Fire and Life Safety Analysis

Grant M. Brown Engineering Building #41

California Polytechnic State University, San Luis Obispo

Daniel Gregory Blanchat

June 12th, 2014
1 Statement of Disclaimer

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Key words: Fire and Life Safety Analysis, Life Safety Code, RSET, ASET, Performance Based Design, Fire Dynamics Simulator

About the Author:

I came to San Luis Obispo from Fresno, CA. I completed my undergrad at California State University, Fresno as part of the Smittcamp Family Honors College. My undergrad consisted of a Physiology & Anatomy Major with a Chemistry Minor. During my masters degree I was actively involved as an officer for Cal Poly’s chapter of the Society of Fire Protection Engineers and recipient of their annual scholarship in my first year. After graduation I will be starting as a Level 1 Fire Protection Engineer for AECOM out of Orange, CA. I would like to thank you for taking time to read my culminating project report.

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Executive Summary

This fire and life safety analysis was performed on the Grant M. Brown Engineering Building in order to determine if the building meets the life safety goals set forth by a prescriptive and performance based analysis. This building was built to a strict set of codes and standards.

For the prescriptive analysis the buildings egress design, fire detection and alarm systems, fire sprinkler system, occupancy classification, construction type, and structural fire protection are evaluated in terms of the life safety of the occupants.

In the performance based design analysis four computer based programs were used to model egress and fire simulated conditions. These models produced outputs that could be compared to tenability limits for the occupants to determine if the Available Safe Egress Time (ASET) was longer than the Required Safe Egress Time (RSET).

In the first design fire scenario a sofa located off the main exit corridor ignites. At 240 seconds the tenability limit for visibility is reached, setting the Available Safe Egress Time (ASET). Full evacuation of the building is accomplished by 191.5 seconds, leaving a margin of 48.5 seconds before conditions become untenable. This building passed the performance based design criteria for maintaining tenability of the occupants during the complete egress of the building.

In the second design fire scenario a set of office storage cabinets located under the main exit stairs on the east side ignites. At 180 seconds the tenability limit for visibility is reached, setting the Available Safe Egress Time (ASET). Full evacuation of the building is accomplished by
252.3 seconds. This evacuation time is more than the first scenario because the stairs become unusable in terms of visual tenability 60 seconds after the start of the fire and thus forcing the second story occupants to have to use only the remaining stairs on the west side of the building. The Available Safe Egress Time does not exceed the Required Safe Egress Time. This building fails the performance based design criteria for maintaining tenability of the occupants during the complete egress of the building.

The end of this analysis makes recommendations on how to improve the buildings fire safety from the results found in the study.
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3 Acronyms and Abbreviations

AHJ  Authority Having Jurisdiction
ASET  Available Safe Egress Time
Cal Poly  California Polytechnic State University
CBC  California Building Code
CFC  California Fire Code
CFD  Computational Fluid Dynamics
CPSU  California Polytechnic State University
CPU  Central Processing Unit
CSFM  California State Fire Marshal
EOL  End of Line
EPSS  Emergency Power Supply System
FACP  Fire Alarm Control Panel
FATC  Fire Alarm Terminal Cabinet
FDS  Fire Dynamic Simulator
GPM  Gallons Per Minute
HRR  Heat Release Rate
ITM  Inspection, Testing, and Maintenance
LSC  Life Safety Code
NFPA  National Fire Protection Association
NIST  National Institute of Technology
PSI  Pounds per Square Inch
RSET  Required Safe Egress Time
SFPE  Society of Fire Protection Engineers
UL  Underwriter Laboratory
4 Building Introduction

The Grant M. Brown Engineering Building (Building 41) was constructed on the northwest side of Californian Polytechnic State University of San Luis Obispo’s (Cal Poly) main campus on the corner of Highland and California. Two levels make up the structure. The building consists of two main entrances located on the east and west side. There are two set of stairs with the East being on the interior and open to the second floor. The West stairs are positioned on the exterior. An elevator is located to the West side of the building connecting the two floors. The main building on the north side is designated as Building A. The two remaining satellite buildings are Building B on southeast side and Building C on the southwest accompany the main building.

This building houses many different rooms. The classrooms, computer labs, and research labs are found spanning the middle section of Building A. The teacher offices and conference rooms are found in Building A along the north facing wall. The mechanic shops are found on the south side of Building A. The flight simulator can be found on the satellite room to Building A located on its west side. Building B houses the wind tunnel and stands alone from the rest except for a masonry wall that is built to close off the inner yard behind the mechanic shops.

Figure 1 below shows the location of the building on the Cal Poly campus.
Figure 1: Map of San Luis Obispo, CA

Figure 2: Location on Campus
5 Applicable Codes and Standards

Used During Construction

6 Current Codes and Standards Applied for Analysis

Used For Analysis
- California Mechanical Code – CMC 2010 Edition
- California Electrical Code – CEC 2010 Edition
7 Building Overview

Figure 3: First Floor Layout
7 Building Overview

Figure 4: Second Floor Layout
7  Building Overview

Gross Floor Area

Table 1: Gross Floor Area

<table>
<thead>
<tr>
<th>First Floor Buildings</th>
<th>Gross Floor Area in Square Feet (SF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building ‘A’</td>
<td>19,348 SF</td>
</tr>
<tr>
<td>Building ‘B’</td>
<td>5,869 SF</td>
</tr>
<tr>
<td>Building ‘C’</td>
<td>1,314 SF</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>26,531 SF</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second Floor Buildings</th>
<th>Gross Floor Area in Square Feet (SF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building ‘A’ Only</td>
<td>11,827 SF</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>11,827 SF</strong></td>
</tr>
</tbody>
</table>

**Total Floor Area:** 38,358 SF

Occupancy Classification
Business Occupancy
- NFPA 101 LSC 2012
Business Group B
- CBC 2010 Section 304.1

Type of Construction
Type II-B

Sprinkler Design
Light Hazard
Ordinary Hazard Group 1
7.1 Building Square Footage

<table>
<thead>
<tr>
<th>Building Level</th>
<th>Gross Square Footage (G.S.F.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building A, Level 1</td>
<td>19,348 SF</td>
</tr>
<tr>
<td>Building A, Level 2</td>
<td>11,827 SF</td>
</tr>
<tr>
<td>Building B</td>
<td>5,869 SF</td>
</tr>
<tr>
<td>Building C</td>
<td>1,314 SF</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>38,358 SF</strong></td>
</tr>
</tbody>
</table>

7.2 Building Height

The Grant M. Brown Engineering building is a two story structure. Building A is a single story building that is sanctioned as the main building. Building A has an actual building height of 45’.

The two satellite buildings (Building B and C) lie to the south and southwest of the main building. The two satellite buildings are both single story structures.

This building does not qualify as a high-rise structure because no floors are used for human occupancy located more than 75 feet above the lowest floor level having building access. For reference, see the CBC, 2010 in Section 403.1.

7.3 Allowable Increases

The CBC 2010 and the IBC 2012 specify allowable increases to be made to the code for building height, area, and the number of allowed stories. This is approved as long as it meets the requirements for an installed automatic sprinkler system. This system needs to be installed throughout the building, and the building must maintain a certain level of frontage area.

Section 504.2

The value listed in Table 503 can be increased by 20 feet above the listed building height. The number of stories is also allowed to be increased by 1.
Section 506.2
The allowable building area increase due to street frontage.

Section 506.3
Defines the allowable building area increase due to automatic sprinkler system installation.

Type II-B, Business Occupancy

Table 3: Allowable Increases (SF in on a single story basis)

<table>
<thead>
<tr>
<th>Building Height</th>
<th>Actual</th>
<th>Allowable</th>
<th>Adjusted (Sprinklered)</th>
<th>Passes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>19,348 SF</td>
<td>23,000 SF</td>
<td>86,250 SF</td>
<td>Yes</td>
</tr>
<tr>
<td># of Stories</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>Yes</td>
</tr>
</tbody>
</table>

7.4 Frontage Increase

\[ I_f = \frac{[F/P - 0.25]W}{30} \]

\[ I_f \] = Area increase due to frontage
\[ E \] = Building perimeter that fronts on a public way or open space having 20 feet open minimum width (feet).
\[ P \] = Perimeter of entire building (feet).
\[ W \] = Width of public way or open space (feet) accordance w/ Sec. 506.2.1.
\[ I_f = [1-.25]30/30 \]
\[ I_f = 0.75 \]

7.5 Area Modifications

\[ A_a = \{ A_t + [A_t \times I_f] + [A_t \times I_s] \} \]

\[ A_a \] = Allowable building area per story (SF).
\[ A_t \] = Tabular building area per story in accordance with Table 503 (23,000 SF).
\[ I_f \] = Area increase factor due to frontage as calculated in accordance with Section 506.2.
\[ I_s \] = Area increase factor due to sprinkler protection as calculated in accordance with Section 506.3.
\[ A_a = A_t + (A_t \times 0.75) + (A_t \times 2) \]
\[ A_a = A_t (1 + 0.75 + 2) \]
\[ A_a = 3.75A_t \]
\[ A_a = 86,250 \text{ SF} \]
7.6 Adjusted Values for Table 503 from the IBC 2012.

Table 4: Adjusted Values for Table 503 from the IBC 2012

<table>
<thead>
<tr>
<th>GROUP</th>
<th>STORIES(S)</th>
<th>AREA (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>S UL</td>
<td>3 15,500</td>
</tr>
<tr>
<td>A-2</td>
<td>S UL</td>
<td>3 15,500</td>
</tr>
<tr>
<td>A-3</td>
<td>S UL</td>
<td>3 15,500</td>
</tr>
<tr>
<td>A-4</td>
<td>S UL</td>
<td>3 15,500</td>
</tr>
<tr>
<td>A-5</td>
<td>S UL</td>
<td>3 15,500</td>
</tr>
<tr>
<td>B</td>
<td>S UL</td>
<td>3 15,500</td>
</tr>
</tbody>
</table>

Adjusted
| B     | S UL       | 3 15,500 | 2 10,000 | 3 14,000 | 2 11,500 | 2 11,500 | 1 6,000 |
| B     | A UL       | 3 15,500 | 2 10,000 | 3 14,000 | 2 11,500 | 2 11,500 | 1 6,000 |
|       | Height     | 180       | 85       | 75       | 85       | 75       | 85       | 70       | 60       |

Shows that the building even meets the most minimum standard after being adjusted for an automatic sprinkler system.

8 Prescriptive-Based Design

8.1 Egress System

8.1.1 System Overview

This building models a basic style of construction with an upside down L shape. Only the northern part of the building has a second floor. The buildings primary egress path is the main corridor that spans the length of the building on both floors. It is connected on the interior by an open air staircase on the east side. This is a 1 hour fire-rated corridor as required by the LSC “7.1.3.1 Exit Access Corridors. Corridors used as exit access and serving an area having an occupant load exceeding 30 shall be separated from other parts of the building by walls having not less than a 1-hour fire resistance rating in accordance with Section 8.3”
Upon examining the premises you will notice it has two stairs. One of the stairs is located on the east side of the building and is an interior open air staircase. Neither of these stairs are located in a fire protected enclosure due to the fact that the building only has two connecting floors. This meets the Life Safety Code (LSC) standard 7.1.3.2.1. The code reads, “The separation shall have a minimum 1-hour fire resistance rating where the exit connects three or fewer stories.” The ending of it lands right next to an exit leading to a public way. Here we find the double doors leading out of the building to be 36 inches each for a total 72 inches of doorway. The stairs are 48 inches of nominal width with 42 inches of clearance (actual measurements) once handrails are taken into effect. This is a standard style staircase with a landing located at the midpoint.

The second staircase is located on the west side opposite of the first. This staircase is located outside and it is considered that you exited the building upon reaching it. This staircase also has a width of 48 inches of nominal width with 42 inches of room after the handrails have
been taken into account. The construction of this stair is a switchback design with an intermediate landing between levels. To reach it you exit through the two double doors (36 inches for a combined 72 inches) to the outside where the stairs are located.

![Figure 7: West Side Stairs](image)

Another means of egress that should be noted is the elevator. It is located on the northwest side of the building. Though this has the capability of moving people we cannot consider it into our plan for an appropriate means of egress in case of a fire. It is too much risk to recommend people use it due to a possible mechanical failure and entrapment of the passengers it carries in an emergency situation.

### 8.1.2 Occupancy Classification

In section 6.1.11 of the LSC, Building 41 is categorized under Group B as a *Business Occupancy*. This is justified in section 6.1.11.1 (3) that reads, “College and university instructional buildings, classrooms under 50 persons, and instructional laboratories.” This building is not considered an *Educational Occupancy* because section 6.1.2.2 states that, “Educational occupancies are limited to facilities used for educational purposes through the
twelfth grade.” A college classroom does not meet this criterion and is classified as a business occupancy. The CBC also defines this as, “Educational occupancies for students above the 12th grade” (CBC, 2010, Section 304). The different occupancies used in Building 41 are shown in the table below.

**Table 5: Occupancy Types**

<table>
<thead>
<tr>
<th>Use</th>
<th>Occupancy Type</th>
<th>Occupancy Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices, Classrooms, and Laboratories (&lt;50 people)</td>
<td>B</td>
<td>Facilities for office, professional, or service-type transactions. Educational occupancies for students above the 12th grade. Laboratories: testing, research and (SFM) instruction</td>
</tr>
<tr>
<td>Electrical, Mechanical, Telephone, and Data</td>
<td>S-1</td>
<td>Facilities used for moderate hazard storage and not classified as a hazardous occupancy.</td>
</tr>
<tr>
<td>Storage</td>
<td>S-2</td>
<td>Facilities used for low hazard storage and not classified as a hazardous occupancy.</td>
</tr>
</tbody>
</table>

**8.1.3 Occupant Load Factors (OLFs) and Exit Capacities**

When Exit Capacities are calculated, it is recommended to reference Table 7.3.3.1 from the LSC Handbook. Here it shows when calculating the Exit Capacity for stairs a capacity factor of .3 inches per person is used in the calculations. Doors use a capacity factor of .2 inches per person. When a set of stairs ends at a door/set of doors the limiting factor calculated from the two different capacity factors (.3 and .2) is used. For stairs wider than 44 inches and subject to the .3 in rule, Equation 7.3.3.2 from LSC is used. For the first floor the exit capacity was calculated to be able to handle 1620 people in need of egress. This covers the estimated 445 people in the building and leaves a margin of safety of 1,175 people. The second floor was calculated to be able to exit 330 people when only 142 people were required, leaving a margin of safety of 188 people. This building then does in fact meet all egress capacity needs.
Table 6: Occupancy Classification and Loading Factors per NFPA 101

<table>
<thead>
<tr>
<th>Use</th>
<th>Load Factor (ft²/Person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices (Business)</td>
<td>100</td>
</tr>
<tr>
<td>Laboratories (Educational)</td>
<td>50</td>
</tr>
<tr>
<td>Conference Room (Assembly less Concentrated)</td>
<td>15</td>
</tr>
<tr>
<td>Storage (S-1)</td>
<td>300</td>
</tr>
<tr>
<td>Storage (S-2)</td>
<td>300</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>0</td>
</tr>
<tr>
<td>Walkways</td>
<td>0</td>
</tr>
</tbody>
</table>

Occupant load is calculated using the formula: \( \text{Room Occupant Load} = \frac{\text{Room Area (ft}^2\text{)}}{\text{Load Factor (ft}^2\text{/Person)}} \)

Table 7: First Floor - Calculated Occupant Load

<table>
<thead>
<tr>
<th>Building 1st Floor</th>
<th>Usage</th>
<th>Gross Floor Area</th>
<th>OLF</th>
<th>Occupant Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building A</td>
<td>Offices</td>
<td>1,870 SF</td>
<td>100</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Laboratories</td>
<td>12,833 SF</td>
<td>50</td>
<td>257</td>
</tr>
<tr>
<td></td>
<td>Conference Rm.</td>
<td>296 SF</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Storage (S-1)</td>
<td>1,133 SF</td>
<td>300</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Storage (S-2)</td>
<td>394 SF</td>
<td>300</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Bathrooms</td>
<td>614 SF</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Walkways</td>
<td>2,208 SF</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Building B</td>
<td>Laboratories</td>
<td>5,741 SF</td>
<td>50</td>
<td>115</td>
</tr>
<tr>
<td></td>
<td>Storage (S-2)</td>
<td>128 SF</td>
<td>300</td>
<td>1</td>
</tr>
<tr>
<td>Building C</td>
<td>Laboratories</td>
<td>1,314 SF</td>
<td>50</td>
<td>27</td>
</tr>
</tbody>
</table>

Total: 26,531 SF  Total: 445 People

Table 8: First Floor – Calculated Exit Capacity

<table>
<thead>
<tr>
<th>Exit</th>
<th>Width (inches)</th>
<th>Capacity Factor (in/person)</th>
<th>Capacity (persons)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Main Lobby Doors</td>
<td>72</td>
<td>.2</td>
<td>360</td>
<td>2 doors @ 36 in</td>
</tr>
<tr>
<td>West Main Lobby Doors</td>
<td>72</td>
<td>.2</td>
<td>360</td>
<td>2 doors @ 36 in</td>
</tr>
<tr>
<td>Room-Double Doors</td>
<td>144</td>
<td>.2</td>
<td>720</td>
<td>4 doors @ 36 in</td>
</tr>
<tr>
<td>Room-Single Doors</td>
<td>36</td>
<td>.2</td>
<td>180</td>
<td>1 doors @ 36 in</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
<td>1620 People</td>
<td></td>
</tr>
</tbody>
</table>

Total People Required from OLF Calculations: 445 People  Passes: YES
Table 9: Second Floor - Calculated Occupant Load

<table>
<thead>
<tr>
<th>Building 2nd Floor</th>
<th>Usage</th>
<th>Gross Floor Area</th>
<th>OLF</th>
<th>Occupant Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building A</td>
<td>Offices</td>
<td>2,771 SF</td>
<td>100</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Laboratories</td>
<td>4,599 SF</td>
<td>50</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>Conference Rm.</td>
<td>280 SF</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Storage (S-1)</td>
<td>306 SF</td>
<td>300</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Storage (S-2)</td>
<td>81 SF</td>
<td>300</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Bathrooms</td>
<td>353 SF</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Walkways</td>
<td>2253 SF</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total: 10,643</td>
<td>Total: 142 People</td>
</tr>
</tbody>
</table>

Table 10: Second Floor – Calculated Exit Capacity

<table>
<thead>
<tr>
<th>Exit</th>
<th>Width (inches)</th>
<th>Capacity Factor (in/person)</th>
<th>Capacity (persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Stairs</td>
<td>48</td>
<td>.3</td>
<td>165</td>
</tr>
<tr>
<td>West Stairs</td>
<td>48</td>
<td>.3</td>
<td>165</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
<td>330 People</td>
</tr>
<tr>
<td>Total People Required from OLF Calculations:</td>
<td>142 People</td>
<td>Passes: YES</td>
<td></td>
</tr>
</tbody>
</table>

7.3.3.2* For stairways wider than 44 in. (1120 mm) and subject to the 0.3 in. (7.6 mm) width per person capacity factor, the capacity shall be permitted to be increased using the following equation:

\[ C = 146.7 + \left( \frac{Wn - 44}{0.218} \right) \]

where:
- \( C \) = capacity, in persons, rounded to the nearest integer
- \( Wn \) = nominal width of the stair as permitted by 7.3.2.2 (in.)

