Cal Poly Fire Protection Final Project

Battalion Headquarters Complex (UEPH)
Location Unknown

Fire Protection Consultant
Mathew J. Mershimer
Project Overview

• This design-build project will construct housing facilities for approximately 296 persons.

• The project is a 3-story building with a footprint total of 38,574 square feet and with a total of 113,381 square feet.

• The facility will be constructed at unknown location on a military base.
Applicable Codes and Standards

- NFPA 10 (2010 Edition) – Portable Fire Extinguishers
Applicable Codes and Standards

- UFC 1-200-01(Change 1, 01 July 2013) - General Building Requirements
- UFC 3-600-01 (Change 2, 01 February 2013) – Fire Protection Engineering for Facilities
- UFC 4-021-01 (January 2010) – Design O&M: Mass Notification Systems
- Factory Mutual Loss Prevention Data Sheet 3-26 (July 2011 with Engineering Bulletin 04-12) – Fire Protection Water Demand for Non-storage Sprinklered Properties
Presentation Guide

• Prescriptive Based Design
  • Occupancy Classifications
  • Construction Type
  • Egress
  • Water Based Suppression
  • Fire Alarm

• Performance Based Design
Special Note

• Military projects require the building size, height and area to be in accordance with IBC requirements and the life safety and egress features to be in accordance with NFPA 101.
Building 1st Floor Layout
Building 2\textsuperscript{nd} Floor Layout
Building 3rd Floor Layout
Atrium VS. Communicating Space

• Ch. 30 NFPA 101 New Apartment Buildings
• 30.3.1 Protection of Vertical Openings.
• 30.3.1.1.2 Where the provisions of 8.6.6 are used, the requirements of 30.3.5.7 shall be met
• 8.6.6 Communicating Space. Unless prohibited, unenclosed floor openings forming a communicating space between floor levels shall be permitted, provided that the following conditions are met:
  • The communicating space does not connect more than three contiguous stories.
  • Plus a few other requirements that will be meet.
• This will be a communicating space not an atrium.
Atrium VS. Communicating Space
Occupancy Classification

- **IBC: Residential (R-2)**
  - Apartment Houses
- **IBC: Storage (S-1)**
  - Electrical room
- **IBC: Storage (S-2)**
  - Washers and dryers
- **IBC: Section 509 Incidental Uses**
  - Laundry rooms over 100 square feet
  - Waste and linen collection rooms over 100 square feet

<table>
<thead>
<tr>
<th>Floor</th>
<th>Gross Floor Area (SF)</th>
<th>Occupancy Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>38,574</td>
<td>R-2, S-1, S-2, Incidental Uses</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>37,029</td>
<td>R-2, S-2, Incidental uses</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>37,778</td>
<td>R-2, S-2, Incidental uses</td>
</tr>
</tbody>
</table>
Construction Type

- IBC Type V-B
- Type V construction is that type of construction in which the structural elements, exterior walls and interior walls are of any material permitted by this code.
- For a Type V-B there are no special requirements that are being put on this building. The building elements do not require any fire resistive rating based on the code. This building is not close to other buildings (greater than 30 ft.) so the separation requirements are met as well.
Area, Height and Stories

• \( A_a = [7,000sf + (7,000sf \times .75) + (7,000sf \times 0)] = 12,250sf \) = Allowable building area per floor for the R-2 Occupancy.

• The allowable building area is determined to be 36,750 square feet. Therefore, the building is not in compliance with allowable height, area and story limitations.

• This building will need to be broken up into multiple buildings by adding fire walls in multiple locations to meet the allowable building area requirements. In accordance to IBC Table 706.4 group R-2 occupancies will need to have a 2 hour rated fire wall.
This building is now broken up into 5 separate spaces in one structure.

At walls double acting fire doors will be used and be on magnetic release.
Occupant Loads

- Calculated based on NFPA 101 Table 7.3.2.1
- Occupant load Factor: 200 \(\frac{ft^2}{\text{person}}\) (Residential use-dormitories)
- Occupant load Factor: 100 \(\frac{ft^2}{\text{person}}\) NET (Industrial-General)
- Occupant load Factor: 500 \(\frac{ft^2}{\text{person}}\) (Storage use-In Other)
- Occupant load Factor: 15 \(\frac{ft^2}{\text{person}}\) NET (Assembly use-less concentrated)
### Occupant Loads Continued

