Fire Protection System and Life Safety Evaluation of Building X

Presented by

Anthony W. Sublett

Culminating Project
Master of Science in Fire Protection Engineering
California Polytechnic State University
San Luis Obispo
June 2016
Introduction:

- Building X is a support structure for a new construction nuclear power plant

- Building X is required to meet either the prescriptive requirements or performance-based goals and objectives to be in compliance with NEIL (the insurance agency that provides coverage for all four units at this power plant)
Presentation Outline:

• Introduction
• Regulatory Requirements
• Prescriptive Analysis
  i. Construction
  ii. Occupancy
  iii. Required Safe Egress Time (RSET) Analysis
  iv. Fire Protection Systems
  v. Maintenance and Testing of Fire Protection Systems
• Performance – Based Analysis
  i. Tenability Analysis
  ii. Toxicity
  iii. Fire Scenarios Available Safe Egress Time (ASET) Analysis
• Conclusion & Recommendations
<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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A&lt;sup&gt;d&lt;/sup&gt;</td>
<td>B</td>
<td>HT</td>
</tr>
<tr>
<td>Primary structural frame&lt;sup&gt;g&lt;/sup&gt;</td>
<td>3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>(see Section 202)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bearing walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior&lt;sup&gt;f,g&lt;/sup&gt;</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Interior</td>
<td>3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Nonbearing walls and partitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonbearing walls and partitions&lt;sup&gt;g&lt;/sup&gt;</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Interior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor construction and secondary members (see Section 202)</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof construction and 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>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Construction:

- Exterior Walls made of Non-combustible materials
- One Story building with two internal balconies with an occupancy capacity of 10
- Both Sets of internal balconies have 2 hour fire walls that protect their vertical openings
Construction:

- Fire retardant treated wood in the atrium
- 75,674 sq.ft.
600 occupants
970 Exit Capacity
Ordinary Hazard Group I Sprinkled

Front View of Building
North Entrance
Cafeteria
No Hot Food Served
Automatic Detection and Suppression
- Mixed Occupancy Business & Assembly A1-A3
- Automatic Supervised Sprinklers-relaxed separation of occupancies requirement from 2-hour to a 1-hour fire for resistant rated construction
- 15 Exits in yellow
- 7 Exits in Red Evaluated as Primary Horizontal Exit Discharges that were taken credit for
Discharge rate limited by 2 stair cases (40") clear width single doors from stairwell of building \( x \) = total of \( 2 \times 56 = 112 \) per/min

Total minimal evacuation time by 970 occupants through 7 exits = 14.15 minutes
Egress Analysis:

- Two fundamental concepts of egress evaluated for Building X:

  1. Exit capacity has to exceed occupant load
  2. Available safe egress time has to exceed required safe egress time: ASET > RSET

- ASET is the available safe egress time before the fire area is exposed to a tenability parameter that can incapacitate the occupants.

- RSET is the required safe egress time it takes the occupants to egress from the fire area.

