Fire and Life Safety Evaluation & Analysis

Bonderson Engineering Projects Center
Building 197 Cal Poly, San Luis Obispo
Garrett Brown
Building Location & Overview
Codes

Codes Built Under
• CBC (California Building Code) 2001
• CFC (California Fire Code) 2001
• UBC (Uniform Building Code) 1997
• NFPA 13: Installation of Sprinkler Systems 1999
• NFPA 72: National Fire Alarm and Signaling Code 2002

Codes Building Analyzed Against
• IBC (International Building Code) 2012
• CBC (California Building Code) 2013
• CFC (California Fire Code) 2013
Building Design & Overview

- Commissioned in 2006
- Designed as a student project facility
- 2 Stories at 14’-0” Floor to Floor
- 2’-0” Reinforced Concrete Slab Foundation
- Glass curtain wall across entire north elevation
- 19,000 ft² Total
  - Two Story Atrium at entrance lobby
  - Two story high-bay projects area
Building Design & Overview

- Steel Frame, Concrete over metal deck
- Braced Frame and Moment Frame Construction
- No SFRM on framing members or deck
- Fully Sprinklered
- Smoke detection and A/V alarms throughout
Structural Fire Protection – Construction Type

Building information
• First Floor Area: 13,253 ft²
• Second Floor Area: 5,747 ft²
• Total Area: 19,000 ft²
• Building Height: 29' -0"
• Construction Type Used: II-B (II-N under UBC)

Construction Types Per Table 503 of 2012 IBC

<table>
<thead>
<tr>
<th>Construction Type</th>
<th>Height / Area Limitations</th>
<th>Acceptable?</th>
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<tbody>
<tr>
<td>I-A</td>
<td>UL / UL</td>
<td>Yes</td>
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<tr>
<td>I-B</td>
<td>11 / UL</td>
<td>Yes</td>
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<tr>
<td>II-A</td>
<td>5 / 37,500 ft²</td>
<td>Yes</td>
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<tr>
<td>II-B</td>
<td>3 / 23,000 ft²</td>
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<tr>
<td>III-A</td>
<td>5 / 28,500 ft²</td>
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<tr>
<td>III-B</td>
<td>3 / 19,000 ft²</td>
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<td>IV</td>
<td>5 / 36,000 ft²</td>
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<td>V-A</td>
<td>3 / 18,000 ft²</td>
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<tr>
<td>V-B</td>
<td>2 / 9,000 ft²</td>
<td>No (Area Limited)</td>
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</table>
### Structural Fire Protection – Fire Resistance Rating

**Building information**

- Wide Flange Beams W16 x 26 and Columns W12 x 42
- 20 gauge decking with lightweight concrete fill
- Steel stud and gypsum board interior framing
- All building elements allowed 0-hr rating

### Rating Requirements Per Table 601 of 2012 IBC

<table>
<thead>
<tr>
<th>BUILDING ELEMENT</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
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<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A&lt;sub&gt;d&lt;/sub&gt;</td>
<td>B</td>
<td>A&lt;sub&gt;d&lt;/sub&gt;</td>
</tr>
<tr>
<td>Primary structural frame&lt;sup&gt;6&lt;/sup&gt; (see Section 202)</td>
<td>3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Bearing walls</td>
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<tr>
<td>Exterior</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Interior</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<td>Nonbearing walls and partitions</td>
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<td>Exterior</td>
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<td>Nonbearing walls and partitions</td>
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<tr>
<td>Interior</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Floor construction and associated secondary member (see Section 202)</td>
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<td>1</td>
<td>0</td>
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<tr>
<td>Roof construction and associated secondary members (see Section 202)</td>
<td>1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>1&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1&lt;sup&gt;b,c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Building information

- Fire separation distances are greater than 30’-0”
- Exterior walls do not need to carry more than a 0-hr rating

