Fire and Life Safety Analysis

Grant M. Brown Engineering Building #41

California Polytechnic State University, San Luis Obispo

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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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2 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.

Table of Contents

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.

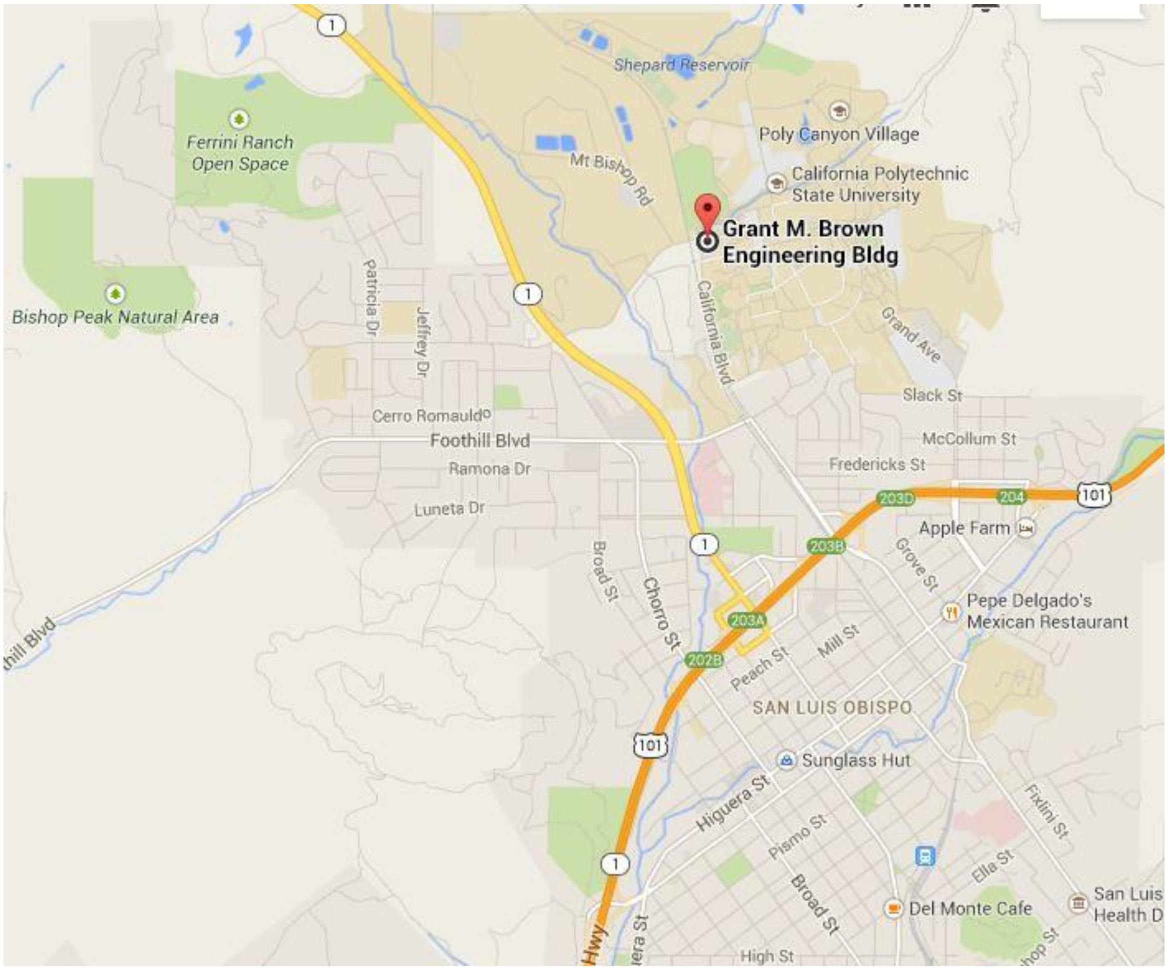


Figure 1: Map of San Luis Obispo, CA

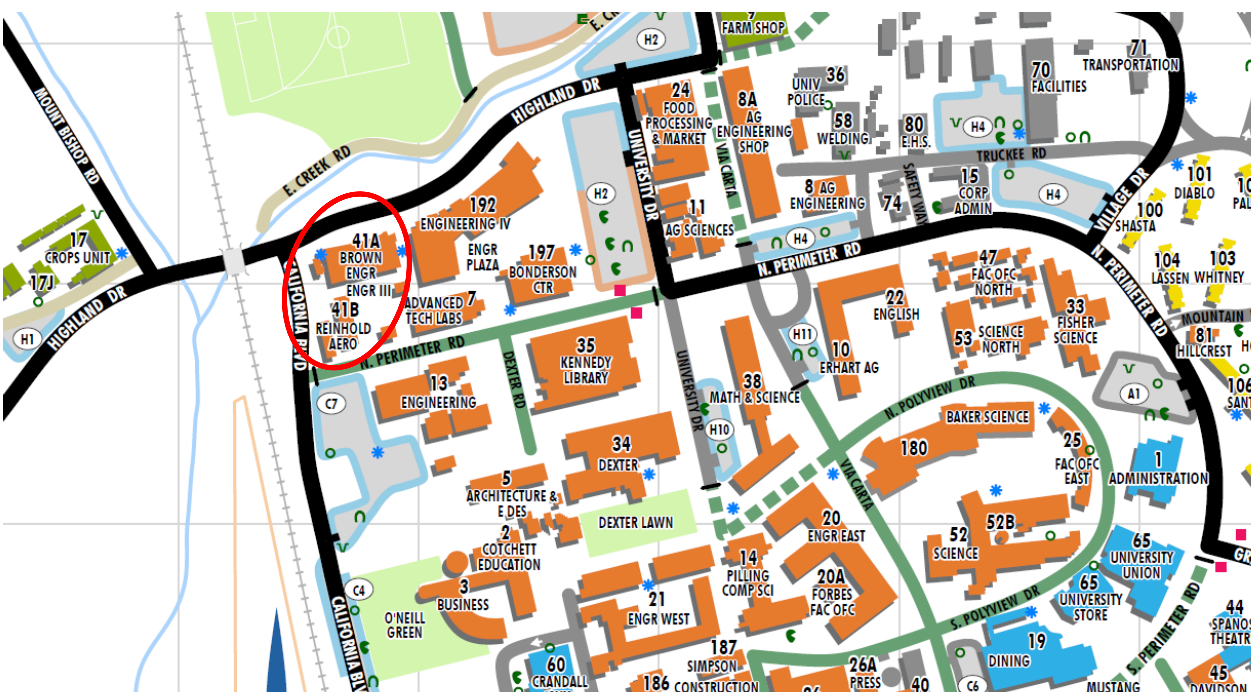


Figure 2: Location on Campus

5 Applicable Codes and Standards

Used During Construction

- Building Standards Administrative Code – 2001 Edition
- California Building Code – CBC 2001 Edition
- California Plumbing Code – CPC 2001 Edition
- California Mechanical Code – CMC 2001 Edition
- California Fire Code – CFC 2001 Edition
- California Electrical Code – CEC 2001 Edition
- Energy Efficiency Standards – 2001 Edition
- National Electrical Code – NEC 2001 Edition
- NFPA 13: Automatic Sprinkler Systems – 1996 Edition
- NFPA 72: National Fire Alarm Code – 1999 Edition

6 Current Codes and Standards Applied for Analysis

Used For Analysis

- California Building Code – CBC 2010 Edition
- California Plumbing Code – CPC 2010 Edition
- California Mechanical Code – CMC 2010 Edition
- California Fire Code – CFC 2010 Edition
- California Electrical Code – CEC 2010 Edition
- International Building Code (IBC) – 2012 Edition
- NFPA Fire Protection Handbook – 20th Edition
- NFPA 13: Automatic Sprinkler Systems – 2013 Edition
- NFPA 72: National Fire Alarm Code – 2010 Edition
- NFPA 101: Life Safety Code (LSC) – 2012 Edition
- SFPE Handbook of Fire Protection Engineering – 4th Edition

7 Building Overview

Figure 3: First Floor Layout

7 Building Overview

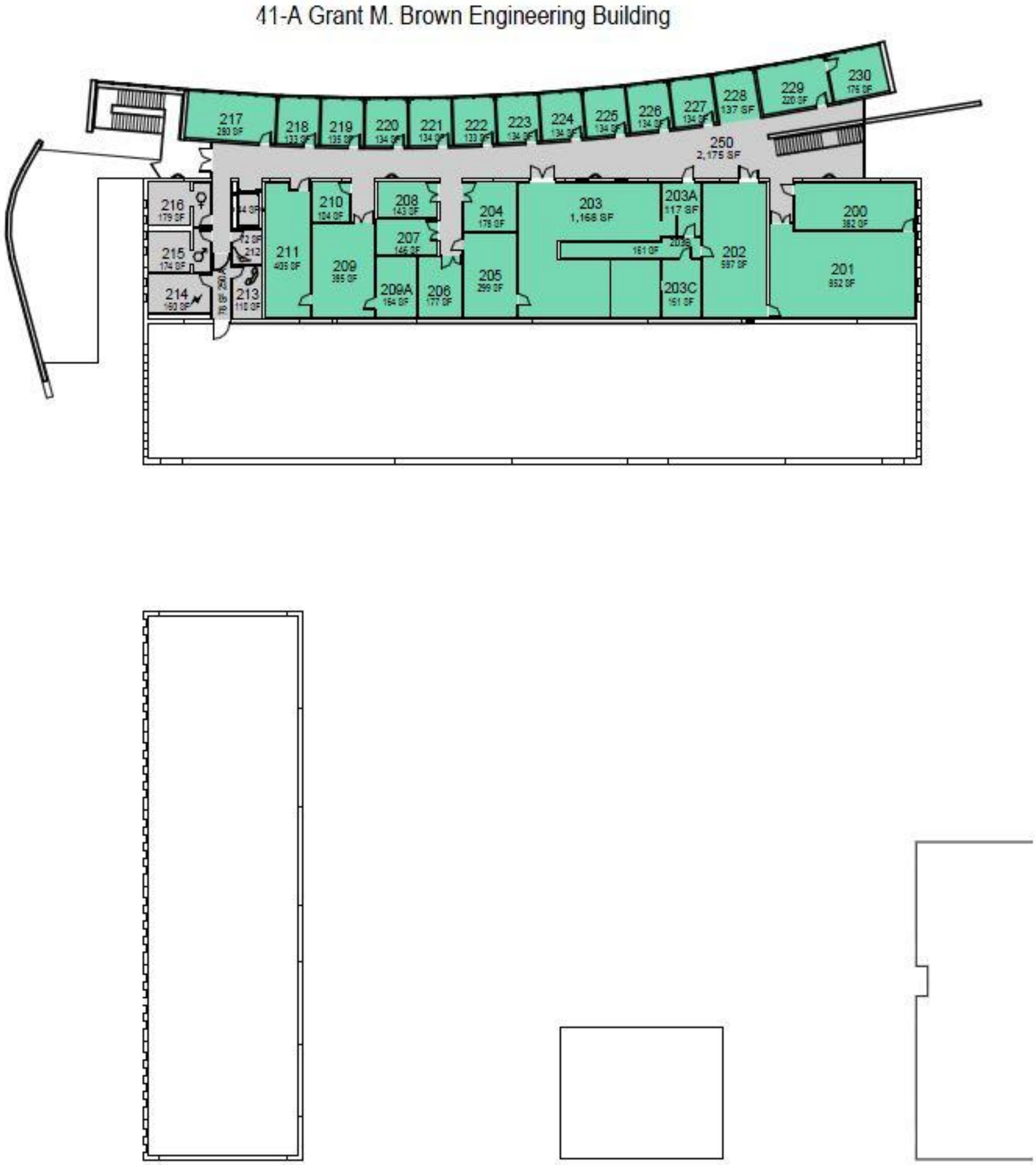


Figure 4: Second Floor Layout

7 Building Overview

Gross Floor Area

Table 1: Gross Floor Area

First Floor Buildings	Gross Floor Area in Square Feet (SF)
Building ‘A’	19,348 SF
Building ‘B’	5, 869 SF
Building ‘C’	1,314 SF
Total:	26, 531 SF

Second Floor Buildings	Gross Floor Area in Square Feet (SF)
Building ‘A’ Only	11,827 SF
Total:	11,827 SF

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 2: Building Square Footage	
Building Level	**Gross Square Footage (G.S.F.)**
Building A, Level 1	19,348 SF
Building A, Level 2	11,827 SF
Building B	5,869 SF
Building C	1,314 SF
TOTAL:	38,358 SF

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 instillation.

Type II-B, Business Occupancy

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

	Actual	**Allowable**	**Adjusted (Sprinklered)**	**Passes**
Building Height	45’	55’	75’	Yes
Area	19,348 SF	23,000 SF	86, 250 SF	Yes
# of Stories	2	4	5	Yes

7.4 Frontage Increase

I_f = [F/P - 0.25]W/30

I_f = Area increase due to frontage

F = 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 x I_f] + [A_t x 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 x 0.75) + (A_t x 2)

A_a = A_t (1 + 0.75 + 2)

A_a = 3.75A_t

A_a = 86,250 SF

7.6 Adjusted Values for Table 503 from the IBC 2012.

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

TABLE 503
ALLOWABLE BUILDING HEIGHTS AND AREAS[a]
Building height limitations shown in feet above grade plane. Story limitations shown as stories above grade plane.
Building area limitations shown in square feet, as determined by the definition of "Area, building," per story

		TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
	HEIGHT(feet)	UL	160	65	55	65	55	65	50	40
GROUP		STORIES(S) AREA (A)								
A-1	S	UL	5	3	2	3	2	3	2	1
	A	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
A-2	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-3	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-4	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-5	S	UL	UL	UL	UL	UL	UL	UL	UL	UL
	A	UL	UL	UL	UL	UL	UL	UL	UL	UL
B	S	UL	11	5	3	5	3	5	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
Adjusted B	S	UL	12	6	4	6	4	6	4	3
	A	UL	UL	140,625	86,250	106,875	71,250	135,000	67,500	33,750
	Height	UL	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.

Figure 5: East Side Doors

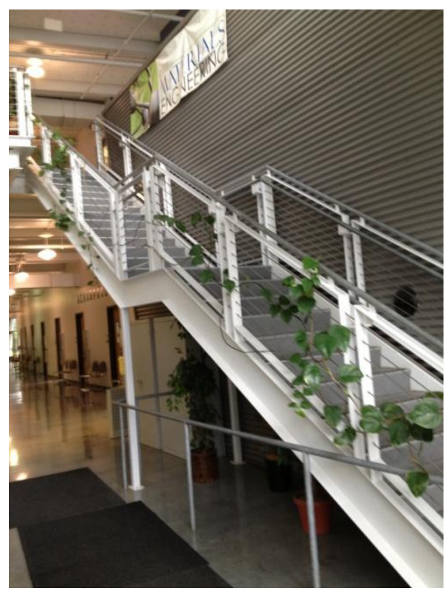


Figure 6: East Side Stairs

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.

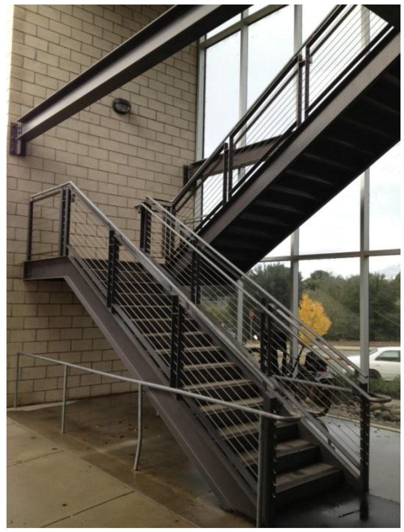


Figure 7: West Side Stairs

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

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

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

Occupancy Classification and Loading Factors per NFPA 101	
Use	Load Factor (ft^2/Person)
Offices (Business)	100
Laboratories (Educational)	50
Conference Room (Assembly less Concentrated)	15
Storage (S-1)	300
Storage (S-2)	300
Bathrooms	0
Walkways	0

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

Table 7: First Floor - Calculated Occupant Load

Building 1st Floor	**Usage**	**Gross Floor Area**	**OLF**	**Occupant Load**
Building A	Offices	1,870 SF	100	19
	Laboratories	12,833 SF	50	257
	Conference Rm.	296 SF	15	20
	Storage (S-1)	1,133 SF	300	4
	Storage (S-2)	394 SF	300	2
	Bathrooms	614 SF	0	0
	Walkways	2,208 SF	0	0
Building B	Laboratories	5,741 SF	50	115
	Storage (S-2)	128 SF	300	1
Building C	Laboratories	1,314 SF	50	27
		Total: 26,531 SF		Total: **445 People**

Table 8: First Floor – Calculated Exit Capacity

Exit	Width (inches)	Capacity Factor (in/person)	Capacity (persons)	Notes
East Main Lobby Doors	72	.2	360	2 doors @ 36 in
West Main Lobby Doors	72	.2	360	2 doors @ 36 in
Room-Double Doors	144	.2	720	4 doors @ 36 in
Room-Single Doors	36	.2	180	1 doors @ 36 in
Total:			1620 People	
Total People Required from OLF Calculations:			445 People	Passes: YES

Table 9: Second Floor - Calculated Occupant Load

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

Table 10: Second Floor – Calculated Exit Capacity

Exit	Width (inches)	Capacity Factor (in/person)	Capacity (persons)
East Stairs	48	.3	165
West Stairs	48	.3	165
Total:			330 People
Total People Required from OLF Calculations:			142 People Passes: YES

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:

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

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

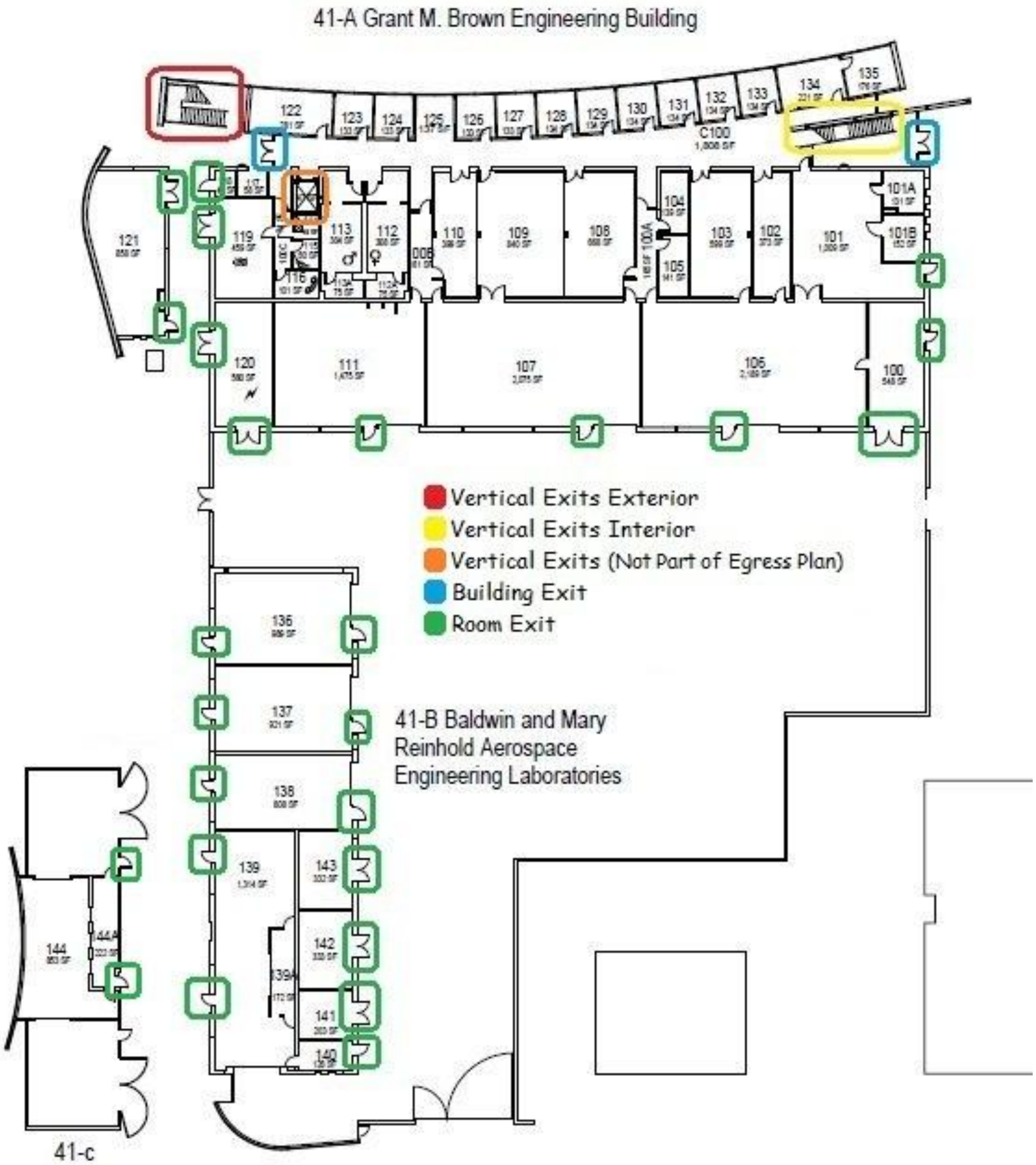
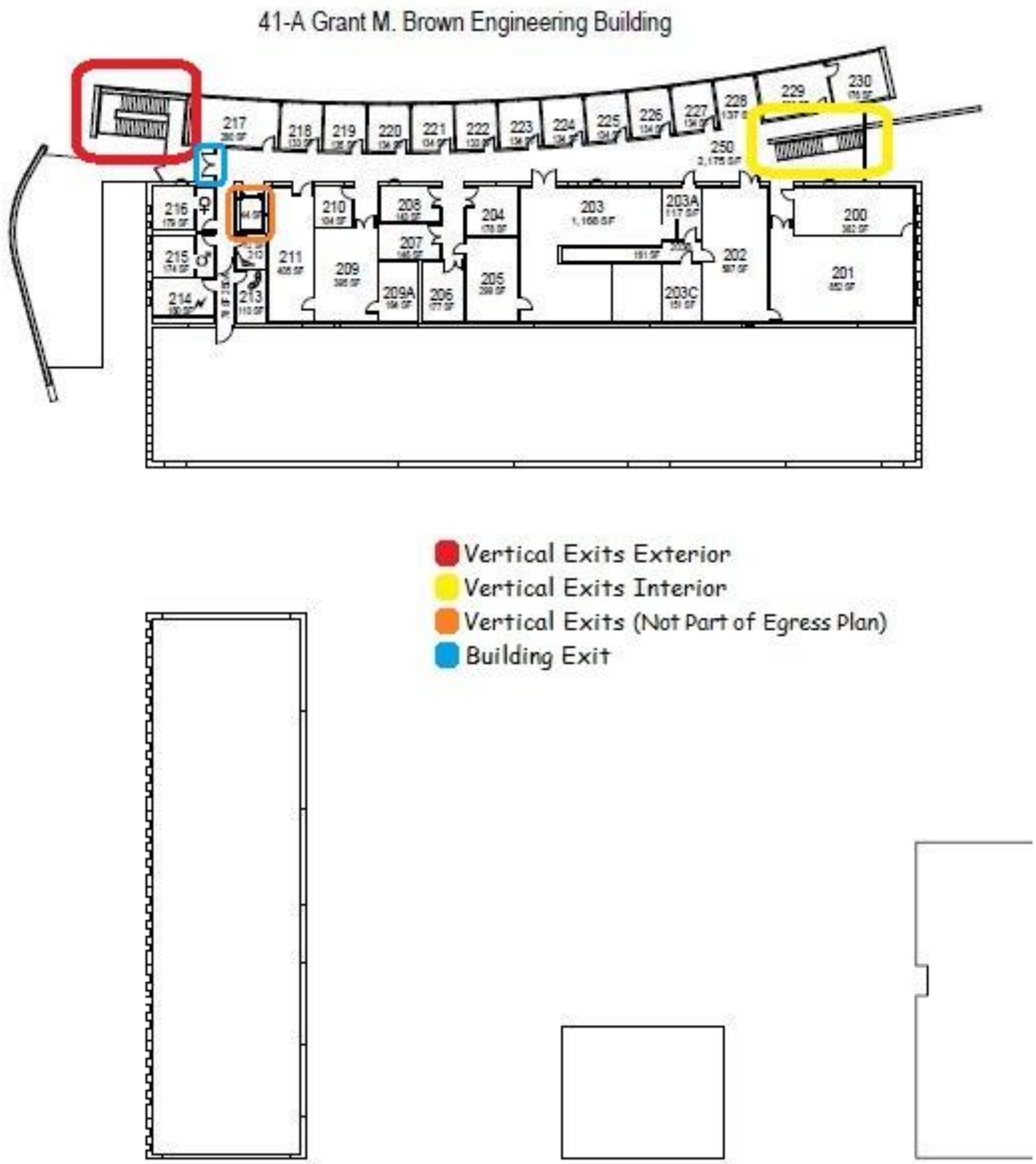


Figure 9: Exits and Stairs – Level 2



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.

