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Keywords: Life Safety Code, RSET, ASET, Performance Based Design, Fire Dynamics Simulator (FDS), Smoke Management
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Executive Summary

Analyzing the fire protection features of the Warren J. Baker Center for Science and Mathematics Building 180, located on Cal Poly Campus in San Luis Obispo California was done using two methods. The prescriptive based analysis of the building focused on the building design, egress, structural fire protection, fire suppression, fire alarm and detection systems to determine if current codes and standards were met. The performance based analysis discusses certain methods and design fire scenarios that are present within the building and the building’s ability to protect occupants until they can exit safely. The performance based analysis was done using Pathfinder and PyroSim [4] to determine ASET vs RSET values.

The prescriptive based analysis determined that Warren J Baker Center for Science and Mathematics building design, egress, structural fire protection, fire suppression systems, fire alarm and detection systems complied with all applicable codes and standards.

The performance based analysis looked at the following. This analysis looked at typical design fire scenarios present in the building and determined the atrium area has the largest fuel loads and will impact occupant egress the most.

• Atrium Design Fire Scenarios:

  - Any occupant who is not intimate with ignition shall not be exposed to instantaneous or cumulative untenable conditions. (NFPA 101 -2015 – Section 5.2.2)

  - Design fire 1 is based on scenario 6 from the LSC 2015 (Balcony Spill Fire Plume). The fire is located on the second floor in a seating area within the atrium. The area is fully sprinkled and is the largest fuel area that would affect the most floors if there was a fire. The fire will become sprinkler controlled at some point during the fire and there will be activation of the smoke management system.

  - Design fire 2 is based on scenario 8 from the LSC 2015 (Axial Fire Plume). This fire is located on the second floor in the atrium opening. This fire will not be sprinkler controlled but activation of the smoke management system will occur. The fire detection system will activate and the passive smoke control system will be engaged.

All the furniture within both design fire areas are TB 133 compliant, this limits the Heat Release Rate (HRR) to 80 kW per item. Running the PyroSim model with a HRR around 80 kW concluded that the fire will not spread to the other pieces furniture. The PyroSim results from both scenarios indicated that all tenable conditions were maintain for the time limit of 600 seconds except for visibility. The visibility requirement of 13 meters was lost about 270 seconds within both fire scenarios but the occupants should have egressed the floor by this time according to Pathfinder and the calculated RSET values to be discussed later in this report.
Using TB 133 compliant furniture within the atrium areas is vital for the passive smoke control system to maintain tenable conditions for occupants to egress safely. If non-compliant furniture is introduced into these areas the passive naturally ventilated smoke control system should be replaced with a mechanical smoke control system, then this would help with exhausting smoke within the atrium and maintaining the visibility for a longer period. The other recommendation is to implement a phased evacuation plan for the building. The phased evacuation would use the horizontal exits within the building to compartmentalize the wings and atrium from one another. The building is already separated this way with rated walls and doors. The voice communication system in the building can be used to coordinate and direct occupants on whether they should stay in place and/or who should evacuate to the closest safe exit. The adjoining fire rated doors in the corridors could be relocated to the align with the walls of the atrium eliminating areas of trapped smoke, and allowing for safe egress from the center stair to outside the building without going through the atrium.
Abbreviations and Acronyms

AASC        Aero Automatic Sprinkler Company
AHJ           Authority Having Jurisdiction
ANSI         American National Standards Institute
ASET          Available Safe Egress Time
ASME         American Society of Mechanical Engineers
Cal Poly     California Polytechnic State University
CBC         California Building Code
CFC         California Fire Code
CSFM      California State Fire Marshal
CSM          Center for Science and Mathematics
EOL          End of Line
EPSS        Emergency Power Supply System
FACP       Fire Alarm Control Panel
FATC       Fire Alarm Terminal Cabinet
FD          Fire Department
FM          FM Global
GPM       Gallons per Minute
HRR         Heat Release Rate
ICC           International Code Council
ITM     Inspection, Testing and Maintenance
IR           Infrared
LSC          Life Safety Code
NAC         Notification Appliance Circuit
NFPA     National Fire Protection Association
NIST        National Institute of Technology
OSID     Open-Area Smoke Imaging Detection
RNPS     Remote Notification Power Supply
RSET         Required Safe Egress Time
PSI          Pounds per Square Inch
SFPE       Society of Fire Protection Engineers
SFRM     Spray-Applied Fire Resistive Material
SLC            Signal Line Circuit
STEPS      Simulation of Transient Evacuation and Pedestrian movements
SLO         San Luis Obispo
UDACT     Universal Digital Alarm Communicator Transmitter
UL          Underwriters Laboratory
UV           Ultraviolet

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Figure 56 – PyroSim Model Design Fire 1 (DF-1) - Temperature @ 600 Seconds
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Figure 58 – PyroSim Model Design Fire 1 (DF-1) - CO @ 600 Seconds
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Figure 65 – PyroSim Model Design Fire 2 (DF-2) - Temperature @ 270 Seconds
Figure 66 – PyroSim Model Design Fire 2 (DF-2) - Temperature @ 600 Seconds
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1.0 Building Description

The Warren J. Baker Center for Science and Mathematics (CSM) building 180 is one of the newest and largest buildings on campus. The CSM building held its first classes in the Fall of 2013. It is a six-story building with a total square footage of 190,182, there is an Elevator Machine Room located on the roof (Level 7). The building is constructed as Type 1-B with separate occupancies. It has a fire pump supplying the fully sprinklered building and standpipes. The building also contains a Fire Alarm and Emergency Voice/Alarm Communication System (EVACS). In the center of the building between the East and West wings, there is a five-story open atrium with a natural ventilation smoke control system. See Figure 1 below for building location within the Cal Poly campus.

![Figure 1 – CSM Building 180](image)

Explanation of an 80-foot-high building being classified as Non-High Rise: The CSM building is located on a hillside that allows the first floor to exit outside from the main door located on the West side of the building. The second through the sixth floors have their main exit to outside on the North and South doors in the center area. These main exits along with Stairs #1, 4 and 5 discharges directly out onto open areas for safe egress from the building. The distance from the second floor to the highest occupied floor is 64 feet. The AHJ and CSFM accepted this code exception and that is under IBC value of 75 feet from the lowest level of fire department access to highest occupied floor for a High-Rise Building. See Figure 2 below.
2.0 Purpose

The purpose of this report is to analyze the Warren J. Baker Center for Science (CSM)-Building 180, in every aspect of fire protection, using a prescriptive and performance based analysis. The prescriptive based analysis includes the analysis of the building’s design, egress components, structural fire protection, fire suppression systems, and the fire alarm systems. This analysis is conducted using the California Building Code (CBC) and applicable NFPA codes to determine if the current systems and construction within the building meet the requirements of the codes.

The performance based analysis was performed on the natural ventilation smoke control system within the atrium of the building. The purpose of this analysis was to determine if the smoke control system was adequate to maintain safe conditions within the atrium for a time greater than it takes the occupants to exit the space. This was determined by using the computer programs Pathfinder and PyroSim [4] to find the Required Safe Egress Time (RSET) of the occupants and the Available Safe Egress Time (ASET). Through the performance based analysis as well as the prescriptive requirements of the applicable codes, it can be determined if the building is considered safe for the occupants.
3.0 Codes & Standards
(For Report Analysis)
- International Building Code (IBC) 2015
- International Fire Code (IFC) 2015
  - NFPA 13 – 2015
  - NFPA 14 – 2013
  - NFPA 25 – 2011
  - NFPA 101 - 2015
  - NFPA 92B - 2009

(Existing CSM Building Designed to)
- International Building Code (IBC) 2007
- International Fire Code (IFC) 2007
- California Building Code (CBC) 2007
- California Fire Code (CFC) 2007

4.0 Prescriptive Based Analysis

The prescriptive based analysis will analyze the following building components:
- Building Design
- Egress Analysis
- Structural Fire Protection
- Fire Suppression Systems
- Fire Alarm Systems

This analysis is conducted using the California Building Code (CBC) and applicable NFPA codes to determine if the current systems and construction within the building meets the requirements of the codes.

4.1 Building Design

The CSM building is designed and constructed to Type 1-B with separate occupancies. It is a six story non-high rise building with a primary occupancy of university classrooms and laboratories, this translates to a Group B – Business occupancy. The building also contains a fully automatic sprinkler system per section 304.1 of the IBC and fire alarm system with EVACS. The building also has a passive smoke control system in the center open atrium area.
4.2 Egress Analysis

Egress analysis is looking at the CSM building for code compliant components. We will do this using FPH and LSC along with other NIST data to obtain results to insure code compliance.

4.2.1 Building Square Footage

The CSM building has six main levels with an Elevator Machine Room located on the roof (Level-7). Table 1 below is a summary of the building square footage per floor.

<table>
<thead>
<tr>
<th>Building Level</th>
<th>Square Footage (SF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>23,146</td>
</tr>
<tr>
<td>Level 2 (985 sq. ft.: H-3)</td>
<td>43,458</td>
</tr>
<tr>
<td>Level 3</td>
<td>43,209</td>
</tr>
<tr>
<td>Level 4</td>
<td>33,307</td>
</tr>
<tr>
<td>Level 5</td>
<td>25,294</td>
</tr>
<tr>
<td>Level 6</td>
<td>19,958</td>
</tr>
<tr>
<td>Level 7</td>
<td>250</td>
</tr>
<tr>
<td>TOTAL</td>
<td>190,182</td>
</tr>
</tbody>
</table>

Building SF are from ACAD Drawings

4.2.2 Occupancy Classification

The CSM building is classified as multiple occupancy by LSC Sections 6.1.14.2.1 & 6.1.14.2.2. LSC Section 6.1.14.3.2 requires us to use the most restrictive requirements involved for occupancies. The Assembly class rooms on level one and the terraces on levels 3, 4, 5 and 6 would be classified as Group A-3 by IBC Section 303.4. The majority of the CSM building is classified as Group B except for level 1 described above. There are also storage rooms (Group S), mechanical rooms (Group S-1) and electrical rooms (Group S-2) located throughout the building at different levels. The occupancy classifications for the CSM building are shown in the Architectural drawings in Appendix A.

4.2.3 Occupant Loads

In order to calculate occupant load, we must divide the floor area by the occupant load factor given in Table 2 below. These occupant load factors are based on CBC (2016) Table 1004.1.2
Table 2 – Occupant Load Factor

<table>
<thead>
<tr>
<th>Use</th>
<th>(sq.ft. per occupant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly Use (Less concentrated use,</td>
<td>15 net (or # of fixed</td>
</tr>
<tr>
<td>without fixed seating)</td>
<td>Seats)</td>
</tr>
<tr>
<td>Business Use (Lecture)</td>
<td>15 net</td>
</tr>
<tr>
<td>Business Use (Laboratories)</td>
<td>50 net</td>
</tr>
<tr>
<td>Business Use (Admin-Office)</td>
<td>100 gross</td>
</tr>
<tr>
<td>Storage Use (In other than storage</td>
<td>300 gross</td>
</tr>
<tr>
<td>occupancies)</td>
<td></td>
</tr>
</tbody>
</table>

Reference: CBC (2016) Table 1004.1.2

Using the different room square footages with the correct occupant load factors, we derive our occupant loads per floor in Table 3.

Table 3 – Occupant Load per Floor

<table>
<thead>
<tr>
<th>Level</th>
<th>West</th>
<th>Center</th>
<th>East</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>712</td>
<td></td>
<td></td>
<td>712</td>
</tr>
<tr>
<td>2</td>
<td>322</td>
<td>78</td>
<td>182</td>
<td>582</td>
</tr>
<tr>
<td>3</td>
<td>314</td>
<td>129</td>
<td>237</td>
<td>680</td>
</tr>
<tr>
<td>4</td>
<td>212</td>
<td>73</td>
<td>209</td>
<td>494</td>
</tr>
<tr>
<td>5</td>
<td>87</td>
<td>87</td>
<td>186</td>
<td>273</td>
</tr>
<tr>
<td>6</td>
<td>80</td>
<td>174</td>
<td></td>
<td>254</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>1560</td>
<td>448</td>
<td>988</td>
<td>2996</td>
</tr>
</tbody>
</table>
4.2.4 Building Plans

The next 7 figures (Figures 3-9) shows the floor plans for the seven levels of the CSM building. The plans include occupancy classifications for each room, Stairwells, Main Exits, Required & Actual Exits and Travel Paths. All the number of exits, exit signage, travel paths and distances meet or exceed the code requirements, except on the second floor there is one dead-end corridor of 54 feet.

<table>
<thead>
<tr>
<th>Building Level</th>
<th>Required # of Exits</th>
<th>Actual # of Exits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

CBC Table 1021.1
Occupant Load : 712

Figure 3 – CSM Building 180 Floor-1 – Occupancy Classification
Figure 4 – CSM Building 180 Floor-2 – Occupancy Classification

Figure 5 – CSM Building 180 Floor-3 – Occupancy Classification
Figure 6 – CSM Building 180 Floor-4 – Occupancy Classification

Figure 7 – CSM Building 180 Floor-5 – Occupancy Classification
Figure 8 – CSM Building 180 Floor-6 – Occupancy Classification

Figure 9 – CSM Building 180 Floor-7 – Occupancy Classification
4.2.5 **Occupant Behavior**

The CSM is mainly used by students and professors for classes and laboratory experiments. Most of the classes are one hour long, and occupants usually come and go between classes. The center open atrium area is setup for people to congregate or study on floors two through six. Most occupants will be alert and ready to egress if needed.

In the case of an alarm, most occupants would react quickly, therefore we would have very little pre-movement time. From SFPE Handbook Table 3-12.2 for our type of building and occupants we would get a **pre-movement time of 36 seconds**. This amount of time needs to be added to get a total egress time for tenability analyses.

4.2.6 **Egress Capacity**

We will use egress capacities for doors and stairs based on LSC Table 7.3.3.1, however the original designers used IBC Section 1005.3.1 for stairs (0.2) and Section 1005.3.2 for doors (0.15) if the building is protected by a fully automatic sprinkler system. The values from LSC are more conservative (0.3) for stairs and (0.2) for doors. See Table 4 for calculation results.

### Table 4 – Egress Capacity per Doors and Stairs

<table>
<thead>
<tr>
<th>Level</th>
<th>Component</th>
<th>Load (persons)</th>
<th>Factor (in/person)</th>
<th>Width (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Door Main</td>
<td>1080</td>
<td>0.2</td>
<td>216</td>
</tr>
<tr>
<td>1</td>
<td>Door Back</td>
<td>480</td>
<td>0.2</td>
<td>96</td>
</tr>
<tr>
<td>1</td>
<td>Door 4</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>2</td>
<td>Stair 5</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>2</td>
<td>Door 5</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>2</td>
<td>Stair 4</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>2</td>
<td>Door 4</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>2</td>
<td>Door West</td>
<td>360</td>
<td>0.2</td>
<td>72</td>
</tr>
<tr>
<td>2</td>
<td>Door Main N</td>
<td>720</td>
<td>0.2</td>
<td>144</td>
</tr>
<tr>
<td>2</td>
<td>Door Main S</td>
<td>720</td>
<td>0.2</td>
<td>144</td>
</tr>
<tr>
<td>2</td>
<td>Door East a</td>
<td>360</td>
<td>0.2</td>
<td>72</td>
</tr>
<tr>
<td>2</td>
<td>Door East b</td>
<td>360</td>
<td>0.2</td>
<td>72</td>
</tr>
<tr>
<td>3</td>
<td>Stair 5</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>3</td>
<td>Door 5</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Stair 4</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>3</td>
<td>Door 4</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Stair 3</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>3</td>
<td>Door 3</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Door 1</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>4</td>
<td>Stair 4</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>Door 4</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>4</td>
<td>Stair 3</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>Door 3</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>4</td>
<td>Stair 1</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>Door 1</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>5</td>
<td>Stair 3</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>5</td>
<td>Door 3</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>5</td>
<td>Stair 1</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>5</td>
<td>Door 1</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>6</td>
<td>Stair 3</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>6</td>
<td>Door 3</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>6</td>
<td>Stair 1</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>6</td>
<td>Door 1</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>7</td>
<td>Stair 3</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>7</td>
<td>Door 3</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
<tr>
<td>7</td>
<td>Stair 1</td>
<td>165</td>
<td>0.3</td>
<td>48</td>
</tr>
<tr>
<td>7</td>
<td>Door 1</td>
<td>180</td>
<td>0.2</td>
<td>36</td>
</tr>
</tbody>
</table>
4.2.7 Quantity of Exits

LSC Section 7.4.1.1 and 7.4.1.2 requires 500 to 1000 occupants we need 3 exits and under 500 occupants we need 2 exits. Levels 1, 5 and 6 require the same number as provided 3, 2 and 2 respectively. Level 2, our main exit floor, requires 3 exits and 7 are provided. Levels 3 and 4 require 3 and 2 exits and 4 and 3 are provided respectively. The CSM meets or exceeds the required exits per code. See Table 5 below.

Table 5 – Required Exits per Occupant Loads

<table>
<thead>
<tr>
<th>Occupant Load Per Story</th>
<th>Minimum Number of Exits from Story</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-500</td>
<td>2</td>
</tr>
<tr>
<td>501-1000</td>
<td>3</td>
</tr>
</tbody>
</table>

4.2.8 Arrangement of Exits

LSC Section 7.5.1.3.3 allows us to have exits up to one third the diagonal distance to determine the distance between exits for a fully sprinklered building. With the quantity of exits we have for the CSM this requirement is verified. We also looked a common travel path and dead-end corridors. See floor plans for these verified values. There was only one dead end corridor that was just outside the code compliant 50 feet. The rest of the building meets code requirements.

4.2.9 Exit Sign Arrangement

After walking through the CSM building, it was clear that exit signs are placed in a very effective manor to aid in finding exit pathways and exit doors. The building meets or exceeds LSC requirements for exit signage. I placed the minimum exit signage on the floor plans in this report.

4.2.10 Calculating Total Egress Time

Using FPH Section 4-2 we need to evaluate the places where occupants will be queuing up while exiting. This usual occurs at stairwell door exits. From FPH Table 4.2.7 the maximum unimpeded exit flow will be $F_s = 235$ ft/min (Corridors/Doorways) and $F_s = 187$ ft/min (Stairwells). To figure out our actual exit flow we must look at or exiting effective width (We) for both the
stairway and doorways. Our stairways are 48 in and our doorways are 36 in.: 

Flow Capability of a stairway is \( We = 48 \text{ in} - 12 \text{ in} = 36 \text{ in} (3 \text{ ft}) \) (12 in comes from FPH Table 4.2.4)

Flow Capability of a doorway is \( We = 36 \text{ in} - 12 \text{ in} = 24 \text{ in} (2.0 \text{ ft}) \) (12 in comes from FPH Table 4.2.4)

Maximum Specific Flow (Fsm) for the stairway is \( Fs = 18.5 \text{ persons/min/ft of effective width} \) (18.5 comes from FPH Table 4.2.8)

Therefore \( Fsm = 18.5 \text{ persons/min/ft} \times 3 \text{ ft} = 55.5 \text{ persons/min} \)

Maximum Specific Flow (Fsm) for the doorway is \( Fs = 24 \text{ persons/min/ft of effective width} \) (24 comes from FPH Table 4.2.8)

Thus, the flow capacity of the door is more restricting, so \( Fsm = 48 \text{ persons/min} \)

Stairwells

Estimating speed of movement for estimated stairway flow: \( Fs = k-akD \)
\( (a=2.86 \text{ ft}^2/\text{person} \text{ (constant)}; K=212 \text{ ft/min} \text{ (FPH Table 4.2.5 - 7 x 11 Stairs)}; D=0.175 \text{ person/ft}^2 \text{ (FPH Figure 4.2.7)} \)

\( Fs=212 \text{ ft/min} - 2.86 \text{ ft}^2/\text{person} * 212 \text{ ft/min} * 0.175 \text{ person/ft}^2 \)

\( Fs = 105 \text{ ft/min} \)

Finding Travel Distance between floors: 16 ft per floor and 7 x 11 Stairs
(From FPH Table 4.2.6 our conversion factor is 1.85)

16 ft * 1.85 = 29.6 ft (plus two landing with 10 ft travel) Floor-to-Floor Travel Distance = 49.6 ft

Travel Time to go between floors = 49.6 ft / 105 ft/min = 0.47 min / floor

All the occupants from level 1 will exit through the three main West exit double doors. The rest of the occupants from levels 2 thru 7 will exit from Stairs 1, 3, 4 and 5. The East and Center occupants will exit through Stairs 1 and 3 evenly (718 people) and the West occupants will exit through Stairs 4 and 5 evenly (424 people).

East and Center occupants to Exit: 718 people / 48 people / min = 14.6 min + 0.47 min (to get from second floor to exit) + 0.36 min (Pre-Evacuation Time) = 15.7 min

The CSM building meets or exceed code requirement for the egress analysis. The exit capacity and locations allow for occupants to egress the CSM building within 15.7 minutes, which is reasonable for 2,996 occupants. We will now look at the prescriptive analysis for Structural Fire Protection.
4.3 Structural Fire Protection

Structural fire protection in a building is designed to limit the spread of fire and smoke to as small an area as possible, by using the code requirements to evaluate and specify fire endurance capabilities of structural elements. In summary, here are the three main goals of structural fire protection:

- Limit the spread of fire within a building (provide compartmentation)
- Prevent the total or partial collapse of a building (maintain structural integrity)
- Limit the spread of fire between buildings (provide exposure protection)

The structural fire protection must be designed and constructed to have a greater fire resistance than the expected fire severity.

4.3.1 Allowable Floor Area & Fire Resistance Rating

The CSM building is Type 1-B construction\(^1\) fully sprinklered with mixed-use occupancy. First looking at the allowable building area per floor. The allowable building area per floor is determined by increasing the tabular area from Table 503 by 200% for sprinkler protection (CBC Section 506.3) and by 75% when the frontage area exceeds 30 feet on all sides of the building (CBC Section 506.2) as shown in Table 6. Group H-3 occupancies are not permitted to have an area increase due to sprinkler protection per CBC Section 506.3 Exception 2 [2].

<table>
<thead>
<tr>
<th>Construction Type 1-B</th>
<th>Group B</th>
<th>Group A-3</th>
<th>Group S-1</th>
<th>Group S-2</th>
<th>Group H-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Area (Table 503)</td>
<td>UL</td>
<td>UL</td>
<td>48,000</td>
<td>79,000</td>
<td>60,000</td>
</tr>
<tr>
<td>Sprinkler Increase (506.3)</td>
<td>UL</td>
<td>UL</td>
<td>96,000</td>
<td>158,000</td>
<td>0*</td>
</tr>
<tr>
<td>Frontage Increase (506.2)</td>
<td>UL</td>
<td>UL</td>
<td>36,000</td>
<td>59,250</td>
<td>45,000</td>
</tr>
<tr>
<td>Allowable Area Per Story</td>
<td>UL</td>
<td>UL</td>
<td>180,000</td>
<td>296,250</td>
<td>105,000</td>
</tr>
</tbody>
</table>

The actual building area per floor shown in Table 1 indicating compliance with the requirements from Table 6.

Second the CSM building has more than one occupancy it is considered a mixed-use building and requires fire resistance-rated assemblies between these different occupancies. The fire resistance ratings for Type 1-B construction are shown in Table 7, also included in this table is the CSM project specifications.

---

\(^1\) In Type 1-B construction, building element are considered of noncombustible material.
Table 7 - Fire-resistance rating for building elements – Type 1-B

<table>
<thead>
<tr>
<th>Building Element</th>
<th>Fire resistance rating (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Structural Frame</td>
<td>2*</td>
</tr>
<tr>
<td>Bearing Walls (Exterior)</td>
<td>2</td>
</tr>
<tr>
<td>Bearing Walls (Interior)</td>
<td>2*</td>
</tr>
<tr>
<td>No Bearing Walls (Interior)</td>
<td>0</td>
</tr>
<tr>
<td>Floor Construction and Associated Secondary Members</td>
<td>2</td>
</tr>
<tr>
<td>Roof Construction and Associated Secondary Members</td>
<td>1</td>
</tr>
</tbody>
</table>

Ref. CBC- 2007 Table 601 (*1 hour permitted where only supporting a roof.)

Fire-resistance rating specified in CSM project

For fully Sprinklered Group B occupancy buildings, non-rated corridors are permitted under CBC-2007.

The floor and ceiling construction in the CSM building are based upon UL Design No. U438 for 2-hour rating. The primary structure is comprised of I (or W) beams fire proofed with Spray-Applied Fire Resistive Material (SFRM), Glass Fiber Reinforced Gypsum (GFRG) and concrete encased. Girders and beams are designed according to UL Design No. 917 and columns according to UL Design No. X772 and SFRM boxed with steel channels and gypsum wallboard. Retaining walls on levels 1 and 2 are made of reinforced concrete and comply with dimensions specified in CBC-2007, Table 721.1(2) to meet a 2-hour fire rating. The requirements for exterior walls are based on fire separations distance and occupancy, as well as construction type. The fire resistance rating for different fire separation distances for Group B occupancies and Type 1-B construction are shown in Table 8, based on the requirements from CBC Table 3.
Table 8 - Fire Resistance Ratings for Fire Separation Distances [1]

<table>
<thead>
<tr>
<th>Fire Separation Distance (feet)</th>
<th>Group B, Type 1B</th>
</tr>
</thead>
<tbody>
<tr>
<td>X&lt;5</td>
<td>1</td>
</tr>
<tr>
<td>5&lt;X&lt;10</td>
<td>1</td>
</tr>
<tr>
<td>10&lt;X&lt;30</td>
<td>1</td>
</tr>
<tr>
<td>X&gt;30</td>
<td>0</td>
</tr>
</tbody>
</table>

Since there is a separation distance of at least 30 feet around the entire CSM building, the exterior walls are not required to have a fire resistance rating as noted above.

The fire-rating requirements between the different occupancies are shown in Table 9, also included in this table is the CSM project specifications.

Table 9 - Fire-resistance rating for occupancies separation

<table>
<thead>
<tr>
<th>Building Element</th>
<th>Fire resistance rating (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B to A-3</td>
<td>1</td>
</tr>
<tr>
<td>B to H-3</td>
<td>1</td>
</tr>
<tr>
<td>B to S-1</td>
<td>No separation required</td>
</tr>
<tr>
<td>B to S-2</td>
<td>1</td>
</tr>
<tr>
<td>S-1 to H-3</td>
<td>1</td>
</tr>
<tr>
<td>S-1 to S-2</td>
<td>1</td>
</tr>
</tbody>
</table>

Ref. CBC- 2007 Table 508.3.3

Fire-rating specified in the CSM project

Ref. ZGF, 2009

The fire-resistance rating between the different occupancies for the CSM building are shown in Appendix A.

Figure 10 is a picture of the CSM building under construction. Some examples of beam and column fire protection are illustrated in Figure 11 and Figure 12.
Figure 10 – CSM Building 180 Under Construction

Figure 11 – Beam (left) and column (right) fire proofed with SFRM
Ref. ZGF, 2009
4.3.2 Atrium Fire Separation

The CSM building has a five-story atrium from Levels 2 to 6 between the East and West wings, this atrium area is required to be separated from adjacent spaces by a 2 hour fire barrier per CBC 404.6 [1]. This atrium area is also protected with a naturally ventilated smoke control system. The 2 hour fire rated separation is shown in Figure 13 on Level 3 of the atrium, which is typical on each level. Within the 2 hour fire separation between the atrium and the East and West wings of the building there are magnetically held open doors. Upon activation of the fire alarm system, the doors close to maintain the 2 hour rated separation, and the naturally ventilated smoke control system is activated.
Figure 13 – Level 3 Showing 2 Hour Rated Fire Separation for Atrium Area [1]
4.3.3 Smoke and Fire Barriers

As defined in NFPA 101-2015, Section 3.3.31.2; A Smoke Barrier is continuous membrane, or a membrane with discontinuities created by protected openings, where such membrane is designed and constructed to restrict the movement of smoke.

In the CSM, except for the atrium openings\(^2\), vertical openings separating stories are required as a smoke barrier. In addition, every floor that separates stories is required to be constructed as a smoke barrier in accordance with NFPA 101-2015, Section 8.6.

As defined in NFPA 101-2015, Section 3.3.31.2; A Fire Barrier is continuous membrane or a membrane with discontinuities created by protected openings with a specified fire protection rating, where such membrane is designed and constructed with a specified fire resistance rating to limit the spread of fire.

A Fire Barrier must be permitted to be used as a smoke barrier, provided that it meets the requirements for smoke barriers per NFPA 101-2015, Section 8.5.3.

Fire barriers used in CSM, which includes barrier penetrations, ducts and air-transfer openings, doors, windows, expansion joints, etc., are designed and installed to maintain continuity and protect openings to meet the requirements of smoke barriers as defined in Section 8.5 of the Life Safety Code.

4.3.4 Penetrations and Joints

As defined in NFPA 101-2015, Section 8.5.6.2; Penetrations for cables, cable trays, conduits, pipes, tubes, vents, wires, and similar items to accommodate electrical, mechanical, plumbing, and communications systems that pass through a wall, floor, or floor/ceiling assembly constructed as a smoke barrier, or through the ceiling membrane of the roof/ceiling of a smoke barrier assembly, must be protected by a system or material capable of restricting the transfer of smoke.

The penetrations installed in CSM comply with provisions of NFPA 101-2015, Section 8.5.6, related to the materials and methods of construction used to protect through penetrations and membrane penetrations of smoke barriers. Figures 14 and 15 are examples of penetrations installed in CSM.

\(^2\) Atrium space is permitted to have openings in accordance with Section NFPA 101-2015, Section 8.6.1.
As indicated in NFPA 101-2015, Section 8.5.7.4; Smoke barriers that are also constructed as fire barriers must be protected with a joint system designed and tested to resist the spread of fire for a period of time equal to the required fire resistance rating of the assembly and restrict the transfer of smoke.
Fire Protection Analysis – Warren J. Baker Center for Science and Mathematics (CSM)

The design of the CSM considers an expansion joint intended to prevent the penetration of fire, and for this building, according to NFPA 101- 2015 Section 8.6.2, the openings through floors must be continuous from floor to floor, or floor to roof and enclosed with a 2-hour fire resistant barriers. Therefore, the expansion joint used in CSM must be proved to have a fire resistance rating not less than 2 hours, tested in accordance with UL 2079, Standard for Tests of Fire Resistance of Building Joint Systems per NFPA 101- 2015, Section 8.6.3(4).

4.3.5 Interior Finishes

As defined by NFPA 101 – 2015, Section 3.3.92.3 Interior Finish are the exposed surfaces of walls, ceilings, and floors within buildings. Interior finishes within the CSM building must comply with Section 803.5 of the CBC-2007 regarding to the flame spread required for walls and ceilings in exits, corridors, rooms and enclosed spaces, according to the group and location designated. Interior walls and ceiling finishes other than textiles, must be tested in accordance with NFPA 286 Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth. Flame spread and smoke development test requirements for Class A, Class B and Class C interior wall and ceiling finishes are shown in Table 10.

Table 10 – Flame Spread and Smoke Development per Classification

<table>
<thead>
<tr>
<th>Classification (Class)</th>
<th>Flame Spread</th>
<th>Smoke Development</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0-25</td>
<td>0-450</td>
<td>No continued propagation of fire in any element thereof when tested</td>
</tr>
<tr>
<td>B</td>
<td>26-70</td>
<td>0-450</td>
<td>-</td>
</tr>
<tr>
<td>C</td>
<td>76-200</td>
<td>0-450</td>
<td>-</td>
</tr>
</tbody>
</table>

Ref. NFPA 101-2015, Section 10.2.3.4

Table 11 shows the flame spread classifications required for interior finishes in the CSM, according the specifications stated on Section 803.5 of the CBC-2007 and the occupancies groups and location designated. Because the building is fully sprinklered, Class A materials are not required for exits, corridors, rooms and enclosed spaces.
The CSM building meets or exceeds all the code requirements for a Type 1-B construction. The walls are rated per code and the 1-hour rated separation between different occupancies are meet. The center open atrium area is separated from the East and West wings with 2-hour rated walls. Figure 13 shows two rated doors in the exit corridors leading the East and West wings. If these doors were relocated to align with the atrium wall instead of being offset as designed and constructed, it would eliminate these areas that trap smoke in the event of a fire. It also allows Stair 3 to egress into the corridor instead of the atrium area. This is an area of concern for the tenable condition of visibility described later in this report. The Fire Suppression System is an integral part of the fire life safety system designed into the CSM building.
4.4 Fire Suppression Systems

The fire sprinkler system for the CSM building has a network of piping designed in accordance with fire protection engineering drawing and specifications that includes a water supply source, control valves, fire pump, water-flow alarm, and test-n-drains. Fire sprinkler systems are commonly activated by heat from a fire, discharging water over the fire area. The definitions, design criteria, and requirements for these systems are stated in NFPA 13 - Standard for the Installation of Sprinkler Systems. The original Fire suppression building plans from Aero Automatic Sprinkler Company (AASC) will be included at the end this report in Appendix C. I actual worked on these plans for over a year and half while working for AASC. The plans I prepared for the CSM building included several unique challenges that I will go over throughout this section of the report. I also was tasked with creating a 3D NAVISWORKS model for coordination with all other trades. This 3D model included everything from sprinkler piping to hangers for the entire project. I got the opportunity to present this 3D model to the California State Fire Marshal (CSFM) at his office in Sacramento, California. This really help him in the plan review process and we obtained “Approvals and Permits” much quicker.

4.4.1 Water Supply

The CSM building fire suppression systems are supplied from the Cal Poly underground water distribution system.
NFPA 13 and CSFM require a flow test be performed for each water supply to a building. The flow test is used to determine if sufficient flow and pressure is available for the water-based fire protection systems. It is also used to determine how much flow is available for firefighting purposes in and around the building, usually the flow available at 20 psi.
A flow test was performed by Fluid Resource Management on August 19, 2011. In Figure 16, we show a partial Site Plan that indicates which fire hydrants were used in performing the fire hydrant flow test. It also indicates the flow available at 20 psi (2270 gpm). In Figure 17, we have the fire hydrant flow test results including a reduction of 10% for values used in our hydraulic calculations.
From the point of connection into the building, the water supply underground piping is 8” PVC (C900) with an 8” Wilkins Model 350ADA Double Check Detector Assembly included. (See attached manufacturer data sheet in Appendix C)
Figure 16 – Partial Site Plan for Fire Hydrant Flow Test

<table>
<thead>
<tr>
<th>FLOW TEST SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATIC PSI</td>
</tr>
<tr>
<td>RESIDUAL PSI</td>
</tr>
<tr>
<td>PITOT PSI</td>
</tr>
<tr>
<td>ORIFICE DIAMETER</td>
</tr>
<tr>
<td>COEFFICIENT OF DISCHARGE</td>
</tr>
<tr>
<td>GPM</td>
</tr>
</tbody>
</table>

DATE: 8-19-2011
LOCATION: N. POLY VIEW DRIVE
BY WHO: FLUID RESOURCE MANAGEMENT, INC.

<table>
<thead>
<tr>
<th>ADJUSTED FLOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% REDUCTION</td>
</tr>
<tr>
<td>STATIC PSI</td>
</tr>
<tr>
<td>RESIDUAL PSI</td>
</tr>
<tr>
<td>GPM</td>
</tr>
</tbody>
</table>

Figure 17 – Fire Hydrant Flow Test Results

Cal Poly SLO, FPE 596 – Culminating Project
4.4.2 Hazard Classification

The CSM building is classified as multiple occupancy by LSC Sections 6.1.14.2.1 & 6.1.14.2.2. LSC Section 6.1.14.3.2 requires us to use the most restrictive requirements involved for occupancies. The Assembly class rooms on level one and the terraces on levels 3, 4, 5 and 6 would be classified as Group A-3 by IBC Section 303.4. The majority of the CSM building is classified as Group B except for level 1 described above. There are also storage rooms (Group S), mechanical rooms (Group S-1) and electrical rooms (Group S-2) located throughout the building at different levels. The second level has two small 721 and 261 square foot separate rooms with an H-3 occupancy within 1-hour rated construction, because of the small area and in a rated enclosed rooms this was not considered as one of the remote areas. Also, these H-3 rooms are located on the second floor so the elevation pressure required is approximately 32 psi (74.5 ft) less than the sixth floor.

These above classifications translate to NFPA 13 as mainly classrooms, laboratories (Class C), offices, and storage. Looking these occupancies up in NFPA 13 and the Appendix we have mainly Light and Ordinary Hazard Group 1 (Table 12).

<table>
<thead>
<tr>
<th>Description</th>
<th>Hazard Classification</th>
<th>NFPA 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classrooms, auditoriums, corridors, offices, conference rooms</td>
<td>Light Hazard</td>
<td>5.2</td>
</tr>
<tr>
<td>Laboratories, storage, mechanical, electrical</td>
<td>Ordinary Hazard Group 1</td>
<td>5.3.1</td>
</tr>
</tbody>
</table>
**4.4.3 Fire Sprinkler Design Criteria**

Design densities and areas of sprinkler operation for the different hazard classifications are determined from NFPA 13 Figure 11.2.3.1.1. This is included in Figure 18 below.

![Figure 18 – NFPA 13 – Density and Area of Operation Curves](image)

Sprinkler maximum spacing areas for different hazards are determined from NFPA 13 Table 8.6.2.2.1. Hose stream allowances (HSA) are determined from NFPA 13 Table 11.2.3.1.2. A summary of the design criteria for the present occupancy hazards is shown in Table 13 below.

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Max Area (ft²)</th>
<th>Density (gpm/ft²)</th>
<th>Operation Area (ft²)</th>
<th>Inside HSA (gpm)</th>
<th>Combined HSA (gpm)</th>
<th>Duration (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>225</td>
<td>0.10</td>
<td>1500</td>
<td>0/100</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>OH Group 1</td>
<td>130</td>
<td>0.15</td>
<td>1500</td>
<td>0/100</td>
<td>250</td>
<td>60-90</td>
</tr>
</tbody>
</table>

Quick Response sprinkler heads are used throughout the CSM building. This allows us to reduce the remote area without revising the density per NFPA 13 Section 11.2.3.2.3.1 if we meet the four requirements (1) Wet pipe system, (2) Light or ordinary hazard occupancy, (3) 20 ft. max. ceiling height, (4) There are no unprotected ceiling pockets as allowed by 8.6.7 and 8.8.7 exceeding 32 ft². We meet these four requirements for most of our remote areas. This allows us to use the following equation:

\[ Y (\% \text{ reduction}) = -3(x)/2 + 55 \]

Most of our ceiling heights are 10’-6” (x) this yields a reduction in remote area of 39.25% or a minimum remote area of operation of 912 ft².

The main remote area that does not meet these conditions is in the open Atrium (1500 ft²).
4.4.4 Fire Pump

The electric driven in-line fire pump is located on level 1 in the Fire Pump Room. The in-line fire pump is a Peerless Model 6PVF10 supplied by an electric controller with emergency power by-pass. This fire pump is connected to the building's emergency generator because it is part of the atrium smoke control system. One of our limiting factors in our fire pump selection was the engineers only allowing for a 60 hp motor on the emergency generator. That is the main reason we had to stay with a 750 gpm fire pump. With this limiting factor, we had to get creative in our Standpipe Hydraulic Calculations. This was the most demanding part of the fire suppression system. The fire pump performance is given in Figure 19 below.

Figure 19 – NFPA 13 – Peerless Fire Pump Performance Data
The complete Peerless fire pump data sheet is included in Appendix C at the end of this report. The rated Horse Power for our fire pump is 58.1 hp.

4.4.5 Standpipe System

The standpipe system is designed to NFPA 14 requirements. The CSM building is equipped with Class I or Class III standpipes in all required egress stairs. Class I and Class III standpipes require a minimum pressure of 100 psi (Section 7.8.1) with 500 gpm (Section 7.10.1.1.1) flowing at the most remote standpipe outlets. An additional 250 gpm per standpipe is required up to 1000 gpm for a fully sprinklered building (Section 7.10.1.1.3), See Table 14 below.

<table>
<thead>
<tr>
<th>Pressure at most remote outlet</th>
<th>NFPA 14</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 psi</td>
<td>7.8.1</td>
</tr>
<tr>
<td>Flow at most remote outlet</td>
<td></td>
</tr>
<tr>
<td>500 gpm</td>
<td>7.10.1.1.1</td>
</tr>
<tr>
<td>Flow for each additional SP</td>
<td></td>
</tr>
<tr>
<td>250 gpm</td>
<td>7.10.1.1.3</td>
</tr>
<tr>
<td>Max Flow</td>
<td></td>
</tr>
<tr>
<td>1000 gpm</td>
<td>7.10.1.1.5 (fully sprinklered building)</td>
</tr>
<tr>
<td>Duration</td>
<td></td>
</tr>
<tr>
<td>30 minutes</td>
<td>9.2</td>
</tr>
</tbody>
</table>

Table 14 – Standpipe Requirements

Stairways 1, 4 & 5 have a Class I standpipe installed labeled the same as the stair numbers. Standpipe 4 has two outlets on the lower roof (Level 5) and Standpipe 1 is the most remote with two outlets on the high roof. Stairway 3 has a Class III Standpipe (Standpipe # 3) installed and is located in the center of the building. Standpipe # 3 serves the fire sprinkler system for Levels 2-6. The standpipe system is fed from the fire pump on Level 1. All four Standpipes are equipped with 2 ½” x 1 ½” reducers with a 1 ½” cap and chain. The 6” and 4” interconnecting piping for the standpipe system is routed above the first and second level ceilings and connected to each standpipe with an isolation control valve (tampered butterfly valve) located at the lowest interconnection level. The standpipe interconnection is also fed by a 4-way FDC located near the loading dock area on Level 2 on the front of the CSM building. Standpipe # 4 & 5 have 2 ½” pressure reducing valves located at Level 1 only due to a pressure over 175 psi at the valves. See Figures 20 and 21 for building standpipe locations and standpipe isometric.
Figure 20 - Building Standpipe Locations

Figure 21 - Standpipe Isometric
### 4.4.6 Fire Sprinkler System Components

**RISERS** – There are six fire sprinkler risers for the CSM building. The first level 3” riser is in the Fire Pump Room and is equipped with a pressure reducing valve (Elkhart Model URFA-205-2.5 with tamper switch) [Note: Pressure reducing valve also acts as check valve (Setting “E”) give us a 61-psi loss at 250 gpm and 70.1 psi loss at 328 gpm]. There are only three pressure reducing valves used on this fire suppression system. The other five risers are in Stairwell #3 and are connected to 6” Standpipe #3. The risers are located behind a fire rated access door. The risers are all 2 ½” with a tampered butterfly valve, 2 ½” check valve, 2 ½” riser manifold (TYCO Model 513) with Test-N-Drain and 175 psi relief valve. All metal signage and engraved hydraulic placards are attached to the risers.