Rating Requirements Per Table 602 of 2012 IBC

<table>
<thead>
<tr>
<th>FIRE SEPARATION DISTANCE = X (feet)</th>
<th>TYPE OF CONSTRUCTION</th>
<th>OCCUPANCY GROUP H</th>
<th>OCCUPANCY GROUP F-1, M, S-1</th>
<th>OCCUPANCY GROUP A, B, E, F-2, I, R, S-2, U</th>
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<tbody>
<tr>
<td>X &lt; 5c</td>
<td>All</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<tr>
<td>5 ≤ X &lt; 10</td>
<td>IA</td>
<td>3</td>
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<td>1</td>
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<tr>
<td></td>
<td>Others</td>
<td>2</td>
<td>1</td>
<td>1</td>
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<tr>
<td>10 ≤ X &lt; 30</td>
<td>IA, IB</td>
<td>2</td>
<td>1</td>
<td>1d</td>
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<tr>
<td></td>
<td>IIB, VB</td>
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<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>Others</td>
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<td>1</td>
<td>1d</td>
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<tr>
<td>X ≥ 30</td>
<td>All</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>
Rated Separations

- Labs and shop areas are separated with 1-hr rated walls
- LSC 38.3.6.1 (3): the entire corridor on first floor does not have to be rated due to sprinklers throughout
- Atrium: 2-hour rating avoided through use of sprinklers throughout
- Atrium separated from high bay with 1-hour rated wall / glass.
- Roll up tool checkout window automatically closes when fire alarm triggers
Rated Separations

- LSC 38.3.6.1 (3): the entire corridor on first floor does not have to be rated due to sprinklers throughout
- Rated walls consist of 5/8” Type – X Drywall over steel studs
Structural Fire Protection – Interior Finishes

**Finishes Requirements**

- LSC 7.1.4.1: Exit wall and ceiling finishes Class A or B
- Exit floor finishes not less than Class II
Occupancy Classification

- Educational facilities past K-12 are classified by the IBC as B - Business
- Architect classified the entire building as B Business
- IBC 2012: should be a Mixed Occupancy Building
  - Business Occupancies
  - Assembly Occupancies
  - Shops, Labs
  - Mechanical Spaces
  - Storage

<table>
<thead>
<tr>
<th>LSC / (IBC) Classification</th>
<th>LSC / (IBC) Occupant Load Factors (ft²/Person)</th>
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<tbody>
<tr>
<td>Business Use</td>
<td>100 Gross</td>
</tr>
<tr>
<td>Assembly Use – Less concentrated</td>
<td>15 Net</td>
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<tr>
<td>Storage Use – Other than Mercantile</td>
<td>500 Gross</td>
</tr>
<tr>
<td>Shops, Labs, Vocational Rooms</td>
<td>50 Net</td>
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<tr>
<td>(Mechanical Spaces)</td>
<td>(300 Gross)</td>
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Occupancy Classification – 1st Floor
### Occupancy – 1st Floor

<table>
<thead>
<tr>
<th>Room / Space</th>
<th>Room Usage</th>
<th>Net Area (Sqft)</th>
<th>Gross Area</th>
<th>Corridor Area assigned to the space</th>
<th>Calculated Area (Sqft)</th>
<th>LSC - Usage Category</th>
<th>Net</th>
<th>O.L.F.</th>
<th>Occupant Load</th>
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<tbody>
<tr>
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<td>1765</td>
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<td>102</td>
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<td>γ</td>
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<td>2208</td>
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<td>114</td>
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<td>2033</td>
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<td>Wood Shop</td>
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<td>Educational - Labs / Shops</td>
<td>γ</td>
<td>50</td>
<td>16</td>
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<td>116</td>
<td>Tool Storage</td>
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<td>117</td>
<td>Shop Office</td>
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<td>81</td>
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<td>129</td>
<td>72</td>
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</table>

**Floor Total**: 360

Reference LSC 2012 - Table 7.3.1.2 Occupancy Load Factors
Reference IBC - 2012 - Table 1004.1.2 Occupancy Load Factors
### Occupancy – 2nd Floor