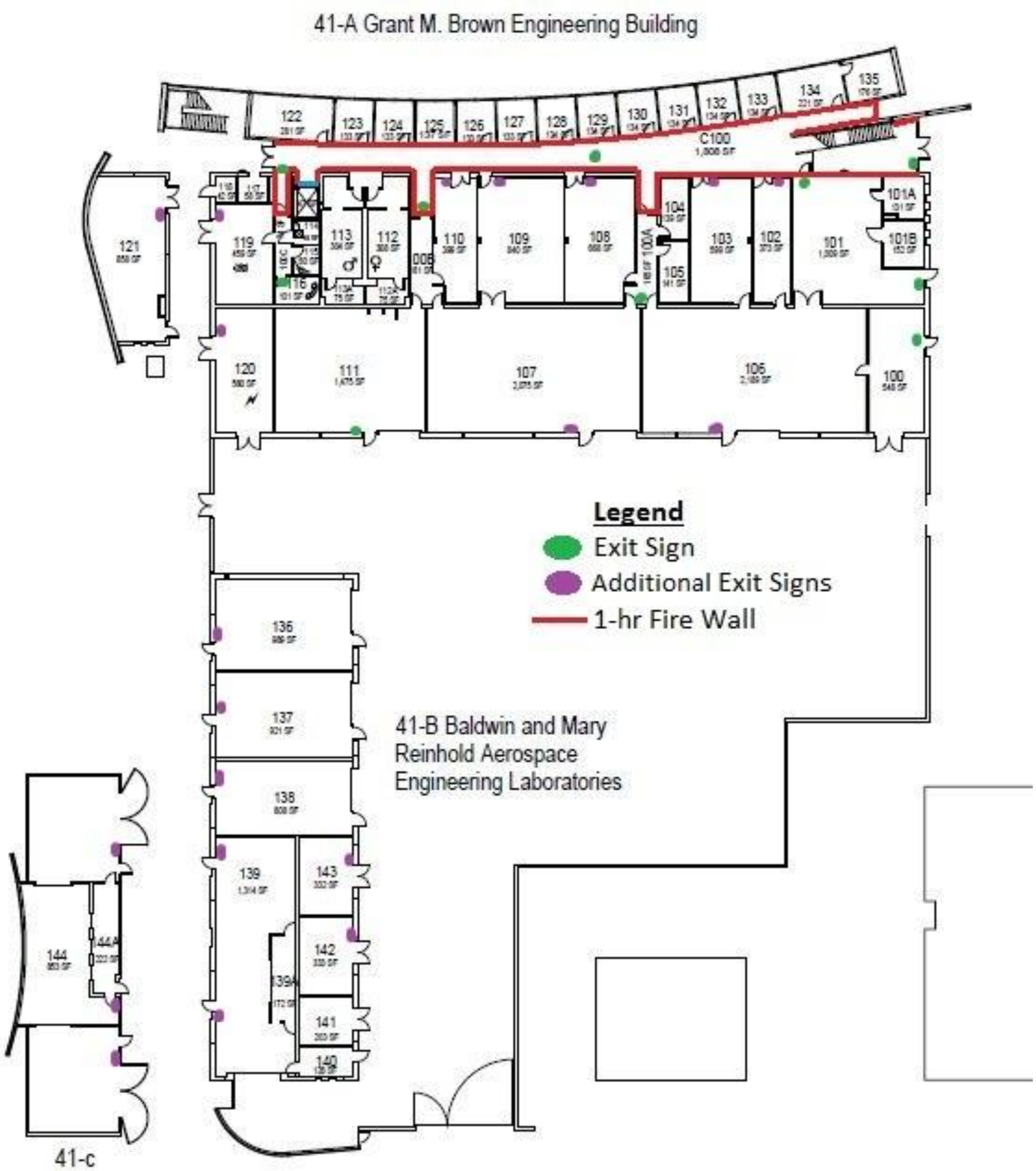
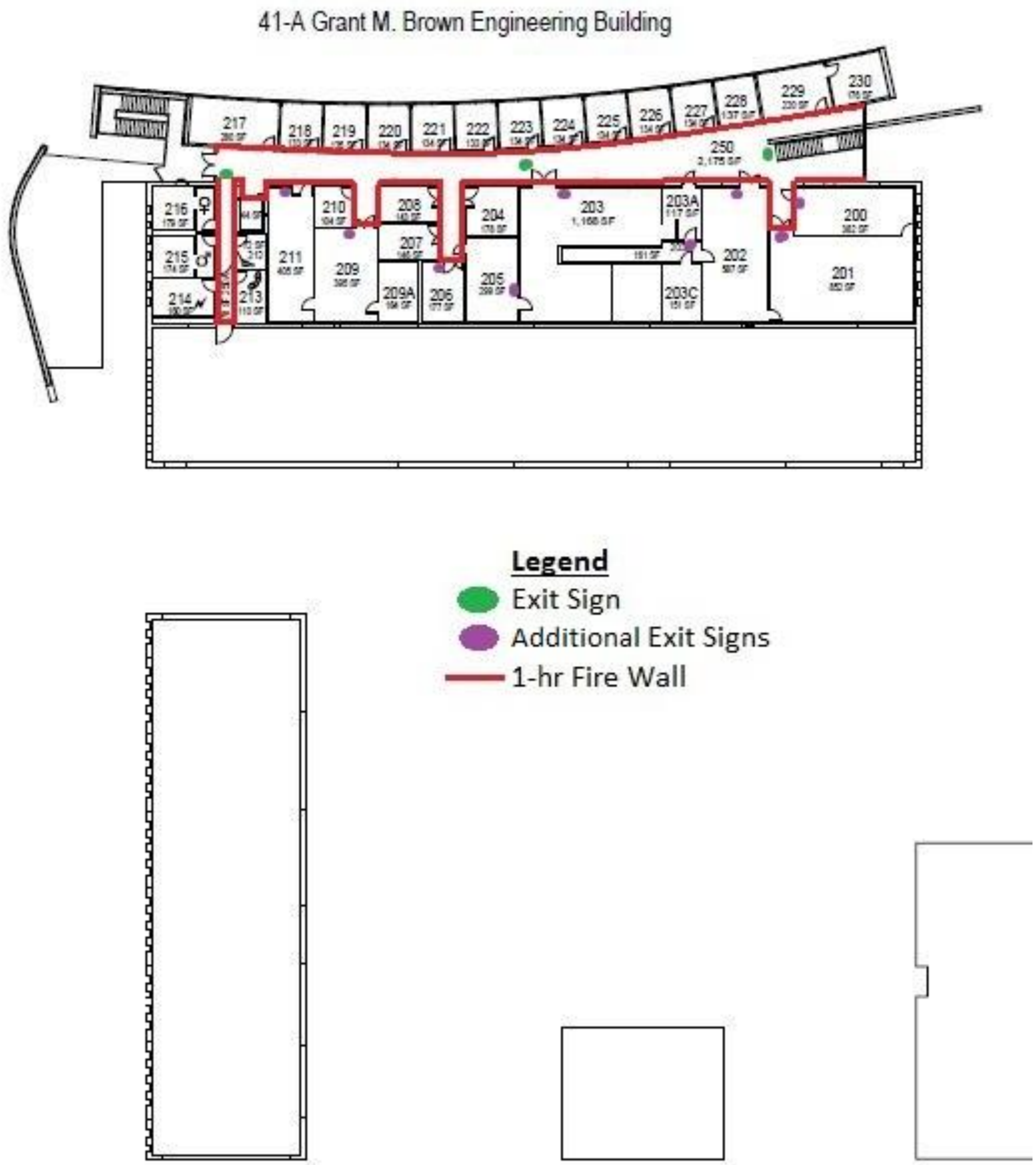


Figure 10: Horizontal Exits & Exit Signs – Level 1

Figure 11: Horizontal Exits & Exit Signs – Level 2



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)

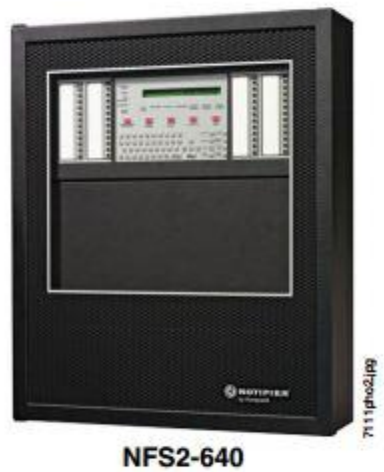


Figure 12: NFS2-640

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

FACP - Notifier NFS2-640 *Specifications:*	http://www.notifier.com/products/facp/Pages/notifier-nfs2-640-control-panel.aspx
Signaling Line Circuits (SLCs)	1 expandable to 2; Style 4, 6, or 7
Intelligent Devices	636 Total Devices 159 Detectors/159 Modules Per SLC
Notification Appliance Circuits (NACs)	4 (Built in); 1.5 amps ea.
Voice Evacuation Available	Yes: w/ integrated Digital Voice Command
Power	6 amps Total System Power
Annunciators	32 LCD Type 32 ACS Type
Networkable	Yes: NOTI-FIRE-NET

8.2.1.2 Smoke Detectors

NOTIFIER FSP-751

WIRING DIAGRAMS

Figure 13: FSP-715T with B710LP

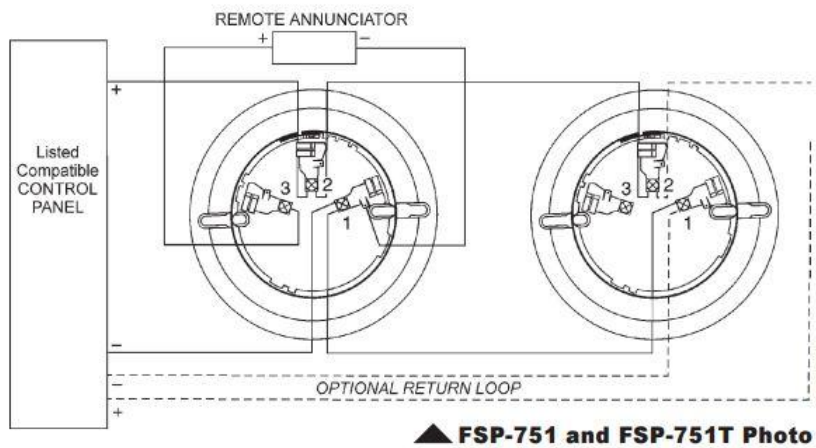


Figure 14: FSP-751 & FSP-751T

Specifications:

Table 12: NOTIFIER FSP-751

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

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

- Electrical Room
- Mat. Eng. Lab & Test area (2nd floor)

8.2.1.3 Heat Detectors

NOTIFIER FST-751

Figure 15: FST-751

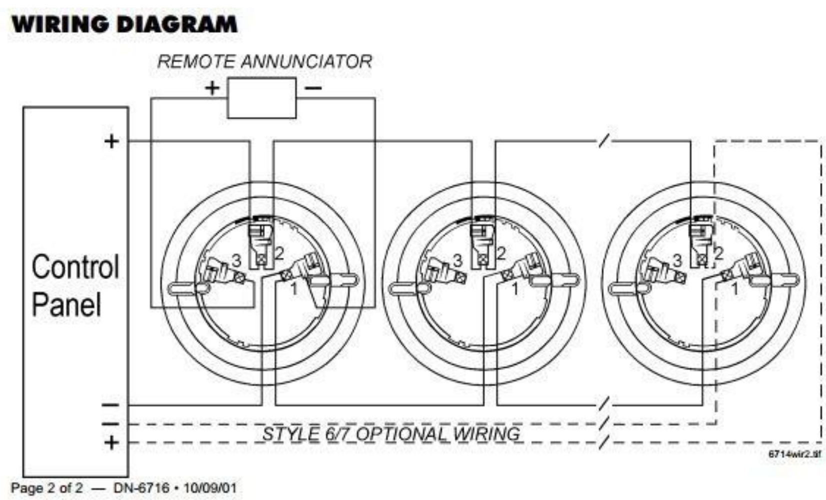


Figure 16: FST-751 Wiring Diagram

Specifications:

Table 13: FST-751

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

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 shwn 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)*

- Elevator Shaft (2nd floor)
- Machine Room (1st floor)

8.2.1.4 Duct Detectors

NOTIFIER FSD-751P

Figure 17: FSD-751P

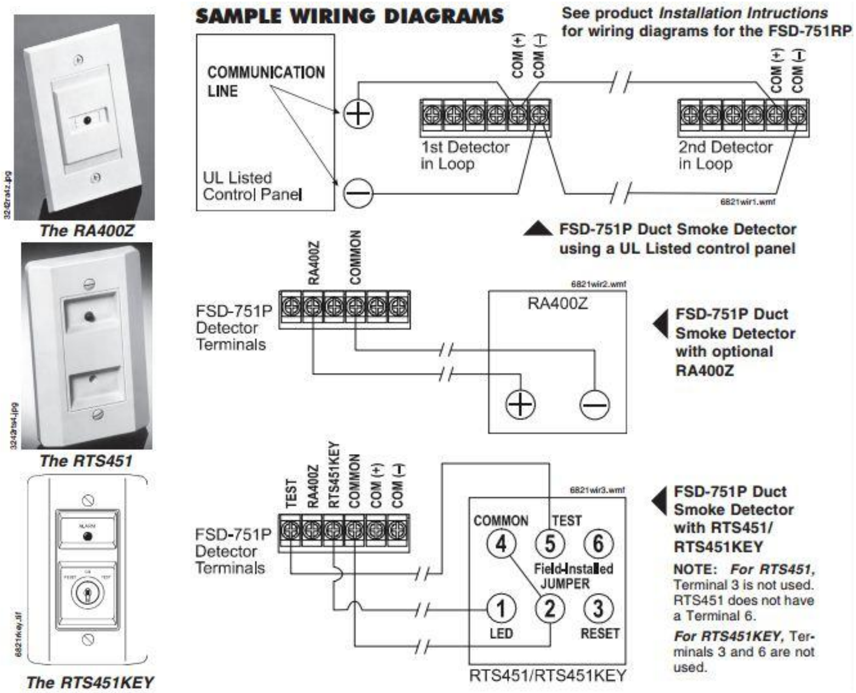


Figure 18: FSD-751P Wiring Diagram

Specifications:

Table 14: FSD-751P Specifications

Operating Voltage Range	15-32 VDC
Standby Current	300µA @ 24 VDC (one communication every 5

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

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

Specifications:

Table 15: NBG-12LX Specifications

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

For this building, 19 Notifier NBG-12LX Addressable Manual Pull Stations were installed. This is a dual-action pull station. Dual-action means that is takes 2 solid motions in order for the station to sends an 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.

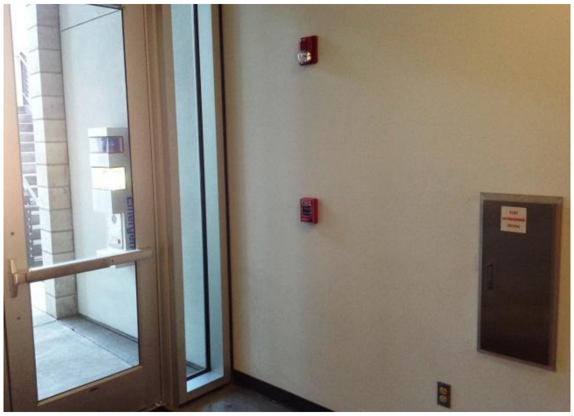


Figure 20: Manual Pull Station in Hall

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

Visual

Audio/Visual

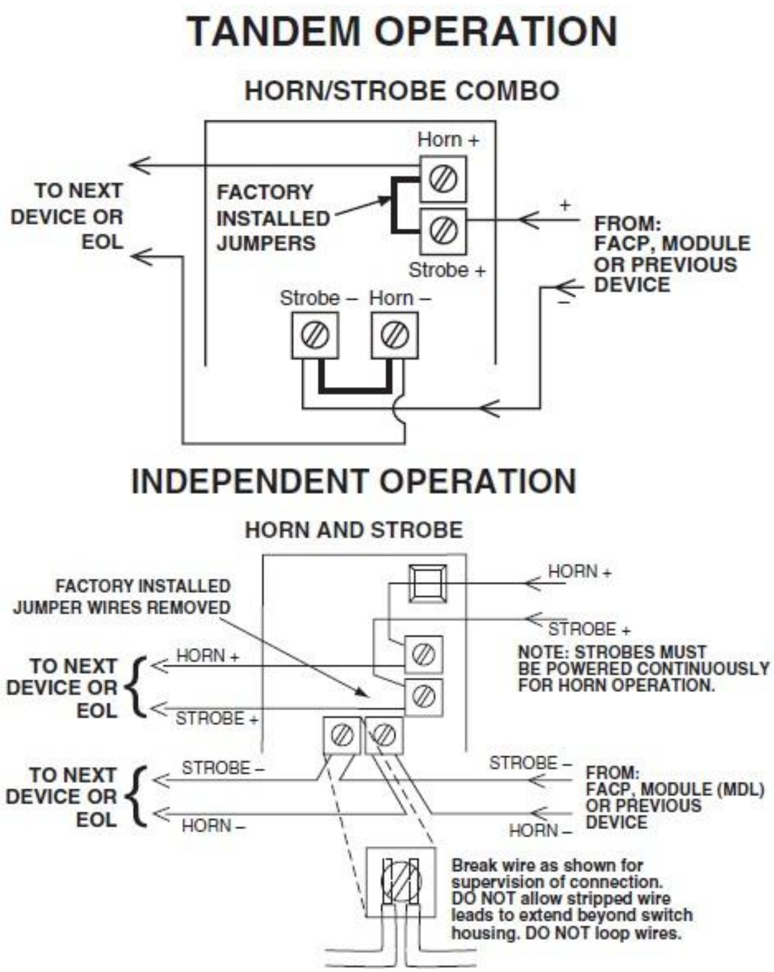


Figure 21: System Sensor P241575 & S241575

Specifications: System Sensor P241575 & S241575

Table 16: System Sensor P241575 & S241575

Horn Voltage	10.5-30 Volts
Strobe & Horn/Strobe Voltage	12-volt models – 10.5 to 17 volts; 24-volt models – 20 to 30 volts
Strobe & Horn/Strobe Voltage(with MDL module)	12-volt models – 11 to 17 volts; 24-volt models – 21 to 30 volts
Flash Rate	1 Flash Per Second
Operating Temperature Range	0° to 49°C (32° to 120°F)

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

Horn, Strobe, & Horn/Strobe Voltage	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
Operating Humidity Range	10% to 93% Relative Humidity, noncondensing
Flash Rate	1 Flash Per Second
Operating Temperature Range	0° to 49°C (32° to 120°F)
Selectable Light Outputs	All candelas are selectable via a manual slide switch.
12/24 Volt Applications	15 or 15/75 Candela
24 Volt Application	30, 75, 110 candela 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 S5512 (Strobe); UL S4011 (Combo)
Notes	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.

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.

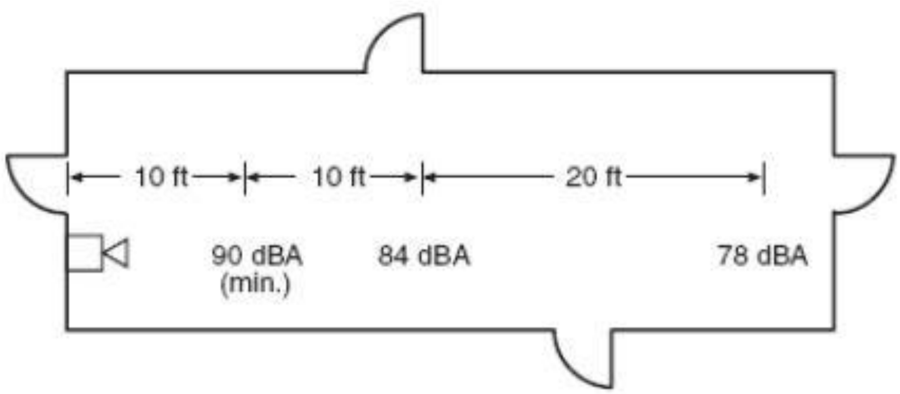


FIGURE 14.3.1 Example of 6 dBA Rule (1 ft = 0.305 m)

Figure 22: dBA Rule

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

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: -400C to 700C (-400F to 1580F)
- 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*

10. Public Emergency Alarm Reporting System Wired System – *Daily*
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*

    l. 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)
28. Public Emergency Alarm Reporting System Transmission Equipment – *Semiannually & Annually*
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

Cal Poly – Witnessed by Bruce Bjornson of Hoffman and Associates			
Test Hydrant ID:	**#29**	Date of Test:	**1/31/02**
Hydrant Elevation:	**0 ft**	Static Pressure:	**85.00 psi**
Test Flow:	**1045.00 gpm**	Test Residual Pressure:	**65.00 psi**
Calculated System Flow Rate:	**576.75 gpm**	Calculated Inflow Residual Pressure:	**57.87 psi**
Available Inflow Residual Pressure:	**78.34 psi**		

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 24: Building A Riser

Figure 25: Building B Riser

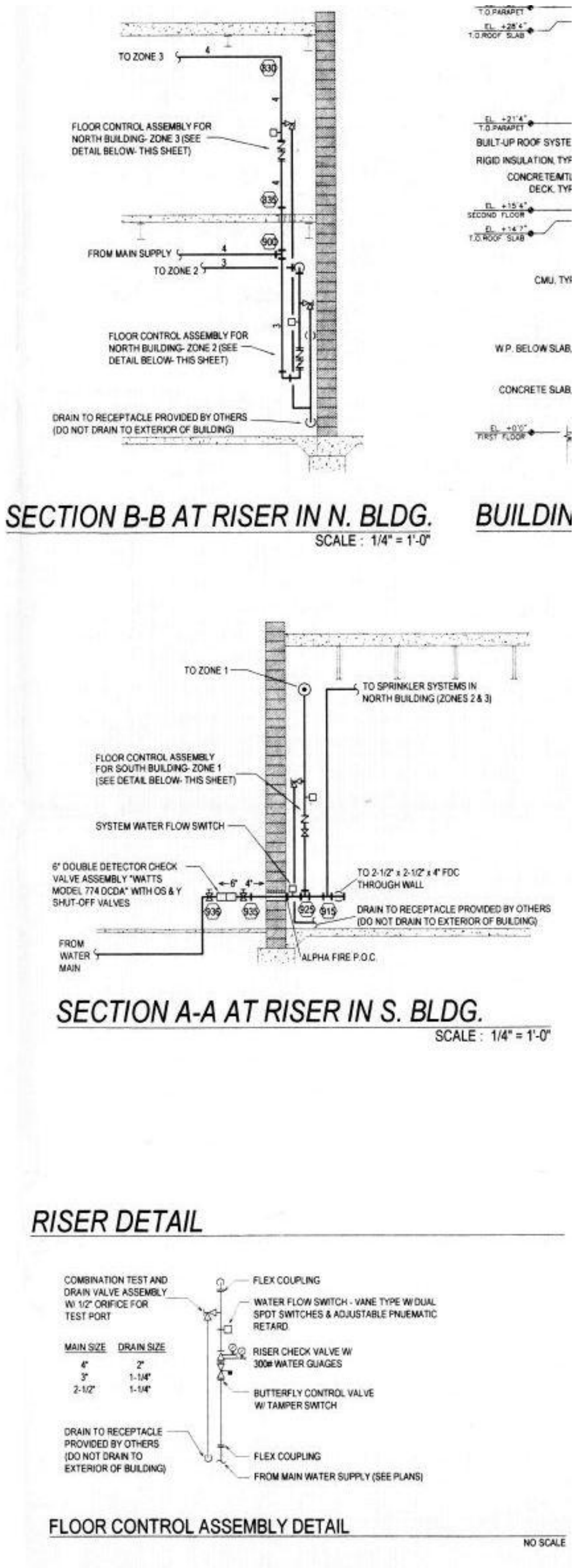


Figure 26: Riser Diagram

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/Escut.: **Brass/White**
   III. Number of Sprinklers: **8**
   IV. Orifice: **½ Inch**
   V. K Factor: **5.6**
   VI. Type: **Concealed Sprinkler Pendent (CSP)**

Bracing:

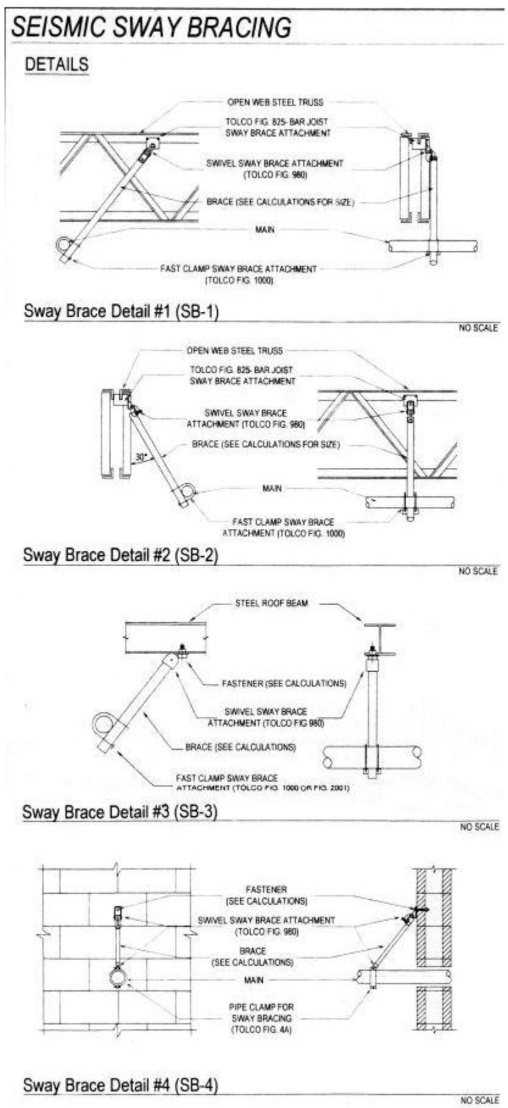


Figure 27: Bracing Diagram

Pipe Hangers:

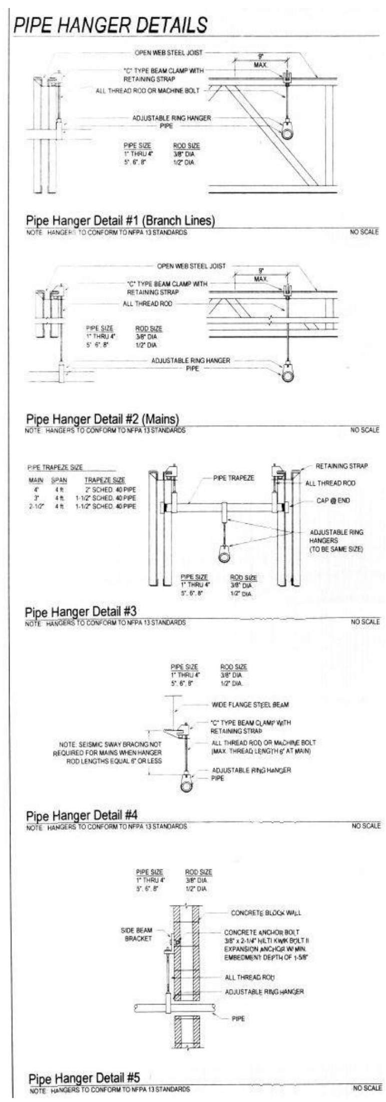


Figure 28: Pipe Hangers Diagram

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 waterflow, 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)

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

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

	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
BUILDING ELEMENT	A	B	A[d]	B	A[d]	B	HT	A[d]	B
Primary structural frame (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls Exterior Interior	 3 3[a]	 2 2[a]	 1 1	 0 0	 2 1	 2 0	 2 1/HT	 1 1	 0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and secondary members (see Section 202)	$1^1/_2$[b]	1[b, c]	1[b, c]	0[c]	1[b, c]	0	HT	1[b, c]	0

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.