Available Safe Egress Time (ASET)
Required Safe Egress Time (RSET)
Ordinary Hazard Group 1 Depicts Ceiling Grids of Sprinkler Systems
<table>
<thead>
<tr>
<th>Step No.</th>
<th>Nozzle Ident and Location</th>
<th>Flow in gpm</th>
<th>Pipe Fittings and Devices</th>
<th>Equivalent Pipe Length (FT)</th>
<th>Friction loss (psi/ft)</th>
<th>Pressure Summary</th>
<th>Normal Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200 H</td>
<td>q</td>
<td>L</td>
<td>10.83</td>
<td>C = 120</td>
<td>Ft 4.6</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td>2</td>
<td>Po 0.00</td>
<td>Po 0.0</td>
<td>Po 0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>T</td>
<td>12.83</td>
<td>qf 0.051</td>
<td>Pt 0.6</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td>2</td>
<td>201 H</td>
<td>q</td>
<td>L</td>
<td>10.83</td>
<td>C = 120</td>
<td>Pt 5.2</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td>2</td>
<td>Po 0.00</td>
<td>Po 0.0</td>
<td>Po 0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>T</td>
<td>12.83</td>
<td>qf 0.051</td>
<td>Pt 0.6</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td>3</td>
<td>202 H</td>
<td>q</td>
<td>L</td>
<td>10.83</td>
<td>C = 120</td>
<td>Pt 5.8</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td>2</td>
<td>Po 0.00</td>
<td>Po 0.0</td>
<td>Po 0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>T</td>
<td>12.83</td>
<td>qf 0.051</td>
<td>Pt 0.6</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td>4</td>
<td>203 H</td>
<td>q</td>
<td>L</td>
<td>9.83</td>
<td>C = 120</td>
<td>Pt 6.4</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td>2</td>
<td>Po 0.00</td>
<td>Po 0.0</td>
<td>Po 0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>T</td>
<td>8.33</td>
<td>qf 0.054</td>
<td>Pt 0.9</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td>5</td>
<td>204 H</td>
<td>q</td>
<td>L</td>
<td>9.83</td>
<td>C = 120</td>
<td>Pt 7.3</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td>2</td>
<td>Po 0.00</td>
<td>Po 0.0</td>
<td>Po 0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>T</td>
<td>41</td>
<td>qf 0.154</td>
<td>Pt 6.3</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td>6</td>
<td>2025 H</td>
<td>q</td>
<td>L</td>
<td>10.83</td>
<td>C = 120</td>
<td>Pt 21.5</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td>2</td>
<td>Po 0.00</td>
<td>Po 0.0</td>
<td>Po 0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>T</td>
<td>12.83</td>
<td>qf 2.260</td>
<td>Pt 29.0</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td>7</td>
<td>206 H</td>
<td>q</td>
<td>L</td>
<td>10.83</td>
<td>C = 120</td>
<td>Pt 50.5</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td>2</td>
<td>Po 0.00</td>
<td>Po 0.0</td>
<td>Po 0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>T</td>
<td>10</td>
<td>qf 1.145</td>
<td>Pt 12.4</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td>8</td>
<td>207 H</td>
<td>q</td>
<td>L</td>
<td>10</td>
<td>C = 120</td>
<td>Pt 62.9</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td>2</td>
<td>Po 0.00</td>
<td>Po 0.0</td>
<td>Po 0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>T</td>
<td>10</td>
<td>qf 0.391</td>
<td>Pt 3.9</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td>9</td>
<td>208 H</td>
<td>q</td>
<td>L</td>
<td>9.83</td>
<td>C = 120</td>
<td>Pt 66.8</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td>2</td>
<td>Po 0.00</td>
<td>Po 0.0</td>
<td>Po 0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>T</td>
<td>9.83</td>
<td>qf 0.738</td>
<td>Pt 7.3</td>
<td>Pt 5.6</td>
</tr>
<tr>
<td>10</td>
<td>209 H</td>
<td>q</td>
<td>L</td>
<td>25</td>
<td>C = 120</td>
<td>Pt 74.1</td>
<td>Pt 5.6</td>
</tr>
</tbody>
</table>

**NOTES**

Sprinklers are installed in a 10.83 ft x 10 ft Light Haz Design density .10 for 1500 sq ft per table 11.2.3.1 NFPA COVERAGE PER SPRINKLER 120 FT, AREA OF APPLICATION 1590 SF (16) 1/2 INCH EXTENDED COVERAGE PENDANT SPRINKLERS

**K-FACTOR**

\[ Q = k \times \left( \frac{P_f}{P_h} \right)^{1/2} \]

\[ A^* = AD = 14.8 \]

\[ P_f = Q/k \times \sqrt{2g} \]