Solution: \( C = 165 \) People

8.1.4 Size, Arrangement, and Number of Means of Egress

Every building is required to meet the regulations for the number of means of egress presented in the LSC 7.4.1.2. In this it states that for occupant loads between 0 to <50 there shall be at least one exit. For occupant loads between 50 to <500 there needs to be 2. In cases where the occupant load is from 501-1000 there has to be 3 exits. For anything with an occupant load over 1000 a total of 4 exits are required. For the first level we found a total occupant load to be calculated at 445 people. This would require a minimum of two exits out.
It is seen that this requirement has been met. For the second floor the occupant load has been calculated at 142 requiring two exits when two are provided. This building does meet the total number of exits required.

“A.3.3.75 Exit. Exits include exterior exit doors, exit passageways, horizontal exits, exit stairs, and exit ramps.” Found in the LSC Handbook. We have discussed the two main points of egress on the second floor and the two main exits on the first floor so far. This building also possesses a unique feature not normally seen in an educational facility due to the high amount of labs, shops, and equipment rooms. With rooms of this nature they are normally much larger in scale. A select few possess doors leading to the outside. These are direct exits from the classroom into the yard or perimeter of the building. This building has two main exits leading to a public way and twenty-six exits leaving classrooms as seen in the diagrams below.
Figure 8: Exits and Stairs – Level 1

41-A Grant M. Brown Engineering Building

Vertical Exits Exterior
Vertical Exits Interior
Vertical Exits (Not Part of Egress Plan)
Building Exit
Room Exit

41-B Baldwin and Mary
Reinhold Aerospace
Engineering Laboratories

26 | Blanchat
As stated in the LSC under section 7.5.1.1 “Exits shall be located and exit access shall be arranged so that exits are readily accessible at all times.” Another code to be noted for this is in accordance for the proper arrangement. It reads, “Where more than one exit, exit access, or exit discharge is required from a building or portion thereof, such exits, exit accesses, or exit discharges shall be: remotely located from each other and arranged to minimize the possibility that more than one has the potential to be blocked by any one fire or other emergency.
condition.” as seen in the LSC 7.5.1.3.1. The other main code to consider from the LSC is seen in 7.5.1.3.2 and states “Where two exits, exit accesses, or exit discharges are required, they shall be located at a distance from one another not less than one-half the length of the maximum overall diagonal dimension of the building or area to be served, measured in a straight line between the nearest edge of the exits, exit accesses, or exit discharges.” With this building we find the two main exits (together having enough exit capacity to satisfy the floor) to be located at opposite ends of the main lobby. On the second floor this situation is repeated. In accordance to the number of exits and arrangement rules set out in the LSC the building meets all the requirements. The exits are arranged so that they are at opposite ends of the building clear of obstacles and meet the one half diagonal rule.

8.1.5 Horizontal Exits, Exit Signs, & Fire Rated Separation

The LSC provides us with information regarding horizontal exits in buildings. In section 7.1.2.1 it states that any corridor that is being used as an exit access must meet certain guidelines when the exit access has an occupant load of over 30 people. As stated previously in this report, “7.1.3.1 Exit Access Corridors. Corridors used as exit access and serving an area having an occupant load exceeding 30 shall be separated from other parts of the building by walls having not less than a 1-hour fire resistance rating in accordance with Section 8.3” For more than four stories the rule that a minimum two hour rating shall be used. When a corridor is considered to be a means of egress that said corridor should keep clear of anything that would impede its exiting capabilities. This means the corridor should be free of storage and no extra installations shall be made that might impede with the path. This can be found in the LSC
under 7.1.3.2.3. In the diagram below you can see the horizontal exit access corridors signified in red.

Exit signs are found in the LSC under section 7.10.1.5.1. Here the code specifies that the exit accesses should be readily visible and clearly marked. These signs need to be placed where occupant may find the exit or way to an exit to be unclear. When it comes to additional signs being added to the building the LSC specifies that view of an exit sign should not exceed a limit of 100 feet from the last or out of a viewable distance. You use the shorter of the two distance measurements when coming to this conclusion. In figures 12-13 below it can be seen where previously placed (green) exit signs exist and where recommended (purple) signs should be placed. The recommended additional signs where determined when a walkthrough of the building was done. The code says there should be signs where the exit is not clear. In these rooms it was hard to tell because of all the machinery and lab equipment used. So proper making of the exit would be crucial so people know to leave out the door from the room to outside instead of venturing back into the building to one of the main exits. The rooms not connected to the main core of the building have no information on access sign placement due to restricted access to them. In these rooms all sign placement was placed on a theoretical basis without knowing if they were already in place.

The LSC states the specific ratings looked at for this building. Ratings are broken down into A, B, and C. A requires the interior wall and ceiling finish to have a flame spread index of 0-25. Class B the flame index spread is 26-75. Class C has a flame spread index of 76-200. This building falls under the Business classification. For B classification the required index falls to
Class A or B. This can be found in the paragraphs of the LSC in sections 10.3.5.

Figure 10: Horizontal Exits & Exit Signs – Level 1
8.2 Fire Detection, Alarm, and Communication Systems

This building is equipped with a manual fire alarm system with elevator recall, fire sprinkler monitoring, and duct detector monitoring. This building is fully sprinklered with a wet pipe system.
NFPA 72 10.4 (2013 Edition) states that all systems shall be installed in accordance with the specifications and standards approved by the authority having jurisdiction. This building is found to be considered a Business Occupancy by meeting the standard 6.1.11 from NFPA 101 Life Safety Code Handbook. A.6.1.11.1 (3) “College and university instructional buildings, classrooms under 50 persons, and instructional laboratories.”

From NFPA 101 Section 38.3.4 we find the code for a Business Occupancy in terms of detection, alarm, and communications systems. In accordance with section 9.6, section 38.4.4.1 states a fire alarm system shall be installed for all business occupancies meeting the conditions. In addition the initiation devices need to be one of the following (38.3.4.2): Manual pull station, automatic fire detection system, or automatic sprinkler system. All options need to comply with 9.6.2.1 from NFPA 101.

See Appendix at the back of this report to see the floor plans of the building. The first page provides you with a color coordinated key. The second page is of building A’s first floor. Page three is the second floor of building A. The forth page is buildings B and C. The last, fifth page, is of the technical components of the control panels, devices, and riser diagram.
8.2.1 Devices & Compliance with NFPA

8.2.1.1 Fire Alarm Control Panel (FACP)

The Fire Alarm Control Panel (FACP) can be identified on page one of the plan view as the first symbol listed in the table. This symbol is identified by a yellow highlighter. On page two of the plan view the FACP is located in the bottom left corner of the building next to the Fire Control Power Supply (FCPS). The FACP is made by Notifier (NFS-640). The use of this panel is appropriate for a mid-sized application. The installation time is considered minimized.

Table 11: FACP-NFS2-640

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FACP - Notifier NFS2-640</strong></td>
<td><strong><a href="http://www.notifier.com/products/fACP/Pages/notifier-nfs2-640-control-panel.aspx">http://www.notifier.com/products/fACP/Pages/notifier-nfs2-640-control-panel.aspx</a></strong></td>
</tr>
<tr>
<td>Signaling Line Circuits (SLCs)</td>
<td>1 expandable to 2; Style 4, 6, or 7</td>
</tr>
<tr>
<td>Intelligent Devices</td>
<td>636 Total Devices</td>
</tr>
<tr>
<td></td>
<td>159 Detectors/159 Modules Per SLC</td>
</tr>
<tr>
<td>Notification Appliance Circuits (NACs)</td>
<td>4 (Built in); 1.5 amps ea.</td>
</tr>
<tr>
<td>Voice Evacuation Available</td>
<td>Yes: w/ integrated Digital Voice Command</td>
</tr>
<tr>
<td>Power</td>
<td>6 amps Total System Power</td>
</tr>
<tr>
<td>Annunciators</td>
<td>32 LCD Type</td>
</tr>
<tr>
<td></td>
<td>32 ACS Type</td>
</tr>
<tr>
<td>Networkable</td>
<td>Yes: NOTI-FIRE-NET</td>
</tr>
</tbody>
</table>
8.2.1.2 Smoke Detectors

NOTIFIER FSP-751

**Specifications:**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage Range</td>
<td>15-32 Volts DC peak</td>
</tr>
<tr>
<td>Standby Current</td>
<td>300μA @ 24 VDC (one communication every 5 seconds with LED blink enabled)</td>
</tr>
<tr>
<td>Max. Alarm Current (LED on)</td>
<td>6.5 mA @ 24 VDC</td>
</tr>
<tr>
<td>Standby Current</td>
<td>300μA @ 24 VDC (one communication every 5 seconds with LED blink enabled)</td>
</tr>
<tr>
<td>Operating Humidity Range</td>
<td>10% to 93% Relative Humidity, noncondensing</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>0° to 49°C (32° to 120°F)</td>
</tr>
<tr>
<td>Height</td>
<td>1.66 inches (42.16 mm) installed in B710LP Base</td>
</tr>
<tr>
<td>Diameter</td>
<td>6.2 inches (157.48 mm) installed in B710LP Base</td>
</tr>
<tr>
<td></td>
<td>4.1 inches (104.14 mm) installed in B501 Base</td>
</tr>
<tr>
<td>Weight</td>
<td>3.6 oz (104 g)</td>
</tr>
</tbody>
</table>

This building utilizes the NOTIFIER **FSP-751** Low-Profile Intelligent Plug-in Smoke Detectors with FlashScan®. Throughout the building there are a total of 19 detectors installed. This style of smoke detectors is considered “low-profile” and works with the NOTIFIER intelligent system. This model of detector has a built in heat sensing...
element that compliments the smoke detector by activating if the heating element is tripped.

**Mounting:**

NFPA 72 (2013 Edition) Section 17.7.3.2.1* reads, “Spot-type smoke detectors shall be located on the ceiling or, if on a sidewall between the ceiling and 12 in. (300mm) down from the ceiling to the top of the detector.”

This space is crucial. Detectors mounted closer than the recommended 12 inches will respond faster than a standard mount.

The mounting of the smoke detectors in this building comply with the NFPA codes listed above and in the text of NFPA 72.

**Spacing:**

In accordance with NFPA 72 (2013 Edition) Section 17.7.3.2.3.1* spacing shall be based upon a standard of 30 feet of nominal spacing such that each detector is no less than ½ the nominal distance to the next detector. This should be located within the top 15% of the ceiling height. Any point on the ceiling should have a detector within a range of .7 of the 30ft of listed nominal spacing. Corridors and irregular areas will need to readjust spacing but still need to fit the .7 of the nominal spacing as a minimum requirement.

The smoke detector spacing in this building complies with the NFPA codes listed above and in the text of NFPA 72.

**Locations:** See Appendix for Floor Plans (Blue Markings)
- Aero Flight Controls/SIM
- Mechanical Room
- Elevator Hallway
- Elevator shaft
- Machine Room
- Tel/Data Room
8.2.1.3  Heat Detectors

NOTIFIER FST-751

**Specifications:**

Table 13: FST-751

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage Range</td>
<td>15–28 VDC</td>
</tr>
<tr>
<td>Standby Current</td>
<td>300µA @ 24 VDC (one communication every 5 seconds with LED blink enabled)</td>
</tr>
<tr>
<td>Max. Alarm Current (LED on)</td>
<td>6.5 mA @ 24 VDC</td>
</tr>
<tr>
<td>Standby Current</td>
<td>300µA @ 24 VDC (one communication every 5 seconds with LED blink enabled)</td>
</tr>
<tr>
<td>Operating Humidity Range</td>
<td>10% to 93% Relative Humidity, noncondensing</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>0° to 49°C (32° to 120°F)</td>
</tr>
<tr>
<td>Height</td>
<td>1.7 inches (43 mm) installed in B710LP Base</td>
</tr>
<tr>
<td>Diameter</td>
<td>6.1 inches (154.94 mm) installed in B710LP Base</td>
</tr>
<tr>
<td></td>
<td>4.1 inches (104.14 mm) installed in B501 Base</td>
</tr>
<tr>
<td>Weight</td>
<td>5 oz (150 g)</td>
</tr>
</tbody>
</table>

This building utilizes the NOTIFIER FST-751 series intelligent thermal detector.

There are only 2 detectors of this type installed in the building. This detector measures analog levels of thermal measurements and sends them to the control panel. This
detector is addressable so that firefighters can check the FACP and identify the exact location of the unit when it is going off. Flashpoint is used and has been found to speed up detection by up to 5x the previous designs with communication between the analog devices and the intelligent system.

**Mounting:**

NFPA 72 (2013 Edition) Section 17.6.3.1.3.1* reads, “...spot-type heat-sensing fire detectors shall be located on the ceiling not less than 4 in (100mm) from the sidewall or on the sidewalls between 4in and 12 in (100 mm and 300 mm) from the ceiling.”

Dead air space was found to be an issue from tests done in 1993. This issue was addressed by the 4 in rule. Recent studies have shown that this dead air space is less significant than once thought, but the research could only be applied to smoke detectors at this time.

The mounting of the heat detectors in this building comply with the NFPA codes listed above and in the text of NFPA 72.

**Spacing:**

In accordance with NFPA 72 (2013 Edition) Section 17.7.3.2.3.1* Detectors installed in this system shall be kept within the listed spacing. Detectors shall not exceed ½ of their listed spacing between units or adjacent walls. Or.. All points on the ceiling of interest shall not exceed .7 times the listed space.

The heat detector spacing in this building complies with the NFPA codes listed above and in the text of NFPA 72.

**Locations:** See Appendix for Floor Plans (Red Markings)
8.2.1.4  Duct Detectors

NOTIFIER FSD-751P

Figure 17: FSD-751P

Figure 18: FSD-751P Wiring Diagram

Specifications:

Table 14: FSD-751P Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage Range</td>
<td>15-32 VDC</td>
</tr>
<tr>
<td>Standby Current</td>
<td>300µA @ 24 VDC (one communication every 5</td>
</tr>
</tbody>
</table>
### Duct Air Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standby Current</td>
<td>300µA @ 24 VDC (one communication every 5 seconds with LED blink enabled)</td>
</tr>
<tr>
<td>Operating Humidity Range</td>
<td>10% to 93% Relative Humidity, noncondensing</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>0° to 55°C (32° to 131°F)</td>
</tr>
<tr>
<td>Duct Air Velocity</td>
<td>500 to 4,000 feet/min. (152.4 to 1219.2 meters/min.)</td>
</tr>
<tr>
<td>Height</td>
<td>2.750 inches (69.850 mm)</td>
</tr>
<tr>
<td>Diameter</td>
<td>14.375 inches (365.125 mm)</td>
</tr>
</tbody>
</table>

The **NOTIFIER FSD-751P** Intelligent Photoelectric Duct Smoke Detectors with FlashScan. This building is equipped with 38 duct detectors spaced throughout. They are located in the HVAC system of the building. The purpose of the HVAC is to move conditioned air in all areas of the building. During a fire the smoke introduced can be picked up and distributed by the HVAC. In efforts to identify a fire the duct detectors are used to sense and smoke inside the system. This is a photoelectric detector.

**Mounting:**

NFPA 72 (2013 Edition) Section 17.7.4.1 states, “Detectors should not be located in direct airflow or closer than 36 in. (910 mm) from an air supply diffuser or return air opening...” In the situation that the air is moving at a high velocity the detector should be setback further.

The mounting of the duct detectors in this building comply with the NFPA codes listed above and in the text of NFPA 72.

**Locations:** See Appendix for Floor Plans (Red Markings)

- HVAC system throughout the building
8.2.1.5  Manual Pull Station

NOTIFIER NBG-12LX

![Figure 19: NBG-12LX Manual Pull Station](image)

**Specifications:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping Weight</td>
<td>9.6 oz. (272.15g)</td>
</tr>
<tr>
<td>Normal Operating Voltage:</td>
<td>24 VDC</td>
</tr>
<tr>
<td>Max. SLC Loop Voltage</td>
<td>28.0 VDC</td>
</tr>
<tr>
<td>Max. SLC Standby Current</td>
<td>375 μA</td>
</tr>
<tr>
<td>Max. SLC Alarm Current</td>
<td>5 mA</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>0° to 49°C (32° to 120°F)</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>10% to 93% (noncondensing)</td>
</tr>
<tr>
<td></td>
<td>For use indoors in a dry location</td>
</tr>
</tbody>
</table>

For this building, 19 Notifier NBG-12LX Addressable Manual Pull Stations were installed. This is a dual-action pull station. Dual-action means that it takes 2 solid motions in order for the station to send a activation signal. Due to the addressable...
feature this station can easily be located on the FACP and can air in firefighter response time.