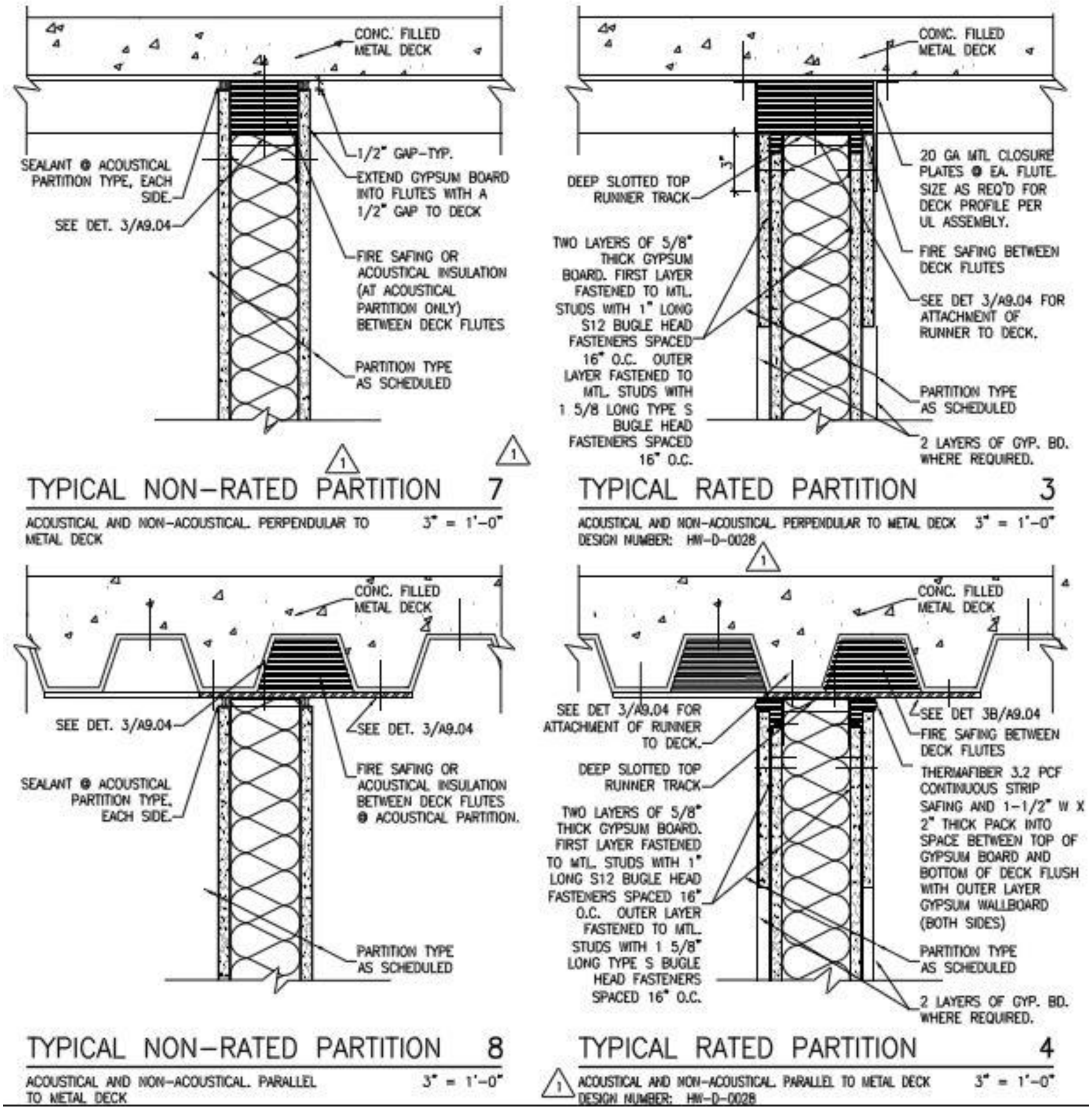


Figure 29: Wall/Partition Diagram

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.

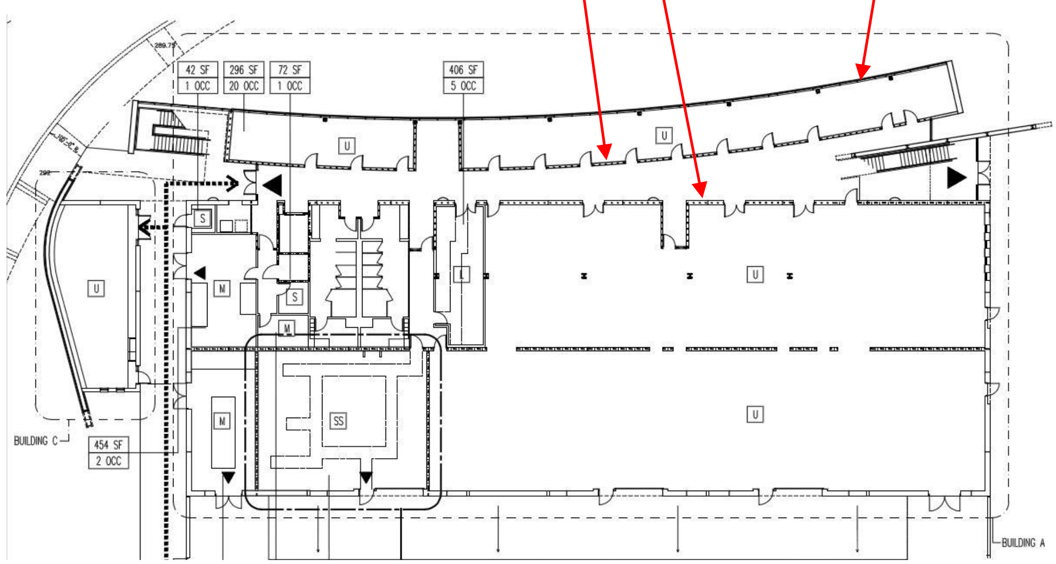


Figure 30: Partition Differentiation

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 buildings 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 buildings 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

Tenability Limits		
Performance Criteria	**Tenability Limit**	**Source**
Temperature	60°C	SFPE Handbook 3rd Edition 2-129 Table 2-6.19
Visibility	4 Meters	SFPE Handbook 3rd Edition Table 2-4.2 for Familiar Occupants
Radiant Heat Flux	2.5 kWm^{-2} or 375°C	SFPE Handbook 3rd Edition 2-129 Table 2-6.19
Carbon Monoxide	30,000 ppm/min (1,000 ppm for 30 minutes)	NFPA 101

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).

Table 2-6.19 ***Limiting Conditions for Tenability Caused by Heat***[106]

Mode of Heat Transfer	Intensity	Tolerance Time
Radiation	$<2.5\ kW{\cdot}m^{-2}$	>5 min
	$2.5\ kW{\cdot}m^{-2}$	30 s
	$10\ kW{\cdot}m^{-2}$	4 s
Convection	<60°C 100% saturated	>30 min
	100°C <10% H_2O[a]	12 min
	120°C <10% H_2O	7 min
	140°C <10% H_2O	4 min
	160°C <10% H_2O	2 min
	180°C <10% H_2O	1 min

[a]VW

Figure 31: Tenability Limits for Heat

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 3rd 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***

Degree of Familiarity with Inside Building	Smoke Density (extinction coefficient)	Visibility
Unfamiliar	0.15 1/m	13 m
Familiar	0.5 1/m	4 m

Figure 32: Tenability for Visibility – SFPE Hb. Table 2-4.2

9.2.3 Radiant Heat Flux: < 2.5 kW/m²

The hot smoke layer can produce a radiant heat flux to the occupants walking below it. This heat flux shall not exceed 2.5 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°C (SFPE Handbook 3rd Edition Figure 2-6.29).

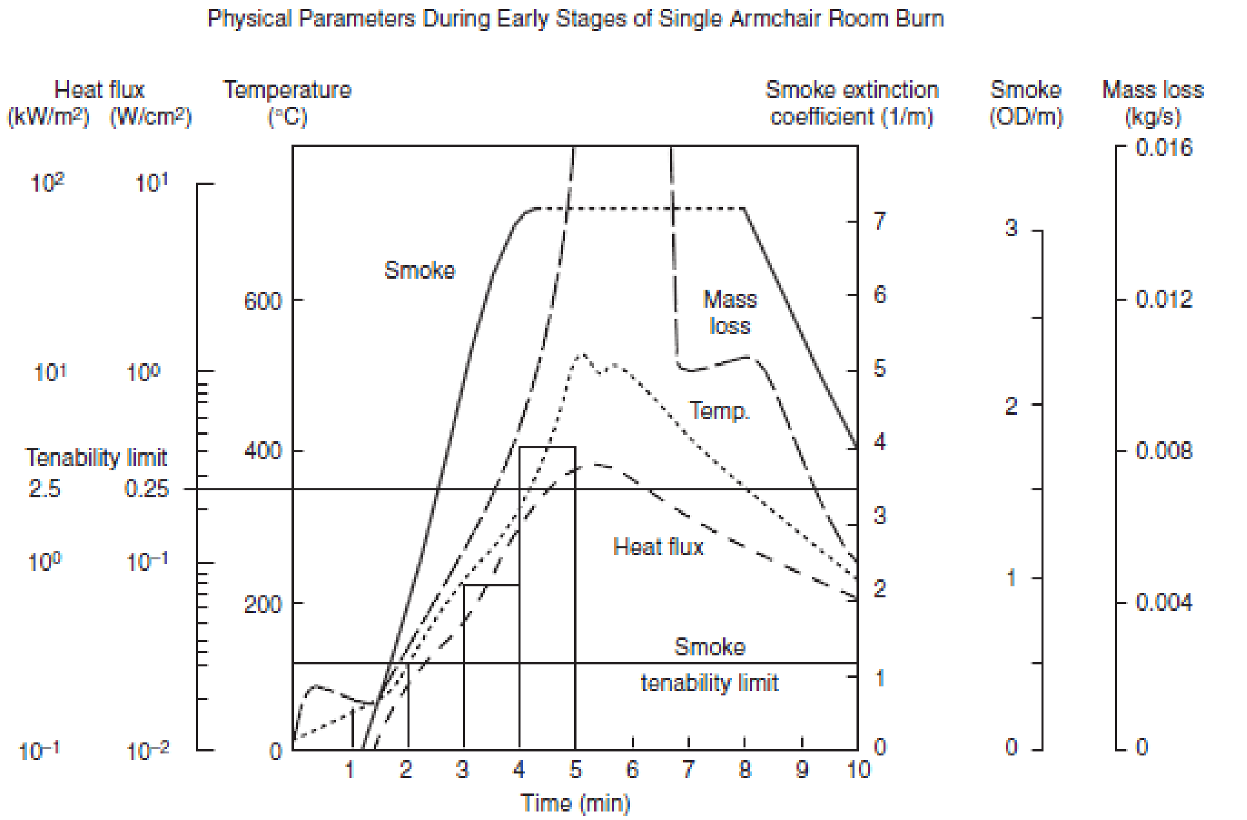


Figure 2-6.29. ***Profiles for heat (radiant flux and temperature), smoke and mass loss rate during the first 10 min of a single armchair (polystyrene, with polyurethane cushions and covers) room burn.[56] (Expanded detail from Figure 2-6.15.) Histogram shows average temperature each minute during the first five minutes.***

Figure 33: Heat Flux & Temperature from the SFPE Hb. 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.

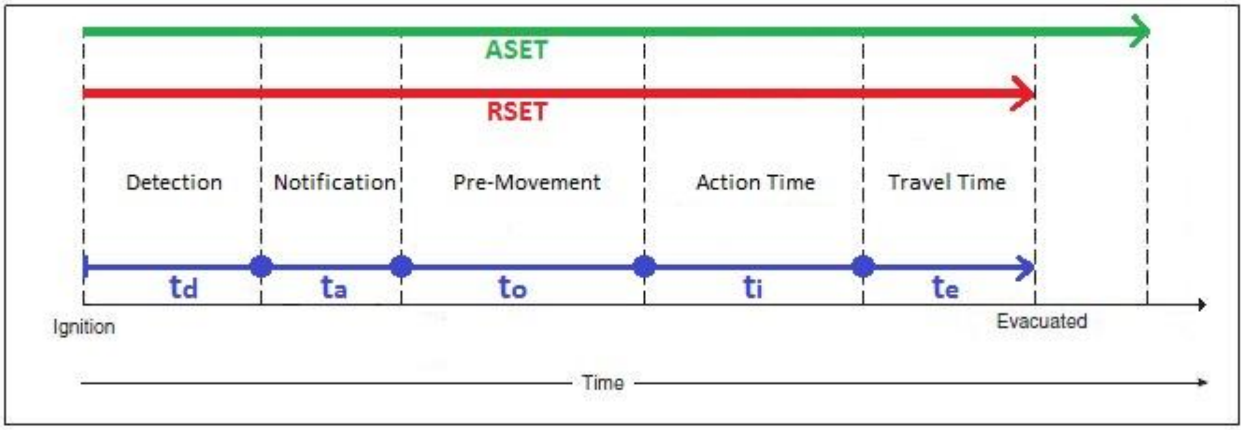


Figure 34: ASET vs RSET Chart

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 conformation, 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_a+t_o+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.

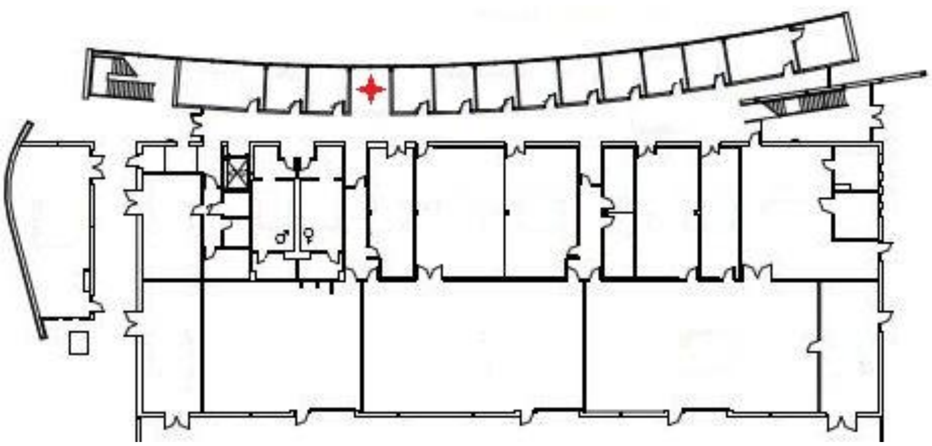


Figure 35: Scenario 1 – Couch in the Corridor

Figure 36: Scenario 1 - Corridor

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.

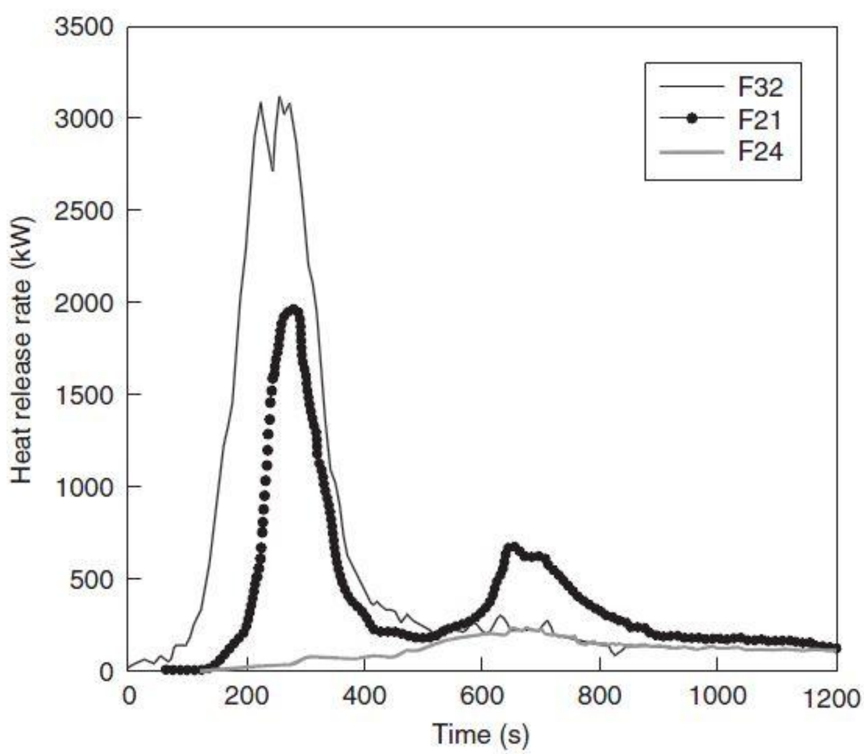


Figure 3-1.52. ***Several upholstered furniture items tested by NIST.***

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.

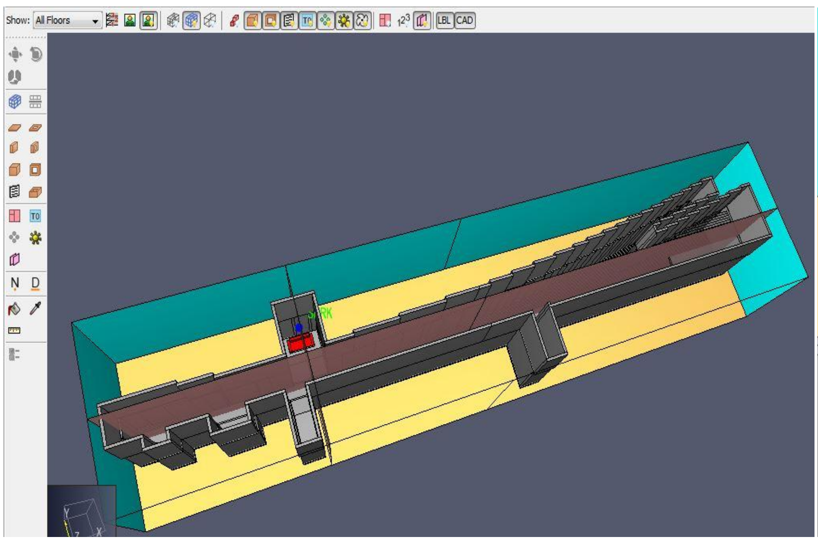


Figure 38: Scenario 1 – PyroSim Overview

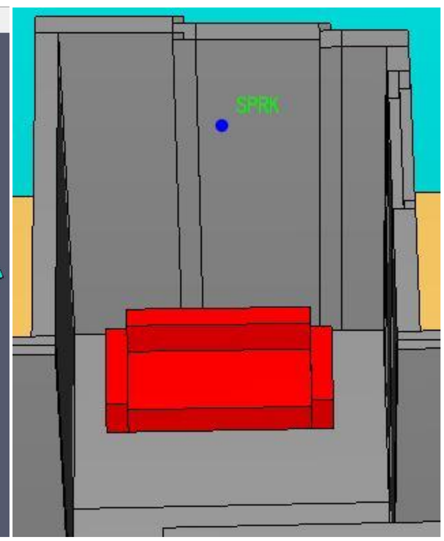


Figure 39: Scenario 1 – Couch

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.

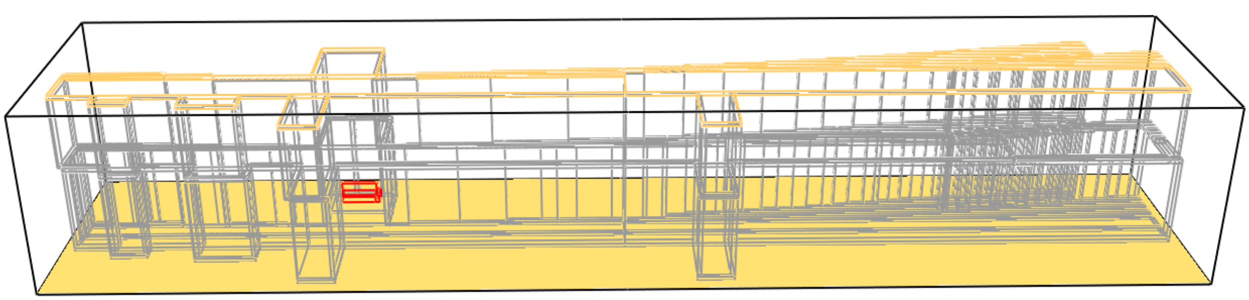


Figure 40: Scenario 1 – FDS Overview

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.

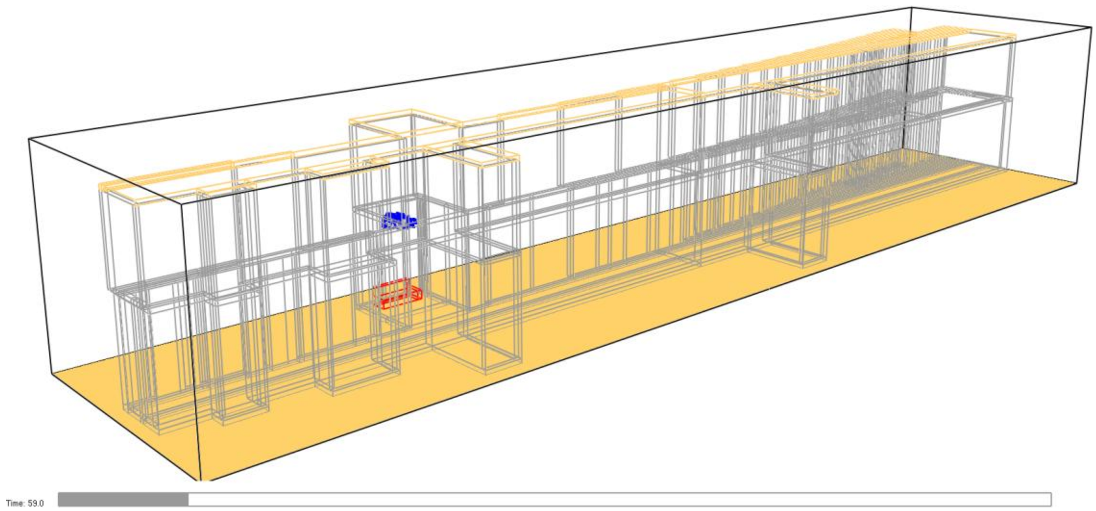


Figure 41: Scenario 1 - Sprinkler Activates @ 59 Seconds

<u>Scenario 1 @ 60 Seconds</u>

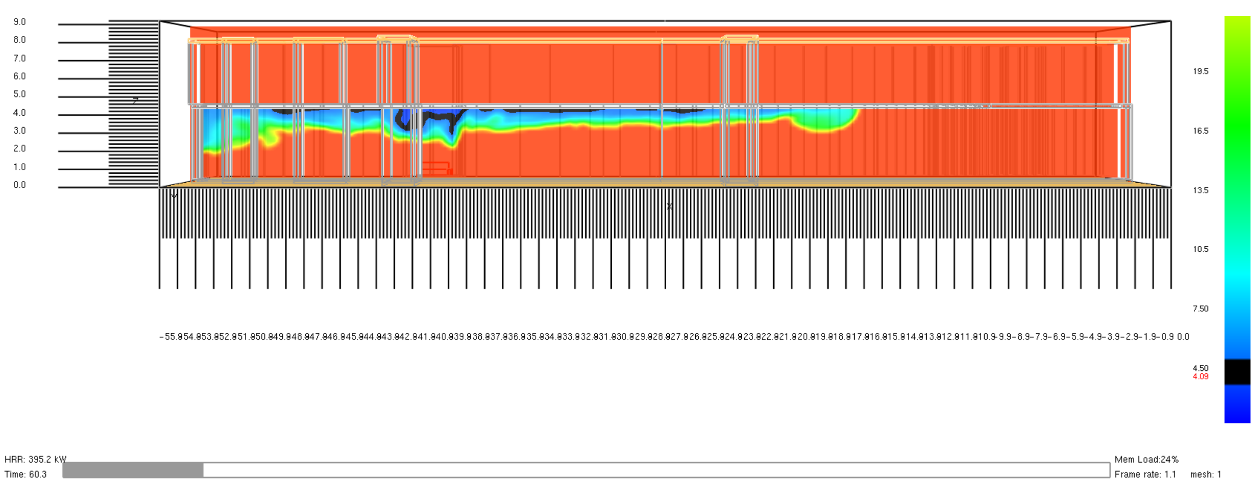


Figure 42: 41 Scenario 1 Tenability >4m at 60 Seconds

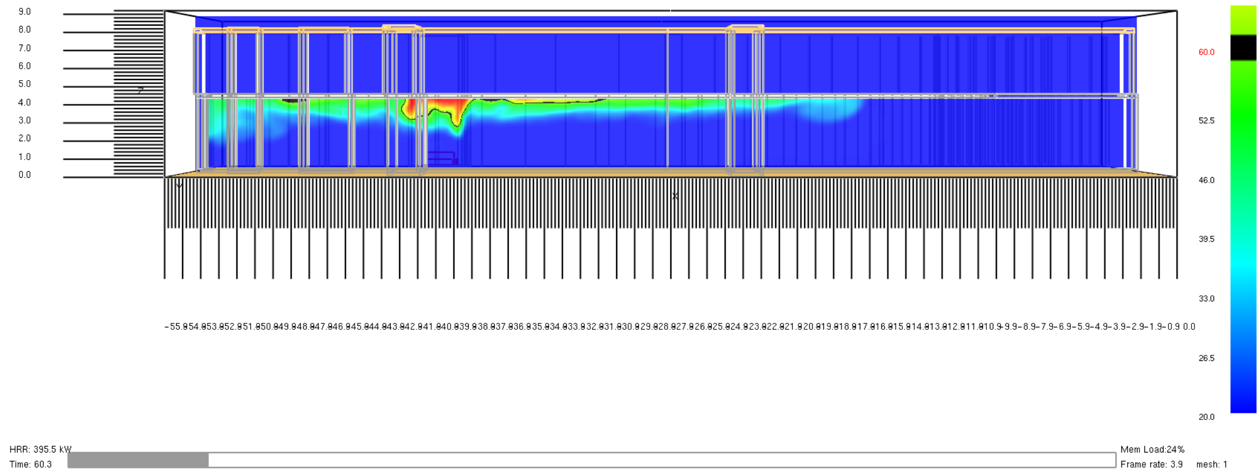


Figure 43: Scenario 1 Tenability < 60°C at 60 Seconds

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

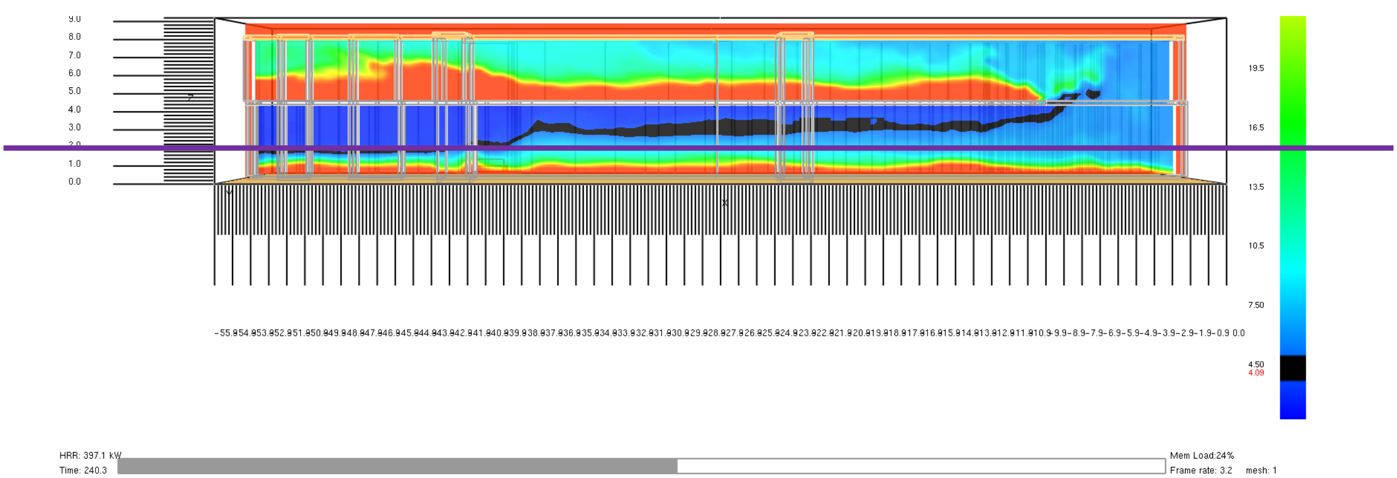


Figure 44: Scenario 1 – Tenability Limit is Reached for >4m Visibility 6 ft Above Floor @ 240s