**Elevation** 33.2 ft
<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>11</td>
<td>210H</td>
<td>Q</td>
<td>64.2</td>
<td>L</td>
<td>12.33</td>
<td>C=120,000 P=131.5 Pt=5.6</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>211H</td>
<td>q</td>
<td>65.1</td>
<td>L</td>
<td>10.33</td>
<td>C=120,000 P=136.3 Pt=5.6</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>212H</td>
<td>Q</td>
<td>80.1</td>
<td>L</td>
<td>45</td>
<td>C=160,000 P=204.8 Pt=5.6</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td>PIPE 13</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>213H</td>
<td>Q</td>
<td>415.5</td>
<td>T</td>
<td>51</td>
<td>Pf=0.202 Pt=12.3 Pn=0</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>214H</td>
<td>q</td>
<td>25.2</td>
<td>L</td>
<td>12.33</td>
<td>C=120,000 P=20.2 Pt=5.6</td>
</tr>
<tr>
<td>17</td>
<td>17</td>
<td>PIPE 14</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>215H</td>
<td>q</td>
<td>25.2</td>
<td>L</td>
<td>12.33</td>
<td>C=120,000 P=22.7 Pt=5.6</td>
</tr>
<tr>
<td>19</td>
<td>19</td>
<td>PIPE 15</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>216H</td>
<td>Q</td>
<td>51.9</td>
<td>T</td>
<td>10.33</td>
<td>C=120,000 P=2.2 Pt=5.6</td>
</tr>
<tr>
<td>21</td>
<td>21</td>
<td>PIPE 16</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>22</td>
<td>217H</td>
<td>q</td>
<td>27.9</td>
<td>L</td>
<td>45</td>
<td>C=120,000 P=24.9 Pt=5.6</td>
</tr>
<tr>
<td>23</td>
<td>23</td>
<td>PIPE 17</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>24</td>
<td>218H</td>
<td>Q</td>
<td>79.8</td>
<td>T</td>
<td>81</td>
<td>Pf=0.209 Pt=12.7 Pn=98.1</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td>PIPE 17A</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>26</td>
<td>219H</td>
<td>q</td>
<td>0</td>
<td>L</td>
<td>1.66</td>
<td>C=120,000 P=37.6 Pt=0</td>
</tr>
<tr>
<td>27</td>
<td>27</td>
<td>PIPE 18</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>28</td>
<td>220H</td>
<td>Q</td>
<td>199.5</td>
<td>T</td>
<td>179.79</td>
<td>Pf=0.014 Pt=2.6 Pn=0</td>
</tr>
<tr>
<td>29</td>
<td>29</td>
<td>PIPE 18A</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>221H</td>
<td>q</td>
<td>199.5</td>
<td>L</td>
<td>149</td>
<td>C=120,000 P=40.3 Pt=18.8</td>
</tr>
<tr>
<td>31</td>
<td>31</td>
<td>PIPE 18B</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>32</td>
<td>222H</td>
<td>Q</td>
<td>199.5</td>
<td>T</td>
<td>213</td>
<td>Pf=0.014 Pt=3.0 Pn=0</td>
</tr>
<tr>
<td>33</td>
<td>33</td>
<td>PIPE 19A</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>34</td>
<td>223H</td>
<td>q</td>
<td>124.8</td>
<td>L</td>
<td>86</td>
<td>C=120,000 P=43.9 Pt=18.8</td>
</tr>
<tr>
<td>35</td>
<td>35</td>
<td>PIPE 19B</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>36</td>
<td>224H</td>
<td>q</td>
<td>244.3</td>
<td>L</td>
<td>112</td>
<td>Pf=0.053 Pt=6.0 Pn=0</td>
</tr>
<tr>
<td>37</td>
<td>37</td>
<td>PIPE 20A</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>38</td>
<td>225H</td>
<td>Q</td>
<td>105.9</td>
<td>T</td>
<td>1.56</td>
<td>C=120,000 P=49.2 Pt=18.8</td>
</tr>
<tr>
<td>39</td>
<td>39</td>
<td>PIPE 20B</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>40</td>
<td>226H</td>
<td>Q</td>
<td>350.2</td>
<td>T</td>
<td>41.98</td>
<td>Pf=0.104 Pt=4.3 Pn=0</td>
</tr>
<tr>
<td>41</td>
<td>41</td>
<td>PIPE 21A</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>42</td>
<td>227H</td>
<td>q</td>
<td>137.5</td>
<td>L</td>
<td>199</td>
<td>C=120,000 P=53.5 Pt=18.8</td>
</tr>
<tr>
<td>43</td>
<td>43</td>
<td>PIPE 21B</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>44</td>
<td>228H</td>
<td>Q</td>
<td>487.7</td>
<td>T</td>
<td>177.9</td>
<td>Pf=0.192 Pt=33.9 Pn=0</td>
</tr>
<tr>
<td>45</td>
<td>45</td>
<td>PIPE 22A</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>46</td>
<td>229H</td>
<td>q</td>
<td>0</td>
<td>L</td>
<td>13.33</td>
<td>C=120,000 P=87.4 Pt=18.8</td>
</tr>
<tr>
<td>47</td>
<td>47</td>
<td>PIPE 22B</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cal Poly Fire Protection Engineering**
Fire Protection Systems: Wet Pipe Sprinkler System Design Bases

