_c \) = Visibility criterion (3.2 ft - 1 m., per the result from FDS)
• \( LCT_{50} \) = Lethal exposure dose from test data, (0.012 lb/cu. ft. * min - 200 g/cu. m. *min)
  • Used Polyurethane properties for the couch
Fire Scenario 1

• Conclusion
  • A couch fire in the lobby will create an environment in the pre-function area that will make it difficult for all occupants to exit when pre-function is at full occupancy load.

• Recommendations
  • To provide a glass wall to form a smoke partition using one of the exception rule in Section 404.6 enclosure of atriums. The wall must have a sprinkler systems pendent on both sides of the wall with a 4-12 inch distance from the glass wall at 6 foot intervals along the wall.
    • Smoke control exhaust not possible due to level 3 and 4.
    • Natural ventilation will not work because it only has one wall that can be used to naturally vent the smoke.
Fire Scenario 2

• Kiosk Fire in a trade show in the main ball room on the 3rd floor.
• The ballroom has a 2 hr. fire and smoke rating.
• Per discussion in previous section the recommendation of not using the north doors as egress doors was used.
• Pendant set up at 15 ft. apart around the Kiosk Fire. Area coverage is the maximum 225 sq. ft. (RTI value: 50, Activation Temp. 155°F)
Fire Scenario 2

• Egress time
  • Egress time in the previous Pathfinder model will not be an accurate as an egress time because the model was done in an empty room.
  • 7 net occupancy load factor was used for the remaining open area.
  • Aisle are 6 feet apart. The surrounding kiosk near the fire scenario is 3 feet.
Fire Scenario 2

• Egress time (continued)
  • New occupant load for the room is 2416 persons for the main ballroom.
  • Egress time using the doors is 94 seconds.
  • This is the required time the tenability criteria must be maintained.
Fire Scenario 2

- Heat Release Input Parameters
  - Peak HRR is 1720 kW at 1230 seconds
  - Soot Yield 0.015
  - Values found in SFPE Handbook and Handbook of Smoke Control Engineering

- Adjacent Kiosk ignition temperature 650°F

- Max HRR 100 kW for a fire resistant kiosk per Section 402.6.2 (IBC), the surrounding kiosk will be compliant with fire resistance. Required by Phoenix Fire Department.

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Qdot (kW)</th>
<th>CO Yield</th>
<th>Soot Yield</th>
</tr>
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</tbody>
</table>
Fire Scenario 2

• HRR output with Sprinklered Activation
  • Pendant activation at 1181 seconds, 55 seconds before peak HRR and 74 seconds before surrounding kiosk ignite in fire.
Fire Scenario 2

- Tenability at 94 seconds
  - Temperature passed, 20°C
Fire Scenario 2

- Tenability at 94 seconds
  - Visibility passed, 30 meters
Fire Scenario 2

• Tenability at 94 seconds
  • FED passed, 0.002

\[ FED_{max} = \frac{\kappa t}{2.303\delta_m S_c LCT_{50}} \]

• \(\kappa\) = Proportionality constant (8, exit sign illuminated)
• \(t\) = Exposure time (1.56 minutes)
• \(\delta_m\) = Mass Optical Density (1400 sq. ft. / lbs. - 0.29 sq. m./g)
  - Wood values
• \(S_c\) = Visibility criterion (30 m, per the result from FDS)
• \(LCT_{50}\) = Lethal exposure dose from test data, (0.047 lbs/ cu. ft * min - 400 g/cu. m.*min)
  - Used Cellulosic materials
Fire Scenario 2

• Conclusion
  • A Kiosk fire does meet tenability during the egress time of the occupants. Fire Suppression Sprinklers does activate before flame spread and peak heat release rate. It is assumed that the sprinklers will activate in time to cool down surrounding kiosk thus flame spread will not happen.

• Recommendations
  • There is no recommendation is needed since the fire scenario passed the objectives of the performance based analysis
Prescriptive Recommendation and Performance Base Result

• Prescriptive recommendation
  • Egress doors for the Terrace on Level 3 must be separated to meet Section 1021.2.4
  • North doors that lead to vestibules that have encroachment issues per Section 1005.7 is required to extend the width of the vestibule or not use the doors as a means of egress.
    • The latter option will entail that when section B, E, and C of the ballroom is used with partition walls in place, less than 49 occupants can be in each of the service spaces.
Prescriptive Recommendation and Performance Base Result

• Performance Based Analysis recommendation
  • Lobby Couch Fire
    • To provide a glass wall to form a smoke partition using one of the exception rule in Section 404.6. The glass wall is required to have a pendants on both sides of the wall with a 4-12 inch distance from the glass wall at 6 foot intervals along the wall.
Question and Answers