CAL POLY
Fire Protection Engineering

Cumulating Project for the Cal Poly Engineering IV Building

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Keyworks: Fire Protection, Prescriptive Analysis, Performance Based Design, Atrium Fire, FDS, Pyrosim, Hydraulic Flow Model

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Abstract

This report analyzes the fire protection systems of Engineering IV building at California Polytechnic State University, San Luis Obispo. It is a cumulative project of the Fire Protection Engineering Program at Cal Poly. The report consists of a prescriptive analysis and a performance-based design analysis. The building contains dry laboratories, classrooms, offices, and administrative spaces. The building is a three-story structure. There is an atrium that connects the first floor to the third floor. However, the building has a horizontal enclosure to separate the connection between the second floor and the third floor.

The prescriptive analysis is based on the code standards and regulations, which includes five subsections: means of egress analysis, structure analysis, fire alarm analysis, and sprinkler system analysis. The means of egress analysis section determines the occupancy load of each floor, occupancy capacity based on the door/stair width factor, common path, travel distance, and dead-end corridors. The structural analysis determines height limitations, number of story limitations, and area limitations based on the construction type of this building. The fire alarm analysis discusses detection devices application, notification devices application, and battery calculations for the system. The sprinkler system analysis discusses water source information, water demand curve, and design area. Overall, the Engineering IV building meets the code requirements and standard regulations.

The performance-based design establishes a computational fire dynamic simulation (FDS) to calculate the time to reach untenable conditions based on the assumed tenability criteria (smoke density, visibility, the temperature at 6 feet above the walking surface). The tenability criteria are referred from SFPE Handbook 5th edition. Pyrosim is utilized in the analysis to present a visual friendly output result and to determine the available safe egress time based on assumptions. Required safe egress time (RSET) is determined by an evacuation model (hand calculation) and the results are compared to ASET. Three design fire scenarios are selected in this report based on recommendations of NFPA 101, Chapter 5. The first design fire scenario is a typical office catching on fire. The consequence of the office fire is smoke spreading to a corridor which may cause occupants to get stuck in a corridor. The ASET for this design fire scenario is 385 seconds, which is greater than RSET. The second fire scenario is selected in the atrium. Smoke spread into a large open space may delay the time to detect the fire. As a result, it will raise the risk for occupants to evacuate the building within a safe time. The result shows that ASET is 355 seconds and RSET is 343 seconds. The last design fire scenario is in a lab with a large fuel load. In this report, it discusses the possibility of people getting stuck in the compartment and corridor. Based on the assumptions, the result indicates that ASET is greater than RSET. Therefore, all three design fire scenarios proves that the fire protection system design in this building is adequate for occupancy to evacuate before the time reaches untenable conditions. In one of the design fires, ASET is only slightly greater RSET and the safety factor is close to 1, which may challenge occupant's life safety. But Stair 3 in the atrium may be used for means of egress at the beginning of the fire. Even though it is not designed for evacuation, it can decrease overall evacuation time by avoiding queuing on the second floor.

Building Overview

Engineering Building IV is a new building at Cal Poly, San Luis Obispo, located on the northwest edge of the main campus. It contains dry laboratories, classrooms, offices and administrative space. The total area of this building is 104,631 SF.

The new construction of a three-story teaching and research laboratory is built with two elevators and three exterior stairways and one interior stairway. The building type is Type II – F.R. in the Uniform Building Code, which is equivalent to Type I-B in International Building Code or California Building Code. In the report, all the analysis is based on Type I-B construction type. The building is constructed of steel brace frames, concrete-filled metal decks. The exterior wall is constructed of steel STUD frame walls faced with fiber-reinforced cementitious panel and metal panel siding. The roof is a modified bituminous membrane roof on rigid insulation. The main occupancy types are B occupancy and A-3 occupancy. Figures 1 to Figures 3 are the color-coded floor plan for each floor.