**FEED MAINS, CROSS MAINS, and BRANCH LINES** – See Aero Automatic Sprinkler Company (AASC) plans at the end of this report in Appendix C for exact locations of fire sprinkler piping. The 4”/6” standpipe feed mains, 4”/6” standpipes, and 1”/1¼”/1½”/2” branch line piping is all black steel schedule 40. The 3” feed mains and cross mains on level 1 are black steel schedule 10 and the other five level have 2½” feed mains and cross mains with black steel schedule 10. Another unique challenge to this project is they want all trades to run down the center corridors on Levels 2-6 supported on a seismically designed system. This meant I had to run my main piping down low along with all the other trades and then pipe down to all the branch lines just above the 10’-6” ceilings. It was a coordination nightmare and all the branch lines are now trapped. These sprinkler systems don’t drain back to the riser. It also meant long hangers and branch line restraints. This did save on earthquake bracing the mains. I would have preferred to run the sprinkler system up high, tight to the structure, and provide my own earthquake bracing as I normally do.

**FIRE SPRINKLERS** – See AASC title blocks for Fire Sprinkler Legends that describe ever sprinkler head used at each level. All fire sprinklers in the building are quick response with a K factor of 5.6 and a temperature rating of 155 °F. Pendent sprinkler located in the quarter point of the ceiling tiles are used for areas with finished ceilings and Upright sprinkler heads are used for all other areas. A couple of Horizontal Sidewall sprinkler head were used in some special applications.

### 4.4.7 Hydraulic Calculations

**COMPUTER BASED HYDRAULIC CALCULATIONS** – The computer based hydraulic calculations performed by AASC used HydraCalc program. The hydraulic program is inter connected to the HydraCad program so the hydraulic information is taken off the 2D cad drawings and automatically transferred into the hydraulic calculation program. If you change a pipe size in the calculations, it changes those pipe sizes on the drawings. See Figure 22 below for a summary of the computer based hydraulic calculation results.
Figure 22 – Computer Hydraulic Calculation Results

See Figure 23 below for a summary of the standpipe computer based hydraulic calculations.

Cal Poly SLO, FPE 596 – Culminating Project
After looking at the computer based hydraulic calculation results, we see that the standpipe system is more demanding than our fire sprinkler systems. The standpipe calculations were used to size the fire pump, but another limiting factor was the 60 hp limitation from the emergency generator as discussed earlier.

**HAND HYDRAULIC CALCULATIONS** – Hand calculations were performed and compared to the computer based hydraulic calculations. I choose remote area 6-4 to be the most demanding remote area. Although this is a Light Hazard area due to the long branch line with eight sprinkler heads to one side of the cross main and must calculate 1500 ft² (can’t take the Quick Response reduction in remote area) and we have sprinkler heads spaced at 210 ft² (21.0 gpm) and being located on the highest floor (level 6) this is the most remote and demanding area. The other Lab areas on this floor get to use the area reduction (912 ft² min.) and with Ordinary Hazard Group I spaced at 130 ft² (19.5 gpm). These areas do require 150 gpm more hose flow so the demand may seem more, but the 150 gpm is added at the source (SRC) and not calculated through the sprinkler system. See Figure 24 below for most remote area.
The hand calculations were performed starting with the most remote sprinkler head being node S652. The area for this sprinkler head is 147 ft² (14.8 gpm, 7 psi min.). We used a K factor for all the pendent sprinkler heads of 5.6. This hand calculation was also unique in that when I solved for an equivalent K factor for each of the drops back to the branch lines the elevation pressure gained almost equaled the friction loss, therefore giving me an equivalent K factor of approximately 5.6. I calculated the system from the remote sprinkler head back to the base of riser at Standpipe # 3 (BOR6) then down 6” Standpipe # 3 to the fire pump (PO/PI) and out thru the 8” backflow preventer (BF1/BF2) to the 8” underground connection (SRC). Comparing these pressure and flow demands with the flow test values we see a safety factor of 13.57 psi with 447.3 gpm flowing. See Table 15 below for a comparison of the hand calculations to computer based calculations.
Table 15 – Comparison of Hand to Computer Hyd. Calc’s. for Most Remote Area 6-4

<table>
<thead>
<tr>
<th></th>
<th>Hand Calculation</th>
<th>Computer Based Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSI Req. at BOR6</td>
<td>130.51</td>
<td>116.86</td>
</tr>
<tr>
<td>GPM Req. at BOR6</td>
<td>359.3</td>
<td>347.3</td>
</tr>
<tr>
<td>PSI Req. at Source (SRC)</td>
<td>44.14</td>
<td>39.09</td>
</tr>
<tr>
<td>GPM Req. at Source (SRC)</td>
<td>459.3</td>
<td>447.3</td>
</tr>
<tr>
<td>PSI Available at Source (SRC)</td>
<td>52.66</td>
<td>52.66</td>
</tr>
<tr>
<td>PSI Safety Factor</td>
<td>8.52</td>
<td>13.57</td>
</tr>
</tbody>
</table>

There are some differences between the hand and computer based hydraulic calculations. The equivalent K factors that I used at every flowing sprinkler head were different from the computer-generated values. The computer is able to balance the nodes to 0.10 psi and figure a more accurate K factor value thru these iterations. This would explain most of the differences between the two hydraulic calculations. See hand calculation included in Appendix C at the end of this report.

In Figure 25 below, I included the two most demanding computer based hydraulic calculation graph results.
NFPA 25 “Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems” covers the requirements to keep fire sprinkler system in working order. Because fire sprinkler systems are not used often, they can sometimes sit for many years without operating. Therefore, it is extremely important to perform ITM on sprinkler systems at a minimum of NFPA 25 requirements. Table 16 shows the NFPA 25 requirement for ITM on fire sprinkler systems.
<table>
<thead>
<tr>
<th>Component</th>
<th>Inspection</th>
<th>Frequency</th>
<th>Testing</th>
<th>Frequency</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprinklers</td>
<td>Check for corrosion, loading, foreign materials, paint, physical damage, proper orientation, and obstructions. Replace any violations.</td>
<td>Annually</td>
<td>Sprinklers in service for 50 years shall be tested by a recognized testing lab. A sample of 1% but not less than 4 sprinklers shall be tested. If any fail, all sprinklers represented by sample must be replaced</td>
<td>10 years</td>
<td>Replacement sprinklers shall have the same characteristics as installed sprinklers and shall be new and listed</td>
</tr>
<tr>
<td>Spare Sprinklers</td>
<td>Proper number of sprinklers and a sprinkler wrench for each type of sprinkler</td>
<td>Annually</td>
<td></td>
<td></td>
<td>Cabinet must be located so not exposed to dust, corrosion, or 100 F.</td>
</tr>
<tr>
<td>Pipe and Fittings</td>
<td>In good condition, free of mechanical damage, leakage, corrosion, misalignment, and external loading.</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hangers and Braces</td>
<td>Not damaged or loose or else replaced or refastened</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gauges</td>
<td>Ensure good condition and that normal supply pressure is being maintained</td>
<td>Monthly</td>
<td>Replaced or tested by comparison with a calibrated gauge. Must be within 3% of full scale or replaced.</td>
<td>5 years</td>
<td></td>
</tr>
<tr>
<td>Alarm Devices</td>
<td>Free of physical damage</td>
<td>Quarterly</td>
<td>Done by opening inspector's test valve and recording time until alarm sounds</td>
<td>Quarterly</td>
<td></td>
</tr>
<tr>
<td>Hydraulic Nameplate</td>
<td>Attached securely to sprinkler riser and is legible</td>
<td>Quarterly</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 16 – NFPA 25 – ITM Requirements and Frequency

<table>
<thead>
<tr>
<th>Component</th>
<th>Inspection</th>
<th>Frequency</th>
<th>Testing</th>
<th>Frequency</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hose Connections</td>
<td>Hose, hose couplings, and nozzles connected to the sprinkler system shall be inspected</td>
<td>Annually</td>
<td>Tested 5 years after installation following NFPA 1962. After service test, each shall be flow tested to ensure water discharge and operation of water flow alarm</td>
<td>3 years</td>
<td>Clean and dry all hoses connected to sprinkler system after use. If exposed to hazardous materials, dispose or decontaminate.</td>
</tr>
<tr>
<td>Control Valves</td>
<td>Ensure in normal open or closed position, sealed or locked, accessible, provided with appropriate wrenches, free from leaks, and has proper identification</td>
<td>Weekly</td>
<td>Operated through full range and returned to normal position. Post indicator valves shall be opened until torsion felt, then backed a quarter turn from open position</td>
<td>Annually</td>
<td>Operating stems shall be lubricated annually then completely closed and reopened.</td>
</tr>
<tr>
<td>Check Valves</td>
<td>Inspected internally to verify all components operate properly, move freely, and are in good condition</td>
<td>5 years</td>
<td></td>
<td></td>
<td>Internal components shall be cleaned, repaired or replaced as necessary</td>
</tr>
<tr>
<td>Fire Department Connections</td>
<td>Verify FDC is visible and accessible, no damage, caps and gaskets are in place, ID signs are in place, check valve no leaking and drain valve is operating</td>
<td>Quarterly</td>
<td></td>
<td></td>
<td>Components shall be repaired or replaced as necessary. Any obstructions present shall be removed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Annually</td>
<td>Exercise isolating switch and circuit breaker</td>
</tr>
</tbody>
</table>
### Table 16 – NFPA 25 – ITM Requirements and Frequency

<table>
<thead>
<tr>
<th>Component</th>
<th>Inspection</th>
<th>Frequency</th>
<th>Testing</th>
<th>Frequency</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backflow Preventer</td>
<td>Backflow Assembly</td>
<td>Weekly</td>
<td>Backflow prevention test</td>
<td>Annually</td>
<td>Exercise OS&amp;Y valves. Check detector assembly.</td>
</tr>
</tbody>
</table>

The Fire Suppression System meets or exceeds all code and local AHJ requirements. The fire pump, sprinkler and standpipe systems will provide the proper design density for the hazard within the CSM building, even the small H-3 occupancy on Level 2. The fire pump is on emergency backup power because it is part of the atrium smoke control system per CBC Section 404.7. The Fire Suppression System is tied into the Fire Alarm System via flow and tamper switches which will be addressed in the next section.

#### 4.5 Fire Alarm Systems

The building contains a Class B, addressable manual fire alarm system. NFPA 72 Section 12.3.2 describes a Class B pathways as follows:

1. Does not include a redundant path.
2. Operational capability stops at a single open.
3. Conditions that affect the intended operation of the path are annunciated as a trouble.
4. Operational capabilities are maintained in the application of a single ground fault.
5. A single ground condition shall result in the annunciation of a trouble signal.

NFPA 72 Section 3.3.8 describes an addressable device is one with discrete identification that can have its status individually identified or that is used to individually control other functions. With an addressable system, the name, location, and type of alarm are annunciated at the control panel to assist firefighters upon arrival to a fire situation, or troubleshoot system problems.

The CSM building is fully sprinklered so a complete automatic fire alarm system is not required per CBC-2007 Section 907.2; therefore, the manual system was installed with partial areas covered for alarm detections. Heat detectors are not required because the fire sprinklers are used as heat detectors, to give occupants the ability to initiate the fire alarm system manual pull station are installed at each exit from the building. NFPA 72 Chapters 17 & 21 requires detection in the following areas:

- Fire Fighter’s Service Elevator Recall – Section 21.3.5 requires a smoke detector within 21 feet of the center line of each elevator door.
• Door Releasing Service – Section 17.7.5.6.5.1 (c) requires smoke detectors on both sides door releasing service when the height above the door to the ceiling is greater than 24 inches on both sides of the door.
• Elevator Shutdown – Section 21.4.1 & 21.4.2 requires heat detectors be used to shut down elevator power prior to sprinkler operation must be located within 2 feet of each sprinkler head and have a lower temperature rating and a higher RTI compared to the sprinkler.

The CSM building has an open atrium between the second through sixth level located in the center of the building. There is a natural ventilating smoke exhaust system installed. The smoke exhaust system can be activated by the beam detectors installed throughout the atrium or by the firefighter’s smoke control panel. The “As-Built” Fire Alarm Plans are included in Appendix D at the end of this report to show location of all the devices in the Emergency Voice/Alarm Communication System (EVACS)(speakers, speaker/strobes, smoke detectors, manual pull station, Fire Alarm Control Panel (FACP), etc.). Catalog cut sheets are also included in Appendix D at the end of this report for the devices used in the fire alarm system as well as the “Fire Alarm and Emergency Communication System Record of Completion”.

4.5.1 Fire Alarm Control Panel (FACP)

The FACP is located on the first floor “Main Electrical / Transformer Room” (122). There is only 1 FACP and it is a Honeywell Notifier Model NFS-640 (CAB-4 Series). There is also a firefighter smoke control panel to allow the firefighters to exhaust smoke from the atrium. The amplifier (AMP), a Notifier Model DAA2, is located here to provide power to the speakers. The FACP is setup to follow the sequence of operations matrix shown in Figure 28.

- Alarm Signals:
  These signals will activate the alarm system throughout the entire building.
  - Manual pull station activation
  - Spot smoke detector activation
  - Duct smoke detector activation
  - Sprinkler water flow activation
  - Fire pump running
  - Atrium smoke control system alarm
  - Beam smoke detector activation

- Supervisory Signals:
  These signals will result in a supervisory signal at the fire alarm control panel.
  - Sprinkler tamper switch
  - Fire pump loss of phase
  - Fire pump phase reversal
  - Shunt trip power supervision
• Trouble Signals:
These signals will result in a trouble signal at the fire alarm control panel.
  • Panel trouble condition
  • AC power failure
  • Low battery
  • Open circuit
  • Ground fault

See Figure 26 for location of FACP.

Figure 26 – Fire Alarm Control Panel – FACP (Located in Room 122 on First Level)

4.5.2 Initiating Devices

Different types of initiating devices located throughout the building are listed below.

• Manual Pull Stations - Notifier Model NBG-12LX
  There are 31 manual pull stations, one located near all building exits. NFPA 72 Section 17.14.8.4 requires a manual pull station shall be located with 5 feet of each exit doorway.
Spot Type Smoke Detectors – Notifier Model FSP-851
The building does not require smoke detector because of the fully sprinklered building, but there are 18 photoelectric smoke detectors located in certain areas such as electrical rooms, elevator lobbies, and at magnetically held doors at the lobby perimeter. The smoke detectors are spaced in accordance with NFPA 72 Section 17.3.2.3.1 (1) or (2).
1) The distance between smoke detectors shall not exceed a nominal spacing of 30 feet and there shall be detectors within a distance of one half the nominal spacing, measured at right angles from all walls or partitions extending upward to within the top 15 percent of the ceiling height.
2) All points on the ceiling shall have a detector within a distance equal to or less than 0.7 times the nominal 30 foot spacing.

Duct Detectors – System Sensor Model DNRECL
There are 64 photoelectric duct detectors located in accordance with NFPA 72 Section 17.7.5.5. Activation of the duct detector shuts down the associated air handling unit and closes associated fire/smoke dampers to preserve the enclosure fire rating.

Beam Detectors – OSID
There are 38 beam detector imagers and receivers located in the atrium. The beam detectors are located on each floor of the atrium from the second to the fifth floor and are installed per NFPA 72 Section 17.7.3.3, Projected Beam-Type Smoke Detectors. The beam detectors are used to activate the atrium smoke control system.

Fire Sprinklers – Tyco Model FRB
The building is fully sprinklered with quick response (RTI=50) sprinkler heads with an activation temperature of 155 deg. F (68 °C). The fire sprinkler system is designed with a riser located at every floor, each riser has a water flow switch that when activated will cause the fire alarm system to go into alarm. See Figure 27 for Atrium Smoke Beam Detection and Figure 28 for Sequence of Operations (Atrium Detection & Activation).
Figure 27 - Atrium Smoke Beam Detection
The CSM building has a passive naturally ventilated smoke management system for the five-story atrium in the center of the building. The atrium is fully sprinkled and has a fully functioning smoke detection system. In the event of a fire within the atrium and detection by a smoke detector, beam detector, or sprinkler activation the smoke management system will activate. In activation of the smoke management system the alarm will sound, the police will be notified, and magnetic door locks for the horizontal exits present in the atrium will deactivate. The doors will shut to keep smoke and hot gases from entering other parts of the building. 

**4.5.3 Atrium Smoke Management System**

Note: Second Floor Flow Switch Covers Entire Floor. Not just the Atrium.
building. There will also be activation of the smoke vents and makeup air vents to help exhaust the smoke. The exhaust vents are located on the roof of the building and the makeup air vents are the exit doors located on the second floor of the building. The roof has two 5 ft. by 10 ft. smoke exhaust vents in both open areas (Total of Four). The makeup air vents which both on the north and south side of the building are four 3 ft. by 12 ft. doors that have motors to automatically open in the event of a fire. These motorized exit doors are activated by the fire alarm system that will open the doors automatically and remain open to supply the makeup air required for the smoke exhaust within the atrium. The matrix above in Figure 28 above shows other systems that shut down in the event of an alarm within the atrium such as HVAC units shut down and elevator recall.

4.5.4 Notification Devices

The two types of notification devices located throughout the building are Visual and Audible they are list below.

- **Visual Notification Device** – Notifier Models SW (Indoor-Strobe Only) SPWS (Indoor-Speaker/Strobe)
  
  There are 165 Speaker/Strobes and 73 Strobes located throughout the building. The strobes are only located in smaller rooms, like bathrooms. Per NFPA 72 Section 18.5.5, all wall mounted devices must be not less than 80 inches and not greater than 96 inches above the finished floor. The spacing for wall mounted devices must follow NFPA 72 Table 18.5.5.4.1 (a) and Table 18.5.5.4.1 (b) for ceiling mounted devices. For example, Room 335 – Teaching Lab, one of the larger rooms (25 feet by 41 feet), contains one wall mount Speaker/Strobe with 135 cd. From NFPA 72 Table 18.5.5.4.1 (a), one devise in a room with 135 cd can have a spacing of 60 feet by 60 feet maximum. This encompasses the entire space as required by NFPA 72 Section 18.5.5.4.5.

  The corridor spacing must meet NFPA Section 183.5.5.5. For corridors under 20 feet wide, visible notification device must be 15 feet from end of corridor and not great than 100 feet between devices. Looking at the corridors on the plans, the farthest distance between devices is 85 feet.

- **Audible Notification Device** – Notifier Models SPW (Indoor-Speaker Only) SPWS (Indoor-Speaker/Strobe) System Sensor Model SPWK (Outdoor-Speaker Only)
  
  There is 1 exterior bell located on the outside wall of the Fire Pump Room (121). There are 165 Speaker/Strobes, 6 speakers only, 7 speakers only (outside) located throughout the building. Audio only devices are installed in unoccupied areas, such as Mechanical Rooms. Per NFPA 72 Section 18.5.5, all wall mounted devices must be not less than 80 inches and not greater than 96 inches above the finished floor. Audible devices shall meet or exceed NFPA 72 Section 18.4.3.1, which states that the sound level should be 15 dBA above ambient noise level or 5 dBA above the maximum sound level having a duration of at least 60 seconds, whichever is greater, measured at 5 feet above the floor. Without actually measuring the sound levels between classes (Table A 18.4.3 - average ambient sound level for an educational occupancy is 45 dBA) I would use average ambient sound level for a business occupancy is 55 dBA, this gives
us a total sound level of 70 dBA's. The speakers have adjustable sound levels from 76 to 86 dBA's at 10 feet.

In looking at the As-Built Plans, all the Initiating and Notification device locations and spacing meet or exceed NFPA 72 requirements.

### 4.5.5 Power Supply

The main requirements for Secondary Power Supply, according to NFPA 72-2016 are summarized below:

- **Primary Power Supply**
  - NFPA 72 Section 10.6.5.1.1 states that the branch circuit supplying the fire alarm equipment or emergency communication systems shall be supplied by one of the following:
    - (1) Electric utility
    - (2) An engine-driven generator or equivalent in accordance with 10.6.11.2, where a person trained in its operation is on duty at all times
    - (3) An engine-driven generator or equivalent arranged for cogeneration with an electric utility in accordance with 10.6.11.2, where a person trained in its operation is on duty at all times

- **Secondary Power Supply**
  - NFPA 72 Section 10.6.7.1.1 Operation on secondary power shall not affect the required performance of a system or supervising station facility, including alarm, supervisory, and trouble signals and indications.

- NFPA 72 Section 10.6.7.2.1.2 states the secondary power supply for emergency voice/alarm communications service shall be capable of operating the system under quiescent load for a minimum of 24 hours and then shall be capable of operating the system during a fire or other emergency condition for a period of 15 minutes at maximum connected load.

Battery supplies are installed in the CSM at the following equipment:

- Fire Alarm Control Panel (FACP)
- Remote Notification Power Supply (RNPS): 3-5th Floor East
- RNPS1: 2nd Floor East
- RNPS2: 3rd and 4th Floor East
- RNPS3: 5th Floor East
- RNPS4: 6th Floor East
- RNPS5: 4th Floor West
The secondary power supply calculations are shown on the As-Built Fire Alarm drawings (FA 4.0) included in Appendix D at the end of this report.

An example of the Battery Calculation is shown below in Table 17:

First Floor Table illustrates calculations details for the Fire Alarm Control Panel (FACP) with the Standby and Alarm Current per unit, according to the manufacturer and the quantities of devices supplied by design.

As stated above the required Standby Time is 24 hours operating under quiescent load, and 15 minutes (0.25 hour) operating under Alarm conditions at maximum connected load (EVACS) systems. (First Floor Table taken from As Built Fire Alarm Drawing FA 4.0)

### Table 17 – First Floor – Secondary Power Supply Calculations for FACP

<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 Capacity Per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACP</td>
<td>Fire Alarm Control Unit</td>
<td>0.2850</td>
<td>X 1</td>
<td>0.2850</td>
<td>0.2850</td>
<td>X 1</td>
<td>0.2850</td>
</tr>
<tr>
<td>UDACT</td>
<td>Universal Dialer</td>
<td>0.0400</td>
<td>X 1</td>
<td>0.0400</td>
<td>0.1600</td>
<td>X 1</td>
<td>0.1600</td>
</tr>
<tr>
<td>FDU-80</td>
<td>Remote Annunciator</td>
<td>0.0643</td>
<td>X 2</td>
<td>0.1286</td>
<td>0.0643</td>
<td>X 2</td>
<td>0.1286</td>
</tr>
<tr>
<td>APS-6</td>
<td>Power Supply Amp</td>
<td>0.0000</td>
<td>X 1</td>
<td>0.0000</td>
<td>0.0250</td>
<td>X 1</td>
<td>0.0250</td>
</tr>
<tr>
<td>OSE-SFM</td>
<td>Beam Smoke Emitter</td>
<td>0.0035</td>
<td>X 10</td>
<td>0.0350</td>
<td>0.0035</td>
<td>X 10</td>
<td>0.0350</td>
</tr>
<tr>
<td>OSI-90</td>
<td>Beam Smoke Image</td>
<td>0.0310</td>
<td>X 10</td>
<td>0.3100</td>
<td>0.0310</td>
<td>X 10</td>
<td>0.3100</td>
</tr>
<tr>
<td>PULL</td>
<td>Manual Pull (addressable)</td>
<td>0.0004</td>
<td>X 29</td>
<td>0.0016</td>
<td>0.0004</td>
<td>X 29</td>
<td>0.0016</td>
</tr>
<tr>
<td>FRM-1</td>
<td>Relay Module</td>
<td>0.0017</td>
<td>X 9</td>
<td>0.0153</td>
<td>0.0022</td>
<td>X 9</td>
<td>0.0198</td>
</tr>
<tr>
<td>FSP-851</td>
<td>Smoke Detector</td>
<td>0.0003</td>
<td>X 16</td>
<td>0.0048</td>
<td>0.0003</td>
<td>X 16</td>
<td>0.0048</td>
</tr>
<tr>
<td>FDM-1</td>
<td>Dual Monitor Module</td>
<td>0.0008</td>
<td>X 18</td>
<td>0.0144</td>
<td>0.0064</td>
<td>X 18</td>
<td>0.1152</td>
</tr>
<tr>
<td>SPK</td>
<td>Speaker Only</td>
<td>0.0000</td>
<td>X 3</td>
<td>0.0000</td>
<td>0.0008</td>
<td>X 3</td>
<td>0.0024</td>
</tr>
<tr>
<td>SR</td>
<td>Strobe Only 15CD</td>
<td>0.0000</td>
<td>X 7</td>
<td>0.0000</td>
<td>0.0660</td>
<td>X 7</td>
<td>0.4620</td>
</tr>
<tr>
<td>SR</td>
<td>Strobe Only 30CD</td>
<td>0.0000</td>
<td>X 6</td>
<td>0.0000</td>
<td>0.0940</td>
<td>X 6</td>
<td>0.5640</td>
</tr>
<tr>
<td>SR</td>
<td>Strobe Only 75CD</td>
<td>0.0000</td>
<td>X 2</td>
<td>0.0000</td>
<td>0.1580</td>
<td>X 2</td>
<td>0.3160</td>
</tr>
<tr>
<td>FTM-1</td>
<td>Fire Fighter Phone Jack</td>
<td>0.0075</td>
<td>X 12</td>
<td>0.0900</td>
<td>0.0075</td>
<td>X 12</td>
<td>0.0900</td>
</tr>
<tr>
<td>XPS-R</td>
<td>Six Relay Control Module</td>
<td>0.0015</td>
<td>X 1</td>
<td>0.0015</td>
<td>0.0320</td>
<td>X 1</td>
<td>0.0320</td>
</tr>
<tr>
<td>XPS-M</td>
<td>10-Input Monitor Module</td>
<td>0.0035</td>
<td>X 1</td>
<td>0.0035</td>
<td>0.0550</td>
<td>X 1</td>
<td>0.0550</td>
</tr>
<tr>
<td>SPSR</td>
<td>Speaker Strobe 15CD</td>
<td>0.0000</td>
<td>X 3</td>
<td>0.0000</td>
<td>0.0670</td>
<td>X 3</td>
<td>0.2130</td>
</tr>
<tr>
<td>SPSR</td>
<td>Speaker Strobe 30CD</td>
<td>0.0000</td>
<td>X 14</td>
<td>0.0000</td>
<td>0.0960</td>
<td>X 14</td>
<td>1.3440</td>
</tr>
<tr>
<td>SPSR</td>
<td>Speaker Strobe 75CD</td>
<td>0.0000</td>
<td>X 14</td>
<td>0.0000</td>
<td>0.1530</td>
<td>X 14</td>
<td>2.1420</td>
</tr>
<tr>
<td>SPSR</td>
<td>Speaker Strobe 155CD</td>
<td>0.0000</td>
<td>X 3</td>
<td>0.0000</td>
<td>0.0760</td>
<td>X 3</td>
<td>0.2680</td>
</tr>
<tr>
<td>FST-851</td>
<td>Heat Detector (addressable)</td>
<td>0.0004</td>
<td>X 4</td>
<td>0.0016</td>
<td>0.0004</td>
<td>X 4</td>
<td>0.0016</td>
</tr>
<tr>
<td>FMM-1</td>
<td>Monitor Module</td>
<td>0.0037</td>
<td>X 19</td>
<td>0.0703</td>
<td>0.0037</td>
<td>X 19</td>
<td>0.0703</td>
</tr>
<tr>
<td>FDM-1</td>
<td>Dual Relay/ Monitor Module</td>
<td>0.0013</td>
<td>X 64</td>
<td>0.0832</td>
<td>0.0240</td>
<td>X 64</td>
<td>1.5360</td>
</tr>
<tr>
<td>DSR</td>
<td>Duct Smoke Detectors</td>
<td>0.0003</td>
<td>X 64</td>
<td>0.0192</td>
<td>0.0003</td>
<td>X 64</td>
<td>0.0192</td>
</tr>
</tbody>
</table>

**TOTAL SYSTEM**
- Standby Current (AMPS): 1.1140
- Alarm Current (AMPS): 11.6905

**CALCULATIONS**
- **Required Standby Time (HRS):** 24
- **Total System Standby Current (AMPS):** 28.7348
- **Total Alarm Current (AMPS):** 11.6905
- **Adjusted Battery Capacity (AMPS):** 35.6

Ref. Deep Blue Integration, 2013
In this case, the adjusted battery capacity requirement for the FACP, including a 20% safety margin, is 35.6 Amp-Hour and the Fire Alarm installation drawings indicate the battery capacity installed is 55 Amp-hours (See Appendix D for Fire Alarm Drawings), so the system complies with the NFPA 72 requirements for secondary power supply.

4.5.6 Emergency Voice / Alarm Communication System (EVACS)

An Emergency Voice Alarm Communication System (EVACS) is installed throughout the CSM building. According to NFPA 72, a dedicated manual or automatic device is used for originating and distributing voice instructions, as well as alerts and evacuation signals pertaining to a fire emergency, to the occupants of this building. The system is designed to assist emergency response personnel in managing the movement of both building occupants and firefighters during a fire or other emergency.

The EVACS system installed in this building has a One-way Emergency Communication System with In-building fire emergency voice/alarm communications, as well as a Two-way Emergency Communication System (Telephone System). The telephone system is used to facilitate the exchange of information and the communication of instructions, primarily used by emergency services personnel.

As the signals from the EVACS are sent to the University Police Department's Communications Center, which is staffed 24 hours a day, 7 days a week with certified, professionally trained dispatchers (supervising station), this indicates that the building may be considered a Protected Premise. According to NFPA 72, Section 3.3.281.2, the fire alarm system of the CSM may be classified as a Proprietary Supervising Station Alarm System.

4.5.7 Fire Alarm - Inspection, Testing and Maintenance (ITM)

Inspection, Testing, and Maintenance is covered in NFPA 72 Chapter 14. The visual inspection requirements from Section 14.3 are indicated in Table 18 below. The fire alarm system testing from NFPA 72 Table 14.4.3.2 indicates the methods and frequencies for testing all equipment and devices. I included the CSM Building System Record of Completion in Appendix D at the end of this report. NFPA 72 Section 14.5 indicates the requirements for maintaining the fire alarm system in working order. Maintenance should be performed in accordance with manufactures instructions.
### Table 18 – NFPA 72 Chapter 14 – ITM Requirements and Frequency

<table>
<thead>
<tr>
<th>Component</th>
<th>Frequency</th>
<th>Method</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All equipment</strong></td>
<td>Annually</td>
<td>Ensure there are no changes that affect equipment performance. Inspect for building modifications, occupancy changes, changes in environmental conditions, device location, physical obstructions, device orientation, physical damage, and degree of cleanliness.</td>
<td>14.3.4</td>
</tr>
<tr>
<td><strong>Control Equipment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuses</td>
<td>Annually</td>
<td>Verify system normal condition</td>
<td></td>
</tr>
<tr>
<td>Interface equipment</td>
<td>Annually</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamps and LEDs</td>
<td>Annually</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary (main) power supply</td>
<td>Annually</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trouble signals</td>
<td>Semiannually</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Supervising station alarm systems - transmitters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital alarm communicator transmitter (DACT)</td>
<td>Annually</td>
<td>Verify location, physical condition, and a system normal condition</td>
<td></td>
</tr>
<tr>
<td><strong>In-building fire emergency voice / alarm communications equipment</strong></td>
<td>Semiannually</td>
<td>Verify location and condition</td>
<td></td>
</tr>
<tr>
<td><strong>Batteries</strong></td>
<td>Semiannually</td>
<td>Inspect for corrosion or leakage. Verify tightness of connections. Verify marking of the month/year of manufacture.</td>
<td>10.6.10</td>
</tr>
<tr>
<td>Sealed lead-acid (SLA)</td>
<td>Semiannually</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Remote annunciators</strong></td>
<td>Semiannually</td>
<td>Verify location and condition</td>
<td></td>
</tr>
<tr>
<td><strong>Notification appliance circuit power extenders</strong></td>
<td>Annually</td>
<td>Verify proper fuse ratings, if any. Verify that lamps and LEDs indicate normal operating status of the equipment.</td>
<td>10.6</td>
</tr>
<tr>
<td><strong>Initiating devices</strong></td>
<td>Semiannually</td>
<td>Verify detector is rigidly mounted. Confirm that no penetrations in a return air duct exists in the vicinity of the detector. Confirm the detector is installed so as to sample the airstream at the proper location in the duct.</td>
<td>17.7.5.5</td>
</tr>
<tr>
<td>Duct detectors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual fire alarm boxes</td>
<td>Semiannually</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoke detectors</td>
<td>Semiannually</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projected beam smoke detectors</td>
<td>Semiannually</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervisory signal devices</td>
<td>Semiannually</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waterflow devices</td>
<td>Quarterly</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 18 – NFPA 72 Chapter 14 – ITM Requirements and Frequency

<table>
<thead>
<tr>
<th>Component</th>
<th>Frequency</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notification appliances</td>
<td>Semiannually</td>
<td>Verify that the candela rating marking agrees with the approved drawings</td>
</tr>
<tr>
<td>Audible appliances</td>
<td>Semiannually</td>
<td></td>
</tr>
<tr>
<td>Visible appliances</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervising station alarm systems</td>
<td>Daily</td>
<td>Verify receipt of signal</td>
</tr>
<tr>
<td>- receivers</td>
<td>Annually</td>
<td>Verify location and normal condition</td>
</tr>
<tr>
<td>Signal receipt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receivers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Fire Alarm System designed and installed within the CSM building meets or exceeds all Code and AHJ requirements. This is an addressable system that can indicate location of any device that is connected to it. One major recommendation to decrease the time for the occupants to safely egress the building is to upgrade the existing EVAC’s (pre-recorded messages) system to a full communication system giving instructions to occupants to stay in place or which direction would be safer to travel for exiting the building in the event of an emergency. The Fire Safety Regulation and Management Plan that is in place for the CSM building is also an important plan to keep occupant’s safe.

4.6 Fire Safety Regulation and Management Plan

This plan is to make sure the CSM building complies with all the current state and local fire prevention and life safety programs.

4.6.1 Campus Safety Monitoring

The Administration & Finance Department includes Environmental Health and Safety, which functions as the monitoring body for Fire & Life Safety at Cal Poly. All alarms are monitored by a trained staff 24/7.

4.6.2 Plan Goals & Objectives

The goal of this plan is to provide an environment for the occupants that is reasonably safe from fire by the following means:
(1) Protection of occupants not intimate with the initial fire development
(2) Improvement of the survivability of occupant’s intimate with the initial fire development (NFPA 101, 2015, Section 4.1.1)

Life Safety Code has three objectives to obtain these goals Occupant Protection (Section 4.2.1), Structural Integrity (Section 4.2.2) and System Effectiveness (Section 4.2.3), (NFPA 101, 2015, Section 4.2).

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Life safety Code gives us two methods that will achieve these objectives: Prescriptive-Based Option (NFPA 101, 2015, Section 4.4.2), or Performance-Based Option, (NFPA 101, 2015, Section 4.4.3).

**Prescriptive-Based Option** – (NFPA 101, 2015, Section 4.4.2)

- A prescriptive-based life safety design shall be in accordance with Chapters 1 through 4, Chapters 6 through 11, Chapter 43, and the applicable occupancy chapter, Chapters 12 through 42. (Section 4.4.2.1)

- Prescriptive-based designs meeting the requirements of Chapters 1 through 3, Sections 4.5 through 4.8, and Chapters 6 through 43 of this Code shall be deemed to satisfy the provisions of Sections 4.1 and 4.2. (Section 4.4.2.2)

- Where a requirement of this Code conflicts with another requirement of this Code, the following shall apply:
  1. Where a specific requirement contained in Chapters 11 through 43 conflicts with a general requirement contained in Chapters 1 through 4 and Chapters 6 through 10, the requirement of Chapters 11 through 43 shall govern.
  2. Where a requirement contained in Chapters 1 through 4 and Chapters 6 through 10 conflicts with another requirement contained in Chapters 1 through 4 and Chapters 6 through 10, the more specific requirement shall govern.
  3. Where a requirement contained in Chapters 11 through 43 conflicts with another requirement contained in Chapters 11 through 43, the more specific requirement shall govern. (Section 4.4.2.3)

**Performance-Based Option** – (NFPA 101, 2015, Section 4.4.3)

- A performance-based life safety design shall be in accordance with Chapters 1 through 5.

**4.6.3 Code Requirement**


**4.6.4 Fire Drill & Emergency Evacuation Plan**

IFC Section 404 indicates that all Group B buildings with an occupant load of 500 or more or more than 100 persons above or below the lowest level of exit discharge shall have fire drills. Employees and supervisory personnel shall be periodically instructed in accordance with Section 4.7 and shall hold drills periodically when practicable. (NFPA 101, 2015, Section 38.7.2 and Section 4.7)
4.6.5 Fire Drill

All building occupants need to participate in the drill procedures to establish conduct of the drill as a matter of routine, emergency evacuation and relocation drills shall be conducted at least annually for Group B occupancy (IFC Table 405.2). Drills shall be designed in cooperation with the local authorities and carried out by competent persons designated to exercise leadership (IFC Section 405.3). When conducting drills, emphasis shall be placed on orderly evacuation rather than on speed. Drills shall be held at expected and unexpected times and under varying conditions to simulate the unusual conditions that can occur in case of fire (IFC Section 405.4). Drill participants shall relocate to a predetermined location as shown previously on Figure 1 and remain at such location until dismissal is given. Records shall be maintained of required emergency evacuation drills and include the following information (IFC Section 405.5):

1. Identity of the person conducting the drill
2. Date and time of the drill
3. Notification method used
4. Staff members on duty and participating
5. Number of occupants evacuated
6. Special conditions simulated
7. Problems encountered
8. Weather conditions when occupants were evacuated
9. Time required to accomplish complete evacuation

4.6.6 Emergency Evacuation Plan

Cal Poly’s Environmental Health and Safety Department regulates a procedure for Fire Drill & Building Evacuation. This procedure ensures the orderly and complete evacuation of all campus buildings in the event of an emergency and/or the activation of alarm system. The Emergency Evacuation Plan stated below is the master plan for the Cal Poly campus and uses the guidance of Cal Poly’s Environmental Health & Safety Fire Drill & Building Evacuation Procedure in combination with Annex A, NFPA 101 Section A 4.8.2.1 and Chapter 4 of the California Fire Code (CFC).

Purpose

This procedure has been prepared to ensure the orderly and complete evacuation of campus buildings in the event of an emergency and/or the activation of alarm system.

The primary objectives of this evacuation plan are to ensure:
1. everyone leaves the building safely;
2. a procedure is in place to safely evacuate individuals who cannot negotiate stairs;
3. building occupants are accounted for after an emergency evacuation (See Figure 1)
4. personnel (Building Coordinators) are selected from among building occupants,
   with functions to ensure plan objectives are met.

Policy

The following are emergencies for which a total or partial evacuation of a building may
become necessary:
   a. Fire.
   b. Explosion.
   c. Bomb threats.
   d. Release of hazardous chemical substance, in quantities or toxicity, which threatens
      human life.
   e. Building air contamination.
   f. Weather related emergencies (flood, severe storm, severe wind).
   g. Earthquake. An earthquake alone is not necessarily a reason to evacuate.
      Evacuation is indicated if the earthquake causes apparent structural damage or
      creates a secondary hazard such as flooding, hazardous materials release, exposed
      electrical conductors, etc...

Evacuation Process

1. At the sound of the Emergency Alarm, it is the responsibility of all building
   occupants to evacuate immediately and proceed to the area shown in Figure 1 or
   remain in an area of refuge within the building. An area of refuge for occupants on
   Levels 2-6 is in Stairway #3, within the atrium in the middle of the building.
2. The voice evacuation system can provide specific instructions for evacuation of the
   CSM building. Specific areas could be evacuated in certain emergencies to help
   occupants better egress the building faster.
3. Building occupants are also responsible for ensuring that their visitors follow the
   evacuation procedures described herein, and leave the building along with all other
   occupants.
4. Faculty members are responsible for dismissing their classes and directing students
   to leave the building by the nearest building exit or area of refuge upon hearing the
   building alarm or upon being notified of an emergency.
5. Designated essential personnel needed to continue or shut down critical
   operations, while an evacuation is underway, are responsible for recognizing and
   determining when to abandon the operation and evacuate themselves safely.
6. Contract workers will be made familiar with the procedures outlined herein, and are expected to leave the building when the alarm sounds.