Design Bases Requirements Per NFPA 13:

- Ordinary Hazard Group I
- Flow Density Required Over Operation: 0.15 gpm/sq.ft.
- Maximum Area of Sprinkler Operation: 1500 sq. ft.
- Hose Stream: 250 gpm

- Single riser splits into two independent risers that feed the center mains for the sprinkler system
- Flow and pressure at base of riser: 487.7 gpm @ 87.4 psi per hydraulic calculation on previous slide

- Standpipe in mechanical room fed from a class 50 underground ductile 8 inch pipe which supplies two 4 inch loops of pipe that can be put on line interchangeably

- Acceptable Flow Rate at base of riser per NFPA 13 Table 11.2.2.1: 850-1500 gpm for 60-90 min
- Total Water Required: 850 gpm for 90 min = 76,500 gallons of water required from above ground water storage tank

Fire Hydrants:

One fire hydrant located 10 feet in front of building with a 4 inch outlet and national pumper thread of 2 ½ inches provides water for the Burke County Fire Department.
Building X – Water Based Fire Suppression System

Pump Curve Data

SPP PUMPS, LP
6716 BEST FRIEND RD
NORCROSS, GA 30071
DIESEL FIRE PUMP STARTUP AND FLOW TEST

PERFORMANCE CURVE

FLOW (GPM)

HEAD (PSI)

850 gpm

122 psi
Fire Protection Systems:

• Ground Level Fire Water Storage Tank

• 101,153 gallon ground level fire water storage tank meets **76,500 gallons of water demand shown on previous slide**

• Diameter of 32 ft and 8 inches and 16 feet tall

• 20 feet of underground pipe from the Fire Water Storage Tank connection point to the suction line where the 8 inch ductile iron pipe enters the heated pump house that was constructed and is maintained in accordance with NFPA 20.
Fire Protection Systems:
Fire Protection Systems:

- Both pumps controllers are set to start respective pumps in automatic mode

- Jockey pump maintains system pressure of the underground pipe from the pump house to the standpipe in the mechanical room of Building X between 125 psi and 129 psi

- When the pressure falls below 117 psi, the diesel pump will start automatically until it is shut off manually or until pump failure occurs as prescribed in NFPA 20

- The pump house where the diesel and jockey pumps are housed is heated and protected by a wet sprinkler system
Special Fire Protection Systems:

- Xtralis Incipient -Aspirated Smoke Detection (or “air-sampling smoke detection" (ASD)) systems for open-area detection in the server and two electrical rooms in addition server cabinets were provided with individual sample tubes.

- Pipes were laid out below the ceilings in parallel runs, several feet apart. Small holes, also several feet apart, were drilled into each pipe to form a matrix of holes ('sampling points'), providing an even distribution across the ceiling.

- Air or smoke is drawn into the pipework through the holes and onward to a very sensitive smoke detector mounted nearby, using the suction pressure of an aspirator/fan or air pump.

- Server cabinet protection - flexible capillary tubes are fed through sampling points in each server cabinets.
• Incipient detection installed in server cabinets and rooms provides early warning that allow personal to address fires in their pre-incipient stage in the server cabinets and rooms

• Novec 1230 – Automatic Suppression in server cabinets located in the server room and electrical two electrical rooms

• Novec 1230 – Extinguishers for manual suppression in the server room and two electrical rooms

• Novec 1230 interferes with the combustion process, stopping a fire in its pre-combustion stage, before it reaches the “flame” stage, by disrupting a fire by absorbing its heat.

• Novec 1230 fluid evaporates more than 50 times quicker and fluid transitions to a gaseous state rapidly when discharged through a nozzle.

