Houston Community College – San Jacinto

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Spring 2014
Presentation outline

1. Project Overview
2. Prescriptive Requirements
3. Existing Requirements
4. Performance Evaluation
5. Conclusions
Project involvement

- RJA-Houston since 2010
- Hired as FP/LS consultants by architect in 2011
- Drawing reviews, sprinkler design, code questions
Overview

- 1914- Jr High School
- 1927- Houston Junior College
- 1988 - Houston Community College
- Total:155,000 sq. ft.; Footprint:64,000 sq. ft.
- Three stories
- Fully sprinklered
- Gut and remodel
Interior Layout – Level 1
Interior Layout – Level 3
Site Description

- Located in downtown Houston
- Part of HCC campus
- 30 ft. of frontage provided for most of perimeter
- Existing municipal fire hydrants
- Existing FAARs
Code compliance (prescriptive analysis)

- Houston Building Code (HBC), based on the 2006 International Building Code, including City of Houston Amendments

- Houston Fire Code (HFC), based on the 2006 International Fire Code, including City of Houston Amendments and Fire Department Life Safety Bureaus (LSBs)

- Texas (Title 28 §34.607) has adopted a standard where NFPA 101 applies where a local jurisdiction has not adopted a building code. NFPA 101 is not applicable to this project
Reference Documents

- 2007 Edition of NFPA 72
- Appendix L

- Houston Fire Department LSBs:
  - 1 - Fire Extinguishers
  - 2 - Inspection and Testing of Fire Protection and Life Safety Equipment,
  - 3 - Fire Dept Access
  - 4 - Access Gates
  - 5 - Key Boxes
  - 6 - Fire Depository Boxes
  - 8 - Fire Drills
Occupancy Type

- Occupancies present
  - Group A-1
  - Group A-3
  - Group A-4
  - Group B
  - Group M (accessory)
  - Group S-2/F-2 (accessory)
- Mixed use, non-separated.
- Most restrictive potions of 403 and 9 apply throughout.
Construction Type

- Group A-1
- Sprinkler increase - 200% (x3)
- Maximum frontage - 75%
- Type IB construction

Table 503

<table>
<thead>
<tr>
<th>Group</th>
<th>IA</th>
<th>IB</th>
<th>IIA</th>
<th>IIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>UL</td>
<td>5 UL</td>
<td>3 15,500</td>
<td>2 8,500</td>
</tr>
<tr>
<td>A-3</td>
<td>UL</td>
<td>11 UL</td>
<td>3 15,500</td>
<td>2 9,500</td>
</tr>
<tr>
<td>A-4</td>
<td>UL</td>
<td>11 UL</td>
<td>3 15,500</td>
<td>2 9,500</td>
</tr>
<tr>
<td>B</td>
<td>UL</td>
<td>11 UL</td>
<td>5 37,500</td>
<td>4 23,000</td>
</tr>
</tbody>
</table>
h: When an automatic sprinkler system is provided throughout a building, the fire-resistive time periods may be reduced by one hour for permanent partitions, interior-bearing walls, floor construction, roof construction and beams supporting roofs.
Appendix L/Certificate of Occupancy

- Permitting/Certificate of Occupancy
- No change of use
Existing Requirements

- Maintain level of life safety
- Existing permitted to remain, excluding where Appendix L is more restrictive
  - Existing construction type
  - Existing unenclosed openings
  - New means of egress
  - New interior finishes
  - New sprinkler system
  - New fire alarm system

HBC 3403.2
Means of Egress

- 0.3 in./person – stair
- 0.2 in./person – other
- 6 exit stairs
- 5100 occupant capacity
## Occupant load

<table>
<thead>
<tr>
<th>Floor</th>
<th>Occupant Load</th>
<th>Egress Capacity</th>
<th>Number of exits</th>
</tr>
</thead>
<tbody>
<tr>
<td>First floor</td>
<td>1997</td>
<td>3053</td>
<td>15</td>
</tr>
<tr>
<td>Second floor</td>
<td>1096</td>
<td>1040</td>
<td>6</td>
</tr>
<tr>
<td>Third floor</td>
<td>616</td>
<td>1040</td>
<td>6</td>
</tr>
</tbody>
</table>

- Second floor includes third floor balcony
- Contains 502 fixed seats, two 40 in. stairs with 36 in. doors
- Stairs limit the occupant load on the balcony to 266
- Existing Condition
Stage Requirements