Evacuation Instructions

Whenever you hear the Emergency Alarm (Fire Alarm) or are informed of a general building emergency:

1. Remain calm at all times.
2. Do not ignore alarm.
3. Leave the building or relocate to an area of refuge immediately, in an orderly fashion, following directions given during announcement. A partial evacuation announcement may occur to better manage the evacuation process.
4. Exit the building utilizing stairways, not elevators.
5. Dismiss classes in session and instruct students to exit the building or relocate to an area of refuge immediately.
6. Follow quickest evacuation route from where you are (see posted floor evacuation diagram/map near exit doors).
7. Do not go back to your office or classroom for any reason.
8. Proceed to emergency assembly point, lawn area across Poly View Drive near main entrance (See Figure 1).
9. Report to a Building Coordinator if you have any knowledge of missing persons or specific building conditions which might be helpful to responders.
10. Return to the building only after emergency personnel have given the all-clear signal. Silencing the alarm does not mean the emergency is over.

Emergency Evacuation Personnel

1. For the purpose of this plan, Building Coordinators and their alternates are regular employees, who have been selected and trained to ensure building evacuation is carried out as planned, evacuated building occupants are directed to assigned assembly points (see Figure 1) where they are accounted for, and persons needing assistance to evacuate are accommodated.
2. Building Coordinators and their alternates shall be selected among building occupants, and on a voluntary basis.
3. The following is a list of Building Emergency Evacuation personnel and their corresponding duties:

   - Building Coordinators:
     - Maintain a current list of all occupants including part time and student employees in their immediate work area.
• Ensure that all employees in immediate work area are familiar with the emergency evacuation plan for their work area and for the building.
• Assist and encourage work area occupants to leave the building or relocate to an area of refuge in cases where there may be an alternative form of emergency notification, other than the sound of building fire alarms.
• Inform occupants of their duty to immediately report to their designated assembly point (see Figure 1).
• Assist occupants with limited mobility, down stairs if able to negotiate stairways.
• Never put yourself in danger. Leave the building or relocate to an area of refuge as soon as possible and go directly to your assigned assembly area (see Figure 1).
• Check off co-workers who safely reported to assembly area from occupant list.
• Collect information on missing personnel known, or suspected to still be in the building, and report to responding University Police representatives.
• Complete Building Assessment Form, if applicable.

• University Police / SLO City Fire:
  • Collect information on building occupants known or suspected to still be in the building from the Building Coordinators.
  • Meet off-campus emergency responders (fire, medical, etc.) and assist with directions to the building/area as needed.
  • Report information on occupants needing assistance to evacuate and other personnel suspected to still be in the building to fire and rescue response personnel.
  • Assist with securing the building/area and preventing re-entry.

4.6.7 Employee Training and Response Procedures

Employee training and response procedure follows the guidance of the IFC Section 406.3 and California Fire Code, Section 404 and 408.2.

Cal Poly employees who will be using the CSM Building shall be trained in the fire emergency procedures described in IFC and CFC. Employees shall receive training in the contents of fire prevention, evacuation, emergency lockdown and fire safety. Evacuation plans and their duties as part of new employee orientation and at least annually thereafter. Records shall be kept and made available to the fire code official upon request.
• Fire prevention training: Employees shall be apprised of the fire hazards of the materials and processes to which they are exposed. Each employee shall be instructed in the proper procedures for preventing fires in the conduct of their assigned duties (IFC Section 406.3.1).

• Evacuation training: Employees shall be familiarized with the fire alarm and evacuation signals, their assigned duties in the event of an alarm or emergency, evacuation routes, areas of refuge, exterior assembly areas and procedures for evacuation (IFC Section 406.3.2).

• Emergency lockdown training: Where a facility has a lockdown plan, employees shall be trained on their assigned duties and procedures in the event of an emergency lockdown (IFC Section 406.3.3).

• Fire Safety training: Employees assigned fire-fighting duties shall be trained to know the locations and proper use of portable fire extinguishers or other manual fire-fighting equipment and the protective clothing or equipment required for its safe and proper use (IFC Section 406.3.4).

Assembly Occupancies located on Level 1 shall have an occupant load limit posted.

4.6.8 Testing and Maintenance

The Maintenance Department at Cal Poly and SLO City Fire Department implement maintenance, testing and inspection procedures to support the operational reliability of fire and life safety systems and reduce the occurrence of false alarms. Inspection, Testing and Maintenance (ITM) is done in accordance with current NFPA standards on the following systems at code compliant intervals:

• Automatic fire extinguishing systems (including fire pump)
• Fire detection and alarm systems
• Portable fire extinguishers
• Building systems, including:
  o Fire/smoke doors
  o Fire/smoke dampers
  o Exit lighting
  o Emergency lighting
  o Standpipe systems
4.6.9 Corresponding Policies

- Campus Building Evacuation Procedure
- Campus Hot Work Program
- Code of Safety Practice – Monthly Inspection of Fire Extinguishers
- Protect Your Lungs from Wildfire Smoke
- Requirements for Bulletin Boards in Corridors
- 3 Most Common Fire Safety Hazards Across Campus (poster)
- Campus Annual Fire Safety Report (for calendar years 2009 thru 2014)

The policies above can be retrieved online at: [http://www.afd.calpoly.edu/ehs/firesafety.asp](http://www.afd.calpoly.edu/ehs/firesafety.asp)

The Fire Safety Regulation and Management Plan for the CSM building indicates how important the safety of every person is on our Cal Poly Campus. Having periodic drill and testing keeps everyone more familiar in what to do in the case of an emergency. This concludes the Prescriptive portion of this report. It was nice to see that the CSM building has been designed and constructed to meet or exceed all Code and AHJ requirements. The next portion of this report will go into details of the Performance Base Analysis.

5.0 Performance Based Analysis

NFPA 101-2015 – Section 5.2.2 defines the performance based goal as “Any occupant who is not intimate with ignition shall not be exposed to instantaneous or cumulative untenable conditions”. The performance based analysis will be looking at two design fire scenarios as described below. The HRR values from the design fire scenarios will be used in PyroSim to analyze ASET values for tenable conditions. The RSET values will be obtained from Pathfinder model along with detection and pre-movement time. See Figure 29 below for Pass / Fail – ASET vs RSET.

![Figure 29 - Pass / Fail – ASET vs RSET](image-url)
5.1 Design Fire Scenarios

Choosing the correct design fire is the first and most important step toward analyzing any effect of a fire on a building. The process to develop my scenarios is outlined below:

- **Qualitative Hazard Analysis.** The peak fire growth rate or maximum heat release rate and duration of a fire within a given space is dependent upon the type, quantity and configuration of the materials within the space. Potential fuel sources and potential ignition sources were reviewed based upon representative materials and equipment within various areas. Fuel sources were chosen based upon the potential for a developing fire to cause conditions where occupants or the structure may be threatened.

- **Heat Release Rate Curves.** The fire scenarios were quantified by assuming a fast $t^2$ fire. This assumption is a reasonable estimate for the types of hazards that are likely in the building.

- **Maximum Heat Release Rate.** The maximum heat release rate was estimated by determining the maximum fire size of a given fuel package.

Fire growth and heat release rates are dependent on the fuel type and its configuration. The fuel source material, shape, orientation and location determine how rapidly an item will burn. The heat release rate is measured in Btu/sec (British thermal units/sec) or kW (kilowatts). Heat release rate histories are typically characterized by a fire growth rate and can be determined by empirical fire tests on various items of fuels and combustibles. Fire growth rates are often designated as slow, medium, fast or ultra-fast, based upon on how quickly an item burns, in relation to other items. Figure 30 is shown to provide perspective as to the order-of-magnitude maximum heat release rates. Figure 31 compares various standard fire growth rates.
Figure 30 - Relative Fire Sizes

Figure 31 - Typical Fire Growth Rates
Figure 32 provides a comparison of the standard fire curves to the heat release rates for selected fuel packages (Appendix C of NFPA 92B - 2009).

To account for the range of possible design fire scenarios, two design fires have been chosen that represent the largest fuel package and affect the most occupants. The design fires are identified as follows:

5.1.1 Design Fire # 1 – Second Floor Center of the Atrium

The Second Floor is open to the Third, Fourth, Fifth and Sixth Floors at two principal locations. As a result of these openings, there is the potential for a balcony spill plume condition to be created from a fire on the Second Floor in the center of the atrium. Design Fire #1 examines the potential for a furniture fire to develop within the atrium below the balcony located within the center of the space. The fire examined was coaches, tables and a rug configured together with a maximum heat release rate of approximately 80 kW with an approximate 12-foot ceiling height. Fuel loads would be transient in nature, but are assumed to be a mixture of cellulosic and hydrocarbon materials of a generally non-hazardous and non-toxic nature. All the furniture within this area is California TB 133 compliant. This gives us our maximum HRR per item of 80 kW and a maximum ceiling temperature increase of 94 °C. The furniture items in the area are shown in Figure 33.
5.1.2 Design Fire # 2 – Second Floor Open Atrium

The Second Floor is open to the Third, Fourth, Fifth and Sixth Floors at two principal locations. As a result of these openings, there is the potential for an axial plume condition to be created from a fire on the Second Floor in the open area of the atrium. Design Fire #2 examines the potential for a furniture fire to develop within the open atrium area. The fire examined was coaches and a table configured together with a maximum heat release rate of approximately 80 kW with an approximate 80-foot ceiling height. Fuel loads would be transient in nature, but are assumed to be a mixture of cellulosic and hydrocarbon materials of a generally non-hazardous and non-toxic nature. All the furniture within this area is California TB 133 compliant. This gives us our maximum HRR per item of 80 kW and a maximum ceiling temperature increase of 94 °C. The items in the area are shown in Figure 34.
Figure 34 - Second Floor Furniture Arrangement Open Atrium Area
5.1.3 Analyzing Furniture Arrangement Using PyroSim

Looking at the furniture arrangement and the fact that all items comply with California TB 133 with a maximum HRR of 80 kW, I ran several values of Heat Release Rate per Unit Area (HRRPUA) to get an approximate HRR of 80 kW. The first model was using standard furniture and shows the fire spreading to other pieces of furniture around 369 seconds with a HRR of over 1000 kW. I did this to demonstrate the parameters within the model will allow for other objects to catch on fire. See Figures 35, 36 and 37 below.

![Figure 35](image-url)

**Figure 35 – Furniture Arrangement Showing Fire Spread @ 396 Seconds**

Figure 35 shows the fire spreading to the other couches at around 396 seconds. This is with standard couch HRR of 1000 kW or greater.
Figure 36 – Furniture Arrangement Showing Fire Spread @ 396 Seconds – HRR 1000 kW

Figure 37 – Furniture Arrangement Showing Fire Spread @ 396 Seconds – Temperature
From Figure 37 above if this fire was under the balcony area it would be sprinkler controlled at 68 °C or around 320 seconds and only allow the HRR to be around 300 kW.

Using the same parameters in the modeling for a HRR of approximately 80 kW it was determined that the fire would not spread to the other items in the fire area. Figures 38, 39, 40 and 41 show the results of these simulations.

Figure 38 – Furniture Arrangement HRR-80 kW @ 270 Seconds

Figure 39 – Furniture Arrangement HRR-80 kW @ 600 Seconds
Figures 38 and 39 shows that the fire does not spread to the other pieces of furniture in our arrangement with an 80 kW fire.

Comparing Figure 40 to Figure 36, we see that a 80 kW (TB 133) fire peaks around 500 seconds then decreases and a 1000 kW (Standard Couch) fire will just continue to grow as the other pieces of furniture would catch on fire until everything is burned in our furniture arrangement or the fire is controlled by the fire sprinklers under the center balcony area.
From Figure 41 at a HRR of approximately 80 kW the maximum ceiling temperature is 52 °C at 550 seconds. With the TB 133 compliant furniture, the sprinkler heads will not activate (activation @ 68 °C).

5.2 Tenability Condition Assessment

The ASET has become fundamental in performance based analysis of life safety in the event of a fire. It is determined from the time of ignition of the fire to the point to which occupant’s encounter an incapacitating dose from products of combustion and heat. These tenability requirements consist of visibility from smoke density, toxic products (CO), temperature, and heat flux from the fire. These criteria will be evaluated using PyroSim to determine the tenable limits occupants will be exposed too. The values discussed below have been pulled from the SFPE Handbook 5th Edition and will be used for this analysis. See Tables 19, 20 and Figures 42, 43 for SFPE data.

- Visibility - 13 m
- Temperature - 60°C
- Radiant Flux – 1.7 kW/m²
- Carbon Monoxide – 30000 ppm*min (600 sec = 10 min) in 10 min CO can’t be greater than 3000 ppm or 0.003 parts (1 g CO = 0.0357 mole) Therefore X_CO can’t be greater than 1.07e-4 mol/mol in 10 min.
- Measured at 1.8 m Above Finish Floor (AFF)

Table 19 – Visibility Criteria

<table>
<thead>
<tr>
<th>Degree of familiarity with inside of building</th>
<th>Smoke density (extinction coefficient)</th>
<th>Visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfamiliar</td>
<td>0.15 l/m</td>
<td>13 m</td>
</tr>
<tr>
<td>Familiar</td>
<td>0.5 l/m</td>
<td>4 m</td>
</tr>
</tbody>
</table>

Table 20 – CO Concentration Criteria

<table>
<thead>
<tr>
<th>Species</th>
<th>CO at rest ppm · min</th>
<th>CO light activity ppm · min</th>
<th>CO at rest ppm · min</th>
<th>CO light activity ppm · min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human 70 kg</td>
<td>80,000–100,000</td>
<td>30,000–35,000</td>
<td>~110,000–240,000</td>
<td>~60,000–190,000</td>
</tr>
<tr>
<td>Baboon ~20 kg</td>
<td>38,000–40,000</td>
<td>27,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macaque 3–4 kg</td>
<td>38,000–40,000</td>
<td>27,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat ~300 g</td>
<td>30,000–40,000</td>
<td>22,000–36,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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5.3 RSET - Pathfinder

Pathfinder was used to analyze occupant movement within the CSM building during an evacuation. Figures 44 – 49 represent the scenarios run for this simulation.
Figure 44 – Pathfinder Model Fully Occupied (2996) & Stair 2 Closed (Atrium Exposed Stair)

This pathfinder simulation shows the building fully loaded with occupants in the entire building with Stair 2 CLOSED (Atrium Exposed Stair). Figure 46 indicates total egress time for this scenario.

Figure 45 – Pathfinder Model Fully Occupied (2996) & Stair 2 Open (Atrium Exposed Stair)

This pathfinder simulation shows the building fully loaded with occupants in the entire building with Stair 2 OPEN (Atrium Exposed Stair). Figure 47 indicates total egress time for this scenario.
Figure 46 – Pathfinder Model Last OccupantExiting (1229.0 sec) & Stair 2 Closed

This pathfinder simulation shows the building after all occupants have egressed the building with Stair 2 CLOSED (Atrium Exposed Stair). It indicates that it takes 1229 seconds for all occupants to egress the CSM building fully loaded.

Figure 47 – Pathfinder Model Last OccupantExiting (650.3 sec) & Stair 2 Open

This pathfinder simulation shows the building after all occupants have egressed the building with Stair 2 OPEN (Atrium Exposed Stair). It indicates that it takes 650.3 seconds for all occupants to egress the CSM building fully loaded. With Stair 2 OPEN the egress time for the building is almost cut in half, even though that is not a code required stair.
Figure 48 – Pathfinder Model Center Atrium Loaded & Stair 2 Open (Atrium Exposed Stair)

This pathfinder simulation shows the center of the building fully loaded with occupants with Stair 2 OPEN (Atrium Exposed Stair). Figure 49 indicates total egress time for this scenario. The center open atrium area was used in PyroSim to analyze the atrium smoke control systems ability to maintain tenable conditions.

Figure 49 – Pathfinder Model Last Occupant Exiting Center Atrium (274.8 sec) & Stair 2 Open

This pathfinder simulation shows the center area after all occupant have egressed the building with Stair 2 OPEN (Atrium Exposed Stair). It indicates that it takes 274.8 seconds for all occupants to egress the center area of the CSM building.
Using the data from the Figures above we can determine our RSET values shown in Table 21 below.

### Table 21 – RSET for Center Atrium Area

<table>
<thead>
<tr>
<th>Level</th>
<th>t(detection) [sec*]</th>
<th>t(pre-movement) [sec**]</th>
<th>t(movement) [sec] (Pathfinder)</th>
<th>RSET Total Time [sec]</th>
<th>1.5 times RSET [sec]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>60</td>
<td>36</td>
<td>55.0</td>
<td>151.0</td>
<td>226.2</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>36</td>
<td>27.5</td>
<td>123.5</td>
<td>185.3</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>36</td>
<td>54.9</td>
<td>150.9</td>
<td>226.4</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>36</td>
<td>55.0</td>
<td>151.0</td>
<td>226.2</td>
</tr>
<tr>
<td>6</td>
<td>60</td>
<td>36</td>
<td>82.4</td>
<td>178.4</td>
<td>267.6</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>36</td>
<td>274.8</td>
<td>370.8</td>
<td>556.2</td>
</tr>
</tbody>
</table>

RSET = t(detection) + t(pre-movement) + t(movement)

Note: RSET values with 1.5 safety margin were used for evaluation.

- t(detection) = Time from ignition to detection and notification [60 sec*]
- t(pre-movement) = Time from notification to start of egress [36 sec**]
- t(movement) = Time to completely evacuate [Pathfinder]

* Visual Awareness, Smoke / Beam Detectors, Sprinklers, or Manual Pull
** Prerecorded voice message with trained staff (SFPE Handbook Table 3-12.2)

### 5.4 ASET – PyroSim

PyroSim models were run for the two design fire scenarios. The HRR values used to maintain approximately 80 kW was used in both simulations.

#### 5.4.1 ASET – PyroSim Design Fire 1

Figures 50 – 60 represent the different tenability conditions within the CSM building during a fire. The times of 270 and 600 second were used: the first time is when all occupants have vacated the floor and the second is the total time for all the occupants in the center atrium area to safely egress outside.

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Figure 50 shows a section cut of the PyroSim model that indicates the two design fire scenarios. Design Fire 1 (DF-1) is located under the balcony in the center area of the second floor. Design Fire 2 (DF-2) is in the open area of the second floor. The North and South main doors are also located on the second floor and allow air in as well as the roof exhaust dampers for the Open Atrium Naturally Ventilated Smoke Control System.
Figure 51 shows Smoke View of DF-1 at 270 seconds. You can see the fire burning on the couch and the balcony spill plume with smoke going into the two open areas of the atrium. Also notice the smoke exiting the roof dampers. The smoke appears denser on the second and sixth floors. At 270 seconds, all occupants should have egressed each floor, but it takes around 600 seconds to egress the entire center area of the CSM building.
Figure 52 shows Smoke View of DF-1 at 600 seconds. You can still see the fire burning on the couch and the balcony spill plume smoke going into the two open areas of the atrium. Also notice more smoke exiting the roof dampers. The smoke appears denser on the second, fourth and sixth floors. At 600 seconds, all occupants should have egressed the entire center section of the CSM building. You can see the smoke accumulating in the two corridor areas leading to the East and West wings. The West wing is of greater concern because Stair 3 exits into this area and as the visibility results indicate the tenable conditions of 13 meters fails ASET vs RSET.
Figure 53 shows the Visibility of DF-1 at 270 seconds. You can see the tenability requirement of 13 meters is maintained throughout most of the center area of the CSM building. The only areas that are 13 meters or less are in the open areas and the alcove leading to the West wing. This is a concern because Stair 3 exits into this area. At 270 seconds, all occupants should have egressed each floor, but it takes around 600 seconds to egress the entire center area of the CSM building.
Figure 54 shows the Visibility of DF-1 at 600 seconds. You can see the tenability requirement of 13 meters is still maintained throughout most of the center area of the CSM building. The only areas that are 13 meters or less are in the open areas, sixth floor, and the alcove leading to the West wing. This is a concern because Stair 3 exits into this area. Occupant may get disoriented and look for another safer way out, this could lead to a longer egress time. At 600 seconds, all occupants should have egressed the entire center area of the CSM building.
Figure 55 shows the Temperature of DF-1 at 270 seconds. You can see the tenability requirement of 60 °C is maintained throughout all the center area of the CSM building. The highest temperatures are near the fire on the couch which is expected, but still under 60 °C.
Figure 56 shows the Temperature of DF-1 at 600 seconds. You can still see the tenability requirement of 60 °C is maintained throughout all the center area of the CSM building. Most of the area is at 21.37 °C or less.
Figure 57 – PyroSim Model Design Fire 1 (DF-1) - CO @ 270 Seconds

Figure 57 shows the CO Concentration of DF-1 at 270 seconds. You can see the tenability requirement of 1.07e-4 mol/mol in ten minutes is maintained throughout all the center area of the CSM building. The highest CO Concentration are near the fire and the sixth floor, but still well under 1.07e-4 mol/mol in ten minutes.
Figure 58 shows the CO Concentration of DF-1 at 600 seconds. You can see the tenability requirement of 1.07e-4 mol/mol in ten minutes is still maintained throughout all the center area of the CSM building. The highest CO Concentration are near the fire and the sixth floor, but still well under 1.07e-4 mol/mol in ten minutes.
Figure 59 shows the Velocities of DF-1 at 270 seconds. This model gives you a better understanding of how the smoke is moving in the model. The highest velocities are in the open areas and thru the exhaust dampers which is to be expected.
Figure 60 – PyroSim Model Design Fire 1 (DF-1) - Velocity @ 600 Seconds

Figure 60 shows the Velocities of DF-1 at 600 seconds. This model gives you a better understanding of how the smoke is moving in the model. The highest velocities are in the open areas, sixth floor, and thru the exhaust dampers which is to be expected.
5.4.2 ASET – PyroSim Design Fire 2

The same fire parameters were used for design fire 2. The results are shown in Figures 61 – 70.

Figure 61 – PyroSim Model Design Fire 2 (DF-2) @ 270 Seconds

Figure 61 shows Smoke View of DF-2 at 270 seconds. You can see the fire burning on the couch and the smoke from the axial plume fire going into the two open areas of the atrium and the sixth floor. Also notice the smoke exiting the roof dampers. The smoke appears denser on the second and sixth floors. At 270 seconds, all occupants should have egressed each floor, but it takes around 600 seconds to egress the entire center area of the CSM building.
Figure 62 shows Smoke View of DF-2 at 600 seconds. You can still see the fire burning on the couch and the smoke from axial plume fire going into the two open areas of the atrium. Also notice more smoke exiting the roof dampers. The smoke appears denser on the second and sixth floors. At 600 seconds, all occupants should have egress the entire center section of the CSM building.
Figure 63 shows the Visibility of DF-2 at 270 seconds. You can see the tenability requirement of 13 meters is maintained throughout most of the center area of the CSM building. The only areas that are 13 meters or less are in the open areas. At 270 seconds, all occupants should have egressed each floor, but it takes around 600 seconds to egress the entire center area of the CSM building.
Figure 64 – PyroSim Model Design Fire 2 (DF-2) - Visibility @ 600 Seconds

Figure 64 shows the Visibility of DF-2 at 600 seconds. You can see the tenability requirement of 13 meters is still maintained throughout most of the center area of the CSM building. The only areas that are 13 meters or less are in the open areas and sixth floor. At 600 seconds, all occupants should have egressed the entire center area of the CSM building.
Figure 65 shows the Temperature of DF-2 at 270 seconds. You can see the tenability requirement of 60 °C is maintained throughout all the center area of the CSM building. The highest temperatures are near the fire on the couch which is expected.
Figure 66 – PyroSim Model Design Fire 2 (DF-2) - Temperature @ 600 Seconds

Figure 66 shows the Temperature of DF-2 at 600 seconds. You can still see the tenability requirement of 60 °C is maintained throughout all the center area of the CSM building. Most of the area is at 23.53 °C or less.
Figure 67 – PyroSim Model Design Fire 2 (DF-2) - CO @ 270 Seconds

Figure 67 shows the CO Concentration of DF-2 at 270 seconds. You can see the tenability requirement of $1.07 \times 10^{-4}$ mol/mol in ten minutes is maintained throughout all the center area of the CSM building. The highest CO Concentration are near the fire and the sixth floor, but still well under $1.07 \times 10^{-4}$ mol/mol in ten minutes.
Figure 68 – PyroSim Model Design Fire 2 (DF-2) - CO @ 600 Seconds

Figure 68 shows the CO Concentration of DF-2 at 600 seconds. You can see the tenability requirement of 1.07e-4 mol/mol in ten minutes is still maintained throughout all the center area of the CSM building. The highest CO Concentration are near the fire and the sixth floor, but still well under 1.07e-4 mol/mol in ten minutes.
Figure 69 shows the Velocities of DF-2 at 270 seconds. This model gives you a better understanding of how the smoke is moving in the model. The highest velocities are in the open areas, sixth floor, and thru the exhaust dampers which is to be expected.
Figure 70 shows the Velocities of DF-2 at 600 seconds. This model gives you a better understanding of how the smoke is moving in the model. The highest velocities are in the open areas, sixth floor, and thru the exhaust dampers which is to be expected.
5.4.3 ASET vs RSET Results

For both design fires scenarios, the results for ASET being greater than RSET were all met for the tenable conditions set except visibility of 13 meters. The tenable criteria that was close to the values set was visibility of 13 meters, after 270 seconds visibility range was lost in a small portion of the sixth and second floors near the fires as shown in Figures 53 and 63; however, after 270 second all occupants should have exited the floors as indicated in Table 21 from our Pathfinder results. The major concern is at 600 seconds some areas of the sixth and second floors have a visibility of less than 13 meters, see Figures 54 and 64. This is not as much of a problem for the sixth floor (occupants egress sixth floor in 267.6 seconds), but the egress Stair 3 empties out onto the second-floor area. This will impair the occupants from exiting thru this area. They can shelter in place within the 2-hour rated Stair Enclosure, but would more than likely try to exit to outside the building.

5.4.4 Structural Results of Design Fire

The maximum HRR that the SFRM fire proofed steel I-Beam can withstand without yielding was examined. It was determined that a fire with a HRR of 14.9 MW give us maximum values of calculated ceiling jet temperature vs time that were inputted into the excel spread sheets below to obtain the results shown below in Figure 74. The I-Beam for this analysis is shown in Figure 71

Figure 71 - I-Beam on Second floor being Analyzed

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Figure 72 shows I-Beam properties and our Fire Condition inputted into an Excel spreadsheet to yield Mo (Moment), Moment Load without insulation vs Time. This is plotted in Figure 74.
Figure 73 shows I-Beam properties and our Fire Condition inputted into an excel spread sheet to yield Mo (Moment) without 0.5” of insulation vs Time. This is plotted in Figure 74.
As you can see from the graph above the I-beam would have failed without fire proofing at around 45 minutes for our fire scenario, but with just 0.5” of fire proofing the I-beam did not fail. The Fire of 14.9 MW for our fuel load is not ever going to be reached, as seen previously with the PyroSim model for TB 133 furniture with a HRR around 80 kW. This was just an exercise to see how large a fire could be and not yield the SFRM protected I-Beam.
6.0 Conclusions

- The CSM building meets or exceeds all the prescriptive base code requirements for building design, egress analysis, structural fire protection, fire sprinkler systems and fire alarm systems design and installation.
- The two design fire scenarios DF - 1 & 2 were setup up on the second floor in the center balcony and open areas. All the furniture with these areas are TB 133 compliant (maximum HRR of 80 kW per piece of furniture). Running this criteria in the PyroSim model yielded the results in Figures 51 – 70. The furniture within the atrium area must be compliant with TB 133 standards or the analysis will have to be re-evaluated for much higher HRR values.
- The performance base analysis was interesting in that, all the tenability criteria were met for the values set when comparing ASET being greater than RSET except for visibility of 13 meters. The second floor at 600 seconds (Figure 64) shows the area where egress Stair 3 exits out onto the second level having visibility impaired.
- The Atrium Smoke Management Study done by Arup North America Ltd [3] for the original building design used standard furniture HRR and the same tenability conditions. The only difference was for visibility they used a K value of 8 for light emitting exit signage, and I used a k value of 3 for reflective exit signage (more conservative). The actual exit signage designed and installed is light emitting. This would account for my results indicating that visibility was lost at 13 meters on the second and sixth floors (ASET less than RSET), when as their report stated all tenability conditions are met.

7.0 Recommendations

There are two major recommendations that I would make to ensure the safety of the occupants within the CSM building in the event of a fire.

- The first would be to put in place a voice evacuation system with live directives in conjunction with well-trained, staff that can be heard by all occupants in the building. The building is already designed with 1-hour rated separations for the East Wing, Center Area (Atrium) and West Wing. With the addressable fire alarm system and the EVACS system trained personal could direct occupant to the closest egress path away from the fire, this would reduce queuing and reduce the overall time to safely egress the building.
- Add a mechanical ventilated smoke exhaust system in accordance with NFPA 92B to the existing naturally ventilated smoke exhaust system. This would ensure that occupants would have enough time to exit the building before conditions became untenable. The mechanical ventilated smoke exhaust system would bring the second-floor visibility criteria of 13 meters back into compliance.
Fire Protection Analysis – Warren J. Baker Center for Science and Mathematics (CSM)

• Move the corridor doors to the East and West wings in the atrium area to align with the walls so no smoke can propagate into these areas. The would also allow Stair 3 to exit into the corridor and not directly into the atrium area.

References

Appendix A - Architectural Drawings:
Appendix B - Structural Drawings:
Appendix C – Fire Sprinkler Drawings / Hyd. Calc’s. & Material/Equipment

Brochures:
Tol-Brace Seismic Calculations

Brace Information

<table>
<thead>
<tr>
<th>Brace Type</th>
<th>Brace Component Type</th>
<th>Adjusted Load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BF-3/4 inch</td>
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<tr>
<td></td>
<td>BF-1 inch</td>
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Tol-Brace Components

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</tr>
<tr>
<td></td>
<td>BF-1 inch</td>
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</tbody>
</table>

SEISMIC CRITERIA

SEISMIC DESIGN CATEGORY             D
SITE SOIL PROFILE TYPE                    B
SPECTRAL RESPONSE ACCELERATIONS:
S1 = 0.481*
S2 = 1.26*
SEISMIC COEFFICIENT:
Cp = 0.61**
SEISMIC IMP. FACTOR                         1.0

* S1 & S2 VALUES TAKEN FROM STRUCTURAL DRAWING
S 1.01 -  DATED 10-23-2009
** VALUE INTERPOLATED FROM TABLE 9.3.5.6.2 OF N.F.P.A.

NOTES
1 LAT 1 TO BE USED FOR LATERAL SWAY BRACING
   OF SPRINKLER SYSTEM 6" MAINS. MAX SPACING 40'-0".
2 LONG 1 TO BE USED FOR LONGITUDINAL
   SWAY BRACING OF SPRINKLER SYSTEM 6"
   MAINS. MAX SPACING 45'-0".
3 LAT 2 TO BE USED FOR LATERAL SWAY BRACING
   OF SPRINKLER SYSTEM 3" OR 2"
   MAINS WITH BRANCH LINES. MAX SPACING 35'-0".
4 LONG 2 TO BE USED FOR LONGITUDINAL
   SWAY BRACING OF SPRINKLER SYSTEM 3"
   OR 2"
   MAINS. MAX SPACING 80'-0".

This was the major coordination problem for this project.
<table>
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**Hand Hydraulic Calculations**

Cal Poly - CMS Hand Calculation - Remote Area 6-4

Sheet 1 of 4
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**American Fire Sprinkler Association**
17750 Mont Drive, Suite 300, Dallas, Texas 75261
Tel.: 214.349.3900
Fax: 214.349.0999
www.fssaonline.org
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<td>E TCB F 53.54</td>
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<td>0.006</td>
<td>Pt 130.51</td>
<td>Pt</td>
<td>Inside Hose Added @ BOR6 = 100 gpm</td>
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<td>Q 459.3</td>
<td>6.357</td>
<td>F</td>
<td>T 55.25</td>
<td>Pe 23.9</td>
<td>Pn</td>
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<td>6.357</td>
<td>L 55.25</td>
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<td>Pt</td>
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<td>SP05</td>
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<td>7ETB F 173.51</td>
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<td>SPC2</td>
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<td>Elev=365.4ft (SP05)</td>
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**HYDRAULIC CALCULATIONS**
<table>
<thead>
<tr>
<th>NOZZLE IDENT. AND LOCATION</th>
<th>FLOW IN GPM</th>
<th>PIPE SIZE</th>
<th>PIPE FITTINGS AND DEVICES</th>
<th>EQUIV. PIPE LENGTH</th>
<th>FRICTION LOSS PSI/FT</th>
<th>PRESSURE SUMMARY</th>
<th>NORMAL PRESSURE</th>
<th>NOTES</th>
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<td>8.329</td>
<td>L 13.83</td>
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<td>Pt 163.82</td>
<td>Pt</td>
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<td>Elev=348.9ft (SPC2)</td>
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<td>ETBC</td>
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<td>T 149.25</td>
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<td>Pump Curve</td>
<td>At 459.3 gpm</td>
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<td>L 41</td>
<td>F</td>
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<td>Pe 1.7</td>
<td>Pv</td>
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<td>F</td>
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<td>F</td>
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<td>Pn</td>
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<td>F</td>
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<td>Pn</td>
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<td>F</td>
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<td>Pt 0.16</td>
<td>Pn</td>
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</table>
HYDRAULIC CALCULATIONS

PROJECT:
CAL POLY CENTER FOR SCIENCE
1 GRAND AVE., BUILDING #70
SAN LUIS OBISPO, CA 93407

FOR THE:
GILBANE BUILDING COMPANY
1 GRAND AVE., BUILDING #70
SAN LUIS OBISPO, CA 93407

AS PRESENTED BY:

Aero Automatic Sprinkler Company
21605 North Central Ave.
Phoenix, AZ 85024
623-580-7800
623-434-3420 fax
## Fluid Resource Management
### Fire Hydrant Flow Test Worksheet

**Date:** 8/10/2011  
**Time:** 9:12am

### Water System
- **Cal Poly Math and Science**

### Water Tank Levels
- Full

### Pump Levels
- Booster

### Flowing Hydrant(s) Table

<table>
<thead>
<tr>
<th>Flowing Hydrant(s)</th>
<th>Concurrent Flow</th>
<th>Residual Hydrant</th>
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<td>#2</td>
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<tr>
<td>Hydrant #</td>
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<tr>
<td>Static Pressure (psi)</td>
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<td></td>
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<tr>
<td>Test Gauge #</td>
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<tr>
<td>Pilot Pressure (psi)</td>
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<td>Test Gauge #</td>
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<tr>
<td>Nozzle Size (inches)</td>
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<td>Nozzle Coefficient</td>
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<td>Hydrant Flow (gpm)</td>
<td>914</td>
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<td>Tested by</td>
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<tr>
<td>Projected Flow @ 20 ps</td>
<td>2270.268</td>
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### Comments:

...
**FLUID RESOURCE MANAGEMENT**  
**FIRE HYDRANT FLOW TEST WORKSHEET**

**WATER SYSTEM**  
Cal Poly Math and Science  
**DATE**  
August 19, 2011  
**TIME**  
9:28am

**WATER TANK LEVELS** Full  
**PUMP LEVELS** Fed from City line

<table>
<thead>
<tr>
<th>Flowing Hydrant(s)</th>
<th>Concurrent Flow</th>
<th>Residual Hydrant</th>
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<td>#1</td>
<td>#2</td>
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<tr>
<td>Hydrant #</td>
<td>63</td>
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<tr>
<td>Static Pressure (psi)</td>
<td>64</td>
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<td>Test Gauge #</td>
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<tr>
<td>Pilot Pressure (psi)</td>
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<td>Test Gauge #</td>
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<td>Nozzle Coefficient</td>
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<tr>
<td>Hydrant Flow (gpm)</td>
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<tr>
<td>Tested by</td>
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**Projected Flow @ 20 psi**  
2662.1147  
#DIV/0!  
#DIV/0!

Comments:
Approved Fire Pumps
1151 N. Pomona Rd., Ste. B Corona, Ca 92882
Dena Mueller
Phone 951-738-9100
Fax 951-7389191

Project: Cal Poly Center for Science
Quote Ref.: UK-99999-1
Page No.: 1
Date: Monday, February 28, 2011

Type: PG - In-Line Close Coupled Fire
Pump Model: 6PV/F10
Pump Op. Speed: 3550 RPM, 60 Hz Electric
Impeller Dia.: 8.24 inch
Curve No.: 3116186
Market: FM/UL/ULC Listed Fire Pump

Item: 1
Impeller No.: 2699332
Liquid: Water
Temperature: 59 °F
Viscosity: 1.14 cSt
Sp. Gravity: 1.00

Rated Flow: 750 US gpm
Rated Head: 113 psi
Imp. Dia.: 8.24 inch
Rated Power Required: 58.1 hp
Rated Efficiency: 85.3 %

NFPA Limits:
140% Head at shutoff: 158.2 psi
65% Head at 150% flow: 73.4 psi
Flow at 150%: 1125 US gpm
Head at 150: 89 psi
Power Req. at 150%: 69.3 hp
Efficiency at 150%: 64.5 %
Peak Power: 75.4 hp
Closed Valve Pressure: 125.2 psi
Approval: UL

Comments: Performance curve represents typical performance. NPSH data is

<table>
<thead>
<tr>
<th>Flow (US gpm)</th>
<th>Head (psi)</th>
<th>Pump Efficiency (%)</th>
<th>Power Required (hp)</th>
<th>NPSH Required (ft)</th>
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<tr>
<td>0.0</td>
<td>125.2</td>
<td>0.0</td>
<td>34.7</td>
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<tr>
<td>197.6</td>
<td>125.2</td>
<td>36.6</td>
<td>39.5</td>
<td></td>
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<tr>
<td>395.1</td>
<td>124.2</td>
<td>62.8</td>
<td>45.7</td>
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<tr>
<td>592.7</td>
<td>119.6</td>
<td>78.8</td>
<td>52.6</td>
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<tr>
<td>790.2</td>
<td>110.9</td>
<td>86.2</td>
<td>59.5</td>
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<td>967.8</td>
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<td>87.0</td>
<td>65.7</td>
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<td>84.4</td>
<td>82.8</td>
<td>70.7</td>
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<td>1382.9</td>
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Field Adjustable Pressure Reducing (URFA)

Elkhart’s URFA valve is a true pressure reducing valve, operated automatically by inner hydraulic controls. While the valves are preset at the factory, they are field adjustable — allowing you to tailor the pressure to your needs. They feature manual valve open and close, as well as pressure adjustment — all of which require extremely low torque to change due to the patent pending design. Inlet pressure up to 400 psi (27.58 bar) is controlled under all flow and no-flow conditions.

Valve size and weight permit installation in significantly tighter areas and smaller hose cabinets (those used for 1½" or 2½" valves) — allowing savings of both space and money. The URFA also functions as a floor control valve in automatic sprinkler systems as well as a standpipe valve or hose valve for Class I and Class III systems.
### Threads

**ADDITIONAL INFORMATION**

- Valve inlet information is NPT unless otherwise specified. Special threads available through adapter use.
- See index T-12 for alternative outlet thread options.
URFA-20S-2.5
(250 GPM)

URFA-20S-2.5
(300 GPM)
STATIC PRESSURE REDUCTION

INLET PRESSURE (PSI)

OUTLET PRESSURE (PSI)
Elkhart Brass
Fire Fighting Equipment

URFA Valve Calculator

Project Name: Cal Poly Center for Science
Floor Location: First Floor
Static Inlet Pressure (PSI) *: 183
Residual Inlet Pressure (PSI) *: 174.5
Design Static Outlet Pressure
Design Residual Outlet Pressure
Flow Rate (GPM) *: 250
Valve Body Style: URFA-20S-2.5 (IN-LINE BODY)

<table>
<thead>
<tr>
<th>Indicator Setting</th>
<th>Static Outlet Pressure (PSI)</th>
<th>Residual Outlet Pressure (PSI)</th>
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<tr>
<td>A</td>
<td>56.40</td>
<td>43.77</td>
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<tr>
<td>B</td>
<td>85.56</td>
<td>55.34</td>
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<tr>
<td>C</td>
<td>107.90</td>
<td>69.71</td>
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<td>D</td>
<td>135.24</td>
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<td>E</td>
<td>163.20</td>
<td>113.60</td>
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Pressure loss across valve is

\[
174.5 \text{ PSI} - 113.6 \text{ PSI} = 60.9 \text{ PSI} \]

@ 250 GPM
Elkhart Brass  
Fire Fighting Equipment  

URFA Valve Calculator

Project Name:  Cal Poly Center for Science  
Floor Location:  First Floor [R/A=2]  
Static Inlet Pressure (PSI):  183  
Residual Inlet Pressure (PSI):  169  
Design Static Outlet Pressure  
Design Residual Outlet Pressure  
Flow Rate (GPM):  328  
Valve Body Style:  URFA-20S-2.5 (IN-LINE BODY)

<table>
<thead>
<tr>
<th>Indicator Setting</th>
<th>Static Outlet Pressure (PSI)</th>
<th>Residual Outlet Pressure (PSI)</th>
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<tbody>
<tr>
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<td>163.20</td>
<td>98.86</td>
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Pressure loss across valve is  
169 psi - 98.86 psi = 70.14 psi  
@ 328 GPM
WILKINS
Double Check Detector Assembly

MODEL 350ADA
SPECIFICATION SUBMITTAL SHEET

APPLICATION
Designed for installation on potable water lines connections in fire sprinkler systems to protect against both backsplosion and backpressure of polluted water into the potable water supply. Model 350ADA shall provide protection where a potential health hazard does not exist. Incorporates metered by-pass to detect leaks and unauthorized water use.

