Fictitious Architects

COURT HOUSE PROJECT

Presented by Ryan Rigsbee
Overview

• General building information
• Prescriptive Based Analysis
• Performance Based Analysis
• Results and Recommendations
General Building Information

DESIGN

- Type IIA Construction
  - Fully Sprinklered
  - Full Area Detection
  - Smoke Control

- Occupancy
  - Primary: Group A-3
    - 11 courtrooms
  - Secondary: B, I-3, S1, S2

- 4 Stories + Basement
  - Approximately 118,100 square feet
  - Overall height: 65 feet (ground to roof slab)
  - 4 story atrium, smoke control required

<table>
<thead>
<tr>
<th>Approximate Square Footage per Floor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basement</td>
</tr>
<tr>
<td>Level 1</td>
</tr>
<tr>
<td>Level 2</td>
</tr>
<tr>
<td>Level 3</td>
</tr>
<tr>
<td>Level 4</td>
</tr>
</tbody>
</table>
PARTIAL LIST OF APPLICABLE CODES & STANDARDS

- 2010 Building Standards Administrative Code, C.C.R. Title 24, Part 1
- 2010 Building Code (CBC), C.C.R. Title 24, Part 2
- 2010 Building Electrical Code (CEC), C.C.R. Title 24, Part 3
- 2010 Building Mechanical Code (CMC), C.C.R. Title 24, Part 4
- 2010 Building Fire Code (CFC), C.C.R. Title 24, Part 9
- NFPA 14 Standpipe Systems (Ca Amended) 2007 Edition
- NFPA 20 Stationary Pumps 2007 Edition
- NFPA 24 Private Fire Mains (Ca Amended) 2010 Edition
- NPFA 72 National Fire Alarm Code (Ca Amended) 2010 Edition
Prescriptive Based Analysis

• Egress Analysis
• Fire Alarm and Notification
• Fire Suppression
• Structural Fire Protection
• Smoke Control
Egress Analysis

- 4 Smoke proof enclosures
  - One at each remote corner of the building
- Occupant load
  - Exit capacity well exceeds actual usage
- Required safe egress time
  - 14.92 minutes (based on 2009 NFPA handbook)
- Available safe egress time
  - At least 20 minutes (based in FDS modeling)

<table>
<thead>
<tr>
<th>Floor</th>
<th>Exit Capacity</th>
<th>Actual Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basement</td>
<td>1060</td>
<td>34</td>
</tr>
<tr>
<td>First</td>
<td>2140</td>
<td>418</td>
</tr>
<tr>
<td>Second</td>
<td>700</td>
<td>585</td>
</tr>
<tr>
<td>Third</td>
<td>700</td>
<td>449</td>
</tr>
<tr>
<td>Fourth</td>
<td>700</td>
<td>525</td>
</tr>
</tbody>
</table>
Egress Analysis (Level 2)
Fire Alarm and Signaling

Fire Alarm Control Panel (FACP)
- Simplex 4100ES FACP (model 4100-9111)
- California State Fire Marshal (CSFM) Listed

Initiating Devices
- Full area detection
- Simplex TrueAlarm Analog Sensors
  - Heat sensing
- Beam Detection
  - Installed at the opening in Level 4 slab
  - Obscuration set to 35% (L<150 feet)
- Manual Pull Station
  - AHJ requires one installed near main entrance
  - Simplex addressable manual station (4099-9003)
Initiating (Level 1)
Fire Alarm and Signaling

Alarm Notification Devices

- Fire Emergency / Voice Alarm Communication System (EVACS)
  - Simplex TrueAlert multi-candela (ceiling mounted with speaker)

Alarm Notification Devices

- Speakers in addition to those on the Multi-candela devices will be required for full coverage
- Simplex Multi-application peripherals will be installed, model 4209-9721(CD)
- Prior to coordination with Acoustical Consultant, 25 foot spacing will be used

<table>
<thead>
<tr>
<th>Strobe (candela)</th>
<th>Spacing (feet x feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>20 x 20</td>
</tr>
<tr>
<td>30</td>
<td>30 x 30</td>
</tr>
<tr>
<td>75</td>
<td>44 x 44</td>
</tr>
<tr>
<td>110</td>
<td>53 x 53</td>
</tr>
</tbody>
</table>
Fire Suppression

WET AUTOMATIC FIRE SUPPRESSION SYSTEM

- Each Level is a separate zone (<52,000 ft²)
- Wet Sprinkler Riser
  - Located in southeast stair
- High pressure alarm check valve