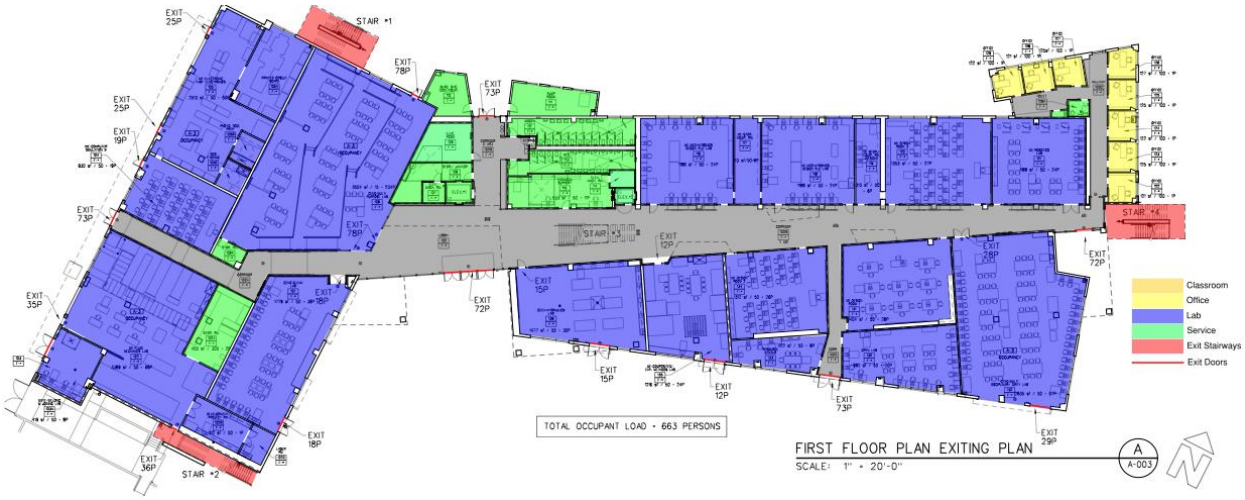


Figure 1. First Floor Building Layout

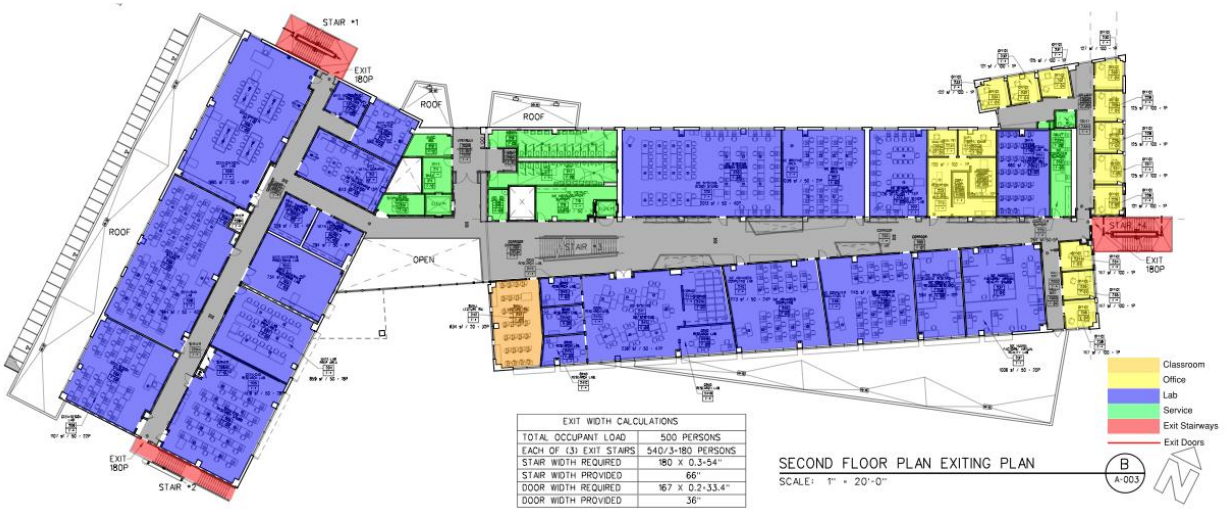


Figure 2. Second Floor Building Layout

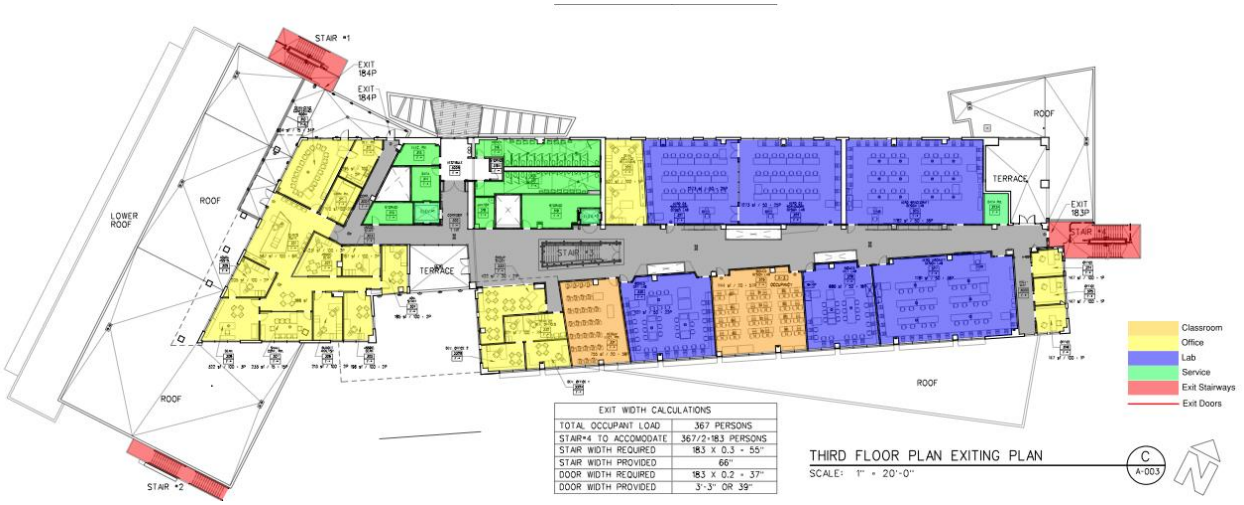


Figure 3. Third Floor Building Layout

Even though Engineering IV Building is a three-story building, it has a two-story atrium. To save cost, this building is not required to have a smoke control system. Therefore, the third floor is separated by horizontal closures as Figure 4 shows below. As a result, if a fire ignited on the first-floor atrium, it could quickly affect the tenability of the second floor. The report includes two main sections: the prescriptive analysis and performance-based design. Under the prescriptive analysis, there are five subsections: means of egress requirements, structural analysis, smoke control requirements, fire alarm requirements, and sprinkler system requirements. The performance-based design includes the analysis of three fire scenarios and comparison between available safe egress time (ASET) and required safe egress time (RSET).

Figure 4. Horizontal closure between the second floor and third floor.

Applicable Codes and Standards

The following codes and standards are referenced throughout this design

- 2016 California Building Code (CBC)
- SFPE Handbook 5th Edition

The following is a partial list of applicable standards throughout this design

- NFPA 13 Automatic Sprinkler System – 2019 Edition
- NFPA 72 National Fire Alarm Code – 2019 Edition
- NFPA 92 Smoke Control System – 2018 Edition.
- NFPA 101 Life Safety Code – 2018 Edition

The Engineering IV building was designed based on 2001 edition codes and standards. But the project is referenced from the newer version to verify if the building is still qualified to meet current code requirements.

Means of Egress Analysis

Occupancy Classification and Capacity

According to CBC 2016, the Engineering IV building is classified into two sections: A-3 and B. If the occupancy space is less than 50 people, it defined as type B occupancy. Otherwise, it is classified as A-3 occupancy. Based on the use, area, and occupancy factor of spaces, the occupancy load is provided in Table 1 to Table 3.

According to California Building Code (CBC) Section 1005.3.1, the capacity, in inches, of means of egress stairways shall be calculated by multiplying the occupant load served by such stairways by a means of egress capacity factor of 0.3 inches (7.6 mm) per occupant. Where stairways serve more than one story, only the occupant load of each story considered individually shall be used in calculating the required capacity of the stairways serving that story. And the egress capacity factor of 0.2 inches per occupant for doors as it states in Section 1005.3.2. Overview of the exits plan of the first floor, there are 5 main exit doors. But 11 classrooms or labs have exit doors open to the outside for each space to evacuate. Thus, the first floor can provide total occupancy capacity (5 main exits) is 2520 people. The second floor has three exit stairs and the third floor has two exit stairs. Stair 3 on the second and third floors cannot be used for means of egress due to its connection with the atrium. The provided occupancy capacity for these two floors is 540 people and 390 people. Details exit capacity calculation can be found from Table 1 to Table 3. All floors provide adequate exit capacity based on the code requirements.

Table 1. First floor exit summary

Exit Number	Exit Component	Exit Width	Egress Factor	Exit Capacity	Occupant Load
-	-	in	in/person	People	People
Lobby Exit	Door	216	0.2	1080	136
Room 101 Exit	Door	72	0.2	360	18
Room 102-1 Exit	Door	32	0.2	160	36
Room 102-2 Exit	Door	32	0.2	160	35
Room 103 Ext	Door	84	0.2	420	8
West Corridor Exit	Door	72	0.2	360	73
Room 104 Exit	Door	32	0.2	160	19

Room 105-1 Exit	Door	32	0.2	160	25
Room 105-2 Exit	Door	32	0.2	160	25
Room 106 Exit	Door	32	0.2	160	78
North Corridor Exit	Door	72	0.2	360	73
East Corridor Exit	Door	72	0.2	360	80
Room 130 Exit	Door	280	0.2	1400	29
South Corridor Exit	Door	72	0.2	360	73
Room 135 Exit	Door	72	0.2	360	12
Room 136 Exit	Door	72	0.2	360	15
			Total	5960	735

Table 2. Second floor exit summary

Exit Number	Exit Component	Exit Width	Egress Factor	Exit Capacity	Required Capacity
-	-	in	in/person	People	People
Stair 1	Stair	66	0.3	220	174
	Door	36	0.2	180	
Stair 2	Stair	66	0.3	220	173
	Door	36	0.2	180	
Stair 4	Stair	66	0.3	220	174
	Door	36	0.2	180	
			Total	540	521

Table 3. Third floor exit summary

Exit Number	Exit Component	Exit Width	Egress Factor	Exit Capacity	Required Capacity
-	-	in	in/person	People	People
Stair 1	Stair	66	0.3	220	183
	Door	39	0.2	195	
Stair 4	Stair	66	0.3	220	184
	Door	39	0.2	195	
			Total	390	367

Travel Distance

According to CBC Section 404.9.1, where required access to the exits is not through the atrium, exit access travel distance shall comply with Section 1017. In Table 1017.2 (Table 5), it provides the maximum allowable travel distance based on different occupancy. The building is mainly B occupancy and A-3 occupancy. Thus, the maximum travel distance with the sprinkler system is 250 feet for B and 300 feet for A-3.

Table 5. Exit access travel distance

OCCUPANCY	WITHOUT SPRINKLER SYSTEM (feet)	WITH SPRINKLER SYSTEM (feet)
A, E, F-1, M, R, S-1	200[e]	250[b]
R-2.1	Not Permitted	250[c]
B	200	300[c]
F-2, S-2, U	300	400[c]
H-1	Not Permitted	75[d]
H-2	Not Permitted	100[d]
H-3	Not Permitted	150[d]
H-4	Not Permitted	175[d]
H-5	Not Permitted	200[c]
I-2, *I-2.1*, I-3[f], I-4	Not Permitted	200[c]
L	*Not Permitted*	*200[c]*

The maximum travel distance is found on the second floor, which is 225 feet from Room 241 to Stair 1 which located in the northeast. It does not conflict with the code requirements.

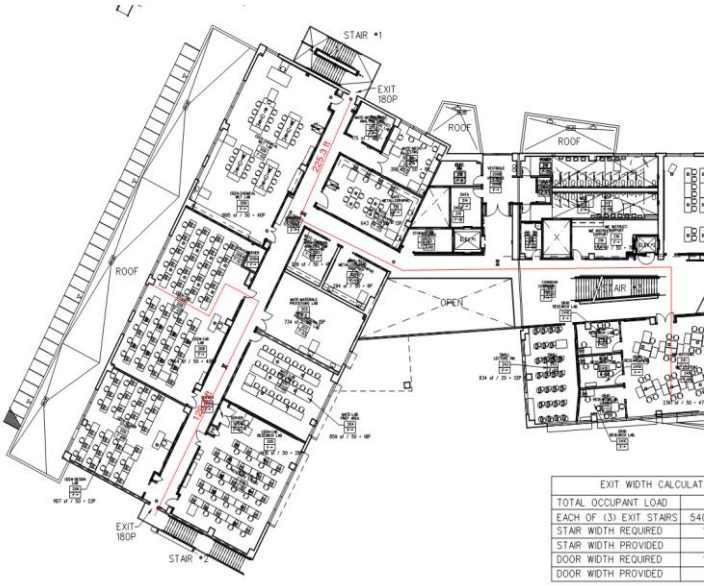


Figure 5. Location of maximum travel distance

California Building Code requires the maximum common path of egress travel distance for A occupancy is 75 feet with a sprinkler system and B occupancy is 100 feet with a sprinkler system.

Table 6. The maximum common path of egress travel distance

OCCUPANCY	MAXIMUM OCCUPANT LOAD OF SPACE	MAXIMUM COMMON PATH OF EGRESS TRAVEL DISTANCE (feet)		
		Without Sprinkler System (feet)		With Sprinkler System (feet)
		Occupant Load		
		OL ≤ 30	OL > 30	
A[c], E, M	49	75	75	75[a]
B	49	100	75	100[a]
F	49	75	75	100[a]
H-1, H-2, H-3	3	NP	NP	25[b]
H-4, H-5	10	NP	NP	75[b]
I-2[d], *I-2.1,* I-4	10	NP	NP	75[a]
I-3	10	NP	NP	100[a]
R-1	10	NP	NP	75[a]
R-2	10	NP	NP	125[a]
R-2.1	*10*	*NP*	*NP*	*75*
R-3[e], *R-3.1*[e]	10	NP	NP	125[a, g]
R-4[e]	10	*NP*	*NP*	125[a, g]
S[f]	29	100	75	100[a]
U	49	100	75	75[a]
L	*See Section 453.6.1*			

The maximum common path is found on the first floor as shown in Figure 6. It is 87 feet from Office 129 to the east corridor exit. It exceeds 75 feet but less than 100 feet. Since this common path only passes through offices which are B occupancy, it still meets the code requirements.