STANDARDS COMPLIANCE (HORIZONTAL & VERTICAL)
- AWWA C510 (with gate only)
- CSA Certified (4"-8"
- UL® Classified
- FM® Approved
- Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California
- NYC MEA 221-04M-2 (2 1/2" - 8"

MATERIALS
Main valve body Ductile Iron ASTM A536 Grade 4
Access covers Ductile Iron ASTM A536 Grade 4
Coatings FDA Approved electrostatic epoxy finish
Internals Stainless steel, 300 Series
Fasteners & springs Stainless Steel, 300 Series
Elastomers EPDM (FDA approved)
Polymers NORYL™, NSF Listed

OPTIONS
- with flanged end OS & Y gate valves (standard)
- less shut-off valves (grooved body connections)
- less water meter
- with remote reading meter
- with gpm meter (standard)
- with cu ft/min meter
- with grooved end OS & Y gate valves
- with flanged inlet gate connection and grooved outlet gate connection
- Post Indicator Gate Valves
- butterfly valves

ACCESSORIES
- Repair kit (rubber only)
- Thermal expansion tank (Model XT)
- OS & Y Gate valve tamper switch (OSY-40)
- Test Cock Lock (Model TCL24)

DIMENSIONS & WEIGHTS (do not include pkg.)

<table>
<thead>
<tr>
<th>MODEL 350ADA Size</th>
<th>WITHOUT GATES</th>
<th>WITH OS &amp; Y GATES</th>
<th>WITH LESS GATE VALVES</th>
<th>WITH BUTTERFLY VALVES</th>
<th>WEIGHT</th>
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<tbody>
<tr>
<td>n</td>
<td>lbs</td>
<td>kg</td>
<td>lbs</td>
<td>lbs</td>
<td>kg</td>
</tr>
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<td>2 - 10</td>
<td>50 - 100</td>
<td>22,7 - 44,5</td>
<td>22,7 - 44,5</td>
<td>22,7 - 44,5</td>
<td>42</td>
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<tr>
<td>20</td>
<td>100</td>
<td>44,5</td>
<td>44,5</td>
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MODEL 350ADA with OS & Y option

MODEL 350ADA with butterfly valves

DIMENSION (approximate)

<table>
<thead>
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<th>MODEL 350ADA Size</th>
<th>A</th>
<th>A with BUTTERFLY VALVES</th>
<th>B LESS GATE VALVES</th>
<th>C</th>
<th>D</th>
<th>OS &amp; Y GATE</th>
<th>E</th>
<th>F WITH BUTTERFLY VALVES</th>
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<tbody>
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<td>in (mm)</td>
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Attention: Model 350ADA (grooved body) and Model 350DA (flange body) have different lay lengths.

(Patent No. 5473331)
FLOW CHARACTERISTICS
MODEL 350ADA 2 1/2", 3" & 4" (STANDARD & METRIC)

FLOW RATES (L/s)

PRESSURE LOSS (Psi)

FLOW RATES (GPM)

MODEL 350ADA 6", 8" & 10" (STANDARD & METRIC)

FLOW RATES (L/s)

PRESSURE LOSS (Psi)

FLOW RATES (GPM)

† Rated Flow (Established by approval agencies)

TYPICAL INSTALLATION
Local codes shall govern installation requirements. Unless otherwise specified, the assembly shall be mounted at a minimum of 12" (305mm) and a maximum of 30" (762mm) above adequate drains with sufficient side clearance for testing and maintenance. The installation shall be made so that no part of the unit can be submerged.

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Capacity thru Schedule 40 Pipe (GPM)

MODEL 350ADA (VERTICAL INSTALLATION)

MODEL 350ADA B (OUTDOOR INSTALLATION)

SPECIFICATIONS
The Double Check Detector Backflow Prevention Assembly shall be ASSE® Listed 1048, and supplied with full port gate valves. The main body and access cover shall be epoxy coated ductile iron (ASTM A 536 Grade 4), the seat ring and check valve shall be Noryl™ (NSF Listed), the stem shall be stainless steel (ASTM A 276) and the seat disc elastomers shall be EPDM. The first and second check valves shall be accessible for maintenance without removing the device from the line. The Double Check Detector Backflow Prevention Assembly shall be a WILKINS Model 350ADA.

WILKINS a Zurn company, 1747 Commerce Way, Paso Robles, CA 93446 Phone: 805/238-7100 Fax: 805/238-6766
IN CANADA: ZURN INDUSTRIES LIMITED, 3544 Nashua Cr., Mississauga, Ontario L4V 1L2 Phone: 905/405-2272 Fax: 905/405-1292

Page 2 of 2
LEVEL 6 R/A # 1,2,3 & 4
These are my Computer Hydraulic Calculations for the CSM Building

Aero Automatic Sprinkler Co.
21605 N. Central Ave.
Phoenix, Arizona 85024
623-580-7800

Job Name : Cal Poly Center for Science LVL 6 [R/A=4]
Building   : FP-6.06E
Location   : San Luis Obispo, Ca.
System     : 6-4
Contract   : 10034
Data File  : Cal Poly CFS LVL 6-4.WXF
HYDRAULIC CALCULATIONS
for

Project name: Cal Poly Center For Science
Location: San Luis Obispo, Ca.
Drawing no: FP-6.06E
Date: 9-25-2011

Design
Remote area number: 6-4
Remote area location: 6 th. Floor Office/Lobby
Occupancy classification: Light Hazard
Density: 0.10 - Gpm/SqFt
Area of application: 1500 - SqFt
Coverage per sprinkler: 210 - SqFt
Type of sprinklers calculated: Tyco; Mod. TY-FRB; 1/2"; 1/2";K=5.6; 155 Deg
No. of sprinklers calculated: 14
In-rack demand: N/A - GPM
Hose streams: 100 - GPM
Total water required (including hose streams): 447.28 - GPM @ 39.09 - Psi
Type of system: WET
Volume of dry or preaction system: N/A - Gal

Water supply information
Date: 8-19-2011
Location: N. Poly View Drive
Source: Fluid Resource Management

Name of contractor: Aero Automatic Sprinkler Co.
Address: 21605 N. Central Ave. Phoenix, Az. 85024
Phone number: 623-580-7847
Name of designer: Neal Larsen
Authority having jurisdiction: C.S.F.M.
Notes: (Include peaking information or gridded systems here.) Flow Test Information:
Hydrant # 63; Static = 60 psi; Res.= 55 psi [Elev.=351.0']
Hydrant # 64; Flow = 914 gpm
FLOW TEST USED IN HYD. CALCS REDUCED BY 10 % [STATIC=54psi; RES.=49psi]
### Water Supply Curve (C)

#### City Water Supply:
- C1 - Static Pressure: 54
- C2 - Residual Pressure: 49
- C2 - Residual Flow: 914

#### City Water Adjusted to Pump Inlet for Pf - Elev - Hose Flow:
- A1 - Adjusted Static: 51.872
- A2 - Adj Resid: 49.314 @ 790.2
- A3 - Adj Resid: 40.224 @ 1382.9

#### Pump Data:
- P1 - Pump Churn Pressure: 125.2
- P2 - Pump Rated Pressure: 110.9
- P2 - Pump Rated Flow: 790.2
- P3 - Pump Pressure @ Max Flow: 67.9
- P3 - Pump Max Flow: 1382.9

#### Demand:
- D1 - Elevation: 33.565
- D2 - System Flow: 347.282
- D2 - System Pressure: 160.618
- D3 - System Demand: 447.282
- Safety Margin: 13.576

#### Water Supply Curve (C)

| Flow (N^1.85) | Water Supply Curve (C)
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Computer Programs by Hydratec Inc.  Route 111  Windham N.H. USA  03087
### Fitting Legend

| Abbrev. | Name                        | ½ | 3/₄ | 1   | 1 1/₂| 2   | 2 1/₂| 3   | 3 1/₂| 4   | 5   | 6   | 8   | 10  | 12  | 14  | 16  | 18  | 20  | 24  |
|---------|-----------------------------|----|-----|-----|------|-----|------|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| B       | Generic Butterfly Valve    | 0  | 0   | 2.25| 2    | 2.5 | 6    | 7   | 10   | 0   | 12  | 9   | 10  | 12  | 19  | 21  | 0   | 0   | 0   | 0   |
| C       | Generic Check Vlv          | 4  | 5   | 5   | 7    | 9   | 11   | 14  | 16   | 19  | 22  | 27  | 32  | 45  | 55  | 65  | 76  | 87  | 98  | 109 | 130 |
| E       | 90' Standard Elbow         | 2  | 2   | 2   | 3    | 4   | 5    | 6   | 7    | 8   | 10  | 12  | 14  | 18  | 22  | 27  | 35  | 40  | 45  | 50  | 61  |
| G       | Generic Gate Valve         | 0  | 0   | 0   | 1    | 1   | 1    | 1   | 1    | 2   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 10  | 11  | 13  |
| I       | 90' Ell Grvd-Vic #10       | 0  | 0   | 2   | 3    | 4   | 3.5  | 6   | 5    | 8   | 7   | 8.5 | 10  | 13  | 17  | 20  | 23  | 25  | 33  | 36  | 40  |
| T       | 90' Flow Thru Tee          | 3  | 4   | 5   | 6    | 8   | 10   | 12  | 15   | 17  | 20  | 25  | 30  | 35  | 50  | 60  | 71  | 81  | 91  | 101 | 121 |
| Zic     | Wilkens 350ADA             |    |     |     |      |     |      |     |      |     |     |     |     |     |     |     |     |     |     |     |     |

Fitting generates a Fixed Loss Based on Flow

### Units Summary

- **Diameter Units**: Inches
- **Length Units**: Feet
- **Flow Units**: US Gallons per Minute
- **Pressure Units**: Pounds per Square Inch
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### Pressure / Flow Summary - STANDARD

Computer Programs by Hydratec Inc.  Route 111  Windham N.H. USA  03087
### Flow Summary - Standard

**Aero Automatic Sprinkler Co.**  
**Cal Poly Center for Science LVL 6 [R/A=4]**  
**Page 5**  
**Date 9-25-11**

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The maximum velocity is 24.81 and it occurs in the pipe between nodes L658 and MN41
# FLOWING SPRINKLER R/A # 4

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<th>CFact Pt Ft</th>
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**Computer Programs by Hydratec Inc.  Route 111  Windham N.H. USA  03087**
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### Final Calculations - Hazen-Williams - 2007

Aero Automatic Sprinkler Co.  
Cal Poly Center for Science LVL 6 [R/A=4]  
Date 9-25-11

| Node1 Elev1 K Qa Nom Fitting or Eqv. | Pipe Ftng’s Total Pt/Ft Pt Pe Pf Notes |
|---|---|---|---|---|---|---|---|---|
| Node2 Elev2 Fact Qt Act Eqv. Ln. | to or Ftng’s Pe | ****** | Notes | ****** |

| Node1 | Elev1 | K | Qa | Nom | Fitting or Eqv. | Pipe Ftng’s Total | Pt/Ft | Pt | Pe | Pf | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MN41 | 0.0 | 0.0 | 2.5 | 0.0 | 3.833 | 120 | 59.446 | 35.212 | K Factor = 9.99 |

#### *FEED MAIN*

| Node1 | Elev1 | K | Qa | Nom | Fitting or Eqv. | Pipe Ftng’s Total | Pt/Ft | Pt | Pe | Pf | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MN01 | 92 | 0.0 | 2.5 | 0.0 | 3.833 | 120 | 59.446 |
| to | MN02 | 92 | 0.0 | 2.635 | 0.0 | 3.833 | 0.0 | 0.0 | Vel = 0 |
| MN02 | 92 | 0.0 | 2.5 | 0.0 | 8.167 | 120 | 59.446 |
| to | MN03 | 92 | 0.0 | 2.635 | 0.0 | 8.167 | 0.0 | 0.0 | Vel = 0 |
| MN03 | 92 | 0.0 | 2.5 | 0.0 | 5.833 | 120 | 59.446 |
| to | MN04 | 92 | 0.0 | 2.635 | 0.0 | 5.833 | 0.0 | 0.0 | Vel = 0 |
| MN04 | 92 | 0.0 | 2.5 | 0.0 | 6.167 | 120 | 59.446 |
| to | MN05 | 92 | 0.0 | 2.635 | 0.0 | 6.167 | 0.0 | 0.0 | Vel = 0 |
| MN05 | 92 | 0.0 | 2.5 | 0.0 | 4.250 | 120 | 59.446 |
| to | MN06 | 92 | 0.0 | 2.635 | 0.0 | 4.250 | 0.0 | 0.0 | Vel = 0 |
| MN06 | 92 | 0.0 | 2.5 | 0.0 | 7.750 | 120 | 59.446 |
| to | MN07 | 92 | 0.0 | 2.635 | 0.0 | 7.750 | 0.0 | 0.0 | Vel = 0 |
| MN07 | 92 | 0.0 | 2.5 | 0.0 | 1.250 | 120 | 59.446 |
| to | MN08 | 92 | 0.0 | 2.635 | 0.0 | 1.250 | 0.0 | 0.0 | Vel = 0 |
| MN08 | 92 | 0.0 | 2.5 | 0.0 | 10.750 | 120 | 59.446 |
| to | MN09 | 92 | 0.0 | 2.635 | 0.0 | 10.750 | 0.0 | 0.0 | Vel = 0 |
| MN09 | 92 | 0.0 | 2.5 | 0.0 | 1.250 | 120 | 59.446 |
| to | MN10 | 92 | 0.0 | 2.635 | 0.0 | 1.250 | 0.0 | 0.0 | Vel = 0 |
| MN10 | 92 | 0.0 | 2.5 | 0.0 | 12.000 | 120 | 59.446 |
| to | MN11 | 92 | 0.0 | 2.635 | 0.0 | 12.000 | 0.0 | 0.0 | Vel = 0 |
| MN11 | 92 | 0.0 | 2.5 | 0.0 | 16.474 | 149.750 | 120 | 59.446 |
| 21 1T | MN12 | 93.333 | 0.0 | 2.635 | 0.0 | 16.474 | 32.948 | -0.577 |
| MN12 | 93.333 | 0.0 | 2.635 | 0.0 | 182.698 | 0.0 | 0.0 | Vel = 0 |
| MN12 | 93.333 | 0.0 | 2.635 | 0.0 | 58.869 | K Factor = 0 |

| Node1 | Elev1 | K | Qa | Nom | Fitting or Eqv. | Pipe Ftng’s Total | Pt/Ft | Pt | Pe | Pf | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MN40 | 92.417 | 32.22 | 2.5 | 0.0 | 3.083 | 120 | 35.201 |
| to | MN41 | 92.417 | 32.22 | 2.635 | 0.0 | 3.083 | 0.0036 | 0.111 | Vel = 1.90 |
| MN41 | 92.417 | 216.76 | 2.5 | 0.0 | 3.167 | 120 | 35.212 |
| to | MN42 | 92.417 | 248.98 | 2.635 | 0.0 | 3.167 | 0.1557 | 0.493 | Vel = 14.65 |
| MN42 | 92.417 | 32.78 | 2.5 | 0.0 | 3.083 | 120 | 35.201 |
| to | MN43 | 92.417 | 281.76 | 2.635 | 0.0 | 3.083 | 0.0036 | 0.111 | Vel = 1.90 |
| MN43 | 92.417 | 32.78 | 2.5 | 0.0 | 14.000 | 120 | 35.705 |

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Computer Programs by Hydratec Inc.  
Route 111  
Windham N.H. USA 03087
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SPRF

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| SPRF 99.750 | 0.0 | 2.469 | 0.0 | 12.250 | 0.0 | 0.0 | Vel = 0 |

SPRF

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| SP15 69 | 0.0 | 6.065 | 0.0 | 16.000 | 0.0 | 6.930 |
| SP14 53 | 0.0 | 6.065 | 0.0 | 16.000 | 0.0 | 6.930 |
| SP13 53 | 0.0 | 6.065 | 0.0 | 16.000 | 0.0 | 6.930 |
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**Notes:**

- K Factor = 0
- Fixed loss = 1.75

*Computer Programs by Hydratec Inc.  Route 111    Windham N.H. USA  03087*
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System Demand Pressure: 160.618
Safety Margin: 13.576
Continuation Pressure: 174.194
Pressure @ Pump Outlet: 174.194
Pressure From Pump Curve: -122.847
Pressure @ Pump Inlet: 51.347

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BF1 13 | 0.0 | 8 | 1Zic | 0.0 | 4.000 | 120 | 46.742 |
| BF2   | 13 | 13 | 447.28 | 7.981 | 1G | 6.326 | 118.616 | 0.0013 | 0.217 Vel = 2.67 |
| SRC   | 13 | 0.0 | 447.28 | 8.27 | 1T | 55.354 | 164.616 | 0.0013 | 0.217 Vel = 2.67 |
| SRC   | 0.0 | 447.28 | 52.667 | K Factor = 61.63 |
STANDPIPE # 1 [1000 & 750]
Job Name : Cal Poly Center for Science SP 1-1 [1000 GPM]
Building : Center for Science
Location : San Luis Obispo, Ca.
System : S/P # 1
Contract : 10034
Data File : Cal Poly CFS SP 1-1.WXF
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**HYDRAULIC DESIGN INFORMATION SHEET**

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**Calculation**

- Gpm Required 1000
- Psi Required 47.18
- At SRC

**Summary**

- C-Factor Used: Overhead 120
- Underground 140

**Water Flow Test:**

- Date of Test: 9-19-2011
- Cap. N/A

- Time of Test: 9:12 a.m.
- Rated Cap. 750
- Elev. N/A

- Static (Psi): 60 [54] @ Psi 113

- Residual (Psi): 55 [49] Elev. 1'-9"

**Location:** Static & Residual pressures taken from Hydrant # 63. Flow taken from Hydrant # 64 along N. Poly View Drive

**Source of Information:** Fluid Resource Management (R. Ellison)

**Note:** Flow test used in Hyd. Calculations was reduced by 10 %
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<td>P3 - Pump Pressure @ Max Flow : 67.9</td>
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<td>P3 - Pump Max Flow : 1382.9</td>
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<td>D3 - System Demand : 1000</td>
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![Water Supply Curve (C)](image_url)

Computer Programs by Hydratec Inc.  Route 111  Windham N.H. USA  03087
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Fitting generates a Fixed Loss Based on Flow

## Units Summary

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*S/P # 1 REMOTE ROOF HOSE VALVES

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Final Calculations - Hazen-Williams - 2007
Computer Programs by Hydratec Inc. Route 111 Windham N.H. USA 03087
### Final Calculations - Hazen-Williams - 2007

#### Aero Automatic Sprinkler Co.
Cal Poly Center for Science SP 1-1 [1000 GPM]

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*STANDPIPE FEED*

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Computer Programs by Hydratec Inc.  Route 111  Windham N.H. USA  03087
### Final Calculations - Hazen-Williams - 2007

Aero Automatic Sprinkler Co.  
Cal Poly Center for Science SP 1-1 [1000 GPM]  
Date 9-25-11

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K Factor = 83.31

K Factor = 144.19

Computer Programs by Hydratec Inc.  
Route 111  
Windham N.H. USA  03087
Job Name: Cal Poly Center for Science SP 1-2 [750 GPM]
Building: Center for Science
Location: San Luis Obispo, Ca.
System: S/P # 1
Contract: 10034
Data File: Cal Poly CFS SP 1-2.WXF
Aero Automatic Sprinkler Co.
Cal Poly Center for Science SP 1-2 [750 GPM]
Page 1
Date 9-25-11

HYDRAULIC DESIGN INFORMATION SHEET

Name - Cal Poly Center For Science
Location - San Luis Obispo, Ca.
Building - Center for Science
Contractor - Aero Automatic Sprinkler Co.
Calculated By - Neal Larsen
Occupancy - Light / Ordinary Hazard Gr. 1

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E   | Flow at Top Most Outlet | - 500 Gpm | System Type
M   | Pres. at Top Most Outlet | - 100 Psi | (X) Wet | ( ) Dry
Flow For Ea. Additional Standpipe | - 500 Gpm
D   | Total Additional Flow | - 1000 Gpm
E   | Elevation at Highest Outlet | - 99'-9" Feet
S   | Hose Valve Connection | ( )1 1/2" | (X)2 1/2"
I   | Class Service | (X)I | ( )II | (X)III
G   | Note: At Roof level there are two (2) standpipes available.
N   | (Standpipe # 1 & 3)

Calculation
Gpm Required 750
Psi Required 44.73
At SRC
Summary
C-Factor Used:
Overhead 120
Underground 140

W   | Water Flow Test: | Pump Data: | Tank or Reservoir:
A   | Date of Test | - 9-19-2011 | Cap. N/A
T   | Time of Test | - 9:12 a.m. | Rated Cap. 750 | Elev. N/A
E   | Static (Psi) | - 60 [54] | @ Psi | 113
R   | Residual (Psi) | - 55 [49] | Elev. | 1'-9"
Flow (Gpm) | - 914 | Well
S   | Elevation | - 13'-0"

P   | Location: Static & Residual pressures taken from Hydratn # 63. Flow taken from Hydrant # 64 along N. Poly View Drive
L   | Source of Information: Fluid Resource Management (R. Ellison)
Y   | Note: Flow test used in Hyd. Calculations was reduced by 10 %
City Water Supply:
- C1 - Static Pressure : 54
- C2 - Residual Pressure: 49
- C2 - Residual Flow : 914

City Water Adjusted to Pump Inlet
for Pf - Elev - Hose Flow
- A1 - Adjusted Static: 51.872
- A2 - Adj Resid : 49.314 @ 790.2
- A3 - Adj Resid : 40.224 @ 1382.9

Pump Data:
- P1 - Pump Churn Pressure : 125.2
- P2 - Pump Rated Pressure : 110.9
- P2 - Pump Rated Flow : 790.2
- P3 - Pump Pressure @ Max Flow : 67.9
- P3 - Pump Max Flow : 1382.9

City Water Supply Curve (C)

Water Supply Curve (C)
Computer Programs by Hydratec Inc. Route 111 Windham N.H. USA 03087
Fittings Used Summary

Aero Automatic Sprinkler Co.
Cal Poly Center for Science SP 1-2 [750 GPM]

Fitting Legend

| Abbrev. | Name                          | ½ | ¾ | 1  | 1¼ | 1½ | 2  | 2½ | 3  | 3½ | 4  | 5  | 6  | 8  | 10 | 12 | 14 | 16 | 18 | 20 | 24 |
|---------|-------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| B       | Generic Butterfly Valve       | 0  | 0  | 2.25 | 2 | 2.5 | 6  | 7  | 10 | 0  | 12 | 9  | 10 | 12 | 19 | 21 | 0  | 0  | 0  | 0  | 0  |
| C       | Generic Check Vlv             | 4  | 5  | 5   | 7 | 9   | 11 | 14 | 16 | 19 | 22 | 27 | 32 | 45 | 55 | 65 | 76 | 87 | 98 | 109 | 130 |
| E       | 90° Standard Elbow            | 2  | 2  | 2   | 3 | 4   | 5  | 6  | 7  | 8  | 10 | 12 | 14 | 18 | 22 | 27 | 35 | 40 | 45 | 50 | 61  |
| G       | Generic Gate Valve            | 0  | 0  | 0   | 1 | 1   | 1  | 1  | 2  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 10 | 11 | 13 | 11  | 13  |
| I       | 90° Ell Grvd-Vic #10          | 0  | 0  | 2   | 3 | 4   | 3.5 | 6  | 5  | 8  | 7  | 8.5 | 10 | 13 | 17 | 20 | 23 | 25 | 33 | 36 | 40  |
| T       | 90° Flow Thru Tee             | 3  | 4  | 5   | 6 | 8   | 10 | 12 | 15 | 17 | 20 | 25 | 30 | 35 | 50 | 60 | 71 | 81 | 91 | 101 | 121 |
| Zic     | Wilkens 350ADA                |    |    |     |    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

Fitting generates a Fixed Loss Based on Flow

Units Summary

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<th>Inches</th>
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<td>Flow Units</td>
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<td>Pressure Units</td>
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The maximum velocity is 16.75 and it occurs in the pipe between nodes HV1 and SPRF.
### *S/P # 1 REMOTE ROOF HOSE VALVES*

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Computer Programs by Hydratec Inc. Route 111 Windham N.H. USA 03087
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Safety Margin 5.795
Continuation Pressure 162.162
Pressure @ Pump Outlet 162.162
Pressure From Pump Curve -112.559
Pressure @ Pump Inlet 49.603

PI 1.750 0.0 8 1G 4.0 14.000 120 49.603
PI to 0.0 1I 13.0 52.000 -2.166
POC 6.750 750.0 7.981 1T 35.0 66.000 0.0054 0.359 Vel = 4.81
POC to 0.0 8 2E 56.936 41.000 140 47.796
BF1 13 750.0 8.27 0.0 97.936 0.0034 0.336 Vel = 4.48
BF1 to 0.0 8 1Zic 0.0 4.000 120 45.425
BF2 13 750.0 7.981 0.0 4.000 0.0055 0.022 Vel = 4.81
BF2 to 0.0 8 2E 56.936 46.000 140 49.967
SRC 13 750.0 8.27 1T 55.354 164.616 0.0034 0.565 Vel = 4.48

Computer Programs by Hydratec Inc.  Route 111  Windham N.H. USA  03087
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STANDPIPE STATIC & FLOW FOR PRESSURE REDUCING VALVE SETTING ‘E’
Job Name : Cal Poly Center for Science SP - STATIC
Building   : Center for Science
Location   : San Luis Obispo, Ca.
System     : S/P # 1,3,4,5
Contract   : 10034
Data File  : Cal Poly CFS SP 1-1-STATIC.WXF
HYDRAULIC DESIGN INFORMATION SHEET

Name - Cal Poly Center For Science                          Date - 9-25-2011
Location - San Luis Obispo, Ca.
Building - Center for Science                       System No. - S/P # 1,3,4,5
Contractor - Aero Automatic Sprinkler Co.           Contract No. - 10034
Calculated By - Neal Larsen                          Drawing No. -
Occupancy - Light / Ordinary Hazard Gr. 1

S   (X)NFPA 14 Number of Standpipes ( )1 ( )2 ( )3 (X)4 ( )
Y   ( )Other
S   ( )Specific Ruling Made by Date

E    Flow at Top Most Outlet - 0.05 Gpm System Type
M    Pres. at Top Most Outlet - N/A Psi (X) Wet ( ) Dry
Flow For Ea. Additional Standpipe - N/A Gpm
D    Total Additional Flow - 0.05 Gpm
E    Elevation at Highest Outlet - 101-0 Feet
S    Hose Valve Connection ( )1 1/2" (X)2 1/2"
I    Class Service (X)I ( )II (X)III
G    Note: This is a static Calculation to determine were Pressure Reducing Va.
N    are required (only three (3) on 1 st. floor)

       Calculation Gpm Required 0.05 Psi Required 59.99 At SRC
Summary C-Factor Used: Overhead 120 Underground 140

W    Water Flow Test: Pump Data: Tank or Reservoir:
A    Date of Test - 9-19-2011 Cap. N/A
T    Time of Test - 9:12 a.m. Rated Cap. 750 Elev. N/A
E    Static (Psi) - 60 @ Psi 113
R    Residual (Psi) - 55 Elev. 1'-9" Well
Flow (Gpm) - 914 Proof Flow Gpm N/A
S    Elevation - 13'-0"

P    Location: Static & Residual pressures taken from Hydratn # 63. Flow taken
from Hydrant # 64 along N. Poly View Drive
L    Source of Information: Fluid Resource Management (R. Ellison)
Y    Note: Full Flow test was used in this Static Hyd. Calculation.
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Fitting generates a Fixed Loss Based on Flow

### Units Summary

- **Diameter Units**: Inches
- **Length Units**: Feet
- **Flow Units**: US Gallons per Minute
- **Pressure Units**: Pounds per Square Inch

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Computer Programs by Hydratec Inc.  Route 111  Windham N.H. USA  03087
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**Final Calculations - Hazen-Williams - 2007**

*Computer Programs by Hydratec Inc.  Route 111  Windham N.H. USA  03087*
# Final Calculations - Hazen-Williams - 2007

## Aero Automatic Sprinkler Co.

**Cal Poly Center for Science SP - STATIC**

**Page 6**

**Date** 9-25-11

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**Computer Programs by Hydratec Inc. Route 111 Windham N.H. USA 03087**
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Computer Programs by Hydratec Inc.  Route 111  Windham N.H. USA  03087
## Final Calculations - Hazen-Williams - 2007

Aero Automatic Sprinkler Co.
Cal Poly Center for Science SP - STATIC

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System Demand Pressure | 183.028
Safety Margin | 0.008
Continuation Pressure | 183.036

Pressure @ Pump Outlet | 183.036
Pressure From Pump Curve | -125.164
Pressure @ Pump Inlet | 57.872

| PI to PO | 1.750 | 0.0 | 8 | 1G 4.0 | 14.000 | 120 | 57.872 |
| POC to BF1 | 6.750 | 0.05 | 7.981 | 1T 35.0 | 66.000 | 0 | 0.0 Vel = 0 |
| BF1 to BF2 | 13 | 0.05 | 8.27 | 0.0 | 56.936 | 0 | 0.0 Vel = 0 |
| BF2 to SRC | 13 | 0.05 | 8.27 | 1G 6.326 | 118.616 | 0 | 0.0 Vel = 0 |
| SRC | 0.05 | 60.000 | K Factor = 0.01 |

- **PO**:
  - 0.05
  - 183.028 K Factor = 0

- **System Demand Pressure**: 183.028
- **Safety Margin**: 0.008
- **Continuation Pressure**: 183.036

- **Pressure @ Pump Outlet**: 183.036
- **Pressure From Pump Curve**: -125.164
- **Pressure @ Pump Inlet**: 57.872

- **PI** to **PO**: 1.750
  - 0.0
  - 8
  - 1G 4.0
  - 14.000
  - 120
  - 57.872

- **POC** to **BF1**: 6.750
  - 0.05
  - 7.981
  - 1T 35.0
  - 66.000
  - 0
  - 0.0

- **BF1** to **BF2**: 13
  - 0.05
  - 8.27
  - 0.0
  - 56.936
  - 0
  - 0.0

- **BF2** to **SRC**: 13
  - 0.05
  - 8.27
  - 1G 6.326
  - 118.616
  - 0
  - 0.0

- **SRC**: 0.05
  - 60.000
  - K Factor = 0.01
Job Name : Cal Poly Center for Science 1st flr. Riser [250 gpm]
Building : Center for Science
Location : San Luis Obispo, Ca.
System : 1st floor
Contract : 10034
Data File : Cal Poly CFS LVL 1-250.WXF
### HYDRAULIC DESIGN INFORMATION SHEET

**Name** - Cal Poly Center For Science  
**Date** - 9-25-2011  
**Location** - San Luis Obispo, CA.  
**Building** - Center for Science  
**System No.** - 1st floor  
**Contractor** - Aero Automatic Sprinkler Co.  
**Contract No.** - 10034  
**Calculated By** - Neal Larsen  
**Drawing No.** -  
**Occupancy** - Light / Ordinary Hazard Gr. 1

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- **Flow at Top Most Outlet**: 250 Gpm  
- **Pres. at Top Most Outlet**: N/A Psi  
- **Flow For Ea. Additional Standpipe**: N/A Gpm  
- **Total Additional Flow**: 250 Gpm  
- **Elevation at Highest Outlet**: 3'-0" Feet  
- **Hose Valve Connection**: 1 1/2"  
- **Class Service**: I  
- **Note**: This is a flow calculation for 250 gpm @ 1st flr riser to determine the residual pressure for setting the Pressure Reducing Va. [Setting 'E']

**Calculation**  
- **Gpm Required 250**:  
- **Psi Required 59.54**: At SRC  
- **C-Factor Used**:  
  - Overhead: 120  
  - Underground: 140

**Water Flow Test**:  
- **Date of Test**: 9-19-2011  
- **Time of Test**: 9:12 a.m.  
- **Rated Cap. 750**: Elev. N/A  
- **Static (Psi)**: 60 @ Psi 113  
- **Residual (Psi)**: 55 Elev. 1'-9" Well  
- **Flow (Gpm)**: 914  
- **Elevation**: 13'-0"  
- **Location**: Static & Residual pressures taken from Hydrant # 63. Flow taken from Hydrant # 64 along N. Poly View Drive  
- **Source of Information**: Fluid Resource Management (R. Ellison)  
- **Note**: Full Flow test was used in this Static Hyd. Calculation.
### Water Supply Curve (C)

#### Aero Automatic Sprinkler Co.  
**Cal Poly Center for Science 1st fl. Riser [250 gpm]**  
**Page 2**  
**Date 9-25-11**

#### City Water Supply:
- **C1** - Static Pressure: 60
- **C2** - Residual Pressure: 55
- **C2** - Residual Flow: 914

#### City Water Adjusted to Pump Inlet for Pf - Elev - Hose Flow:
- **A1** - Adjusted Static: 0
- **A2** - Adj Resid: 0 @ 0
- **A3** - Adj Resid: 0 @ 0

#### Pump Data:
- **P1** - Pump Churn Pressure: 125.2
- **P2** - Pump Rated Pressure: 110.9
- **P2** - Pump Rated Flow: 0
- **P3** - Pump Pressure @ Max Flow: 67.9
- **P3** - Pump Max Flow: 0

#### Demand:
- **D1** - Elevation: -4.331
- **D2** - System Flow: __________
- **D2** - System Pressure: 182.606
- **Hose (Adj City)**: __________
- **Hose (Demand)**: 250
- **D3** - System Demand: 250
- **Safety Margin**: __________

#### Calculation:
- **City Residual Flow @ 0**: 3501.77
- **City Residual Flow @ 20**: 2812.57
- **City Water @ 150% of Pump**: 60.00

#### Pump Flow Terminated at Adjusted Curve 0 psi

---

**Graph:**  
- **D1** - Elevation: -4.331
- **D2** - System Flow: __________
- **D2** - System Pressure: 182.606
- **Hose (Adj City)**: __________
- **Hose (Demand)**: 250
- **D3** - System Demand: 250
- **Safety Margin**: __________

**Graph Axis:**  
- **FLOW (N^1.85)**
- **200** to **1800**
- **14** to **210**

**Graph Points:**  
- **C1**
- **C2**
- **P1**
- **P2**
- **P3**
- **A1**
- **A2**
- **A3**

---

**Computer Programs by Hydratec Inc.**  
**Route 111**  
**Windham N.H. USA 03087**
### Fittings Used Summary

| B | Generic Butterfly Valve | 0 | 0 | 2.25 | 2.5 | 6 | 7 | 10 | 0 | 12 | 9 | 10 | 12 | 19 | 21 | 0 | 0 | 0 | 0 | 0 |
|---|--------------------------|---|---|------|-----|---|---|----|---|----|---|----|---|----|---|---|---|---|---|---|---|
| C | Generic Check Vlv       | 4 | 5 | 5 | 7 | 9 | 11 | 14 | 16 | 19 | 22 | 27 | 32 | 45 | 55 | 65 | 76 | 87 | 98 | 109 | 130 |
| E | 90' Standard Elbow       | 2 | 2 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 12 | 14 | 18 | 22 | 27 | 35 | 40 | 45 | 50 | 61 |
| G | Generic Gate Valve       | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 13 |
| I | 90' Ell Grvd-Vc #10      | 0 | 0 | 2 | 3 | 4 | 3.5 | 6 | 5 | 8 | 7 | 8.5 | 10 | 13 | 17 | 20 | 23 | 25 | 33 | 36 | 40 |
| T | 90' Flow Thru Tee        | 3 | 4 | 5 | 6 | 8 | 10 | 12 | 15 | 17 | 20 | 25 | 30 | 35 | 50 | 60 | 71 | 81 | 91 | 101 | 121 |
| Zic | Wilkens 350ADA | Fitting generates a Fixed Loss Based on Flow |

### Units Summary

- **Diameter Units**: Inches
- **Length Units**: Feet
- **Flow Units**: US Gallons per Minute
- **Pressure Units**: Pounds per Square Inch
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The maximum velocity is 14.71 and it occurs in the pipe between nodes BR01 and SPC1.
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<td>0.0</td>
<td>250.00</td>
<td>2.635</td>
<td>0.0</td>
<td>47.281</td>
<td>0.1569</td>
<td>7.419</td>
<td>Vel = 14.71</td>
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<tr>
<td>SPC1 to SPC2</td>
<td>12.667</td>
<td>250.00</td>
<td>6.065</td>
<td>0.0</td>
<td>37.917</td>
<td>0.0027</td>
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<td>SPC2 to PO</td>
<td>1.833</td>
<td>250.00</td>
<td>7.981</td>
<td>45.0</td>
<td>84.750</td>
<td>0.0007</td>
<td>0.060</td>
<td>Vel = 1.60</td>
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<td>K Factor = 18.50</td>
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<td></td>
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<td></td>
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<td></td>
</tr>
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</table>

System Demand Pressure: 182.606
Safety Margin: 0.0
Continuation Pressure: 182.606
Pressure @ Pump Outlet: 182.606
Pressure From Pump Curve: -124.735
Pressure @ Pump Inlet: 57.871

Pl to POC:
POC to BF1:
BF1 to BF2:
BF2 to SRC:
SRC to SRC:

Fixed loss = 6.379
Vel = 1.60
Vel = 1.49
Vel = 1.49

K Factor = 18.50
K Factor = 32.40
Job Name: Cal Poly Center for Science 1st flr. Riser [328 gpm]
Building: Center for Science
Location: San Luis Obispo, Ca.
System: 1st floor
Contract: 10034
Data File: Cal Poly CFS LVL 1-328.WXF
## Hydraulic Design Information Sheet

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<thead>
<tr>
<th>Name</th>
<th>Cal Poly Center For Science</th>
<th>Date - 9-25-2011</th>
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<td>Location</td>
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<tr>
<td>Building</td>
<td>Center for Science</td>
<td></td>
</tr>
<tr>
<td>Contractor</td>
<td>Aero Automatic Sprinkler Co.</td>
<td></td>
</tr>
<tr>
<td>Contract No.</td>
<td>10034</td>
<td></td>
</tr>
<tr>
<td>Calculated By</td>
<td>Neal Larsen</td>
<td></td>
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<tr>
<td>Occupancy</td>
<td>Light / Ordinary Hazard Gr. 1</td>
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</tr>
</tbody>
</table>

### Design Details

- **S (X)NFPA 14** Number of Standpipes ( )1 ( )2 ( )3 (X)4 ( )
- **Y ( )Other**
- **S ( )Specific Ruling**
- **T** Made by |
- **E** Flow at Top Most Outlet - 328 Gpm System Type
- **M** Pres. at Top Most Outlet - N/A Psi (X) Wet ( ) Dry Flow For Ea. Additional Standpipe - N/A Gpm
- **D** Total Additional Flow - 328 Gpm
- **E** Elevation at Highest Outlet - 3'-0" Feet
- **S** Hose Valve Connection ( )1 1/2" (X)2 1/2"
- **I** Class Service (X)I ( )II (X)III
- **G** Note: This is a flow calculation for 328 gpm @ 1st flr riser to determine the residual pressure for setting the Pressure Reducing Va. [Setting 'E']

### Calculation

<table>
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<tr>
<th>Gpm Required</th>
<th>328</th>
<th>Psi Required</th>
<th>59.24</th>
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<tr>
<td>Calculation</td>
<td>C-Factor Used:</td>
<td>120</td>
<td>140</td>
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<td>Water Flow Test:</td>
<td>Pump Data:</td>
<td>Tank or Reservoir:</td>
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<td>A Date of Test</td>
<td>- 9-19-2011</td>
<td>Cap. N/A</td>
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<tr>
<td>T Time of Test</td>
<td>- 9:12 a.m.</td>
<td>Rated Cap. 750 Elev. N/A</td>
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<tr>
<td>E Static (Psi)</td>
<td>- 60</td>
<td>@ Psi 113</td>
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<tr>
<td>R Residual (Psi)</td>
<td>- 55</td>
<td>Elev. 1'-9&quot;</td>
<td>Well</td>
</tr>
<tr>
<td>S Elevation</td>
<td>- 914</td>
<td>Proof Flow Gpm N/A</td>
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<tr>
<td>P Location</td>
<td>Static &amp; Residual pressures taken from Hydratn # 63. Flow taken from Hydrant # 64 along N. Poly View Drive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L Source of Information: Fluid Resource Management (R. Ellison)</td>
<td></td>
<td></td>
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<tr>
<td>Y Note : Full Flow test was used in this Static Hyd. Calculation.</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Computer Programs by Hydratec Inc.  Route 111  Windham N.H. USA  03087
City Water Supply:
- C1 - Static Pressure: 60
- C2 - Residual Pressure: 55
- C2 - Residual Flow: 914

City Water Adjusted to Pump Inlet for Pf - Elev - Hose Flow:
- A1 - Adjusted Static: 0
- A2 - Adj Resid: 0 @ 0
- A3 - Adj Resid: 0 @ 0

Pump Data:
- P1 - Pump Churn Pressure: 125.2
- P2 - Pump Rated Pressure: 110.9
- P2 - Pump Rated Flow: 0
- P3 - Pump Pressure @ Max Flow: 67.9
- P3 - Pump Max Flow: 0

Demand:
- D1 - Elevation: -4.331
- D2 - System Flow: 182.189
- D2 - System Pressure: 0
- Hose (Adj City): 328
- Hose (Demand): 328
- D3 - System Demand: 328

City Residual Flow @ 0 = 3501.77
City Residual Flow @ 20 = 2812.57
City Water @ 150% of Pump = 60.00

Pump flow terminated at adjusted curve 0 psi
### Fittings Used Summary

#### Fitting Legend

| Abbrev. | Name                        | ½ | ¾ | 1   | 1¼  | 1½  | 2   | 2½  | 3   | 3½  | 4   | 5   | 6   | 8   | 10  | 12  | 14  | 16  | 18  | 20  | 24  |
|---------|-----------------------------|---|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| B       | Generic Butterfly Valve    | 0 | 0 | 2.25| 2   | 2.5 | 6   | 7   | 10  | 0   | 12  | 9   | 10  | 12  | 19  | 21  | 0   | 0   | 0   | 0   | 0   |
| C       | Generic Check Vlv          | 4 | 5 | 5   | 7   | 9   | 11  | 14  | 16  | 19  | 22  | 27  | 32  | 45  | 55  | 65  | 76  | 87  | 98  | 109 | 130 |
| E       | 90' Standard Elbow         | 2 | 2 | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 10  | 12  | 14  | 18  | 22  | 27  | 35  | 40  | 45  | 50  | 61  |
| G       | Generic Gate Valve         | 0 | 0 | 0   | 1   | 1   | 1   | 1   | 1   | 1   | 2   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 10  | 11  | 13  |
| I       | 90' Ell Grvd-Vic #10       | 0 | 0 | 2   | 3   | 4   | 3.5 | 6   | 5   | 8   | 7   | 8.5 | 10  | 13  | 17  | 20  | 23  | 25  | 33  | 36  | 40  |
| T       | 90' Flow Thru Tee          | 3 | 4 | 5   | 6   | 8   | 10  | 12  | 15  | 17  | 20  | 25  | 30  | 35  | 50  | 60  | 71  | 81  | 91  | 101 | 121 |
| Zic     | Wilkens 350ADA             |    |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

Fitting generates a Fixed Loss Based on Flow

### Units Summary

<table>
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<tr>
<th>Units</th>
<th>Description</th>
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<tr>
<td>Diameter Units</td>
<td>Inches</td>
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<tr>
<td>Length Units</td>
<td>Feet</td>
</tr>
<tr>
<td>Flow Units</td>
<td>US Gallons per Minute</td>
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<tr>
<td>Pressure Units</td>
<td>Pounds per Square Inch</td>
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</table>
The maximum velocity is 19.3 and it occurs in the pipe between nodes BR01 and SPC1

<table>
<thead>
<tr>
<th>Node No.</th>
<th>Elevation</th>
<th>K-Fact</th>
<th>Pt Actual</th>
<th>Pn</th>
<th>Flow Density</th>
<th>Area</th>
<th>Press Req</th>
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<td>BR01</td>
<td>3.0</td>
<td></td>
<td>169.15</td>
<td>na</td>
<td>328.0</td>
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<td>SPC1</td>
<td>12.667</td>
<td></td>
<td>177.23</td>
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<td>177.4</td>
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<td>PO</td>
<td>1.833</td>
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<td>PI</td>
<td>1.75</td>
<td></td>
<td>57.73</td>
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<td>POC</td>
<td>6.75</td>
<td></td>
<td>55.65</td>
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<td>BF1</td>
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<td>BF2</td>
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<td>59.13</td>
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<td>59.25</td>
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## Final Calculations - Hazen-Williams - 2007

### Aero Automatic Sprinkler Co.

**Cal Poly Center for Science 1 st. flr. Riser [328 gpm]**

<table>
<thead>
<tr>
<th>Node1 to Node2</th>
<th>Elev1</th>
<th>K</th>
<th>Qa</th>
<th>Nom</th>
<th>Fitting</th>
<th>Pipe</th>
<th>CFact</th>
<th>Pt</th>
<th>Pe</th>
<th>Notes</th>
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<td>BR01 to SPC1</td>
<td>3</td>
<td></td>
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<td>328.00</td>
<td>2.5</td>
<td>16.474</td>
<td>14.333</td>
<td>120</td>
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<td>2.635</td>
<td>16.474</td>
<td>32.948</td>
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<td>8</td>
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<td>Vel = 2.10</td>
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### System Demand Pressure

- Value: 182.189

### Safety Margin

- Value: 0.0

### Continuation Pressure

- Value: 182.189

### Pressure @ Pump Outlet

- Value: 182.189

### Pressure From Pump Curve

- Value: -124.455

### Pressure @ Pump Inlet

- Value: 57.734

<table>
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<th>PI to POC</th>
<th>1.750</th>
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<th>8</th>
<th>1G</th>
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<th>120</th>
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<td>6.750</td>
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<td>55.354</td>
<td>0.0007</td>
<td>0.122</td>
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### SRC to SRC

- Value: 59.249

**K Factor = 24.30**

---

Computer Programs by Hydratec Inc.  Route 111  Windham N.H. USA  03087
Appendix D — Fire Alarm Drawings & Material/Equipment Brochures:
GENERAL NOTES

1. NOTIFICATION DEVICES CANNOT BE T-TAPPED. ADDRESSEABLE (DC) DEVICES CAN BE T-TAPPED. ALL FIRE ALARM CABLING SHALL BE RUN FROM DEVICE TO DEVICE, WITH NO SPLICES. ANY REQUIRED TERMINATIONS MUST BE MADE IN APPROVED BOX.