STANDPIPE

- One riser in each stair enclosure
- Hose connection at level landings
- Standpipe hose connection at roof required

LIGHT HAZARD OCCUPANCY

- Minimum area of sprinkler operation 1500 square feet
- Flow density required over sprinkler operation area 0.10 gpm/ft²
- Maximum protection area per sprinkler head 225 ft² (15 ft x 15 ft)
  - NFPA 13 Table 8.6.2.2.1(a)

WATER SUPPLY

- Diesel powered split case fire pump
  - 1,000 GPM at 80PSI
Fire Suppression

FLOW SUMMARY - Hydraulic Graph $N^{1.85}$

- 0 GPM @ 175 PSI
- 209 GPM @ 141 PSI (Demand at Bottom of Riser)
- 1000 GPM @ 141 PSI (150% of Rated Cap with Flow Demand from Remote Roof Standpipe)
- 1500 GPM @ 135 PSI
- 1400 GPM @ 65 PSI

Graphs showing:
- City Water Supply
- Demand
- City + Fire Pump
Building height and area
- Type IIA construction (CBC Table 503)
  - Maximum height: 55 feet
  - Maximum Stories: 3
  - Maximum story area: 15,500 ft²

Building height and area Modification
- Modification to CBC Table 503
  - Frontage increase
  - Building area modification
  - Automatic Fire Sprinkler Increase
- Type IIA construction
  - Maximum height: 75 feet
  - Maximum Stories: 4
  - Maximum story area: 58,125 ft²
  - Total allowable area: 174,375 ft²
  - Actual Area: 118,100 ft²
## Structural Fire Protection

### Type IIA Fire-Resistance Rating Requirements for Building Elements (CBC Table 601 & 602)

<table>
<thead>
<tr>
<th>Element</th>
<th>Fire-Rating Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary structural frame</td>
<td>1 hour</td>
</tr>
<tr>
<td>Bearing walls (exterior &amp; interior)</td>
<td>1 hour</td>
</tr>
<tr>
<td>Nonbearing wall and partitions (exterior)</td>
<td>0 hour¹</td>
</tr>
<tr>
<td>Nonbearing walls and partitions (interior)</td>
<td>0 hour</td>
</tr>
<tr>
<td>Floor construction and secondary members</td>
<td>1 hour</td>
</tr>
<tr>
<td>Floor constructions and secondary members</td>
<td>1 hour</td>
</tr>
</tbody>
</table>

¹Based on the provisions in Table 602 for a separation distance greater than or equal to 30 feet in Group A Occupancy

- **Atrium (CBC Section 404.6)**
  - Extent of atrium will be separated from adjoining spaces by 1-hour fire-resistance-rated material

- **shafts (CBC Section 708.4)**
  - Penetrating 3 or less stories: 1-hour
  - Penetrating 4 or more stories: 2-hour

- **Exterior Walls (CBC Table 705.8)**
  - Separation distance more than 30 feet
  - Unprotected / Sprinklered
  - 1-hour fire-resistance-rated (reinforced concrete)
### Smoke Control (Prescriptive)

<table>
<thead>
<tr>
<th>Axisymmetric</th>
<th>Balcony Spill</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q</strong> = 5,000 kW</td>
<td><strong>Q</strong> = 1,200 kW</td>
</tr>
<tr>
<td><strong>Z</strong> = 32 ft</td>
<td><strong>H</strong> = 12 ft</td>
</tr>
<tr>
<td><strong>Z&lt;sub&gt;L&lt;/sub&gt;</strong> = 13.65 ft</td>
<td><strong>W</strong> = 30 ft</td>
</tr>
<tr>
<td><strong>Z&lt;sub&gt;b&lt;/sub&gt;</strong> = 20 ft</td>
<td></td>
</tr>
<tr>
<td><strong>Smoke Temp</strong> = 165°F</td>
<td><strong>Smoke Temp</strong> = 80°F</td>
</tr>
<tr>
<td><strong>Elevation</strong> = 0 ft</td>
<td><strong>Elevation</strong> = 0 ft</td>
</tr>
<tr>
<td><strong>Exhaust</strong> = 114,000 CFM</td>
<td><strong>Exhaust</strong> = 227,000 CFM</td>
</tr>
</tbody>
</table>
Performance Based Analysis