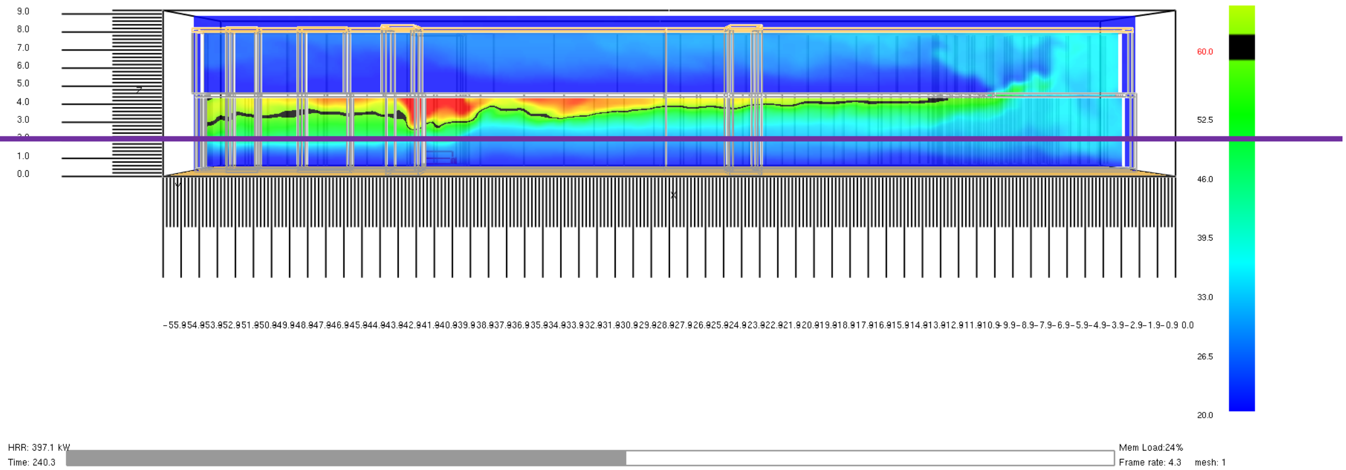


Figure 45: Scenario 1 - Tenability of < 60°C Has Not Been Exceeded at 240 Seconds

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.

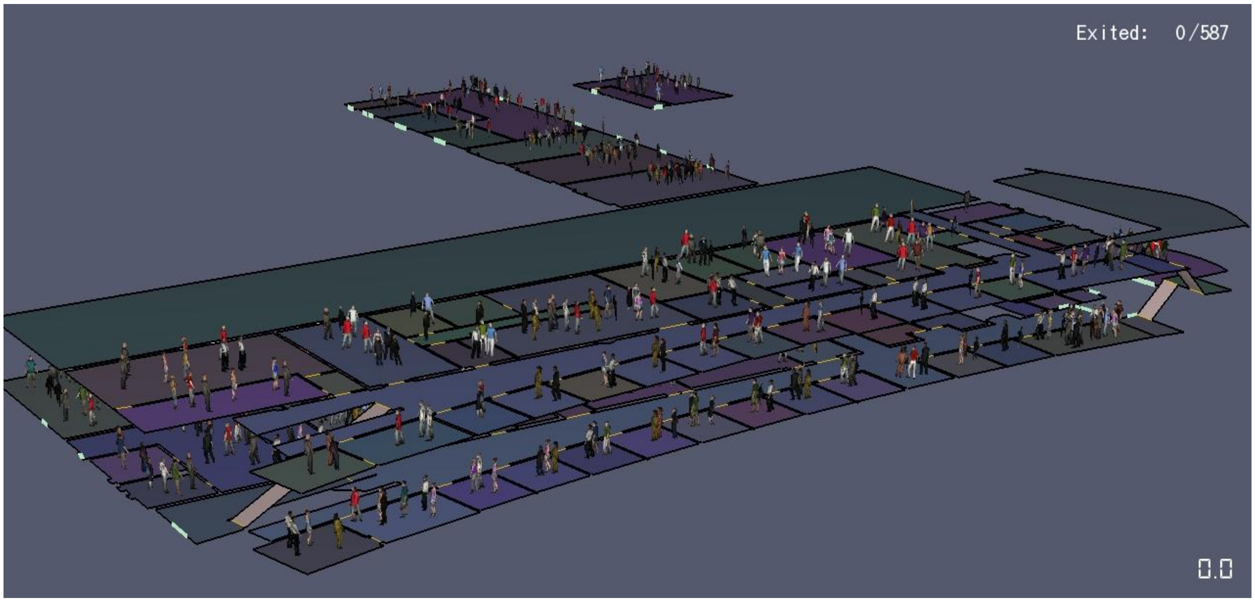


Figure 46: Pathfinder – Overview of the Building Before Egress Begins

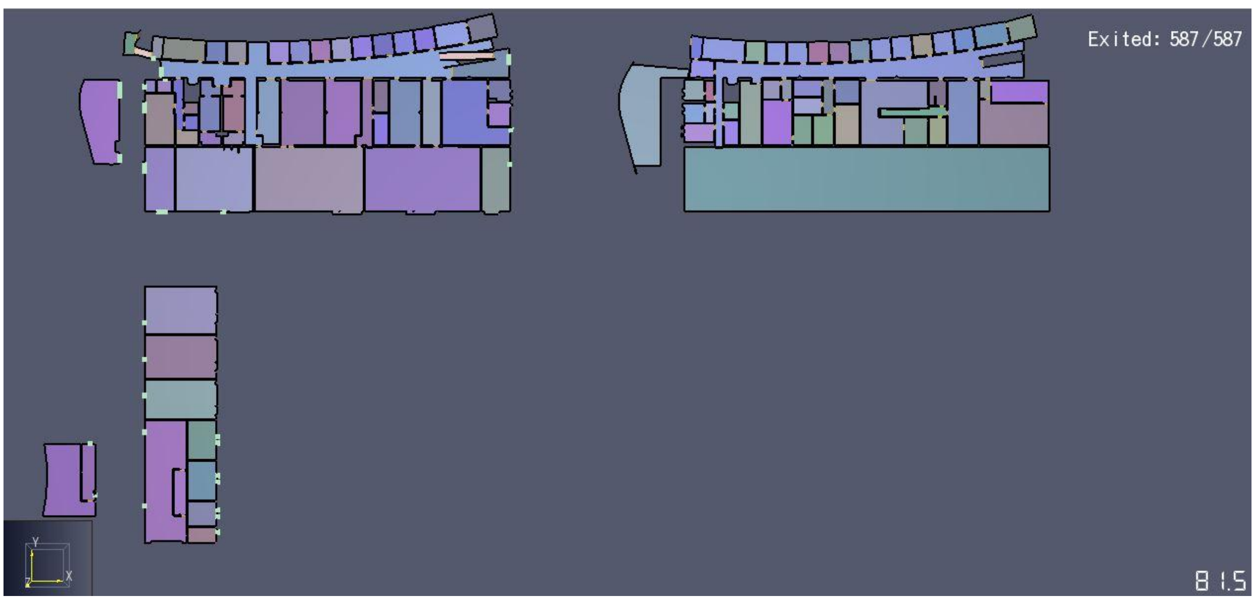


Figure 47: Pathfinder at 81.5 Seconds and Complete Evacuation

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

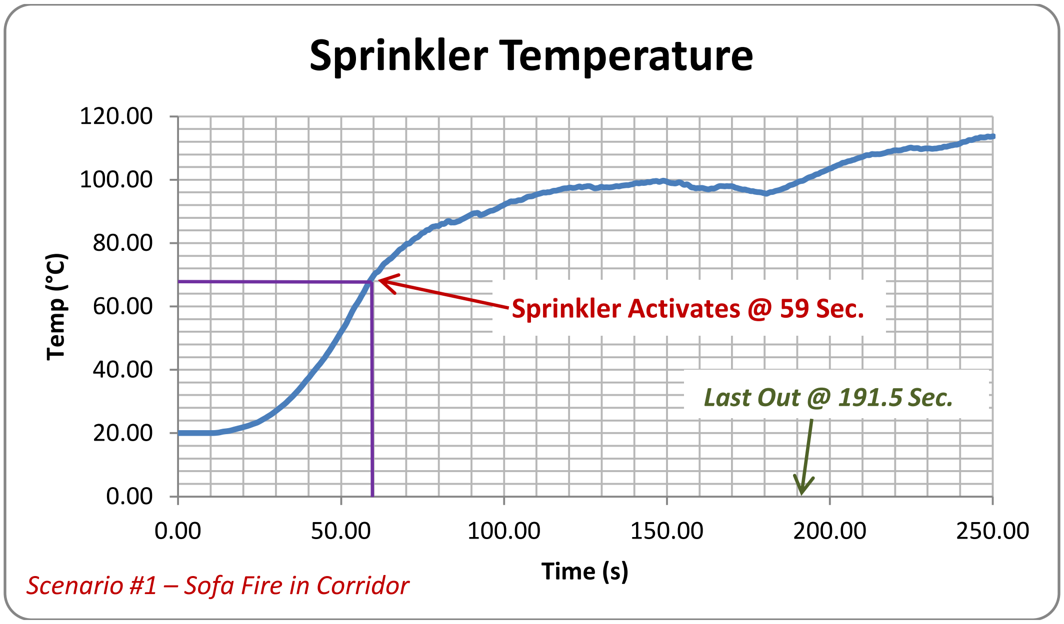


Figure 48: Scenario 1 Sprinkler Temperature

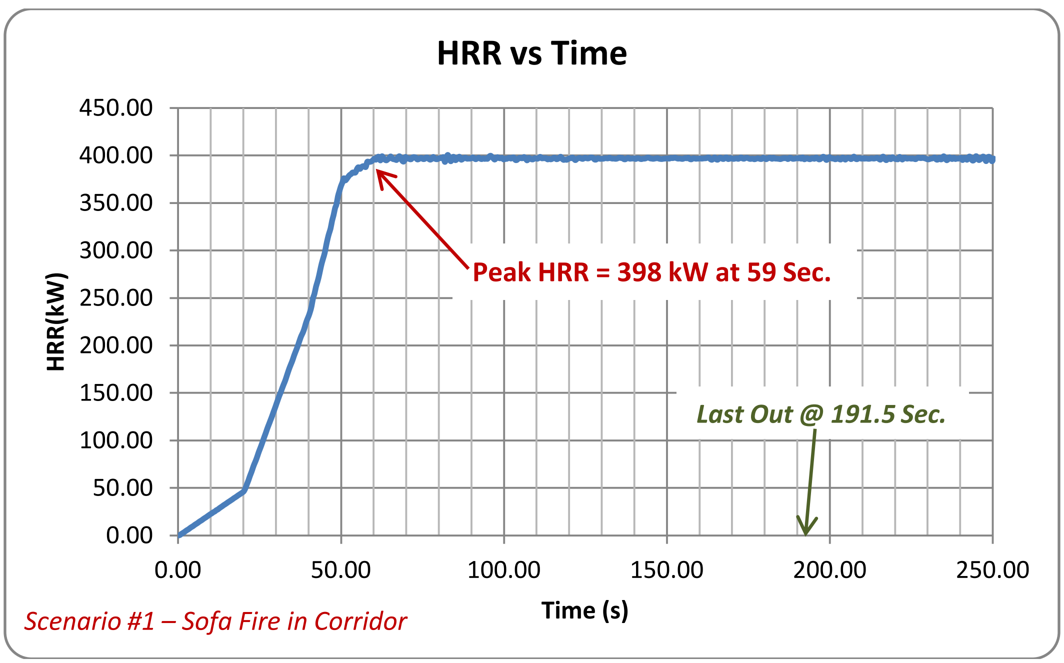


Figure 49: Scenario 1 HRR vs. Time

From the charts above it is shown that the sprinkler fires at 59 seconds setting the maximum HRR for the fire at 398 kW.

Scenario #1 – Sofa Fire in Corridor

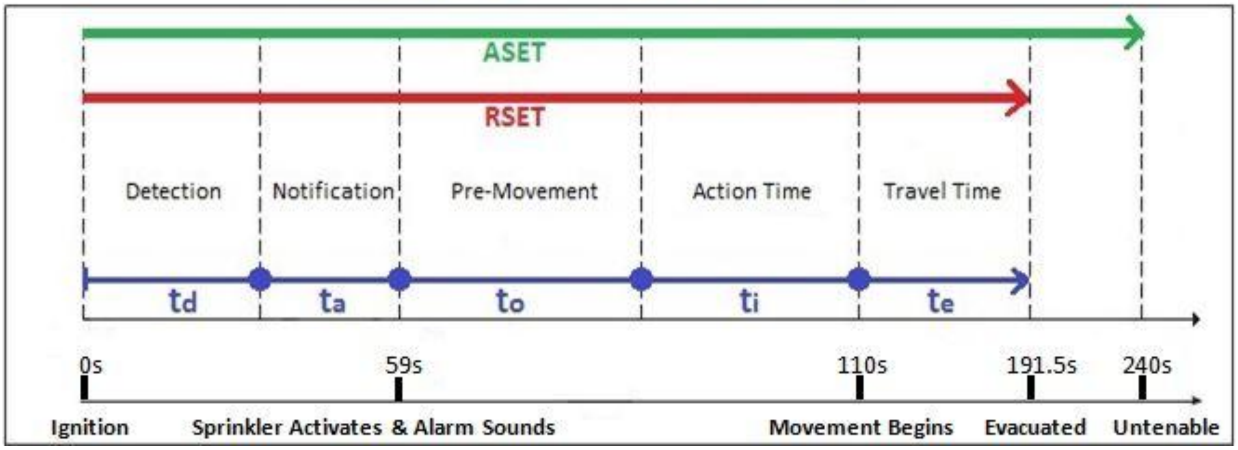


Figure 50: Scenario 1 – ASET vs. RSET

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.

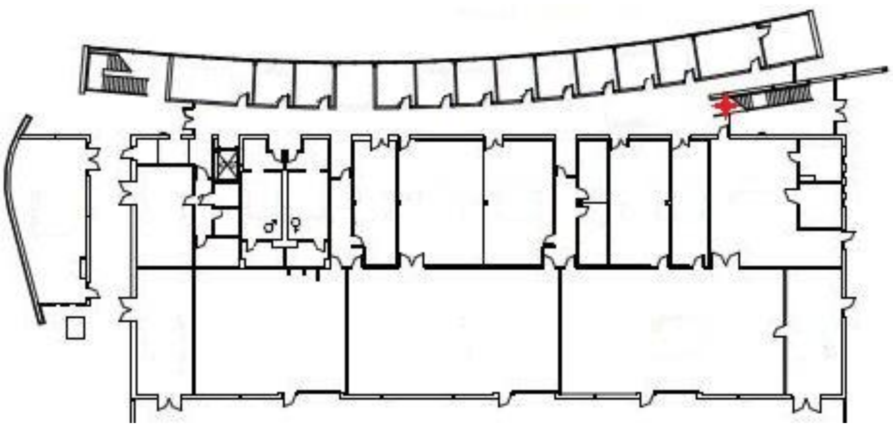


Figure 51: Scenario 2 – Cabinets in Main Walkway

Figure 52: Cabinets Under the Stairs

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.

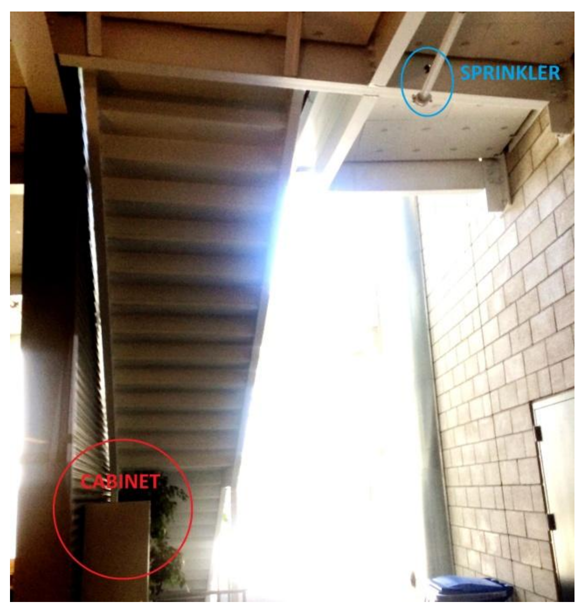


Figure 53: Sprinkler Location

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.

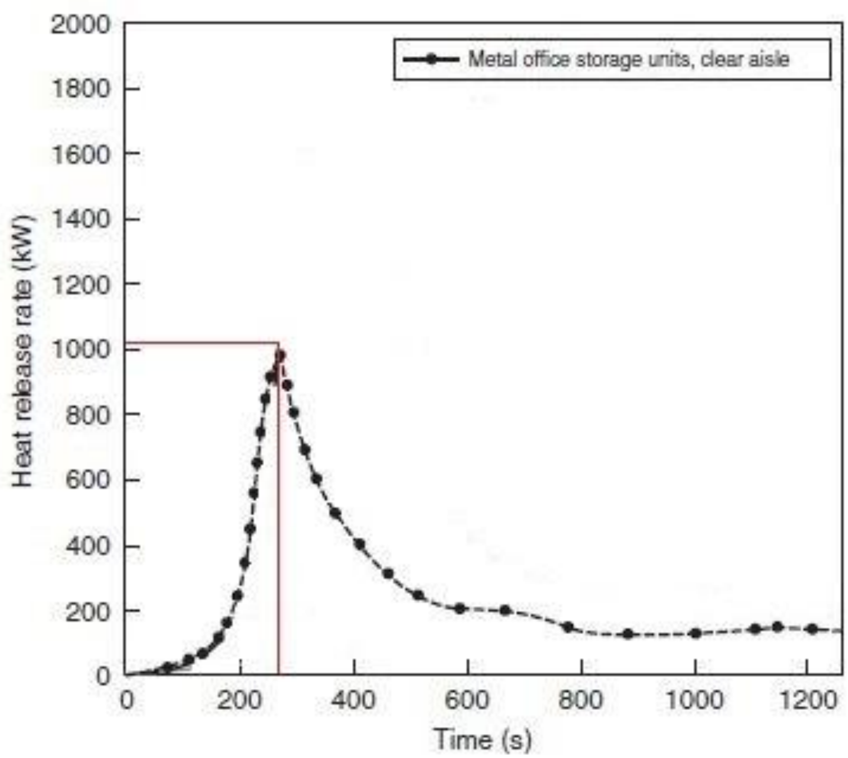


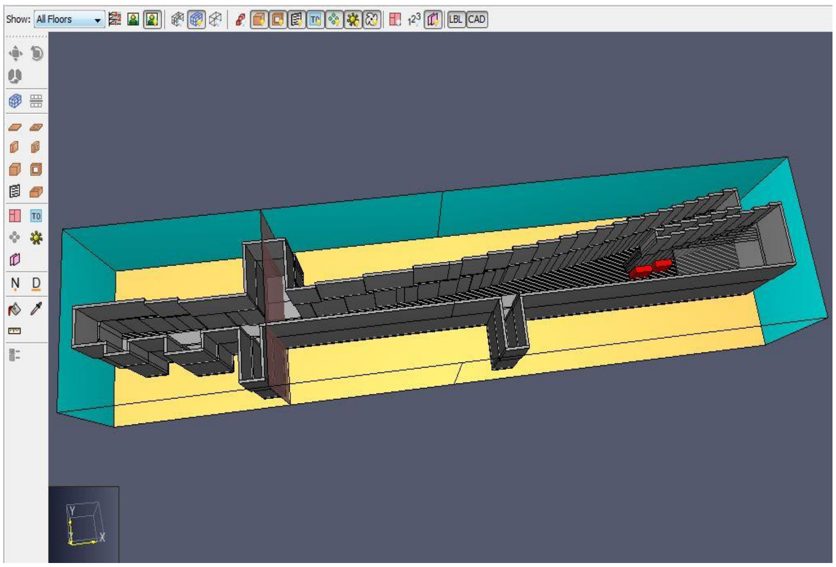
Figure 3-1.13. *Storage units.*

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.



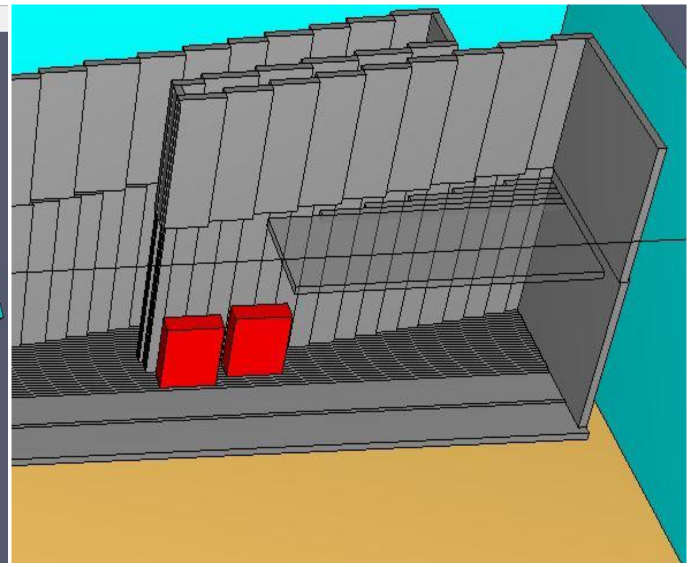


Figure 55: Scenario 2 – PyroSim Overview

Figure 56: Scenario 2 – Cabinets

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.