<table>
<thead>
<tr>
<th>Occupancy Type</th>
<th>Room</th>
<th>Occupant Load (People)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Living Areas</td>
<td>4 each = 592</td>
</tr>
<tr>
<td>Industrial</td>
<td>Electrical Room</td>
<td>2 each = 4</td>
</tr>
<tr>
<td>Industrial</td>
<td>Telecomm Room</td>
<td>1 each = 6</td>
</tr>
<tr>
<td>Assembly</td>
<td>Mud Room</td>
<td>22</td>
</tr>
<tr>
<td>Industrial</td>
<td>Mech. Room</td>
<td>9</td>
</tr>
<tr>
<td>Storage</td>
<td>Janitors Closet</td>
<td>1 each = 3</td>
</tr>
<tr>
<td>Assembly</td>
<td>Lobby</td>
<td>100</td>
</tr>
<tr>
<td>Storage</td>
<td>Recycle Room</td>
<td>1</td>
</tr>
<tr>
<td>Assembly</td>
<td>Activity Room</td>
<td>29 each = 87</td>
</tr>
<tr>
<td>Business</td>
<td>Laundry Room</td>
<td>2 each = 12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>836</strong></td>
</tr>
</tbody>
</table>
Egress Capacity and Required Exits

• 1st Floor Egress (360 ppl ttl)
  Doors 72”=360*2=720
  Doors 36”=180*5=900
  1st Floor total=1620

• 2nd Floor Egress (236 ppl ttl)
  Stairs 48”= 165*3=495
  2nd Floor total=495

• 3rd Floor Egress (240 ppl ttl)
  Stairs 48”= 165*3=495
  3rd Floor total=495
## Egress Capacity and Required Exits Continued

<table>
<thead>
<tr>
<th>Occupancy Type</th>
<th>Room</th>
<th>Occupant Load (People)</th>
<th>Number of Exits</th>
<th>Exits Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Living Areas</td>
<td>4 each= 592</td>
<td>1 per</td>
<td>1 per</td>
</tr>
<tr>
<td>Industrial</td>
<td>Electrical Room</td>
<td>2 each =4</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Industrial</td>
<td>Telecomm Room</td>
<td>1 each =6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Assembly</td>
<td>Mud Room</td>
<td>22</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Industrial</td>
<td>Mech. Room</td>
<td>9</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Storage</td>
<td>Janitors Closet</td>
<td>1 each=3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Assembly</td>
<td>Lobby</td>
<td>100</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Storage</td>
<td>Recycle Room</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Assembly</td>
<td>Activity Room</td>
<td>29 each=87</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Floor</td>
<td>Total</td>
<td>896</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>
Water Based Fire Protection

• The water supply for the building was supplied by CH2M Hill and was performed on February 07, 2012.
• Static Pressure (psi): 47
• Flow Pressure (psi): 46
• Discharge Flow Rate (gpm): 1190
• 10% reduced Static Pressure (psi)
• 10% reduced Flow Pressure (psi):
Water Based Fire Protection

• Sprinklers
  • Tyco rapid response residential sprinkler head (TY4234).
    • K-Factor: 6.9
    • Wet Pipe
    • Max Coverage: 20 ft. x 20 ft.
    • Temperature rating: 155 F
    • Minimum flow: 22 GPM
    • Minimum Pressure: 10.2 PSI
    • Recessed type installation
    • Minimum spacing 8ft.
    • Deflector to ceiling: 1-1/4 to 4 inches
  • Tyco Pendent sprinkler (TY4951)
    • K-Factor: 8.0
    • Wet Pipe
    • Temperature rating: 155 F
    • Minimum spacing 8ft.

• Pipe
  • The pipe used in this system is BlazeMaster CPVC.
    • Riser: 3” pipe
    • Main Line: 3”Pipe
    • Main Branch Line: 2”
    • Branch Line: 1.5”
  • The underground pipe will be Blue Brute C-900 PVC.
    • Underground: 6” pipe

• Hardware
  • Backflow Preventer
    • Watts Series 709 Double Check Valve
  • Check Valve
    • Viking Easy Riser Swing Check Valve
Water Based Fire Protection

• The hydraulic calculations will be in accordance with UFC 3-600-01.
• The UFC code for this type of building requires the use of FM Global Engineering Bulletin 04-12 for the hazard classifications and NFPA 13R for design.
• This is referenced in UFC 3-600-01 Section 4-2.3.1.
• The apartments and lobby areas are classified as a hazard category HC-1.
• The Utility and equipment rooms are classified as hazard category HC-2.
Water Based Fire Protection