<table>
<thead>
<tr>
<th>Second Floor</th>
<th>201 Waiting</th>
<th>451</th>
<th>72</th>
<th>523 Business</th>
<th>50</th>
<th>100</th>
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<td>202 Vestibule</td>
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<td>206A Telectom Room 2</td>
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<td>300</td>
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</tr>
</tbody>
</table>

**Floor Total**: 126
Egress Analysis

- Egress through Atrium Lobby
- East end of corridors on both floors
- South side corridor on first floor
- Three 36” exits from covered work area
Egress Analysis

- Two Stairs
- One exterior stair on east side limited by door width 34.5"
- One unenclosed interior stair 50"
Egress Analysis

Unenclosed Interior Stair (Both 2003 & 2012 LSC)
• The interior stair allowed to be unenclosed per LSC 38.3.1.1 exception (2)
  • Exit Access Stairs Pursuant to 38.2.4.6 Allowed
• Must Be Fully Sprinklered
• Common Path of Travel < 100’

Convenience Opening
• 2012 Code
  • Separated from corridor or use rated corridor
• Existing Convenience Openings
  • Separated from other fire or smoke compartments only
Egress Capacity – 1st Floor

- Exit Capacities
- Location of Exits
- Exit Arrangement & Separation
  LSC 7.5.1.3.2
- Corridors: 480 persons Capacity

Max Diagonal Room 104
1/3 Max Diagonal = 30.5'

91'-7"

52'-0"

<table>
<thead>
<tr>
<th>Room / Space</th>
<th>Room Usage</th>
<th>Occupant Load</th>
<th>No. Exit Doors</th>
<th>Total Exit Clear Width (in)</th>
<th>Total Door Exit Capacity</th>
<th>Exit Door Capacity &gt; Occ Load</th>
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</thead>
<tbody>
<tr>
<td>101</td>
<td>Entry Lobby &amp; Corridor</td>
<td>6</td>
<td>2</td>
<td>69</td>
<td>345</td>
<td>y</td>
</tr>
<tr>
<td>102</td>
<td>Robotics Club Room</td>
<td>13</td>
<td>1</td>
<td>69</td>
<td>345</td>
<td>y</td>
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<tr>
<td>103</td>
<td>Elevator Mech Room</td>
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<td>1</td>
<td>34.5</td>
<td>172.5</td>
<td>y</td>
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<td>104</td>
<td>Conference / Exhibition</td>
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<td>103.5</td>
<td>517.5</td>
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<td>110</td>
<td>Project Lab</td>
<td>13</td>
<td>2</td>
<td>69</td>
<td>345</td>
<td>y</td>
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<tr>
<td>111</td>
<td>Mens Restroom</td>
<td>3</td>
<td>1</td>
<td>34.5</td>
<td>172.5</td>
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<tr>
<td>112</td>
<td>Womens Restroom</td>
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<tr>
<td>115</td>
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<td>116</td>
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<tr>
<td>118</td>
<td>Storage</td>
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<td>y</td>
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<tr>
<td>119</td>
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<td>3</td>
<td>103.5</td>
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</table>

Occupant Load 360
Egress Capacity – 2nd Floor

- Exit Capacities
- Location of Exits
- Exit Arrangement & Separation LSC 7.5.1.3.2