Figure 57: Scenario 2 – FDS Overview

Scenario 2 @ 60 Seconds

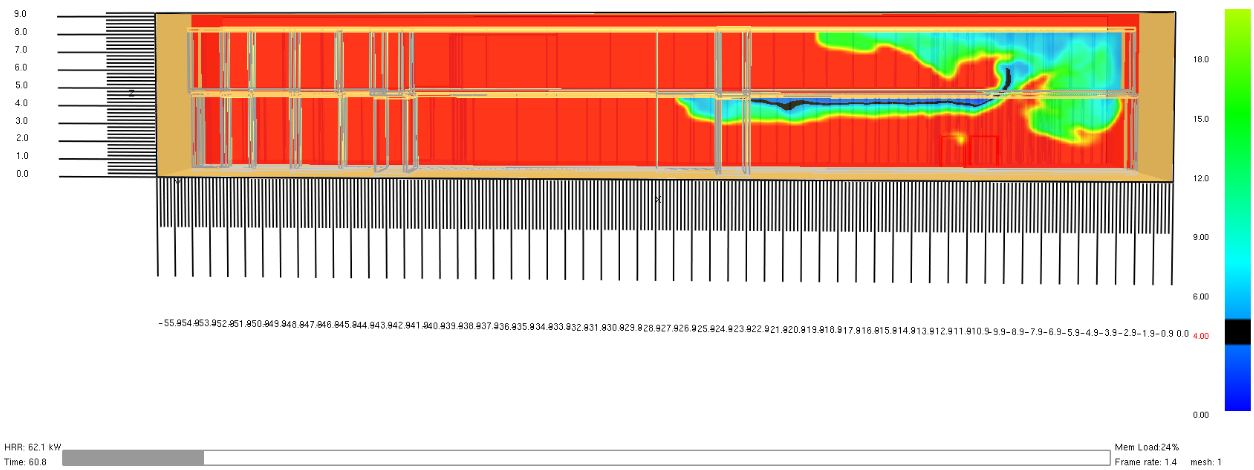


Figure 58: Scenario 2 - Tenability >4m at 60 Seconds

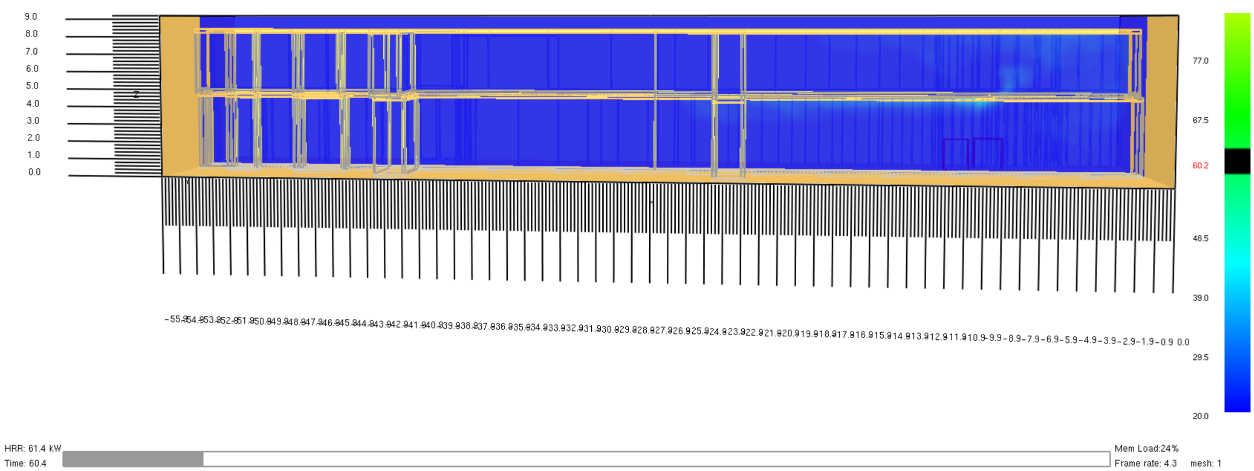


Figure 59: Scenario 2 - Tenability < 60°C at 60 Seconds

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

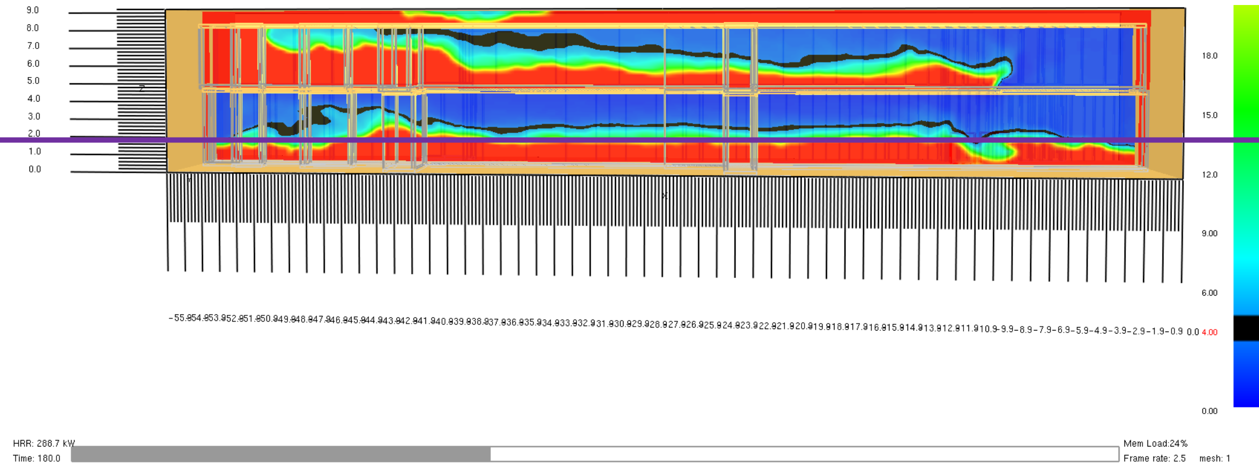


Figure 60: Scenario 2 – Tenability Limit is Reached for >4m Visibility 6 ft Above Floor @ 180s

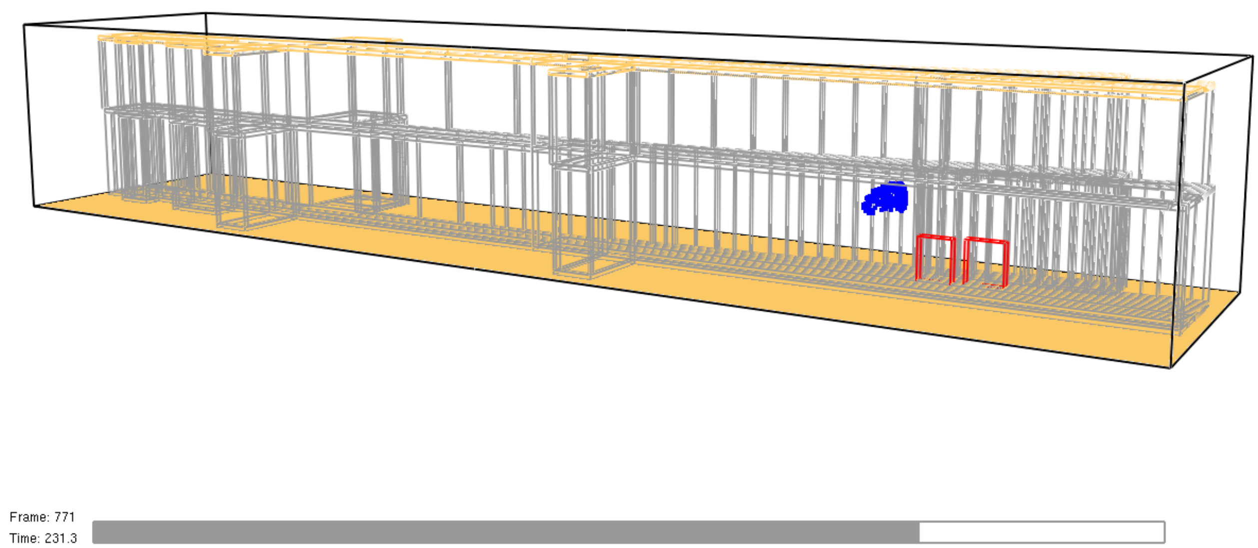


Figure 61: Scenario 2 - Sprinkler Fires at 231 Seconds

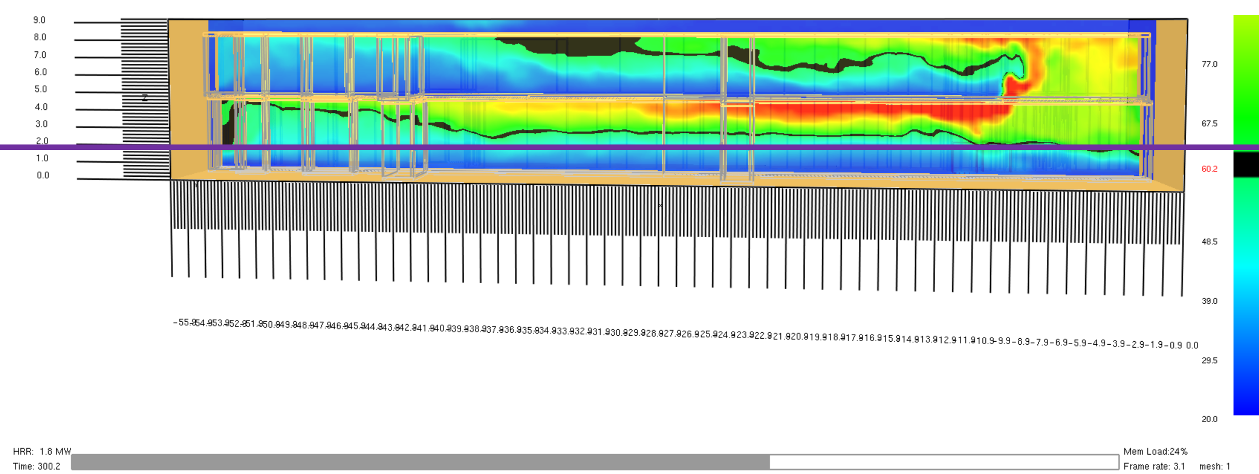


Figure 62: Scenario 2 - Tenability Limit is Reached for <60°C Temp 6 ft Above Floor @ 300s

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.

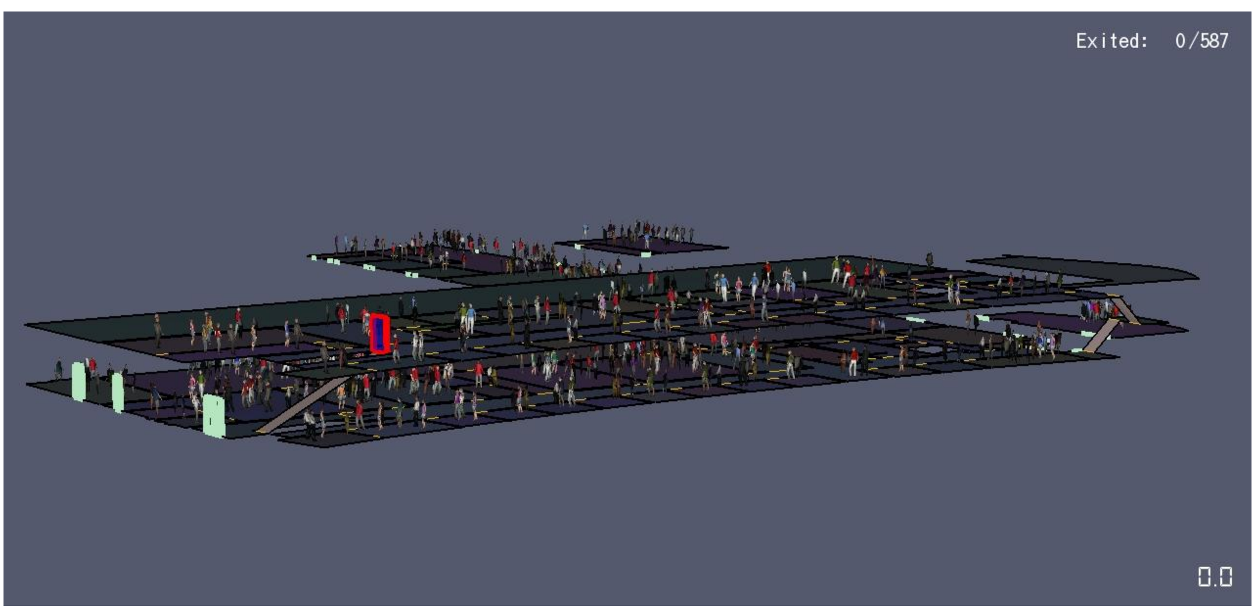


Figure 63: Scenario 2 – Pathfinder Overview Before Egress Begins with East Stairs Closed

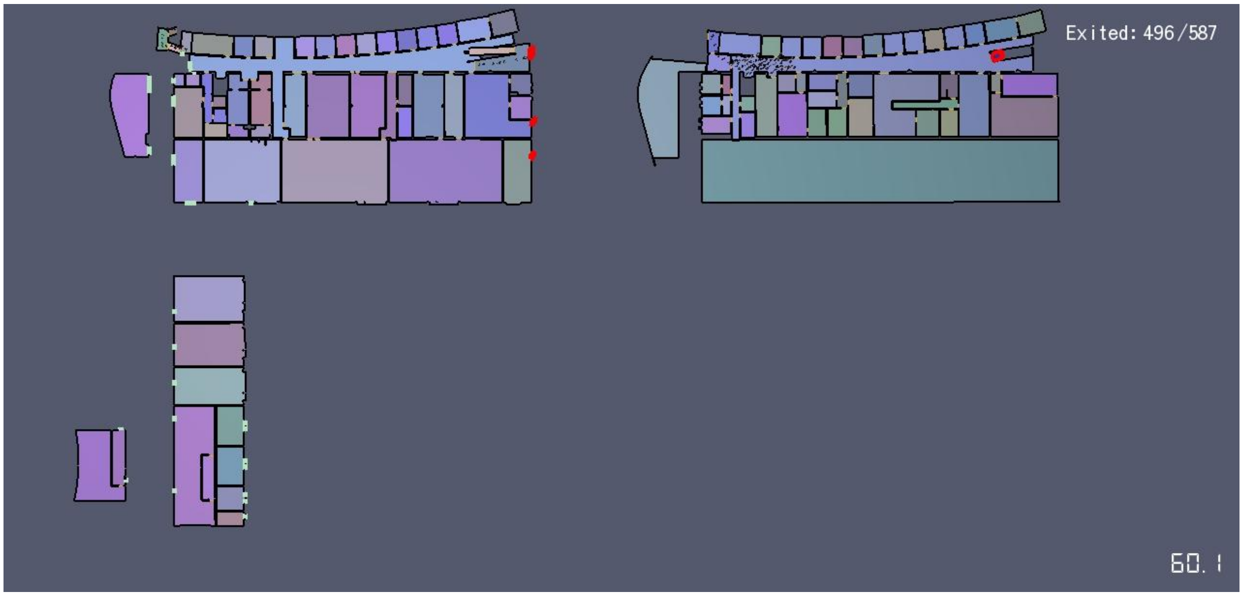


Figure 64: Scenario 2 - Pathfinder at 60 Seconds When East Exit is Untenable To Use

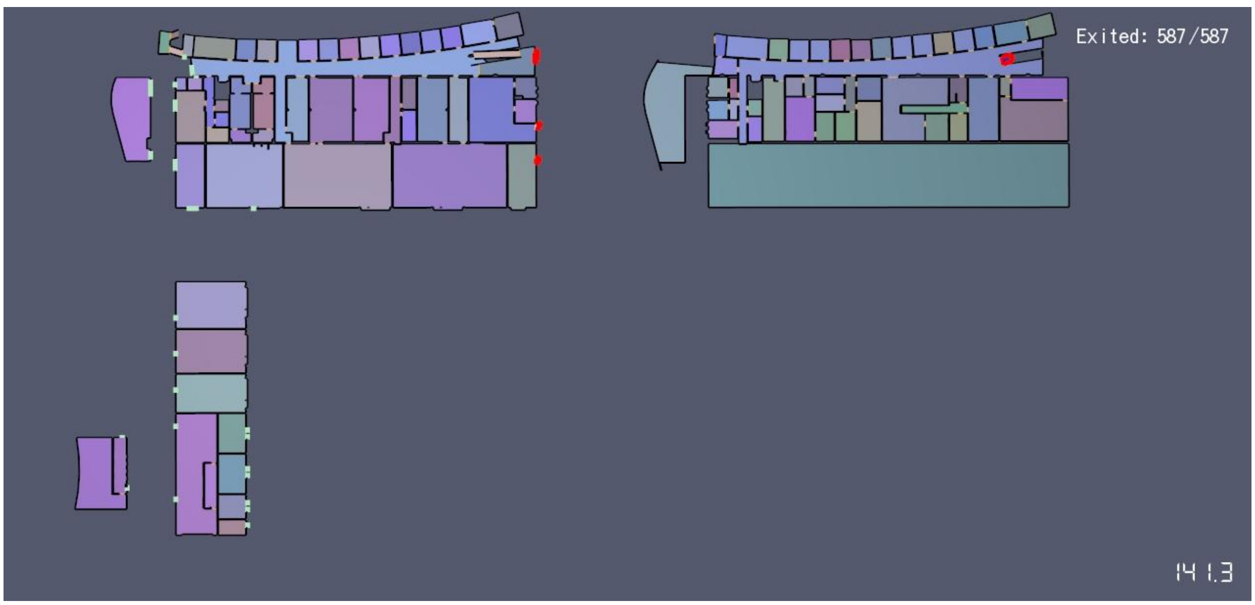


Figure 65: Scenario 2 - Pathfinder at 141.3 Seconds and Complete Evacuation

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

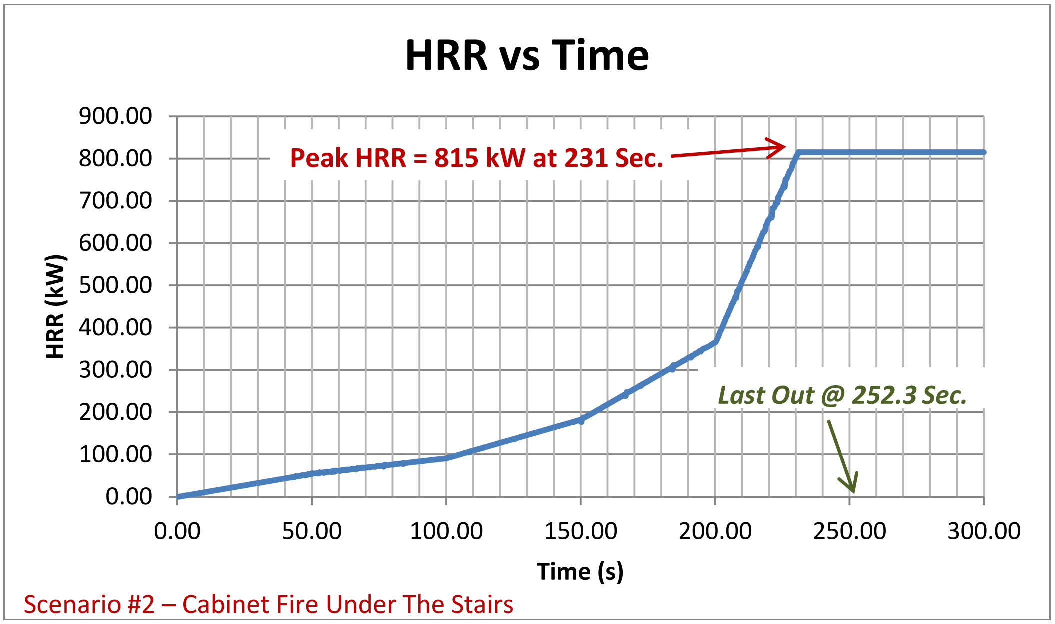


Figure 66: Scenario 2 Sprinkler Temperature

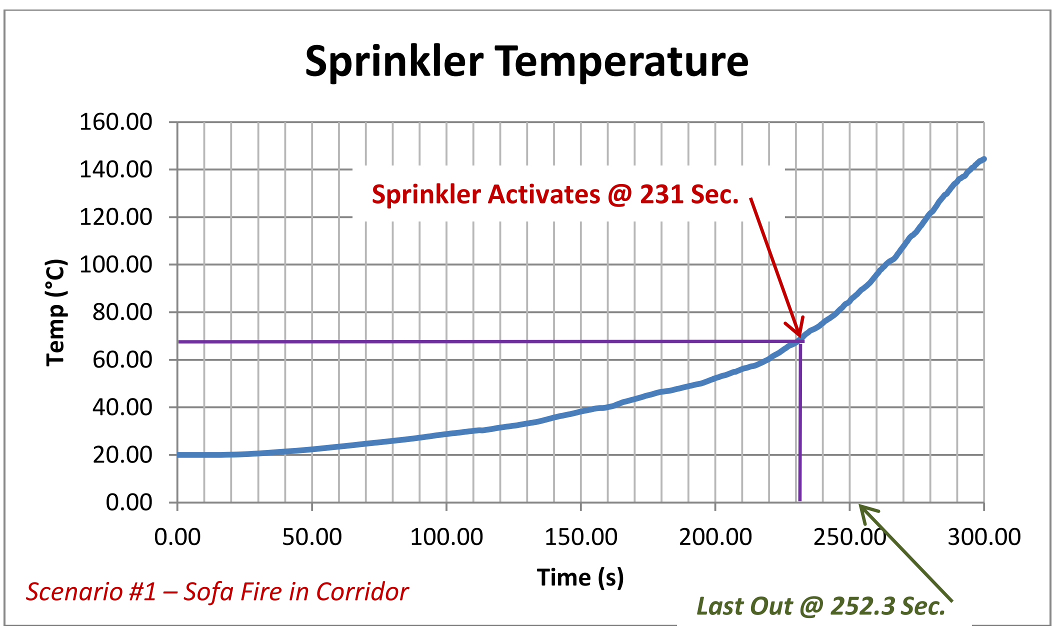


Figure 67: Scenario 2 HRR vs. Time

From the charts above it is shown that the sprinkler fires at 231 seconds setting the maximum HRR for the fire at 815 kW.

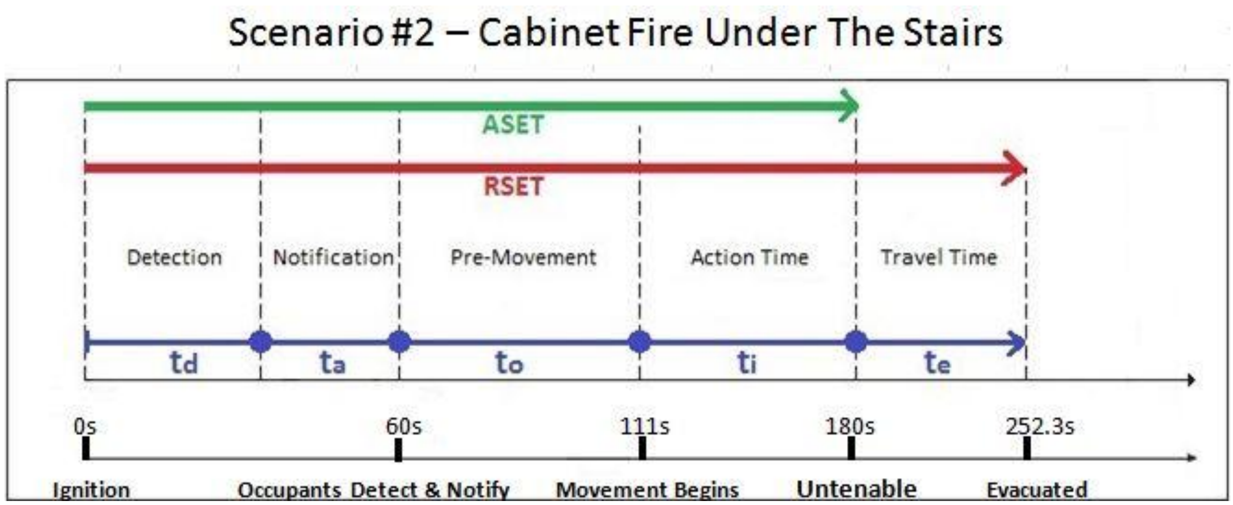


Figure 68: Scenario 2 – ASET vs RSET

RSET = 252.3 Seconds

ASET = 180 Seconds

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.

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Appendix A Fire Detection, Alarm, and Communication Systems

Secondary Power Supply

Table 22: Secondary Power Supply

Item	Description	Standby Current Per Unit (AMPS)		QTY		Standby Current Per Unit (AMPS)	Alarm Current Per Unit (AMPS)		QTY		System Alarm Current (AMPS)
A	FACP	.25	X	1	=	.25	.65	X	1	=	.65
B	Smoke Det	.00036	X	19	=	.00684	.00036	X	19	=	.00684
C	Heat Det	.0003	X	2	=	.0006	.0003	X	2	=	.0006
D	Duct Det	.0003	X	38	=	.0114	.0003	X	38	=	.0114
E	Man Pul	.000375	X	19	=	.007125	.005	X	19	=	.095
F	Monitor Mod	.00035	X	7	=	.00245	.00035	X	7	=	.00245
G	Relay Mod	.000375	X	12	=	.0045	.000375	X	12	=	.0045
H	Hrn/Str P24	0	X	14	=	0	.082	X	14	=	1.148
I	Strobe S24	0	X	4	=	0	.064	X	4	=	.256
J	H2O Bell KMS	.03	X	1	=	.03	.03	X	1	=	.03
K	Relay AP&C	.015	X	7	=	.105	.015	X	7	=	.105
L	Ceil Hrn/Str	0	X	5	=	0	.091	X	5	=	.455
M	Strobe S12	0	X	4	=	0	.074	X	4	=	.296
N	Hrn/Str P12	0	X	15	=	0	.087	X	15	=	1.305
O	Floor Smoke	.0003	X	2	=	.0006	.0003	X	2	=	.0006
P	FCPS	.001287	X	1	=	.001287	.001287	X	1	=	.001287
		Total System Standby Current (AMPS)				.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

Standby:___24___Hours Alarm:___5___Minutes x 1/60__0.0833__Hours

Required Standby Time (Hours)		**Total System Standby Current (AMPS)**		**Required Standby Capacity (AMP-Hours)**	**Required Alarm Time (Hours)**		**Total System Alarm Current (AMPS)**		**Required Alarm Current (AMP-Hours)**
24	X	.419802	=	10.075248	.0833	X	4.367677	=	.3638274941

Required Standby Capacity (AMP-Hours)		**Required Alarm Capacity (AMP-Hours)**		**Total Required Capacity (AMP-Hours)**		**Factor of Safety**		**Required Battery Capacity (AMP-Hours)**
10.075248	+	.3638274941	=	10.43907649	X	1.2	=	12.52689059

Fire Alarm Plan Drawings

CALPOLY ENGINEERING III - PHASE 2
SAN LUIS OBISPO. CA
SFM 18-40-03-0001-137-370-0

TYPE OF SYSTEM:
MANUAL FIRE ALARM SYSTEM WITH ELEVATOR RECALL, FIRE SPRINKLER MONITORING AND DUCT DETECTOR MONITORING

PROJECT DATA:

EXISTING BLDG A	32,480 SF
EXISTING BLDG B	5,869 SF
NEW BLDG C	1,314 SF
TOTAL	39,663 SF

CONSTRUCTION TYPE:	**TYPE II - N**
OCCUPANCY GROUP:	**B**
SPRINKLERED:	**FULLY SPRINKLERED**

APPLICABLE CODES AND STANDARDS:

CALIFORNIA BUILDING CODE	CBC 2001 EDITION
CALIFORNIA PLUMBING CODE	CPC 2001 EDITION
CALIFORNIA MECHANICAL CODE	CMC 2001 EDITION
CALIFORNIA FIRE CODE	CFC 2001 EDITION
CALIFORNIA ELECTRICAL CODE	CEC 2001 EDITION
ENERGY EFFICIENCY STANDARDS	2001 EDITION
NATIONAL ELECTRICAL CODE	NEC 2001 EDITION
NATIONAL FIRE ALARM CODE	NFPA 72 1999 EDITION

SYMBOL	QTY	DESCRIPTION	PART NUMBER	CSFM LISTING NUMBER
FACP	1	FIRE ALARM CONTROL PANEL	NOTIFIER NFS-640	EXISTING
FATC	1	FIRE ALARM TERMINAL CAN	EXISTING	EXISTING
	19	EXISTING SMOKE DETECTOR	NOTIFIER FSP-751	EXISTING
	2	EXISTING HEAT DETECTOR	NOTIFIER FST-751	EXISTING
	38	EXISTING DUCT DETECTOR	NOTIFIER FSD-751P	EXISTING
	5	EXISTING MANUAL PULL STATION	NOTIFIER NBG-12LX	EXISTING
M	7	EXISTING MONITOR MODULE	NOTIFIER FMM-1 OR FMM-101	EXISTING
R	12	EXISTING RELAY MODULE	NOTIFIER FRM-1	EXISTING
	14	EXISTING HORNSTROBE	SYSTEM SENSOR P241575	EXISTING
	4	EXISTING STROBE	SYSTEM SENSOR S241575	EXISTING
	1	EXISTING WATERFLOW BELL	NOTIFIER KMS-10-24	EXISTING
FSD	31	EXISTING FIRE SMOKE DAMPER	BY OTHERS	BY OTHERS
	3	EXISTING VALVE TAMPER SWITCH	BY OTHERS	BY OTHERS
	2	EXISTING OS&Y TAMPER SWITCH	BY OTHERS	BY OTHERS
	4	EXISTING WATERFLOW SWITCH	BY OTHERS	BY OTHERS
	7	EXISTING RELAY	AIR PRODUCTS & CONTROLS PAM-2	BY OTHERS
	14	NEW MANUAL PULL STATION	NOTIFIER NBG-12LX	7150-0028:199
	5	NEW CEILING MOUNT HORNSTROBE	SYSTEM SENSOR PC24XX	7135-1209:204
	4	NEW WALL MOUNT STROBE	SYSTEM SENSOR S1224MC	7125-1209:222
	15	NEW WALL MOUNT HORNSTROBE	SYSTEM SENSOR P1224MC	7135-1209:223
	2	NEW UNDERFLOOR SMOKE DETECTOR	NOTIFIER FSP-851	7270-0028:206
FCPS	1	NEW FIRE CONTROL POWER SUPPLY	NOTIFIER ACPS-2406	7315-0028:213

XX - DENOTES STROBE CANDELA RATING

WIRE DESIGNATION	DESCRIPTION
A	16/2 FPL SIGNALING LINE CIRCUIT (SLC) CABLE
B	2 - #12 THHN NOTIFICATION APPLIANCE CIRCUIT (NAC) CABLES

LEGENDS
NO SCALE

1. PRIMARY POWER SOURCE (120VAC) MUST BE ON A DEDICATED BRANCH CIRCUIT. FIRE ALARM CIRCUIT BREAKER MUST BE CLEARLY MARKED AND MECHANICALLY SECURED TO PREVENT ANY UNAUTHORIZED TAMPERING.