• Novec 1230 fluid will quickly vaporize and evenly distribute itself throughout the space being protected.

• Doors to the server cabinets and these three rooms at maintained closed per administrative controls

• Minimum design concentration of 85 percent can be held at the highest level of combustibles for a minimum period of 10 minutes in accordance with 2008 edition of NFPA 2001, paragraph 5.6
The NFS2-3030 Intelligent Alarm Panel listed to UL standard 864, 9th edition functional capabilities:

- Notifier alarm supports automatic alarms from smoke detectors, 2 potter water flow alarms located on the 2 risers, heat detectors, gas filled sprinklers, burglar alarm contacts, and manual pull stations.

- All smoke detectors and flow alarms feed into a Siemen’s fire alarm panel located in the main corridor.

- Installation, acceptance testing, and maintenance procedures and surveillance meets NFPA 72 requirements.
Detection & Alarms

- Actuation of the flow meter and or a pull alarm will alert personal to evacuate the building.

- All smoke detectors and flow alarms feed into a Siemens fire alarm panel located in the main corridor.

- The fire panel sends a signal through a phone line to a monitoring company which notifies Burke County fire department and the control room on site.
**Notification:**

- Alarm system supports two separate digital phone lines that send a signal to an independent monitoring station.

- There are internal fire alarms located inside the building that will actuate if either of three events occurs:
  1. Smoke Detector actuates
  2. Heat Detector actuates
  3. Glass Bulb Sprinkler actuates

The alarm system also has a voice command system which allows direct voice commands to be given to building occupants over the PA system.
Signals Supported by Alarm System:

The following three types of signals are supported by this alarm system:

1. Alarm Signal - A warning fire signal that requires immediate action in response to a possible fire event

2. Supervisory notification - alarms sent to the alarm system for low water level alarms and similar issues

3. Trouble Alarms - alarms that give indication that there is a problem with the system that may prohibit it from functioning properly when called upon
All building occupants will be notified by visible and audible notification through the use of the following appliances located at their list locations which can be seen on the floor plans in Appendix A:

- 4 Horn Strobe/75 CD, Wall Mount Red Wheelock HSR located 80” A.F.F. to the center lens.
- 57 Speaker Strobe/75 Multi-Candela Wheelock E50-24MCW-FR located 80” A.F.F.
- 75 Strobe, Selectable Candela Wall Mount Wheelock STR located 80” A.F.F.
- 8 Addressable Relay Module Notifier FRM-1 located as needed.
- 1 Universal Digital Alarm Communicator/Transmitter Notifier UDACT located as needed.
- 2 Digital Audio Amplifiers Notifier DAA-5025 located 66” A.F.F. to top of cabinet.
- 1 Digital Voice Evacuation Control Panels Notifier DVC-EM located 66” A.F.F. to top of cabinet.
- 4 Field Charger Power Supply Amps Notifier FCPS-24S8 located 66” A.F.F. to top of cabinet.
- 2 Sprinkler Valve Tamper Switches by Others by Others by Others.
- 2 Sprinkler Water Flow Switches by Others by Others by Others.
- 4 Surge Suppressor, 120 VAC DTK-120HW Mounts in Panel cabinet.

Audible Notification Appliances (NA) for Public Mode, Speaker Strobes, and Candela Strobes meet the installation and audio requirements of NFPA 72.
Mass Notification Systems

• Building X has a 1 Digital Voice Evacuation Control Panel Notifier DVC-EM located 66” above the finished floor to the top of the cabinet

➢ This unit has the capability issuing non-fire mass notifications in the event of tornado or some other life threatening event

➢ The DVC can be networked with ONYX Series panels via NOTI-Fire-Net with an NCA-2. The associated NCA-2 supports NOTI-Fire-Net applications.
Secondary Power Supply

- 4 circuits which powered by four field charger power supplies 120 vac, 60 Hz, 3.2 A max that are rated at 8 amps.