• Egress Analysis
• Smoke control
Performance Based Analysis

- Occupant Speed
- STEPS
Egress Analysis

<table>
<thead>
<tr>
<th>Occupant Age/Type</th>
<th>Walking Speeds (ft/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Horizontal</td>
</tr>
<tr>
<td>Young</td>
<td>4.27</td>
</tr>
<tr>
<td>Middle</td>
<td>3.94</td>
</tr>
<tr>
<td>Old</td>
<td>3.28</td>
</tr>
<tr>
<td>Disabled</td>
<td>1.64</td>
</tr>
</tbody>
</table>

Occupant load at beginning of simulation
Egress Analysis

Occupants during queuing

Time for complete evacuation (RSET) = 17 minutes
Smoke Control (Performance)

- Geometry
- Reduced Exhaust Rate
- Natural Make-up Openings
- Tenability Criteria
- Design Fire Scenarios
- (FDS) Results
Geometry

- Adjacent spaces on Levels 1 & 2 separated by 1-hour fire-resistance-rated construction
- Levels 3 & 4 separated from atrium by 1-hour fire-resistance-rated accordion fire door
  - Creates reservoir for smoke filling
## Design Fire Scenarios

<table>
<thead>
<tr>
<th>ID</th>
<th>Location</th>
<th>Calculated Fire Size&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF1</td>
<td>Growth and Decay</td>
<td>5,000 kW</td>
</tr>
<tr>
<td>DF2</td>
<td>First Floor Below Bridge</td>
<td>1,200 kW</td>
</tr>
<tr>
<td>DF3</td>
<td>First Floor Security Screening/Queuing</td>
<td>1,200 kW</td>
</tr>
<tr>
<td>DF4</td>
<td>Second Floor Elevator Lobby</td>
<td>1,200 kW</td>
</tr>
</tbody>
</table>

<sup>1</sup> Fire size at sprinkler activation was based on calculation developed by Heskestad and Delichastios.

<sup>2</sup> The FDS fire size is slightly different due to the manner in which the fire parameters are entered into the model.
Geometry – Level 1
Geometry - Level 2

Design Fire Locations:
1. DF1 - First Floor Lobby Adjacent to Stair
2. DF2 - First Floor Below Bridge
3. DF3 - First Floor Security Screening Queuing
4. DF4 - Second Floor Elevator Lobby

Area affected during a fire event.
Geometry – Level 3
Reduced Exhaust Rate

- Prescriptive Mechanical Exhaust
  - 5,000 kW axisymmetric
    - 114,000 CFM exhaust
  - 1,200 kW balcony spill plume
    - 227,000 CFM exhaust

- Performance-based Mechanical Exhaust
  - 100,000 CFM
  - Exhaust vents located at high level in atrium connected to exhaust fan ducts
Natural Make-up Openings

- Automatic doors and windows
  - L1 Main entrance clear area: 111 square feet
  - L1 West window clear area: 26.5 square feet
  - L2 East window clear area: 26.5 square feet
  - L2 West window clear area: 26.5 square feet
- Velocity through openings: ≤ 525 FPM

West Face View

East Face View
Tenability Criteria

- Criteria measured 6 ft above walking surface
- Temperature (NFPA 130)
  - Thermal burns occur in respiratory tract with air above 60°C (140°F)
- Visibility (SFPE Handbook)
  - Allowable visibility for occupants unfamiliar with their surroundings is 13 meters (42 ft)
FDS Design Fire Outputs

Heat Release Rate (kW) vs. Time (s)

- DF1
- DF2
- DF3
- DF4
- Temperature and visibility remain tenable at egress walking services for the duration of the evacuation period.
DF2 Temperature

Smokeview 5.6 - Oct 29 2010

Frame: 144
Time: 144.0
DF3 Visibility
Results

• Performance based egress analysis
  • RSET = 17 minutes
  • ASET ≥ 20 minutes

• Performance based smoke control analysis
  • 100,000 CFM mechanical exhaust
  • Natural make-up openings
  • 1-hour fire-resistance-rated accordion fire door
  • 20 minutes of tenable conditions (ASET)
Summary

• General building information
• Prescriptive Based Analysis
  • Egress Analysis, Fire Alarm and Notification, Fire Suppression, Structural Fire Protection, Smoke Control

• Performance Based Smoke Control Analysis
  • Egress Analysis
  • Smoke Control
Construction progress January 2013

Topping out February 2013