• NFPA 13R
• 7.1.1.3*Number of Design Sprinklers.
• 7.1.1.3.1 For each of the following situations, the number of sprinklers in the design area shall be all of the sprinklers within a compartment, **up to a maximum of four sprinklers**, that require the greatest hydraulic demand:
  (1) A flat, smooth, horizontal ceiling with no beams up to a maximum of 24 ft (7.3 m) above the floor.
Hydraulic Calculations

• **HC-1**
  - WET 4 Sprinklers, Hose demand 250, K-factor 5.6 or greater, Max area of 225 ft², 20 GPM Per Head

• **Calculation 1 Third floor**
  - Occupancy: HC-1
  - Sprinklers: 4, 20 GPM each minimum.
  - Area of operation: both Bedrooms and Closets totaling 408 sq. ft.
  - Hose Demand: 250 GPM

• **Sprinkler**
  - Tyco
  - Ty2234
  - K-Factor: 6.9

• The Manual Calculation showed that a demand of 362 GPM @ 37.7 PSI. (112 GPM Sprinkler Demand)

• The Computer Aided Calculation showed a demand of 338.4 GPM @ 39.4 PSI. (88 GPM Sprinkler Demand)

• These values are based on the most remote area. Both of these calculations prove that the water supply provided will be enough for this project.
Hydraulic Calculations

• **HC-2**
  - WET 4 Sprinklers, Hose demand 250, K-factor 8.0 or greater, Max area of 130 ft², 26 GPM per head

• **Calculation 2 First floor**
  - Occupancy: HC-2
  - Sprinklers: 4, 26 GPM each minimum
  - Area of operation: Entire mechanical room totaling 595 sq. ft.
  - Hose Demand: 250 GPM

• **Sprinkler**
  - Tyco
  - Ty4951
  - K-Factor: 8.0

• The Manual Calculation showed that a demand of 392 GPM @ 29.9 PSI. (142 GPM Sprinkler Demand)

• The Computer Aided Calculation showed a demand of 355.1 GPM @ 28.5 PSI. (105 GPM Sprinkler Demand)

• These values are based on the most remote area. This calculation proves that the water supply provided will be enough for this project.
Sprinkler Layout

Hydraulic Calculation #1

<table>
<thead>
<tr>
<th>OCCUPANCY:</th>
<th>HC-1 FM GLOBAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>DENSITY:</td>
<td>0.10 gpm/sq. ft.</td>
</tr>
<tr>
<td>AREA OF OPERATION:</td>
<td>ENTIRE AREA (4 SPRINKLERS)</td>
</tr>
<tr>
<td>SPRINKLER DEMAND:</td>
<td>88.4 gpm</td>
</tr>
<tr>
<td>AVAIL. PRESSURE (@ SOURCE):</td>
<td>42.21 psi</td>
</tr>
<tr>
<td>TOTAL DEMAND (@ SOURCE):</td>
<td>338.4 gpm @ 39.36 psi</td>
</tr>
</tbody>
</table>
Sprinkler Layout
Fire Alarm

- The fire alarm system design will be based on UFC 3-600-01, NFPA 72, NFPA 70 and NFPA 101.
- The Fire alarm will be designed around a fully addressable system containing detection, notification, signaling and mass notification component.
Voltage Drop Calculations

<table>
<thead>
<tr>
<th>Appliance number</th>
<th>Appliance description</th>
<th>Appliance current draw</th>
<th>Distance from previous appliance</th>
<th>Wire Gauge</th>
<th>Voltage @ Appliance</th>
<th>Voltage Drop</th>
<th>% Drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Strobe</td>
<td>0.3</td>
<td>45</td>
<td>12</td>
<td>19.83</td>
<td>0.57</td>
<td>2.81</td>
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</tr>
<tr>
<td>2 Strobe</td>
<td>0.3</td>
<td>45</td>
<td>12</td>
<td>19.25</td>
<td>1.09</td>
<td>5.36</td>
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<tr>
<td>3 Strobe</td>
<td>0.3</td>
<td>45</td>
<td>12</td>
<td>18.73</td>
<td>1.56</td>
<td>7.66</td>
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</tr>
<tr>
<td>4 Strobe</td>
<td>0.3</td>
<td>45</td>
<td>12</td>
<td>18.26</td>
<td>1.98</td>
<td>9.71</td>
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<tr>
<td>5 Strobe</td>
<td>0.3</td>
<td>45</td>
<td>12</td>
<td>17.85</td>
<td>2.34</td>
<td>11.49</td>
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<tr>
<td>6 Strobe</td>
<td>0.3</td>
<td>45</td>
<td>12</td>
<td>17.48</td>
<td>2.66</td>
<td>13.03</td>
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<tr>
<td>7 Strobe</td>
<td>0.3</td>
<td>45</td>
<td>12</td>
<td>17.17</td>
<td>2.92</td>
<td>14.30</td>
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<tr>
<td>8 Strobe</td>
<td>0.3</td>
<td>45</td>
<td>12</td>
<td>16.91</td>
<td>3.13</td>
<td>15.33</td>
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<tr>
<td>9 Strobe</td>
<td>0.3</td>
<td>45</td>
<td>12</td>
<td>16.70</td>
<td>3.28</td>
<td>16.09</td>
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<tr>
<td>10 Strobe</td>
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<td>45</td>
<td>12</td>
<td>16.54</td>
<td>3.39</td>
<td>16.60</td>
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<tr>
<td>11 Strobe</td>
<td>0.3</td>
<td>45</td>
<td>12</td>
<td>16.44</td>
<td>3.44</td>
<td>16.86</td>
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<td>Total</td>
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<td>16.44</td>
<td>3.44</td>
<td>16.86</td>
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## Battery Calculations