**Mounting:**
NFPA 72 (2013 Edition) Section 17.14 and further sections state that these stations need to be securely mounted upon a background of contrasting color (17.14.3 & 17.14.4). These pull stations need to be mounted between 42-48 inches (1.07-1.22 meters) above the finished floor (17.14.5).

The mounting of the manual pull stations in this building comply with the NFPA codes listed above and in the text of NFPA 72.

**Spacing:**
In accordance with NFPA 72 (2013 Edition) Section 17.14.8.4 fire alarm pull boxes need to be located within 5 ft (1.5 m) of each exit doorway on every floor.

The distance allowed between boxes should not be more than a measure 200 feet (17.14.8.5*). If groupings of doors are in use than exceed 40 feet across, fire alarm pull stations need to be mounted on both sides within 5 feet of that sides exit.

The manual pull station spacing in this building complies with the NFPA codes listed above and in the text of NFPA 72.
Locations: See Appendix for Floor Plans (Green Markings)

- Throughout buildings A, B, and C on all floors

8.2.2 Disposition of Alarm, Supervisory Signals, & Trouble Signals

In a fire alarm system there are three basic types of signals being used.

1. Alarm: This signal required immediate action and warns of the danger of a fire.

2. Supervisory: With this signal action is needed. The supervisory signal requires the fire alarm system to communicate with the fire protection system for the building before action can proceed.

3. Trouble: This signal comes from multiple sources. Anytime the power supply is compromised (whether it is primary or secondary) this would be signaled to the receiving panel. It can also be produced due to a device malfunction in the system or a break in the circuit.

Alarm:

Anytime a manual pull station, automatic fire detectors, waterflow at a sprinkler, or activation of any fire suppression equipment signal is received it shall be treated as a fire alarm signal. This signal is sent to a central station that has no direct financial interest in the property and normally under contract. Once the alarm is received by the central station several things need to happen. That signal needs to be retransmitted to a communication center. Then the central station needs to decipher and decide if the alarm needs a manual reset. If needed a technician should be sent to the property and arrive in under 2 hours from when the signal
was first received. The owner/subscriber of the alarm also needs to be notified and informed.

**Supervisory:**

When a supervisory signal is received the central station has a different set of steps to follow. First communication needs to immediately happen with the people the subscriber has designated to handle the situation. Notification of the fire department or law enforcement having jurisdiction should be taken next. Sometimes both are required to be notified depending on the authority having jurisdiction. A technician should be sent within the 2 hour window from the time the signal is received till a tech arrives to turn it off. The central station is also responsible for notifying the authority having jurisdiction when any suppression equipment or sprinkler systems go out of use for more than 8 hours.

**Trouble:**

Upon receiving a trouble signal the central station is required to perform the listed steps in order to fulfill their duty. Immediate communication needs to happen to the person designated by the subscriber of the system. If maintenance is needed the central station is required to send out personnel to arrive within 4 hours of the signal being received. Sometimes it is required to notify the authority having jurisdiction and the subscriber when the system interruption lasts longer than 8 hours.
8.2.3  Alarm Notification Devices & Compliance with NFPA

System Sensor P241575, S241575, P1224MC, & S1224MC

Figure 21: System Sensor P241575 & S241575

Specifications: System Sensor P241575 & S241575

Table 16: System Sensor P241575 & S241575

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horn Voltage</td>
<td>10.5-30 Volts</td>
</tr>
<tr>
<td>Strobe &amp; Horn/Strobe Voltage</td>
<td>12-volt models – 10.5 to 17 volts; 24-volt models – 20 to 30 volts</td>
</tr>
<tr>
<td>Strobe &amp; Horn/Strobe Voltage (with MDL module)</td>
<td>12-volt models – 11 to 17 volts; 24-volt models – 21 to 30 volts</td>
</tr>
<tr>
<td>Flash Rate</td>
<td>1 Flash Per Second</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>0° to 49°C (32° to 120°F)</td>
</tr>
</tbody>
</table>
### Light Output
- Models with 15 only in the model number are listed at 15 candela
- Models with 1575 are listed at 15 candela per UL 1971 but will provide 75 candela on axis (straight ahead)
- Models with 30, 75 or 110 are rated for that candela.

### Sound Output
Sound output levels are established at Underwriters Laboratories in their reverberant room. Always use the sound output specified as UL Reverberant Room when comparing products.

### Listings
UL, FM, CSFM, MEA

### Notes
Do not exceed: 1) 16-33 voltage range limit; 2) maximum number of 70 strobe lights when connecting the MDL Sync module with a maximum line impedance of 4 ohms per loop and; 3) maximum line impedance as required by the fire alarm control manufacturer.

### Specifications: System Sensor P1224MC & S1224MC

**Table 17: System Sensor P1224MC & S1224MC**

<table>
<thead>
<tr>
<th>Horn, Strobe, &amp; Horn/Strobe Voltage</th>
<th>Regulated 12 DC/FWR and Regulated 24 DC/FWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Voltage Ranges:</td>
<td>12V=8-17.5 Volts; 24V=16-33 Volts</td>
</tr>
<tr>
<td>Synchronous Applications with MDL Module</td>
<td>12V=9-17.5 Volts; 24V=17-33 Volts</td>
</tr>
<tr>
<td>Operating Humidity Range</td>
<td>10% to 93% Relative Humidity, noncondensing</td>
</tr>
<tr>
<td>Flash Rate</td>
<td>1 Flash Per Second</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>0° to 49°C (32° to 120°F)</td>
</tr>
<tr>
<td>Selectable Light Outputs</td>
<td>All candelas are selectable via a manual slide switch.</td>
</tr>
<tr>
<td>12/24 Volt Applications</td>
<td>15 or 15/75 Candela</td>
</tr>
<tr>
<td>24 Volt Application</td>
<td>30, 75, 110 candela</td>
</tr>
<tr>
<td></td>
<td>15/75 is listed at 15 candela per UL 1971 but will provide 75 candela on axis (straight ahead). 15, 30, 75, or 110 are rated for that candela.</td>
</tr>
<tr>
<td>Sound Output</td>
<td>Sound output levels are established at Underwriters Laboratories in their reverberant room. Always use the sound output specified as UL Reverberant Room when comparing products.</td>
</tr>
<tr>
<td>Listings</td>
<td>UL S5512 (Strobe); UL S4011 (Combo)</td>
</tr>
<tr>
<td>Notes</td>
<td>Do not exceed: 1) 8-17.5 or 16-33 voltage range limit; 2) maximum number of 70 strobe lights when connecting the MDL Sync module with a maximum line impedance of 4 ohms per loop and; 3) maximum line impedance as required by the fire alarm control manufacturer.</td>
</tr>
</tbody>
</table>
line impedance as required by the fire alarm control manufacturer.

This facility was built using System Sensor P241575 & S241575 SpectrAlet series notification appliances. The devices used in this building were of the 24 volt panels that utilize a DC or full-wave rectified (FWR) source of power. These devices are designed to trigger audio and visual stimulation of the buildings occupants and to aid in emergency responses.

Average ambient sound levels are found to be in the 55 dBA area for occupancies classified under Business. Keep in mind that a 6 decibel (db) drop can be seen for every time the distance from the source doubles.

![figure](image)

**Figure 14.3.1** Example of 6 dBA Rule (1 ft = 0.305 m)

In order to have these devices be considered effective standards were set. A sound level 15 db above the average ambient sound level is required. If the maximum sound level is known, then it is required to be 5 db above the maximum ambient sound (NFPA 72, 2013 Edition Section 18.4.3.1). For areas used for sleeping a sound level of a
minimum 75 dBA is required (18.4.5.1). This was tested at a considered average pillow height.

**Mounting:**

**Audible:**  
NFPA 72 (2013 Edition) Section 18.4.8 “If ceiling height allow, and unless otherwise permitted by 18.4.8.2 through 18.4.8.5, wall-mounted appliances shall have their tops above the finished floors at heights of not less than 90 in (2.29 m) and below the finished ceilings at distances of not less than 6 in. (150 mm).” In the text it also states that permission is given to the installation of ceiling-mounted or recessed appliances.

**Visible:**  
NFPA 72 (2013 Edition) Section 18.4.8 “Wall-mounted appliances shall be mounted such that the entire lens is not less than 80 inches (2.03 m) and not greater than 96 inches (2.44 m) above the finished floor or at the mounting height specified using the performance-based alternative of 18.5.5.6.” Section 18.5.5 references placement of combination audio/visible appliances. This height requirement is to ensure that the light source (visual) is able to be seen throughout the covered area.

We find the spacing to be referenced in NFPA 72, 2013 Edition, Section 18.5.5.4.1 “Spacing shall be in accordance with either Table 18.5.5.4.1(a) and Figure 18.5.5.4.1 or Table 18.5.5.4.1(b).” *See appendix A2 for NFPA tables.*

The mounting of the notification appliances for audio and visual stimulation in the building comply with the NFPA codes listed above and in the text of NFPA 72.

**Locations:** *See Appendix for Floor Plans (Orange Markings)*

- Throughout buildings A, B, and C on all floors
8.2.4 Mass Notification System

**Code Blue InterAct 4100 Speakerphone**

![Code Blue InterAct 4100 Speakerphone](image)

*Figure 23: Code Blue InterAct 4100 Speakerphone*

**Specifications:**

- Nine (9) number storage capabilities
- Nine (9) messages with up to 30 seconds each
- 2 Auxiliary inputs/3 Auxiliary outputs (3 NO or 3 NC)
- 12-24v AC/DC primary power supply
- 12v DC auxiliary power supply
- SLA/AGM battery backup:
  - 504 hours standby
  - 40 hours talk time
- Multiple programming options including:
  - Silent monitoring from a remote location
  - Programmable ring time
- Self-monitoring capability and fault reporting:
  - Loss of power
  - Battery low voltage
- Highly flexible, digitally stored voice identifier (standard)
- Multiple password protection levels for security
- Built with powerful DSP technology
- Enhanced speaker and microphone sensitivity
- Operational temperature: -40°C to 70°C (-40°F to 158°F)
- Non-volatile memory ensures programming is retained during power loss
• Conformal coated PCBs; weather resistant construction
• ADA compliant with Braille signage
• Two highly visible LED indicators for hearing impaired
• Optional dual button faceplate and optional keypad
• Sleep mode

A mass notification system is intended to utilize audio signals, visual signals, text messages, graphic, tactical signals, etc. to communicate an emergency message in order to provide information to the people in the building or space. This delivery of emergency information is intended to start evacuation or present valuable information/instructions to the receiver.

In this building the Code Blue IA4100 FP1 was used. The FP1 signifies that this model is a standard speaker with a single red *Push for Help* button. This unit uses some of the most advanced analog speakerphone technology available. With its location outside of the building the system needs to be resistant to vandalism and weather. The stainless steel faceplate solves many of these issues.

As for the internals, this system employs Blue Alert Mass Notification System by Code Blue. This Blue Alert system allows multiple avenues in order to deliver a message. Feature such as: live broadcast, text-to-speak, up to 9 pre-recorded messages, multiple warning tones, and the ability to have a message repeated several times can provide more than one way to inform the public. Pre-recorded messages are found to be greatly beneficial when tested. Messages created during an incident can come out unclear, rushed, background noise filled, and inadequate in information. By recording specific emergency related messages they information can be structured properly and delivered in an understandable and clear format.
The mass notification system runs off of an auxiliary power supply. This allows the system to have a strong power source in order for all components to be used. In the case of an emergency this system can run off of a reserve battery supply with 504 hours of standby time and 40 hours of talk time.

This system has the ability to be fully independent with no interface to any of the buildings fire alarm systems or others. It also has the option to be integrated with the current emergency systems in the building. In this case, the fire alarm system. When integrated into the fire alarm system there can be a separate or combination strobe with the fire alarm strobe. The MNS strobe is usually a clear or yellow color labeled as “ALERT”.

Blue Alert M.N.S. has been found to meet and maintain the standards found in the NFPA 72, 2010 Edition under chapter 24 for emergency communication systems.

### 8.2.5 Secondary Power Supply

The calculated secondary power supply would require 12.53 AMP-Hours in order to meet the needs of the system. Due to campus security issues I was unable to access the electrical room where the backup power supply was located to confirm the system in place meets the calculated requirements. It was not specified on the plans obtained either.

*See Appendix for Calculations*

### 8.2.6 Inspection, Testing, & Maintenance

The inspection, testing, and maintenance of a system can be found in chapter 14 of NFPA 72, 2013 edition.

*Inspection:*
Initial inspections are performed on a building in order to make sure than installation is up to the standards set by the NFPA 7s’s code and the other installation standards being utilized. Another key aspect of initial/reacceptance inspection is to comply with approved design documents. By making sure compliance is kept the reliability of the devices being operated is maintained. The designers of a system and the authority having jurisdiction normally are in charge of the responsibilities in initial testing.

Testing: Below is a summarized list of table 14.4.3.2 found in the NFPA 72 Handbook:

1. All Equipment
2. Control Equipment and Transponders
   a. Functions – Annually
   b. Fuses - Annually
   c. Interface Equipment - Annually
   d. Lamps and LEDs - Annually
   e. Primary Power Supply - Annually
3. Fire Alarm Control Unit Trouble Signals
   a. Audible and Visual - Annually
   b. Disconnect Switches - Annually
   c. Ground-Fault Monitoring Circuit - Annually
   d. Transmission of Signals to Off-Premises Location
4. Supervising Station Alarm Systems – Transmission Equipment
   a. All equipment - Annually
   b. Digital Alarm Communicator Transmitter (DACT) - Annually
   c. Digital Alarm Radio Transmitter (DART) - Annually
   d. McCulloh Transmitter - Annually
   e. Radio Alarm Transmitter (RAT) - Annually
   f. Performance-Based Technologies - Annually
5. Emergency Communications Equipment
   a. Amplifier/Tone Generators - Annually
   b. Call-in Signal Silence - Annually
   c. Off-hook Indicator (ring down) - Annually
   d. Phone Jacks - Annually
   e. Phone Set - Annually
   f. System Performance - Annually
6. Engine-Driven Generator- Monthly
7. Secondary (standby) Power Supply - Annually
8. Uninterruptible Power Supply (UPS) - Annually
9. Battery Tests
a. Lead-Acid Type
   i. Battery Replacement - Annually
   ii. Charger Test – Annually
   iii. Discharge Test – Annually
   iv. Load Voltage Test – Annually
   v. Specific Gravity – Semiannually
b. Nickle-cadmium Type
   i. Battery Replacement – Annually
   ii. Charger Test – Annually
   iii. Discharge Test – Annually
   iv. Load Voltage Test – Semiannually
c. Sealed Lead-acid Type
   i. Battery Replacement – Annually
   ii. Charger Test – Annually
   iii. Discharge Test – Annually
   iv. Load Voltage Test – Semiannually

11. Remote Annunciators – Annually
12. Reserved
13. Reserved
14. Reserved
15. Conductors – Metallic
    a. Stray Voltage – N/A
    b. Ground Faults – N/A
    c. Short-circuit Faults – N/A
    d. Loop Resistance – N/A
    e. Circuit Integrity – N/A
16. Conductors – Nonmetallic
    a. Fiber Optics – N/A
    b. Circuit Integrity – N/A
17. Initiating Devices (17 is summarized)
    a. Electromechanical Releasing Device – Annually
    b. Fire Extinguishing System(s) or Suppression System(s) Alarm Switch – Annually
    c. Fire-gas Other Detectors– Annually
    d. Heat Detectors– Annually
    e. Manual Fire Alarm Boxes – Annually
    f. Radiant Energy Fire Detectors– Semiannually
    g. Smoke Detectors – Functional Test – Annually
    h. Smoke Detectors – Sensitivity Testing – Annually
    i. Carbon Monoxide Detectors/Carbon Monoxide Alarms for the Purposes of Fire Detection – Annually
    j. Initiating Devices, Supervisory – Annually
    k. Mechanical, Electrosonic, or Pressure-Type Waterflow Device– Semiannually
I. Multi-sensor Fire Detector or Multi-Criteria Fire Detector or Combination Fire Detector – Annually

18. Special Hazard Equipment – Annually (18 is summarized)

19. Combination Systems – Annually (19 is summarized)

20. Interface Equipment – Annually

21. Guard’s Tour Equipment – Annually

22. Alarm Notification Appliances – Annually (22 is summarized)

23. Exit Marking Audible Notification Appliance – Annually

24. Emergency Control Functions – Annually

25. Area of Refuge Two-Way Communication System – Annually

26. Special Procedures – Annually (26 is summarized)

27. Supervising Station Alarm Systems – Receiving Equipment – Monthly (27 is summarized)


29. Low-power Radio – N/A

30. Mass Notification Systems – Annually

Maintenance:

Maintenance is required by the code. The maintenance performed should be in line with the manufacturers published instructions. One main point to take into consideration is the cleaning. For instance, a smoke detector can have its sensors obstructed from a buildup of dust and particles. Yearly, if not semiannual cleaning would be required in order to maintain the function of these devices. Other main areas of concern in the subject of cleaning are elevator hoistways, machine rooms, HVAC ducts, and boiler rooms.