- Stage ventilation
- Rated proscenium
- Standpipes
Fire Protection Systems

- Fire Alarm
  - Initiation
  - Detection
  - Manual
  - Waterflow
- Notification
  - Horns
  - Strobes

- Suppression
  - Sprinkler system
  - Class I standpipe
  - Class II standpipe
  - Fire extinguishers

- Mass notification
Suppression

- Fire extinguishers (LSB 01)
  - 75ft
  - Group A: 3000 sq. ft.
  - Group B: 6000 sq. ft.
- NFPA 13 system
  - Light Hazard
  - Ordinary Hazard 1
- Class I standpipes required where the floor of the highest story is greater than 30 ft. above grade
- Class II standpipes required where stage is larger than 1000 sq. ft.

- 908.1: Fire pumps are not permitted to directly connect to city line
- 2,500 gal. break tank
- Standpipes require a break tank and larger pump
Water Supplies
Performance Analysis

- Objective is to provide an analysis of the hazard associated with the large number of existing balcony seats.
- Goal is to determine if seats must be removed.
- Tenability: visibility criteria of 17.1m (56ft)
- Maintained at 6 ft. above balcony floor
- ASET vs RSET
- DETACT, FDS, Pathfinder, Flow Calculations
Scenarios

- **Scenario 1**
  - Fire grows and spreads on stage
  - Occupants egress
  - Sprinklers activate and control
  - Balcony contains 266 seats

- **Scenario 2**
  - Fire grows and spreads on stage
  - Occupants egress
  - Sprinklers activate and control
  - Balcony contains 502 seats
Required Safe Egress Time

- Preaction: 0s
- Premovement: 30s
- Movement time
- Margin of Safety
Scenario 1 Start

Floor 3.00
Scenario 2 Start

Floor 3.00
Flow Model Calculations

- Stairs – 40”, Doors – 36”
- Max flow model
- 114 p/min
Pathfinder: Steering vs SFPE

Steering

SFPE
Egress Times

- Hand calculations
- Pathfinder SFPE Mode
- Pathfinder Steering mode
  - No flow reduction based on density
  - Does not limit max flow

<table>
<thead>
<tr>
<th>Balcony Seats</th>
<th>Flow** Model</th>
<th>Path (SFPE)</th>
<th>Path (Steer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>266</td>
<td>140s</td>
<td>165s</td>
<td>106s</td>
</tr>
<tr>
<td>502</td>
<td>265s</td>
<td>315s</td>
<td>190s</td>
</tr>
</tbody>
</table>

*Does not include premovement time
**Does not include walking time
DETACT Sprinkler Model

- Ceiling height - 11m
- Radial distance – 4m
- Ambient temperature - 20°C
- Actuation temperature (ordinary) - 74°C
- RTI (quick response) - 50
- Fire growth power - 2
- Growth rate (fast) - 0.047
- Activation time – 376s
- HRR at activation ≈ 6600 kW
- Alpert correlation/Heskestad
DETACT Fusible Link Model

- Ceiling height - 11m
- Radial distance – 6m
- Ambient temperature - 20°C
- Actuation temperature (ordinary) - 74°C
- RTI - 167
- Fire growth power - 2
- Growth rate (fast) - 0.047
- Activation time – 495
- HRR at activation ≈ 11,500 kW
- Alpert correlation/Heskestad
Fire simulation

- Reynolds-averaged form of the Navier-Stokes equations
- Radiation finite volume technique
- Conservation of mass, energy, momentum
- Soot yield - 0.0356 kg/kg (Arup)
- HVAC Shutdown
- Doors open
- T-squared fire
- Sprinkler activation controls fire
Model HRR

![HRR vs Time Graph](image-url)
Scenario 1 – Fire simulation (165s)
Scenario 1 – Fire simulation (165s)
Scenario 1 – Fire simulation (195s)
Scenario 1 – Fire simulation (195s)
Scenario 2 – Fire simulation (315s)
Scenario 2 – Fire simulation (315s)
Scenario 2 – Fire simulation (345s)
Scenario 2 – Fire simulation (345s)
Fire simulation – breaking point
Fire simulation – breaking point
Conclusion/Recommendations

- Prescriptive – seats may remain
- Performance – remove seats 266 vs. 400
- Recommendation: balcony seating arrangement should be included in remodel, and should be reduced to 266 occupants
Questions?