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>STANDBY CURRENT PER UNIT (AMPS)</th>
<th>QTY</th>
<th>TOTAL STANDBY CURRENT PER ITEM</th>
<th>ALARM CURRENT PER UNIT (AMPS)</th>
<th>QTY</th>
<th>TOTAL ALARM CURRENT PER ITEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACU</td>
<td>Fire Alarm Control Unit</td>
<td>0.2300</td>
<td>X 1</td>
<td>0.2300</td>
<td>0.2300</td>
<td>X 1</td>
<td>0.2300</td>
</tr>
<tr>
<td>SD</td>
<td>Smoke Detector</td>
<td>0.0003</td>
<td>X 20</td>
<td>0.0050</td>
<td>0.0041</td>
<td>X 20</td>
<td>0.0082</td>
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<tr>
<td>HD</td>
<td>Heat Detector</td>
<td>0.0000</td>
<td>X 6</td>
<td>0.0000</td>
<td>0.0000</td>
<td>X 6</td>
<td>0.0000</td>
</tr>
<tr>
<td>RLY</td>
<td>Strobe</td>
<td>0.0500</td>
<td>X 11</td>
<td>0.5500</td>
<td>0.3000</td>
<td>X 1</td>
<td>0.3000</td>
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<tr>
<td>RLY</td>
<td>Relay (not failsafe)</td>
<td>0.0000</td>
<td>X 15</td>
<td>0.0000</td>
<td>0.0210</td>
<td>X 15</td>
<td>0.3150</td>
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<tr>
<td>HS</td>
<td>Speaker-Strobe</td>
<td>0.0000</td>
<td>X 11</td>
<td>0.0000</td>
<td>0.0750</td>
<td>X 11</td>
<td>0.8250</td>
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<tr>
<td>DH</td>
<td>Door Holder</td>
<td>0.0650</td>
<td>X 0</td>
<td>0.0000</td>
<td>0.0000</td>
<td>X 0</td>
<td>0.0000</td>
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<tr>
<td>ANN</td>
<td>Annunciator</td>
<td>0.1000</td>
<td>X 1</td>
<td>0.1000</td>
<td>0.2000</td>
<td>X 1</td>
<td>0.2000</td>
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<tr>
<td>MS</td>
<td>Manual Station</td>
<td>0.0014</td>
<td>X 4</td>
<td>0.0056</td>
<td>0.0014</td>
<td>X 4</td>
<td>0.0056</td>
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<tr>
<td>WF</td>
<td>Waterflow Switch</td>
<td>0.0000</td>
<td>X 1</td>
<td>0.0000</td>
<td>0.0000</td>
<td>X 1</td>
<td>0.0000</td>
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<tr>
<td>TS</td>
<td>Tamper Switch</td>
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<td>X 1</td>
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<tr>
<td>0</td>
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<td>X 0</td>
<td>0.0000</td>
<td>0.0000</td>
<td>X 0</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

**TOTAL SYSTEM STANDBY CURRENT (AMPS):** 0.8906

**TOTAL SYSTEM ALARM CURRENT (AMPS):** 1.9576

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**Prepared for:**

- REQUIRED STANDBY TIME (HRS): 24
- TOTAL SYSTEM STANDBY CURRENT (AMPS): 0.8906
- REQUIRED STANDBY CAPACITY (AMP-HOURS): 21.3744
- REQUIRED ALARM TIME (HOURS): 0.083
- TOTAL SYSTEM ALARM CURRENT (AMPS): 1.9576
- REQUIRED ALARM CAPACITY (AMP-HOURS): 0.1625