After each alarm normal operation needs to be established as fast as possible. Testing of retransmission signals is something responsible by the central station and should be done at regular intervals.
8.3 Fire Suppression Systems

8.3.1 Water Supply Test Data

A test on the water supply feeding into the school was done on hydrant #29 on campus. This test is required in order to show that an approved water supply is capable of supplying a certain level of flow in order to maintain proper operation of the fire protection systems of the building. The fire department connection (hydrant) must meet the codes listed in the CBC under section 912 (2010 Edition):

912.1 Installation. Fire department connections shall be installed in accordance with the NFPA standard applicable to the system design and shall comply with Sections 912.2 through 912.5. [F]

912.2 Location. With respect to hydrants, driveways, buildings and landscaping, fire department connections shall be so located that fire apparatus and hose connected to supply the system will not obstruct access to the buildings for other fire apparatus. The location of fire department connections shall be approved by the fire chief. [F]

912.2.1 Visible location. Fire department connections shall be located on the street side of buildings, fully visible and recognizable from the street or nearest point of fire department vehicle access or as otherwise approved by the fire chief. [F]

912.2.2 Existing buildings. On existing buildings, wherever the fire department connection is not visible to approaching fire apparatus, the fire department connection shall be indicated by an approved sign mounted on the street front or on the side of the building. Such sign shall have the letters "FDC" at least 6 inches (152 mm) high and words in letters at least 2 inches (51 mm) high or an arrow to indicate the location. All such signs shall be subject to the approval of the fire code official. [F]

912.3 Access. Immediate access to fire department connections shall be maintained at all times and without obstruction by fences, bushes, trees, walls or any other fixed or moveable object. Access to fire department connections shall be approved by the fire chief. [F]
Table 18: Actual Flow Test Information

<table>
<thead>
<tr>
<th>Test Hydrant ID:</th>
<th>#29</th>
<th>Date of Test:</th>
<th>1/31/02</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrant Elevation:</td>
<td>0 ft</td>
<td>Static Pressure:</td>
<td>85.00 psi</td>
</tr>
<tr>
<td>Test Flow:</td>
<td>1045.00 gpm</td>
<td>Test Residual Pressure:</td>
<td>65.00 psi</td>
</tr>
<tr>
<td>Calculated System Flow Rate:</td>
<td>576.75 gpm</td>
<td>Calculated Inflow Residual Pressure:</td>
<td>57.87 psi</td>
</tr>
<tr>
<td>Available Inflow Residual Pressure:</td>
<td>78.34 psi</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.3.2 Classification & Design Criteria

**Laboratory Areas, General storage & Mechanical Spaces**

- Occupancy: **Ordinary Hazard Group 1**
- Density: **0.15 GPM/SQ. FT.**
- Max. Area Per Sprinkler: **130 SQ. FT.**
- Design Area of Discharge: **1500 SQ. FT.**
- Hose Stream Allowance (Inside and outside) for OH 1: **250 GPM**
- Water Supply Duration: **60-90 minutes**

**Office Areas & General Building Spaces**

- Occupancy: **Light Hazard Occupancy**
- Density: **0.1 GPM/SQ. FT.**
- Max. Area Per Sprinkler: **225 SQ. FT.**
- Design Area of Discharge: **1500 SQ. FT.**
- Hose Stream Allowance (Inside and outside) for OH 1: **100 GPM**
- Water Supply Duration: **30 minutes**

8.3.3 Manual Hydraulic Calculations

Hydraulic calculations done on this building focused on the second floor on the northeast side. This was found to be the most remote area of the building in reference to the riser.

The remote area was found to be 1560 square feet with 12 sprinklers operating. The area of coverage per sprinkler was 130 square feet. All sprinklers were Viking Micromatic Model M Upright.
Results showed 264.5 GPM @ 59.79 PSI at the base of the riser. In comparison to the city water supply this amount is adequate to cover the required demands. Even with hose stream added in (+250 GPM) the total came to 514.5 GPM. This is well under the 1045 GPM @ 65 Static and 85 PSI Residual provided by the city water main.

8.3.4 Location of Components & Sprinkler Specifications

This system was designed with components that conform to the standards represented in NFPA #13 (1996 Edition) and the standards held by the governing state of California.

8.3.4.1 Risers:
This system is supported by two risers. One riser is located at the north part of the building. This riser has a 4 inch pipe coming in for the main, and utilizes a 2 inch drain. From the 4 inch main it sends off to zone 3 with a continuation of the 4 inch pipe. Pipe going to zone 2 uses a 3 in pipe coming from the main.

The southern building is the point of connection to the city’s water main and has a 6 inch main coming from it that is fed into the 4 inch main for the building. A 2 inch drain is also used here.
Figure 26: Riser Diagram
8.3.4.2 **Cross-Mains:**

The branch lines are allied “Dyna-thread / Super 40”. This piping is made of engineered black steel pipe. The pipe has threaded cast iron or ductile iron fittings.

First Floor: The cross-mains on the east side and the small section in the middle of the building are made up of 4 inch piping. On the west side the cross-main uses 3 inch piping.

Second Floor: Water coming from the south riser enters on a 4 inch cross-main and T’s off at the north end of the building going west (toward second riser on the north) with a 4 inch and east (supplying first floor branch lines) with a 3 inch pipe.

8.3.4.3 **Branch Lines:**

For the main branch lines allied “Dyna-flow / Super flo” was used. This piping was engineered as light wall sprinkler pipe. This pipe has grooved fittings and couplings.

First Floor: Branch lines running on the main hallway and through the north offices uses 1½ inch line with the rest of the first floor using 1¼ inch.

Second Floor: Branch lines running on the main hallway and through the north offices uses 2 inch line with the rest of the first floor using 1½ inch.

8.3.4.4 **Sprinklers:**

Sprinklers should be spaced no less than 6 feet between two adjacent sprinkler heads. A sprinkler head shall not be allowed to be closer than 4 feet to a wall and up to 9 feet from a wall (NFPA 13 – 1996 Edition: section 4-6.3.2).

1. **Viking Micromatic Model M Pendent with #401 2-Piece Escutcheon**
   
   I. Temp. Rating: **155° F**
   
   II. Finish Head/Escut.: **Chrome/Chrome**
III. Number of Sprinklers: 4
IV. Orifice: ½ Inch
V. K Factor: 5.6
VI. Type: Standard Sprinkler Pendent (SSP)

2. Viking Micromatic Model M Upright
   I. Temp. Rating: 155°F
   II. Finish Head/Escut.: Brass/
   III. Number of Sprinklers: 195
   IV. Orifice: ½ Inch
   V. K Factor: 5.6
   VI. Type: Standard Sprinkler Upright (SSU)

3. Viking Micromatic Model M Upright 200
   I. Temp. Rating: 200°F
   II. Finish Head/Escut.: Brass/
   III. Number of Sprinklers: 20
   IV. Orifice: ½ Inch
   V. K Factor: 5.6
   VI. Type: Standard Sprinkler Upright (SSU)

4. Viking Horizon Mirage Model B-2 Standard Response Concealed Pendent Sprinkler with White Cover Plate
   I. Temp. Rating: 155°F
   II. Finish Head/Escut.: Brass/White
   III. Number of Sprinklers: 45
   IV. Orifice: ½ Inch
   V. K Factor: 5.6
   VI. Type: Concealed Sprinkler Pendent (CSP)

5. Viking Micromatic Model M/M-5 Sidewall with Model E-1, 2-piece Escutcheon
   I. Temp. Rating: 155°F
   II. Finish Head/Escut.: Chrome/Chrome
   III. Number of Sprinklers: 2
   IV. Orifice: ½ Inch
   V. K Factor: 5.6
   VI. Type: Horizontal Sidewall (HSW)

6. Viking Microfast Model M Upright Quick Response
   I. Temp. Rating: 155°F
   II. Finish Head/Escut.: Brass/
   III. Number of Sprinklers: 72
   IV. Orifice: ½ Inch
V. K Factor: 5.6
VI. Type: Standard Sprinkler Upright (SSU)

7. Viking Horizon Mirage Model B-2 Quick Response Concealed Pendent Sprinkler with White Cover Plate
   I. Temp. Rating: 155°F
   II. Finish Head/Esct.: Brass/White
   III. Number of Sprinklers: 8
   IV. Orifice: ½ Inch
   V. K Factor: 5.6
   VI. Type: Concealed Sprinkler Pendent (CSP)

Bracing:

Pipe Hangers:

Figure 27: Bracing Diagram
Figure 28: Pipe Hangers Diagram
8.3.5 Inspection, Testing, & Maintenance

As seen in NFPA Handbook (20th edition), sprinkler systems will fail if neglected. Of the reported sprinkler system failures, 55% of them can be attributed to maintenance not being up kept on the system. Overall the owner of the building is required to maintain the upkeep on the system when it comes to having it inspected, tested, and maintained.

Sometimes outside parties can aid in this. Some properties covered by insurance may be at a high value and/or risk. When it comes to something like this, insurance companies will sometimes provide help and resources as an extended service to their clients. This can help the insurance company and the owner of the property to feel good about the status of the system in place. With a properly installed system that is kept up to par insurance companies can offer a more precise and possible more affordable level of coverage to their clients.

In many cities some of this responsibility may be taken up by the fire department. This is more of a broad inspection to make sure everything is flowing. Checking the status of valves to make sure they are set and ready or any other minor needs. This level of inspection is normally very basic and not intended to take the place of a full inspection.

Most of the time maintenance and inspection is offered by the sprinkler contractor, manufacturer, or a specialized inspection company. This type of inspection should be one of the most thorough. Including a full system check that includes
anything required to properly protect the property. All components should be addressed and finding reported back to the property owner. This check is seen to meet the requirements for the needed protection of the property.

Another avenue that is sometimes utilized by business owners is the use of central station supervision. This person is on contract to watch and maintain all parts of the system. From workflow, valve statuses, condition of the equipment, and reminding the owner of needed upkeep.

Scheduled Maintenance

Table 19: NFPA 13 Table A.27.1 (2013 Edition)

<table>
<thead>
<tr>
<th>Parts</th>
<th>Activity</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flushing Piping</td>
<td>Test</td>
<td>5 years</td>
</tr>
<tr>
<td>Fire Department Connections</td>
<td>Inspection</td>
<td>Monthly</td>
</tr>
<tr>
<td>Control Valves</td>
<td>Inspection</td>
<td>Weekly – Sealed</td>
</tr>
<tr>
<td></td>
<td>Inspection</td>
<td>Monthly – Locked</td>
</tr>
<tr>
<td></td>
<td>Inspection</td>
<td>Monthly – Tamper Switch</td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td>Yearly</td>
</tr>
<tr>
<td>Main Drain</td>
<td>Flow Test</td>
<td>Quarterly – Annual</td>
</tr>
<tr>
<td>Open Sprinklers</td>
<td>Test</td>
<td>Annually</td>
</tr>
<tr>
<td>Pressure Gauge</td>
<td>Calibration Test</td>
<td></td>
</tr>
<tr>
<td>Sprinklers</td>
<td>Test</td>
<td>50 Years</td>
</tr>
<tr>
<td>Sprinklers – High-temperature</td>
<td>Test</td>
<td>5 Years</td>
</tr>
<tr>
<td>Sprinklers – Residential</td>
<td>Test</td>
<td>20 Years</td>
</tr>
<tr>
<td>Waterflow Alarms</td>
<td>Test</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Preaction/Deluge Detec. Sys.</td>
<td>Test</td>
<td>Semiannually</td>
</tr>
<tr>
<td>Preaction/Deluge Systems</td>
<td>Test</td>
<td>Annually</td>
</tr>
<tr>
<td>Antifreeze Solution</td>
<td>Test</td>
<td>Annually</td>
</tr>
<tr>
<td>Cold Weather Valves</td>
<td>Open and Close Valves</td>
<td>Fall, close; Spring, open</td>
</tr>
<tr>
<td>Dry/Preaction/Deluge System</td>
<td>Test</td>
<td>Annually</td>
</tr>
<tr>
<td>Air and Water Pressure</td>
<td>Inspection</td>
<td>Weekly</td>
</tr>
<tr>
<td>Enclosure</td>
<td>Inspection</td>
<td>Daily – Cold Weather</td>
</tr>
<tr>
<td>Priming Water Level</td>
<td>Inspection</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Low-point Drains</td>
<td>Test</td>
<td>Fall</td>
</tr>
<tr>
<td>Dry Pipe Valves</td>
<td>Trip Test</td>
<td>Annually – Spring</td>
</tr>
<tr>
<td>Dry Pipe Valves</td>
<td>Full Flow Trip</td>
<td>3 Years – Spring</td>
</tr>
<tr>
<td>Quick-opening Devices</td>
<td>Test</td>
<td>Semiannually</td>
</tr>
</tbody>
</table>
### 8.4 Structural Fire Protection

#### 8.4.1 Construction Type and Fire-Resistance Requirements

**TABLE 601 FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS** (hours)

Table 20: CBC 2010 Edition - Table 601

<table>
<thead>
<tr>
<th>BUILDING ELEMENT</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A&lt;sup&gt;d&lt;/sup&gt;</td>
<td>B</td>
<td>A&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Primary structural frame (see Section 202)</td>
<td>3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Bearing walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Interior</td>
<td>3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Nonbearing walls and partitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td>See Table 602</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor construction and secondary members (see Section 202)</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Roof construction and secondary members (see Section 202)</td>
<td>1&lt;sup&gt;1/2&lt;/sup&gt;,&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1&lt;sup&gt;b, c&lt;/sup&gt;</td>
<td>1&lt;sup&gt;b, c&lt;/sup&gt;</td>
<td>0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1&lt;sup&gt;b, c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

The construction of this building is found to be a Type II-B construction according to the 2010 CBC. This is a non combustible construction. As seen in the table above the building is not required to have any fire resistive ratings for the primary structural frame, bearing walls, nonbearing walls and partitions, floor construction, and roof construction.

#### 8.4.2 Walls/Partitions

Below shows the structure of the various non-rate/rated partitions. For these partitions fire/smoke sealants and/or fire safing should be used at the head of rated partition jambs where the jamb meets with dissimilar materials. At the base/sill of the partition fire sealants do not need to be used.
Gypsum:
For the walls/partitions two types of gypsum board is used. Type ‘X’ gypsum board measuring 5/8” being one. For ‘Wet’ spaces require a water resistant type ‘X’ gypsum board measuring 5/8” thick is used. These ‘wet’ spaces can be defined as the bathrooms, janitors’ closet, and other similar spaces.

Vertical Stud Framing:
3 5/8” Steel Stud Partitions - 20 Gage - Spacing @ 16” O.C. - Used up to 16’-4” High

3 5/8” Metal Stud Partitions - 18 Gage - Spacing @ 16” O.C. - Used from 16’-4” to 17’-10” High

3 5/8” Metal Stud Partitions - 16 Gage - Spacing @ 16” O.C. - Used from 17’-10” to 19’-2” High

4” Metal Stud Partitions - 20 Gage - Spacing @ 16” O.C. - Used up to 17’-8” High

4” Metal Stud Partitions - 18 Gage - Spacing @ 16” O.C. - Used from 17’-8” to 19’-4” High

6” Steel Stud Partitions - 20 Gage - Spacing @ 16” O.C. - Used up to 24’-5” High

Some parts of the building use non-rated partitions that are full height. For the corridors in this building we see a 1-hour fire rated partition with 20-minute doors and 45-minute protection of all other openings being used. For occupancy separation, 1-hour fire rated partition with 60-minute opening protection is used.

Life Safety Code 2012 - 7.1.3.1 Exit Access Corridors. Corridors used as exit access and serving an area having an occupant load exceeding 30 shall be separated from other parts of the building by walls having not less than a 1-hour fire resistance rating in accordance with Section 8.3
9 Performance-Based Design

Performance-based design method is an alternate method to the prescriptive design requirements of NFPA 101. This method can be applied when a building’s unique design does not meet the required specifications of the code. This performance-based analysis can be used to show that the building does uphold the minimum level of tenability in order for a full and safe evacuation of the building’s occupants to take place. Proving that the level of safety in the building is maintained can justify that the building is safe enough to build outside of the prescriptive requirements.

In this report NFPA 101 Chapter 5 will be used as a guide to the criteria of a performance-based design analysis. For Building 41 two design fires are selected and evaluated. Various software tools will be employed in order to simulate the fire, examine the tenability of the building during the fire, and determine the egress time of the occupants.

9.1 Performance Criteria

Section 5.2.2 of NFPA 101 specifies a performance criterion concluding that, “Any occupant who is not intimate with ignition shall not be exposed to instantaneous or cumulative untenable conditions.” (NFPA 101 Section 5.2.2*).

NFPA 101 also states in section 5.3.1 that the prescriptive requirements be retained in that the building’s fire protection systems and features comply with applicable NFPA standards for those systems and features.
9.2 Tenability Requirements

In order to ensure the building occupants remain safe, a tenability criterion is used to set a tolerable level of exposure during the egress of the building. The table below outlines the limits used in this analysis for tenability at a height of 6 feet above the occupied floor levels.

Table 21: Tenability Limits

<table>
<thead>
<tr>
<th>Performance Criteria</th>
<th>Tenability Limit</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>60°C</td>
<td>SFPE Handbook 3rd Edition 2-129 Table 2-6.19</td>
</tr>
<tr>
<td>Visibility</td>
<td>4 Meters</td>
<td>SFPE Handbook 3rd Edition Table 2-4.2 for Familiar Occupants</td>
</tr>
<tr>
<td>Radiant Heat Flux</td>
<td>2.5 kWm⁻² or 375°C</td>
<td>SFPE Handbook 3rd Edition 2-129 Table 2-6.19</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>30,000 ppm/min (1,000 ppm for 30 minutes)</td>
<td>NFPA 101</td>
</tr>
</tbody>
</table>

9.2.1 Temperature: < 60°C for >30 minutes

For a smoke layer 6 feet above the walking surface a temperature tenability limit of 60°C is used. This allows exposure for over 30 minutes at that level without it having life threatening affects on the egressing occupants (SFPE Handbook 3rd Edition Table 2-6.19).
9.2.2 Visibility: 4 Meters

The smoke layer should not descend before 6 feet above the walking surface. A visibility limit of 4 meters can also be employed for occupants that are familiar with their surroundings (SFPE Handbook 3\textsuperscript{rd} Edition Table 2-4.2). Occupants of this building are considered to be familiar with their surroundings.