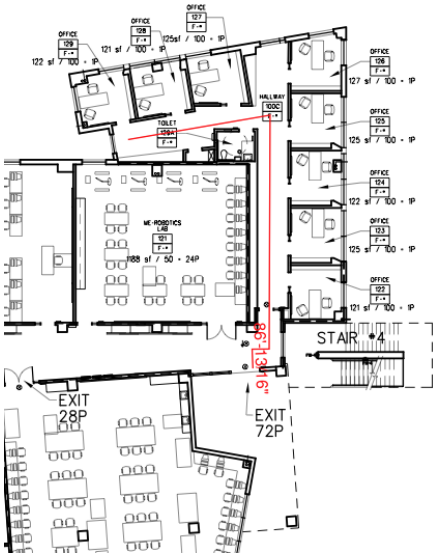


Figure 6. Maximum common path in Engineering IV building.

Dead-End Corridors

CBC Section 1020.4 states that the length of dead-end corridors limitation is 50 feet with automatic sprinkler system. As shown in Figure 7 below, the maximum length of dead-end corridors is about 34 feet located on the second floor.

Figure 7. Maximum dead-end corridors in Engineering IV building.

Exit Sign

CBC Section 1031.1 states that exit and exit access doors shall be marked by an approved exit sign readily visible from any direction of egress travel. The path of egress travel to exits and within exits shall be marked by readily visible exit signs to indicate the direction of egress travel in cases where the exit or the path of egress travel is not immediately visible to the occupants. Intervening means of egress doors within exits shall be marked by exit signs. Exit signs shall be placed within 100 feet between from the nearest visible exit sign in an exit access corridor or exit passageway. Appendix B provides the locations of exit throughout the building. Therefore, the layout of exit signs meets the code requirements.

Minimum Number of Exits

CBC Table 1006.3.1 (Table 7) requires the minimum number of exits or access to exits per story. It states that for occupant load per story is less than 500, the minimum number of exits is 2; occupant load is between

501 – 1,000, the minimum number of exits is 3; occupant load is greater than 1,000, the minimum number of exits is 4. The first floor in Engineering IV building requires 3 exits, and it provides 5 exits; The second floor requires 3 exits, and it provides 3 exits; The third floor requires 2 exits, and it provides 2 exits. Therefore, Engineering IV building meets these requirements.

Table 7. Minimum number of exits requirements

OCCUPANT LOAD PER STORY	MINIMUM NUMBER OF EXITS OR ACCESS TO EXITS FROM STORY
1-500	2
501-1,000	3
More than 1,000	4

Exit Separation

CBC Section 1007.1.1 Exceptions 2 also requires exits separation shall be placed a distance apart equal to not less than one-third of the length of the maximum overall diagonal dimension of the building or area to be served measured in a straight line between them. Engineering IV building has provided adequate exit separation distance. An example is shown in Figure 8.

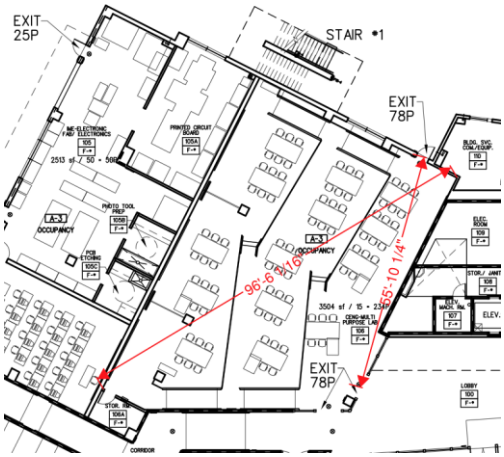


Figure 8. Exits separation

Interior Finish

The interior finish requires the wall and the ceiling flame spread index shall follow CBC Table 803.11 (Table 8). Engineering IV building uses a gypsum board for suspended ceiling and finished walls, which is Class A material. CBC 804.4. states the specific code requirements of the floor finish. Where a building is equipped throughout with an automatic sprinkler system, Class B materials are permitted in any area where Class A materials are required, and materials complying with ASTM Standard E648 and having a specific optical density smoke rating not to exceed 450 per ASTM E662 are permitted in any area where Class B materials are required. In this building, the majority floor finish is concrete, which is noncombustible. Some offices also use synthetic carpeting. Thus, all interior finishes meet with the code requirements.

Table 8. Interior wall and ceiling finish requirements

GROUP	SPRINKLERED[i]			NONSPRINKLERED		
	Interior exit stairways, interior exit ramps and exit passageways[a, b]	Corridors and enclosure for exit access stairways and exit access ramps	Rooms and enclosed spaces[c]	Interior exit stairways, interior exit ramps and exit passageways[a, b]	Corridors and enclosure for exit access stairways and exit access ramps	Rooms and enclosed spaces[c]
A-1 & A-2	B	B	C	A	A[d]	B[e]
A-3[f], A-4, A-5	B	B	C	A	A[d]	C
B, E, M, R-1	B	C	C	A	B	C

Summary of Prescriptive Egress Analysis

The section above discusses egress designs present within Engineering IV building. The discussion includes exit capacity, travel distance, dead-ends corridors, exit sign, minimum of exits, exit separation and interior finish. All designs are referenced based on current California Building Code and Life Safe Code in this report. The designs are adequate to meet the code requirements. In the next section, prescriptive structural analysis will be outlined.

Structural Analysis

Fire Resistance Analysis

Engineering IV building elements that listed in Table 9 is made of noncombustible material. In addition, this building has a height of 51 ft, 3 stories and area per story of 42,400 ft^2. Based on the information provides above, Type I-B construction type fulfills the code requirement per 2016 CBC. But according to the actual building height, number of stories and area per story, Type II-A construction type can also be considered conservative.

The structural elements in Type I-B buildings shall be made of steel, iron, concrete or masonry. Table 9 provides the requirement of fire resistance for this construction type, which is taken from 2016 CBC Table 601.

Table 9. Fire resistance rating requirements for building elements (Hours)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A[d]	B
Primary structural frame[f] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls Exterior[e, f] 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[d]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	$1\frac{1}{2}$[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

Construction Materials

The Engineering IV building is using steel for the main structural design. There is no fireproofing required. All ratings from U.L designs shall be unrestrained. Table 10 is the designed materials for the building elements.

Table 10. Construction materials

Building Element	Design	Note
1. Columns Wide Flange Roof Decks	 X – 772 X – 771	
2. Floor Decks & Roof decks	D – 925	Unprotected (No fireproofing required)
3. Floor & Roof Beams Supporting Concrete	N – 782	As noted above roof beams to be sprayed with an increase of ½ hourly rating due to the addition of insulation on top of concrete

Height Limitation Analysis

Engineer IV Building is a three-story building. According to CBC 2016 Table 504.3 (Table 11), the allowable height is 180 ft. The actual height is 51 ft such that meets the requirement by code.

Table 11. Allowable building height

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION									
	SEE FOOTNOTES	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
B, F, M, S, U	NS[b]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
A, E	*NS[b]*	*UL*	*160*	*65*	*55*	*65*	*55*	*65*	*50*	*40*
	S (without area increase)	*UL*	*180*	*85*	*75*	*85*	*75*	*85*	*70*	*60*
	S (with area increase)	*UL*	*160*	*65*	*55*	*65*	*55*	*65*	*50*	*40*

The A-3 occupancy is allowed 11 stories; however, Engineering IV Building is installed with an automatic sprinkler system. As a result, increasing one floor is allowed by code. Therefore, 12 stories allowed versus 3 stories actual. The B occupancy is allowed 12 stories versus 3 stories actually. Thus, the allowable stories meet the requirement by code (Table 12).

Table 12. The allowable number of stories

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION									
	SEE FOOTNOTES	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A-1	NS	UL	5	3	2	3	2	3	2	1
	S *(without area increase)*	UL	6	4	3	4	3	4	3	2
	S (with area increase)	*UL*	*5*	*3*	*2*	*3*	*2*	*3*	*2*	*1*
A-2	NS	UL	11	3	2	3	2	3	2	1
	S *(without area increase)*	UL	12	4	3	4	3	4	3	2
	S (with area increase)	*UL*	*11*	*3*	*2*	*3*	*2*	*3*	*2*	*1*
A-3	NS	UL	11	3	2	3	2	3	2	1
	S *(without area increase)*	UL	12	4	3	4	3	4	3	2
	S (with area increase)	*UL*	*11*	*3*	*2*	*3*	*2*	*3*	*2*	*1*
A-4	NS	UL	11	3	2	3	2	3	2	1
	S *(without area increase)*	UL	12	4	3	4	3	4	3	2
	S (with area increase)	*UL*	*11*	*3*	*2*	*3*	*2*	*3*	*2*	*1*
A-5	NS	UL	UL	UL	UL	UL	UL	UL	UL	UL
	S	UL	UL	UL	UL	UL	UL	UL	UL	UL
B	NS	UL	11	5	3	5	3	5	3	2
	S	UL	12	6	4	6	4	6	4	3

Area Limitation Analysis

The allowable area of each floor is referencing CBC Table 506.2 (Table 13). For A-3 and B occupancy with a sprinkler system, the required maximum area limitation is unlimited for Type I-B construction.