- All notification appliances, initiating, and signaling devices are powered from the main fire alarm control panel located in the main hall way on the first floor.
Fire Scenario – Performance Based Analysis

- Upholstered Chair Design Fire Peak Heat Release Rate of 2000 kw per table B.2.3.2.6.2(e) NFPA 72-2010
- 18 occupants attending meeting in executive meeting room
- Occupants can exit the meeting room through its one exit discharge into the adjacent large office area which has two exits that provide exit discharge to the horizontal egress path for half of the 89 occupants that the large office is credited for (see next slide)
- The dimensions for the executive meeting room evaluated in CFAST model: 52’ X 42’ with 8’ ceilings
- It is equipped with smoke detectors, and heat detectors, and quick response sprinklers
FIGURE 1-L Scenario 1 Egress Path and Exit Discharge From Large Office Occupied by 89 Occupants

- Upholstered Chair On Fire
- 30 Occupants travel 90'
- 6 ft wide aisle
- 30 Occupants travel 90'
- 4 ft wide aisle
- 29 Occupants travel 90' max
- 4 ft wide aisle
- 80
- 84
- 90

LIFE SAFETY LEGEND:
- FIRE EXTINGUISHERS IN CABINETS Fixed ON BRACKETS (SOS)
- 29
Wet Pipe Quick Response Sprinkler System Activation Time

Heat Release Rate of the Fire (Q) (Steady State) 3000.00 kW

Radial Distance to the Detector (r) **never more than 0.707 or \( \frac{1}{2}\sqrt{2} \) of the listed spacing** 10.00 ft m

Activation Temperature of the Fixed Temperature Heat Detector \( (T_{activation}) \) 135 °F °C

Detector Response Time Index (RTI) 25.00 (m-sec)^{-1/2}

Height of Ceiling above Top of Fuel (H) 10.00 ft m

Ambient Air Temperature \( (T_a) \) 85.00 °F °C

Convective Heat Release Fraction \( (\chi_c) \) 0.70

\[ T_{activation} = 4.04 \text{ minutes} \]
Scenario 1 Available Safe Egress Time (ASET):
The following ASET tenability limits were calculated using CFAST fire modeling shown in the graphs in the following slides.
Time at which Visibility Level reached 6 feet or 1.8 m was 520 seconds 8.6 minutes as shown in the graph produced from the CFAST Smoke View Model shown in the figure above.
Although the smoke layer temperature exceeded 60°C at 380 seconds it is not a Tenability Limit since the smoke layer is still above 6 feet or 1.8 meters which is above the occupants' heads.
Tenability parameter of exposure to CO2 has no impact since not enough CO2 is being added to decrease the O2 levels to 12% or less where there would be a deadly impact to breathing. An Additional 10 % CO2 (which is where CO2 increases level out) would only decrease the O2 levels to 19%.
Scenario 1 RSET Performance Criteria

**Executive Meeting Room:**
Four RSET elements for 18 Occupants in the large meeting room 52’ X 42’ with 8’ ceilings summed up as follows:
Notification time of 10 seconds plus Reaction Time of 30 seconds plus Pre-Evacuation Activity Time of 30 seconds plus Travel Time of 13.2 seconds = **83.2 seconds**

The limiting ASET factor (tenability factor) that was reached by CFAST:
Time at which Visibility Level reached 6 feet or 1.8 m was 520 seconds

**Conclusion to Performance Based Fire Scenario I**
Since ASET > RSET = 520 seconds > 83.2 seconds
Conclusion and Recommendations:
The life safety and fire protection systems met the performance based design objectives and were deemed as adequately designed for the following reasons:

1. Since the limiting ASET factor calculated for the large meeting room by CFAST was when Visibility Levels descending to 6 feet which was at 8 minutes and 40 seconds which was over 7 minutes greater than RSET of 1 minutes and 23 seconds for the 18 occupants to egress from the large meeting room.

2. Since the automatic sprinkler system would actuate in 4 minutes and thus reduce temperatures and the rate at which smoke would descend 4 minutes prior to when the large meeting room was predicted to becoming uninhabitable due to limited visibility and 1 minute and 33 seconds before temperatures would reach 60 degrees Celsius (which took 6 minutes and 33 seconds).

Recommendations:
Since the life safety and fire protection systems meet the performance based design objectives and goals ASET>RSET No design recommendations are warranted at this juncture.