![Table 2-4.2: Allowable Smoke Densities and Visibility That Permits Safe Escape](image)

9.2.3 Radiant Heat Flux: $< 2.5 \text{ kW/m}^2$

The hot smoke layer can produce a radiant heat flux to the occupants walking below it. This heat flux shall not exceed $2.5 \text{ kW/m}^2$ in order to keep occupants from experiencing pain on exposed skin. In order to stay below this value the smoke layer temperature needs to stay below $375^\circ\text{C}$ (SFPE Handbook 3\textsuperscript{rd} Edition Figure 2-6.29).
9.2.4 Carbon Monoxide: 1,000 ppm for 30 minutes

A person’s ability to exit a building is impaired by a decrease in the amount of oxygen in the building along with the toxic effects that Carbon Monoxide has. NFPA 101 defines a tolerable amount of CO to be at 1,000ppm for up to 30 minutes of exposure.

9.3 Available Safe Egress Time vs. Required Safe Egress Time

During a fire the egress of the occupants is a crucial part of performance-based design. Life safety of the occupants is considered to be achieved when the required safe egress time (RSET) is shorter than the available safe egress time (ASET).
9.3.1 Available Safe Egress Time (ASET)

The definition of ASET reads: “...The time when fire-induced conditions within an occupied space or building become untenable.” (SFPE Handbook 3rd Edition Chapter 14 Page 3-367). These tenability limits are set in the above section 9.2 and shall be maintained.

9.3.2 Required Safe Egress Time (RSET)

The RSET is the amount of time that is passes from the start of the fire until the last occupant has exited from the building. This time needs to be less than the ASET time in order for this building to be considered to have passed the requirements for life safety. RSET can be broken down into time intervals that total RSET. This information can be found in the SFPE Handbook 3rd Edition under Chapter 14.

\[ RSET = t_d + t_a + t_o + t_i + t_e \]

Where,

- \( t_d \) = time from fire ignition to detection (Detection Time)
- \( t_a \) = time from detection to notification of occupants of a fire emergency (Notification Time)
- \( t_o \) = time from notification until occupants decide to take action (Pre-Movement Time)
- \( t_i \) = time from decision to take action until evacuation commences (Action Time)
- \( t_e \) = time from the start of evacuation until it is completed (Travel Time)

The figure below from the SFPE Handbook (Figure 3-13.3) shows the sequence of the occupants’ response to a fire.
9.3.4 Detection Time ($t_d$) and Notification Time ($t_a$)

The time till detection and notification is the period of time that elapses from the start of the fire in the building until the occupants of the building are aware of the fire and need to evacuate. Occupants will detect or become aware of the fire either by visual confirmation, by detectors, sprinklers, manual pull stations, or by fire induced conditions such as heat and smoke.

For this building visual confirmation or triggering of the fire sprinkler system would be the main source of detection for scenario 1. There are no smoke or heat detectors located in the corridor lounge area. A detection and notification time of 59 seconds will be used for scenario 1. This time is found by the activation of the sprinklers in FDS.

A similar time of 60 seconds shall be implied for the second scenario as an estimate of the time of someone discovering the fire and using a manual pull station. This area also has no smoke or heat detectors around the source of the fire. The second fire is in the main corridor and easily visible throughout the length of the building making its detection and notification time fast.
9.3.5 Pre-Movement ($t_o$) and Action Time ($t_i$)

This is the time it takes for a person to begin exiting the building after the occupant realizes there is a fire or alarm sounding. The amount of time required for this can vary depending on where the occupant is or what they are doing. The occupant might need to investigate, make a decision on the level of danger, shut down a workstation, collect belongings, warn others around them, and seeking assistance. This complex thought process is something that varies upon each individual situation.

The NFPA Handbook estimates the delay time to the start of evacuation in table 4.2.1. This building would fall under mid-rise office building. Adding together the mean delay times for a cool day and a warn day and then taking their average showed a delay time of 51 seconds. This a delay time of 51 seconds will be applied as the total delay time ($t_o+t_e+t_i$).

9.3.6 Travel Time ($t_e$)

Travel time is the time from the start of the occupants’ evacuation until the end of it. The occupant travel time was calculated using the Pathfinder software for this analysis.

9.4 Computer Modeling Software

9.4.1 Pathfinder

Pathfinder is a graphical modeling software that was developed to predict the egress times of occupants in buildings. This was used in order to obtain the evacuation time of the building in this project. This interface allows the user to create a 3D rendering of the building, insert occupants on an individual level, set walking speeds/behaviors, and provide a video
simulation of the total evacuation of the building. This software was developed by Thunderhead Engineering.

9.4.2 PyroSim

PyroSim is an advanced fire modeling graphical user interface. It was used in bulk geometry design and simple parameter inputs. It produces an exportable Fire Dynamics Simulator (FDS) input file to be used by FDS. This software was developed by Thunderhead Engineering and was used to create the FDS models. This software allows the user to see the model in a 3D design instantly in order to ensure the inputs the user is encoding are correct.

9.4.3 Fire Dynamics Simulator (FDS)

Fire Dynamics Simulator is a simulation for low speed flows that has an emphasis on smoke and heat transport from fires. It is a computational fluid dynamics model. FDS was developed by the National Institute of Standards and Technology (NIST) and first released in February 2000. Version 6 of the FDS software was used in the analysis of this report.

9.4.4 Smokeview (SMV)

Smokeview is a 3D visualization program used to display the output of FDS simulations. Smokeview was also created by the researchers at NIST.
9.5 Design Fire Scenarios

NFPA 101 defines eight different design fires. For this analysis two of the eight design fires are being used. Below are the design fire criteria according to the text from NFPA 101.

5.5.3.1* Design Fire Scenario 1. Design Fire Scenario 1 shall be described as follows:
(1) It is an occupancy-specific fire representative of a typical fire for the occupancy.
(2) It explicitly accounts for the following:
   a) Occupant activities
   b) Number and location of occupants
   c) Room size
   d) Contents and furnishings
   e) Fuel properties and ignition sources
   f) Ventilation conditions
   g) Identification of the first item ignited and its location

5.5.3.2* Design Fire Scenario 2. Design Fire Scenario 2 shall be described as follows:
(1) It is an ultrafast-developing fire, in the primary means of egress, with interior doors open at the start of the fire.
(2) It addresses the concern regarding a reduction in the number of available means of egress.
9.6  Scenario 1 – Corridor Lounge Area

This fire scenario is located on the first floor on the west section of the building. This lounge area is an extension of the primary corridor. This area is mainly used by students as a place to study, rest, or meet fellow students. The area is furnished with a couch, a few chairs, and a table. The source of the fire will be on the couch located near the north wall. The area has a sprinkler located directly above the center of the room for complete coverage. Below you can see the location of the fire.

The sofa located on the north side of the room will be assumed to ignite and develop the fire. For the purpose of this experiment it will be assumed that none of the other combustibles in the room will ignite at this time.
9.6.1 HRR

The sofa is modeled from a HRR curve found in the SFPE Handbook figure 3-1.52. Specifically curve F32 from the figure. This is a three cushion sofa made of polyurethane foam padding. This foam padding complies with California TB 117 Standard. The fabric on this couch is polyolefin fabric. This furniture item is widely bought by consumers and is considered to be one with the worst performance rating when studied in a fire. Below you see the graph of the HRR used. This graph provided the basis for the FDS input parameters. In FDS a ramp function will be implied to best match the live burn results in order to create a simulated fire for this design fire scenario.

![Graph of HRR](image)

Figure 3-1.52. Several upholstered furniture items tested by NIST.
Figure 37: Scenario 1 – F32 Sofa HRR (SFPE Hb Figure 3-1.52)
9.6.2 PyroSim

Below is building 41 modeled in Pyrosim. PyroSim was used in modeling the bulk geometry of the building and imputing in the basic parameters of the experiment. In the model the couches appear in red. The blue dot located above the couches is the sprinkler that is found in the corridor area. This sprinkler sits at 4.2 meters high with the ceiling at 4.4 meters high. This sprinkler serves at the detecting device. Upon activation the flow switch will sound the alarm notifying the occupants of the building that there is a fire.

9.6.3 FDS

Below is a look at the FDS model before ignition takes place. The FDS model is shown here as an outline of the obstructions in order to clearly see the fire progress during simulation.
At 59 seconds into the simulation the sprinkler activates. Upon activation the HRR for the couch is set to plateau and remain steady for the rest of the simulation. The sprinkler is designed to contain the fire to that area and keep it from growing.

**Figure 41: Scenario 1 - Sprinkler Activates @ 59 Seconds**

**Scenario 1 @ 60 Seconds**

**Figure 42: Scenario 1 Tenability >4m at 60 Seconds**
Figure 43: Scenario 1 Tenability < 60°C at 60 Seconds

The figures above show the tenability for scenario 1 at the 60 seconds time mark.

Tenability levels were determined and set in section 9.2 of this report based off of studies done by outside sources.

In the figure above, the fire has steadily grown up until the 59 second mark where the sprinkler fires. From these figures it can be seen that the tenability for visibility and temperature have not yet been exceeded at the 60 second time stamp.

9.6.4 ASET vs RSET

Figure 44: Scenario 1 – Tenability Limit Is Reached for >4m Visibility 6 ft Above Floor @ 240s
ASET: Above captures the building at 240 seconds. The purple line indicates 6 feet above the occupants walking surface. The tenability criterion for visibility is exceeded at this time frame. Visibility is found to be the most limiting condition and will be used to set the ASET for the model at 240 seconds. Therefore, the Available Safe Egress Time for scenario 1 is set at 240 seconds after ignition of the sofa in the corridor of the hallway of Building 41.

RSET: The Required Safe Egress Time of the building was found from the predictions made in section 9.3.2 of this report combined with the evacuation time determined from the computer simulated egress of the building performed by Pathfinder.
The building took 1 minute and 21.5 seconds (81.5 Seconds) to fully evacuate the maximum occupant load of 587 people from the building to an area of safe refuge. This time will be added to the detection, notification, pre-movement, and action time in order to find a final REST time of 191.5 seconds.
9.6.5 Summary of Scenario 1

From the charts above it is shown that the sprinkler fires at 59 seconds setting the maximum HRR for the fire at 398 kW.
Figure 50: Scenario 1 – ASET vs. RSET

RSET = 191.5 Seconds
ASET = 240 Seconds

The Available Safe Egress Time exceeds the Required Safe Egress Time with a margin of 48.5 seconds. This building passes the performance based design criteria for maintaining tenability of the occupants during the complete egress of the building.
9.7 Scenario 2 – Cabinet Fire in the Main Walkway

The next scenario is located on the first floor on the east section of the building. The area focused on is located under the main set of stairs. Under the stairs are two large metal filing cabinets stocked with paper. These cabinets pose a threat for arson and would take out a primary means of egress if set on fire. There is a sprinkler near, but not directly over the source. Due to the openness of the area this sprinkler would not be expected to activate until the fire is fully developed.

The two cabinets located under the stairs will be assumed to ignite and develop the fire. For the purpose of this experiment it will be assumed that none of the other combustibles in the area will ignite at this time. The blue indicates the sprinkler that is found in the main walkway. This sprinkler sits at 4.2 meters high with the ceiling at 4.4 meters high.
9.7.1  HRR

The cabinets are modeled from a HRR curve found in the SFPE Handbook figure 3-1.15. They are considered metal office storage units with a clear aisle. Below you see the graph of the HRR used. This graph provided the basis for the FDS input parameters. In FDS a ramp function will be implied to best match the live burn results in order to create a simulated fire for this design fire scenario.

![Graph of HRR](image)

*Figure 3-1.13. Storage units.*

**Figure 54: Scenario 2 – Metal Office Storage Units HRR (SFPE Hb Figure 3-1.15)**

9.7.2  PyroSim

Below is building 41 modeled in Pyrosim. Like the previous scenario, PyroSim was used in modeling the bulk geometry of the building and imputing in the basic parameters of the
experiment. In the model the cabinets appear in red. The blue dot located above the cabinets is the sprinkler that is found in the main walkway. This sprinkler serves as a detecting device, but due to its placement will not be the first source of detection.

9.7.3 FDS

Below is a look at the FDS model before ignition takes place. The FDS model is shown here as an outline of the obstructions in order to clearly see the fire progress during simulation.
Scenario 2 @ 60 Seconds

Figure 58: Scenario 2 - Tenability >4m at 60 Seconds

Figure 59: Scenario 2 - Tenability <60°C at 60 Seconds

The figures above show the tenability for scenario 2 at the 60 seconds time mark.

Tenability levels were determined and set in section 9.2 of this report based off of studies done by outside sources.

In the figure above, it can be seen that the tenability for visibility and temperature have not yet been exceeded at the 60 second time stamp.
9.7.4 ASET vs RSET

Figure 60: Scenario 2 – Tenability Limit is Reached for >4m Visibility 6 ft Above Floor @ 180s

Figure 61: Scenario 2 - Sprinkler Fires at 231 Seconds

Figure 62: Scenario 2 - Tenability Limit is Reached for <60°C Temp 6 ft Above Floor @ 300s
ASET: Above captures the building at 180 seconds and at 300 seconds. The purple line indicates 6 feet above the occupants walking surface. The tenability criterion for visibility of more than 4 meters fails at 180 seconds. The tenability criterion for temperature staying lower than 60°C fails at 300 seconds. Visibility is therefore found to be the most limiting condition and will be used to set the ASET for the model at 180 seconds. Therefore, the Available Safe Egress Time for scenario 2 is set at 180 seconds after ignition of the cabinets in the main walkway of Building 41. The sprinkler activated at 231 seconds, but is considered not effective toward the life safety of the occupants due to the fact that it did not activate until after the ASET frame had passed.

RSET: The Required Safe Egress Time of the building was found from the predictions made in section 9.3.2 of this report combined with the evacuation time determined from the computer simulated egress of the building performed by Pathfinder.
For this simulation the east stairs were considered unusable to account for the worst case scenario of a main path of egress being taken out by a fire. At 60 seconds after first movement begins the main exit doors on the east side close to simulate conditions being untenable for visibility due to fire found from the FDS model at 180 seconds after ignition. The
building took 2 minutes and 21.3 seconds (141.3 Seconds) to fully evacuate the maximum occupant load of 587 people from the building to an area of safe refuge. This time will be added to the detection, notification, pre-movement, and action time in order to find a final REST time of 252.3 seconds.
9.7.5 Summary of Scenario 2

Figure 66: Scenario 2 Sprinkler Temperature

From the charts above it is shown that the sprinkler fires at 231 seconds setting the maximum HRR for the fire at 815 kW.
The Available Safe Egress Time does not exceed the Required Safe Egress Time. This building fails the performance based design criteria for maintaining tenability of the occupants during the complete egress of the building.

10 Conclusion

This report on the Grant M. Brown Engineering Building evaluated both the prescriptive-based design and a performance-based analysis. The prescriptive-based design applied to this building was covered and summarized in detail throughout the report with an overview of the active and passive fire protection systems.

The performance-based analysis of this report focused on evaluating how effective the prescriptive-based requirements were in protecting the life safety of the occupants. It was found that the fire protection systems were not adequate for the building in one of the
scenarios. It failed to maintain the life safety of the occupants during a full evacuation of the building. The performance based analysis shows that the tenability criteria has not been met for scenario 2. The building became untenable before a full evacuation could take place. The available safe egress time (ASET) was significantly less than the required safe egress time (RSET). Therefore the system in place does not provide a level of safety required to protect all of the occupants in various fire scenarios during the egress of the building’s occupants.

11 Recommendations

- A clear area under the east side stairs needs to be maintained in order to prevent the loss of a main path of egress due to ignition of flammable objects under the stairs whether by accident or arson.
- Staff and students should be trained on the building’s fire evacuation plan at the beginning of each quarter.
- Consideration of installing a sprinkler on the underside of the stairs in order to prevent fires like scenario 2 from jeopardizing the use of a main path of egress.
- Scheduled Inspection, Testing, and Maintenance (ITM)
- Keep the main path of egress clear of obstructions.

12 References

2. Cal Poly Environmental Health & Safety Fire Drill & Building Evacuation Procedure
   http://afd.calpoly.edu/ehs/docs/campus%20building%20evacuation%20procedure.pdf
7. Fire Safety Management Plan Checklist
10. Griffith University Building Fire and Evacuation Plan
11. http://maps.google.com, Cal Poly Campus, San Luis Obispo, CA
    http://publicecodes.cyberregs.com/icod/ibc/2012/index.htm
    http://publicecodes.cyberregs.com/icod/ifc/2012/index.htm
    https://www.notifier.com/salesandsupport/documentation/Pages/default.aspx
27. PyroSim User Manual, PyroSim 2012, Thunderhead Engineering
28. Texas Tech University Health Sciences Center El Paso Fire Safety Management Plan
## Appendix A  Fire Detection, Alarm, and Communication Systems

### Secondary Power Supply

#### Table 22: Secondary Power Supply

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Standby Current Per Unit (AMPS)</th>
<th>QTY</th>
<th>Standby Current Per Unit (AMPS)</th>
<th>QTY</th>
<th>Alarm Current Per Unit (AMPS)</th>
<th>QTY</th>
<th>System Alarm Current (AMPS)</th>
</tr>
</thead>
<tbody>
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<td>.65</td>
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**Total System Standby Current (AMPS)**: 0.419802  
**Total System Alarm Current (AMPS)**: 4.367677

**Required Operating Time of Secondary Power Source from NFPA 72, 2013 Edition, Section 10.6.7.2.1**

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**Required Standby Capacity (AMP-Hours)**: 10.075248  
**Required Alarm Capacity (AMP-Hours)**: 4.367677

**Required Battery Capacity (AMP-Hours)**: 12.52689059

**Factor of Safety**: 1.2
Fire Alarm Plan Drawings
Room Spacing for Alarm & Notification Devices

NFPA 72, 2013 Edition, Table 18.5.5.4.1(a), Table 18.5.5.4.1(b), and Figure 18.5.5.4.1

**Table 18.5.5.4.1(a) Room Spacing for Wall-Mounted Visible Appliances**

<table>
<thead>
<tr>
<th>Maximum Room Size</th>
<th>Minimum Required Light Output [Effective Intensity (cd)]</th>
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**Table 18.5.5.4.1(b) Room Spacing for Ceiling-Mounted Visible Appliances**

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<th>Minimum Required Light Output [Effective Intensity (cd)]</th>
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<td>70 × 70</td>
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NA: Not allowable.