Table 13. Allowable area of each floor.

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A-1	NS	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
	S1	UL	UL	62,000	34,000	56,000	34,000	60,000	46,000	22,000
	SM *(without height increase)*	UL	UL	46,500	25,500	42,000	25,500	45,000	34,500	16,500
	SM (with height increase)	*UL*	*UL*	*15,500*	*8,500*	*14,000*	*8,500*	*15,000*	*11,500*	*5,500*
A-2	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000
	SM *(without height increase)*	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000
	SM (with height increase)	*UL*	*UL*	*15,500*	*9,500*	*14,000*	*9,500*	*15,000*	*11,500*	*6,000*
A-3	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000
	SM *(without height increase)*	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000
	SM (with height increase)	*UL*	*UL*	*15,500*	*9,500*	*14,000*	*9,500*	*15,000*	*11,500*	*6,000*
A-4	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000
	SM *(without height increase)*	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000
	SM (with height increase)	*UL*	*UL*	*15,500*	*9,500*	*14,000*	*9,500*	*15,000*	*11,500*	*6,000*
A-5	NS	UL	UL	UL	UL	UL	UL	UL	UL	UL
	S1									
	SM									
B	NS	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
	S1	UL	UL	150,000	92,000	114,000	76,000	144,000	72,000	36,000
	SM	UL	UL	112,500	69,000	85,500	57,000	108,000	54,000	27,000

To display a clearer contrast, Table 14 provides a comparison between code requirements and actual situation of building height, number of stories and area per story.

Table 14. Comparison between code requirements and provided building height, number of stories and area per story

	Allowable	Actual
Height	180 feet	51 feet
Stories	12 (B and A-3)	3
Area per Story	UL	42,400 sf

Fire Separation

CBC states that fire separation distance requires the exterior walls and openings in exterior walls shall comply with Tables 601 and 602 (Table 15). The distance shall be measured from the building face to one of the following at right angles from the face of the wall:

1. The closest interior lot line;
2. To the centerline of a street, an alley or public way; or
3. To an imaginary line between two buildings on the lot

Figure 9 below illustrates the fire distance from Engineering IV building to the other three buildings surround it. The minimum distance is 25 feet. According to CBC Table 602 (Table 15), the required fire-resistance rating for exterior walls is 1 hour (Type I-B, occupancy group A and B, fire separation distance between 10 feet and 30 feet). The provided exterior walls of these buildings are 1 hour. Therefore, the design meets the code requirements.

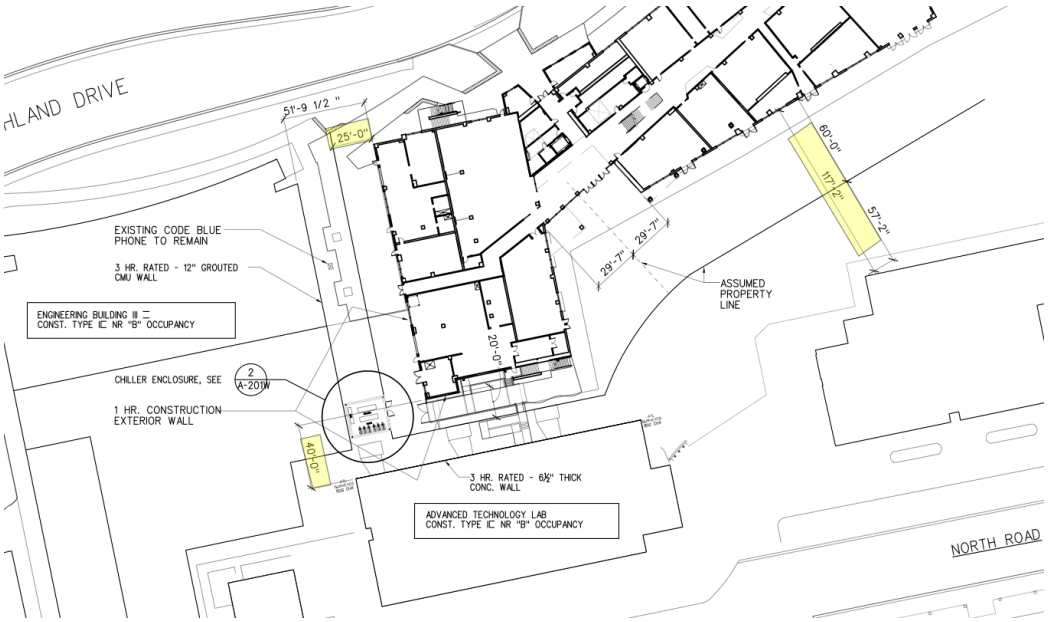


Figure 9. Fire distance between Engineering IV building and other buildings

Table 15. Fire-Resistance Rating Requirements

FIRE SEPARATION DISTANCE = X (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP H[e], *L*	OCCUPANCY GROUP F-1, M, S-1[f]	OCCUPANCY GROUP A, B, E, F-2, I, R[h], S-2, U[h]
X < 5[b]	All	3	2	1
5 ≤ X < 10	IA Others	3 2	2 1	1 1
10 ≤ X < 30	IA, IB IIB, VB Others	2 1 1	1 0 1	1[c] 0 1[c]
X ≥ 30	All	0	0	0

Summary of Prescriptive Structural Analysis

The structural analysis outlines the fire protection features within Engineering IV building. The prescriptive analysis is focused on the code requirements of 2016 CBC. Based on the construction type, all the structural materials meet the code requirements. In addition, the allowable building height, area and fire separation do not conflict with the current code requirements. The following section will analyze the prescriptive fire alarm design.

Fire Alarm Design Analysis

Identification of the Type of Fire Alarm System

A completed fire alarm system floor plan of each floor is attached in Appendix C. Engineering IV building is installed with a conventional fire alarm system which is fully addressable. The fully addressable fire alarm system provides details on the individual detectors. In this system, various form of detection and notification devices are connected to one fire alarm control panel (FACP). These devices are monitored and protecting the building 24/7.

The fire alarm system in Engineering IV building installs both manual and automatic with sprinkler monitoring, elevator control interface and HVAC shutdown, which cover all areas of all floors.

Operating Characteristics of Fire Alarm System

In Appendix D (also see Table 16), the table of a sequence of operation illustrates the initiating devices correspond with the fire alarm protection system.

Table 16. Sequence of Operation

	Manual Pull Station	Area Smoke Detector	Area Heat Detector	Duct Smoke Detector	Elevator Smoke Detector	Elevator Heat Detector	Sprinkler Flow Switch	Sprinkler Tamper Switch	Interruption of Normal Power
Annunciate Alarm Signal at FACP	YES	YES	YES	YES	YES	YES	YES	NO	NO
Annunciate Trouble Signal at FACP	YES	YES	YES	YES	YES	YES	YES	YES	YES
Transmit Signal to Central Station via Digital Communicator	YES	YES	YES	YES	YES	YES	YES	YES	YES
Transmit Signal to BMS	YES	YES	YES	YES	YES	YES	YES	YES	YES
Initiate Building Audible Alarm Signal	YES	YES	YES	YES	YES	YES	YES	NO	NO
Initiate Building Visual Alarm Signal	YES	YES	YES	YES	YES	YES	YES	NO	NO
Shutdown Associated Air Handling Systems	NO	YES	YES	YES	YES	YES	YES	NO	NO
Activate Associated Fire Smoke Dampers	NO	YES	YES	YES	YES	YES	YES	NO	NO
Recall Elevators to Designated Level	NO	NO	NO	NO	YES	NO	NO	NO	NO
Recall Elevators to Alternate Level	NO	NO	NO	NO	YES	NO	NO	NO	NO
Disconnect Power to Elevator Controllers	NO	NO	NO	NO	NO	YES	NO	NO	NO

When manual pull station, area smoke detector, area heat detector, duct smoke detector, elevator smoke detector, elevator heat detector and sprinkler flow switch activate, they will annunciate alarm and trouble conditions at the fire alarm control panel; transmit a signal to central station and BMS; initiate building audible and visual alarm signal.

All types of smoke detector and heat detector and sprinkler flow switch will shut down associated air handling systems and fire smoke dampers.

When elevator smoke detector activates, it will recall elevators to a designated or alternate level. The elevator heat detector will disconnect power to elevator controllers.

Sprinkler tamper switch and interruption of normal power annunciate trouble signal at FACP and transmit a signal to central station and BMS.