2. ALL FIRE ALARM CABLING TO BE INSTALLED IN MIN. 3/4" CONDUIT.

3. THE FIRE ALARM SYSTEM SHALL CONFORM TO ARTICLE 760 OF THE NATIONAL ELECTRIC CODE, AND ALL APPLICABLE SECTIONS OF THE CALIFORNIA BUILDING CODE AND NFPA STANDARDS.

4. ALL EQUIPMENT SHALL BE U.L. AND CALIFORNIA STATE FIRE MARSHALL LISTED.

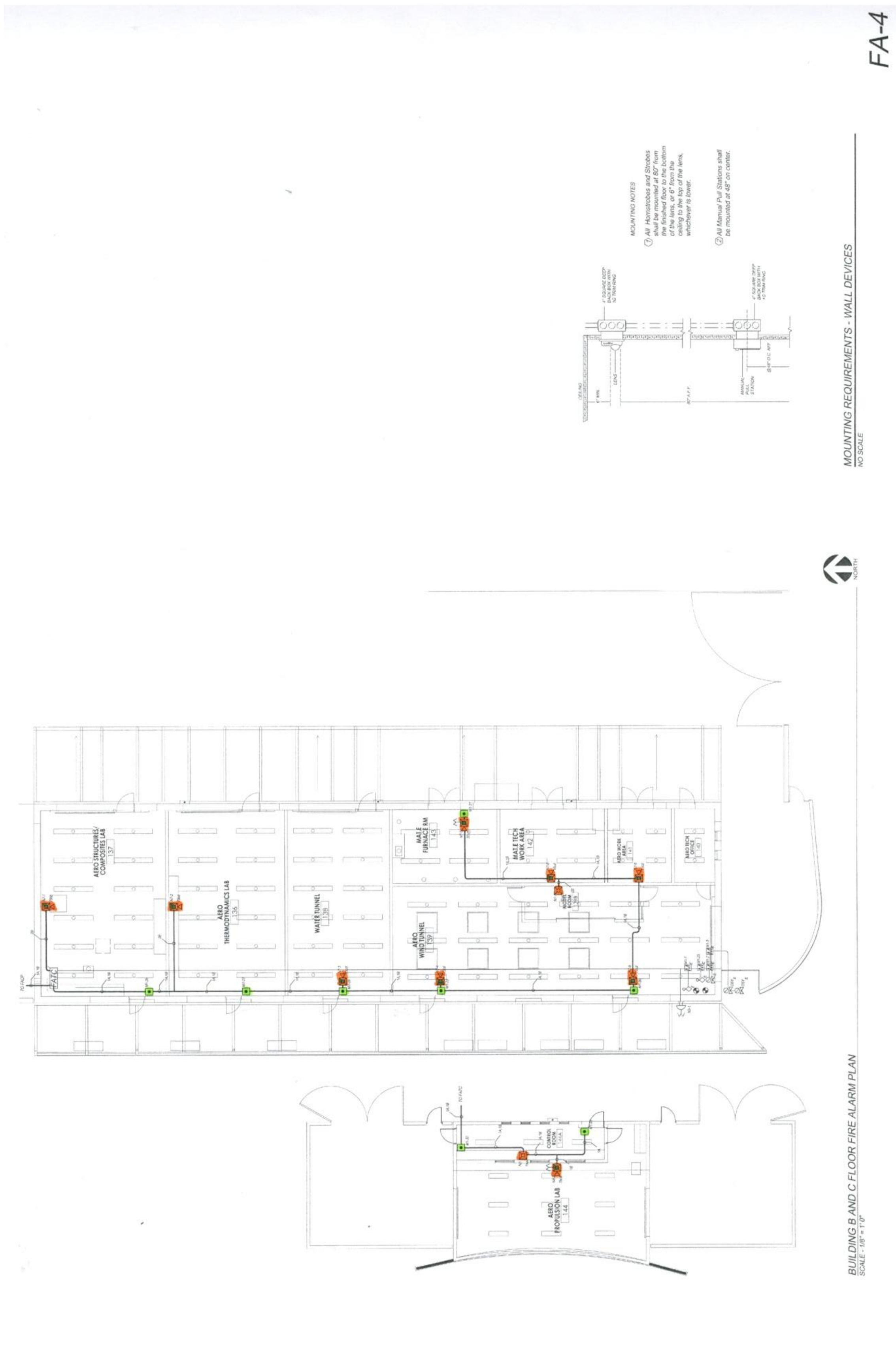
5. ALL TESTING SHALL BE PERFORMED IN ACCORDANCE WITH SECTION 7-1.6 OF 1999 NFPA 72.

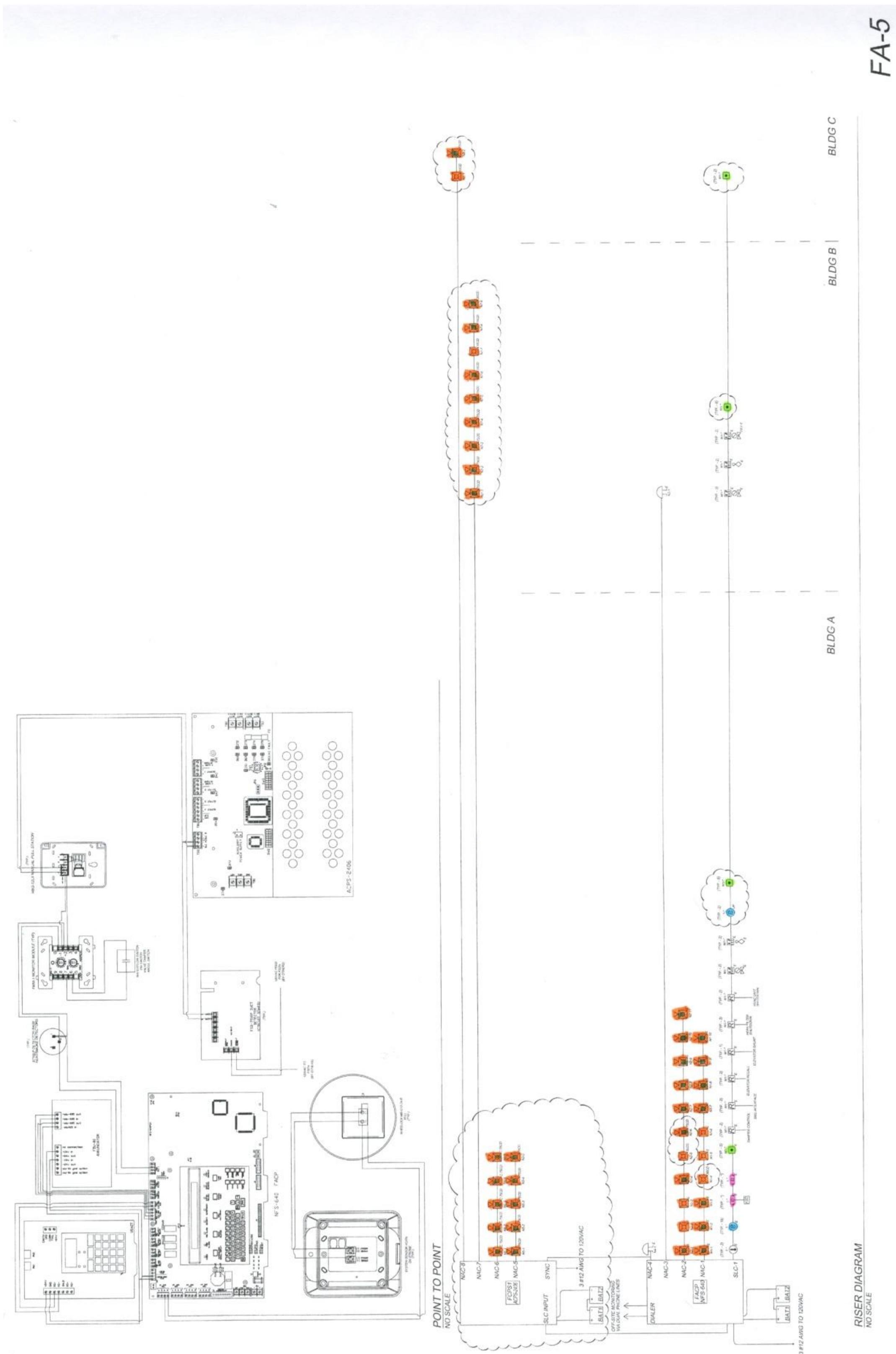
GENERAL NOTES
NO SCALE

FA-1


FA-2
BUILDING A FIRST FLOOR FIRE ALARM PLAN
SCALE - 1/8" = 1'-0"


FA-3
NORTH
BUILDING A SECOND FLOOR FIRE ALARM PLAN
SCALE - 1/8" = 1'0"


FA-4
MOUNTING NOTES
① All Hornstrobes and Strobes shall be mounted at 80" from the finished floor to the bottom of the lens, or 6" from the ceiling to the top of the lens, whichever is lower.
② All Manual Pull Stations shall be mounted at 48" on center.
MOUNTING REQUIREMENTS - WALL DEVICES
NO SCALE
NORTH
AERO STRUCTURES/ COMPOSITES LAB
137
AERO THERMODYNAMICS LAB
136
WATER TUNNEL
138
AERO WIND TUNNEL
139
MAT.E FURNACE RM
143
MAT.E TECH WORK AREA
142
AERO PROPULSION LAB
144
BUILDING B AND C FLOOR FIRE ALARM PLAN
SCALE - 1/8" = 1'0"


FA-5
BLDG C
BLDG B
BLDG A
POINT TO POINT
NO SCALE
RISER DIAGRAM
NO SCALE
3 #12 AWG TO 120VAC

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*

Maximum Room Size		Minimum Required Light Output [Effective Intensity (cd)]	
ft	m	One Light per Room	Four Lights per Room (One Light per Wall)
20 × 20	6.10 × 6.10	15	NA
28 × 28	8.53 × 8.53	30	NA
30 × 30	9.14 × 9.14	34	NA
40 × 40	12.2 × 12.2	60	15
45 × 45	13.7 × 13.7	75	19
50 × 50	15.2 × 15.2	94	30
54 × 54	16.5 × 16.5	110	30
55 × 55	16.8 × 16.8	115	30
60 × 60	18.3 × 18.3	135	30
63 × 63	19.2 × 19.2	150	37
68 × 68	20.7 × 20.7	177	43
70 × 70	21.3 × 21.3	184	60
80 × 80	24.4 × 24.4	240	60
90 × 90	27.4 × 27.4	304	95
100 × 100	30.5 × 30.5	375	95
110 × 110	33.5 × 33.5	455	135
120 × 120	36.6 × 36.6	540	135
130 × 130	39.6 × 39.6	635	185

NA: Not allowable.

TABLE 18.5.5.4.1(b) *Room Spacing for Ceiling-Mounted Visible Appliances*

Maximum Room Size		Maximum Lens Height*		Minimum Required Light Output (Effective Intensity); One Light (cd)
ft	m	ft	m	
20 × 20	6.1 × 6.1	10	3.0	15
30 × 30	9.1 × 9.1	10	3.0	30
40 × 40	12.2 × 12.2	10	3.0	60
44 × 44	13.4 × 13.4	10	3.0	75
20 × 20	6.1 × 6.1	20	6.1	30
30 × 30	9.1 × 9.1	20	6.1	45
44 × 44	13.4 × 13.4	20	6.1	75
46 × 46	14.0 × 14.0	20	6.1	80
20 × 20	6.1 × 6.1	30	9.1	55
30 × 30	9.1 × 9.1	30	9.1	75
50 × 50	15.2 × 15.2	30	9.1	95
53 × 53	16.2 × 16.2	30	9.1	110
55 × 55	16.8 × 16.8	30	9.1	115
59 × 59	18.0 × 18.0	30	9.1	135
63 × 63	19.2 × 19.2	30	9.1	150
68 × 68	20.7 × 20.7	30	9.1	177
70 × 70	21.3 × 21.3	30	9.1	185

*This does not preclude mounting lens at lower heights.

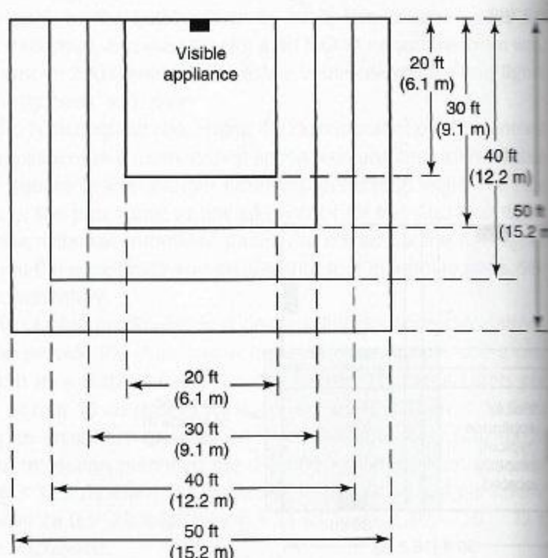


FIGURE 18.5.5.4.1 *Room Spacing for Wall-Mounted Visible Appliances.*

2013 National Fire Alarm and Signaling Code Handbook

Catalog Cut Sheets

NFS2-640

Intelligent Addressable Fire Alarm System

NOTIFIER® by Honeywell

Intelligent Fire Alarm Control Panels

General

The NFS2-640 intelligent Fire Alarm Control Panel is part of the ONYX® Series of Fire Alarm Controls from NOTIFIER.

In stand-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 peripheral equipment to suit the application.

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

NOTE: Unless called out with a version-specific "E" at the end of the part number, "NFS2-640" refers to models NFS2-640 and NFS2-640E; similarly, "CPU2-640" refers to models CPU2-640 and CPU2-640E.

NFS2-640

Features

- Certified for seismic applications when used with the appropriate seismic mounting kit.
- Approved for Marine applications when used with listed compatible equipment (see *DN-60688*).
- One, expandable to two, isolated intelligent Signaling Line Circuit (SLC) Style 4, 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/636 per FACP or network node.
- Standard 80-character display, 640-character large display (NCA-2, or display-less (a node on a network).
- Network options:
  - High-speed network for up to 200 nodes (NFS2-3030, NFS2-640, NFS-320(C), NFS-320SYS, NCA-2, DVC, ONYXWorks, NFS-3030, NFS-640, and NCA).
  - Standard network for up to 103 nodes (NFS2-3030, NFS2-640, NFS-320(C), NFS-320SYS, NCA-2, DVC, ONYXWorks, NCS, NFS-3030, NFS-640, NCA, AFP-200, AFP-300/400, AFP-1010, and AM2020). Up to 54 nodes when DVC 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.
- Built-in Alarm, Trouble, Security, and Supervisory relays.
- VeriFire® Tools online or offline programming utility. Upload/ Download, save, store, check, compare, and simulate panel databases. Upgrade panel firmware.
- Autoprogramming and Walk Test reports.
- Multiple central station communication options:
  - Standard UDACT
  - Internet
  - Internet/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 separate 200-event alarm-only file.
- Alarm Verification selection per point, with tally.
- Presignal/Positive Alarm Sequence (PAS).
- Silence inhibit and Auto Silence timer options.
- March time/temporal/California two-stage coding/strobe synchronization.
- Field-programmable on panel or on PC, with VeriFire 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/System Reset/Drill via monitor modules.
- 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

- Backlit, 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 DVC digital audio loop.
- Printer and CRT EIA-232 ports.
- EIA-485 annunciator and terminal mode ports.
- Alarm, Trouble, Supervisory, and Security relays.

FLASHSCAN® INTELLIGENT FEATURES

- Poll up to 318 devices in less than two seconds.
- Activate up to 159 outputs in less than five seconds.
- Multicolor LEDs blink device address during Walk Test.

NOTIFIER®

November 13, 2002 DN-6714 • H-200

FSI-751 and FSP-751/751T

Low-Profile Intelligent Plug-in Smoke Detectors with FlashScan®

Section: Intelligent/Addressable Devices

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-751 and FSI-751 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 FSI-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.

UL LISTED S1115

ULC CS308

California State Fire Marshal 7272-0028:206 *(FSP-751/-751T)* 7271-0028:201 *(FSI-751)*

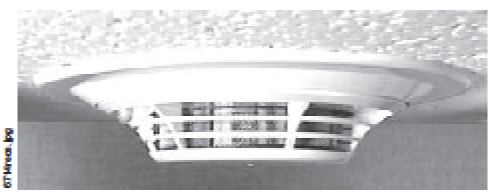
MARYLAND **State Fire Marshal** 2020 *(FSI-751)* 2013 *(FSP-751/-751T)*

FM Approved

MEA 277-99-E *(FSP-751/ -751T only)*

6714pho1.jpg

FSP-751T with B710LP base



FSP-751 with RMK400 recessed mounting kit

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 (RA400Z).
- Dual LED design provides 360° viewing angle.
- Visible bicolor LEDs blink green every time the detector is addressed, and illuminate steady red on alarm.
- Walk test with address display (an address of 121 will blink the detector LED: 12-*(pause)*-1) *(FlashScan® systems only)*.
- Built-in functional test switch activated by external magnet.
- Optional relay, isolator, or sounder bases.
- Listed to UL 268.

FlashScan® is a registered trademark of NOTIFIER.

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 49°C (32°F to 120°F).

For more information, contact NOTIFIER. Phone: (203) 484-7161 FAX: (203) 484-7118
NOTIFIER 12 Clintonville Road, Northford, Connecticut 06472

ISO 9001 CERTIFIED ENGINEERING & MANUFACTURING

October 9, 2001 DN-6716 • H-210

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.

LISTED S747

California State Fire Marshal 7270-0028:196

FM Approved

MARYLAND State Fire Marshal Permit 2011

MEA 278-99-E

CS630

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 (58°C).
- Addressable by device.
- Direct 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 viewing angle of the visual alarm indicators (Two bicolor LEDs). LEDs blink green in Normal condition and turn on steady red in Alarm.
- Integral communications and built-in device-type identification.
- Remote test feature from the panel.
- Built-in functional test switch activated by external magnet.
- Walk test with address display (an address of 121 will blink the detector LED 12-(pause)-1).
- Low standby current.
- 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.
- SEMS screws for wiring of the separate base.
- 94-5V plastic flammability rating.
- Remote LED output connection to optional RA400Z remote LED annunciator.
- Optional sounder, relay, and isolator bases.
- Optional recessed (RMK400) or surface (SMK400) base mounting kits.

APPLICATIONS

Use thermal detectors for protection of property.

For further information call NOTIFIER for manual I56-407-00, *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.

For more information, contact NOTIFIER. Phone: (203) 484-7161 FAX: (203) 484-7118

NOTIFIER 12 Clintonville Road, Northford, Connecticut 06472

ISO 9001 CERTIFIED ENGINEERING & MANUFACTURING

NOTIFIER®

March 24, 2005 DN-6821 • H-215

FSD-751P and FSD-751RP

Intelligent Photoelectric Duct Smoke Detectors with FlashScan®

Section: Intelligent Addressable Devices

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 this detection technology with an efficient housing 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/RTS451KEY Remote Test Station.

Traditional panels support addresses of 0 – 99. The FlashScan® protocol supports addresses of 0 – 159. Patented **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 grouped fashion. 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:

- ***NOT*** a substitute for open area smoke detectors.
- ***NOT*** a substitute for early warning detection.
- ***NOT*** a 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*, (A05-1004-00).

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 18 AWG (0.75 mm²). The duct smoke detector terminals accommodate wire sizes up to 12 AWG (3.25 mm²). Flexible conduit is recommended for the last foot (30.48 cm) of conduit; solid conduit connections 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-751P/FSD-751RP detector is designed for ease of wiring; the housing provides a terminal strip with clamping plates.

FlashScan® is a registered trademark of NOTIFIER.

UL LISTED S1115

ULC CS308 *(FSD-751PA, FSD-751RPA)*

MEA 143-00-E *(FSD-751P)* 389-00-E *(FSD-751RP)*

FM APPROVED

California State Fire Marshal 3240-0028:205

U.S. Coast Guard
161.002/42/1 *(NFS-640)*
161.002/27/3 *(AFP1010/AM2020, FSD-751P)*
161.002/23/3 *(AFP-200)*

MARYLAND State Fire Marshal
Permit #2036 *(FSD-751P)*
Permit #2060 *(FSD-751RP)*

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 accessory.

NOTIFIER panels offer different feature sets across different panel models. As a result, certain features of the FSD-751P/FSD-751RP 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 (one 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" (13.970 mm) high x 2.750" (69.850 mm) deep.
Options: RTS-451, RTS-451KEY, RA400Z. Separate auxiliary power 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 (one communication every 5 seconds with LED blink enabled).
Auxiliary power current draw (@ 24 VDC): 26 mA *(standby)*, 87 mA *(alarm)*.
Options: RTS-451, RTS-451KEY, RA400Z, APA451.

NOTIFIER® 12 Clintonville Road, Northford, Connecticut 06472

ISO 9001 CERTIFIED ENGINEERING & MANUFACTURING QUALITY SYSTEMS

NBG-12LX

Addressable Manual Pull Station

NOTIFIER® by Honeywell

Intelligent/Addressable Devices

General

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

Features

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

Construction

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

Specifications

- **Shipping Weight:** 9.6 oz. (272.15 g)
- **Normal operating voltage:** 24 VDC.
- **Maximum SLC loop voltage:** 28.0 VDC.
- **Maximum SLC 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**

The NBG-12LX
Addressable Manual Pull Station

Installation

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

Operation

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

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

Architectural/Engineering Specifications

Manual Fire Alarm Stations shall be non-coded, with a key-operated reset lock in order that they may be tested, and so designed that after actual Emergency Operation, they cannot be restored to normal except by use of a key. An operated station shall automatically condition itself so as to be visually detected as activated. Manual stations shall be constructed of red-colored polycarbonate material with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in white letters, 1.00 inches (2.54 cm) or larger. Stations shall be suitable for surface mounting on matching backbox SB-10 or SB-I/O; or semi-flush mounting on a standard single-gang, double-gang, or

FMM-1(A), FMM-101(A), FZM-1(A) & FDM-1(A)

Monitor Modules with FlashScan®

NOTIFIER® by Honeywell

Intelligent/Addressable Devices

General

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

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

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

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

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

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

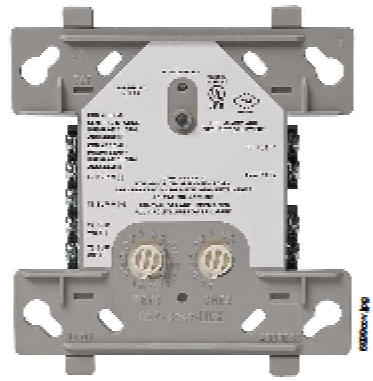
FMM-1(A) Monitor Module

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

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

FMM-1(A) APPLICATIONS

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



FMM-1(A) (Type H)

FMM-1(A) OPERATION

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

FMM-1(A) SPECIFICATIONS

Nominal operating voltage: 15 to 32 VDC.

Maximum current draw: 5.0 mA (LED on).

Average operating current: 350 µA (LED flashing), 1 communication every 5 seconds, 47k EOL.

Maximum IDC wiring resistance: 40 ohms.

EOL resistance: 47K ohms.

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

Humidity range: 10% to 93% noncondensing.

Dimensions: 4.5" (11.43 cm) high x 4" (10.16 cm) wide x 1.25" (3.175 cm) deep. Mounts to a 4" (10.16 cm) square x 2.125" (5.398 cm) deep box.

FCM-1(A) & FRM-1(A) Series

Control and Relay Modules

NOTIFIER® by Honeywell

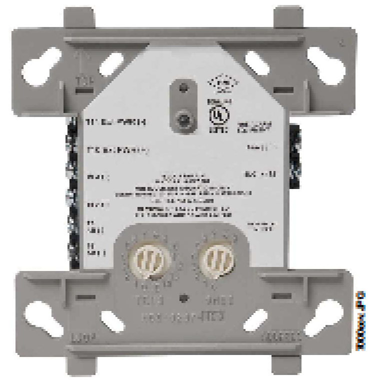
Intelligent / Addressable Devices

General

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

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

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



FCM-1(A)

Features

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

Applications

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

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

Construction

- The face plate is made of off-white heat-resistant plastic.
- Controls include two rotary switches for direct-dial entry of address (01-159).

Operation

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

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

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

Specifications for FCM-1(A)

Normal operating voltage: 15 to 32 VDC.

Maximum current draw: 6.5 mA (LED on).

Average operating current: 350 µA direct poll, 375 µA group poll with LED flashing, 485 µA Max. (LED flashing, NAC shorted.)