**Figure 18.5.5.4.1** Room Spacing for Wall-Mounted Visible Appliances.

- This does not preclude mounting lens at lower heights.
Notifier®
by Honeywell

catalog cut sheets

NFS2-640
Intelligent Addressable
Fire Alarm System

General
The NFS2-640 Intelligent Fire Alarm Control Panel is part of the ONYX® Series of Fire Alarm Controls from Notifier.

In alarm-alone or network configurations, ONYX Series products meets virtually every application requirement.

The NFS2-640’s modular design makes system planning easier. The panel can be configured with just a few devices for small building applications, or networked with many devices to protect a large campus or a high-rise office block. Simply add additional partition equipment to suit the application.

A host of other options are available, including single- or multi-channel voice; firefighters’ telephones; LED, LCD, or PC-based graphic annunciators; fire or integration networking; advanced data-logging products for challenging environments, and many additional options.

NOTE: Values called out with a version-specific “E” at the end of the part number, “NFS2-640E” refers to models NFS2-640 and NFS2-640E. Similarly, “CPU2-640” refers to models CPU2-640 and CPU2-640E.

Features
- Certified for seismic applications when used with the appropriate seismic mounting kit.
- Approves for Marine applications when used with listed compatible equipment (see DM-1068).
- One, expandable to two, isolated Intelligent Signaling Line Circuit (SLC) Style 6, 6 or 7.
- Up to 159 detectors (any mix of ion, photo, thermal, or multi-sensor) and 159 modules (Addressable pull stations, normally open contact devices, two-wire smoke notification, or relay) per SLC: 318 devices per loop/368 per FACP or network node.
- Standard 80-character display, 140-character large display (NCA-2), or display-less (a node on a network).
- Network options:
  - High-speed network for up to 200 nodes (NFS2-3000, NFS2-640, NFS-3000(C), NFS-3200S, NCA-2, DVR, ONYXWorks, NFS-3000, NFS-640, and NCA).
  - Standard network for up to 103 nodes (NFS2-3000, NFS2-640, NFS-3000(C), NFS-3200S, NCA-2, DVR, ONYXWorks, NCS, NFS-3000, NFS-640, NCA, AFP-200, AFP-300/400, AFP-1010, and AM2020). Up to 54 nodes when DVR is used in network paging.
- 6.0 A switch mode power supply with four Class A/B built-in Notification Appliance Circuits (NAC). Selectable System Sensor, Wheelock, or Gentex strobe synchronization.
- VantFire® Tools online or offline programming utilities; Upload Download, save, store, check, compare, and simulate panel databases. Upgrade panel firmware.
- Autorouting and Walk Test reports.
- Multia mode central station communication options:
  - Standard U5ACT
  - Internet
  - Internal/GSM
- 80-character remote annunciators (up to 32).
- EIA-485 annunciators, including custom graphics.
- Printer interface (80-column and 40-column printers).
- History file with 800-event capacity in nonvolatile memory, plus separable 200-event alarm-only file.
- Alarm Verification status per point, tally.
- Pre-signal/Positive Alarm Sequence (PAS).
- Silence inhibit and Auto Silence timer options.
- March time/lampstabilization/California two-stage coding/strobe synchronization.
- Field-programmable panel or on PC, with VantFire Tools program check, compare, simulate.
- Full QWERTY keypad.
- Battery charger supports 18-200 AH batteries.
- Non-alarm points for lower priority functions.
- Remote ACK/Signal Silence/Status (SMS) Drill via monitor module.
- Automatic time control functions, with holiday exceptions.
- Surface Mount Technology (SMT) electronics.
- Extensive, built-in transient protection.
- Powerful Boolean logic equations.
- Support for SCS Series smoke control system in HVAC mode.

NCA-2 as primary display
- Heats, 640-character display.
- Supports SCS Series smoke control system in FSCS mode when SCS is connected to the NCA-2 used as primary display.
- Supports DVR digital audio loop.
- Printer and CRT EIA-232 ports.
- EIA-485 annunciator and terminal mode ports.

FLASHSCAN® INTELLIGENT FEATURES
- Poll up to 512 devices in less than two seconds.
- Activate up to 159 outputs in less than five seconds.
- Multicolor LEDs blink device address during Walk Test.

DN-7111.0 • A-13
103 | Blenchat
**GENERAL**

The NOTIFIER FSP-751 (photo) and FSI-751 (ion) are analog, addressable, low-profile (height measures only 1.66''), 42.164 mm) smoke detectors designed for the entire line of intelligent systems from NOTIFIER. The FSP-751T photo model includes a built-in thermal (heat) detection device. If either condition (smoke or heat) is detected, the device will alarm.

The addressability of the FSP-751 and FSI-751 enables the control panel to provide firefighters with a pinpoint description of where the fire is located. The FSP-751T and FSI-751T are also analog devices. The control panel is capable of not only knowing the detector’s location but exactly how much smoke is in the chamber of the detector. The detector may be set for different sensitivity settings appropriate to the environment of its location.

Analog devices continually send obscuration values to the control panel. These values may be gathered so as to allow the control panel to determine if a detector has accumulated an excessive amount of dirt or dust. A “maintenance” required indication allows the installer to clean the smoke detector before an unwanted false alarm occurs.

The F3I-751 Intelligent Ionization Sensor incorporates a unique single-source chamber design to respond quickly and dependably to a broad range of fires. The FSP-751 Intelligent Photoelectric Sensor’s unique optical sensing chamber is designed with superior signal to noise ratio. The optical chamber is engineered to sense the presence of smoke produced by a wide range of combustion sources.

FlashScan® (patent pending) is a new 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 design (height only 1.66”/42.164 mm).
- Common base for both photo and ion detectors.
- Addressable-analog communication.
- Stable communication technique with noise immunity.
- Low standby current.
- Rotary 01 to 159 address switches (01 to 99 on traditional systems).
- Optional remote, single-gang LED accessory (RA4002).
- Dual LED design provides 360° viewing angle.

FlashScan® is a registered trademark of NOTIFIER.

NOTIFIER is a Honeywell Company.

This document is not intended to be used for installation purposes. We try to keep our product information up-to-date and accurate. We cannot cover all specific applications or anticipate all requirements. All specifications are subject to change without notice. For more information, contact NOTIFIER. Phone: (203) 484-7161 Fax: (203) 484-7188

12 Clintonville Road, Northford, Connecticut 06472

**SPECIFICATIONS**

Size: 1.66” (42.16 mm) high x 4.1” (104.14 mm) diameter.

Shipping weight: 3.6 oz. (104 g).

Operating temperature: 0°C to 40°C (32°F to 120°F).

**ISO 9001**

CERTIFIED

QUALITY MANAGEMENT SYSTEM
FST-751 Series
Intelligent Thermal (Heat) Detectors with FlashScan®
Section: Intelligent/Addressable Devices

GENERAL
The FST-751 Series intelligent thermal detector is used with the intelligent NOTIFIER Fire Alarm Systems to measure thermal levels caused by a fire and report the analog level of the thermal measurement to the control panel. The use of analog information provides significant benefits to the end user, installer, and service personnel in ways which are not possible with a conventional type system. Since this detector is addressable, it helps firefighters to more quickly locate a fire in its early stages.

FlashScan® (U.S. Patent 5,539,389) is a new 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’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-751R), 15°F (8.3°C) per minute.
- Factory preset at 135°F (57°C).
- Addressable by device.
- Dired 01 – 159 entry of address (01 – 99 on traditional systems).
- Two-wire loop connection.
- Visible LEDs “blink” every time the unit is addressed.
- 360° field view 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.
- Walktest with address display (an address of 121 will blink the detector LED T2-gauge-1).
- Low standby current.
- Listed to UL 521.
- 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.
- SEM3 screws for wiring of the separate base.

APPLICATIONS
Use thermal detectors for protection of property.
For further information call NOTIFIER for manual 856-407-00, Applications Manual for System Smoke Detectors, which provides detailed information on detector spacing, placement, zoning, wiring, and special applications.

CONSTRUCTION
These detectors are constructed of Bayblend® in an off-white color.
The FST Series plug-in intelligent thermal detector is designed to commercial standards and offers an attractive appearance.

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 box which is at least 1.5" (38.1 mm) deep. Suitable boxes include:

FlashScan® is a registered trademark of NOTIFIER. Bayblend® is a registered trademark of Bayer Corporation.

This document is not intended to be used for installation purposes. We try to keep our product information up-to-date and accurate. We cannot cover all specific applications or anticipate all requirements. All specifications are subject to change without notice. For more information, contact NOTIFIER. Phone: (203) 484-7181 FAX: (203) 484-7115

NOTIFIER
12 Clintonville Road, Northford, Connecticut 06472

ISO 9001
CERTIFIED
MANUFACTURER
GENERAL
An HVAC system supplies conditioned air to virtually every area of a building. Smoke introduced into this air duct system is thus distributed to the entire building. Smoke detectors for use in air duct systems sense the presence of smoke in the duct.

The FSD-751P air duct smoke detector is a photoelectric detector, combining the detection technology with an efficient alarm design that samples air passing through the duct, allowing detection of a developing hazardous condition. When sufficient smoke is sensed, an alarm signal is initiated at the fire control panel monitoring the detector, and appropriate action can be taken to shut off fans and blowers and change over air handling systems, etc. This can isolate toxic smoke and fire gases or prevent their distribution throughout the areas served by the duct system.

Two LEDs on each detector can be programmed by the system control panel to provide a local alarm indication. A remote alarm output is provided for use with auxiliary devices. The FSD-751P has remote test capability with the RTS451/RTPS451 KEY Remote Test Station.

Traditional panel support addresses of 0 – 99, The FlashScan® protocol supports addresses of 0 – 159. Patent FlashScan® is a new communication protocol developed by NOTIFIER Engineering that greatly enhances the speed of communication between analog intelligent devices. Intelligent devices communicate in a group address. If one of the devices within the group has new information, the panel stops the group poll and concentrates on single points. The net effect is response speed greater than five times that of earlier designs.

APPLICATIONS
Duct smoke detectors have specific limitations. Duct smoke detectors are:

- NOTa substitute for open area smoke detectors.
- NOTa substitute for early warning detection.
- NOTa replacement for a building's regular fire detection system.

Call NOTIFIER for a copy of System Sensor's application guide, Proper Use of Smoke Detectors in Duct Applications, (Actis-1004-00).

INSTALLATION
Wiring: For signal wiring (the wiring between detectors or from detectors to auxiliary devices), it is recommended that single conductor wire be no smaller than 16 AWG (0.75 mm²). The duct smoke detector terminals accommodate wire sizes up to 16 AWG (1.25 mm²). Flexible conduit is recommended for the last foot (30.48 cm) of conduit; solid conduit connection may be used if desired.

Smoke detectors and alarm system control panels have specifications for Signaling Line Circuit (SLC) wiring. Consult the control panel specifications for wiring requirements before wiring the detector loop. The FSD-751D/FSD-751DP detector is designed for ease of wiring; the housing provides a terminal strip with clamping plates.

LED Features: If programmed with the system control panel, two LEDs on each duct smoke detector light to provide local visible indication. Remote LED annunciator capability is available as an option. Each duct smoke detector can only be wired to one remote annunciator.

NOTIFIER panels offer different feature sets across different panel models. As a result, certain features of the FSD-751P/FSD-751DP may be available on some control panels, but not on others. Possible features, if supported by the control panel are:

- Panel controls the LED operation on sensor. Operational modes are: RED blink, RED continuous, GREEN blink, GREEN continuous, and OFF.

SPECIFICATIONS
FSD-751P
Operating voltage range: 15 to 32 VDC.
Standby current: 300 μA @ 24 VDC (ore communication every 5 seconds with LED blink enabled).
Operating temperature range: 32° to 131°F (0° to 55°C).
Humidity range: 10% to 93% (non-condensing).
Duct air velocity: 500 to 4,000 feet/min. (152.4 to 1219.2 meters/min).
Dimensions: 14.375" (365.125 mm) wide x 5.500" (139.70 mm) high x 2.750" (69.850 mm) deep.
Options: RTS-451, RTS-451KEY, RA400Z. Separate auxiliary power is not required.
Listed to UL 268A.

FSD-751RP
Operating voltage range: 15 to 32 VDC (comm. line voltage) and 24 VAC/VDC or 120/240 VAC auxiliary power (separate source). NOTE: The FSD-751RP requires a separate auxiliary source.
Standby current: 300 μA @ 24 VDC (ore communication every 5 seconds with LED blink enabled).
Auxiliary power current draw (at 24 VDC): 20 mA (standby), 87 mA (alarm).

NOTIFIER® is a Honeywell company.
This document is not intended to be used for installation purposes. We try to keep our product information up-to-date and accurate. We cannot cover all specific applications or anticipate all requirements. All specifications are subject to change without notice. For more information, contact NOTIFER®. Phone: (203) 464-7161 FAX: (203) 464-7118

ISO 9001 CERTIFIED SYSTEMS & MANUFACTURING QUALITY SYSTEMS
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 control panels, and the NSP-2S 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/22 AWG wire).
- Can be surface mounted (with SD-10 or SD-I/O) or semi-flush mounted. Semi-flush mounted to a standard single-gang, double-gang, or 4” (10.16 cm) square electrical box.
- Smooth dual-action design.
- Meets ADA controls and operating mechanisms guidelines (Section 4.16.2[13]); meets ADA requirement for 5 lb. maximum activation force.
- Highly visible.
- Attractive shape and textured finish.
- Key reusable.
- Includes Braille text on station handle.
- Optional trim ring (BG12TR).
- 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: 38.0 VDC.
- Maximum SLC standby current: 375 µA.
- Maximum SLC alarm current: 5 mA.
- 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 boxback. 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 reactivate the station, simply unlock the station with the key and pull the door open. This action releases 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 latched, 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
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) cause 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/RF) immunity.
- Four LED indicators for ease of wiring.
- Direct-dial entry of address: 01 – 159 on FlashScan loops: 01 – 99 on ULP loops.
- LED flashes green during normal operation is a programmable option and flashes 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
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 actuating 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 5,599,389) 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, speakers, 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 (EMP/RFI).
- The FCM-1(A) may be used to switch 24 Volt NAC power, audio (up to 73.7 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 modloops.
- Speaker, and audible/visual applications may be wired for Class B or A (Style Y or Z).

Specifications for FCM-1(A)

Normal operating voltage: 15 to 32 VDC.

Maximum current drain: 6.5 mA (LED on).

Average operating current: 350 µA direct poll, 275 µA group poll with LED flashing, 485 µA Max. (LED flashing, NAC shorted).

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).
INSTALLATION AND MAINTENANCE INSTRUCTIONS

SpectrAlert Horns, Strobes, and Horn/Strobes

For use with the following models:

- Horns: 12/24 volt - H12/24
- Strobes: 12 volt - S121S, S2125, S2145, 24 volt - S2415, S2430, S24675, S2475, S24110
- Combo: 12 volt - P121S, P1215S, P1245S, 24 volt - P241S, P2430, P24675, P2475, P24110

Add suffix “F” for units marked FUSEO, “EV” for EVIC, or “AG” for AGENT, available on 241575, not housing only.
Add suffix “W” for white housing units.
The products to which this manual applies may be covered by one or more of the following U.S. Patent numbers: 5,544,665; 6,580,117; 5,398,139; 6,049,441; 5,983,562; 6,133,843

Specifications

- Voltage Range: DC or Full-Wave Rectified
- Horn: 10.5 to 30 Volts
- Strobes & Horn/Strobes: 12-volt models - 10.5 to 17 volts; 24-volt models - 20 to 30 volts
- (with MDI module): 12-volt models - 11 to 17 volts; 24-volt models - 21 to 30 volts

NOTE: Horn and combo units will operate on walk tests with on-time durations of 1 sec. or greater.

- Flash Rate: 1 Flash Per Second
- Operating Temperature: 32°F to 130°F (0°C to 49°C)
- Light Output: Models with 15 only in the model number are listed at 15 candela
  Models with 1675 are listed at 1675 candela per IUL-1971 but will provide 75 candela on axis (straight ahead)
  Models with 30, 75, or 110 are rated for that candela.
- Sound Output: Sound output levels are established at Underwriters Laboratories in their reverberant room. Always use the sound output specified as UL Reverberant Room when comparing products.
- Listings: UL, FM, CSFM, MESA

Note for Strobes: Do not exceed; 1) 16-33 voltage range limit; 2) maximum number of 70 strobe lights when connecting the MDI Sync module with a maximum line impedance of 4 ohms per loop and; 3) maximum line impedance as required by the fire alarm control manufacturer.

General Description

- The SpectrAlert series notification appliances are designed to meet the requirements of most agencies governing these devices, including NFPA, ADA, The National Fire Alarm Code, UL, FM, CSFM, MESA. Also, check with your local Authority Having Jurisdiction for other codes or standards that may apply.
- The SpectrAlert series can be installed in systems using 12- or 24-volt panels having DC or full-wave rectified (FWR) power supplies. The series can also be installed in systems requiring synchronization (module MDI required) or systems that do not require synchronization (no module required).