Identification of the Model and Location of FACP

Engineering IV Building is installed with a Notifier NFS-640 fire alarm control panel, which is shown in Figure 10. A 120 VAC primary power supply connects to it. And there are two additional batteries connected to the FACP as auxiliary power supplies. As shown in a riser diagram (Appendix E), all detection devices and notification devices are connected to the FACP directly.

Figure 10. Notifier NFS-60 Fire Alarm Control Panel.

The location of the FACP is shown in Figure 11. It is located on the first floor, Room 109 electrical room.

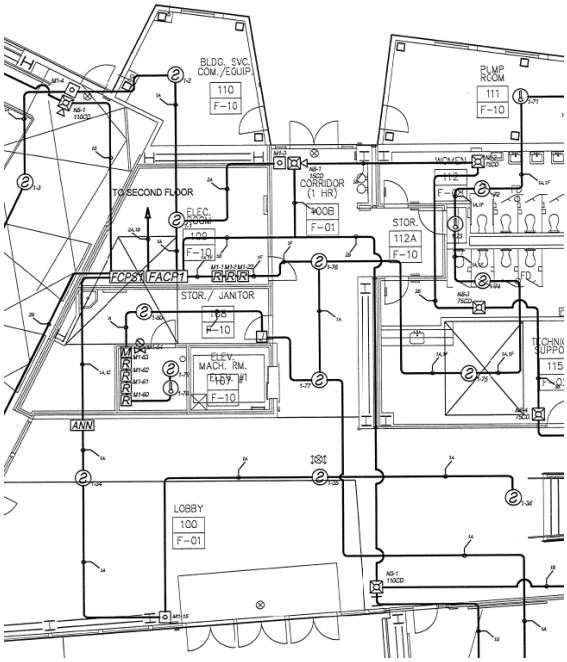


Figure 11. Location of FACP

Identification of The Type and Location of Fire Detection Devices

In this section, the types and locations of fire detection devices installed in the building will be discussed. It includes smoke detectors, heat detectors, duct smoke detectors, automatic sprinklers, and a manual pull station. The completed fire alarm floor plan with each detection devices' location is attached in Appendix F.

Smoke Detector

The smoke detectors installed in the Engineering IV building are Notifier FSP-851 (CSFM #7150-0028:199) model as shown in Figure 12. They are intelligent, photoelectric detectors including point ID capability that enables each detector address to be set with rotary address switches to provide exact detector locations. The listed spacing is 30 feet. There is a total of 243 units installed in the building. They are equipped in almost every classroom, lab, office and corridor.

Figure 12. Notifier FSP-851 Smoke Detector

Heat Detector

The heat detectors installed in the Engineering IV building are Notifier FST-851 (CSFM #7270-0028:196) model as shown in Figure 13. They are intelligent, 135°F fixed temperature detectors including point ID capability that enables each detector address to be set with rotary address switches to provide exact detector locations. The listed spacing is 30 feet. There is a total of 9 units installed in the building. They are equipped in Room 103, Room 103A, Room 108, Room 111, Room 112A, Room 114, Room 216, Room 316, and Elevator #2. Most of them are protecting the storage space or mechanical equipment.

Figure 13. Notifier FST-851 Heat Detector.

Duct Smoke Detector

The duct smoke detectors installed in the Engineering IV building are Notifier FSD-751P (CSFM #3240-0028-205) model as shown in Figure 14. They are intelligent, photoelectric detectors including point ID capability that enables each detector address to be set with rotary address switches to provide exact detector locations. The listed duct air velocity range is 500 to 4,000 ft/min. There is a total of 2 units installed in the building. They are equipped in the pipe that connects to air handling units on the roof. They are monitored by two relay modules.

Figure 14. Notifier FSD-751P Duct Smoke Detector

Manual Pull Station

The manual pull station installed in Engineering IV building is Notifier NBG-12LX models. They are intelligent. There is a total of 22 units equipped through the building. 16 of them are installed on the first floor near the exit doors. 3 of them are installed on the second floor near to the exit stairs. And 3 of them are installed on the third floor near the exits access to the exit stairs.

Location, Spacing and Placement of Fire Detection Devices

General

In this section, I will determine if the location, spacing and placement of fire detection devices installed in Engineering IV building comply with the code requirement of NFPA 72. The automatic sprinkler will be discussed in sprinkler system analysis.

Smoke Detectors

According to NFPA 72 Section 17.7.3.2.3.1 (1), the distance between smoke detectors shall not exceed a nominal spacing of 30 ft and there shall be detectors within a distance of one-half the nominal spacing, measured at right angles from all walls or partitions extending upward to within the 15 percent of the ceiling height. And 17.7.3.2.3.1 (2) states that all points on the ceiling shall have a detector within a distance equal to or less than 0.7 times the nominal 30 ft spacing. The smoke detector FSP-851 coverage area provided by Notifier is 30 feet for ceiling heights 10 feet and greater. After checking each smoke detector spacing of the building, all of them meet the code requirements. Also, according to 17.7.3.2.3.1 (4) and (5) for corridors 15 ft in width or less having ceiling beams or solid joists perpendicular to the corridor or rooms of 900 ft^2 or less, the following shall apply: (a) smooth ceiling spacing shall be permitted; (b) location of spot-type smoke detectors shall be permitted on ceilings, sidewalls, or the bottom of beams or solid joists. Most of the ceilings of Cal Poly Engineering IV building can be considered as a finished smooth ceiling, except the main corridor on the first floor as shown in Figure 15. However, the slope of the ramp is less than 10%. Therefore, a smooth ceiling assumption can still apply to it.

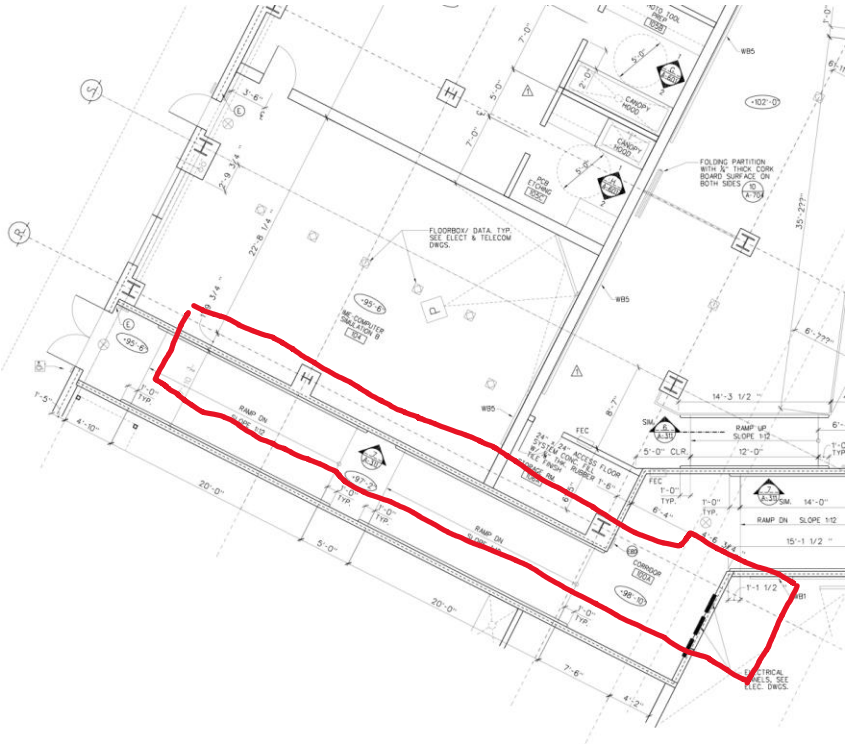


Figure 15. Main Corridor

The locations of smoke detectors also need to consider the effect of ambient temperature, relative humidity, and air velocity. According to NFPA 72, 17.7.1.8, unless specifically designed and listed for the expected conditions, smoke detectors shall not be installed if any of the following ambient conditions exist:

(1) Temperature below 32°F (0°C).
(2) Temperature above 100°F (0°C).
(3) Relative humidity above 93 percent.
(4) Air velocity greater than 300 ft/min (1.5 m/sec).

The code also states in section 17.1.10, the location of smoke detectors shall be based on evaluation of potential ambient sources of smoke, moisture, dust or fumes and electrical or mechanical influences, to minimize nuisance alarms. It explains why Room 103A (welding lab) and Room 111 (pump room) do not have smoke detectors.

In Engineering IV building, the most possible location airflow that can affect the sensibility of smoke detectors is where air vents for the HVAC system are installed. By rough measurement, the smoke detectors are placed several feet away from the air vents. Thus, the influence made by airflow is negligible.

To overview the smoke detector coverage areas, it is found that there are two areas that are not protected. They are atrium and west corridor on the second floor, which are the highlighted area in Figure 16.