INSTALLATION AND MAINTENANCE INSTRUCTIONS

SpectrAlert Horns, Strobes, and Horn/Strobes

3825 Ohio Avenue, St. Charles, Illinois 60174
1-800-SENSOR2, FAX: 630-377-6495
www.systemsensor.com

For use with the following models:

Horns:	**12/24 volt:**	**H12/24**
Strobes:	**12 volt:**	**S1215, S121575**
	24 volt:	**S2415, S2430, S241575, S2475, S24110**
Combo:	**12 volt:**	**P1215, P121575**
	24 volt:	**P2415, P2430, P241575, P2475, P24110**

Add suffix "F" for units marked FUEGO, "EV" for EVAC, or "AG" for AGENT, available on 241575, red housing only.
Add suffix "P" for plain (non-printed) 241575 only.
Add suffix "W" for white housing models.
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; 5,593,569, 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 MDL 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 120° F (0° C to 49° C)
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

Note for Strobes: 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.

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, 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 required) or systems that do not require synchronization (no module required).

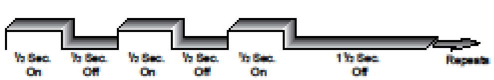
NOTICE: This manual shall be left with the owner/user of this equipment.

Fire Alarm System Considerations

Temporal and Non-Temporal Coded Signals:

The American National Standards Institute and the National Fire Alarm Code require that all horns 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 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 current 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 "lumped" 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 0.050 amps 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

NOTIFIER® by Honeywell

Audio/Visual Devices

General

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

2252pho1.jpg

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.

- **ULC Listed:** S6906
- **FM Approved**

AIR PRODUCTS AND CONTROLS

You in Control

PAM SERIES

MULTI-VOLTAGE RELAY MODULES

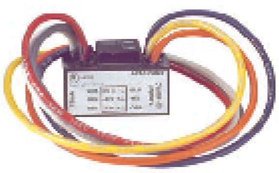
The PAM Series Relays are encapsulated multi-voltage devices with "flying" leads that offer versatile, reliable performance in a convenient package. Several of the versions contain a red LED which indicates when the relay coil is energized. The PAM Series Relays are packaged with a self-tapping screw 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 three input voltages: 24VDC, 24VAC, or 120VAC. The input voltages are polarity-sensitive and diode-protected. PAM-1 Relays contain a red LED which indicates when the relay coil is energized.

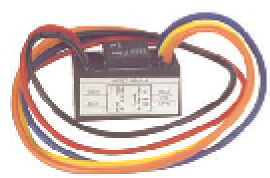


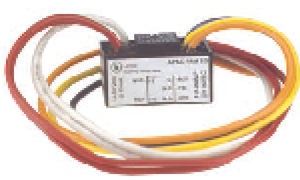
PAM-2

The PAM-2 Relay provides 7.0 A form "C" contacts. The relay may be energized by one of two input voltages: 12VDC or 24VDC. 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 9VDC to 40VDC, making it ideal for 12VDC and 24VDC EOL circuits. The 15mA 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 20VDC to 32VDC, making it ideal for 24VDC 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).

c UL us LISTED

CSFM LISTED MEA ACCEPTED

Air Products and Controls Inc.
1749 E. Highwood
Pontiac, MI 48340
(248) 332-3900 Phone
(888) 332-2241 Toll free
(248) 332-8807 Fax
www.ap-c.com

A HALMA GROUP COMPANY

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INSTALLATION AND MAINTENANCE INSTRUCTIONS

SpectrAlert Selectable Output Strobes, Horns, and Horn/Strobes

3825 Ohio Avenue, St. Charles, Illinois 60174
1-800-SENSOR2, FAX: 630-377-6495
www.systemsensor.com

For use with the following models:
Strobes - 12/24 volt: S1224MC, S1224MCW, S1224MCSP, S1224MCSPW, S1224MCP, S1224MCPW
Combo - 12/24 volt: P1224MC, P1224MCW, P1224MCSP, P1224MCSPW, P1224MCP, P1224MCPW
Horns - H12/24, H12/24W
Suffix "W" indicates white housing models. Suffix "SP" indicates "FUEGO" (Spanish word for "FIRE") lettering on housing.
Suffix "P" indicates plain housing (no lettering).
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; 6,133,843; 6,522,261; 6,661,337; 5,931,569; 6,793,375; 6,822,400; 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 120° 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
24 Volt Application:	30, 75, 110 candela 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 S5512 (Strobe); UL S4011 (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.

The models S1224MC, S1224MCW, S1224MCSP, S1224MCSPW, S1224MCP, S1224MCPW, P1224MC, P1224MCW, P1224MCSP, P1224MCSPW, P1224MCP, and P1224MCPW incorporate a patented voltage booster design that has a more consistent flash bulb voltage over the range of candela selections. The benefit to the customer is a high quality strobe device.

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).

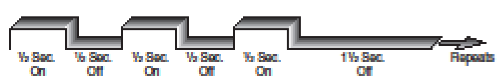
NOTICE: This manual shall be left with the owner/user of this equipment.

Fire Alarm System Considerations

Temporal and Non-Temporal Coded Signals:

The American National Standards Institute and the National Fire Alarm Code require that all horns 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 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 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®

NOTIFIER® by Honeywell

Intelligent/Addressable Devices

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 (FACPs).

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 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.
- 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 360° 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-[pause]-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 flammability 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.

- **B210LP(A):** 6.1" (15.5 cm) diameter.
- **B501(A):** 4.1" (10.4 cm) diameter.
- **B200S(A):** 6.875" (17.46 cm) diameter.

FSP-851(A) in B210LP(A) Base

- **B200SR(A):** 6.875" (17.46 cm) diameter.
- **B224RB(A):** 6.2" (15.748 cm) diameter.
- **B224BI(A):** 6.2" (15.748 cm) diameter.

Shipping Weight: 5.2oz. (147g).

Operating Temperature range: FSP-851(A), 0°C to 49°C (32°F to 120°F). FSP-851T(A), 0°C to 38°C (32°F to 100°F). Low temperature signal for FSP-851T(A) at 45°F +/- 10°F (7.22°C +/- 5.54°C). FSP-851R(A) installed in a DNR(A)/DNRW, -20°C to 70°C (-4°F to 158°F).

UL/ULC 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 30 feet (9.144m) for ceiling heights 10 feet (3.148m) 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 systemsensor.com

ELECTRICAL SPECIFICATIONS

Voltage Range: 15-32 volts DC peak.

Standby Current (max. avg.): 300μA @ 24VDC (one communication every five seconds with LED enabled).

LED Current (max.): 6.5mA @ 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-of-line resistors are not required. Wiring "T-taps" or branches are permitted for Style 4 (Class "B") wiring. 2) When using relay or sounder bases, consult the ISO-X(A) Installation

NOTIFIER®

July 20, 2004 DN-6834 • E-50

ACPS-2406

Addressable Charger/Power Supply with built-in synchronization

Section: Power Supplies

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' audio/visual devices:
  - System Sensor (SpectrAlert® Series)
  - *or* Wheelock
  - *or* Gentex
- Four NACs individually addressable by the FACP:
  - 6.0 A of output power for NAC or 5.0 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 CHG-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).

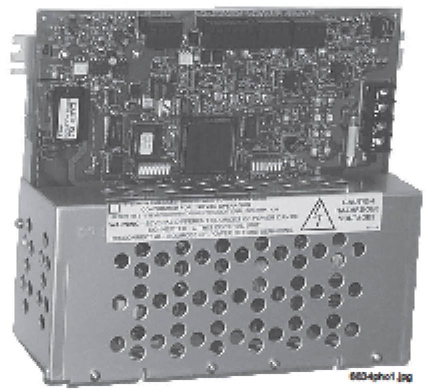
INSTALLATION STANDARDS & CODES

The ACPS-2406 complies with the following standards:

- NFPA 72 National Fire Alarm Code.
- Underwriters Laboratories:
  - UL 864 Standard for Control Units for Fire Alarm Systems.
  - CAN/ULC – S527-M87.

In addition, the installer should be familiar with the following standards:

UL LISTED S635 | ULC CS118 | MEA 173-01-E 345-02-E 317-01-E | FM APPROVED | California State Fire Marshal 7315-0028:213



(shown without cabinet)

- NEC Article 760 Fire Protective Signaling Systems.
- Applicable Local and State Building Codes.
- Requirements of the Local Authority Having Jurisdiction.

SPECIFICATIONS

- **Primary (AC) power:** 110 – 120 VAC, 50/60 Hz input, 2.7 A maximum.
- **Output voltage:** 24 VDC electrically regulated and power-limited (under primary AC mains). Under secondary power, 20.4 to 26.4 VDC.
- **Output circuits – TB4, TB5, TB6:** 2.5 A maximum for any one output circuit. For the entire supply, 5.0 A (continuous), 6.0 A during a fire alarm (1 hour UL rating).
- **Auxiliary power output:** J1 – 24 VDC @ 0.5 A general purpose power (when auxiliary power is used, fourth output rated for 2.0 A).
- **Secondary power (battery) charging circuit – TB2, TB3:** lead-acid battery charger which will charge 7 to 25 AH batteries. Maximum charger current – 1.1 A.
- **Wiring:** utilizes wire sizes 12 to 18 AWG (3.1 to 0.78 mm²).
- **SLC specifications:** *Average SLC current* is 1.287 mA. *SLC data is transmitted* between 24.0 VDC, 5 VDC, and 0 VDC at approximately 3.33 Kbaud.
- **Battery fuse (F2):** 15A, 3AB.

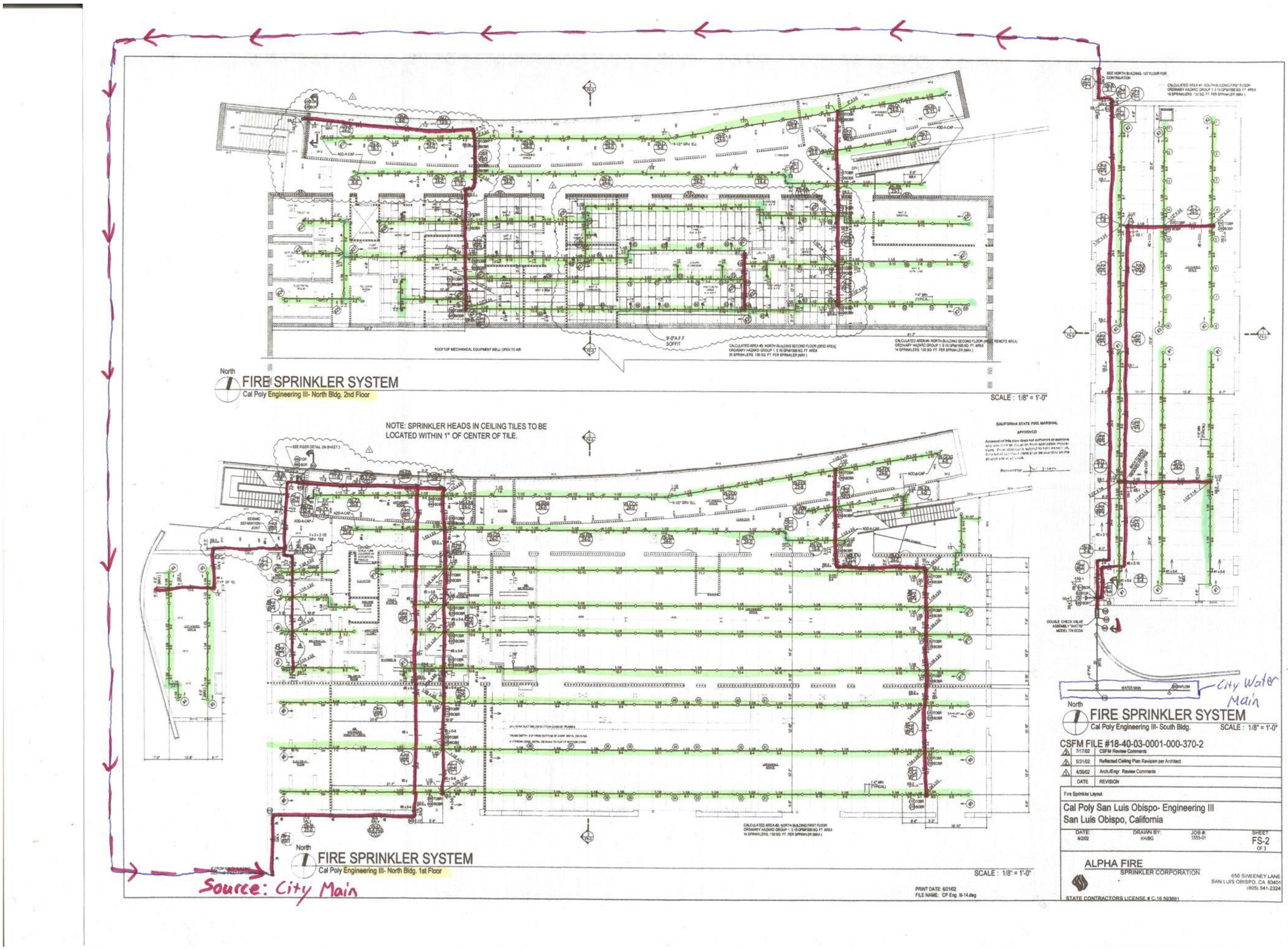
For more information, contact NOTIFIER. Phone: (203) 484-7161 FAX: (203) 484-7118
NOTIFIER 12 Clintonville Road, Northford, Connecticut 06472

ISO 9001 CERTIFIED ENGINEERING & MANUFACTURING QUALITY SYSTEMS

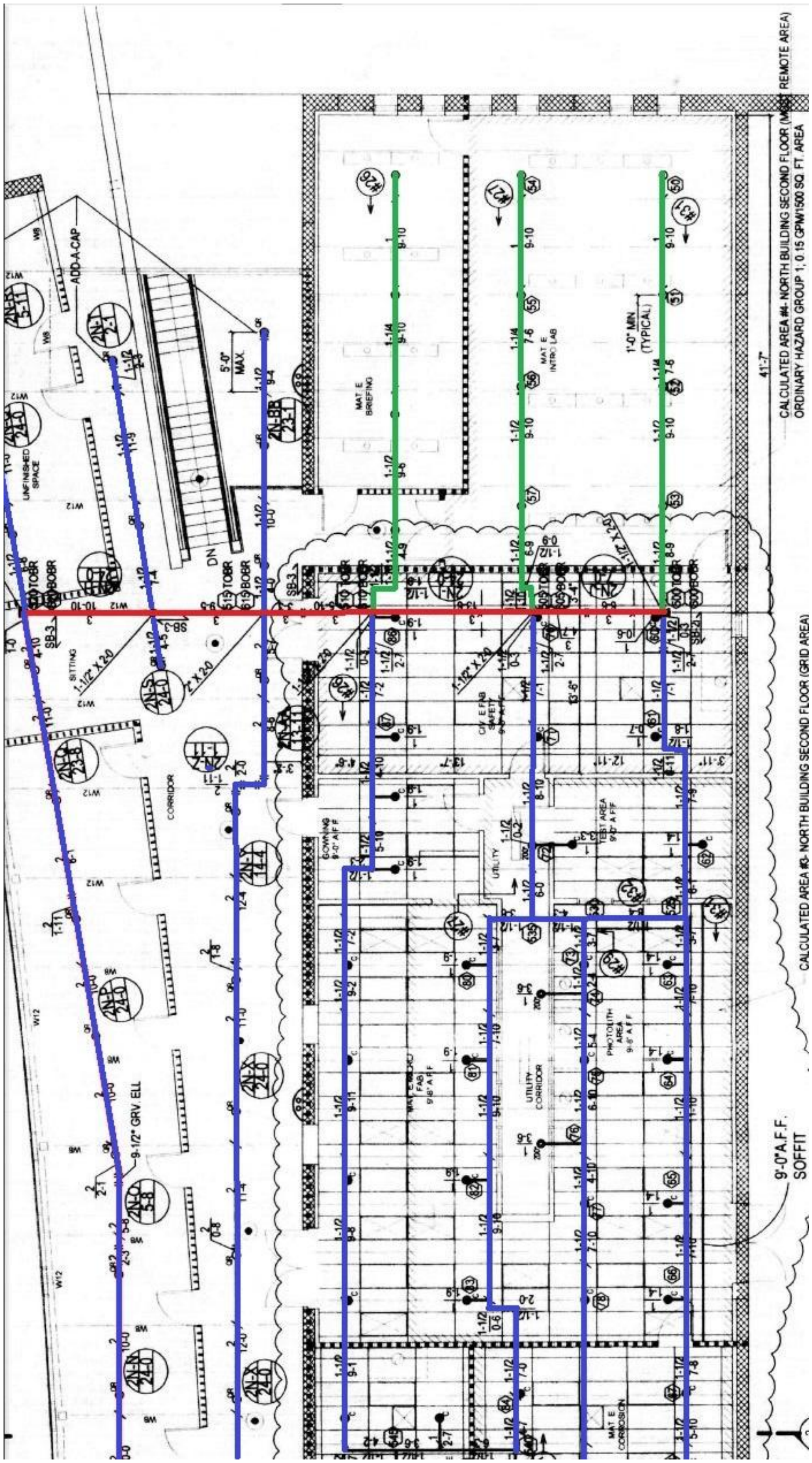
Made in the U.S.A.

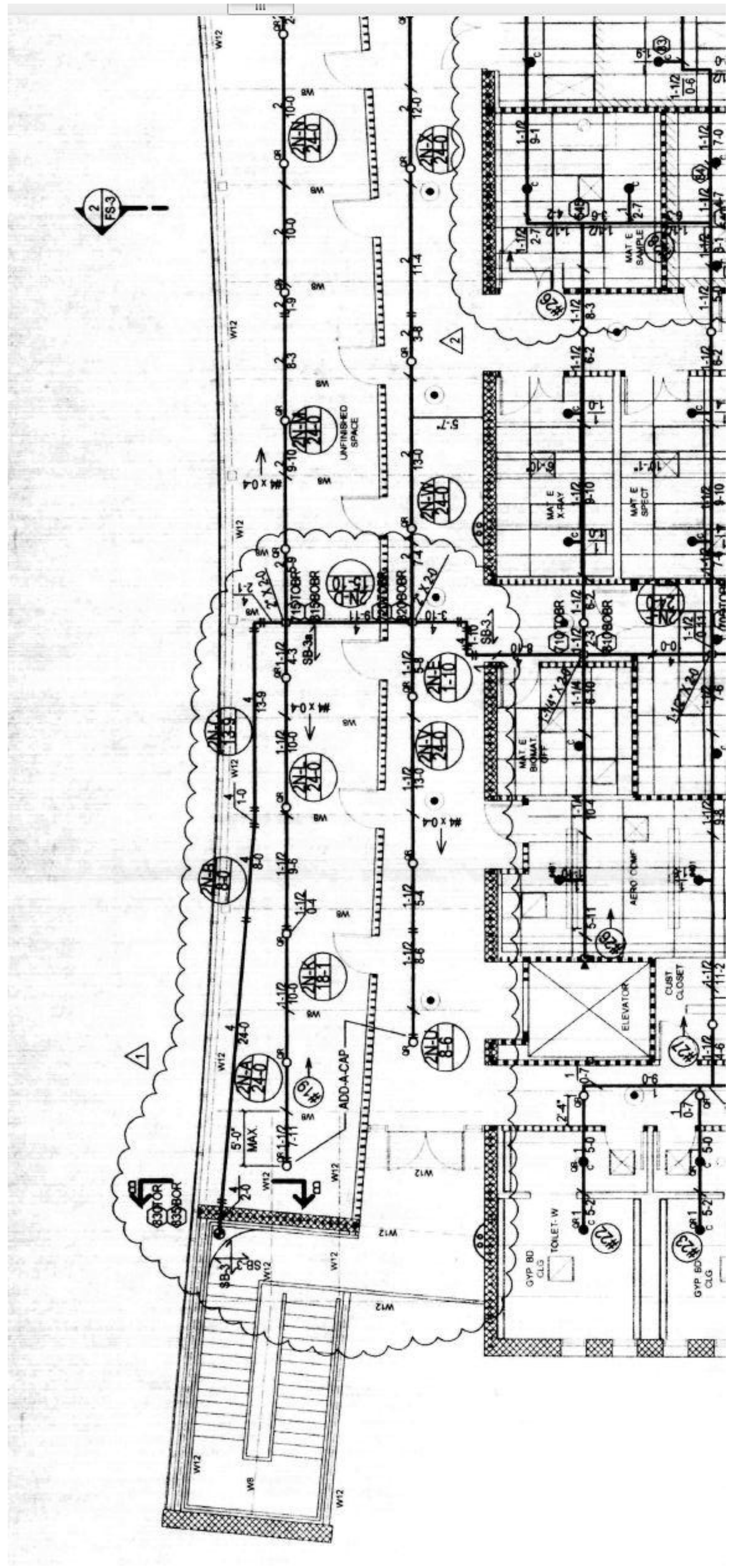
Appendix B Fire Suppression Systems

Fire Suppression System Plan Drawings



Fire Sprinkler System Most Remote Area




UNFINISHED SPACE
ELEVATOR
CUST CLOSET
AERO COMP
ADD-A-CAP

Hydraulic Calculation for the Most Remote Area of the Building

Project name:	Cal Poly - Grant M. Brown Engineering Building 41										Date: June 1st, 2014		
Step No.	Nozzle Ident and Location	Flow in gpm		Pipe size	Pipe Fittings and Devices	Equivalent Pipe Length		Friction loss (psi/ft)		Pressure Summary (psi)		Notes	
		q				L	9.83'	C=	120	Pt	12.10		q = k * (Pt)^1/2
1	S1			1"		F				Pe			q = 5.6 (12.1)^1/2 = 19.5
		Q	19.5			T		pf	0.124	Pf	1.22	Pt=	P = $(19.5/5.6)^2$ = 12.1 psi
		q	20.4			L	7.5'	C=	120	Pt	13.32		q = 5.6(13.32)^1/2
2	S2			1 1/4"		F				Pe			q = 20.4
		Q	39.9			T		pf	0.123	Pf	0.92		
		q	21.1			L	9.83'	C=	120	Pt	14.24		q = 5.6(14.24)^1/2
3	S3			1 1/2"		F				Pe			q = 21.1
		Q	61.0			T		pf	0.127	Pf	1.25		
		q	20.0			L	8.75'	C=	120	Pt	15.49		q = 5.6(15.49)^1/2
4	S4			1 1/2"		F	4'			Pe			q = 20.0
		Q	81.0			T	12.75'	pf	0.215	Pf	2.74		
		q				L		C=	120.000	Pt	18.23		$K_{BL}=Q_T/P_T^{1/2}$
						F				Pe			
		Q				T		pf		Pf			K_{BL}= 18.97
	BL1-N	q	81.0			L	11.08'	C=	120.000	Pt	18.23		q = 18.97(18.23)^1/2
5	I			3"		F				Pe			q = 81.0
	BL2-N	Q	162.0			T		pf	0.990	Pf	10.97		
	BL2-N	q	102.5			L	13.5'	C=	120.000	Pt	29.20		q = 18.97(29.2)^1/2
6	I			3"		F				Pe			q = 102.5
	BL3-N	Q	264.5			T		pf	0.083	Pf	1.12		
	BL3-N	q				L	29.33'	C=	120.000	Pt	30.32		
7	I			3"		F	7'			Pe			
	NE-N	Q	264.5			T	36.33'	pf	0.083	Pf	3.02		
	NE-N	q				L	110.92'	C=	120.000	Pt	33.34		
8	I			2"		F	5'			Pe			
	M-N1	Q	264.5			T	115.92'	pf	0.083	Pf	9,62		
	M-N1	q				L	2.17'	C=	120.000	Pt	42.96		
9	I			2"		F	5'			Pe			
	M-N2	Q	264.5			T	7.17'	pf	0.568	Pf	4.07		
	M-N2	q				L	48.75'	C=	120.000	Pt	47.03		
10	I			4"		F				Pe	11.69		
	BOR	Q	264.5			T	48.75'	pf	0.022	Pf	1.07		
		q				L		C=		Pt	59.79		
						F				Pe			
		Q				T		pf		Pf			

D = 0.15 gpm/ft2
k = 5.6

Q_{total} = 264.5 GPM
with hose = 514.5 GPM

P_{total} = 59.79 psi

Hydraulic Calculation Friction Loss

$$P = 4.52(Q)^{1.85}/C^{1.85}(d)^{4.87} = \_\_\_\_\_ \ psi/FT$$

Q = flow GPM

C = friction loss coefficient

d = internal diameter (inches)

1. $P = 4.52(19.5)^{1.85}/120^{1.85}(1.049)^{4.87} = .124\frac{psi}{FT}$
2. $P = 4.52(39.9)^{1.85}/120^{1.85}(1.380)^{4.87} = .123\frac{psi}{FT}$
3. $P = 4.52(61.0)^{1.85}/120^{1.85}(1.610)^{4.87} = .127\frac{psi}{FT}$
4. $P = 4.52(81.0)^{1.85}/120^{1.85}(3.068)^{4.87} = .215\frac{psi}{FT}$
5. $P = 4.52(162.0)^{1.85}/120^{1.85}(3.068)^{4.87} = .990\frac{psi}{FT}$
6. $P = 4.52(264.5)^{1.85}/120^{1.85}(3.068)^{4.87} = .083\frac{psi}{FT}$
7. $P = 4.52(264.5)^{1.85}/120^{1.85}(3.068)^{4.87} = .083\frac{psi}{FT}$
8. $P = 4.52(264.5)^{1.85}/120^{1.85}(3.068)^{4.87} = .083\frac{psi}{FT}$
9. $P = 4.52(264.5)^{1.85}/120^{1.85}(2.067)^{4.87} = .568\frac{psi}{FT}$
10. $P = 4.52(264.5)^{1.85}/120^{1.85}(4.026)^{4.87} = .022\, psi/FT$

Distances used in Calculations:

BL3→NE-N	NE-N→M-N1	M-N1→M-N2	M-N2→BOR
5’10”	4’10”	2’2”	13’9”
3’3”	11’		1’
9’5”	8’1”		8’
10’10”	13’		24’
	10’		2’
	5’8”		
	2’3”		
	10’		
	10’		
	9’		
	8’3”		
	9’10”		
	9’		
Total: 29.33’	Total: 110.92’	Total: 2.17’	Total: 48.75’