2. ALL INTERIOR INITIATING DEVICES, NOTIFICATION DEVICES, AND MODULES REQUIRE A SQUARE SPECIAL DEEP BACK BOXES U.O.N.

3. PANEL BACK BOXES AND OTHER LISTED BACK BOXES SHALL BE PROVIDED TO THE EC BY DIB: ALL CONTROL PANELS, POWER SUPPLIES, AND BATTERY BOXES SHALL UTILIZE ONLY FACTORY KNOCKOUTS NEAR THE TOP OF THE CAN TO ALLOW PLACEMENT OF BATTERIES.

4. ALL FIRE ALARM CONDUIT TO BE 3/4" MINIMUM U.O.N. FIRE ALARM CONDUIT SHALL BE SEPARATE FROM CONDUIT SYSTEM FOR SECURITY ALARM CABLING AND OTHER SYSTEMS.

5. WALL MOUNT AUDIO/VISUAL DEVICES SHALL BE MOUNTED 87" AFF TO BOTTOM OF THE STROBE LENS.

6. MANUAL PULL STATIONS SHALL BE MOUNTED 48" AFF TO CENTERLINE OF BOX. MPS SHALL BE DOUBLE ACTION AND KEYED THE SAME AS THE FACP.

7. DEDICATED 150 VAC CIRCUIT WITH LOCKOUT @ BREAKER TO BE PROVIDED BY OTHERS AT LOCATION OF PANELS AND POWER SUPPLIES.

8. KNOX BOX, PIV, SUPERVISORY SWITCHES, FLOW SWITCHES, SOLENOIDS, AND SPRINKLER BELLS SHALL BE PROVIDED BY OTHERS.

9. SMOKE DETECTORS SHALL NOT BE PLACED WITHIN 3’ OF ANY SUPPLY AIR REGISTER OR WHERE THE AIR MOVEMENT EXCEEDS THE MANUFACTURER’S LISTING.

10. FIRE FIGHTER TELEPHONE RISER IS CLASS A, STYLE 2

11. VOLTAGE DROP CALCULATIONS FOR NOTIFICATION DEVICES ARE BASED ON THE LAYOUT SHOWN. DEVIATION FROM THESE PLANS COULD RESULT IN ADDITIONAL CONDUIT WORK, REENGINEERING, UPSIZED CABLE AND/OR ADDITIONAL POWER REQUIREMENTS.

12. PAINT ALL FIRE ALARM JUNCTION BOXES AND COVERS RED IN UNFINISHED AREAS (IE ABOVE CEILINGS, MECHANICAL ROOMS ETC.) IN FINISHED AREAS CONDUIT AND JUNCTION BOXES CAN BE PAINTED TO MATCH THE ROOM FINISH. THE INSIDE COVER IF THE JUNCTION BOX MUST BE IDENTIFIED AS "FIRE ALARM" AND THE CONDUIT MUST HAVE PAINTED RED BANDS 2" WIDE AT 10" CENTERS AND AT EACH END OF A FLOOR, WALL OR CEILING PENETRATION.


14. ALL NOTIFICATION DEVICES SHALL BE SYNCHRONIZED.

15. A STAMPED SET OF APPROVED FIRE ALARM PLANS SHALL BE AT THE JOBSITE AND USED FOR INSTALLATION.

16. SIGNALING LINE CIRCUIT IS CLASS B, STYLE 4

17. NOTIFICATION APPLIANCE CIRCUIT IS CLASS B, STYLE 1

18. ALL SMOKE DETECTORS SHALL BE INSTALLED AT LEAST 18" FROM FLUORESCENT LIGHT FIXTURES TO AVOID UNWANTED ALARMS AND SHALL BE INSTALLED IN AREAS THAT DO NOT EXCEED THE MANUFACTURER’S OPERATING TEMPERATURE RANGE BETWEEN 32°F AND 120°F.

CODE REGULATIONS

CENTER FOR SCIENCE AND MATHEMATICS
CALIFORNIA STATE POLYTECHNIC UNIVERSITY
SAN LUIS OBISPO, CALIFORNIA 93407
FIRE ALARM & EMERGENCY COMMUNICATION SYSTEM

SITE PLAN

CENTER FOR SCIENCE

PROJECT DESCRIPTION

1. OCCUPANCY TYPE: A, B, AND H

2. SYSTEM TYPE: CLASS B, ADDRESSEABLE, MANUAL

3. METHOD OF COMMUNICATION: TELEPHONE

4. SCOPE OF WORK: FIRE ALARM & VOICE EVACUATION SYSTEMS

WIRING LEGEND

DRAWING INDEX

AS-BUILT
SET COVER SHEET
FIRE ALARM FIRST FLOOR WEST
SCALE 1/8" = 1'
FIRE ALARM SECOND FLOOR EAST

SCALE 1/8" = 1'

SHEET NOTES
1. PROVIDE FIRE ALARM BEAM DETECTORS TRANSMITTER AND RECEIVER. INTERLOCK WITH SMOKE EVACUATION SYSTEM SUCH THAT WHEN BEAM DETECTOR IS ACTIVATED, SMOKE EVACUATION SYSTEM IS ACTIVATED. REFER TO DETAIL 4 & SFA 2.0.

2. ACTIVATION OF A MANUAL PULL STATION, BEAM DETECTOR OR SPRINKLER WATER FLOW WITHIN THE ATRIUM SHALL ACTIVATE ATRIUM SMOKE EVACUATION SYSTEM. SMOKE EVACUATION SYSTEM SHALL FUNCTION AS DIRECTED BY MECHANICAL DOCUMENTS. REFER TO DETAIL 5.9 FOR ADDITIONAL INFORMATION.

3. ACTIVATION OF ANY ALARM ANYWHERE WITHIN THE BUILDING SHALL SHUT DOWN ALL AIR HANDLING UNITS.

4. ACTIVATION OF THE ATRIUM SMOKE CONTROL SYSTEM SHALL OPEN ALL ATRIUM DOORS WITH MOTORIZED DOOR OPERATORS.
FIRE ALARM THIRD FLOOR WEST

SCALE 1/8" = 1'0"
FIRE ALARM THIRD FLOOR EAST
SCALE 1/8" = 1'

SHEET NOTES
1. PROVIDE FIRE ALARM BEAM DETECTORS TRANSMITTER AND RECEIVER. INTERLOCK WITH SMOKE EVACUATION SYSTEM SUCH THAT WHEN BEAM DETECTOR IS ACTIVATED, SMOKE EVACUATION SYSTEM IS ACTIVATED. REFER TO DETAIL A & B PAS.

2. ACTIVATION OF A MANUAL PULL STATION, BEAM DETECTOR OR SPRINKLER WATER FLOW WITHIN THE ATRIUM SHALL ACTIVATE ATRIUM SMOKE EVACUATION SYSTEM. SMOKE EVACUATION SYSTEM SHALL FUNCTION AS DIRECTED BY MECHANICAL DOCUMENTS. REFER TO DETAIL BWA & PAS FOR ADDITIONAL INFORMATION.

3. ACTIVATION OF AN ALARM ANYWHERE WITHIN THE BUILDING SHALL SHUT DOWN ALL AIR HANDLING UNITS.

4. ACTIVATION OF THE ATRIUM SMOKE CONTROL SYSTEM SHALL OPEN ALL ATRIUM DOORS WITH MOTORIZED DOOR OPERATORS.
Sheet Notes:

1. Provide fire alarm smoke detector transmitter and receiver. Interlock with smoke evacuation system such that when beam detector is activated, smoke evacuation system is activated. Refer to Detail 4 & 6 for details.

2. Activation of a manual pull station, beam detector or sprinkler water flow within the atrium shall activate atrium smoke evacuation system. Smoke evacuation system shall function as directed by mechanical documents. Refer to detail 5968.05 for additional information.

3. Activation of an alarm anywhere within the building shall shut down all air handling units.

4. Activation of the atrium smoke control system shall open all atrium doors with motorized door operators.

Symbol Legend:

Wiring Legend:

Drawing Index:

1. Cover Sheet
2. Riser Diagram
3. First Floor West
4. Second Floor East
5. Second Floor West
6. Third Floor East
7. Third Floor West
8. Fourth Floor East
9. Fourth Floor West
10. Fifth Floor East
11. Fifth Floor West
12. Sixth Floor East
13. Seventh Floor East
14. Calculations
15. Details
FIRE ALARM FIFTH FLOOR EAST
SCALE 1/8" = 1'-0"

SYMBOL LEGEND

WIRING LEGEND

DRAWING INDEX

1 PROVIDE FIRE ALARM BEAM DETECTORS TRANSMITTER AND RECEIVER, INTERLOCK WITH
SMOKE EVACUATION SYSTEM SUCH THAT WHEN BEAM DETECTOR IS ACTIVATED, SMOKE
EVACUATION SYSTEM IS ACTIVATED. REFER TO DETAIL 4 & 5 SYAG.

2 ACTIVATION OF A MANUAL, FULL STATION, BEAM DETECTOR OR SPRINKLER WATER FLOW
WITHIN THE ATRIUM SHALL ACTIVATE ATRIUM SMOKE EVACUATION SYSTEM. SMOKE
EVACUATION SYSTEM SHALL FUNCTION AS DIRECTED BY MECHANICAL DOCUMENTS. REFER
TO DETAIL 5 SYAG FOR ADDITIONAL INFORMATION.

3 ACTIVATION OF AN ALARM ANYWHERE WITHIN THE BUILDING SHALL SHUT DOWN ALL AIR
HANDLING UNITS.

4 ACTIVATION OF THE ATRIUM SMOKE CONTROL SYSTEM SHALL OPEN ALL ATRIUM DOORS
WITH MOTORIZED DOOR OPERATORS.
FIRE ALARM FIFTH FLOOR EAST
SCALE 1/8" = 1'-0"

SHEET NOTES
1. PROVIDE FIRE ALARM BEAM DETECTORS TRANSMITTER AND RECEIVER, INTERLOCK WITH SMOK EVACUATION SYSTEM SUCH THAT WHEN BEAM DETECTOR IS ACTIVATED, SMOK EVACUATION SYSTEM IS ACTIVATED. REFER TO DETAIL 4 & FIG. 0.

2. ACTIVATION OF A MANUAL FULL STATION, BEAM DETECTOR OR SPRINKLER WATER FLOW WITHIN THE ATRIUM SHALL ACTIVATE ATRIUM SMOK EVACUATION SYSTEM. SMOK EVACUATION SYSTEM SHALL FUNCTION AS DIRECTED BY MECHANICAL DOCUMENTS. REFER TO DETAIL 5 SIN FOR ADDITIONAL INFORMATION.

3. ACTIVATION OF AN ALARM ANYWHERE WITHIN THE BUILDING SHALL SHUT DOWN ALL AIR HANDLING UNITS.

4. ACTIVATION OF THE ATRIUM SMOK CONTROL SYSTEM SHALL OPEN ALL ATRIUM DOORS WITH MOTORIZED DOOR OPERATORS.

SYMBOL LEGEND

WIRING LEGEND

DRAWING INDEX

1. COVER SHEET
2. RES. SCHEMATICS
3. FIRST FLOOR WEST
4. SECOND FLOOR EAST
5.的第一 FLOOR WEST
6. THIRD FLOOR EAST
7. 第三 FLOOR WEST
8. 第四 FLOOR EAST
9. 第五 FLOOR EAST
10. 第六 FLOOR WEST
11. 第七 FLOOR EAST
12. 第八 FLOOR EAST
13. 第九 FLOOR EAST
14. 第十 FLOOR EAST
15. 第十一 FLOOR EAST
16. 第十二 FLOOR EAST
17. 第十三 FLOOR EAST
18. 第十四 FLOOR EAST
19. 第十五 FLOOR EAST
20. 第十六 FLOOR EAST
FIRE ALARM SIXTH FLOOR EAST
SCALE 1/8" = 1'0"

Sheets Notes:
1. PROVIDE FIRE ALARM BEAM DETECTORS, TRANSMITTER AND RECEIVER, INTERLOCK WITH SMOKE EVACUATION SYSTEM SUCH THAT WHEN BEAM DETECTOR IS ACTIVATED, SMOKE EVACUATION SYSTEM IS ACTIVATED. REFER TO DETAIL A & B & TAB B.
2. ACTIVATION OF A MANUAL PULL STATION, BEAM DETECTOR OR SPRINKLER WATER FLOW WITHIN THE ATRIUM SHALL ACTIVATE ATRIUM SMOKE EVACUATION SYSTEM. SMOKE EVACUATION SYSTEM IS CAPABLE OF FUNCTION AS PERMITTED BY MECHANICAL DOCUMENTS. REFER TO DRAWING DWG 05 FOR ADDITIONAL INFORMATION.
3. ACTIVATION OF AN ALARM ANYWHERE WITHIN THE BUILDING SHALL SHUT DOWN ALL AIR HANDLING UNITS.
4. ACTIVATION OF THE ATRIUM SMOKE CONTROL SYSTEM SHALL OPEN ALL ATRIUM DOORS WITH MOTORIZED DOOR OPERATORS.
### INPUT PARAMETERS

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### CALC. PARAMETERS

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1. PROPERTY INFORMATION

Name of property: Cal Poly Center For Math And Science 180
Address: 01 Grand AVE, SAW LUIS OBIPO, CA 93407
Description of property: CLASSROOM LABS, LECTURE HALLS, FACULTY OFFICES
Occupancy type: A, B, H3
Name of property representative: GILIANECO - CONTRACTOR, CAL POLY FACILITIES + CAPITOL PROJECTS
Address: 1 GRAND AVE, BLDG 70 - SAW LUIS OBIPO, CA 93407
Phone: 805-441-2786 Fax: 805-441-2786 E-mail: psud@calpoly.edu
Authority having jurisdiction over this property: OSFM 123456 SHE AVE FRESNO, CA 93710
Phone: 916-825-7880 Fax: 805-441-2786 E-mail: polyparent@fire.ca.gov

2. INSTALLATION, SERVICE, AND TESTING CONTRACTOR INFORMATION

Installation contractor for this equipment: Deep Blue Integration Inc.
Address: 3442 Empress Dr., Suite C, San Luis Obispo, California, 93401
License or certification number: B, C-10, C-16 #943465
Phone: 1-888-600-0324 Fax: 805-791-2037 E-mail: info@deepblueintegration.com
Service organization for this equipment: Deep Blue Integration Inc.
Address: 3442 Empress Dr., Suite C, San Luis Obispo, California, 93401
License or certification number: B, C-10, C-16 #943465
Phone: 888-600-0324 Fax: 805-791-2037 E-mail: info@deepblueintegration.com
A contract for test and inspection in accordance with NFPA standards is in effect as of:
Contracted testing company: N/A
Address:
Phone: Fax: E-mail:
Contract expires: Contract number: Frequency of routine inspections:

3. DESCRIPTION OF SYSTEM OR SERVICE

☐ Fire alarm system (nonvoice)
☐ Fire alarm with in-building fire emergency voice alarm communication system (EVACS)
☐ Mass notification system (MNS)
☐ Combination system, with the following components:
  ☐ Fire alarm ☐ EVACS ☐ MNS ☐ Two-way, in-building, emergency communication system
  ☐ Other (specify):

NFPA 72, Fig. 10.18.2.1.1 (p. 1 of 12)
3. DESCRIPTION OF SYSTEM OR SERVICE (continued)

NFPA 72 edition: Additional description of system(s):

3.1 Control Unit
Manufacturer: Honeywell Notifier

3.2 Mass Notification System

3.2.1 System Type:
☐ In-building MNS—combination
☐ In-building MNS—stand-alone ☐ Wide-area MNS ☐ Distributed recipient MNS
☐ Other (specify):

3.2.2 System Features:
☒ Combination fire alarm/MNS ☐ MNS autonomous control unit ☐ Wide-area MNS to regional national alerting interface
☐ Local operating console (LOC) ☐ Direct recipient MNS (DRMNS) ☐ Wide-area MNS to DRMNS interface
☐ Wide-area MNS to high-power speaker array (HPSA) interface ☐ In-building MNS to wide-area MNS interface
☐ Other (specify):

3.3 System Documentation
☒ An owner’s manual, a copy of the manufacturer’s instructions, a written sequence of operation, and a copy of the numbered record drawings are stored on site. Location: At Alarm Panel

3.4 System Software
☒ This system does not have alterable site-specific software.

Operating system (executive) software revision level:
Site-specific software revision date: 2-2013 Revision completed by: Honeywell
☐ A copy of the site-specific software is stored on site. Location:

3.5 Off-Premises Signal Transmission
☒ This system does not have off-premises transmission.

Name of organization receiving alarm signals with phone numbers:

Alarm: Cal Poly Dispatch Center Phone: 805-756-2281
Supervisory: Cal Poly Dispatch Center Phone: 805-756-2281
Trouble: Cal Poly Dispatch Center Phone: 805-756-2281

Entity to which alarms are retransmitted: DACT
Method of retransmission: 🅽undi

If Chapter 26, specify the means of transmission from the protected premises to the supervising station:

If Chapter 27, specify the type of auxiliary alarm system: ☐ Local energy ☐ Shunt ☐ Wired ☐ Wireless

NFPA 72, Fig. 10.18.2.1.1 (p. 2 of 12)
4. CIRCUITS AND PATHWAYS

4.1 Signaling Line Pathways

4.1.1 Pathways Class Designations and Survivability

Pathways class: \( B \)  
Survivability level: 1  
Quantity: 2

(See NFPA 72, Sections 12.3 and 12.4)

4.1.2 Pathways Utilizing Two or More Media

Quantity:  
Description:

4.1.3 Device Power Pathways

☒ No separate power pathways from the signaling line pathway

☐ Power pathways are separate but of the same pathway classification as the signaling line pathway

☐ Power pathways are separate and different classification from the signaling line pathway

4.1.4 Isolation Modules

Quantity:

4.2 Alarm Initiating Device Pathways

4.2.1 Pathways Class Designations and Survivability

Pathways class:  
Survivability level:  
Quantity:

(See NFPA 72, Sections 12.3 and 12.4)

4.2.2 Pathways Utilizing Two or More Media

Quantity:  
Description:

4.2.3 Device Power Pathways

☒ No separate power pathways from the initiating device pathway

☐ Power pathways are separate but of the same pathway classification as the initiating device pathway

☐ Power pathways are separate and different classification from the initiating device pathway

4.3 Non-Voice Audible System Pathways

4.3.1 Pathways Class Designations and Survivability

Pathways class: \( B \)  
Survivability level: 1  
Quantity: 22

(See NFPA 72, Sections 12.3 and 12.4)

4.3.2 Pathways Utilizing Two or More Media

Quantity:  
Description:

4.3.3 Device Power Pathways

☒ No separate power pathways from the notification appliance pathway

☐ Power pathways are separate but of the same pathway classification as the notification appliance pathway

☐ Power pathways are separate and different classification from the notification appliance pathway
5. ALARM INITIATING DEVICES

5.1 Manual Initiating Devices

5.1.1 Manual Fire Alarm Boxes
Type and number of devices: Addressable: **30** Conventional: Coded: Transmitter:

☐ This system does not have manual fire alarm boxes.

5.1.2 Other Alarm Boxes
Description:
Type and number of devices: Addressable: Conventional: Coded: Transmitter:

☐ This system does not have other alarm boxes.

5.2 Automatic Initiating Devices

5.2.1 Smoke Detectors
Type and number of devices: Addressable: **30** Conventional: Beam Smoke Detectors

☐ This system does not have smoke detectors.

Type of coverage: ☐ Complete area ☑ Partial area ☐ Nonrequired partial area

Type of smoke detector sensing technology: ☐ Ionization ☑ Photoelectric ☐ Multicriteria ☐ Aspirating ☑ Beam

5.2.2 Duct Smoke Detectors
Type and number of devices: Addressable: **62** Conventional:

☐ This system does not have alarm-causing duct smoke detectors.

Type of coverage: Partial Area - LOCAL @ SFD LOCATIONS

Type of smoke detector sensing technology: ☐ Ionization ☑ Photoelectric ☐ Aspirating ☐ Beam

5.2.3 Radiant Energy (Flame) Detectors
Type and number of devices: Addressable: Conventional:

☐ This system does not have radiant energy detectors.

5.2.4 Gas Detectors
Type of detector(s):
Number of devices: Addressable: Conventional:

☐ This system does not have gas detectors.

5.2.5 Heat Detectors
Type and number of devices: Addressable: Conventional:

☐ This system does not have heat detectors.

Type of coverage: ☐ Complete area ☐ Partial area ☐ Nonrequired partial area ☐ Linear ☐ Spot

Type of heat detector sensing technology: ☐ Fixed temperature ☐ Rate-of-rise ☐ Rate compensated
5. ALARM INITIATING DEVICES (continued)

5.2.6 Addressable Monitoring Modules
Number of devices: 29 - Troubles Monitors, Non-Alarm Points
☐ This system does not have monitoring modules.

5.2.7 Waterflow Alarm Devices
Type and number of devices: Addressable: 7 Conventional: Coded: Transmitter:
☐ This system does not have waterflow alarm devices.

5.2.8 Alarm Verification
Number of devices subject to alarm verification:
☒ This system does not incorporate alarm verification.
Alarm verification set for: seconds
☒ This system does not incorporate pre-signal.

5.2.9 Presignal
Number of devices subject to presignal:
Describe presignal functions:

5.2.10 Positive Alarm Sequence (PAS)
Describe PAS:
☒ This system does not incorporate PAS.

5.2.11 Other Initiating Devices
Describe:
☒ This system does not have other initiating devices.

6. SUPERVISING SIGNAL-INITIATING DEVICES

6.1 Sprinkler System Supervisory Devices
Type and number of devices: Addressable: 12 Conventional: Coded: Transmitter:
☐ This system does not have sprinkler supervisory devices.
Other (specify):

6.2 Fire Pump Description and Supervisory Devices
Type fire pump: ☒ Electric pump ☒ Engine
Type and number of devices: Addressable: 3 Conventional: Coded: Transmitter:
☐ This system does not have a fire pump.
Other (specify):

6.2.1 Fire Pump Functions Supplied
☒ Power ☒ Running ☒ Phase reversal ☐ Selector switch not in auto ☒ Engine or control panel trouble ☐ Low fuel
Other (specify):

6.3 Duct Smoke Detectors (DSDs)
Type and number of devices: Addressable: Conventional:
☐ This system does not have DSDs causing supervisory signals.
Other (specify):

Type of coverage:
Type of smoke detector sensing technology: ☐ Ionization ☐ Photoelectric ☐ Aspirating ☐ Beam

6.4 Other Supervisory Devices
Describe: Smoke Fire Damper Position Indicators Firefighter Smoke Control Panel
☐ This system does not have other supervisory devices.
7. MONITORED SYSTEMS

7.1 Engine-Driven Generator

☐ This system does not have a generator.

7.1.1 Generator Functions Supervised

☐ Engine or control panel trouble  ☐ Generator running  ☐ Selector switch not in auto  ☐ Low fuel
☐ Other (specify):

7.2 Special Hazard Suppression Systems

☒ This system does not monitor special hazard systems.

Description of special hazard system(s):

7.3 Other Monitoring Systems

☒ This system does not monitor other systems.

Description of special hazard system(s):

8. ANNUCIAITORS

8.1 Location and Description of Annunciators

Location 1:  Floor 2 North Lobby
Location 2:  Floor 1 West Lobby
Location 3:

☐ This system does not have annunciators.

9. ALARM NOTIFICATION APPLIANCES

9.1 In-Building Fire Emergency Voice Alarm Communication System

☐ This system does not have an EVACS.

Number of single voice alarm channels:  1
Number of multiple voice alarm channels:  9
Number of speakers:  172
Number of speaker circuits:  Electrical Rooms at FAPS Locations

Location of amplification and sound-processing equipment:  AT FA CU, Room 122
Location of paging microphone stations:
Location 1:  AT FA CU, Room 122
Location 2:
Location 3:

9.2 Nonvoice Notification Appliances

☐ This system does not have nonvoice notification appliances.

Horns:  66  With visible:  —
Bells:  1  With visible:  66
Chimes:  66  With visible:  —
Visible only:  66  Other (describe):

9.3 Notification Appliance Power Extender Panels

☐ This system does not have power extender panels.

Quantity:  4
Locations: Rooms 267, 332, 467, 632

NFPA 72, Fig. 10.18.2.1.1 (p. 6 of 12)
10. MASS NOTIFICATION CONTROLS, APPLIANCES, AND CIRCUITS

This system does not have an MNS.

10.1 MNS Local Operating Consoles
Location 1:
Location 2:
Location 3:

10.2 High-Power Speaker Arrays
Number of HPSA speaker initiation zones:
Location 1:
Location 2:
Location 3:

10.3 Mass Notification Devices
Combination fire alarm/MNS visible appliances:
MNS-only visible appliances:
Textual signs:
Other (describe):
Supervision class:

10.3.1 Special Hazard Notification
☐ This system does not have special suppression predischarge notification.
☐ MNS systems DO NOT override notification appliances required to provide special suppression predischarge notification.

11. TWO-WAY EMERGENCY COMMUNICATION SYSTEMS

11.1 Telephone System
☐ This system does not have a two-way telephone system.
Number of telephone jacks installed: 12
Number of warden stations installed: 5
Type of telephone system installed: ☑ Sound powered

11.2 Two-Way Radio Communications Enhancement System
☒ This system does not have a two-way radio communications enhancement system.
Percentage of area covered by two-way radio service: Critical areas: % General building areas: %
Amplification component locations:
Inbound signal strength: dBm Outbound signal strength: dBm
Donor antenna isolation is: dB above the signal booster gain
Radio frequencies covered:
Radio system monitor panel location:
11. TWO-WAY EMERGENCY COMMUNICATION SYSTEMS (continued)

11.3 Area of Refuge (Area of Rescue Assistance) Emergency Communications Systems

This system does not have an area of refuge (area of rescue assistance) emergency communications system.

Number of stations: Location of central control point:

Days and hours when central control point is attended:

Location of alternate control point:

Days and hours when alternate control point is attended:

11.4 Elevator Emergency Communications Systems

This system does not have an elevator emergency communications system.

Number of elevators with stations: Location of central control point:

Days and hours when central control point is attended:

Location of alternate control point:

Days and hours when alternate control point is attended:

11.5 Other Two-Way Communication Systems

Describe:

12. CONTROL FUNCTIONS

This system activates the following control functions:

☑ Hold-open door releasing devices ☑ Smoke management ☐ HVAC shutdown ☐ F/S dampers
☐ Door unlocking ☑ Elevator recall ☐ Fuel source shutdown ☐ Extinguishing agent release
☐ Elevator shunt trip ☐ Mass notification system override of fire alarm notification appliances

Other (specify):

12.1 Addressable Control Modules

☐ This system does not have control modules.

Number of devices: 9 ☑ - RELAY + CONTROL FUNCTIONS

Other (specify):

13. SYSTEM POWER

13.1 Control Unit

13.1.1 Primary Power

Input voltage of control panel: 120 VAC Control panel amps: 6 AMP
Overcurrent protection: Type: BREAKER Amps: 20 AMP
Location (of primary supply panel board): PANEL 1D W, CIRCUIT #
Disconnecting means location: TEL/DATA ROOM # 106

13.1.2 Engine-Driven Generator

☑ This system does not have a generator.

Location of generator:

Location of fuel storage: Type of fuel:
13. SYSTEM POWER (continued)

13.1.3 Uninterruptible Power System

Equipment powered by a UPS system:

Location of UPS system:

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): \(24\)  
In alarm mode (minutes): \(15\)

13.1.4 Batteries

Location: \(AT\) FACU Type: \(SLA\)  
Nominal voltage: \(12\) VDC  
Amp-hour rating: \(55\) AH

Calculated capacity of batteries to drive the system:

In standby mode (hours): \(24\)  
In alarm mode (minutes): \(15\)

\(\checkmark\) Batteries are marked with date of manufacture  
\(\square\) Battery calculations are attached

13.2 In-Building Fire Emergency Voice Alarm Communication System or Mass Notification System

\(\square\) This system does not have an EVACS or MNS system.

13.2.1 Primary Power

Input voltage of EVACS or MNS panel: \(120\) VAC  
EVACS or MNS panel amps: \(3\) AMP

Overcurrent protection: Type: \(B\)RE\(A\)K\(E\)  
Amps: \(20\) AMP

Location (of primary supply panel board): \(P\)ANEL  
\(DW\) CIRCUIT

Disconnecting means location: \(TE\)L/\(P\)AT\(A\) \(R\)oom \(106\)

13.2.2 Engine-Driven Generator

Location of generator:

Location of fuel storage: Type of fuel:

13.2.3 Uninterruptible Power System

Equipment powered by a UPS system:

Location of UPS system:

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): \(\)  
In alarm mode (minutes): \(\)

13.2.4 Batteries

Location: \(AT\) FACU Type: \(SLA\)  
Nominal voltage: \(12\) VDC  
Amp-hour rating: \(55\) AH

Calculated capacity of batteries to drive the system:

In standby mode (hours): \(24\)  
In alarm mode (minutes): \(15\)

\(\checkmark\) Batteries are marked with date of manufacture  
\(\square\) Battery calculations are attached

\(\checkmark\) This system does not have a generator.

\(\checkmark\) This system does not have a UPS.
13. SYSTEM POWER (continued)

13.3 Notification Appliance Power Extender Panels

13.3.1 Primary Power

Input voltage of power extender panel(s): 120 VAC

Power extender panel amps: 6 AMP

Overcurrent protection: Type: Breaker

Amps: 20 AMP

Location of primary supply panel board:

Disconnecting means location:

13.3.2 Engine-Driven Generator

Location of generator:

Location of fuel storage:

Type of fuel:

13.3.3 Uninterruptible Power System

Equipment powered by a UPS system:

Location of UPS system:

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): In alarm mode (minutes):

13.3.4 Batteries

Location: Type: Nominal voltage: Amp/hour rating:

Calculated capacity of batteries to drive the system:

In standby mode (hours): In alarm mode (minutes):

☐ Batteries are marked with date of manufacture ☐ Battery calculations are attached

14. RECORD OF SYSTEM INSTALLATION

Fill out after all installation is complete and wiring has been checked for opens, shorts, ground faults, and improper branching, but before conducting operational acceptance tests.

This is a: ☑ New system ☐ Modification to an existing system Permit number:

The system has been installed in accordance with the following requirements: (Note any or all that apply.)

☐ NFPA 72, Edition: 2007


☒ Manufacturer’s published instructions

Other (specify): CBC 2007, CFC 2007, PARTS OF CFC 2010

System deviations from referenced NFPA standards:

NONE

Signed: Printed name: Curtis Speeter Date: Phone: 888-600-0324

Organization: DEEP BLUE INTEGRITY, INC. Title: PRESIDENT

NFPA 72, Fig. 10.18.2.1.1 (p. 10 of 12)
15. RECORD OF SYSTEM OPERATIONAL ACCEPTANCE TEST

☐ New system

All operational features and functions of this system were tested by, or in the presence of, the signer shown below, on the date shown below, and were found to be operating properly in accordance with the requirements for the following:

☐ Modifications to an existing system

All newly modified operational features and functions of the system were tested by, or in the presence of, the signer shown below, on the date shown below, and were found to be operating properly in accordance with the requirements of the following:

☐ NFPA 72, Edition: 2007


☐ Manufacturer's published instructions

☐ Approved plans + specifications


☑ Individual device testing documentation [Inspection and Testing Form (Figure 14.6.2.4) is attached]

On CD Rom

Signed: [Signature]

Printed name: CURTIS STREETER

Organization: DEEP BLUE INTEGRATION INC.

Title: PRESIDENT

Date: 8-15-13

Phone: 888-600-0324

16. CERTIFICATIONS AND APPROVALS

16.1 System Installation Contractor:

This system, as specified herein, has been installed and tested according to all NFPA standards cited herein.

Signed: [Signature]

Printed name: CURTIS STREETER

Organization: DEEP BLUE INTEGRATION INC.

Title: PRESIDENT

Date: 8-15-13

Phone: 888-600-0324

16.2 System Service Contractor:

The undersigned has a service contract for this system in effect as of the date shown below.

Signed: [Signature]

Printed name: CURTIS STREETER

Organization: DEEP BLUE INTEGRATION INC.

Title: PRESIDENT

Date: 8-15-13

Phone: 888-600-0324

16.3 Supervising Station:

This system, as specified herein, will be monitored according to all NFPA standards cited herein.

Signed: [Signature]

Printed name: CURTIS STREETER

Organization: DEEP BLUE INTEGRATION INC.

Title: PRESIDENT

Date: 8-15-13

Phone: 888-600-0324
16. CERTIFICATIONS AND APPROVALS (continued)

16.4 Property or Owner Representative:

This system, as specified herein, will be monitored according to all NFPA standards cited herein.

Signed: [Signature]

Organization: Capital Facilities

Printed name: Perry Judd

Date: [Date]

Phone: 805-441-2186

16.5 Authority Having Jurisdiction:

I have witnessed a satisfactory acceptance test of this system and find it to be installed and operating properly in accordance with its approved plans and specifications, with its approved sequence of operations, and with all NFPA standards cited herein.

Signed: Polly Parenti

Organization: OSFM

Printed name: Polly Parenti

Title: Deputy State Fire Marshal

Date: 8-15-13

Phone: 916-325-7850

NFPA 72, Fig. 10.18.2.1.1 (p. 12 of 12)
CAB-4 Series Cabinets
ONYX® Series Backboxes
with Locking Doors

General
All cabinets for NOTIFIER fire alarm control panels are fabricated from 16-gauge steel. The cabinet assembly consists of two basic parts: a backbox and a locking door. Cabinets are available in either black or red, with or without windows. The window model provides a tasteful combination to accent the decor of the finest lobby setting.

- The key-locked door is provided with a pin-type hinge, two keys and the necessary hardware to mount the door to the backbox.
- The backbox has been engineered to provide ease-of-entry for the installer. Knockouts are positioned at numerous points to aid the installer in bringing a conduit into the enclosure with a minimum of hardship.
- Right- or left-hand hinges, selectable in the field. Door opens 180°.
- Cabinets are arranged in four standard sizes, A (one tier) through D (four tiers), plus a mini cabinet (AA, one tier without a battery compartment). See Ordering Information.
- A trim ring option is available for semi-flush mounting.
- Chassis bridge available for assembling multiple CHS-4 chassis external to the backbox.
- Certified for seismic applications when used with the appropriate seismic mounting kit.

Ordering Information
A complete cabinet assembly consists of: a door, a backbox, an optional battery plate, and an optional semi-flush trim ring. For each cabinet required, order one “DR” door and one “SBB” backbox. The BP2-4 battery plate is required for each cabinet assembly that mounts batteries and/or a power supply in the lower position of the cabinet. The optional trim ring is an attractive “picture frame”-style black metal ring.

MINI “AA” SIZE, ONE TIER
DR-AA4: Door assembly, window, one tier (no battery compartment), BLACK.
DR-AA4R: Door assembly, window, one tier (no battery compartment), RED.
DR-AA4B: Door assembly, solid door, one tier (no battery compartment), BLACK.
DR-AA4BR: Door assembly, solid door, one tier (no battery compartment), RED.
SBB-AA4: Backbox assembly, one tier (no battery compartment), BLACK.
SBB-AA4R: Backbox assembly, one tier (no battery compartment), RED.

NOTE: Black trim rings are used with red or black cabinets.

ONE TIER, “A” SIZE
DR-A4: Door assembly, window, one tier, BLACK.
DR-A4R: Door assembly, window, one tier, RED.
DR-A4B: Door assembly, solid door, one tier, BLACK.

TWO TIERS, “B” SIZE
DR-B4: Door assembly, window, two tiers, BLACK.
DR-B4R: Door assembly, window, two tiers, RED.
ADDR-B4: Two-tier-sized door designed for use with a CA-2 chassis mounted in the top rows. BLACK.
ADDR-B4R: Two-tier-sized door designed for use with a CA-2 chassis mounted in the top rows. RED.
DR-B4B: Door assembly, solid door, two tiers, BLACK.
DR-B4BR: Door assembly, solid door, two tiers, RED.
SBB-B4: Backbox assembly, two tiers, BLACK.
SBB-B4R: Backbox assembly, two tiers, RED.

NOTE: Black trim rings are used with red or black cabinets.

BP2-4: Battery plate. Used to cover battery and power supply when lower position is used in backbox.

THREE TIERS, “C” SIZE
DR-C4: Door assembly, window, three tiers, BLACK.
DR-C4R: Door assembly, window, three tiers, RED.
ADDR-C4: Three-tier-sized door designed for use with a CA-2 chassis mounted in the top rows. BLACK.
ADDR-C4R: Three-tier-sized door designed for use with a CA-2 chassis mounted in the top rows. RED.
DR-C4B: Door assembly, solid door, three tiers, BLACK.
DR-C4BR: Door assembly, solid door, three tiers, RED.
SBB-C4: Backbox assembly, three tiers, BLACK.
SBB-C4R: Backbox assembly, three tiers, RED.