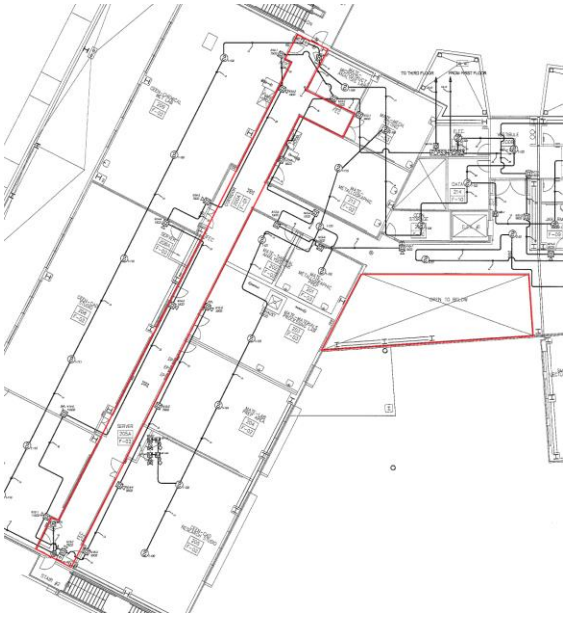


Figure 16. The unprotected area by smoke detectors

To explain why the corridor area is not protected, the reasonable assumption is that a large HVAC vent runs along the ceiling in the corridor. There is no space for the smoke detectors to be installed on the ceiling. But sprinklers are presented in this area with 8' to 15' spacing. Another location without smoke detector is the atrium. The atrium is open to the second floor is about 30 feet high. It does not comply with the code requirements. There are some solutions to this situation. First, no ignitable materials are placed in the atrium, except couches. But the couches are protected by sprinklers and smoke detectors which are mounted on the extended portion on the second floor. Figure 17 shows what it looks like. The second solution is placing sprinklers on the second-floor ceiling with 10' spacing.

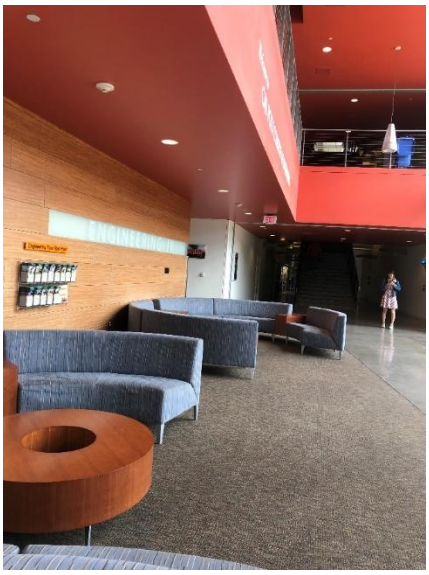


Figure 17. Location of sprinklers, smoke detectors and furniture

Heat Detectors

According to NFPA 72, 17.6.3.1, the heat detector shall be placed on a smooth ceiling. The distance between detectors follows the listed spacing, and there shall be detectors within a distance of one-half the

listed spacing, measured at right angles from all walls or partitions extending upward to within the top 15 percent of the ceiling height. And all points on the ceiling shall have a detector within a distance equal to or less than 0.7 times the listed spacing. The spacing shall be reduced based on ceiling height. More details are shown in Table 17. Engineering IV building only equipped a few heat detectors. All of them are mounted on a smooth ceiling in rooms. The ceiling height of each floor is 15 feet. Taking account of spacing reduction, the heat detectors are still able to cover the required areas. Therefore, device coverage is adequate.

Table 17. Heat detector spacing reduction based on ceiling height

Ceiling Height Greater than (>)		Up to and Including		Multiply Listed Spacing by
ft	m	ft	m	
0	0	10	3.0	1.00
10	3.0	12	3.7	0.91
12	3.7	14	4.3	0.84
14	4.3	16	4.9	0.77
16	4.9	18	5.5	0.71
18	5.5	20	6.1	0.64
20	6.1	22	6.7	0.58
22	6.7	24	7.3	0.52
24	7.3	26	7.9	0.46
26	7.9	28	8.5	0.40
28	8.5	30	9.1	0.34

Duct Smoke Detectors

According to NFPA 17.7.5.5.2, and 17.7.5.5.3, duct smoke detectors should be rigidly mounted within the duct to obtain a representative sample of the airstream. The duct smoke detectors are placed within the duct which connects to the air handling units on the third floor. Therefore, device placement meets the code requirements.

Fire Detector Response Analysis

General

In this section, an appropriate fire scenario is identified and justified. The expected response characteristics of the fire detection devices installed in the building are calculated. It includes hand calculations and FDS results.

Fire Scenario

The selected fire scenario is taking place in Room 122, office room, located on the east end of the first floor. Office 122 is a very typical office room in dimensions. In this compartment, the main source of fuel will be a computer workstation consisting of a computer desk and a bookcase. Each is constructed with 5/8” thick particleboard covered with simulated wood, plastic laminate. The desk was loaded with 99 lb. of paper materials and the bookcase was loaded with 160 lb. of paper materials. This is a very typical office layout. Thus, it would be enough to represent the compartment fuel load. The dimension of the office is 3.5m x 3.2m x 4.6m.

In my Design Fire 2, the assumption made is that all the items will start igniting at the same time. I used the HRR data from the University of Maryland burning database as seen in Figure 18.

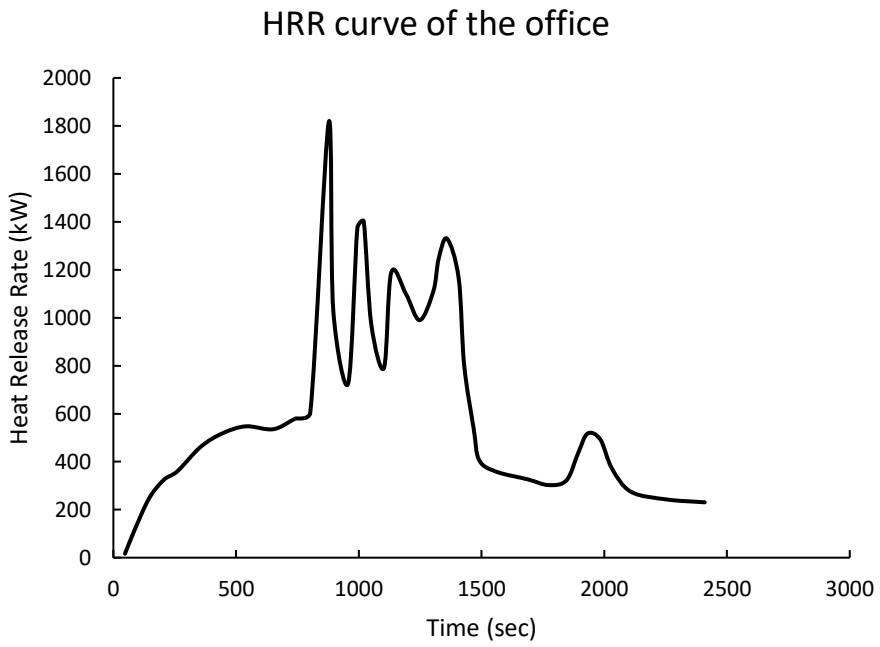


Figure 18. HRR curve of the office compartment. The maximum HRR is 1800 kW.

Sprinkler Activation Time

To calculate the sprinkler activation time, the input parameters need to be determined which is shown in Table 18. The sprinkler is placed on the ceiling height of 4.5 meters above the fire and the radial distance is 1 m away from the center of the fire. Assume an ambient temperature is 20 °C and a sprinkler activation temperature is 68 °C. Based on the manufacturer's specification, the sprinkler RTI is 50 $(ms)^{1/2}$.

Table 18. Input parameters for sprinkler activation time

INPUT PARAMETERS		
Ceiling height (H)	4.5	m
Radial distance (R)	1	m
Ambient temperature (T0)	20	C
Actuation temperature (Td)	68	C
Response time index (RTI)	50	$(ms)^{1/2}$
Heat release rate (kW)	Database	

The method used to determine the sprinkler activation time is Alpert ceiling jet correlation:

$Ceiling\ temperature$:

$$T_j - T_\infty = \frac{5.38}{H}\left(\frac{\dot{Q}}{r}\right)^{\frac{2}{3}}, \frac{r}{H} > 0.18$$

$Ceiling\ smoke\ velocity$:

$$u_j = 0.195\left(\frac{\dot{Q}^{\frac{1}{3}}H^{\frac{1}{3}}}{r^{\frac{5}{6}}}\right), \frac{r}{H} > 0.15$$

Detector temperature:

$$T_d^{i+1} = \frac{\sqrt{u_j}}{RTI}\left(T_j - T_d^i\right) + T_d^i$$

The result indicates that the sprinkler activates at 146 seconds, which shows in Figure 19. When a sprinkler activates, the HRR is about 250 kW.