BL = Branch Line

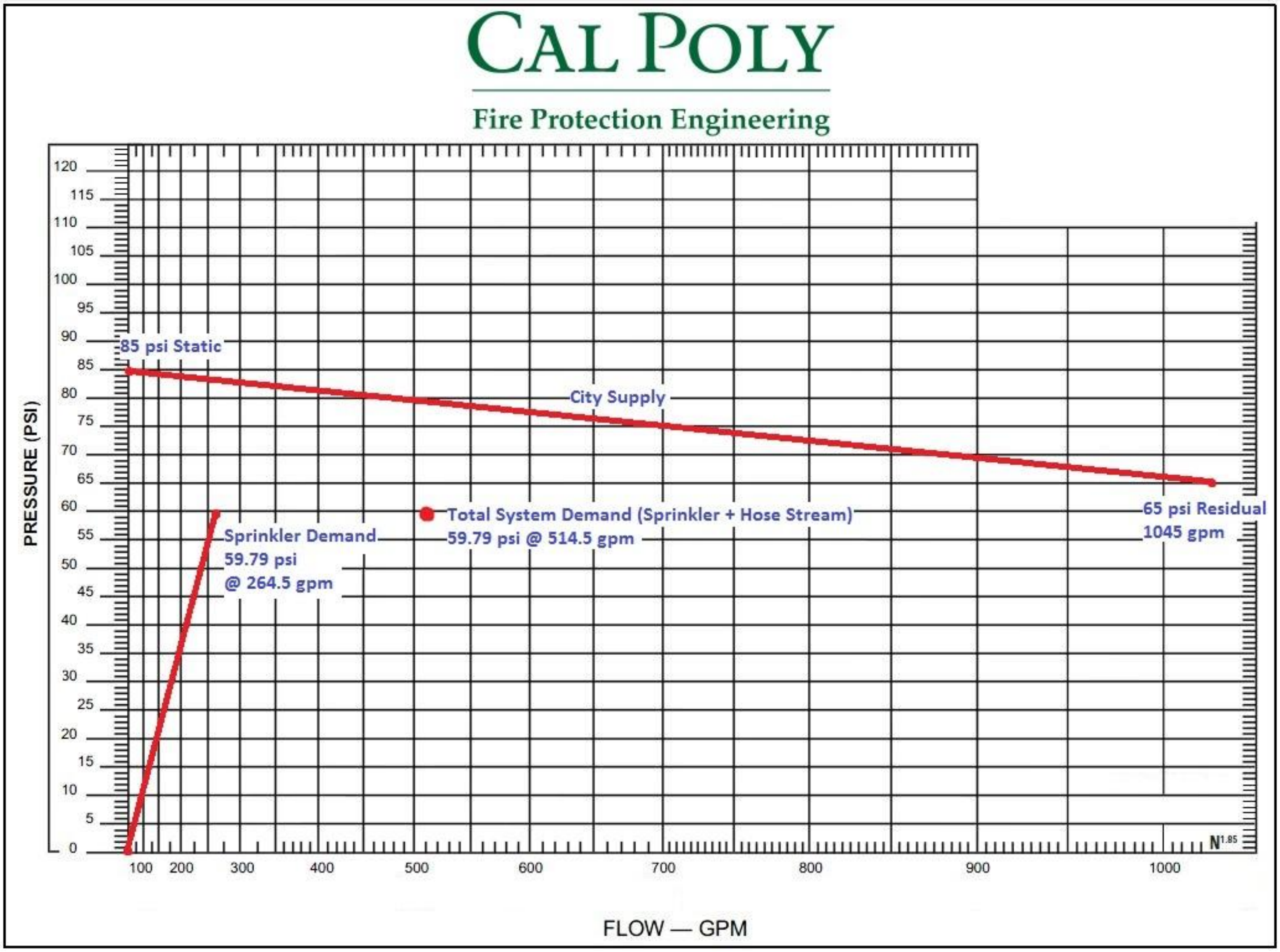
NE = Northeast

N =Node

M = Main

BOR = Base of Riser

Water Supply Graph



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

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

```
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&DUMP RENDER_FILE='Building_41_-_Scenario_2.ge1', DT_RESTART=10.0/

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&MISC RESTART=.FALSE. /

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/&BNDF QUANTITY='WALL TEMPERATURE'/

---------------------------- DEVICES -------------------------------------------------------------------------------------

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     RTI=80.0,
     PART_ID='Water_PART',
     FLOW_RATE=1.0,
     DROPLET_VELOCITY=5.0/

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

&SPEC ID='WATER VAPOR'/

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     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)

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

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&OBST XB=-10.4,-4.1,82.3,82.4,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-10.0,-0.7,80.6,80.7,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
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&OBST XB=-9.2,-4.1,82.5,82.6,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-8.8,-0.7,80.8,80.9,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-8.7,-4.1,82.6,82.7,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-8.2,-4.1,82.7,82.8,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-8.1,-0.7,80.9,81.0,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-7.7,-4.1,82.8,82.9,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-7.5,-0.7,81.0,81.1,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-7.1,-4.1,82.9,83.0,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-6.9,-0.7,81.1,81.2,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-6.6,-4.1,83.0,83.1,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-6.3,-0.7,81.2,81.3,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-6.1,-4.1,83.1,83.2,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-5.6,-4.1,83.2,83.3,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-5.6,-0.7,81.3,81.4,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-5.1,-4.1,83.3,83.4,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
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&OBST XB=-5.0,-0.7,81.4,81.5,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
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&OBST XB=-1.3,-0.7,82.0,82.1,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
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&OBST XB=-55.5,-55.4,78.4,78.5,0.1,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-55.3,78.5,79.5,0.0,0.1, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-55.3,79.9,80.1,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-55.3,79.5,79.9,0.0,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-55.3,78.5,79.5,0.1,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-55.4,-55.3,78.4,78.5,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-55.3,-0.7,78.5,79.5,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-54.6,-54.4,80.0,80.1,0.2,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-54.3,-54.1,80.0,80.1,0.2,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-48.3,-48.2,79.7,79.8,0.1,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-27.0,-0.7,80.0,80.1,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-24.9,-23.1,80.4,80.5,0.1,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-24.9,-0.7,80.2,80.3,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-24.6,-24.4,73.9,77.3,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-24.6,-23.1,80.4,80.5,0.0,0.1, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-24.6,-22.8,73.7,77.3,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-24.6,-22.8,73.7,73.9,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-23.9,-23.1,80.5,80.6,0.1,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-23.9,-0.7,80.3,80.4,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-23.4,-23.1,80.5,80.6,0.0,0.1, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-23.1,-22.9,80.4,80.5,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-23.1,-21.9,80.5,80.6,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-23.1,-11.3,80.5,80.6,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-23.1,-0.7,80.4,80.5,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-23.0,-22.8,73.9,77.3,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-19.1,-9.4,81.0,81.1,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-18.5,-17.0,81.1,81.2,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-17.4,-8.1,81.2,81.3,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-17.0,-15.5,81.3,81.4,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-11.6,-11.3,80.7,80.8,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-11.6,-10.4,82.1,82.2,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-6.3,-5.0,81.2,81.3,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-5.1,-4.5,83.2,83.3,0.0,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-5.1,-4.3,83.1,83.2,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-3.1,-0.7,81.7,81.8,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-55.5,-55.3,80.1,80.1,0.2,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-48.4,-48.3,79.8,79.8,4.4,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-45.9,-45.8,79.7,79.7,4.5,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-42.2,-42.1,83.1,83.1,4.5,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-42.2,-42.1,83.3,83.3,4.5,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-40.9,-40.8,83.3,83.3,4.4,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-7.3,-7.2,82.7,82.7,4.5,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-5.2,-5.1,83.3,83.3,4.4,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-55.5,79.9,80.1,0.2,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.3,-55.3,79.5,79.6,4.4,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.3,-55.3,78.5,78.6,4.5,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-40.1,-40.1,82.5,82.6,4.4,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction

&OBST XB=-55.6,-50.6,79.8,80.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-55.6,-48.2,79.6,79.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-55.6,-28.0,77.2,79.6,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-53.4,-51.6,76.4,77.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-49.2,-46.4,76.0,77.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-44.0,-42.2,73.6,77.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-43.4,-40.2,79.6,83.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-38.2,-28.0,79.6,79.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-34.6,-28.0,79.8,80.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-30.8,-28.0,80.0,80.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-28.0,-0.8,77.2,80.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-27.0,-0.8,80.2,80.4,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-25.0,-0.8,80.4,80.6,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-24.6,-22.8,73.6,77.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-23.0,-11.4,80.6,80.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-21.0,-10.6,80.8,81.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-19.2,-9.4,81.0,81.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-17.8,-8.0,81.2,81.4,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-16.2,-6.8,81.4,81.6,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-14.8,-5.4,81.6,81.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-13.6,-4.2,81.8,82.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-12.2,-4.2,82.0,82.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-11.0,-4.2,82.2,82.4,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-10.6,-0.8,80.6,80.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-9.8,-4.2,82.4,82.6,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-9.2,-0.8,80.8,81.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-8.8,-4.2,82.6,82.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-7.8,-0.8,81.0,81.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
```

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&OBST XB=-7.6,-4.2,82.8,83.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-6.6,-4.2,83.0,83.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-6.4,-0.8,81.2,81.4,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-5.4,-4.2,83.2,83.4,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-5.0,-0.8,81.4,81.6,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-3.6,-0.8,81.6,81.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-2.2,-0.8,81.8,82.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-55.6,-55.4,77.4,79.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-55.6,-53.2,77.2,77.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-55.6,-50.6,79.8,80.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-53.4,-53.2,76.6,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-53.4,-51.6,76.4,76.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-51.8,-51.6,76.6,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-51.8,-49.0,77.2,77.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-50.6,-48.2,79.6,79.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-49.2,-49.0,76.2,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-49.2,-46.4,76.0,76.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-48.2,-43.2,79.4,79.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-46.6,-46.4,76.2,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-46.6,-43.8,77.2,77.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-44.0,-43.8,73.8,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-44.0,-42.2,73.6,73.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-43.4,-43.2,79.6,83.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-43.4,-40.2,83.0,83.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-42.4,-42.2,73.8,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-42.4,-28.0,77.2,77.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-40.4,-40.2,79.6,83.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-40.4,-38.2,79.4,79.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-38.2,-34.6,79.6,79.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-34.6,-30.8,79.8,80.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-30.8,-28.0,80.0,80.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-28.0,-27.0,80.0,80.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-28.0,-24.4,77.2,77.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-27.0,-25.0,80.2,80.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-25.0,-23.0,80.4,80.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-24.6,-24.4,73.8,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-24.6,-22.8,73.6,73.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-23.0,-22.8,73.8,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-23.0,-22.8,77.4,77.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-23.0,-21.0,80.6,80.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-23.0,-0.8,77.2,77.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-21.0,-19.2,80.8,81.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-19.2,-17.8,81.0,81.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-17.8,-16.2,81.2,81.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-16.2,-14.8,81.4,81.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-14.8,-13.6,81.6,81.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-13.6,-12.2,81.8,82.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-12.2,-11.0,82.0,82.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-11.6,-11.4,80.4,80.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-11.6,-10.8,80.8,81.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-11.6,-10.4,80.2,80.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-11.0,-9.8,82.2,82.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-10.8,-9.4,81.0,81.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-10.4,-9.2,80.4,80.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-9.8,-8.8,82.4,82.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-9.4,-8.0,81.2,81.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-9.2,-8.0,80.6,80.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-8.8,-7.6,82.6,82.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-8.2,-6.8,81.4,81.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-8.0,-6.8,80.8,81.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-7.6,-6.6,82.8,83.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-6.8,-5.6,81.0,81.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-6.8,-5.4,81.6,81.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-6.6,-5.4,83.0,83.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-5.6,-4.4,81.2,81.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-5.4,-4.2,81.8,82.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
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&OBST XB=-5.4,-4.2,83.2,83.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-4.4,-4.2,82.0,83.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-4.4,-3.2,81.4,81.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-3.2,-1.8,81.6,81.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-1.8,-0.8,81.8,82.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-1.0,-0.8,77.4,81.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-11.6,-11.6,80.0,80.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls

------------------------------ COUCH ------------------------------------------------------------------------------------

&OBST XB=-40.8,-41.0,81.9,82.8,0.20,0.65,  SURF_ID='BURNER'/ Couch #1
&OBST XB=-41.0,-42.7,82.6,82.8,0.20,0.95,  SURF_ID='BURNER'/ Couch #2
&OBST XB=-42.7,-42.9,81.9,82.8,0.20,0.65,  SURF_ID='BURNER'/ Couch #3
&OBST XB=-41.0,-42.7,81.9,82.6,0.20,0.55,  SURF_ID='BURNER'/ Couch #4

---------------------------- HOLE ------------------------------------------------------------------------------------------

&HOLE XB=-8.8,-1.2,77.8,80.4,4.4,4.6/ Hole
&HOLE XB=-7.4,-1.2,80.4,80.6,4.4,4.6/ Hole
&HOLE XB=-6.2,-1.2,80.6,80.8,4.4,4.6/ Hole
&HOLE XB=-5.0,-1.2,80.8,81.0,4.4,4.6/ Hole
&HOLE XB=-3.8,-1.2,81.0,81.2,4.4,4.6/ Hole
&HOLE XB=-2.4,-1.2,81.2,81.4,4.4,4.6/ Hole

-------------------------- OUTSIDE ------------------------------------------------------------------------------------------

&VENT SURF_ID='OPEN', MB='ZMAX', COLOR='INVISIBLE'/ Vent
&VENT SURF_ID='OPEN', MB='XMIN'/ Vent02
&VENT SURF_ID='OPEN', MB='XMAX'/ Vent03
&VENT SURF_ID='OPEN', MB='YMIN'/ Vent04
&VENT SURF_ID='OPEN', MB='YMAX'/ Vent05

--------------------------- SLICE FILES ------------------------------------------------------------------------------------

&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 /
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Scenario 2

Building 41 - Scenario 2.fds

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&HEAD CHID='Building_41_-_Scenario_2'/
&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'/

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

&REAC ID='CELLULOSE',
     FYI='SFPE HB Table 3-4.16',
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    FUEL='REAC_FUEL',
    C=6.0,
    H=10.0,
    O=5.0,
    N=0.0,
    SOOT_YIELD=0.015/(Table 3-4.16 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)

&RAMP ID='BURNER_RAMP_Q', T=0.0, F=0.0/
&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/

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

&OBST XB=-55.5,-54.1,80.0,80.1,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-55.5,-52.3,79.9,80.0,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-55.5,-50.6,79.8,79.9,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-55.5,-48.2,79.7,79.8,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-55.5,-44.8,79.6,79.7,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-55.5,-0.7,77.3,79.6,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-53.4,-51.6,76.4,77.3,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-49.2,-46.3,76.0,77.3,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-43.9,-42.1,73.7,77.3,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-43.4,-40.1,79.6,83.3,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-39.1,-0.7,79.6,79.7,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-36.4,-0.7,79.7,79.8,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-32.2,-0.7,79.9,80.0,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-34.0,-0.7,79.8,79.9,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-30.4,-0.7,80.0,80.1,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-28.6,-0.7,80.1,80.2,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-27.0,-0.7,80.2,80.3,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-26.0,-0.7,80.3,80.4,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-24.9,-0.7,80.4,80.5,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-24.6,-22.8,73.7,77.3,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-23.9,-11.3,80.5,80.6,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-22.9,-11.4,80.6,80.7,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-21.9,-11.3,80.7,80.8,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-20.8,-10.7,80.8,80.9,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-20.0,-10.0,80.9,81.0,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-19.2,-9.4,81.0,81.1,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-18.5,-8.8,81.1,81.2,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-17.7,-8.1,81.2,81.3,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-17.0,-7.5,81.3,81.4,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-16.2,-6.9,81.4,81.5,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-15.5,-6.3,81.5,81.6,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-14.8,-5.6,81.6,81.7,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-14.0,-5.0,81.7,81.8,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-13.4,-4.4,81.8,81.9,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-12.8,-4.1,81.9,82.0,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-12.2,-4.1,82.0,82.1,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-11.6,-4.1,82.1,82.2,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-11.0,-4.1,82.2,82.3,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-10.6,-0.7,80.5,80.6,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-10.4,-4.1,82.3,82.4,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
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&OBST XB=-10.0,-0.7,80.6,80.7,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
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&OBST XB=-9.4,-0.7,80.7,80.8,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-9.2,-4.1,82.5,82.6,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-8.8,-0.7,80.8,80.9,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-8.7,-4.1,82.6,82.7,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-8.2,-4.1,82.7,82.8,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-8.1,-0.7,80.9,81.0,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
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&OBST XB=-7.5,-0.7,81.0,81.1,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-7.1,-4.1,82.9,83.0,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-6.9,-0.7,81.1,81.2,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-6.6,-4.1,83.0,83.1,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-6.3,-0.7,81.2,81.3,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-6.1,-4.1,83.1,83.2,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-5.6,-4.1,83.2,83.3,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-5.6,-0.7,81.3,81.4,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-5.1,-4.1,83.3,83.4,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
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&OBST XB=-4.4,-0.7,81.5,81.6,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-3.8,-0.7,81.6,81.7,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-3.1,-0.7,81.7,81.8,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
&OBST XB=-2.5,-0.7,81.8,81.9,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
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&OBST XB=-1.3,-0.7,82.0,82.1,4.4,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Floor
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&OBST XB=-55.5,-55.4,78.4,78.5,0.1,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-55.3,78.5,79.5,0.0,0.1, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-55.3,79.9,80.1,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-55.3,79.5,79.9,0.0,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-55.3,78.5,79.5,0.1,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-55.3,77.5,78.4,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-53.2,77.3,77.5,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-0.7,77.3,78.4,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.4,-55.3,78.4,78.5,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.4,-0.7,78.4,78.5,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.3,-54.6,80.0,80.1,0.0,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.3,-54.1,79.8,79.9,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-55.3,-50.6,79.6,79.7,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-55.3,-0.7,78.5,79.5,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-54.6,-54.4,80.0,80.1,0.2,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-53.4,-51.6,76.4,76.6,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-53.2,-53.1,79.9,80.0,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-53.2,-53.1,79.9,80.0,0.2,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-53.1,-53.0,79.9,80.0,0.0,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-52.3,-51.9,79.8,79.9,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-40.2,-40.1,82.4,82.5,0.0,0.1, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-40.2,-40.1,81.0,81.1,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-40.2,-40.1,82.5,82.8,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-40.2,-40.1,81.1,82.5,0.1,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-40.2,-40.1,82.5,82.8,0.2,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-40.2,-40.1,81.1,82.5,0.2,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-40.2,-40.1,81.0,81.1,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-39.1,-0.7,79.6,79.7,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-31.5,-30.4,79.8,79.9,0.1,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-31.5,-28.6,79.9,80.0,0.1,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-31.1,-28.6,79.9,80.0,0.0,0.1, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-30.4,-28.6,80.0,80.1,0.1,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-30.4,-0.7,79.8,79.9,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-29.3,-28.6,80.0,80.1,0.0,0.1, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-28.6,-28.1,80.1,80.2,0.0,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-28.6,-27.0,80.0,80.1,0.0,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-28.6,-0.7,79.9,80.0,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-28.1,-25.9,80.1,80.2,0.0,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-27.0,-26.9,80.2,80.3,0.0,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-27.0,-0.7,80.0,80.1,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-25.8,-23.9,80.3,80.4,0.0,0.1, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-24.6,-23.1,80.4,80.5,0.0,0.1, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-24.6,-22.8,73.7,77.3,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-24.6,-22.8,73.7,73.9,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-23.9,-23.1,80.5,80.6,0.1,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-23.1,-22.9,80.4,80.5,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-23.1,-21.9,80.5,80.6,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-3.8,-0.7,81.6,81.7,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-2.5,-0.7,81.8,81.9,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-1.9,-0.7,81.9,82.0,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-1.9,-0.7,81.9,82.0,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-1.3,-0.7,82.0,82.1,0.0,0.2, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-1.3,-0.7,82.0,82.1,0.2,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-55.5,-55.3,80.1,80.1,0.2,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-48.4,-48.3,79.8,79.8,4.4,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
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&OBST XB=-42.2,-42.1,83.1,83.1,4.5,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-42.2,-42.1,83.3,83.3,4.5,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-40.9,-40.8,83.3,83.3,4.4,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-7.3,-7.2,82.7,82.7,4.5,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-5.2,-5.1,83.3,83.3,4.4,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.5,-55.5,79.9,80.1,0.2,4.4, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.3,-55.3,79.5,79.6,4.4,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-55.3,-55.3,78.5,78.6,4.5,4.6, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction
&OBST XB=-40.1,-40.1,82.5,82.6,4.4,4.5, COLOR='GRAY 60', SURF_ID='INERT'/ Obstruction

&OBST XB=-55.6,-50.6,79.8,80.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-55.6,-48.2,79.6,79.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-55.6,-28.0,77.2,79.6,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-53.4,-51.6,76.4,77.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-49.2,-46.4,76.0,77.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-44.0,-42.2,73.6,77.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-43.4,-40.2,79.6,83.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-38.2,-28.0,79.6,79.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-34.6,-28.0,79.8,80.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-30.8,-28.0,80.0,80.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
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&OBST XB=-28.0,-0.8,77.2,80.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-27.0,-0.8,80.2,80.4,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-25.0,-0.8,80.4,80.6,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-24.6,-22.8,73.6,77.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-23.0,-11.4,80.6,80.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-21.0,-10.6,80.8,81.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-19.2,-9.4,81.0,81.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-17.8,-8.0,81.2,81.4,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-16.2,-6.8,81.4,81.6,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-14.8,-5.4,81.6,81.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-13.6,-4.2,81.8,82.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-12.2,-4.2,82.0,82.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-11.0,-4.2,82.2,82.4,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-10.6,-0.8,80.6,80.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-9.8,-4.2,82.4,82.6,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-9.2,-0.8,80.8,81.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-8.8,-4.2,82.6,82.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-7.8,-0.8,81.0,81.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-7.6,-4.2,82.8,83.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-6.6,-4.2,83.0,83.2,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-6.4,-0.8,81.2,81.4,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-5.4,-4.2,83.2,83.4,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-5.0,-0.8,81.4,81.6,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-3.6,-0.8,81.6,81.8,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-2.2,-0.8,81.8,82.0,8.2,8.4, COLOR='INVISIBLE', SURF_ID='INERT'/ 2nd Story Roof
&OBST XB=-55.6,-55.4,77.4,79.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-55.6,-53.2,77.2,77.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-55.6,-50.6,79.8,80.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-53.4,-53.2,76.6,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-53.4,-51.6,76.4,76.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-51.8,-51.6,76.6,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-51.8,-49.0,77.2,77.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-50.6,-48.2,79.6,79.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-49.2,-49.0,76.2,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-49.2,-46.4,76.0,76.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-48.2,-43.2,79.4,79.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-46.6,-46.4,76.2,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-46.6,-43.8,77.2,77.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-44.0,-43.8,73.8,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-44.0,-42.2,73.6,73.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-43.4,-43.2,79.6,83.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-43.4,-40.2,83.0,83.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-42.4,-42.2,73.8,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-42.4,-28.0,77.2,77.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-40.4,-40.2,79.6,83.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-40.4,-38.2,79.4,79.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-38.2,-34.6,79.6,79.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-34.6,-30.8,79.8,80.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-30.8,-28.0,80.0,80.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-28.0,-27.0,80.0,80.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-28.0,-24.4,77.2,77.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-27.0,-25.0,80.2,80.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-25.0,-23.0,80.4,80.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-24.6,-24.4,73.8,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-24.6,-22.8,73.6,73.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-23.0,-22.8,73.8,77.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-23.0,-22.8,77.4,77.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-23.0,-21.0,80.6,80.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-23.0,-0.8,77.2,77.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-21.0,-19.2,80.8,81.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-19.2,-17.8,81.0,81.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-17.8,-16.2,81.2,81.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-16.2,-14.8,81.4,81.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-14.8,-13.6,81.6,81.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-13.6,-12.2,81.8,82.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-12.2,-11.0,82.0,82.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
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&OBST XB=-11.6,-10.4,80.2,80.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
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&OBST XB=-10.8,-9.4,81.0,81.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
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&OBST XB=-6.8,-5.6,81.0,81.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-6.8,-5.4,81.6,81.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-6.6,-5.4,83.0,83.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-5.6,-4.4,81.2,81.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-5.4,-4.2,81.8,82.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-5.4,-4.2,83.2,83.4,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-4.4,-4.2,82.0,83.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-4.4,-3.2,81.4,81.6,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-3.2,-1.8,81.6,81.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-1.8,-0.8,81.8,82.0,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-1.0,-0.8,77.4,81.8,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls
&OBST XB=-11.6,-11.6,80.0,80.2,4.6,8.2, COLOR='GRAY 60', SURF_ID='INERT'/ 2nd Story Walls

------------------------------ CABINET ------------------------------------------------------------------------------------------------------------------------

&OBST XB=-9.3936,-7.8936,79.9,80.4,0.2,2.0, SURF_ID='BURNER'/ Cab 1
&OBST XB=-11.2526,-9.75265,79.6,80.1,0.2,2.0, SURF_ID='BURNER'/ Cab 2

---------------------------- HOLE ------------------------------------------------------------------------------------------------------------------------

&HOLE XB=-8.8,-1.2,77.8,80.4,4.4,4.6/ Hole
&HOLE XB=-7.4,-1.2,80.4,80.6,4.4,4.6/ Hole
&HOLE XB=-6.2,-1.2,80.6,80.8,4.4,4.6/ Hole
&HOLE XB=-5.0,-1.2,80.8,81.0,4.4,4.6/ Hole
&HOLE XB=-3.8,-1.2,81.0,81.2,4.4,4.6/ Hole
&HOLE XB=-2.4,-1.2,81.2,81.4,4.4,4.6/ Hole

-------------------------- OUTSIDE ------------------------------------------------------------------------------------------------------------------------

&VENT SURF_ID='OPEN', MB='ZMAX', COLOR='INVISIBLE'/ Vent
&VENT SURF_ID='OPEN', MB='XMIN'/ Vent02
&VENT SURF_ID='OPEN', MB='XMAX'/ Vent03
&VENT SURF_ID='OPEN', MB='YMIN'/ Vent04
&VENT SURF_ID='OPEN', MB='YMAX'/ Vent05

--------------------------- SLICE FILES ------------------------------------------------------------------------------------------------------------------

&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/

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&TAIL /
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