NOTE: This manual shall be left with the owner/user of this equipment.

Fire Alarm System Considerations

- Temporal and Non-Temporal Coded Signals:
  - The American National Standards Institute and the National Fire Alarm Code require that all horns used for building evacuation installed after July 1, 1986, must produce Temporal Coded Signals.
  - Signals other than those used for evacuation purposes do not have to produce the Temporal Coded Signal. Temporal coding is accomplished by interrupting a steady sound in the following manner:
    
    ![Temporal Coded Signal Diagram]

- Power Supply Considerations:
  - Panels typically supply DC filtered voltage or FWR (full-wave rectified) voltage. The system design engineer must calculate the number of units used in a zone based on the type of panel supply. Be certain the sum of all the device currents do not exceed the current capability of the panel.
  - Calculations are based on using the device currents found in the subsequent charts and must be the current specified for the type of panel power supply used.

Wire Sizes

- The designer must be sure that the last device on the circuit has sufficient voltage to operate the device within its rated voltage. When calculating the voltage available to the last device, it is necessary to consider the voltage drop due to the resistance of the wire. The thicker the wire, the less the voltage drop. Generally, for purposes of determining the wire size necessary for the system, it is best to consider all of the devices as “jumped” on the end of the supply circuit (simulates “worst case”).
- Typical wire size resistance:
  - 18 AWG solid: Approximately 8 ohms/1,000 ft.
  - 16 AWG solid: Approximately 5 ohms/1,000 ft.
  - 14 AWG solid: Approximately 3 ohms/1,000 ft.
  - 12 AWG solid: Approximately 2 ohms/1,000 ft.

Example: Assume you have 10 devices on a zone and each requires 50 mA average and 2000 ft. of 14 AWG wiring (total length = outgoing + return). The voltage at the end of the loop is 0.080 volts per device x 10 devices x 3 ohms/1,000 ft. x 2000 ft. = 3 volts drop.

Note: If class “A” wiring is installed, the wire length may be up to 4 times the single wire length in this calculation.
KMS Series
Alarm Bells

General
The NOTIFIER KMS Series bells are low-current, audible signaling devices for use in fire alarm systems or other signaling applications in Canada.

Features
- Under-dome design.
- Available in two gong sizes — 6” (15.24 cm) and 10” (25.4 cm) diameter.
- Low operating current.
- Low “kick” current.
- Indoor/outdoor installation.
- Mount to standard 4” square electrical box.

Operation
KMS Series bells use a low-current, high efficiency DC motor to drive the striker. All DC models are polarized for use with supervision circuitry. The operating mechanism is completely enclosed in a cast aluminum base.

Applications
KMS Series bells are ideally suited for almost any kind of alarm signaling application. They can be used in schools, factories, office buildings, or private residences. Their low current consumption means additional savings on standby power.

Construction
Each bell gong is made of steel finished in red enamel. The striker is also made of steel, and the mechanism housing is made of cast aluminum. Optional backboxes are of steel finished with red enamel to match the gong.

Installation
Bells may be installed on a wall surface or semi-flush. A weatherproof backbox (WBB) also permits installation on an exterior wall surface.

Agency Listings and Approvals
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: S8908
- FM Approved
The PAM Series Relays are encapsulated multi-voltage devices with “flying” loads that offer versatile, reliable performance in a convenient package. Several of the versions contain a red LED which indicates when the relay coil is energized. The PAM Series Relays are packaged with a self-tapping screw and a piece of double sided tape for easy installation almost anywhere. The relays are also packaged with wire-nuts to aid installation.

PAM Relays are ideal for applications where remote relays are required for control or status feedback. They are suitable for use with HVAC, Temperature Control, Fire Alarm, Security, Energy Management, Lighting Control Systems and Building Automation Systems.

**PRODUCT DESCRIPTION**

**PAM-1**
The PAM-1 Relay provides 10.0 A form “C” contacts. The relay may be energized by one of the input voltages: 24 VDC, 24 VAC, or 120 VAC. The input voltages are polarity-sensitive and diode-protected. PAM-1 Relays contain a red LED which indicates when the relay coil is energized.

**PAM-2**
The PAM-2 Relay provides 7.0 A form “C” contacts. The relay may be energized by one of the input voltages: 12 VDC or 24 VDC. The input voltages are polarity-sensitive and diode-protected. PAM-2 Relays contain a red LED which indicates when the relay coil is energized.

**PAM-4**
The PAM-4 Relay provides 10.0 A form “C” contacts. The relay may be energized across a wide voltage range from 9 VDC to 40 VDC, making it ideal for 12 VDC and 24 VDC EOL circuits. The 15 mA operating current is constant across the operating range. The input voltages are polarity-sensitive and diode-protected.

**PAM-SD**
The PAM-SD Relay provides 7.0 A form “C” contacts. The relay may be energized by an input voltage between 20 VDC to 32 VDC, making it ideal for 24 VDC NAC circuits. The input voltages are polarity-sensitive and diode-protected. The PAM-SD provides an additional set of wires for redundant input voltage (circuit supervision pass through).

Distributed By:
INSTALLATION AND MAINTENANCE INSTRUCTIONS

SpectrAlert Selectable Output Strobes, Horns, and Horn/Strobes

For use with the following models:
- Strobes: S1224MC, S1224MCW, S1224MCSP, S1224MCP, S1224MCSPW, S1224MCPW
- Combo: S1224MC, S1224MCP, P1224MC, P1224MCP, P1224MCSP, P1224MCPW, P1224MCSPW, P1224MCPW
- Horns: H1212W, H1212W

Suffix “W” indicates white housing model. Suffix “P” indicates “Puerc” (Spanish word for “fire”) housing on horn.

The Products to which this manual applies may be covered by one or more of the following U.S. Patent numbers: 5,914,665; 5,850,178; 5,598,139; 6,049,446; 6,133,841; 6,522,266; 6,666,337; 5,931,369; 6,793,370; 6,822,402; 6,833,783; 6,838,997

Specifications

Automatic selection for 12 or 24 volt rated operation (DC or Full-Wave Rectified)

Electrical

Horns, Strobes, and Horn/Strobes Voltages: Regulated 12 DC/FWR and Regulated 24 DC/FWR

Operational Voltage Ranges:
- 12V: 8-17.5 Volts; 24V: 16-33 Volts

Synchronous Applications
- with MDL Module: 12V = 9-17.5 Volts; 24V = 17-33 Volts

Operational Humidity Range: 10-93% RH (non-condensing)

NOTE: Horn units will operate on walk tests with on-time durations of .25 sec. or greater.

Flash Rate: 1 flash per second

Operating Temperature: 32° F to 129° F (0° C to 49° C)

Selectable Light Outputs: All candelas are selectable via a manual slide switch.

12/24 Volt Applications:
- 15 or 15/75 candela
- 30, 75, 110 candela

24 Volt Application: 15/75 is listed at 15 candela per UL 1971 but will provide 75 candela on axis (straight ahead). 15, 30, 75, or 110 are rated for that candela.

Sound Output: Sound output levels are established at Underwriters Laboratories in their reverberant room. Always use the sound output specified as UL Reverberant Room when comparing products.

Listings:
- UL 55312 (strobe); UL 5401 (combo)

Note for Strobes:
- Do not exceed: 1) 8-17.5 or 16-33 voltage range limit; 2) maximum number of 70 strobe lights when connecting the MDL Sync module with a maximum line impedance of 4 ohms per loop and; 3) maximum line impedance as required by the fire alarm control manufacturer.

General Description

The SpectrAlert series notification appliances are designed to meet the requirements of most agencies governing these devices, including: NFPA, ADA, The National Fire Alarm Code, UL, ULC, FM, CSFM, MEA. Also, check with your local authority having jurisdiction for other codes or standards that may apply.

The SpectrAlert series can be installed in systems using 12- or 24-volt panels having DC or full-wave rectified (FWR) power supplies. The series can also be installed in systems requiring synchronization (module MDL or compatible equivalent required) or systems that do not require synchronization (no module required).

NOTICE: This manual shall be left with the owner/user of this equipment.

Fire Alarm System Considerations

Temporal and Non-Temporal Coded Signals:

The American National Standards Institute and the National Fire Alarm Code require that all homes used for building evacuation installed after July 1, 1996, must produce Temporal Coded Signals. Signals other than those used for evacuation purposes do not have to produce the Temporal Coded Signal. Temporal coding is accomplished by interrupting a steady sound in the following manner:

Power Supply Considerations

Panels typically supply DC filtered voltage or FWR (full-wave rectified) voltage. The system designer must determine the number of units used in a zone based on the type of panel supply. Be certain the sum of all the device currents do not exceed the current capability of the panel. Calculations are based on using the device current found in the subsequent charts and must be the current specified for the type of panel power supply used.
**FSP-851(A) Series**

*Intelligent Plug-In Photoelectric Smoke Detectors with FlashScan®*

**General**

Notifier FSP-851(A) Series intelligent plug-in smoke detectors with integral communication provide features that surpass conventional detectors. Detector sensitivity can be programmed in the control panel software. Sensitivity is continuously monitored and reported to the panel. Point ID capability allows each detector's address to be set with rotary, decimal address switches, providing exact detector location for selective maintenance when chamber contamination reaches an unacceptable level.

The FSP-851(A) photoelectric detector's unique optical sensing chamber is engineered to sense smoke produced by a wide range of combustion sources. Dual electronic thermistors add 135°F (57°C) fixed-temperature thermal sensing on the FSP-851T(A). The FSP-851R(A) is a remote test capable detector for use with DNR(A)/DNRW duct detector housings. FSP-851(A) series detectors are compatible with Notifier Onyx and CLIP series Fire Alarm Control Panels (FACP).

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 in the group has new information, the panel’s CPU stops the group pull and concentrates on single points. The net effect is response speed greater than five times that of earlier designs.

**Features**

- Sleek, low-profile design.
- Addressable-analog communication.
- Stable communication technique with noise immunity.
- Low standby current.
- Two-wire SLC connection.
- Compatible with FlashScan® and CLIP protocol systems.
- Rotary, decimal addressing (1-99 on CLIP systems, 1-159 on FlashScan systems).
- Optional remote, single-gang LED accessory.
- Dual LED design provides 90º viewing angle.
- Visible bi-color LEDs blink green every time the detector is addressed, and illuminate steady red on alarm (FlashScan systems only).
- Remote test feature from the panel.
- Walk test with address display (an address on 121 will blink the detector LED: 12-cause-1/FlashScan systems only).
- Built-in functional test switch activated by external magnet.
- Built-in tamper-resistant feature.
- Sealed against back pressure.
- Constructed of off-white fire-resistant plastic, designed to commercial standards, and offers an attractive appearance.
- 94.5V plastic tamperability rating.
- SEMS screws for wiring of the separate base.
- Optional relay isolator, and sounder bases.

**Specifications**

- Sensitivity: 0.5% to 2.35% per foot obscuration
- Size: 2.1" (5.3 cm) high; base determines diameter.
  - B20L(P)(A): 6.1" (15.5 cm) diameter.
  - B20S(P)(A): 4.1" (10.4 cm) diameter.
  - BZ20(P)(A): 6.875" (17.48 cm) diameter.

**Shipping Weight:** 5.2oz. (147g)

**Operating Temperature Range:** FSP-851(A), 0°C to 49°C (32°F to 120°F). FSP-851R(A), 0°C to 80°C (32°F to 100°F). Low temperature signal for FSP-851T(A) at 45°F +/- 1°F (7°C +/- 0.6°C); FSP-851R(A) installed in a DNR(A)/DNRW.

-20°C to 70°C (-4°F to 158°F).

**UL/LC Listed Velocity Range:** 0-4000 ft/min. (1219.2 m/min.), suitable for installation in ducts.

**Relative Humidity:** 10%-93% noncondensing.

**Thermal Ratings:** Fixed-temperature setpoint 135°F (57°C).

**DETECTOR SPACING AND APPLICATIONS**

Notifier recommends spacing detectors in compliance with NFPA 72. In low airflow applications with smooth ceiling, space detectors 20 feet (6.14m) for ceilings higher than 10 feet (3.04m) and higher. For specific information regarding detector spacing, placement, and special applications refer to NFPA 72. System Smoke Detector Application Guide, document A05-1003, is available at systemsavcor.com

**ELECTRICAL SPECIFICATIONS**

- Voltage Ratings: 15-32 volts DC max.
- Standby Current (max. avg.): 300µA @ 24VDC (one communication every five seconds with LED enabled).
- LED Current (max.): 8.5mA @ 24 VDC (ON).

**Installation**

FSP-851(A) plug-in detectors use 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.

Mount base (all base types) on an electrical backbox which is at least 1.5" (3.81 cm) deep. For a chart of compatible junction boxes, see DN-60054.

**NOTE:** 1) Because of inherent supervision provided by the SLC loop, end-cap resisters are not required. Wiring "Flush" or branches are permitted for Style 4 (Class "B") wiring. 2) When using relay or sounder bases, consult the ISO-X(P) installation...
ACPS-2406
Addressable Charger/Power Supply with built-in synchronization

GENERAL
The ACPS-2406 is an auxiliary power supply and battery charger with a host of unique features. Each of the four Notification Appliance Circuits (NAC) is individually addressable, eliminating the need for control modules. In addition, each circuit can provide notification appliance synchronization without an additional module, normally required when non-coded devices are installed. Device manufacturers supported are System Sensor, Wheelock, and Gentex. The ACPS-2406 is compatible with all NOTIFIER intelligent Fire Alarm Control Panels (FACPs).

FEATURES
- Each NAC can be synchronized with any of the following manufacturers' audiovisual devices:
  - System Sensor (SpectAlert+ Series)
  - Wheelock
  - Gentex
- Four NACs individually addressable by the FACPs.
- 6.0 A of output power for NAC or 5.6 A of general purpose power.
- Each circuit can be DIP-switch-selected as general purpose 24 VDC power, four-wire detector power, or a Notification Appliance Circuit.
- Steady, March Time (120 PPM), Dual Stage, Temporal, or UZC Zone-Coded and Non-Coded devices—all DIP-switch-selectable by circuit.
- Universal Zone Coder (UZC-256) supervised output option allows for programmable coded outputs. Up to 256 different codes.
- Charges 7 to 25 AH batteries with full supervision.
- The charger on the ACPS may be disabled via a DIP switch. When disabled, a remote charger, for example a COH-120, may be used to battery-back multiple ACPS supplies.
- AC loss detection and AC loss delay reporting.
- Brownout detection.
- Power-limited outputs.
- Isolated Signaling Line Circuit (SLC) interface.
- Selectable ground fault detection.
- Canadian dual-stage operation.
- Two Class A/B and two Class B (Style Y) only.
- A total of five (or less) ACPS power supplies may be connected together to synchronize multiple power supplies (connect to any NAC output from one ACPS to sync signal input—single pair required).

INSTALLATION STANDARDS & CODES
The ACPS-2406 complies with the following standards:
- Underwriters Laboratories:
  - UL 864 Standard for Control Units for Fire Alarm Systems
  - CAN/ULC-S027-M87.
In addition, the installer should be familiar with the following standards:

NOTIFIER® is a Honeywell company.
This document is not intended to be used for installation purposes. We try to keep our product information up-to-date and accurate. We cannot cover all specific applications or anticipate all requirements. All specifications are subject to change without notice. For more information, contact NOTIFIER. Phone (203) 488-7161 FAX (203) 488-7118
12 Clintonville Road, Northford, Connecticut 06472

ISO 9001
Certification for Quality Systems

115 | Blanchat
Appendix B     Fire Suppression Systems

Fire Suppression System Plan Drawings
Fire Sprinkler System Most Remote Area
## Hydraulic Calculation for the Most Remote Area of the Building

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Nozzle Ident and Location</th>
<th>Flow in gpm</th>
<th>Pipe Size</th>
<th>Pipe Fittings and Devices</th>
<th>Equivalent Pipe Length</th>
<th>Friction loss (psi/ft)</th>
<th>Pressure Summary (psi)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S1</td>
<td>Q 20.4</td>
<td>1&quot;</td>
<td>L 9.83'</td>
<td>C=120</td>
<td>Pt 12.10</td>
<td>Pt+</td>
<td>q = k * (Pf/P1/2)</td>
</tr>
<tr>
<td>2</td>
<td>S2</td>
<td>Q 39.9</td>
<td>1 1/4&quot;</td>
<td>L 7.5'</td>
<td>C=120</td>
<td>Pt 13.32</td>
<td>Pt+</td>
<td>q = 5.6(13.32)*1/2</td>
</tr>
<tr>
<td>3</td>
<td>S3</td>
<td>Q 81.0</td>
<td>1 1/2&quot;</td>
<td>L 9.83'</td>
<td>C=120</td>
<td>Pt 14.24</td>
<td>Pt+</td>
<td>q = 5.6(14.24)*1/2</td>
</tr>
<tr>
<td>4</td>
<td>S4</td>
<td>Q 81.0</td>
<td>1 1/2&quot;</td>
<td>L 9.75'</td>
<td>C=120</td>
<td>Pt 15.49</td>
<td>Pt+</td>
<td>q = 5.6(15.49)*1/2</td>
</tr>
<tr>
<td>5</td>
<td>BL1-N</td>
<td>Q 81.0</td>
<td>3&quot;</td>
<td>L 11.00'</td>
<td>C=120.000</td>
<td>Pt 15.23</td>
<td>Pt</td>
<td>q = 16.97</td>
</tr>
<tr>
<td>BL2-N</td>
<td></td>
<td>Q 162.0</td>
<td>3&quot;</td>
<td>L 13.5'</td>
<td>C=120.000</td>
<td>Pt 20.29</td>
<td>Pt</td>
<td>q = 102.5</td>
</tr>
<tr>
<td>6</td>
<td>BL3-N</td>
<td>Q 264.5</td>
<td>3&quot;</td>
<td>L 29.33'</td>
<td>C=120.000</td>
<td>Pt 30.32</td>
<td>Pt</td>
<td>q = 106.0</td>
</tr>
<tr>
<td>7</td>
<td>NE-N</td>
<td>Q 264.5</td>
<td>2&quot;</td>
<td>L 11.92'</td>
<td>C=120.000</td>
<td>Pt 33.34</td>
<td>Pt</td>
<td>q = 115.92</td>
</tr>
<tr>
<td>M-N1</td>
<td></td>
<td>Q 264.5</td>
<td>2&quot;</td>
<td>L 7.17'</td>
<td>C=120.000</td>
<td>Pt 42.98</td>
<td>Pt</td>
<td>q = 47.07</td>
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<tr>
<td>M-N2</td>
<td></td>
<td>Q 264.5</td>
<td>4&quot;</td>
<td>L 48.75'</td>
<td>C=120.000</td>
<td>Pt 59.79</td>
<td>Pt</td>
<td>q = 115.92</td>
</tr>
</tbody>
</table>