NOTE: Black trim rings are used with red or black cabinets.

BP2-4: Battery plate. Used to cover battery and power supply when lower position is used in backbox.

FOUR TIERS, “D” SIZE

DR-D4: Door assembly, window, four tiers, BLACK.
DR-D4R: Door assembly, window, four tiers, RED.
ADDR-D4: Four-tier-sized door designed for use with a CA-2 chassis mounted in the top rows. BLACK.
ADDR-D4R: Four-tier-sized door designed for use with a CA-2 chassis mounted in the top rows. RED.
DR-D4B: Door assembly, solid door, four tiers, BLACK.
DR-D4BR: Door assembly, solid door, four tiers, RED.
SBB-D4: Backbox assembly, four tiers, BLACK.
SBB-D4R: Backbox assembly, four tiers, RED.

NOTE: Black trim rings are used with red or black cabinets.

BP2-4: Battery plate. Used to cover battery and power supply when lower position is used in backbox.

ACCESSORIES

ADP-4B: Annunciator dress panel.
CB-1: Chassis bridge. Provides a bridge between CHS Series chassis.
DP-1B: Blank dress panel, covers one CAB-4 tier, BLACK.
SEISKIT-CAB: Seismic mounting kit. Required for seismic-certified applications with NFS2-3030, NFS2-640, and NFS-320SYS. Includes battery bracket for two 26 AH batteries.
VP-2B: Ventilator panel.
WC-2: Wire channel. Provides a pair of wire trays to neatly route wiring between CHS chassis.

Agency Listings and Approvals

These listings and approvals below apply to the CAB-4 Series Cabinets. In some cases, certain modules or applications may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- UL Listed: S635
- ULC Listed: S635
- MEA: 317-01-E, 345-02-E
- CSFM: 7165-0028:0243 (NFS2-640), 7165-0028:0224 (NFS2-3030)
- FM approved
- FDNY: COA# 6067, COA# 6065

Cabinet Dimensions and Features

Knockouts on top of cabinets.

Keyhole dimensions

Height of mounting bolt after installation

"A" SIZE CABINET

Cabinet Dimensions and Features

Knockouts on top of cabinets.

Keyhole dimensions

Height of mounting bolt after installation

"A" SIZE CABINET

Cabinet Dimensions and Features

Knockouts on top of cabinets.

Keyhole dimensions

Height of mounting bolt after installation

"A" SIZE CABINET
The BP2-4 Battery Plate covers the Main Power Supply and the batteries in the cabinet. Only one BP2-4 is required per cabinet unless an AA cabinet is used (no battery compartment).

"D" sized cabinet with solid door. Solid door option available on all sizes in black or red.
FDU-80
80 Character Liquid Crystal Display

General
The FDU-80 is a compact, cost-effective, 80-character, backlit LCD remote Fire Annunciator for use with the NOTIFIER Fire-Warden-100-2, NFS2-640, and NFS-320 Fire Alarm Control Panels (FACPs). The FDU-80 mimics the display of the control panel and displays complete system point status information.

Up to 32 FDU-80s may be connected onto the EIA-485 terminal port of each FACP. The FDU-80 requires no programming, which saves time during system commissioning.

Features
• 80-character Liquid Crystal Display.
• Mimics all display information from the host panel.
• Control switches for System Acknowledge, Signal Silence, Drill and Reset with enable key.
• System status LEDs for Power, Alarm, Trouble, Supervisory and Alarm Silenced.
• No programming necessary — FDU-80 connects to the terminal port on the FACP.
• Displays device type identifiers, individual point alarm, trouble or supervisory, zone and custom alpha labels.
• Time-and-date display field.
• Aesthetically pleasing design.
• May be powered from the host FACP or by remote power supply (requires 24 VDC).
• Up to 32 FDU-80 annunciators per FACP.
• Plug-in terminal blocks for ease of installation and service.
• Can be remotely located up to 6,000 feet (1828.8 m) from the FACP.
• Local piezo sounder with alarm and trouble resound.
• Semi-flush mounts to 2.188" (5.556 cm) minimum deep, three-gang electrical box (NOTIFIER PN 10103) or three-gangable electrical switchbox.
• Surface-mounts to NOTIFIER PN SBB-3 surface backbox.

Operation
The FDU-80 annunciator provides the FACP with point annunciation with full display text on an 80-character LCD display. The FDU-80 also provides an array of LEDs to indicate system status, and includes control switches for remote control of critical system functions.

The FDU-80 provides the FACP with up to 32 remote serially connected annunciators. All field-wiring terminations on the FDU-80 use removable, compression-type terminal blocks for ease of wiring and circuit testing.

Communication between the FACP and the annunciators is accomplished over an EIA-485 serial interface, which greatly reduces wire and installation cost over traditional systems.

Installation
The FDU-80 can be semi-flush mounted to a 2.188" (5.556 cm) minimum deep, three-gang electrical box or three-gangable electrical switchboxes. Alternately, an SBB-3 surface backbox is available for surface-mount applications.

Ordering Information
FDU-80: 80 character, backlit, LCD Fire Annunciator with control switches for remote control of system functions, and key-switch lock.

FDU-80C: ULC-listed version; see DN-60573 for details.

10103: Three-gang electrical box, minimum 2.188" (5.556 cm) deep, for semi-flush mount applications.

SBB-3: Three-gang surface backbox for surface-mount applications.

Agency Listings And Approvals
These listings and approvals apply to the modules specified in this document. In some cases, certain modules or applications may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

• UL Listed: S635
• MEA Listed: 245-00-E
• FDNY: COA#6038
• CSFM: 7120-0028:209
• FM Approved

NOTE: For ULC-listed version, see DN-60573.
NBG-12LX
Addressable Manual Pull Station

General
The Notifier NBG-12LX is a state-of-the-art, dual-action (i.e., requires two motions to activate the station) pull station that includes an addressable interface for any Notifier intelligent control panel except FireWarden series panels, and the NSP-25 panel. Because the NBG-12LX is addressable, the control panel can display the exact location of the activated manual station. This leads fire personnel quickly to the location of the alarm.

Features
- Maintenance personnel can open station for inspection and address setting without causing an alarm condition.
- Built-in bicolor LED, which is visible through the handle of the station, flashes in normal operation and latches steady red when in alarm.
- Handle latches in down position and the word “ACTIVATED” appears to clearly indicate the station has been operated.
- Captive screw terminals wire-ready for easy connection to SLC loop (accepts up to 12 AWG/3.25 mm² wire).
- Can be surface mounted (with SB-10 or SB-I/O) or semi-flush mounted. Semi-flush mount to a standard single-gang, double-gang, or 4” (10.16 cm) square electrical box.
- Smooth dual-action design.
- Meets ADAAG controls and operating mechanisms guidelines (Section 4.1.3[13]); meets ADA requirement for 5 lb. maximum activation force.
- Highly visible.
- Attractive shape and textured finish.
- Key reset.
- Includes Braille text on station handle.
- Optional trim ring (BG12TR).
- Meets UL 38, Standard for Manually Actuated Signaling Boxes.
- Up to 99 NBG-12LX stations per loop on CLIP protocol loops.
- Up to 159 NBG-12LX stations per loop on FlashScan® protocol loops.
- Dual-color LED blinks green to indicate normal on FlashScan® systems.

Construction
Shell, door, and handle are molded of durable polycarbonate material with a textured finish.

Specifications
- Shipping Weight: 9.6 oz. (272.15 g)
- Normal operating voltage: 24 VDC.
- Maximum SLC loop voltage: 28.0 VDC.
- Maximum SLC loop current: 375 μA.
- Temperature Range: 32°F to 120°F (0°C to 49°C)
- Relative Humidity: 10% to 93% (noncondensing)
- For use indoors in a dry location

Installation
The NBG-12LX will mount semi-flush into a single-gang, double-gang, or standard 4” (10.16 cm) square electrical outlet box, or will surface mount to the model SB-10 or SB-I/O surface backbox. If the NBG-12LX is being semi-flush mounted, then the optional trim ring (BG12TR) may be used. The BG12TR is usually needed for semi-flush mounting with 4” (10.16 cm) or double-gang boxes (not with single-gang boxes).

Operation
Pushing in, then pulling down on the handle causes it to latch in the down/activated position. Once latched, the word “ACTIVATED” (in bright yellow) appears at the top of the handle, while a portion of the handle protrudes from the bottom of the station. To reset the station, simply unlock the station with the key and pull the door open. This action resets the handle; closing the door automatically resets the switch.

Each manual station, on command from the control panel, sends data to the panel representing the state of the manual switch. Two rotary decimal switches allow address settings (1 – 159 on FlashScan® systems, 1 – 99 on CLIP systems).

Architectural/Engineering Specifications
Manual Fire Alarm Stations shall be non-coded, with a key-operated reset lock in order that they may be tested, and so designed that after actual Emergency Operation, they cannot be restored to normal except by use of a key. An operated station shall automatically condition itself so as to be visually detected as activated. Manual stations shall be constructed of red-colored polycarbonate material with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in white letters, 1.00 inches (2.54 cm) or larger. Stations shall be suitable for surface mounting on matching backbox SB-10 or SB-I/O, or semi-flush mounting on a standard single-gang, double-gang, or 4”
(10.16 cm) square electrical box, and shall be installed within the limits defined by the Americans with Disabilities Act (ADA) or per national/local requirements. Manual Stations shall be Underwriters Laboratories listed.

Manual stations shall connect with two wires to one of the control panel SLC loops. The manual station shall, on command from the control panel, send data to the panel representing the state of the manual switch. Manual stations shall provide address setting by use of rotary decimal switches.

The loop poll LED shall be clearly visible through the front of the station. The LED shall flash while in the normal condition, and stay steadily illuminated when in alarm.

**Product Line Information**

**NBG-12LX**: Dual-action addressable pull station. Includes key locking feature.

**SB-10**: Surface backbox; metal.

**SB-I/O**: Surface backbox; plastic.

**BG12TR**: Optional trim ring.

**17021**: Keys, set of two.

**NY-Plate**: New York City trim plate

**Agency Listings and Approvals**

In some cases, certain modules or applications may not be listed by certain approval agencies, or listing may be in progress. Consult factory for latest listing status.

- **UL / CUL Listed**: S692 (listed for Canadian and non-Canadian applications)
- **MEA**: 67-02-E
- **CSFM**: 7150-0028:0199
- **FDNY**: COA #6038 (NFS2-640), COA #6058 (NFS2-3030)
- **BSMI**: CI313066760047
- **U.S. Coast Guard**: 161.002/23/3 (AFP-200); 161.002/27/3 (AM-2020/AFP-1010); 161.002/42/1 (NFS-640)
- **Lloyd's Register**: 02/6007 (NFS-640); 94/60004 (E2) (AFP-200); 03/60011 (E1); 07/60007 (NFS2-3030)

**FM Approved**

**Patented**: U.S. Patent No. D428,351; 6,380,846; 6,314,772; 6,632,108.
ACPS-610(E)
Addressable Charger/Power Supply

General
The ACPS-610(E) is an auxiliary power supply with a battery charging option and a host of special features. Selectable charging options allow the ACPS-610(E) to provide 6 amps of shared power to four outputs while charging batteries from 12 to 200 AH, or 10 amps of shared power when the unit is configured for use with an external battery charger. Four individually addressable outputs can be independently configured for auxiliary power or Notification Appliance Circuits (NAC). NAC outputs support notification appliance synchronization for devices manufactured by System Sensor®, Wheelock, and Gentex. An option to disable battery charging allows the system designer to use the four built-in circuits to distribute 10 amps of power for general purposes, excluding NAC applications.

The ACPS-610(E) is compatible with NOTIFIER intelligent fire alarm control panels using CLIP and FlashScan® protocol.

Features
- Provides 6.0 A of NAC power or 10 A of general purpose power.
- Four Class B (Style Y) or four Class A (Style Z) outputs, individually addressable by the FACP.
- When built-in outputs are configured for NAC operation, each circuit supports strobe synchronization with the following manufacturers’ audio/visual devices: System Sensor (SpectrAlert® and SpectrAlert Advance Series) or Wheelock or Gentex.
- Each circuit can be software-selected for use as: a Notification Appliance Circuit, general purpose 24 VDC power, four-wire detector power, or door holder.
- Steady, March Time (120 PPM), Two Stage, Temporal, or UZC Zone-Coded and Non-Coded devices - software-selectable by circuit.
- Universal Zone Coder (UZC-256) option supports for programmable coded outputs. Up to 256 different codes.
- Auxiliary Outputs: 24V @ 0.5A and 5V @ 0.15A
- Charges 12 to 200 AH batteries with full supervision. The charger on the ACPS may be disabled via software. When disabled, a separate, external charger is required, for example a CHG-120.
- May be used to provide battery backup for multiple ACPS supplies.
- AC loss detection, brownout detection, and AC loss delay reporting.
- Power-limited outputs.
- Isolated Signaling Line Circuit (SLC) interface.
- Selectable ground fault detection.
- Canadian two stage operation.

Specifications
- Primary (AC) power:
  - ACPS-610: 120 VAC, 50/60 Hz input, 5.0 A maximum
  - ACPS-610E: 220/240 VAC, 50/60 Hz input, 2.5 A maximum
- Output voltage: 24 VDC electrically regulated and power limited (under primary AC mains). Under secondary power, 20.4 to 26.4 VDC.
- Output circuits - TB3, TB4, TB5, TB6 on Main Board: 1.5 A maximum for any NAC output circuit. 2.5 A maximum for any Power output with battery charger disabled.
- Secondary power (battery) charging circuit - lead-acid battery charger which will charge 12 to 200 AH batteries. Maximum charger current - 5.0 A.
- Secondary power auxiliary outputs - TB2 on CPS-24 Board:
  - 24V @ 0.5A, power limited
  - 5V @ 0.15A, power limited
- Wiring: utilizes wire sizes 12 to 18 AWG (3.1 to 0.78 mm²).
- SLC specifications: Average SLC current is 1.287 mA. SLC data is transmitted between 24.0 VDC, 5 VDC, and 0 VDC at approximately 3.33 Kbaud.
- Battery fuse (F2): 15A, Fast-acting
- Weight: 4.5 lb

ACPS Programming
The ACPS-610(E) is programmable via the simple-to-use PK-PPS programming utility, which requires a Windows® PC with a USB port and cable. A copy of the PK-PPS programming utility is included with each ACPS-610(E). Programming may be performed during an on-line session with the ACPS-610(E), or previously saved programs may be downloaded to individual ACPS-610(E) units. The ACPS-610(E) requires the use of a minimum of 5 SLC address points, and will use up to 14 SLC address points to fulfill requirements for Canadian supervision and two stage operation.
Listings and Approvals

These listings and approvals apply to the modules specified in this document. In some cases, certain modules or applications may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL Listed:** S635
- **ULC Listed:** S635
- **FM Approved**
- **CSFM:** 7315-0028:248
- **MEA #30-08-E**

Product Line Information

**ACPS-610:** Addressable charger power supply, with selectable built-in synchronization, and four built-in control modules. Includes installation instructions and PK-PPS programming utility CD. Requires Windows PC with USB port and USB cable. Several mounting options available (see below).

**ACPS-610E:** Same as ACPS-610, but configured for 220/240 VAC operation.

**CAB-PS1:** The CAB-PS1 can house one ACPS-610(E) and two 12 AH batteries. Dimensions: 15.218" (38.654 cm) high x 14.5" (36.83 cm) wide x 3.562" (9.048 cm) deep with door.

**DR-PS1:** When installing an ACPS-610(E) into an older version of the CAB-PS1 used for an ACPS-2406(E), the new wider door must be ordered for use with the older version cabinet.

**BB-25:** The BB-25 can house one ACPS-610(E) and two 12 volt, 26 AH batteries.

**CAB-4 Series:** The ACPS-610(E) can mount in any of the CAB-4 Series cabinets. This can be in the bottom of the cabinet or a tier via a CHS-PS and CHS-BH. See CAB-4 Series data sheet (DN-6857).

**EQ Cabinet Series:** The ACPS-610(E) can mount in any of the EQ Cabinet Series cabinets. See EQ Cabinet Series data sheet (DN-60229).

**CHS-PS/CHS-6:** Power supply mounting plate. Optional kit used to mount the ACPS-610(E) in a location other than the bottom of the CAB-4 cabinet or in an EQ Series cabinet (e.g., 2nd, 3rd, or 4th tier).

**CHS-BH:** Battery mounting chassis used to mount batteries in a location other than the bottom of the CAB-4 cabinet (e.g., 2nd, 3rd, or 4th tier).

**Batteries:** ACPS-610(E) battery charging circuit range is 12 - 200 AH. See BAT Series data sheet (DN-6933).
FCM-1(A) & FRM-1(A) Series

Control and Relay Modules

General

FCM-1(A) Control Module: The FCM-1(A) Addressable Control Module provides Notifier intelligent fire alarm control panels a circuit for Notification Appliances (horns, strobes, speakers, etc.). Addressability allows the FCM-1(A) to be activated, either manually or through panel programming, on a select (zone or area of coverage) basis.

FRM-1(A) Relay Module: The FRM-1(A) Addressable Relay Module provides the system with a dry-contact output for activating a variety of auxiliary devices, such as fans, dampers, control equipment, etc. Addressability allows the dry contact to be activated, either manually or through panel programming, on a select basis.

FlashScan® (U.S. Patent 5,539,389) is a communication protocol developed by NOTIFIER Engineering that greatly enhances the speed of communication between analog intelligent devices. Intelligent devices communicate in a grouped fashion. If one of the devices within the group has new information, the panel CPU stops the group poll and concentrates on single points. The net effect is response speed greater than five times that of other designs.

Features

- Built-in type identification automatically identifies these devices to the control panel.
- Internal circuitry and relay powered directly by two-wire SLC loop. The FCM-1(A) module requires power (for horns, strobes, etc.), or audio (for speakers).
- Integral LED “blinks” green each time a communication is received from the control panel and turns on in steady red when activated.
- LED blink may be deselected globally (affects all devices).
- High noise immunity (EMF/RFI).
- The FCM-1(A) may be used to switch 24-volt NAC power, audio (up to 70.7 Vrms).
- Wide viewing angle of LED.
- SEMS screws with clamping plates for wiring ease.
- Direct-dial entry of address 01–159 for FlashScan loops, 01 – 99 for CLIP mode loops.
- Speaker, and audible/visual applications may be wired for Class B or A (Style Y or Z).

Applications

The FCM-1(A) is used to switch 24 VDC audible/visual power, high-level audio (speakers). The FRM-1(A) may be programmed to operate dry contacts for applications such as door holders or Air Handling Unit shutdown, and to reset four-wire smoke detector power.

NOTE: Refer to the SLC Manual (PN 51253) for details regarding releasing applications with the FCM-1(A). Refer to the FCM-1-REL datasheet (DN-60390) for new FlashScan® releasing applications.

Construction

- The face plate is made of off-white heat-resistant plastic.
- Controls include two rotary switches for direct-dial entry of address (01-159).
- The FCM-1(A) is configured for a single Class B (Style Y) or Class A (Style Z) Notification Appliance Circuit.
- The FRM-1(A) provides two Form-C dry contacts that switch together.

Operation

Each FCM-1(A) or FRM-1(A) uses one of 159 possible module addresses on a SLC loop (99 on CLIP loops). It responds to regular polls from the control panel and reports its type and status, including the open/normal/short status of its Notification Appliance Circuit (NAC). The LED blinks with each poll received. On command, it activates its internal relay. The FCM-1(A) supervises Class B (Style Y) or Class A (Style Z) notification or control circuits.

Upon code command from the panel, the FCM-1(A) will disconnect the supervision and connect the external power supply in the proper polarity across the load device. The disconnection of the supervision provides a positive indication to the panel that the control relay actually turned ON. The external power supply is always relay isolated from the communication loop so that a trouble condition on the external power supply will never interfere with the rest of the system.

Rotary switches set a unique address for each module. The address may be set before or after mounting. The built-in TYPE CODE (not settable) will identify the module to the control panel, so as to differentiate between a module and a sensor address.

Specifications for FCM-1(A)

Normal operating voltage: 15 to 32 VDC.
Maximum current draw: 6.5 mA (LED on).
Average operating current: 350 μA direct poll, 375 μA group poll with LED flashing, 485 μA Max. (LED flashing, NAC shorted.)
Maximum NAC Line Loss: 4 VDC.

External supply voltage (between Terminals T10 and T11): Maximum (NAC): Regulated 24 VDC; Maximum (Speakers): 70.7 V RMS, 50W.

Drain on external supply: 1.7 mA maximum using 24 VDC supply; 2.2 mA Maximum using 80 VRMS supply.

Max NAC Current Ratings: For class B wiring system, the current rating is 3A; For class A wiring system, the current rating is 2A.

Temperature range: 32°F to 120°F (0°C to 49°C).

Humidity range: 10% to 93% non-condensing.

Dimensions: 4.5" (114.3 mm) high x 4" (101.6 mm) wide x 1.25" (31.75 mm) deep. Mounts to a 4" (101.6 mm) square x 2.125" (53.975 mm) deep box.

Accessories: SMB500 Electrical Box; CB500 Barrier

Specifications for FRM-1(A)

Normal operating voltage: 15 to 32 VDC.

Maximum current draw: 6.5 mA (LED on).

Average operating current: 230 μA direct poll; 255 μA group poll.

EOL resistance: not used.

Temperature range: 32°F to 120°F (0°C to 49°C).

Humidity range: 10% to 93% non-condensing.

Dimensions: 4.5" (114.3 mm) high x 4" (101.6 mm) wide x 1.25" (31.75 mm) deep. Mounts to a 4" (101.6 mm) square x 2.125" (53.975 mm) deep box.

Accessories: SMB500 Electrical Box; CB500 Barrier

Agency Listings and Approvals

In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- UL: S635
- ULC: S3705 (A version only)
- FM Approved
- CSFM: 7300-0028:0219
- MEA: 14-00-E
- FDNY: COA #6067, #6065

Contact Ratings for FRM-1(A)

<table>
<thead>
<tr>
<th>Current Rating</th>
<th>Maximum Voltage</th>
<th>Load Description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>.3 A</td>
<td>125 VAC</td>
<td>Inductive (PF=0.35)</td>
<td>Non-Coded</td>
</tr>
<tr>
<td>1.5 A</td>
<td>25 VAC</td>
<td>Inductive (PF=0.35)</td>
<td>Non-Coded</td>
</tr>
<tr>
<td>.7 A</td>
<td>70.7 VAC</td>
<td>Inductive (PF=0.35)</td>
<td>Non-Coded</td>
</tr>
<tr>
<td>2 A</td>
<td>25 VAC</td>
<td>Inductive (PF=0.35)</td>
<td>Non-Coded</td>
</tr>
<tr>
<td>.5 A</td>
<td>30 VDC</td>
<td>Inductive (L/R=5ms)</td>
<td>Coded</td>
</tr>
<tr>
<td>1 A</td>
<td>30 VDC</td>
<td>Inductive (L/R=2ms)</td>
<td>Coded</td>
</tr>
<tr>
<td>.9 A</td>
<td>125 VDC</td>
<td>Resistive (Non-Coded)</td>
<td>Non-Coded</td>
</tr>
<tr>
<td>.9 A</td>
<td>110 VDC</td>
<td>Resistive (Non-Coded)</td>
<td>Non-Coded</td>
</tr>
<tr>
<td>2 A</td>
<td>30 VDC</td>
<td>Resistive (Non-Coded)</td>
<td>Coded</td>
</tr>
<tr>
<td>3 A</td>
<td>30 VDC</td>
<td>Resistive (Non-Coded)</td>
<td>Coded</td>
</tr>
</tbody>
</table>

NOTE: Maximum (Speakers): 70.7 V RMS, 50 W

Product Line Information

NOTE: “A” suffix indicates ULC Listed model.

FCM-1(A): Intelligent Addressable Control Module.


A2143-20: Capacitor, required for Class A (Style Z) operation of speakers.

SMB500: Optional Surface-Mount Backbox.

CB500: Control Module Barrier — required by UL for separating power-limited and non-power limited wiring in the same junction box as FCM-1(A).

NOTE: For installation instructions, see the following documents:
- FCM-1(A) Installation document I56-1169.
- FRM-1(A) Installation document I56-3502.
FAPT-851(A)
Acclimate® Plus™ Multi-Sensor
Low-Profile Intelligent Detector

General
The Notifier FAPT-851(A) Acclimate® Plus™ detector is an intelligent, addressable, multi-sensing, low-profile detector designed for use with Notifier Onyx and CLIP series Fire Alarm Control Panels.

The Acclimate Plus detector uses a combination of photoelectric and thermal sensing technologies to increase immunity to false alarms. Unlike traditional intelligent detectors, the Acclimate Plus detector has a microprocessor in the detector head that processes alarm data. As a result, the Acclimate Plus detector adjusts its sensitivity automatically, without operator intervention or control panel programming.

Areas where the Acclimate Plus detector is especially useful include office complexes, schools, college campuses, manufacturing and industrial facilities, and anywhere else the use of a particular area may change. The Acclimate Plus detector automatically adjusts its sensitivity to the environment.

FlashScan (U.S. Patent 5,539,389) is a communication protocol developed to greatly enhance the speed of communication between analog intelligent devices and compatible systems. Intelligent devices communicate in a grouped fashion. If one of the devices within the group has new information, the panel’s CPU stops the group poll and concentrates on single points. The net effect is response speed greater than five times that of earlier designs.

Features
- Automatically adjusts sensitivity levels without operator intervention or programming. Sensitivity increases with heat.
- Microprocessor-based, combination photo and thermal technology.
- FlashScan® and CLIP system compatible (NFS-320, NFS-640, NFS2-640, NFS-3030 and NFS2-3030)
- Addressable-analog communication.
- Sleek, low-profile design.
- Two-wire SLC connection.
- Direct-Dial entry of address: (1 – 159 on FlashScan systems; 1 – 99 on CLIP systems).
- Addresses can be viewed and changed without electronic programmers.
- Dual bi-color LED design provides 360° viewing angle.
- LEDs lock red when in alarm. In FlashScan, LEDs flash green in standby for normal condition.
- Built-in tamper-resistant feature.
- Constructed of off-white fire-resistant plastic, designed to commercial standards, and offers an attractive appearance.
- SEMS screws for wiring of the separate base.
- Several base options, including relay, isolator, and sounder.
- Built-in functional test switch activated by external magnet.
- Listed to UL 268.
- Capable of heat-only alarm mode, enabled by a special command from the panel. Smoke alarms are ignored.
- Low-temperature signal at 45°F +/- 10°F (7.22°C +/- 5.54°C).

Specifications
Sensitivity: auto-adjusting levels: 1 to 2%/ft. and 2 to 4%/ft. with classic CLIP systems; 1 to 2, 2 to 3, and 3 to 4%/ft. with systems; fixed-sensitivity levels: 1, 2, and 4%/ft. with classic CLIP systems; 0.5, 1, 2, 3, and 4%/ft. with FlashScan systems.
Size: 2.0" (5.3 cm) high x 4.1" (10.4 cm) diameter installed in B501 base, 6.1" (15.5 cm) diameter installed in B710LP base.
Shipping weight: 5.2 oz. (147 g).
Operating temperature: 0°C to 38°C (32°F to 100°F).
Operating altitude: up to 10,000 feet.
UL-Listed velocity range: 0 – 4000 ft./min. (1219.2 m/min.), suitable for installation in ducts.
Relative humidity: 10% – 93% noncondensing.
Thermal sensing rating: fixed-temperature setpoint 135°F (57°C).

ELECTRICAL SPECIFICATIONS:
Voltage range: 15 – 32 volts DC peak.
Standby current (max. avg.): 300 μA.
Loop resistance: 50 ohms maximum; varies according to control panel used. Refer to panel installation manuals.
LED current (max.): 6.5 mA @ 24 VDC (“ON”).

Installation
The FAPT-851(A) plug-in detector uses a separate base to simplify installation, service, and maintenance. A special tool allows maintenance personnel to plug-in and remove detectors without using a ladder. Suitable mounting base boxes include:
- 4.0" (10.16 cm) square box.
- 3.5" (8.89 cm) or 4.0" (10.16 cm) octagonal box.
- Single-gang box (except relay or isolator base).

NOTE: The FAPT-851(A) detector has the unique ability to adjust sensitivity according to the environment, based on heat and smoke levels. Avoid installing these detectors in locations that are susceptible to rapid and high temperature changes. An example of an incorrect application would be near or in line with the output of a self-contained heater.
Agency Listings and Approvals

These listings and approvals apply to the modules specified in this. In some cases, certain modules or applications may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- UL Listed: S1115
- ULC Listed: S1115
- MEA Listed: 225-02-E
- FM Approved
- CSFM: 7272-0028-0206
- U.S. Coast Guard: 161.002/42/1 (NFS-640)
- Lloyd’s Register: 02/60007 (NFS-640)
- Maryland State Fire Marshal: Permit # 2122

Ordering Information

NOTE: “A” suffix indicates ULC Listed model.

- FAPT-851: Low-profile intelligent multi-sensor detector. Must be mounted to one of the bases listed below.
- FAPT-851A: Same as FAPT-851 but with ULC Listing.

INTELLIGENT BASES

- B200S(A): Intelligent sounder base capable of producing sound output in high or low volume with ANSI Temporal 3, ANSI Temporal 4, continuous tone, marching tone, and custom tone.
- B200SR(A): Intelligent sounder base capable of producing sound output with ANSI Temporal 3 or continuous tone. Replaces the B501BH series bases in retrofit applications.
- B710LP: Flanged mounting base. (6.1", 15.5 cm diameter)
- B710LPA: Flanged mounting base, ULC Listed.
- B224RB: Relay base Screw terminals: up to 14 AWG (2.0 mm²). Relay type: Form-C. Rating: 2.0 A @ 30 VDC resistive; 0.3 A @ 110 VDC inductive; 1.0 A @ 30 VDC inductive. Dimensions: 6.2" (15.748 cm) x 1.2" (3.048 cm).
- B224RBA: Relay base, ULC Listed.
- B224BI: Isolator base. Dimensions: 6.2" (15.748 cm) x 1.2" (3.048 cm). Maximum: 25 devices between isolator bases.
- B224BIA: Isolator base, ULC Listed.

ACCESSORIES:

- F110: Retrofit replacement flange for older high profile bases. Converts bases for use with FlashScan® detectors.
- RA100Z(A): Remote LED annunciator. 3 – 32 VDC. Fits U.S. single-gang electrical box. Supported by B710LP(A) and B501(A) bases only.
- SMB600: Surface mounting kit for use with B710LP(A).
- BCK-200B: Black detector covers, box of 10.
- M02-04-00: Test magnet.
- M02-09-00: Test magnet with telescope stick.
- XR2B: Detector removal tool. Allows installation and/or removal of FlashScan® Series detector heads from base in high ceiling installations.
- T55-127-010: Detector removal tool without pole.
- XP-4: Extension pole for XR2B. Comes in three 5-ft. sections.

T55-127-010: Detector removal tool without pole.
XP-4: Extension pole for XR2B. Comes in three 5-ft. sections.
FMM-1(A), FMM-101(A), FZM-1(A) & FDM-1(A)

Monitor Modules with FlashScan®

General

Four different monitor modules are available for Notifier's intelligent control panels for a variety of applications. Monitor modules supervise a circuit of dry-contact input devices, such as conventional heat detectors and pull stations, or monitor and power a circuit of two-wire smoke detectors (FZM-1(A)).

FMM-1(A) is a standard-sized module (typically mounts to a 4” [10.16 cm] square box) that supervises either a Style D (Class A) or Style B (Class B) circuit of dry-contact input devices.

FMM-101(A) is a miniature monitor module a mere 1.3” (3.302 cm) H x 2.75” (6.985 cm) W x 0.5” (1.270 cm) D that supervises a Style B (Class B) circuit of dry-contact input devices. Its compact design allows the FMM-101(A) to be mounted in a single-gang box behind the device it monitors.

FZM-1(A) is a standard-sized module that monitors and supervises compatible two-wire, 24 volt, smoke detectors on a Style D (Class A) or Style B (Class B) circuit.

FDM-1(A) is a standard-sized dual monitor module that monitors and supervises two independent two-wire Style B (Class B) dry-contact initiating device circuits (IDCs) at two separate, consecutive addresses in intelligent, two-wire systems.

FlashScan® (U.S. Patent 5,539,389) is a communication protocol developed by NOTIFIER that greatly increases the speed of communication between analog intelligent devices. Intelligent devices communicate in a grouped fashion. If one of the devices within the group has new information, the panel CPU stops the group poll and concentrates on single points. The net effect is response speed greater than five times that of other designs.

FMM-1(A) Monitor Module

- Built-in type identification automatically identifies this device as a monitor module to the control panel.
- Powered directly by two-wire SLC loop. No additional power required.
- High noise (EMF/RFI) immunity.
- SEMS screws with clamping plates for ease of wiring.
- Direct-dial entry of address: 01 – 159 on FlashScan loops; 01 – 99 on CLIP loops.
- LED flashes green during normal operation (this is a programmable option) and latches on steady red to indicate alarm.

The FMM-1(A) Monitor Module is intended for use in intelligent, two-wire systems, where the individual address of each module is selected using the built-in rotary switches. It provides either a two-wire or four-wire fault-tolerant Initiating Device Circuit (IDC) for normally-open-contact fire alarm and supervisory devices. The module has a panel-controlled LED indicator. The FMM-1(A) can be used to replace MMX-1(A) modules in existing systems.

FMM-1(A) Applications

Use to monitor a zone of four-wire smoke detectors, manual fire alarm pull stations, waterflow devices, or other normally-open dry-contact alarm activation devices. May also be used to monitor normally-open supervisory devices with special supervisory indication at the control panel. Monitored circuit may be wired as an NFPA Style B (Class B) or Style D (Class A) Initiating Device Circuit. A 47K ohm End-of-Line Resistor (provided) terminates the Style B circuit. No resistor is required for supervision of the Style D circuit.

FMM-1(A) Operation

Each FMM-1(A) uses one of the available module addresses on an SLC loop. It responds to regular polls from the control panel and reports its type and the status (open/normal/short) of its Initiating Device Circuit (IDC). A flashing LED indicates that the module is in communication with the control panel. The LED latches steady on alarm (subject to current limitations on the loop).

FMM-1(A) Specifications

Nominal operating voltage: 15 to 32 VDC.
Maximum current draw: 5.0 mA (LED on).
Average operating current: 350 μA (LED flashing), 1 communication every 5 seconds, 47k EOL.
Maximum IDC wiring resistance: 40 ohms.
EOL resistance: 47K ohms.
Temperature range: 32°F to 120°F (0°C to 49°C).
Humidity range: 10% to 93% noncondensing.
Dimensions: 4.5” (11.43 cm) high x 4” (10.16 cm) wide x 1.25” (3.175 cm) deep. Mounts to a 4” (10.16 cm) square x 2.125” (5.398 cm) deep box.
FMM-101(A) Mini Monitor Module

- Built-in type identification automatically identifies this device as a monitor module to the panel.
- Powered directly by two-wire SLC loop. No additional power required.
- High noise (EMF/RFI) immunity.
- Tinned, stripped leads for ease of wiring.
- Direct-dial entry of address: 01 – 159 on FlashScan loops; 01 – 99 on CLIP loops.

The FMM-101(A) Mini Monitor Module can be installed in a single-gang junction directly behind the monitored unit. Its small size and light weight allow it to be installed without rigid mounting. The FMM-101(A) is intended for use in intelligent, two-wire systems where the individual address of each module is selected using rotary switches. It provides a two-wire initiating device circuit for normally-open-contact fire alarm and security devices. The FMM-101(A) can be used to replace MMX-101(A) modules in existing systems.

FMM-101(A) APPLICATIONS

Use to monitor a single device or a zone of four-wire smoke detectors, manual fire alarm pull stations, waterflow devices, or other normally-open dry-contact devices. May also be used to monitor normally-open supervisory devices with special supervisory indication at the control panel. Monitored circuit/device is wired as an NFPA Style B (Class B) Initiating Device Circuit. A 47K ohm End-of-Line Resistor (provided) terminates the circuit.

FMM-101(A) OPERATION

Each FMM-101(A) uses one of the available module addresses on an SLC loop. It responds to regular polls from the control panel and reports its type and the status (open/normal/short) of its Initiating Device Circuit (IDC).

FMM-101(A) SPECIFICATIONS

Nominal operating voltage: 15 to 32 VDC.
Average operating current: 350 μA, 1 communication every 5 seconds, 47K EOL; 600 μA Max. (Communicating, IDC Shorted).
Maximum IDC wiring resistance: 40 ohms.
Maximum IDC Voltage: 11 Volts.
Maximum IDC Current: 400 μA.
EOL resistance: 47K ohms.
Temperature range: 32°F to 120°F (0°C to 49°C).
Humidity range: 10% to 93% noncondensing.

Dimensions: 1.3” (3.302 cm) high x 2.75” (6.985 cm) wide x 0.65” (1.651 cm) deep.
Wire length: 6” (15.24 cm) minimum.

FZM-1(A) Interface Module

- Supports compatible two-wire smoke detectors.
- Supervises IDC wiring and connection of external power source.
- High noise (EMF/RFI) immunity.
- SEMS screws with clamping plates for ease of wiring.
- Direct-dial entry of address: 01 – 159 on FlashScan loops, 01 – 99 on CLIP loops.
- LED flashes during normal operation; this is a programmable option.
- LED latches steady to indicate alarm on command from control panel.

The FZM-1(A) Interface Module is intended for use in intelligent, addressable systems, where the individual address of each module is selected using built-in rotary switches. This module allows intelligent panels to interface and monitor two-wire conventional smoke detectors. It transmits the status (normal, open, or alarm) of one full zone of conventional detectors back to the control panel. All two-wire detectors being monitored must be UL compatible with the module. The FZM-1(A) can be used to replace MMX-2(A) modules in existing systems.

FZM-1(A) APPLICATIONS

Use the FZM-1(A) to monitor a zone of two-wire smoke detectors. The monitored circuit may be wired as an NFPA Style B (Class B) or Style D (Class A) Initiating Device Circuit. A 3.9 K ohm End-of-Line Resistor (provided) terminates the end of the Style B or D (class B or A) circuit (maximum IDC loop resistance is 25 ohms). Install ELR across terminals 8 and 9 for Style D application.

FZM-1(A) OPERATION

Each FZM-1(A) uses one of the available module addresses on an SLC loop. It responds to regular polls from the control panel and reports its type and the status (open/normal/short) of its Initiating Device Circuit (IDC). A flashing LED indicates that the module is in communication with the control panel. The LED latches steady on alarm (subject to current limitations on the loop).

FZM-1(A) SPECIFICATIONS

Nominal operating voltage: 15 to 32 VDC.
Maximum current draw: 5.1 mA (LED on).
Maximum IDC wiring resistance: 25 ohms.
Average operating current: 300 μA, 1 communication and 1 LED flash every 5 seconds, 3.9k eol.
EOL resistance: 3.9K ohms.
External supply voltage (between Terminals T3 and T4):
DC voltage: 24 volts power limited. Ripple voltage: 0.1 Vrms maximum. Current: 90 mA per module maximum.
Temperature range: 32°F to 120°F (0°C to 49°C).
Humidity range: 10% to 93% noncondensing.

Dimensions: 4.5” (11.43 cm) high x 4” (10.16 cm) wide x 1.25” (3.175 cm) deep. Mounts to a 4” (10.16 cm) square x 2.125” (5.398 cm) deep box.
FDM1(A) Dual Monitor Module
The FDM-1(A) Dual Monitor Module is intended for use in intelligent, two-wire systems. It provides two independent two-wire initiating device circuits (IDCs) at two separate, consecutive addresses. It is capable of monitoring normally open contact fire alarm and supervisory devices; or either normally open or normally closed security devices. The module has a single panel-controlled LED.

NOTE: The FDM-1(A) provides two Style B (Class B) IDC circuits ONLY. Style D (Class A) IDC circuits are NOT supported in any application.

FDM-1(A) SPECIFICATIONS
Normal operating voltage range: 15 to 32 VDC.
Maximum current draw: 6.4 mA (LED on).
Average operating current: 750 μA (LED flashing).
Maximum IDC wiring resistance: 1,500 ohms.
Maximum IDC Voltage: 11 Volts.
Maximum IDC Current: 240 μA
EOL resistance: 47K ohms.
Maximum SLC Wiring resistance: 40 Ohms.
Temperature range: 32° to 120°F (0° to 49°C).
Humidity range: 10% to 93% (non-condensing).
Dimensions: 4.5” (11.43 cm) high x 4” (10.16 cm) wide x 2.125” (5.398 cm) deep.

FDM-1(A) AUTOMATIC ADDRESSING
The FDM-1(A) automatically assigns itself to two addressable points, starting with the original address. For example, if the FDM-1(A) is set to address “26”, then it will automatically assign itself to addresses “26” and “27”.

NOTE: “Ones” addresses on the FDM-1(A) are 0, 2, 4, 6, or 8 only. Terminals 6 and 7 use the first address, and terminals 8 and 9 use the second address.

CAUTION:
Avoid duplicating addresses on the system.

Installation
FMM-1(A), FZM-1(A), and FDM-1(A) modules mount directly to a standard 4” (10.16 cm) square, 2.125” (5.398 cm) deep, electrical box. They may also be mounted to the SMB500 surface-mount box. Mounting hardware and installation instructions are provided with each module. All wiring must conform to applicable local codes, ordinances, and regulations. These modules are intended for power-limited wiring only.

The FMM-101(A) module is intended to be wired and mounted without rigid connections inside a standard electrical box. All wiring must conform to applicable local codes, ordinances, and regulations.