<table>
<thead>
<tr>
<th>Room</th>
<th>Name</th>
<th>Exit</th>
<th>Location</th>
<th>Numbers</th>
<th>Width</th>
<th>Height</th>
<th>Separation</th>
<th>Notes</th>
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<tbody>
<tr>
<td>201</td>
<td>Waiting</td>
<td>5</td>
<td>n/a part of corridor</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
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<tr>
<td>202</td>
<td>Vestibule</td>
<td>2</td>
<td>n/a part of corridor</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
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<tr>
<td>203</td>
<td>Device Control Lab</td>
<td>11</td>
<td>2</td>
<td>69</td>
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<td>y</td>
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<td></td>
</tr>
<tr>
<td>204</td>
<td>Open Computer Lab</td>
<td>14</td>
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<td>34.5</td>
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<td></td>
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<tr>
<td>205</td>
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<td>10</td>
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<tr>
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<td>Telecom Room</td>
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<tr>
<td>208</td>
<td>Corridor</td>
<td>0</td>
<td>n/a part of corridor</td>
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<td>n/a</td>
<td>n/a</td>
<td></td>
<td></td>
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<tr>
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<td>Chemistry Lab</td>
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<td>2</td>
<td>69</td>
<td>345</td>
<td>y</td>
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<td></td>
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<tr>
<td>210</td>
<td>Electronics Repair</td>
<td>11</td>
<td>1</td>
<td>34.5</td>
<td>172.5</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>211</td>
<td>Enclosed Mechanical</td>
<td>7</td>
<td>1</td>
<td>69</td>
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<td>y</td>
<td></td>
<td></td>
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<tr>
<td>212</td>
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<td>1</td>
<td>34.5</td>
<td>172.5</td>
<td>y</td>
<td></td>
<td></td>
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<tr>
<td>213</td>
<td>Exterior Mech Equip</td>
<td>5</td>
<td>1</td>
<td>69</td>
<td>345</td>
<td>y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>214</td>
<td>Exterior Mech Equip</td>
<td>6</td>
<td>1</td>
<td>69</td>
<td>345</td>
<td>y</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Occupant Load</td>
<td>93</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fire Suppression Systems

- Equipped with an automatic fire suppression system throughout (CFC 2001 - 1003.2.2)
- Sprinkler system utilizes Quick Response k5.6 sprinklers
- Light hazard occupancy classification in classrooms, hallways
- Ordinary hazard group I for storage and equipment areas
Fire Suppression Systems – Modeled
Fire Suppression Systems - Calculations

- Light hazard occupancy classification in classrooms, hallways
- Ordinary hazard group I for storage and equipment areas
- Project Integration sprinklers Spaced at 130 ft² per sprinkler

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Inside Hose gpm</th>
<th>L/min</th>
<th>Total Combined Inside and Outside Hose gpm</th>
<th>L/min</th>
<th>Duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light hazard</td>
<td>0, 50, or 100</td>
<td></td>
<td>0, 189, or 379</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Ordinary hazard</td>
<td>0, 50, or 100</td>
<td></td>
<td>0, 189, or 379</td>
<td></td>
<td>250</td>
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<tr>
<td>Extra hazard</td>
<td>0, 50, or 100</td>
<td></td>
<td>0, 189, or 379</td>
<td></td>
<td>500</td>
</tr>
</tbody>
</table>

**FIGURE 11.2.3.1.1 Density/Area Curves.**
Fire Suppression Systems - Calculations

- Calculated back to test hydrant
- 11% under supply curve with QR Area Reduction
- Demand: 470 GPM at 67.42 PSI with hose stream allowance
Fire Suppression Systems-Deficiencies

- Upright sprinklers are installed 1’-2” below deck
- Missing end-of-line restraints per NFPA 13-1999
- Bracing may not meet requirements of current version of NFPA 13-2013
- Sprinkler Spray Obstructions
Fire Detection & Alarm Systems

- Required per CFC 1006.2.4.1.2
- Smoke detection throughout
- Remotely monitored at main campus monitoring station
- Fire sprinkler flow switch alarm activation
- Remote annunciator in lobby
- Duct Smoke Detectors
- Manual pull stations
- Horns & Strobes
Fire Detection & Alarm Systems - Audible

- Inadequate Audible Signaling for machine shop and wood shop
- AHJ allowed to determine if visible notification alone is adequate NFPA 72 18.4.4.2
- Using automated shutdown of machinery to lower ambient sound levels

![Fire Alarm System Image]
Fire Detection & Alarm Systems - Visual

- Horns & strobes throughout building
- Adequate coverage for strobes
- Battery backup of fire alarm is adequate
Fire Detection & Alarm Systems
Performance-Based Analysis