**Q_{\text{Total}} = 264.5 GPM**

with hose = 514.5 GPM

**P_{\text{Total}} = 50.79 psi**
Hydraulic Calculation Friction Loss

\[ P = 4.52(Q)^{1.85} / C^{1.85} (d)^{4.87} = ____ \text{ psi/FT} \]

\[ Q = \text{flow GPM} \]

\[ C = \text{friction loss coefficient} \]

\[ d = \text{internal diameter (inches)} \]

1. \[ P = 4.52(19.5)^{1.85} / 120^{1.85} (1.049)^{4.87} = .124 \frac{\text{psi}}{\text{FT}} \]

2. \[ P = 4.52(39.9)^{1.85} / 120^{1.85} (1.380)^{4.87} = .123 \frac{\text{psi}}{\text{FT}} \]

3. \[ P = 4.52(61.0)^{1.85} / 120^{1.85} (1.610)^{4.87} = .127 \frac{\text{psi}}{\text{FT}} \]

4. \[ P = 4.52(81.0)^{1.85} / 120^{1.85} (3.068)^{4.87} = .215 \frac{\text{psi}}{\text{FT}} \]

5. \[ P = 4.52(162.0)^{1.85} / 120^{1.85} (3.068)^{4.87} = .990 \frac{\text{psi}}{\text{FT}} \]

6. \[ P = 4.52(264.5)^{1.85} / 120^{1.85} (3.068)^{4.87} = .083 \frac{\text{psi}}{\text{FT}} \]

7. \[ P = 4.52(264.5)^{1.85} / 120^{1.85} (3.068)^{4.87} = .083 \frac{\text{psi}}{\text{FT}} \]

8. \[ P = 4.52(264.5)^{1.85} / 120^{1.85} (3.068)^{4.87} = .083 \frac{\text{psi}}{\text{FT}} \]

9. \[ P = 4.52(264.5)^{1.85} / 120^{1.85} (2.067)^{4.87} = .568 \frac{\text{psi}}{\text{FT}} \]

10. \[ P = 4.52(264.5)^{1.85} / 120^{1.85} (4.026)^{4.87} = .022 \text{ psi/FT} \]
Distances used in Calculations:

<table>
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<tr>
<th>BL3→NE-N</th>
<th>NE-N→M-N1</th>
<th>M-N1→M-N2</th>
<th>M-N2→BOR</th>
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<tr>
<td>5'10”</td>
<td>4'10”</td>
<td>2’2”</td>
<td>13’9”</td>
</tr>
<tr>
<td>3’3”</td>
<td>11’</td>
<td></td>
<td>1’</td>
</tr>
<tr>
<td>9'5”</td>
<td>8’1”</td>
<td></td>
<td>8’</td>
</tr>
<tr>
<td>10’10”</td>
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<td>2’</td>
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</tr>
<tr>
<td>5’8”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2’3”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9’</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8’3”</td>
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<tr>
<td>9’10”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total: 29.33’</td>
<td>Total: 110.92’</td>
<td>Total: 2.17’</td>
<td>Total: 48.75’</td>
</tr>
</tbody>
</table>

BL = Branch Line
NE = Northeast
N = Node
M = Main
BOR = Base of Riser
Water Supply Graph

CAL POLY
Fire Protection Engineering

- 85 psi Static
- City Supply
- Sprinkler Demand 59.79 psi @ 264.5 gpm
- Total System Demand (Sprinkler + Hose Stream) 59.79 psi @ 514.5 gpm
- 65 psi Residual 1045 gpm

FLOW — GPM
Appendix C  Fire Drill Plan

This part of the report takes into account sections 38.7.2 and 4.7 of the Life Safety Code and section 405 of the International Fire Code with specific reference to section 405.5.

The intention of emergency egress and relocation drills is to educate the staff, students, and visitors of the buildings fire safety features, egress facilities, and procedures. This educational opportunity should be provided in a non-threatening manner in a form of practice. These drills are required to be performed annually for Group B occupancy classifications according to the IFC. More frequent drills can be used in order to ensure familiarization to all the occupants and to establish the drill as a matter of routine. Drills shall be held during both expected and unexpected times in order to simulate all situations. Local authorities shall be included in the drills design. During the drill the occupants need to be relocated to a predetermined location and remain at that location until a recall or dismissal signal has been given. The IFC requires records to be kept of required emergency evacuation drills and include the following information:

1. Identity of the person conduction 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
Appendix D  Emergency Evacuation Plan

Cal Poly’s Administration and Finance oversees the Campus Emergency Management division. This division is designed to aid the campus in a wide range of situations, one being fire. This document can be found online at any time to anyone. When a fire occurs, staff and students are expected to react but in slightly different ways. For someone who discovers or believes there is a fire, Cal Poly recommends the following actions take place:

- Activate the nearest fire alarm pull station.
- Feel doors for heat. If cool, exit carefully. If hot, do not open the door. Stay where you are until help arrives. If a telephone is available, call 911 and describe the emergency and your location. Place cloth material around the bottom of the door to prevent smoke from entering. Close as many doors as possible between you and the fire. Be prepared to signal from a window, but do not break glass unless necessary since outside smoke could enter your room.
- If caught in smoke, drop to your hands and knees and crawl as you exit. Hold your breath as long as possible. Breathe shallowly through your nose and use clothing as a filter.
- If you see fire, confine it by closing doors and windows.
- Start an orderly evacuation (even for small fires, a closed room can reach 1500 degrees within three minutes).
- From a safe location call 911 from a campus telephone.
- Use extinguishers on small fires only if it is safe to do so and when there is no personal risk. When operating a fire extinguisher, remember P-A-S-S: Pull the pin; Aim at the base of the fire; Squeeze the lever; Sweep from side to side.
- Never use an elevator during a fire.
- In laboratories, follow the fire safety training provided by the instructor or other department personnel.

If your clothing catches fire - STOP, DROP AND ROLL to extinguish the flames

*Taken from* [http://afd.calpoly.edu/emergency/specific_emergencies/fire.asp](http://afd.calpoly.edu/emergency/specific_emergencies/fire.asp)
A more detailed plan is also available to the public. This procedure edited from Cal Poly’s generic in order to try and achieve a complete evacuation of Building 41 in case of a fire related emergency or an alarm being activated. This plan strives to maintain a basic set of objectives. To ensure everyone exits the building in a safe manner, even if some of the people are not able to use stairs. After the egress of the building a designated coordinator ensures that everyone in the building has exited and been accounted for while meeting the objectives set forth in the following procedure.

Policy

This procedure focuses on building evacuation for fire emergencies; however, 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 (toxic levels that threaten human life)  
e. Contamination of the air in a building.  
f. Emergencies related to weather (flood, severe storm, severe wind)  
g. If the earthquake causes structural damage or creates a secondary hazard such as flooding, release of hazardous materials, exposed electrical, or any other life threatening situations, then evacuation is recommended.

The Plan will be kept up to date, along with conducting evacuation drills annually or as often as required in order to learn the appropriate plan of action during an emergency. Drills are to be held at both expected and unexpected times in order to simulate an actual emergency situation.
Building Evacuation Procedure

1. When an emergency alarm is activated staff/students/visitors are expected to evacuate immediately. The occupants need to proceed to the predetermined assembly points located away from the building or do a designated safe zone in the building.

2. Staff and students are responsible for visitors and making sure they follow the evacuation procedures and egress the building at the same time.

3. Faculty members should dismiss their classes and direct students to exit the building via the shortest path or to an area of refuge. This should be done immediately following an alarm or notification of an emergency.

4. Critical operations shall be shut down by appointed personal while the evacuation is underway. They are responsible for recognizing and determining when to abandon their duties and proceed to evacuate safely.

5. Contract workers shall be educated in the procedures and understand to evacuate the building when an alarm sounds.

Evacuation Instructions

These instructions should serve as a guide outlining how to react in case of an emergency or the sounding of an alarm:

1. Stay Calm
2. Do not ignore alarm and listen for the announcement of evacuation directions.
3. Exit the building. This should be done immediately and in an orderly fashion.
4. Use stairways to exit the building, not elevators.
5. Dismiss classes in session and instruct students to exit the building immediately.
6. Follow quickest evacuation route from where you are (Evacuation diagrams/maps are posted near exit doors).
7. Do not go back to your office or classroom for any reason
8. Proceed to an emergency assembly point.
9. If you have any knowledge of missing occupants or conditions that could be helpful to responders, report to the coordinator in charge of the building.
10. Return to the building only after emergency personnel have given the all-clear signal. Turning off of the alarm does signal the end of the emergency.

Emergency Evacuation Personnel

1. Building Coordinators/alternates should be regular employees selected and trained to ensure:
   - Building evacuation is carried out as planned.
   - Evacuated building occupants are directed to assigned assembly points outside the building where they will be accounted for.
   - Occupants needing assistance to evacuate are accommodated.

2. Building Coordinators/alternates are selected on a voluntary basis from among building occupants.

3. Building Emergency Evacuation personnel and their corresponding duties follows:

   Building Coordinators
   - Maintain an updated list of all occupants.
   - Make sure the emergency evacuation plan is understood by employees of your immediate work area.
   - Help/instruct your work area occupants to exit the building when an alternative form of emergency notification sounds separate of a building fire alarm.
   - Inform occupants to immediately report to their designated assembly point.
   - Occupants with limited mobility should be assisted down stairs if stairways are a capable option.
   - Never put yourself in danger. Exit the building as soon as possible and go to the assigned assembly area.
   - From the occupant list, check off co-workers as they arrive to assembly area.
   - Collect information on missing occupants, and report to responding University Police representatives.
   - Complete Building Assessment Form, if applicable

   University Police / SLO City Fire

   - Collect information on missing occupants from the Building Coordinators.
   - Meet off-campus emergency responders (fire, medical, etc.) and aid with directions to the building/emergency area.
• Report information on occupants needing evacuation assistance 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.

This detailed procedure can be found in the fire safety section at: http://afd.calpoly.edu/ehs/firesafety.asp
Appendix E  FDS Input Files

Scenario 1

Building 41 - Scenario 1.fds

&HEAD CHID='Building_41_-_Scenario_1'/
&TIME T_END=450.0/
&DUMP RENDER_FILE='Building_41_-_Scenario_2.ge1', DT_RESTART=10.0/

RoomFire.restart /
&MISC RESTART=.FALSE. /

&MESH ID='Mesh 1', IJK=140,60,46, XB=-28.0,0,0,73.0,85.0,0,0,9,2, MPI_PROCESS=0 /
&MESH ID='Mesh 2', IJK=140,60,46, XB=-56.0,-28.0,73.0,85.0,0,0,9,2, MPI_PROCESS=1 /

&BNDF QUANTITY='WALL TEMPERATURE'/
----------------------------------- DEVICES -----------------------------------------------

&PROP ID='Default01_SprayMod01',
 QUANTITY='SPRINKLER LINK TEMPERATURE',
 ACTIVATION_TEMPERATURE=68.0,
 RT=80.0,
 PART_ID='Water_PART',
 FLOW_RATE=1.0,
 DROPLET_VELOCITY=5.0/

&DEV IC ID='SPRK', PROP_ID='Default01_SprayMod01', XYZ=-41.7786,82.3314,4.2/

&SPEC ID='WATER VAPOR'/

&PART ID='Water_PART',
 SPEC_ID='WATER VAPOR',
 DIAMETER=500.0,
 MONODISPERSE=.TRUE.,
 COLOR='BLUE',
 AGE=60.0/

------------------------------------- REACTIONS ------------------------------------------

&REAC ID='POLYURETHANE_REAC',
 FYI='SFPE HANDBOOK 4th Ed, FLEXIBLE GM23, TABLE 3-4.16',
 FUEL='REAC_FUEL',
 C=1.0,
 H=1.8,
 O=0.35,
 N=0.06,
 CO_YIELD=0.031,
 SOOT_YIELD=0.024/ (Average soot yields from SFPE HB 4th Table 3.4.16 = .188 x .125 because 12.5% of couch would be burning in first 60 seconds before the sprinkler activates = .0235 round up ~ .024)

--------------------- FIRE -------------------------------

&SURF ID='BURNER',
 FYI='F32 SOFA F32 Sofa HRR (SFPE Hb Figure 3-1.52)
 COLOR='RED',
 HRRPUA=440.5,
 RAMP_Q='FIRE' / (3000HRR then 3000/6.81Surface Area=440.5)

&RAMP ID='FIRE' T=0.0, F=0.00 /
&RAMP ID='FIRE' T=10.0, F=0.01 /
&RAMP ID='FIRE' T=20.0, F=0.02 /
&RAMP ID='FIRE' T = 30.0,  F=0.06 /
&RAMP ID='FIRE' T = 40.0,  F=0.10 /
&RAMP ID='FIRE' T = 50.0,  F=0.16 /
&RAMP ID='FIRE' T = 60.0,  F=0.17 /
&RAMP ID='FIRE' T = 450.0,  F=0.17 /

-------- OBSTRUCTIONS -------------------------------

&OBST XB=55.5,54.1,80.0,80.1,4,4,4,6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
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Scenario 2

Building 41 - Scenario 2.fds

REACT ID='CELLULOSE', FYI='SFPE HB Table 3-4.16',
FUEL='REAC_FUEL',
C=6.0,
H=10.0,
O=5.0,
N=0.0,
SOOT_YIELD=0.015/(Table 3.16 SFPE HB 4th Ed for Wood (red oak))

&SURF ID='BURNER',
FYI='Storage Units (Fig. 3-1.15 SFPE HB 4th Ed)',
COLOR='RED',
HRRPUA=115,
RAMP_Q='BURNER_RAMP_Q'/(1000x2=2000HRR then 2000/8.7Surface Area=229.89/2=114.9)

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&RAMP ID='BURNER_RAMP_Q', T=50.0, F=0.03/
&RAMP ID='BURNER_RAMP_Q', T=100.0, F=0.05/
&RAMP ID='BURNER_RAMP_Q', T=150.0, F=0.1/
&RAMP ID='BURNER_RAMP_Q', T=200.0, F=0.2/
&RAMP ID='BURNER_RAMP_Q', T=250.0, F=0.6/
&RAMP ID='BURNER_RAMP_Q', T=300.0, F=1.0/
&RAMP ID='BURNER_RAMP_Q', T=350.0, F=0.6/
&RAMP ID='BURNER_RAMP_Q', T=375.0, F=0.2/
&RAMP ID='BURNER_RAMP_Q', T=400.0, F=0.0/

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| &amp;OBST XB=| 32.2, 31.5, 79.9, 80.0, 0.0, 0.2, 4.6, COLOR='GRAY 60', SURF_ID='INERT' | Obstruction |
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| &amp;OBST XB=| 28.6, 27.0, 79.9, 80.0, 0.0, 0.0, 2, | COLOR='GRAY 60', SURF_ID='INERT' | Obstruction |
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&OBST XB=-10.8,-10.4,80.2,82.4,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-10.8,-10.2,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-10.4,-9.8,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-10.8,-9.6,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
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&OBST XB=-8.2,-8.4,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-7.6,-7.6,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-7.2,-7.2,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-6.8,-6.4,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-6.4,-6.0,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
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&OBST XB=-5.6,-5.2,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-5.2,-4.8,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-4.8,-4.4,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-4.4,-4.0,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-3.8,-3.4,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-3.2,-2.8,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-1.8,-1.2,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-1.0,-0.4,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-0.8,-0.0,80.0,81.2,4.6,6.2, COLOR='GRAY 60', SURF_ID='INERT' / 2nd Story Walls
&OBST XB=-0.8,-0.0,79.9,80.4,2.0,2.0, SURF_ID='BURNER' / Cab 1
&OBST XB=-11.6,-11.6,79.9,80.4,2.0,2.0, SURF_ID='BURNER' / Cab 2

&HOLE X8=-8.8,-1.8,77.8,80.4,4.4,4.6/ Hole
&VENT SURF_ID='OPEN', MB='ZMAX', COLOR='INVISIBLE'/ Vent
&VENT SURF_ID='OPEN', MB='YMIN'/ Vent02
&VENT SURF_ID='OPEN', MB='XMIN'/ Vent03
&VENT SURF_ID='OPEN', MB='XMAX'/ Vent04
&VENT SURF_ID='OPEN', MB='YMAX'/ Vent05

&SLCF QUANTITY='TEMPERATURE', PBY=79.0/
&SLCF QUANTITY='PRESSURE', PBY=79.0/
&SLCF QUANTITY='VISIBILITY', PBY=79.0/
&SLCF QUANTITY='TEMPERATURE', PBX=-41.7786/
&SLCF QUANTITY='VISIBILITY', PBX=-41.7786/
&SLCF QUANTITY='MASS FRACTION', SPEC_ID='OXYGEN', PBY=79.0/

--- END -----------------------------------------------

&TAIL /