Agency Listings and Approvals
In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

• UL: S635
• ULC: S635
• FM Approved
• CSFM: 7300-0028:0219
• MEA: 457-99-E
• U.S. Coast Guard:

Product Line Information
NOTE: “A” suffix indicates ULC-listed model.
FDM-1(A): Monitor module, dual, two independent Class B circuits.
SMB500: Optional surface-mount backbox.
NOTE: See installation instructions and refer to the SLC Wiring Manual, PN 51253.
SpectrAlert® Advance
Indoor Selectable Output Speaker Strobes and Dual Voltage Evacuation Speakers

General

The SpectrAlert Advance Series of speakers and speaker strobes is designed to reduce ground faults. The plug-in design allows the installer to pre-wire mounting plates and dress the wires before plugging in the speakers. The plastic cover prevents nicked wires by covering exposed speaker components. This design also allows faster installations with instant feedback to ensure that wiring is properly connected; rotary switches to select voltage and power settings; and 11 field selectable candela settings for wall and ceiling speaker strobes.

The low total harmonic distortion of the SP speaker offers high fidelity sound output while the SPV speaker offers high volume sound output for use in high ambient noise applications. SpectrAlert Advance makes installation easy
• Attach a universal mounting plate to a 4” x 4” x 2-1/8” back box. Flush mount applications are achievable without the need for an extension ring.
• Connect the notification appliance circuit or speaker wiring to the PEMS terminals on the mounting plate.
• Attach the speaker or speaker strobe to the mounting plate by inserting the product tabs into the mounting plate grooves. Rotate the device into position to lock the product pins into the mounting plate terminals. The device will temporarily hold in place with a catch until it is secured with a captured mounting screw.

Features
• Plug-in design
• Protective cover isolates speaker components, reduces ground faults
• Electrical compatibility with existing SpectrAlert products
• Field selectable candela settings on wall and ceiling units:
  – Standard: 15, 15/75, 30, 75, 95, 110, 115
  – High: 135, 150, 177, 185
• Shorting spring on mounting plate tests continuity before installation
• Rotary switch simplifies field selection of speaker voltage and power settings
• Universal mounting plate for wall- and ceiling-mount units
• Compatible with System Sensor synchronization protocol
• SP speakers offer high fidelity sound output
• SPV speakers offer high volume sound output
• Automatic selection of 12 or 24 volt operation at 15 and 15/75 candela
• No extension ring required
• Ceiling and wall mount application
• Optional tamper resistant Torx head screw included

Specifications

PHYSICAL SPECIFICATIONS
Operating Temperature: 32°F to 120°F (0°C to 49°C)
Humidity Range: 10 to 93% non-condensing
Dimensions, Wall-Mount:
  – SPS Speaker Strobe: 6.0”L x 5.0”W x 4.7”D (includes lens and speaker)
  – SP Speaker: 6.0”L x 5.0”W x 2.8”D
  – SP Speaker: 6.0”L x 5.0”W x 2.9”D

Dimensions, Ceiling-Mount:
  – SPS Speaker Strobe: 6.8”Dia x 4.7”D (includes lens and speaker)
  – SP Speaker Strobe: 6.8”Dia x 4.8”D (includes lens and speaker)
  – SP Speaker: 6.8”Dia x 2.8”D
  – SP Speaker: 6.8”Dia x 2.9”D

ELECTRICAL/OPERATING SPECIFICATIONS
Nominal Voltage (speakers): 25 Volts or 70.7 Volts (nominal)
Maximum Supervisory Voltage (speakers): 50VDC
Strobe Flash Rate: 1 flash per second
Nominal Voltage (strobes): Regulated 12VDC/FWR or regulated 24VDC/FWR
Operating Voltage Range (includes fire alarm panels with built-in sync): 8 to 17.5V (12V nominal) or 16 to 33V (24V nominal)
Operating Voltage with MDL Sync Module: 9 to 17.5V (12V nominal) or 17 to 33V (24V nominal)
Frequency Range: 400 to 4000 Hz
Power: ¼, ½, 1, 2 watts

Agency Listings and Approvals

In some cases, certain modules may not be listed by certain approval agencies, or listing may be in progress. Consult factory for latest listing status.
• UL/ULC Listed: S4048
• MEA: 10-08-E
• CSFM: 7320-1653:201
• FM Approved
The speaker strobe shall be a System Sensor SpectrAlert Advance model SPEAKER STROBE COMBINATION. The strobe light shall consist of a protective signaling appliance, flashing at 1Hz over the frequency range of 400 to 4000Hz. Speaker shall have power taps which are selected by rotary switch. The strobe shall comply with the NFPA 72 approved for fire protective service. The module shall synchronize all the zones. Daisy chaining two or more synchronization modules together will synchronize all the zones they control. The module shall not operate on a coded power supply.

**Sound Output**

<table>
<thead>
<tr>
<th>UL Reverberant (dBA @ 10ft)</th>
<th>2W</th>
<th>1W</th>
<th>%W</th>
<th>%W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Mount SP Series</td>
<td>86</td>
<td>83</td>
<td>80</td>
<td>77</td>
</tr>
<tr>
<td>Wall Mount SPV Series</td>
<td>90</td>
<td>87</td>
<td>84</td>
<td>81</td>
</tr>
<tr>
<td>Ceiling Mount SPC Series</td>
<td>88</td>
<td>83</td>
<td>80</td>
<td>77</td>
</tr>
<tr>
<td>Ceiling Mount SPCV Series</td>
<td>90</td>
<td>87</td>
<td>84</td>
<td>81</td>
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<td>Wall Mount SPS Series</td>
<td>85</td>
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<td>79</td>
<td>76</td>
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<td>Wall Mount SPSV Series</td>
<td>89</td>
<td>86</td>
<td>83</td>
<td>80</td>
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<tr>
<td>Ceiling Mount SPSC Series</td>
<td>85</td>
<td>82</td>
<td>79</td>
<td>76</td>
</tr>
<tr>
<td>Ceiling Mount SPSCV Series</td>
<td>89</td>
<td>86</td>
<td>83</td>
<td>80</td>
</tr>
</tbody>
</table>

**Architectural/Engineering Specifications**

**GENERAL**
SpectrAlert Advance speaker and speaker strobes shall mount to a 4" x 4" x 2-1/8" backbox. A universal mounting plate shall be used for mounting ceiling and wall products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate. Also, SpectrAlert Advance speaker strobes, when used with the Sync Circuit, module accuracy shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts. When used with the Sync Circuit Module, 12 volt rated notification appliance circuit outputs shall operate between nine and 17.5 volts; 24 volt rated notification appliance circuit outputs shall operate between 17 and 33 volts. Indoor SpectrAlert Advance products shall operate between 32°F and 120°F. Speaker shall have power taps and voltage that are selected via rotary switches.

**SPEAKER**
The speaker shall be a System Sensor SpectrAlert Advance Model dual-voltage transformer speaker capable of operating at 25.0 or 70.7 nominal Volts. It should be listed to UL/ULC 1480 and shall be approved for fire protective service. The speaker shall have a frequency range of 400 to 4000Hz and shall have an operating temperature between 32°F and 120°F. Speaker shall have power taps and voltage that are selected by rotary switches.

**SPEAKER STROBE COMBINATION**
The speaker strobe shall be a System Sensor SpectrAlert Advance Model listed to UL/ULC and UL/ULC 1480 and shall be approved for fire protective signaling systems. Speaker shall be capable of operating at 25.0 or 70.7 nominal Volts selected via rotary switch, and shall have a frequency range of 400 to 4000Hz. Speaker shall have power taps which are selected by rotary switch. The strobe shall comply with the NFPA 72 requirements for visible signaling appliances, flashing at 1Hz over the strobe’s entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflect system.
Outdoor, Selectable-Output Speaker Strobes and Dual-Voltage Evacuation Speakers for Wall Applications

*SpectrAlert® Advance* outdoor, selectable-output speaker strobes and dual-voltage evacuation speakers meet virtually any outdoor application requirement.

**Features**

- Weatherproof per NEMA 4X, IP56
- Rated from -40°F to 151°F
- Plug-in design reduces ground faults
- Universal mounting plate with onboard shorting spring that tests wiring continuity before devices are installed
- Field-selectable candela settings: 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, and 185
- Automatic selection of 12- or 24-volt operation at 15 and 15/75 candela
- Rotary switch for speaker voltage (25 and 70.7 Vrms) and power settings (1/4, 1/2, 1 and 2 watts)
- Compatible with System Sensor synchronization protocol and legacy SpectrAlert products
- Tamper-resistant construction

**SpectrAlert Advance** offers the broadest line of outdoor speakers and speaker strobes in the industry. From metal and plastic outdoor back boxes, to white and red plastic housings, to wall and ceiling mounting options, SpectrAlert Advance can meet virtually any application requirement.

Wall-mount outdoor speakers and speaker strobes can be used indoors or outdoors in wet or dry applications, and can provide reliable operation from -40°F to 151°F. These speakers provide a broad frequency response range, low harmonic distortion and maintain a high sound pressure level at all tap settings to provide accurate and intelligible broadcast of evacuation messages.

Like the entire SpectrAlert Advance line, wall-mount outdoor speakers and speaker strobes include a variety of features that increase application flexibility and simplify installation. First, field-selectable settings, including candela, speaker voltage and power settings, and automatic selection of 12- or 24-volt operation enable installers to easily adapt devices to meet requirements.

Next, these devices use a universal mounting plate with an onboard shorting spring that ensures wiring continuity before devices are installed, so installers can verify proper wiring without mounting the devices and exposing them to potential construction damage. Once the plates are mounted, all SpectrAlert Advance devices utilize a plug-in design with a single captured screw to speed installation and virtually eliminate costly ground faults.

Outdoor devices ship with weatherproof plastic back boxes (metal back boxes are available separately) that accommodate in-and-out wiring for daisy chaining devices. Plastic back boxes feature removable side flanges and improved resistance to saltwater corrosion. Knock-outs located on the back eliminate the need to drill holes for screw-in mounting. Plastic and metal weatherproof back boxes come with ¾-inch top and bottom conduit entries and ¾-inch knock-outs at the back. A screw-in NPT plug with an O-ring gasket for a watertight seal is included with each back box.

**Agency Listings**

<table>
<thead>
<tr>
<th>Agency</th>
<th>Approval ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL</td>
<td>7325-1603.201</td>
</tr>
<tr>
<td>ENEC</td>
<td>104.46.E</td>
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</tbody>
</table>
**SpectrAlert® Advance Outdoor Speaker and Speaker Strobe Specifications**

### Architectural/Engineering Specifications

**General**
SpectrAlert Advance outdoor speakers and speaker strobes shall mount to a weatherproof back box. A universal mounting plate shall be used for mounting ceiling and wall products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate. Also, SpectrAlert Advance speaker strobes, when used with the Sync•Circuit™ Module accessory, shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts. When used with the Sync•Circuit Module, 12-volt-rated notification appliance circuit outputs shall operate between 9 and 17.5 volts; 24-volt-rated notification appliance circuit outputs shall operate between 17 and 33 volts. Outdoor SpectrAlert Advance products shall operate between −40°F and 151°F from a regulated DC, or full-wave rectified, unfiltered power supply.

**Speaker**
Speaker shall be a System Sensor SpectrAlert Advance Model ______ dual-voltage transformer speaker capable of operating at 25.0 or 70.7 nominal Vrms. Speaker shall be listed to Underwriters Laboratories Standard S4048 for outdoor fire protective signaling systems. Speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature from −40°F to 150.8°F. Speaker shall have power taps and wattage settings that are selected by rotary switches. The speaker must be installed with its weatherproof back box in order to remain outdoor approved per UL listing S4048. The speaker shall be suitable for use in air handling spaces and wet environments.

**Speaker Strobe Combination**
The speaker strobe shall be a System Sensor Model _____ listed to UL 1638 and UL 1480 and be approved for fire protective signaling systems. Speaker shall be capable of operating at 25.0 or 70.7 nominal Vrms and shall have a frequency range of 400 to 4,000 Hz. Speaker shall have power taps that are selected by rotary switch. The strobe shall consist of a xenon flash tube with associated lens/reflector system and operate on either 12 or 24 volts. The strobe shall also feature selectable candela output, providing options for 15 or 15/75 candela when operating on 12 volts and 15, 15/75, 30, 75, 110, 115, 135, 150, 177 or 185 candela when operating on 24 volts. The strobe shall comply with the Americans with Disabilities Act requirement for visible signaling appliances, flashing at 1 Hz over the strobe's entire operating voltage range. The speaker strobe must be installed with its weatherproof back box in order to remain outdoor approved per UL. The speaker strobe shall be suitable for use in wet environments.

### Physical Specifications

| **Operating Temperature** | −40°F to 151°F (−40°C to 66°C) |
| **Dimensions, Wall-Mount** |  |
| SPS Speaker Strobe | 6.0˝ L × 5.0˝ W × 4.7˝ D (including lens and speaker) |
| SP Speaker | 6.0˝ L × 5.0˝ W × 2.9˝ D |
| **Dimensions, Wall-Mount Weatherproof Back Box** | 6.5˝ L × 5.5˝ H × 2.9˝ D |

### Electrical/Operating Specifications

| **Nominal Voltage (speakers)** | 25 V or 70.7 V (nominal) |
| **Maximum Supervisory Voltage (speakers)** | 50 VDC |
| **Strobe Flash Rate** | 1 flash per second |
| **Nominal Voltage (strobes)** | Regulated 12VDC/FWR or regulated 24 DC/FWR |
| **Operating Voltage Range (includes fire alarm panels with built in sync)** | 8 to 17.5 V (12 V nominal) or 16 to 33 V (24 V nominal) |
| **Operating Voltage with MDL Sync Module** | 9 to 17.5 V (12 V nominal) or 16 to 33 V (24 V nominal) |
| **Frequency Range** | 400 to 4,000 Hz |
| **Power** | ¼, ½, 1, 2 watts |
**UL Current Draw Data**

<table>
<thead>
<tr>
<th>Candela</th>
<th>8 to 17.5 Volts</th>
<th>16 to 33 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DC</td>
<td>FWR</td>
</tr>
<tr>
<td><strong>Candela Range</strong></td>
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<tr>
<td><strong>Standard</strong></td>
<td>15</td>
<td>123</td>
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<tr>
<td>15/75</td>
<td>142</td>
<td>148</td>
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<td>115</td>
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<td>Candela Range</td>
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<td>NA</td>
</tr>
<tr>
<td>177</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>185</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Sound Output**

<table>
<thead>
<tr>
<th>UL Reverberant (dBA @ 10 ft.)</th>
<th>2W</th>
<th>1W</th>
<th>½ W</th>
<th>¼ W</th>
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<tbody>
<tr>
<td>Outdoor Speaker</td>
<td>90</td>
<td>87</td>
<td>84</td>
<td>81</td>
</tr>
<tr>
<td>Outdoor Speaker/Strobe</td>
<td>89</td>
<td>86</td>
<td>83</td>
<td>80</td>
</tr>
</tbody>
</table>

**Candela Derating**

For K series products used at low temperatures, listed candela ratings must be reduced in accordance with this table.

<table>
<thead>
<tr>
<th>Listed Candela</th>
<th>Candela rating at –40°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Do not use below 32°F</td>
</tr>
<tr>
<td>15/75</td>
<td>44</td>
</tr>
<tr>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>75</td>
<td>110</td>
</tr>
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<td>95</td>
<td>115</td>
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<tr>
<td>110</td>
<td>135</td>
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<tr>
<td>115</td>
<td>150</td>
</tr>
<tr>
<td>135</td>
<td>177</td>
</tr>
<tr>
<td>150</td>
<td>185</td>
</tr>
</tbody>
</table>

**Dimensions**

Wall-Mount Outdoor Speaker

Wall-Mount Outdoor Speaker Strobe
**Ordering Information for SpectrAlert® Advance Outdoor Speakers and Speaker Strobes**

<table>
<thead>
<tr>
<th>Wall Mount</th>
<th>White</th>
<th>Red</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPWK*</td>
<td></td>
<td>SPRK*</td>
<td>Outdoor Speaker (includes plastic weatherproof back box)</td>
</tr>
<tr>
<td>SPSWK*†</td>
<td></td>
<td>SPSRK*</td>
<td>Outdoor Speaker Strobe, Selectable Candela (15, 15/75, 30, 75, 95, 110, 115) (includes plastic weatherproof back box)</td>
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<tr>
<td>SPSWK-CLR-ALERT</td>
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<td></td>
<td>Outdoor Speaker Strobe, Selectable Candela (15, 15/75, 30, 75, 95, 110, 115), ALERT Printed (includes plastic weatherproof back box)</td>
</tr>
<tr>
<td>SPSRK Outdoor Speaker Strobe, Selectable Candela (135,150,177,185) (includes plastic weatherproof back box)</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessories</th>
<th>White</th>
<th>Red</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>MWBBW</td>
<td>MWBB</td>
<td>Wall, Metal Weatherproof Back Box</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

*Add “-R” to model number for weatherproof replacement device (no back box included), e.g., SPWK-R.
†Add “-P” to model number for plain housing (no “FIRE” marking on cover), e.g., SPSWK-P.
FST-851 Series
Intelligent Thermal (Heat) Detectors
with FlashScan®

General
Notifier FST-851 Series intelligent plug-in thermal detectors with integral communication have features that surpass conventional detectors. Point ID capability allows each detector's address to be set with decade address switches, providing exact detector locations. FST-851 Series thermal detectors use an innovative thermistor sensing circuit to produce 135°F/57°C fixed-temperature (FST-851) and rate-of-rise thermal detection (FST-851R) in a low-profile package. FST-851H provides fixed high-temperature detection at 190°F/88°C. These thermal detectors provide effective, intelligent property protection in a variety of applications. FST-851 Series detectors are compatible with all Notifier intelligent Fire Alarm Control Panels, except FireWarden series panels.

FlashScan® (U.S. Patent 5,539,389) is a communication protocol developed by Notifier Engineering that greatly enhances the speed of communication between analog intelligent devices and certain NOTIFIER systems. Intelligent devices communicate in a grouped fashion. If one of the devices within the group has new information, the panel's CPU stops the group poll and concentrates on single points. The net effect is response speed greater than five times that of earlier designs.

Features
- Sleek, low-profile, stylish design.
- State-of-the-art thermistor technology for fast response.
- Rate-of-rise model (FST-851R), 15°F (8.3°C) per minute.
- Factory preset at 135°F (57°C); high-temperature model at 190°F (88°C).
- Addressable by device.
- Compatible with FlashScan® and CLIP protocol systems.
- Direct dial entry of address 01-159 for FlashScan® loops, 01-99 CLIP mode loops.
- Two-wire SLC connection.
- Visible LEDs “blink” every time the unit is addressed.
- 360°-field viewing angle of the visual alarm indicators (two bi-color LEDs). LEDs blink green in Normal condition and turn on steady red in Alarm.
- Integral communications and built-in device-type identification.
- Remote test feature from the panel.
- Built-in functional test switch activated by external magnet.
- Walk test with address display (an address of 121 will blink the detector LED 12-(pause)-1).
- Low standby current.
- Backward-compatible.
- Built-in tamper-resistant feature.
- Designed for direct-surface or electrical-box mounting.
- Sealed against back pressure.
- Plugs into separate base for ease of installation and maintenance. Separate base allows interchange of photoelectric, ionization and thermal sensors.
- SEMS screws for wiring of the separate base.
- Constructed of off-white Bayblend®, designed to commercial standards, and offers an attractive appearance.

Specifications
Size: 2.1” (5.3 cm) high x 4.1” (10.4 cm) diameter installed in B501 base, 6.1” (15.5 cm) diameter installed in B710LP base.
Shipping weight: 4.8 oz. (137 g).
Operating temperature range: FST-851 Series, FST-851R: –20°C to 38°C (–4°F to 100°F); FST-851H: –20°C to 66°C (–4°F to 150°F).
Detector spacing: UL approved for 50 ft. (15.24 m) center to center. FM approved for 25 x 25 ft. (7.62 x 7.62 m) spacing.
Relative humidity: 10% – 93% noncondensing.
Thermal ratings: fixed-temperature setpoint 135°F (57°C), rate-of-rise detection 15°F (8.3°C) per minute, high-temperature heat 190°F (88°C).
Altitude rating: 10,000 feet.
ELECTRICAL SPECIFICATIONS:
Voltage range: 15 - 32 volts DC peak.
Standby current (max. avg.): 300 µA @ 24 VDC (one communication every 5 seconds with LED enabled).
LED current (max.): 6.5 mA @ 24 VDC (“ON”).
BASES AVAILABLE:
B710LP: 6.1” (15.5 cm) diameter.
B501: 4.1” (10.4 cm) diameter.
B501BH-2 or B501BHT-2: Sounder base assembly.
B224RB Relay Base: Screw terminals: up to 14 AWG (2.0 mm²). Relay type: Form-C. Rating: 2.0 A @ 30 VDC resistive; 0.3 A @ 110 VDC inductive; 1.0 A @ 30 VDC inductive. Dimensions: 6.2” (15.748 cm) x 1.2” (3.048 cm).
B224BI Isolator Base: Dimensions: 6.2” (15.748 cm) x 1.2” (15.748 cm). Maximum: 25 devices between isolator bases. See Note 2 under Installation.
Applications
Use thermal detectors for protection of property. For further information, go to systemsensor.com for manual IS6-407-00, Applications Manual for System Smoke Detectors, which pro-
vides detailed information on detector spacing, placement, zoning, wiring, and special applications.

**Installation**

The FST Series plug-in intelligent thermal detector uses a separate base to simplify installation, service, and maintenance. Installation instructions are shipped with each detector.

Mount base (all base types) on an electrical backbox which is at least 1.5" (3.81 cm) deep. Suitable boxes include:

- 4.0" (10.16 cm) square box.
- 3.5" (8.89 cm) or 4.0" (10.16 cm) octagonal box.
- Single-gang box (except relay or isolator base).
- With B501BH-2 or B501BHT-2 base, use a 4.0" (10.16 cm) square box.
- With B224RB or B224BI base, use a 3.5" (8.89 cm) or 4.0" (10.16 cm) octagonal box, or a 4.0" (10.16 cm) square box.

**NOTE:** 1) Because of the inherent supervision provided by the SLC loop, end-of-line resistors are not required. Wiring “T-taps” or branches are permitted for Style 4 (Class “B”) wiring.

2) When using relay or sounder bases, consult data sheet DN-2243 (ISO-X) for device limitations between isolator modules and isolator bases.

**Agency Listings and Approvals**

These listings and approvals apply to the modules specified in this document. In some cases, certain modules or applications may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- UL Listed: S747
- ULC Listed: S6978
- FM Approved
- CSFM: 7270-0028:196
- BSMI: CI3130667600025
- CCCF: Certif. # 2004081801000018
- U.S. Coast Guard: 161.002/23/3 (AFP-200); 161.002/27/3 (AFP1010/AM2020); 161.002/42/1 (NFS-640)
- Lloyd’s Register: 03/60011

**Product Line Information**

“A” suffix indicates ULC Listed model.

FST-851: Intelligent thermal detector. Must be mounted to one of the bases listed below.

- FST-851A: Same as FST-851 but with ULC Listing.
- FST-851R: Intelligent thermal detector with rate-of-rise feature.
- FST-851RA: Same as FST-851R but with ULC Listing.
- FST-851HA: Same as FST-851H but with ULC Listing.

**BASES:**

- B710LP: Standard U.S. low-profile base
- B501: Standard European flangeless base.
- BH501BHT-2: Same as BH501BH-2, but includes temporal sounder.
- BH501BHA: Sounder base, includes B501 base above.
- BH501BHTA: Same as BH501BHA, but includes temporal sounder.
- B224BI(A): Intelligent isolator base. Isolates SLC from loop shorts.

**ACCESSORIES:**

- F110: Retrofit replacement flange for older style high profile bases. Converts bases for use with FlashScan® detectors.
- RA400Z(A): Remote LED annunciator. 3 – 32 VDC. Fits U.S. single-gang electrical box. Supported by B710LPBP(A) and B501(A) bases only.
- SMK400E: Surface mounting kit provides for entry of surface wiring conduit. For use with B501(A) base only.
- RMK400: Recessed mounting kit. For use with B501(A) base only.
- SMB600: Surface mounting kit for use with B710LPBP(A).
- BCK-200B: Black detector covers, box of 10.
- M02-04-00: Test magnet.
- M02-09-00: Test magnet with telescope stick.
- XR2B: Detector removal tool. Allows installation and/or removal of FlashScan® Series detector heads from base in high ceiling installations.
- T55-127-010: Detector removal tool without pole.
- XP-4: Extension pole for XR2B. Comes in three 5-ft. sections.

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Intelligent Non-Relay Photoelectric Duct Smoke Detector

The InnovairFlex™ Series are the only duct smoke detectors flexible enough to fit configurations from square to rectangular and everything in between.

Features

- Photoelectric, integrated low-flow technology (detector head sold separately)
- Air velocity rating from 300 ft/min to 4000 ft/min (1.52 m/s to 20.32 m/sec)
- Versatile mounting options: square or rectangular configuration
- Broad ranges for operating temperature (−4°F to 158°F) and humidity (0% to 95% non-condensing)
- Patented sampling tube installs from front or back of the detector with no tools required
- New Cover tamper signal
- Increased wiring space with a newly added ¾-inch conduit knockout
- Available space within housing to accommodate mounting of relay module
- Clear cover for convenient visual inspection
- UL 268A listed
- Remote testing capability
- Requires com line power only

The InnovairFlex DNRECL intelligent non-relay photoelectric duct smoke detector features a pivoting housing that fits both square and rectangular footprints capable of mounting to a round or rectangular duct.

The intelligent non-relay photoelectric duct smoke detector senses smoke in the most challenging conditions, operating in airflow speeds of 300 to 4000 feet per minute, temperatures of −4°F to 158°F, and a humidity range of 0 to 95 percent (non-condensing).

An improved cover design isolates the sensor head from the low-flow feature for simple maintenance. A cover tamper feature was added to indicate a trouble signal for a removed or improperly installed sensor cover. The InnovairFlex housing provides a ¾-inch conduit knockout and ample space to facilitate easy wiring and mounting of relay module.

The InnovairFlex duct smoke detector can be customized to meet local codes and specifications without additional wiring. The new InnovairFlex product line is compatible with all previous Innovair models, including remote test accessories.

WARNING: Duct smoke detectors have specific limitations.

DUCT SMOKE DETECTORS ARE:
- NOT a substitute for an open area smoke detector,
- NOT a substitute for early warning detection, and
- NOT a replacement for a building’s regular fire detection system.

Refer to NFPA 72 and 90A for additional duct smoke detector application information.
InnovairFlex Duct Smoke Detector Specifications

**Architectural/Engineering Specifications**

The air duct smoke detector shall be a System Sensor InnovairFlex™ DNRECL Intelligent Non-Relay Photoelectric Duct Smoke Detector. The detector housing shall be UL listed per UL 268A specifically for use in air handling systems. The flexible housing of the duct smoke detector fits both square and rectangular footprints. The detector shall operate at air velocities of 300 ft/min to 4000 ft/min (1.52 m/sec to 20.32 m/sec). The unit shall be capable of providing a trouble signal in the event that the sensor cover is removed or improperly installed. It shall be capable of remote testing using the RTS151KEY remote test station. Terminal connections shall be of the strip and clamp method suitable for 12–18 AWG wiring.

<table>
<thead>
<tr>
<th>Physical Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size:</strong> (Rectangular)</td>
</tr>
<tr>
<td><strong>(Square)</strong></td>
</tr>
<tr>
<td><strong>Weight:</strong></td>
</tr>
<tr>
<td><strong>Operating Temperature Range:</strong></td>
</tr>
<tr>
<td><strong>Storage Temperature Range:</strong></td>
</tr>
<tr>
<td><strong>Operating Humidity Range:</strong></td>
</tr>
<tr>
<td><strong>Air Duct Velocity:</strong></td>
</tr>
</tbody>
</table>

**Electrical Ratings**

Please see detector head installation manual for electrical specifications

**Accessory Current Loads at 24 VDC**

<table>
<thead>
<tr>
<th>Device</th>
<th>Standby</th>
<th>Alarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA100Z</td>
<td>0 mA</td>
<td>12 mA Max.</td>
</tr>
<tr>
<td>RTS151/RTS151KEY</td>
<td>0 mA</td>
<td>12 mA Max.</td>
</tr>
</tbody>
</table>

Installing the InnovairFlex Sampling Tube

The InnovairFlex sampling tube may be installed from the front or back of the detector. The tube locks securely into place and can be removed by releasing the front or rear locking tab (front locking tab shown below right).
Wiring for Intelligent Non-Relay Duct Smoke Detector

System wiring diagram for DNRECL:

DNRECL to RA100Z:

DNRECL to RTS151/RTS151KEY with “R” Remote Test Capable Detector Head Option:
**Accessories**

System Sensor provides system flexibility with a variety of accessories, including two remote test stations and different means of visible and audible system annunciation. As with our duct smoke detectors, all duct smoke detector accessories are UL listed.

---

**Ordering Information**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Accessories</th>
<th>Test magnet</th>
<th>End cap for metal sampling tubes</th>
<th>Remote annunciator alarm LED</th>
<th>Remote test station</th>
<th>Remote test station with key lock</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNRECL</td>
<td>Intelligent non-relay photoelectric low-flow duct smoke detector</td>
<td>DST1</td>
<td>M02-04-00</td>
<td>P48-21-00</td>
<td>RA100Z</td>
<td>RTS151</td>
<td>RTS151KEY</td>
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<tr>
<td>DST1</td>
<td>Metal sampling tube duct width up to 1ft (0.3m)</td>
<td>DST1.5</td>
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<tr>
<td>DST3</td>
<td>Metal sampling tube duct widths 1 ft to 2 ft (0.3 to 0.6 m)</td>
<td>DST5</td>
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<tr>
<td>DST10</td>
<td>Metal sampling tube duct widths 2 ft to 4 ft (0.6 to 1.2 m)</td>
<td>DST10</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>DH400CE-1</td>
<td>Metal sampling tube duct widths 4 ft to 8 ft (1.2 to 2.4 m)</td>
<td>M02-04-00</td>
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<tr>
<td>DST3</td>
<td>Metal sampling tube duct widths 2 ft to 4 ft (0.6 to 1.2 m)</td>
<td>RA100Z</td>
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<tr>
<td>DST10</td>
<td>Metal sampling tube duct widths 8 ft to 12 ft (2.4 to 3.7 m)</td>
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<td></td>
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<tr>
<td>DH400CE-1</td>
<td>Metal sampling tube duct widths 8 ft to 12 ft (2.4 to 3.7 m)</td>
<td>RTS151KEY</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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**System Sensor**

3825 Ohio Avenue • St. Charles, IL 60174
Phone: 800-SENSOR2 • Fax: 630-377-6495

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Product specifications subject to change without notice. Visit systemsensor.com for current product information, including the latest version of this data sheet.
**General**

The FTM-1 Addressable Firephone Control Module (FlashScan® only) gives NOTIFIER's NFS-640, NFS2-640, NFS-3030, NFS2-3030 control panels the capability to monitor and control a circuit of up to two firefighter phones. The FTM-1 has the ability to differentiate between normal, off-hook, and trouble conditions. This module is used to connect a remote firefighter telephone to a centralized telephone console. A ringing sound is provided at each off-hook handset until it is connected to the console. The user can then connect that off-hook phone to the main riser for the voice evac system.

Wiring to individual telephone jacks and handsets is supervised, and status is reported to the panel as NORMAL, TROUBLE, or OFF HOOK. This module has two pairs of output termination points available for fault-tolerant wiring (Style Z), and includes a panel-controlled LED indicator.

FlashScan® (U.S. Patent 5,539,389) is a communication protocol that greatly increases the speed of communication between analog intelligent devices. Intelligent devices communicate in a grouped fashion. If one of the devices within the group has new information, the panel CPU stops the group poll and concentrates on single points. The net effect is response speed greater than five times that of other protocols.

**Features**

- Supports two firefighter telephones in either NFPA Style Y or Style Z (Fault Tolerant) telephone circuits.
- Direct-dial entry of address 01–159 for FlashScan®.
- Built-in type identification automatically identifies itself to the control panel.
- Internal circuitry and relay powered directly by two-wire SLC loop.
- Integral LED “blinks” green each time a communication is received from the control panel.
- LED blink may be deselected globally (affects all devices).
- High noise immunity (EMF/RFI).
- Wide viewing angle of LED.
- SEMS screws with clamping plates for wiring ease.

**Construction**

- The face plate is made of off-white Noryl®.
- Controls include two rotary switches for direct-dial entry of address (01-159).
- The FTM-1 is configured for either a single Class B (Style Y) or Class A (Style Z) telephone circuit.

**Agency Listings and Approvals**

These listings and approvals apply to the modules specified in this document. In some cases, certain modules or applications may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL Listed:** S635
- **ULC Listed:** S635 (FTM-1A)
- **FM Approved**
- **CSFM:** 7300-1653:0182, 7165-0028:0224, 7165-0028:0243
- **FDNY:** COA #6065, #6067

**Operation**

The FTM-1 uses one of 159 possible module addresses on a SLC loop. It responds to regular polls from the control panel and reports its type and status, including NORMAL, TROUBLE, or OFF HOOK status of its telephone circuits. The LED blinks with each poll received.

Upon code command from the panel, the FTM-1 will disconnect the supervision and connect the telephone riser to its telephone circuit. The telephone riser is always relay isolated from the communication loop so that a trouble condition on the riser will never interfere with the rest of the system.

Rotary switches set a unique address for each module. The address may be set before or after mounting. The built-in TYPE CODE (not settable) will identify the module to the control panel.
Specifications
Normal operating voltage: 15 to 32 VDC.
Maximum current draw: 7.5 mA (LED on).
Average operating current: 7.5 mA group poll (FlashScan® mode) with LED flashing.
External supply voltage (between Terminals T3 and T4): maximum 28 VDC.
EOL resistance: 3.9K ohms.
Temperature range: 32°F to 120°F (0°C to 49°C).
Humidity range: 10% to 93% non-condensing.
Dimensions: 4.5" (11.43 cm) high x 4" (10.16 cm) wide x 1.25" (3.175 cm) deep. Mounts to a 4" (10.16 cm) square x 2.125" (5.398 cm) deep box.
Weight: 6.3 oz.

SOFTWARE COMPATIBILITY
- NFS-640 - As of Version 3.1.3
- NFS2-640 - As of version 10.0
- NFS-3030 - As of Version 2.2.9
- NFS2-3030 - As of version 10.0
- LCM - As of Version 2.3.7

Product Line Information
FTM-1: Intelligent Addressable Firephone Control Module, 3.9K ohm End-of-Line Resistor included.
FTM-1A: Same as FTM-1 with ULC listing.
SMB500: Optional Surface-Mount Electrical Backbox.
CB500: Control Module Barrier — required by UL for separating power-limited and non-power-limited wiring in the same junction box as FTM-1.
SSM/SSV Series
Alarm Bells

System Sensor’s SSM and SSV series alarm bells are low current, high decibel notification appliances for use in fire and burglary systems or other signaling applications.

Features
• Approved for indoor and outdoor use
• Low current draw
• High dB output
• Available in six-inch, eight-inch, and ten-inch sizes
• AC and DC models
• DC models polarized for use with supervision circuitry
• Mount directly to standard four-inch square electrical box indoors
• SSM and SSV series come pre-wired

Reliable Performance. The SSM and SSV series provide loud resonant tones. The SSM series operates on 24VDC and are motor driven, while the SSV series operates on 120VAC utilizing a vibrating mechanism.

Simplified Installation. For indoor use, the SSM and SSV series mount to a standard four-inch square electrical box. For outdoor applications, weatherproof back box, model number WBB, is used.

The SSM and SSV series come pre-wired, to reduce installation time. The SSM series incorporates a polarized electrical design for use with supervision circuitry.

Agency Listings

UL Listed
ULC Listed
FM Approved
MEA Approved
### Ordering Information

<table>
<thead>
<tr>
<th>UL/FM Model No.</th>
<th>ULC/Canadian Model No.</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>SSM24-6</td>
<td>SSM24-6A</td>
<td>Bell, 6”, 24VDC, Polarized, 82dBA</td>
</tr>
<tr>
<td>SSM24-8</td>
<td>SSM24-8A</td>
<td>Bell, 8”, 24VDC, Polarized, 80dBA</td>
</tr>
<tr>
<td>SSM24-10</td>
<td>SSM24-10A</td>
<td>Bell, 10”, 24VDC, Polarized, 81dBA</td>
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<tr>
<td>SSV120-6</td>
<td>SSV120-6A</td>
<td>Bell, 6”, 120VAC, 85dBA</td>
</tr>
<tr>
<td>SSV120-8</td>
<td>SSV120-8A</td>
<td>Bell, 8”, 120VAC, 82dBA</td>
</tr>
<tr>
<td>SSV120-10</td>
<td>SSV120-10A</td>
<td>Bell, 10”, 120VAC, 82dBA</td>
</tr>
<tr>
<td>WBB</td>
<td></td>
<td>Weatherproof back box for SSM and SSV series, when installed outdoors</td>
</tr>
</tbody>
</table>

---

### SSM/SSV Specifications

#### Architectural/Engineering Specifications

Model shall be a SSM or SSV Series alarm bell. Bells shall have underdome strikers and operating mechanisms. Gongs on said bells shall be no smaller than nominal 6˝/8˝/10˝ (specify size) with an operating voltage of 24VDC or 120VAC (specify by part number). Bells shall be suitable for surface or semi-flush mounting. Outdoor surface mounted installations shall be weatherproof (using optional WBB weatherproof electrical box). Otherwise bells shall mount to a standard 4” square electrical box having a maximum projection of 2½”. Bells shall be located as shown on the drawings or as determined by the Authority Having Jurisdiction. Bells shall be listed for indoor/outdoor use by Underwriters Laboratories and the California State Fire Marshal, and approved by Factory Mutual and MEA.

#### Physical/Operating Specifications

<table>
<thead>
<tr>
<th>Operating Temperature Range</th>
<th>–31°F to 140°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage</td>
<td>SSM series: 24 VDC, SSV series: 120 VAC</td>
</tr>
<tr>
<td>Termination</td>
<td>Provided with 2 sets of leads for in/out wiring</td>
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<tr>
<td>Service Use</td>
<td>Fire Alarm, General Signaling, Burglar Alarm</td>
</tr>
<tr>
<td>Warranty</td>
<td>3 years</td>
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</table>

#### Electrical Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Gong Diameter (inches)</th>
<th>Nominal Voltage</th>
<th>Operating Voltage Limit</th>
<th>Maximum Current</th>
<th>Sound Output (dBA)</th>
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</thead>
<tbody>
<tr>
<td>SSM24-6</td>
<td>6</td>
<td>Regulated 24VDC</td>
<td>16 to 33VDC</td>
<td>DC-31.1mA/FWR-53.5mA</td>
<td>82</td>
</tr>
<tr>
<td>SSM24-8</td>
<td>8</td>
<td>Regulated 24VDC</td>
<td>16 to 33VDC</td>
<td>DC-31.1mA/FWR-53.5mA</td>
<td>80</td>
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<td>SSM24-10</td>
<td>10</td>
<td>Regulated 24VDC</td>
<td>16 to 33VDC</td>
<td>DC-31.1mA/FWR-53.5mA</td>
<td>81</td>
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<tr>
<td>SSV120-6</td>
<td>6</td>
<td>Regulated 120VAC</td>
<td>96 to 132VAC</td>
<td>53mA</td>
<td>85</td>
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<td>SSV120-8</td>
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<td>Regulated 120VAC</td>
<td>96 to 132VAC</td>
<td>53mA</td>
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<tr>
<td>SSV120-10</td>
<td>10</td>
<td>Regulated 120VAC</td>
<td>96 to 132VAC</td>
<td>53mA</td>
<td>82</td>
</tr>
</tbody>
</table>

* Sound output measured at Underwriter Laboratories, as specified in UL464
OSID Smoke Detection

Open-area Smoke Imaging Detection (OSID) by Xtralis is a new innovation in projected beam smoke detection technology. By using advanced dual wavelength projected beams and optical imaging technology for early warning smoke detection, OSID provides a low-cost, reliable and easy-to-install solution that overcomes typical beam detection issues such as false alarm incidents and alignment difficulties.

Unique Detection Technology
The OSID system measures the level of smoke entering beams of light projected over an area of protection. A single OSID Imager can detect up to seven Emitters to provide a wide coverage area. Two innovations in smoke detection technology have been developed for the revolutionary OSID smoke detector:

Dual Wavelength Particle Detection
The beam projected from each Emitter contains a unique sequence of ultraviolet (UV) and infrared (IR) pulses that are synchronised with the Imager and enable the rejection of any unwanted light sources.

By using two wavelengths of light to detect particles, the system is able to distinguish between particle sizes. The shorter UV wavelength interacts strongly with both small and large particles while the longer IR wavelength is affected only by larger particles. Dual wavelength path loss measurements therefore enable the detector to provide repeatable smoke obscuration measurements, while rejecting the presence of dust particles or solid intruding objects.

Optical Imaging with a CMOS Imaging Chip
An optical imaging array in the OSID Imager provides the detector with a wide viewing angle to locate and track multiple Emitters. Consequently, the system can tolerate a much less precise installation and can compensate for the drift caused by natural shifts in building structures.

Optical filtering, high-speed image acquisition and intelligent software algorithms also enable the OSID system to provide new levels of stability and sensitivity with greater immunity to high level lighting variability.

Operation
Status information (Fire Alarm, Trouble and Power) is communicated through the Imager via Status LEDs, dedicated Trouble and Alarm relays, and the Remote Indicator interface. Specific Trouble (Fault) conditions are identified through coded flashes of the Trouble LED.