Software Tools
- Pyrosim
- Pathfinder
- FDS
Performance-Based Analysis

• ASET vs RSET
• Tenability Performance Criteria established by NFPA 101-2012 Chapter 5
• Flashover & Structural Performance
  • Steel Temperature < 538 C
  • No Flashover: Hot gas layer < 500 C

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Performance Metric</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>No life loss not intimate with ignition source</td>
<td>Visibility</td>
<td>&gt;20 ft</td>
</tr>
<tr>
<td>No life loss not intimate with ignition source</td>
<td>Carbon Monoxide</td>
<td>CO &lt;1,400 PPM</td>
</tr>
<tr>
<td>No life loss not intimate with ignition source</td>
<td>Tenable Temperature</td>
<td>Temperature &lt; 60 °C</td>
</tr>
<tr>
<td>Minimize building damage</td>
<td>Prevent Flashover</td>
<td>Upper Layer Temp &lt; 500°C</td>
</tr>
<tr>
<td>Emergency Crews</td>
<td>Structural Integrity</td>
<td>Steel Temperature &lt; 538°C</td>
</tr>
</tbody>
</table>
Performance-Based Analysis

- NFPA 101 Chapter 5 Design Fire Scenarios

- Scenario 1: Occupancy Specific fire

- Scenario 2: Fast Developing Fire in the primary means of egress
Design Fire 1 – Entry Lobby & Atrium

- Student spill of Acetonitrile
- Spill ignites
- Near primary means of egress
- LSC Design Fire Scenario 2
Design Fire 2 – Machine Shop

- 30 gal trash container fire
- Ignition via grinding / welding sparks
- LSC Design Fire Scenario 1
Design Fire 3 – Projects Integration

- 2 Pallets of miscellaneous electronics and computer items for a project
- Placed in the equidistant between sprinklers
- Placed to block primary means of egress
- LSC Design Fire Scenario 1
LSC Design Fire Scenario 2 – Entry Lobby & Atrium

- Acetonitrile Spill
- Assumes a 2.12l jug spilled during transport
- Used in Machine Shop
- Historically stored in various places throughout building
LSC Design Fire Scenario 2 – Entry Lobby & Atrium

Determining Design Fire

• Spill on carpeted area
• Combines data from pool and carpet fires
• Spill area calculated 4.57 ft²
LSC Design Fire Scenario 2 – Entry Lobby & Atrium

Base HRR Curve

• Spill on carpeted area
• 750 kW
• Spill area .425 m² (4.57 ft²)

Figure 3: HRR curve of a 1 m² pool fire of Acetonitrile

Acentonitrile HRR On Carpet Design Fire

Guy Marlair - Review of Large-Scale Fire Testing Focusing on the Fire Behavior of Chemicals
LSC Design Fire Scenario 2 – Entry Lobby & Atrium

FDS Model Results (ASET)

• Temperature Tenability Reached at t=205 Seconds
LSC Design Fire Scenario 2 – Entry Lobby & Atrium

FDsimulate Results (ASET)

- Visibility Tenability Reached at t= 101 Seconds
LSC Design Fire Scenario 2 – Entry Lobby & Atrium

FDS Model Results
FDS Model Results

- Sprinkler activation: 206 Seconds
- Smoke detector activation: 18 Seconds
LSC Design Fire Scenario 2 – Entry Lobby & Atrium

RSET

Detection Time
• Smoke Detector Activation: 18 Seconds

Notification Time
• Assumed to be virtually instantaneous with modern electronic smoke detectors: 1 Second

Pre Movement Time
• Delay / Pre movement time from NFPA Handbook
  • 36 Seconds
  • Intimate with fire area 10 seconds
RSET – Movement Time

- Movement modeled using Pathfinder software
- Modeled using 3D drawing created in CAD
- Assumes main exits at entrance lobby are not usable
- Steering Method was used