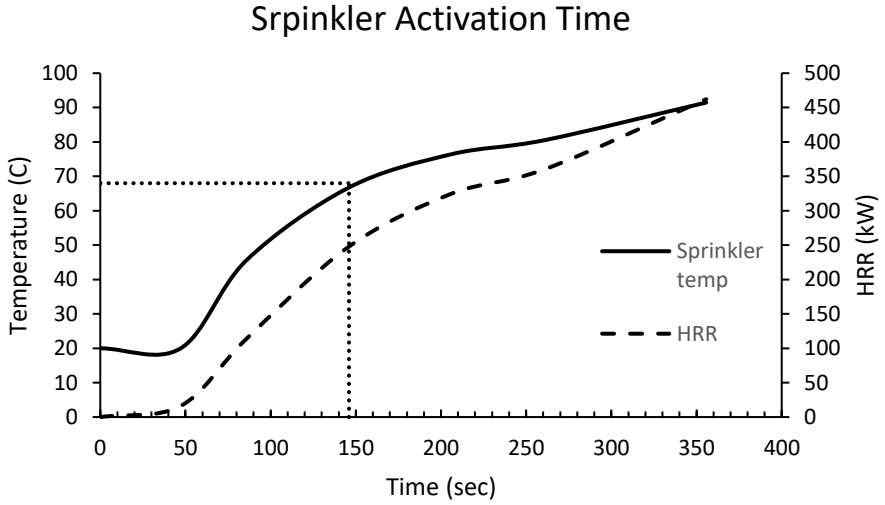


Figure 19. Sprinkler activation time and fire size at that time.

Smoke Detector Activation Time

The method to determine the smoke detector activation time is different than the sprinkler activation calculation. Instead of using Alpert ceiling jet correlation, FDS is used in this analysis. The smoke detector is placed on the ceiling height of 4.4 meters above the fire and the radial distance is 2 m away from the center of the fire. Assume an ambient temperature is 20 ℃ and a smoke detector activation obscuration threshold is 3.28 %/m. Based on the graph shown in Figure 20, the smoke detector activates at about 38 seconds. At that time, the HRR is about 13 kW.

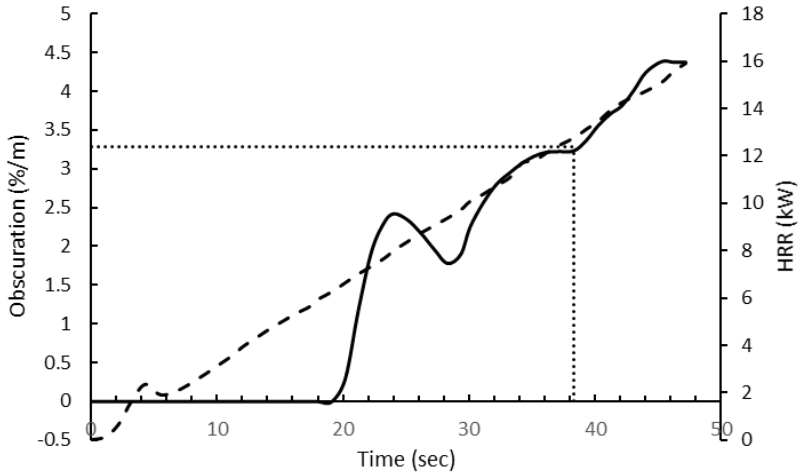


Figure 20. Smoke detector activation time and the fire size at that time.

Fire Alarm System Types and Requirements

In this section, the type of fire alarm system installed in the Engineering IV building is described along with the requirements for the disposition of alarm, supervisory and trouble signals.

The type and location of the fire alarm control panel are discussed in Section 4. Details of wiring connection are attached in Appendix F. There are four power supplies are connected with the FACP to provide adequate voltage to support all devices. The fire alarm annunciator is installed on the wall of first-floor atrium, against the main entrance. The panel is also connected to off-site monitoring via dual phone lines.

The code requirement of the disposition of alarm, supervisory and trouble signals shall refer to NFPA 72, section 10.11 alarm signals; section 10.12 fire alarm notification appliance deactivation; section 10.14 supervisory signals; and section 10.15 trouble signals. The code illustrates the actuation of alarm notification appliances or emergency voice communications, emergency control function interface devices, and annunciation at the protected premises shall occur within 10 seconds after the activation of an initiating device. It also stipulates the supervisory signals and trouble signals activation and deactivation conditions. Furthermore, the code requires that an audible trouble signal shall be permitted to be intermittent provided its sounds at least once every 10 seconds, with a minimum duration of ½ second. Last, to restore the panel to normal condition, it requires all supervisory devices are reset and trouble signal are cleared.

Identification of The Type and Location of Fire Notification Devices

General

In this section, the types, locations and spacings of alarm notification devices installed in Engineering IV building will be discussed. The building contains two types of notification devices, visible alarm notification devices and audible alarm notification devices.

Visible Alarm Notification Appliances

The type of visible alarm notification devices installed in the building is strobe made by System Sensor S1224MCW (CSFM: 7125-1653:162) and horn strobe made by System P1224MCW (CSFM:7125-1653:163). Note that they are all wall mounted. Therefore, the code analysis is based on wall-mounted appliances.

According to Section 18.5.5.1, wall-mounted appliances shall be mounted such that the entire lens is not less than 80 in. and not greater than 96 in. above the finished floor or at the mounting height specified using the performance-based alternative of 18.5.5.7. Engineering IV building fire alarm floor plan provides information of mounting detail, as shown in Figure 21. The horn strobes or strobes installed in the building are mounted at least 80 in. above the finish floor, which meets the code requirements.

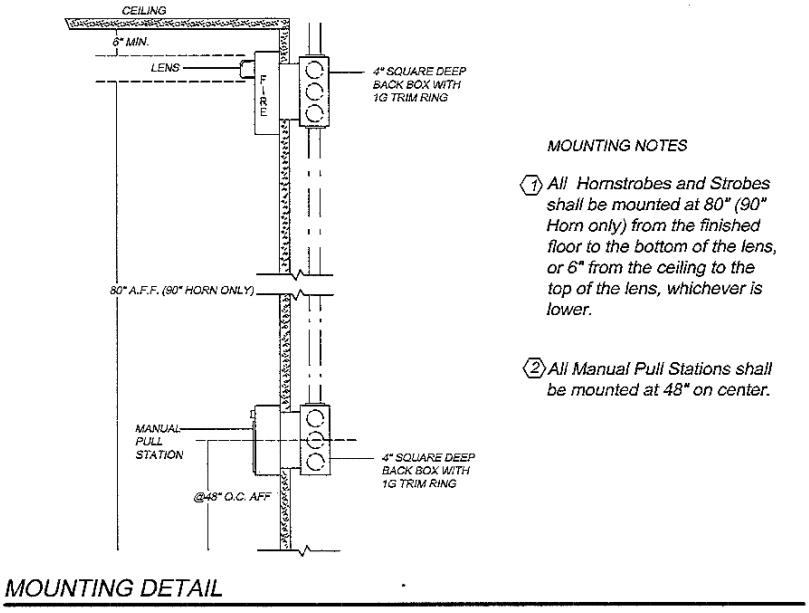


Figure 21. Horn strobes and strobes mounting details.

The spacing for wall-mounted visual notification appliances shall follow Table 18.5.5.5.1 (a) (Table 19).

Table 19. Room spacing for wall-mounted visual notification appliances

Maximum Room Size		Minimum Required Light Output [Effective Intensity (cd)]	
ft	m	One Visual Notification Appliance per Room	Four Visual Notification Appliances per Room (One 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.

Engineering IV building strobes have an effective intensity (cd) of 15cd, 30cd, 75cd, and 110cd. Most of the labs are equipped with 75cd strobes or horn strobes. The typical room size is 32’ x 37’, such as Room 240 IME ADVANCE COMPUTING LAB. The maximum allowable room size for an effective intensity of 75cd is 45’ x 45’. Rooms with a similar geometry with Room 240 have adequate area coverage.

Large design rooms or labs, such as Room 136, CEEN-HYDRAULICS LAB, are equipped with 110cd strobes or horn strobes. The dimension of Room 136 is 35’ x 48’. The maximum allowable room size for an effective intensity of 110cd is 54’ x 54’. Therefore, those large design studios installed with 100cd strobes or horn strobes shall have enough area coverage.

Other, even larger rooms, are equipped with a combination of different effective intensity strobes. For example, Room 106 is installed with one 75cd (allowable room size 45’ x 45’) horn strobe and three 110cd (allowable room size 54’ x 54’) strobes, with approximately covers the total of 52’ x 82’.

Referring to Section 18.5.5.6, spacing in corridors requires the installation of visual notification appliances in corridors 20 ft or less in width shall be following the requirements of spacing in rooms (18.5.5.5) or spacing in corridors (18.5.5.6). In addition, the visual notification appliances shall be located not more than 15 ft from the end of the corridor with a separation not greater than 100 ft between appliances and shall be rated not less than 15 cd.

The Corridor 100 C starts from the western end with initially 8’ wide and runs towards to atrium. At the end of the eastern end, the corridor width increases to 20’. Other corridors in this building are approximately 8’. Therefore, the corridors follow the code requirements of spacing in corridors.

Corridor 100A is served by two 110cd horn strobes and two 15cd strobes. The distance between each strobes or horn strobe is 15’ to 50’ which is much less than the required 100’. Corridor 100A has extra area coverage because there are two corners in the middle of the corridor. As a result, visible light cannot travel from one end to another end without stopping. In this case, two 15cd strobes are installed in the corners to ensure the corridor is fully covered by the strobe. Refer to Figure 22 for the location of strobes installed in Corridor 100A.