An internal heating option is also provided on the Imager to prevent condensation on the optical surface, and a reset input enables an external signal to reset the device.

Simple Installation and Maintenance
The OSID system consists of up to seven Emitters, for the 45° and 90° Imager units, located along the perimeter of the protected area, and an Imager mounted opposite. Each component can be mounted directly to the surface or can be secured with the supplied mounting brackets. Battery powered Emitters with up to five years battery life are also available to reduce installation time and cost.

Features
- Maximum detection range of 150 m (492 ft) for the OSI-10
- Status LEDs for Fire, Trouble and Power
- High false alarm immunity
- Dust and intrusive solid object rejection
- Easy alignment with large adjustment and viewing angles
- No need for precise alignment
- Tolerant of alignment drift
- Automatic commissioning in under ten minutes
- Simple DIP switch configuration
- Dual wavelength LED-based smoke detection
- Simple and easy maintenance requirements
- Conventional alarm interface for straightforward fire system integration
- Three selectable alarm thresholds

Listings/Approvals
- UL
- ULC
- AFNOR
- CE - EMC and CPD
- VdS
- ActivFire
- Major Agency Approvals pending
OSID Smoke Detection

Specifications

Supply Voltage
20 to 30 VDC (24 VDC nominal)

Imager Current Consumption
Nominal (at 24 VDC):
- 8mA (1 Emitter)
- 10mA (7 Emitters)
Peak (at 24 VDC) during training mode:
- 31mA

Emitter Current Consumption
Wired Version (at 24 VDC):
- 350µA Std Power
- 800µA High Power

Battery Version:
- Built-in 5 Year Battery

Field Wiring
Cable Guage
- 0.2 - 4mm² (26-12 AWG)

Alarm Threshold Levels:
- Low - Highest sensitivity / earliest alarm: 20% (0.97 dB)
- Medium - Medium sensitivity: 35% (1.87 dB)
- High - Lowest sensitivity / maximum immunity to nuisance smoke conditions: 50% (3.01 dB)

Adjustment Angle
±60° (horizontal)
±15° (vertical)

Maximum Misalignment Angle
±2°

Dimensions (WHD)
Emitter / Imager:
- 198 mm x 130 mm x 96 mm
(7.80 in. x 5.12 in. x 3.78 in.)

Operating Conditions*
- Temperature: -10 °C to 55 °C (14 °F to 131 °F)
- Humidity: 10 to 95% RH (non-condensing)

Please consult your Xtralis office for operation outside these parameters.

IP Rating
- IP 44 for Electronics
- IP 66 for Optics Enclosure

Status LEDs
- Fire Alarm (Red)
- Trouble / Power (Bi-color Yellow / Green)

Approvals Compliance

Please refer to the Product Guide for details regarding compliant design, installation and commissioning.

** Maximum Distances measured for the Center Field of View of the Imager. For more details on distances for the Imager, see the OSID Product Guide.

Emitter / Imager Dimensions

Ordering Codes

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSI-10</td>
<td>Imager - 7º coverage</td>
<td>OSID-INST</td>
<td>OSID Installation Kit</td>
</tr>
<tr>
<td>OSI-45</td>
<td>Imager - 38º coverage</td>
<td>OSP-001</td>
<td>FTDI Cable 1.5m</td>
</tr>
<tr>
<td>OSI-90</td>
<td>Imager - 80º coverage</td>
<td>OSP-002</td>
<td>Laser Alignment tool</td>
</tr>
<tr>
<td>OSE-SP</td>
<td>Emitter - Standard Power</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSE-SPW</td>
<td>Emitter - Standard Power, Wired</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSE-HPW</td>
<td>Emitter - High Power, Wired</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

www.xtralis.com
The Americas +1 781 740 2223 Asia +852 2916 8894 Australia and New Zealand +61 3 9936 7000
Europe, Middle East & Africa +44 1442 242 330

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Part No. 29573
Open-area Smoke Imaging Detection (OSID) by Xtralis is a new innovation in projected beam smoke detection technology. By using advanced dual wavelength projected beams and optical imaging technology for early warning smoke detection, OSID provides a low-cost, reliable and easy-to-install solution that overcomes typical beam detection issues such as false alarm incidents and alignment difficulties.

**Unique Detection Technology**

The OSID system measures the level of smoke entering beams of light projected over an area of protection. A single OSID Imager can detect up to seven Emitters to provide a wide coverage area. Two innovations in smoke detection technology have been developed for the revolutionary OSID smoke detector:

**Dual Wavelength Particle Detection**

The beam projected from each Emitter contains a unique sequence of ultraviolet (UV) and infrared (IR) pulses that are synchronised with the Imager and enable the rejection of any unwanted light sources.

By using two wavelengths of light to detect particles, the system is able to distinguish between particle sizes. The shorter UV wavelength interacts strongly with both small and large particles while the longer IR wavelength is affected only by larger particles. Dual wavelength path loss measurements therefore enable the detector to provide repeatable smoke obscuration measurements, while rejecting the presence of dust particles or solid intruding objects.

**Optical Imaging with a CMOS Imaging Chip**

An optical imaging array in the OSID Imager provides the detector with a wide viewing angle to locate and track multiple Emitters. Consequently, the system can tolerate a much less precise installation and can compensate for the drift caused by natural shifts in building structures.

Optical filtering, high-speed image acquisition and intelligent software algorithms also enable the OSID system to provide new levels of stability and sensitivity with greater immunity to high level lighting variability.

**Operation**

Status information (Fire Alarm, Trouble and Power) is communicated through the Imager via Status LEDs, dedicated Trouble and Alarm relays, and the Remote Indicator interface. Specific Trouble (Fault) conditions are identified through coded flashes of the Trouble LED.

An internal heating option is also provided on the Imager to prevent condensation on the optical surface, and a reset input enables an external signal to reset the device.

**Simple Installation and Maintenance**

The OSID system consists of up to seven Emitters, for the 45° and 90° Imager units, located along the perimeter of the protected area, and an Imager mounted opposite. Each component can be mounted directly to the surface or can be secured with the supplied mounting brackets. Battery powered Emitters with up to five years battery life are also available to reduce installation time and cost.

**Features**

- Maximum detection range of 150 m (492 ft) for the OSI-10
- Status LEDs for Fire, Trouble and Power
- High false alarm immunity
- Dust and intrusive solid object rejection
- Easy alignment with large adjustment and viewing angles
- No need for precise alignment
- Tolerant of alignment drift
- Automatic commissioning in under ten minutes
- Simple DIP switch configuration
- Dual wavelength LED-based smoke detection
- Simple and easy maintenance requirements
- Conventional alarm interface for straightforward fire system integration
- Three selectable alarm thresholds

**Listings/Approvals**

- UL
- ULC
- FM
- AFNOR
- CE Mark
- VdS
- ActivFire
- BOSEC
- Major Agency Approvals pending
OSID Smoke Detection

On the Imager, a termination card provides all field wiring terminals, and DIP switches enable the user to configure the detector for particular applications. Alignment of the Emitter is simply achieved using a laser alignment tool to rotate the optical spheres until the laser beam projected from the alignment tool is close to the Imager. The Imager is aligned in a similar way so that its Field of View (FOV) encompasses all Emitters. A Trouble or Fault will be indicated if an Emitter is missing or outside the Imager field of view. The OSID system is highly tolerant to dust and dirt and requires little maintenance in practice. Preventative maintenance is limited to occasionally cleaning the optical faces of the detector components.

**Configuration Options**

OSID systems may be configured to suit a range of detection spaces by selecting the number of Emitters and type of Imager. Each type of Imager differs by the lens used in the unit, which determines the field of view and range of the system.

<table>
<thead>
<tr>
<th>Imager</th>
<th>Emitter / Imager Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSI-10</td>
<td>208 mm x 136 mm x 96 mm (8.19 in x 5.35 in x 3.78 in.)</td>
</tr>
<tr>
<td>OSI-45</td>
<td>200 mm x 82 mm x 52 mm (8” x 3.2” x 2”)</td>
</tr>
<tr>
<td>OSI-90</td>
<td>180 mm x 162 mm x 52 mm (7.1” x 6.4” x 2”)</td>
</tr>
</tbody>
</table>

**Ordering Codes**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSI-10</td>
<td>Imager - 7º coverage</td>
</tr>
<tr>
<td>OSI-45</td>
<td>Imager - 38º coverage</td>
</tr>
<tr>
<td>OSI-90</td>
<td>Imager - 80º coverage</td>
</tr>
<tr>
<td>OSE-SP-01</td>
<td>Emitter - Alkaline Battery</td>
</tr>
<tr>
<td>OSE-SP-PW</td>
<td>Emitter - Standard Power, Wired</td>
</tr>
<tr>
<td>OSI-EHE</td>
<td>Emitter environmental housing IP66</td>
</tr>
<tr>
<td>OSI-EHI</td>
<td>Emitter environmental housing IP66</td>
</tr>
<tr>
<td>OSE-AFC</td>
<td>Anti-condensation film for Emitters</td>
</tr>
<tr>
<td>OSEH-ACF</td>
<td>Anti-condensation film for OSID-EHE and OSID-EHI environmental housings</td>
</tr>
</tbody>
</table>

**Specifications**

- **Supply Voltage**: 20 to 30 VDC (24 VDC nominal)
- **Imager Current Consumption**
  - Nominal (at 24 VDC): 8mA (1 Emitter), 10mA (7 Emitters)
  - Peak (at 24 VDC) during training mode: 31mA
- **Emitter Current Consumption**
  - Wired Version (at 24 VDC): 350µA Std Power, 800µA High Power Battery Version (1.9 - 3.2 VDC): Built-in 5 Year Replaceable Battery

**Field Wiring**

- Cable Guage: 0.2 - 4mm² (26-12 AWG)

**Alarm Threshold Levels**

- Low: Highest sensitivity / earliest alarm: 20% (0.97 dB)
- Medium: Medium sensitivity: 35% (1.87 dB)
- High: Lowest sensitivity / maximum immunity to nuisance smoke conditions: 50% (3.01 dB)

**Adjustment Angle**

- ±60° (horizontal)
- ±15° (vertical)

**Maximum Misalignment Angle**

- ±2°

**Dimensions (WHD)**

- Emitter / Imager: 208 mm x 136 mm x 96 mm (8.19 in x 5.35 in x 3.78 in.)

**Operating Conditions**

- Temperature: -10 °C to 55 °C (14 °F to 131 °F)*
- Humidity: 10 to 95% RH (non-condensing)

Please consult your Xtralis office for operation outside these parameters.

**IP Rating**

- IP 44 for Electronics
- IP 66 for Optics Enclosure

**Status LEDs**

- Fire Alarm (Red)
- Trouble / Power (Bi-color Yellow / Green)

**Event log**

- 10,000 events

**Approvals Compliance**

Please refer to the Product Guide for details regarding compliant design, installation and commissioning.

*Product UL listed for use from 0°C to 39°C (32°F to 103°F)
OSID (Open-area Smoke Imaging Detector) combines dual wavelength (IR and UV) beams with CMOS imaging detection. This technology features high tolerance to vibration and structural movement and OSID differentiates better between smoke and environmental conditions than traditional beam detectors. OSID operates in both pitch dark as well as bright sunlight.

One Imager (receiver) can have up to 7 Emitters and provides easy 3D coverage for atria etc.

Fast and easy installation and commissioning is achieved through the flexible ball & socket arrangement and the use of the laser alignment tool. Trouble shooting is simple thanks to the on-board memory and the OSID Diagnostic SW package, both unique for this industry.

Below is an overview of this award winning OSID range.

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSI-10</td>
<td><strong>Imager 8° FOV</strong>&lt;br&gt;Distance 30-150 m with OSE-SP/W. This configuration is for a 1 on 1 system. The OSI-10 is not suited to work with High Powered Emitters.</td>
<td><img src="image1" alt="OSI-10 Imager" /></td>
</tr>
<tr>
<td>OSI-45</td>
<td><strong>Imager 38° FOV</strong>&lt;br&gt;Distance 12-60 m with OSE-SP/W&lt;br&gt;Distance 24-120 m with OSE-HPW&lt;br&gt;The OSI-45 can operate with up to 7 Emitters.</td>
<td><img src="image2" alt="OSI-45 Imager" /></td>
</tr>
<tr>
<td>OSI-90</td>
<td><strong>Imager 80° FOV</strong>&lt;br&gt;Distance 6-34 m with OSE-SP/W&lt;br&gt;Distance 12-68 m with OSE-HPW&lt;br&gt;The OSI-45 can operate with up to 7 Emitters.</td>
<td><img src="image3" alt="OSI-90 Imager" /></td>
</tr>
<tr>
<td>OSE-SP-01</td>
<td><strong>Emitter battery powered-alkaline battery</strong>&lt;br&gt;Using battery powered Emitters, with a guaranteed 5 year life, drastically reduce the wiring and installation costs.</td>
<td><img src="image4" alt="OSE-SP-01 Emitter" /></td>
</tr>
<tr>
<td>OSE-HP-01</td>
<td><strong>Emitter High Power battery powered-alkaline battery</strong>&lt;br&gt;Using battery powered Emitters, with a guaranteed 3 year life, drastically reduce the wiring and installation costs.</td>
<td><img src="image5" alt="OSE-HP-01 Emitter" /></td>
</tr>
<tr>
<td>OSE-SPW</td>
<td><strong>Emitter Wired 24 Vdc</strong>&lt;br&gt;A preferred solution when 24 Vdc is close by.</td>
<td><img src="image6" alt="OSE-SPW Emitter" /></td>
</tr>
<tr>
<td>OSE-HPW</td>
<td><strong>Emitter High Power Wired 24 Vdc</strong>&lt;br&gt;Allows to double the detection ranges of the OSI-45 and OSI-90.</td>
<td><img src="image7" alt="OSE-HPW Emitter" /></td>
</tr>
<tr>
<td>OSID-INST</td>
<td><strong>OSID Installation Kit</strong>&lt;br&gt;Kit including laser alignment tool, test filter, PC cable, cleaning cloth, reflectors and manual.</td>
<td><img src="image8" alt="OSID-INST Kit" /></td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>VKT-301</td>
<td><strong>OSID Demo kit</strong>&lt;br&gt;Kit consisting of 2 X OSE-SP-01, 1 X OSI-90, 1 X OSID-INST and mounting plates, fitted in a rugged carry case.</td>
<td></td>
</tr>
<tr>
<td>OSP-001</td>
<td><strong>FTDI Cable 1.5m</strong>&lt;br&gt;Allows to connect a PC and hence OSID Diagnostic SW to the Imager. The FTDI cable can be extended with another 20 m using cable with an active USB amplifier.</td>
<td></td>
</tr>
<tr>
<td>OSP-002</td>
<td><strong>Laser Alignment tool</strong>&lt;br&gt;A unique alignment tool for fast alignment. Aligns and locks the eyeball. Does also activate Emitters when locked.</td>
<td></td>
</tr>
<tr>
<td>OSID-WG</td>
<td><strong>Wire Guard</strong>&lt;br&gt;A steel cage to protect OSID Imagers and Emitters from vandalism and accidental damage.</td>
<td></td>
</tr>
<tr>
<td>OSID-EHI</td>
<td><strong>Imager Environmental Housing</strong>&lt;br&gt;Custom designed IP 66, NEMA 4-4X protective and environmental housings protect OSID Imagers from dust and water ingress in industrial environments.</td>
<td></td>
</tr>
<tr>
<td>OSID-EHE</td>
<td><strong>Emitter Environmental Housing</strong>&lt;br&gt;Custom designed IP 66, NEMA 4-4X protective and environmental housings protect OSID Emitters from dust and water ingress in industrial environments.</td>
<td></td>
</tr>
<tr>
<td>OSE-ACF</td>
<td><strong>Anti-condensation film for Emitters</strong>&lt;br&gt;An easy applicable film that provide long time resistance to condensation on the acrylic Emitter lens.</td>
<td></td>
</tr>
<tr>
<td>OSEH-ACF</td>
<td><strong>Anti-condensation film for OSID-EH housings</strong>&lt;br&gt;An easy applicable film that provide long time resistance to condensation on the glass fronts</td>
<td></td>
</tr>
<tr>
<td>OSID Diagnostic Tool</td>
<td><strong>Diagnostic software package</strong>&lt;br&gt;A unique software program that allows visualisation of the Imager's view, quality of alignment and IR/UV real time graphs. The program also features real time logging capability for trouble shooting and site evaluation purposes.</td>
<td></td>
</tr>
<tr>
<td>OSID Selection Assistant</td>
<td><strong>System selection tool</strong>&lt;br&gt;The program is an intuitive Excel based program that for a given area will calculate 90°, 45°and 10° OSID solutions as well offer a price comparison with traditional beams. It also gives the exact location to point the alignment laser tool for optimal FOV for the Imagers in multi-Emitter solutions.</td>
<td></td>
</tr>
<tr>
<td>OSE-RBL</td>
<td><strong>Emitter replacement battery Lithium</strong></td>
<td></td>
</tr>
<tr>
<td>OSE-RBA</td>
<td><strong>Emitter replacement battery Alkaline</strong></td>
<td></td>
</tr>
</tbody>
</table>
**Available Fields of View and Detection Ranges**

<table>
<thead>
<tr>
<th>Image Lens Type</th>
<th>Usable Field of View</th>
<th>Detection Range</th>
<th>Max. Number of Emitters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Horizontal</td>
<td>Vertical</td>
<td>Standard Power</td>
</tr>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>10°</td>
<td>7°</td>
<td>4°</td>
<td>30 m (98 ft)</td>
</tr>
<tr>
<td>45°</td>
<td>38°</td>
<td>19°</td>
<td>15 m (49 ft)</td>
</tr>
<tr>
<td>50°</td>
<td>80°</td>
<td>48°</td>
<td>6m (20 ft)</td>
</tr>
</tbody>
</table>

* Range with OSE-HP-01

**One-on-one application and theory of operation**

**Typical Multi-Emitter application**
### Product Specifications

#### General

**Alarm Thresholds (Configurable)**
- Low - Highest sensitivity / earliest alarm: 20% (0.97 dB)
- Medium - Medium sensitivity: 35% (1.87 dB)
- High - Lowest sensitivity / maximum immunity to nuisance smoke conditions: 50% (3.01 dB)

**Alarm Latching (Configurable)**
- Latching / Non-latching configured via DIP switch

**Status LEDs (Imager)**
- Red: Fire Alarm; Bi-color Yellow/Green: Trouble or Normal

**IP Rating**
- IP 44 for Electronics; IP 66 for Optics Enclosure

**DIP Switch Configuration (Termination Card)**
- Configuration for alarm thresholds, number of Emitters and alarm latching/non latching.

#### Electrical

**Imager Supply voltage**
- 20-30 VDC (24 VDC nominal)

**Imager Current Consumption**
- Typical at 24 VDC: 8 mA (one Emitter), 10 mA (seven Emitters)

**Emitter Current Consumption**
- Externally powered Emitter (at 24 VDC): 350 µA Standard Power, 800 µA High Power
- Battery-powered Emitter: Built-in 5 Year Replacement Alkaline Battery, 3 Year Replacement with OSE-HP-01

**Cable Gauge**
- 0.2 - 4 mm² (26-12 AWG)

**Trouble/Fault Relay**
- 2 A @ 30 VDC, NO-C-NC Dry Relay Contacts

**Fire Alarm Relay**
- 2 A @ 30 VDC, NO-C-NC Dry Relay Contacts

**Heater Input Power**
- 24 VDC, 16 mA (400 mW)

#### Environmental

**Operating Temperature**
- -10°C to 55°C (14°F to 131°F)

**Humidity**
- 10 to 95% RH Non-condensing

#### Mechanical

**Dimensions (WHD)**
- 208 mm x 136 mm x 96 mm (8.2 in x 5.4 in x 3.8 in)

**Weight**
- Imager: 610 g; Emitter (battery powered): 1.2 kg
- Emitter (wired): 535 g

**Adjustment Angle**
- Horizontal: ±60°; Vertical: ±15°

**Maximum Misalignment Angle**
- ±2°

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**OSID AWARDS**

Visit the OSID website at [www.xtralis.com](http://www.xtralis.com) and discover application flyers, application notes, software, brochures and much more.
Appendix E – California TB 133:
STATE OF CALIFORNIA
DEPARTMENT OF CONSUMER AFFAIRS
BUREAU OF HOME FURNISHINGS AND THERMAL INSULATION
3485 ORANGE GROVE AVENUE
NORTH HIGHLANDS, CALIFORNIA 95660-5595

TECHNICAL BULLETIN 133

Flammability Test Procedure for Seating Furniture for Use in Public Occupancies

JANUARY 1991
I. Scope

A. This test procedure is designed to test seating furniture for use in occupancies that are identified as or considered to be public occupancies. Such facilities might include, but are not limited to, jails, prisons, nursing care homes, health care facilities, public auditoriums, hotels and motels.

B. This test procedure is not intended to be used for the evaluation of residential furniture.

C. It is the intent of the Bureau that furniture complying with Technical Bulletin 133 be safer furniture when subjected to the ignition source specified by this test. This type of ignition may be typical of arson or incendiary fires or common accidental fires in public buildings. This Bureau expects manufacturers attempting to comply with this standard will also seek to make safer furniture, and will not attempt to compromise the intent of the standard in any manner.

II. Test Facility

A. The test burn room shall be 12 x 10 feet or a close approximation with an 8-foot ceiling height. The room shall have no openings other than a doorway opening approximately 38 x 81 inches, located as indicated in Figures 1 and 2, and such other small openings that may be necessary to make test measurements. The test room shall be constructed of wooden or metal studs and lined with fire rated gypsum wallboard. Tests may be conducted in rooms of different physical dimensions than those specified, for example, the proposed ASTM room, when equivalent test results can be demonstrated. In addition, if compliance is claimed using the heat release criteria, tests performed using a furniture calorimeter are acceptable. When using test rooms of different dimensions or a furniture calorimeter the ignition source must be as specified in Section V of this standard.

B. The test burn room shall be instrumented to monitor temperature, carbon monoxide concentration, smoke opacity and sample weight loss. Other test room instrumentation may be added as required. In addition, the test facility may be instrumented to measure total heat release and heat release rate when compliance with the alternate heat release criteria is claimed. A typical system used to measure heat release, on the principle of oxygen consumption, is described in Appendix A.

C. The test room shall be unfurnished except for the test sample. The test sample shall be positioned as indicated in Figure 1 or 2.
III. Test Sample

The test sample shall consist of typical seating furniture suitable for use in public occupancies, or a full-scale mock-up of the furniture. When a full-scale furniture mock-up is used, the mock-up shall in all respects (including fabrics, filling materials, combustible decorative parts and furniture style) reflect the construction of the actual furniture that it is intended to represent. See Appendix D.

IV. Test Conditioning

The test sample and newsprint shall be conditioned for at least 48 hours prior to testing at 70±5°F and a relative humidity of less than 55%. Test materials shall be tested within 10 minutes of removal from such conditions if test room conditions differ from the above.

V. Test Ignition Source

A. The test ignition source shall be a square gas burner as described in Appendix C.

B. An ignition source of five double sheets of loosely wadded newsprint contained in an ignition box, as described in Appendix B, may be used as a screening test.

VI. Test Procedure

A. Position thermocouple in two test locations (see Figure 1 or 2):

1. Over the geometric center of the ignition source, one inch below the ceiling. This shall be designated as the ceiling thermocouple.

2. Three feet in front of the ignition source, four feet below the ceiling. This shall be designated as the 4 foot thermocouple.

B. Position a smoke opacity monitor in one test location (see Figure 1 or 2): Four feet above the floor level. This shall be designated as the 4-foot smoke opacity monitor.

C. The gas sampling line shall be positioned 6.5 inches below the ceiling and 6.5 inches from the corner (see Figure 1 or 2).

D. A weighing platform shall support the base of the furniture 5±2 inches above the floor. The furniture and weighing platform shall be positioned in the corner so that the furniture is no more than 10 inches from both walls. If the seating furniture is no more than 40 inches in width, refer to Figure 1. If the seating furniture is more than 40 inches, refer to Figure 2.

E. If the seating furniture is no more than 40 inches in width, the square gas burner shall be positioned at the center of the crevice area, 2 inches from the furniture back and 1 inch above the seat surface. (See Figures 12D and 13).

F. If the seating furniture is more than 40 inches in width, the square gas burner shall be positioned 5 inches from the left arm crevice or edge of the seating surface. (See Figures 12D and 14).
G. The gas flow through the square gas burner, described in Appendix C, shall be maintained for 80±2 seconds.

H. Allow combustion to continue until:
   1. All combustion has ceased; or
   2. 1.0 hour of testing has elapsed; or
   3. Flameover or flashover appears to be inevitable.

VII. Test Criteria

A. Seating furniture fails to meet the requirements of this test procedure if any of the following criteria are exceeded in a room test using the room instrumentation.
   1. A temperature increase of 200°F or greater at the ceiling thermocouple.
   2. A temperature increase of 50°F or greater at the 4-foot thermocouple.
   3. Greater than 75% opacity at the 4-foot smoke opacity monitor.
   4. Carbon monoxide concentration in the room, as measured in accordance with Section VI, Part C, of 1000 ppm or greater for 5 minutes.
   5. Weight loss due to combustion of 3 pounds or greater in the first 10 minutes of the test.

B. Seating furniture fails to meet the requirements of this test procedure if any of the following criteria are exceeded in a room test using oxygen consumption calorimetry.
   1. A maximum rate of heat release of 80 kW or greater.
   2. A total heat release of 25 MJ or greater in the first 10 minutes of the test.
   3. Greater than 75% opacity at the 4-foot smoke opacity monitor.
   4. Carbon monoxide concentration in the room, as measured in accordance with Section VI, Part C, of 1000 ppm or greater for 5 minutes.

Note
It is not required that all of the above criteria in VII A and VII B, be measured. Furniture must comply with the criteria described in VII A or VII B. When a furniture calorimeter is used furniture must comply with Criteria B, 1 and 2.

VII. Caution

Full-scale fire tests may be dangerous. All tests should be supervised by experienced test personnel. Adequate fire suppression equipment and self-contained breathing devices must be available for test personnel. Products of combustion can be irritating and dangerous; therefore, test personnel must avoid exposure to smoke and gases produced during testing as much as possible. Full-scale fire tests should never be left unattended. Test personnel must be certain upon completion of the test that combustion is totally suppressed. The performance of the submitted sample is not necessarily on accurate indication of the performance of the furniture in a real-life fire situation.
APPENDIX A

Calculation of the Rate of Heat release by the Method of Oxygen Consumption

This appendix describes the method of measurement of rate of heat release from burning furniture based on the principle of oxygen depletion. Part I describes the instrumentation required for flow and oxygen depletion measurements. Part II describes the method of, and equations for the calculation of rate of heat release.

PART I INSTRUMENTATION

The following is a description of the gas sampling technique and instrumentation used by the Bureau of Home Furnishings to determine the rate of heat release - based on oxygen depletion. Alternative techniques and/or equipment that provide accurate determination of oxygen depletion and the rate of heat release are acceptable.

A. Collection of Combustion Gases and Flow Measurement

A suitable sized collection hood should be installed at the top of the doorway entrance. The hood should be designed and located to ensure a well mixed sample of gases for analysis. The path of the exhaust duct should be at least 20 feet long to ensure accurate flow velocity measurements and may have turning and straightening vanes installed as shown in Figures 9a, 9b and 9c.

B. Duct Air Velocity Measurement

A bi-directional probe or an equivalent system shall be used to measure gas velocity in the duct. The bi-directional probe shall be mounted at the center line of the duct parallel to the direction of the air flow. A pressure transducer with a range of 0 to 1 torr, or equivalent, shall be used to measure the pressure differential across the bi-directional probe in the duct. A thermocouple shall be installed next to the bi-directional probe to record the temperature of the flowing gases. This temperature along with the pressure differential is required to calculate the velocity of the flow in the exhaust duct.

C. Gas Sampling Probe in the Duct

In order to determine oxygen depletion due to the combustion of burning articles, a sample of the exhaust gases shall be extracted from the exhaust duct to measure the mole fractions of oxygen, carbon monoxide and carbon dioxide. A stainless steel gas sampling tube shall be used to obtain a continuously flowing sample. The location and configuration of the sampling probe shall ensure collection of a representative sample of well mixed gases. A suitable sampling tube is shown in Figures 10a-d. Alternative designs that allow an integral sampling of gases over the cross-section of the exhaust duct are acceptable.
PART II  EQUATIONS

A. The rate of heat production shall be calculated as follows:

\[ \dot{Q} = E' X_{O_2} V_a \phi - \left( \frac{E' - E''}{E'} \right) \frac{1 - \phi}{2} \frac{X_{CO}}{X_{O_2}} \]  

(1)

where:

\( E' \) = net heat of combustion per unit volume of oxygen consumed, 17.2 MJ/m³,

\( E'' \) = heat release per unit volume of oxygen consumed in the burning of CO, 23.1 MJ/m³ referred to 25°C.

\( V_a \) = the volume flow rate of air into the system corrected to 25°C (including that which enters the room and that which passes directly into the exhaust duct)

\( X_i \) = mole fraction of the gas specie i, in the gas analyzer,

\( X_i^0 \) = mole fraction of the gas specie i, entering the system, in the gas analyzer, i.e., the initial mole fractions,

\( \phi \) = oxygen depletion.

B. The oxygen depletion or the fraction of oxygen consumed is as follows:

\[ \phi = X_{O_2} \left[ \frac{1 - X_{CO}}{1 - X_{CO} - X_{CO}} \right] \]  

(2)

C. The volume flow rate in the exhaust duct is given by,

\[ V_s = 1 - \phi V_A + \alpha \phi V_A \]  

(3)

Where \( V_S \) and \( V_A \) are referred to standard conditions (25°C and 1 atm) and \( \alpha \) is the expansion factor of the air that is depleted of its oxygen. So

\[ V_A = \frac{V_s}{(1 + (\alpha - 1)\phi)} \]  

(4)

The value of \( \alpha \) ranges from 1.0 for carbon to 1.175 for cellulose with plastics having values in between. In order to reduce the error incurred when unknown
products are burning, $\alpha$ is taken to have an intermediate value of 1.084 which is exact for propane, the calibration burner gas. Setting $\alpha=1.084$, $E'=17.2 \text{ MJ/m}^3$ and $E''=23.1 \text{ MJ/m}^3$, equation (1) becomes:

$$\dot{Q} = 17.2 X_{O_2} \left( \frac{V_s}{1 + 0.084\phi} \right) \left[ \phi - 0.3429 \left( \frac{1-\phi}{2} \right) \frac{X_{CO_2}}{X_{O_2}} \right] \text{ MW} \quad (5)$$

where $V_s$ is measured in the exhaust duct as cubic meters per second.

D. If the gas velocity in the exhaust duct is measured with a pitot-static tube or a bi-directional probe, the standard volume flow rate is given by:

$$V_s = jkA \left[ \frac{2\Delta P}{\rho_0 T_s} \right]^{1/2} = 0.07536 jkA [\Delta P \cdot T_s]^{1/2} \text{ m}^3/\text{sec} \quad (6)$$

where $T_s$ is the gas temperature in the duct in degrees K and $\Delta P$ is the pressure differential across the bi-directional probe (or pitot-static tube) in Pa. $A$ is the cross-sectional area of the duct in m$^2$, $k$ is the ratio of the average mass flow rate per unit area to the centerline mass flow rate per unit area, $j$ is a calibration factor equal to unity for a pitot-static tube and 0.926 for a bi-directional probe, and $\rho_0$ is the density of air, kg/m$^3$, at the reference temperature $T_0$, °K.

E. When carbon monoxide is not measured in the sampling line or its mole fraction can be neglected compared with the mole fraction of CO$_2$, the equation for the oxygen depletion can be simplified as:

$$X_{O_2} - \frac{X_{O_2} (1-X_{CO_2})}{(1-X_{CO_2})} \phi = \frac{X_{O_2} (1-X_{CO_2})}{(1-X_{CO_2})} \quad (7)$$

and the rate of heat release equation will be:

$$\dot{Q} = \frac{17.2 X_{O_2} V_s \phi}{(1 + 0.084\phi)} \text{ MW} \quad (8)$$

F. The room and ducting shall be calibrated using a porous gas burner with a 12 by 12 inch top surface and a 6 inch depth. A gas burner may be constructed with a 1 inch thick (25 mm) plenum; or alternatively a minimum 4 inch (100 mm) layer of Ottawa sand can be used to provide the horizontal surface through which the gas is supplied. This type of burner is shown in Figure 11. The gas supply to the burner shall be of commercial grade propane and shall have a gross heat of combustion of approximately 20,000 ±200 Btu/lbm. The flow rate of propane shall
be metered and kept constant throughout the calibration test. A minimum of 2
calibration points shall be obtained. A lower heat release value of 40 kW shall be
obtained which is the equivalent of approximately 1.0 standard ft³/min (28.32
lit/min) of propane. Then a higher heat release value of 169 kW shall be obtained.
This is the equivalent of approximately 4.0 standard ft³/min (113.27 lit/min) of
propane. Both tests shall be conducted for a period of 10 minutes.
APPENDIX B

Newsprint Ignition Source

A. This appendix describes the newsprint ignition source which may be used for compliance or screening testing. This ignition source consists of five double sheets of loosely wadded newsprint contained in Ignition Box A, B or C as appropriate. The newsprint shall not be tightly crumpled, but should be loosely wadded to approximately fill the selected ignition box.

B. One of three ignition boxes shall be used. Ignition Box A shall be used for furniture with a seat/back crevice. Ignition Box B shall be used with furniture that does not have a crevice. Ignition Box C shall be used for furniture that has a gap in the crevice area.

1. The following is a description of Ignition Box A:
   a. The 10 x 10 x 10 inch ignition box shall be constructed of .016 inch thick galvanized steel flashing and one inch hexagonal chicken wire. The steel flashing shall be cut 10 x 20 inches. A 7 inch long x 1.5 inch deep notch shall be cut centrally along a 10 inch side. One-eighth inch diameter holes shall be punched along both 20 inch sides on 1 inch centers, 0.5 inches from the edge of the flashing. The flashing shall be bent to form a right angle producing two 10 x 10 inch sides of the ignition box. Two pieces of chicken wire shall be cut 11 x 11 inches. The chicken wire shall overlap one inch on the outside of the flashing. A 20 gauge wire shall be used to attach the chicken wire to the flashing through the 1/8 inch holes. The two remaining sides of the ignition box shall be left open (see Figure 3). The ignition box shall be used as indicated in Figures 4 and 5.
   b. Before use, the ignition box should be discolored. This may be accomplished by burning several batches of crumpled newspapers inside the box.

2. Ignition Box B shall be similar to Ignition Box A with the following changes:
   a. Only the side in contact with the seating area shall be left open. An 11 x 12 inch piece of previously described chicken wire shall be used to cover the 10 x 10 inch rear side of the box. Overlap and attachment shall be as previously described.
   b. The 7 inch long x 1.5 inch deep notch shall be eliminated from the top of the ignition box.

3. Ignition Box C shall be similar to Ignition Box B with the following changes:
   a. A 7 inch long x 1.5 inch deep notch shall be cut centrally from the top of the ignition box. The open side of the box will be in contact with the seating area and the notch will be facing the back of the chair.

C. Each double sheet of newsprint shall have the approximate dimensions of 23 x 28 inches. Five double sheets of newsprint shall have the combined weight of 90 grams ±5
grams. Newsprint shall be black and white only; sheets with any type of color shall not be used.
APPENDIX C

Square Gas Burner Ignition Source

A. This appendix describes the square gas burner ignition source which may be used for compliance or screening testing. This ignition source utilizes propane gas as fuel at a volume flow rate of approximately 13 liters per minute for a period of 80 seconds. The propane gas is the same commercial grade as described in Appendix A.

B. The following is a description of the square gas burner:

The 250 x 250 mm (or approximately 10 x 10 inch) square burner shall be constructed of 1/2 inch OD stainless-steel tubing with 0.035 inch wall thickness (see Figure 12a). The front side shall have 14 holes pointing straight out and spaced 13 mm apart and 9 holes pointing straight down and spaced 13 mm apart. The right and left sides shall have 6 holes pointing straight out and spaced 13 mm apart and 4 holes pointing at 45° angle inward and spaced 50 mm apart. All holes shall be of 1 mm diameter (see Figures 12a-c). The 42 inch straight arm of the burner shall be welded on to the rear of the front side (Figure 12a) in a 30° angle. The burner shall be mounted on an adjustable height pole and be balanced by a counter weight or other appropriate mechanism (Figure 12d).

Note 1: When the flow of propane to the burner is stopped the burner shall be removed from the chair and away from high temperature gases. If the square gas burner is to be exposed to heat during burning of the test article, arrangements must be made to allow the remaining propane gas inside the tube to be freely released to avoid any possibility of explosion.

Note 2: Care must be taken to allow free flow of propane through the burner holes. Periodic cleaning of soot deposit and blowing pressurized air through the tube is recommended.
APPENDIX D

Furniture Mock-Up System

Technical Note

In lieu of testing finished products, full-scale mock-up testing may be performed according to the following test procedure.

A. The test sample shall consist of component cushions which duplicate the thickness, construction and design features of a product suitable for use in public occupancies.

B. A metal test frame (Figures 6 and 7) shall be used to support seat and back cushions and, if necessary, arm cushions. The chair frame shall be constructed of slotted "L" angle iron and slotted flat angle iron. The back shall be constructed so that it is adjustable to a maximum angle of 135° from the horizontal plane. The test frame shall be adjustable to accommodate test cushions of various thicknesses and sizes, with or without arm cushions.

C. Component back, seat and arm cushions shall be constructed into mock-up designs of the actual article of furniture. Construction should duplicate all layers found in the actual article of furniture. Cushion construction shall consist of either:

1. Manufacturer's prefabricated cushions of the appropriate size; or

2. Custom-made cushions of the appropriate size. Cushions are constructed by covering the face and four edges of the filling material with the appropriate interliners, etc. and cover fabric. On the back of each cushion, a two-inch overlap of the cover fabric is stapled together and a wire is loosely woven through the fabric edges and drawn to produce a close fit (see Figure 8).

D. The constructed seat cushion may be placed horizontally on the seat area of the test frame and pushed against the back of the frame. The constructed back cushion may then be placed vertically against the back support of the test frame. The back cushion shall be held in place by wire to prevent it from falling forward. If arm cushions are used, the constructed arm cushions may be placed between the seat cushion and the arm supports of the test frame. However, the placement of the seat, back and arm cushions should be done to most closely duplicate the design features of the completed article of furniture.

E. The test procedure shall be the same as for completed articles of furniture (see Section VI). The test criteria shall be the same for completed articles of furniture (see Section VII).

F. For upholstered furniture products containing only wood and/or metal frames, the above procedure appears to be an accurate indicator of the open-flame performance of the finished article. For upholstered furniture products containing
plastic frames and plastic decorative parts, this procedure may not be an accurate indicator of the open-flame performance of the finished article unless the plastic parts are included in the mock-up tested.
FIGURE 1

ROOM CONFIGURATION FOR TESTING SEATING ITEMS
NO MORE THAN 40 INCHES ACROSS

FIGURE 2

ROOM CONFIGURATION FOR TESTING SEATING ITEMS
MORE THAN 40 INCHES ACROSS
FIGURE 3
IGNITION BOX A

* Two opposite sides are chicken wire
FIGURE 4
Placement of Newsprint
Placement of Ignition Box Over Newsprint

FIGURE 5
Placement of Ignition Box
Seating items more than 40 inches across
FIGURE 8
BACK VIEW OF CONSTRUCTED CUSHION

Tolerance ± 1 inch
PLAN VIEW OF THE TEST ROOM AND EXHAUST DUCT
FIGURE 9a
24" TO CEILING

16" x 16" DUCT

FILTER CHAMBER

DOOR

TEST ROOM

6' X 8'
HOOD EVEN WITH TOP OF DOORWAY

FRONT VIEW OF THE TEST ROOM AND THE EXHAUST DUCT

FIGURE 9b

6" X 6" HOOD WITH VERTICAL DUCT CENTERED 4' OUT FROM DOORWAY

FILTER PLENUM

SIDE VIEW OF THE TEST ROOM AND THE EXHAUST DUCT

FIGURE 9c
SMALL HOLES (9) 3/32" DIAMETER
LARGE HOLES (16) 1/8" DIAMETER
DISTANCES BETWEEN HOLES = 1 IN.

ENDS PLUGGED

1/2" OD SS TUBE

FRONT VIEW OF GAS SAMPLING PROBE
FIGURE 10a
SIDE VIEW OF THE GAS SAMPLING PROBE IN THE DUCT

FIGURE 10b
PLAN VIEW

NOTE: SHOWN WITHOUT SAND

ELEVATION

SPACE FILLED WITH WHITE OTTOVIA SILICA SAND

ELEVATION

CALIBRATION GAS BURNER

FIGURE 11
NOTE: 1. All tubing 1/2" OD, SS, 0.035" wall thickness.
2. All holes 1 mm in diameter.
3. All units are mm unless otherwise noted.

PLAN VIEW OF SQUARE GAS BURNER
FIGURE 12a
SIDE VIEW OF SQUARE GAS BURNER
FIGURE 12b

CROSS SECTIONAL VIEW OF EACH SIDE OF SQUARE GAS BURNER
FIGURE 12c
POSITIONING OF SQUARE GAS BURNER ON THE CHAIR
FIGURE 12d
PLACEMENT OF SQUARE GAS BURNER
SEATING FURNITURE NO MORE THAN 40 INCHES ACROSS
FIGURE 13
PLACEMENT OF SQUARE GAS BURNER
SEATING ITEMS MORE THAN 40 INCHES ACROSS
FIGURE 14