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**Prepared by:**

- REQUIRED STANDBY CAPACITY (AMP-HOURS): 21.37
- REQUIRED ALARM CAPACITY (AMP-HOURS): 0.1625
- TOTAL CAPACITY (AMP-HOURS): 21.5369
- TOTAL CAPACITY (AMP-HOURS): 21.5369
- SAFETY FACTOR: 120%
- ADJUSTED BATTERY CAPACITY (AMP-HOURS): 26
Fire Alarm Smoke Detection

• The smoke detectors are placed in sleeping areas and hallways primarily.

• The type of smoke detector is a Siemens (S54320-F4-A2) photoelectric smoke detector with a sounder base.

• This detector uses light scattering detection principle.
Fire Alarm Notification Devices

• There are three types of notification devices in this building: the speaker, speaker/strobe, and strobe.
• These are both provided by Cooper.
• These speakers allow for three audible settings: 90, 95, and 99 db.
# General Alarm Sequence of Operations

<table>
<thead>
<tr>
<th>System Inputs</th>
<th>Control Unit Annunciation</th>
<th>Notification</th>
<th>Required Fire Safety Control</th>
<th>Supplementary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Manual fire alarm box</td>
<td>D</td>
<td>B</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>2. Area smoke detector</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
</tr>
<tr>
<td>3. MNS used to override Fire Alarm Audible Message</td>
<td>I</td>
<td>J</td>
<td>K</td>
<td>L</td>
</tr>
<tr>
<td>4.</td>
<td>M</td>
<td>N</td>
<td>O</td>
<td>P</td>
</tr>
<tr>
<td>5.</td>
<td>Q</td>
<td>R</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td>6.</td>
<td>U</td>
<td>V</td>
<td>W</td>
<td>X</td>
</tr>
<tr>
<td>7. Residential unit smoke detector</td>
<td>Y</td>
<td>Z</td>
<td>AA</td>
<td>AB</td>
</tr>
<tr>
<td>8.</td>
<td>AC</td>
<td>AD</td>
<td>AE</td>
<td>AF</td>
</tr>
<tr>
<td>9. Sprinkler water flow switch</td>
<td>AG</td>
<td>AH</td>
<td>AI</td>
<td>AJ</td>
</tr>
<tr>
<td>10. Sprinkler valve tamper switch</td>
<td>AK</td>
<td>AL</td>
<td>AM</td>
<td>AN</td>
</tr>
<tr>
<td>11. Sprinkler post indicator switch</td>
<td>AO</td>
<td>AP</td>
<td>AQ</td>
<td>AR</td>
</tr>
<tr>
<td>12. Pre-action alarm/flow switch</td>
<td>AS</td>
<td>AT</td>
<td>AU</td>
<td>AV</td>
</tr>
<tr>
<td>13. TAUP 120Vac power failure</td>
<td>AW</td>
<td>AX</td>
<td>AY</td>
<td>AZ</td>
</tr>
<tr>
<td>14. System device wiring trouble/fault</td>
<td>BA</td>
<td>BB</td>
<td>BC</td>
<td>BD</td>
</tr>
<tr>
<td>15. Open circuit</td>
<td>BE</td>
<td>BF</td>
<td>BG</td>
<td>BH</td>
</tr>
<tr>
<td>16. Ground fault</td>
<td>BI</td>
<td>BJ</td>
<td>BK</td>
<td>BL</td>
</tr>
</tbody>
</table>

- A: Audible alarm
- B: Bell
- C: Chime
- D: DC buzzer
- E: Flooding alarm
- F: Gas alarm
- G: Heat alarm
- H: Heat detection
- I: Illumination
- J: Indication
- K: Indication
- L: Indication
- M: Indication
- N: Indication
- O: Indication
- P: Indication
- Q: Indication
- R: Indication
- S: Indication
- T: Indication
- U: Indication
- V: Indication
- W: Indication
- X: Indication
- Y: Indication
- Z: Indication
- AA: Indication
- AB: Indication
- AC: Indication
- AD: Indication
- AE: Indication
- AF: Indication
- AG: Indication
- AH: Indication
- AI: Indication
- AJ: Indication
- AK: Indication
- AL: Indication
- AM: Indication
- AN: Indication
- AO: Indication
- AP: Indication
- AQ: Indication
- AR: Indication
- AS: Indication
- AT: Indication
- AU: Indication
- AV: Indication
- AW: Indication
- AX: Indication
- AY: Indication
- AZ: Indication
- BA: Indication
- BB: Indication
- BC: Indication
- BD: Indication
- BE: Indication
- BF: Indication
- BG: Indication
- BH: Indication
- BI: Indication
- BJ: Indication
- BK: Indication
- BL: Indication