Results: 93 seconds entire building
73 seconds second floor only
LSC Design Fire Scenario 2 – Entry Lobby & Atrium

RSET

Detection Time: 18 s  
Notification Time: 1 s  
Pre Movement Time: 36 s  
Movement Time: 93 s

\[
\text{RSET} = 148 \text{ s} \\
\text{ASET} = 101 \text{ s} \\
\text{ASET} > \text{RSET} \text{ Performance Failure}
\]
LSC Design Fire Scenario 1 – Machine Shop

- Hot work (Welding, Cutting, Grinding)
- HDPE Trash Container Fire
  - Heat of Combustion: 30.1 (kJ/g K)
  - Soot Yield: .03 (g/g)
LSC Design Fire Scenario 1 – Machine Shop

Base HRR Curve

D.W. Stroup and D. Madrykowski, 2003
LSC Design Fire Scenario 1 – Machine Shop

FDS Results (ASET)

• Temperature Tenability: Not Exceeded
LSC Design Fire Scenario 1 – Machine Shop

FDS Results (ASET)

- Visibility Tenability: 608 s
- Smoke Detector Activation: 85 s
- Sprinkler Activation: 598 s
LSC Design Fire Scenario 1 – Machine Shop

RSET
Detection Time: 85 s
Notification Time: 1 s
Pre Movement Time: 10 s
Movement Time: 28 s

RSET = 124 s
ASET = 608 s
ASET > RSET Pass
LSC Design Fire Scenario 1 – Project Integration

- High Bay Area
- Student Projects
- Used as swing space
LSC Design Fire Scenario 1 – Project Integration

Base HRR Curve - Pallet of Miscellaneous Computer Items

*Figure 3-1.52. HRR of pallets of miscellaneous computer items.*

*SFPE Handbook 4th Edition*
LSC Design Fire Scenario 1 – Project Integration

FDS Results (ASET)
  • Temperature Tenability: 88 s
LSC Design Fire Scenario 1 – Project Integration

FDS Results (ASET)
  • Visibility Tenability: 63 s
LSC Design Fire Scenario 1 – Project Integration

FDS Results

- Sprinkler Activation (6) Sprinklers Activate
- 55 Seconds – 124 seconds
- Smoke Detector Activation: 12 s
LSC Design Fire Scenario 1 – Project Integration

FDS Results

• FDS HRR Output
LSC Design Fire Scenario 1 – Project Integration

RSET
Detection Time: 12 s
Notification Time: 1 s
Pre-Movement Time: 10 s
Movement Time: 29 s

\[ \text{RSET} = 52 \text{ s} \]
\[ \text{ASET} = 63 \text{ s} \]
RSET < ASET Performance Success
Performance Based Design - Review

- One of the fire scenarios failed ASET vs RSET Performance Tests
- Steel temperature remained below 538°C
- Upper layer gas temperature never exceeded 500°C
- Flashover would not have occurred for any of these spaces
- Sprinkler system adequately controlled fire once activated
- Sprinkler system activation came just after tenability reached dangerous levels for Atrium at second floor
Prescriptive Design - Review

- Second exit in assembly occupancy should swing in the direction of egress travel
- Fire sprinkler system seismic branchline restraints missing on most lines
- Sprinkler deflector obstructions
- Sprinkler deflector distance from deck
- Fire Alarm audible signals in machine and wood shop may not be loud enough for those occupancies
- Other aspects of prescriptive design appear to meet code
Works Cited

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• NFPA 101-2003
• NFPA 101-2012
• NFPA 13-2013
• NFPA 13-1999
• NFPA 72-2002
• IBC 2012
• CBC 2001
• 1997 UBC


• NIJ Report 604-00: *Flammable and Combustible Liquid Spill / Burn Patterns*


• Stefan Sardqvist: *Initial Fires RHR, Smoke Productino and CO Generation from single Items and Room Fire Tests* Lund, 1993
Questions?

Thank you for your time!