**Cal Poly**

Fire Protection Engineering
Sequence Sample

- Room Smoke Detector
  - Activate Control Panel
  - Annunciate at remote annunciator
  - Provide local alarm Only

- Other Smoke Detector
  - Activate Control Panel
  - Annunciate at remote annunciator
  - Notify fire department
  - Provide full alarm
Fire Alarm Drawings (Ground Floor Riser Diagram)
Fire Alarm Drawings
Fire Alarm Drawings
Performance Based design
FDS Model Dorm Room

- Source of ignition
  - Trash can fire
  - 100 kW
  - Slow Curve
- Active Devices
  - Smoke Detectors
  - Sprinkler System
- Evaluate time of smoke detection.
- Evaluate time of sprinkler activation.
- Evaluate smoke height.
FDS Model Criteria

- Smoke Visibility at the 6ft mark
  - SFPE Table 2-4.2
    - Familiar with building **Visibility 4m**
- FED at the 6ft mark
  - SFPE Table 2-6.7 and Table 2-6.8
  - Incapacitation occurs at **3500 PPM CO**
- Temperature at the 6ft mark
  - SFPE Section 2 Chapter 6
    - Temperature of **200 C**
Hand Calculations

• Smoke detector activation time:
  • The response time is 9 sec in the DETACT model.

• Sprinkler activation time:
  • Sprinkler DETACT model with a HRR is 645 kW and that would bring the sprinkler response time to 231 sec

• Smoke Height:
  • To keep the smoke height above 6ft.
Hand Calculations Continued

Sprinkler DETACT model with a HRR is 645 kW and that would bring the sprinkler response time to 231 sec
Smoke Detector Activation (38 sec)
CO Levels @ 145 sec above 3500ppm.
Sprinkler Activation (145sec FDS Model)
Smoke Visibility @ 145 sec, 6ft (4 m under black line)
Comparison

- Smoke detector activation time:
  - The response time is **9 sec** in the DETACT model.

- Sprinkler activation time:
  - Sprinkler DETACT model with a HRR is 645 kW and that would bring the sprinkler response time to **231 sec**

- Smoke detector activation time:
  - The response time is **38 sec**.

- Sprinkler activation time:
  - The response time to **145 sec**.
Sprinkler Active @ 300 sec.
Smoke Visibility @ 300 sec, 6ft (4 m under black line) with sprinklers
Smoke Visibility @ 300 sec, 6ft (4 m under black line) without sprinklers
CO Levels @ 300 sec above 3500ppm. With Sprinklers
CO Levels @ 300 sec above 3500ppm. Without Sprinklers
Temperature @ 300 sec with sprinklers
Temperature @ 300 sec without sprinklers
RSET

• The Building is general evacuation.
• Time to evacuate entire building 6.5 Minutes
• Time to evacuate the third floor 3.6 Minutes (216 Sec)
• SFPE Table 3-12.2 Delay times
  • Unannounced Fire Drill, Good Fire alarm
  • Min- 0.6 min
  • Max- 14 min
  • Mean- 2.5 min
• Total 3rd floor time
  • Min- 4.6 min
  • Max- 18 min
  • Mean- 6.5 min
ASET

• FDS model run up to 5 min.
• Corridor is still tenable at the 5 min mark.
• Sprinkler activation at 145 sec (2.4 min)

• In a space like this the sprinkler if functioning properly would be expected to suppress the fire and or extinguish the fire prior to spread beyond one room.
Performance Based Analysis Overview

• Sprinklers greatly reduce the impact of a fire in a single dorm room.
  • Reduced occupant temperature
  • Increase occupant visibility
  • Reduced the amount of CO produced
  • Allowed for the ASET > RSET
  • Prevent the spread of fire to another tenant space
Other Possible Design Scenarios

• Fire on the first floor lobby.
  • This will allow us to see how the fire spreads between the two floors.
  • Trashcan fire or Sofa Fire

• Terrorist attack
  • This would look at how the building would function in an abnormal extreme condition because of it housing military personnel.