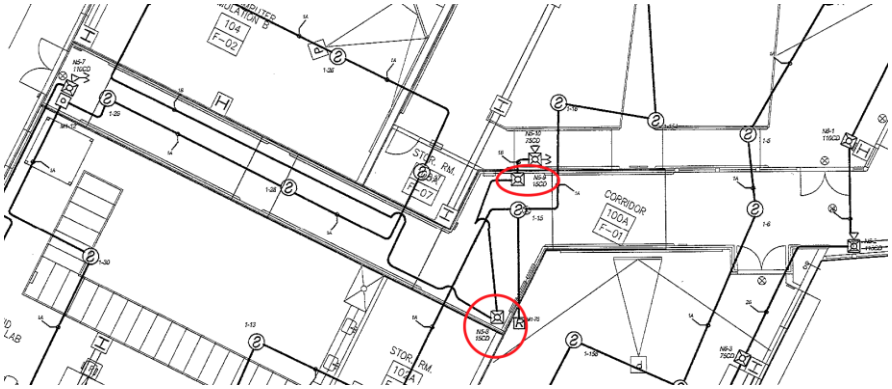


Figure 22. Location of strobes in Corridor 100A

Corridor 100B is covered by only one 15cd horn strobe because the total length of the corridor is 34’. There are three 110cd horn strobes and one 75cd strobe installed in Corridor 100C. The maximum distance between each strobe is 80’. The corridors on the second floor and third floor have a similar layout. All of them meet the code requirements.

Audible Alarm Notification Appliances

The type of audible alarm notification devices installed in the building is horn strobe made by System Sensor P1224MCW (CSFM:7125-1653:163). According to Section 18.4.9.1, wall-mounted appliances shall have their tops above the finished floors at heights of not less than 90 in, and below the finished ceilings at not less than 6 in. The information shown in Figure 21 indicates that the horn strobes are installed in the building properly.

NFPA 72, Section 18.4.4.1, the sound level shall be at least 15 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds, whichever is greater. Engineering IV building is a primary business use and educational use. According to Table A. 18.4.4, the average ambient sound level for business occupancies is 54 dB, for educational occupancies is 45 dBA. This building is primarily running for educational use, so it shall be conservative taking 45 dBA as the average ambient sound level. Thus, the minimum sound pressure level shall be 60 dBA. According to the datasheet provided by System Sensor, the horn strobe (P1224MCW) can provide 75 dBA within 16-33V.

Another factor that could affect the effective intensity is distance. Robert P. Schifiliti discussed in his article, Notification Appliances, in a wide-open space where the sound does not reflect off any surfaces (no reverberation), the SPL (sound pressure level) decreases by roughly 6 dB every time the distance from the source is doubled. For example, if an audible appliance mount on a wall has a rating of 90 dBA at 10 ft. When the distance is 20 ft. away from the appliance, the rating reduces to 84 dBA (Figure 23.)

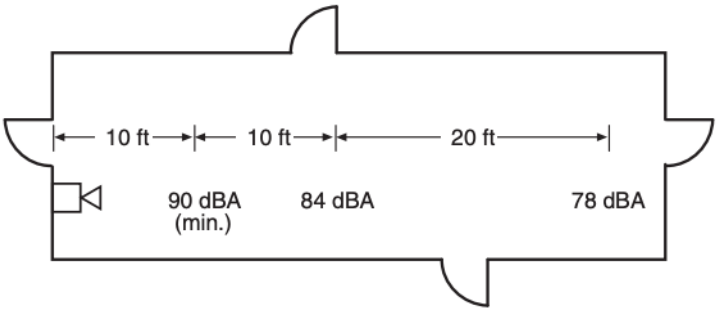


Figure 23. Example of 6 dBA rule.

The 6-dBA rule is not only applicable for horizontal distance but also vertical distance. Engineering IV building has a height of 15 ft for each floor. The horn strobe can still provide a rating of 63 dBA at 30 ft in the two-story atrium (75 dBA at 10 ft).

Section 18.4.8 requires audible notification appliances install at the exit. According to Engineering IV building's fire alarm floor plan, all main exits doors or stairs are equipped with one horn strobe. For instance, at the end of Corridor 100A, a 110cd horn strobe is installed; at the Stair #1 exit on the second floor, a 15cd horn strobe is installed. Therefore, sound pressure level design for this building are conservative.

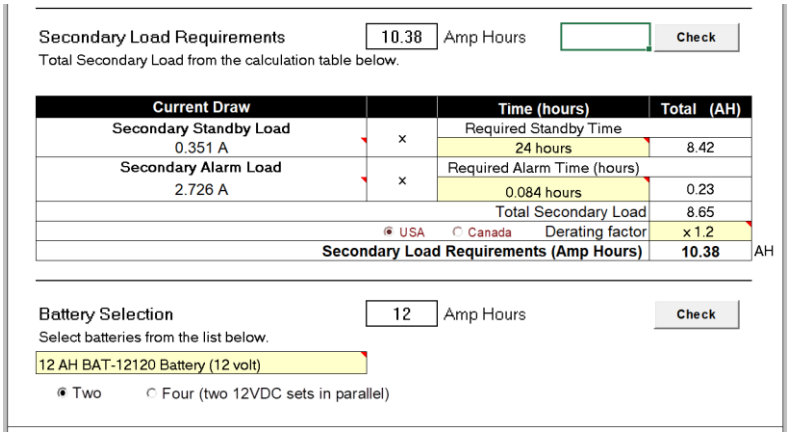
Secondary Power Supply

In this section, the secondary power supply requirements for the fire alarm system will be determined.

According to 10.6.6.2, the secondary power supply shall automatically provide power to the supervising station facility and equipment within 60 seconds whenever the primary power supply voltage is insufficient for required system operation. Section 10.6.7.2 states that the secondary power supply shall provide a minimum of 24 hours of operation capacity under quiescent load and shall be capable of operating all alarm notification appliances for 5 minutes. And the battery calculation shall include a minimum 20 percent safety margin.

Engineering IV building is running Class B circuits which is a single line wire. Class B circuits are easier in installation and more economically friendly than Class A. Two YUASA batteries, 8 AH 24 VDC are provided for each power supply and FACP.

In the Engineering IV building fire alarm floor plan, it does not provide any battery calculations. Instead, Notifier Battery Calculation is used to verify the capacity of the secondary power supply. The results are shown in Figure 24 to Figure 28. The secondary load requirements are below the provided power supply capacity. The battery calculations were found to be adequate and appropriate for this application.



Secondary Load Requirements 10.38 Amp Hours Check

Total Secondary Load from the calculation table below.

Current Draw		Time (hours)	Total (AH)
Secondary Standby Load 0.351 A	x	Required Standby Time 24 hours	8.42
Secondary Alarm Load 2.726 A	x	Required Alarm Time (hours) 0.084 hours	0.23
		Total Secondary Load	8.65
		(•) USA ( ) Canada Derating factor	x 1.2
		Secondary Load Requirements (Amp Hours)	**10.38** AH

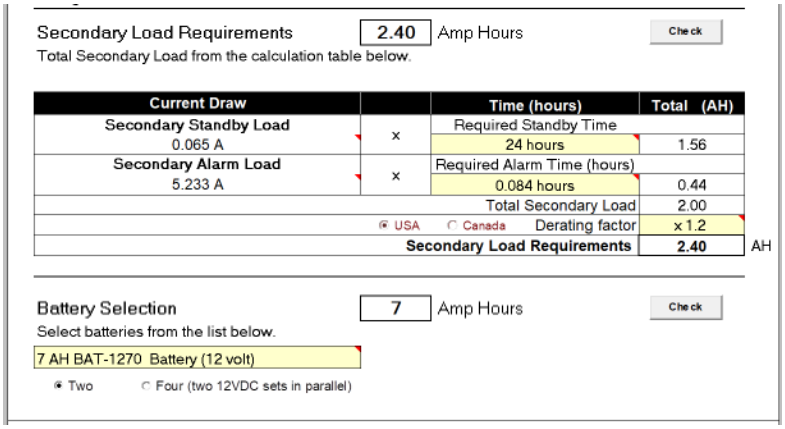
Battery Selection 12 Amp Hours Check

Select batteries from the list below.

12 AH BAT-12120 Battery (12 volt)

(•) Two ( ) Four (two 12VDC sets in parallel)

Figure 24. NFS-60 battery calculation



Secondary Load Requirements 2.40 Amp Hours Check

Total Secondary Load from the calculation table below.

Current Draw		Time (hours)	Total (AH)
Secondary Standby Load 0.065 A	x	Required Standby Time 24 hours	1.56
Secondary Alarm Load 5.233 A	x	Required Alarm Time (hours) 0.084 hours	0.44
		Total Secondary Load	2.00
		(•) USA ( ) Canada Derating factor	x 1.2
		Secondary Load Requirements	**2.40** AH

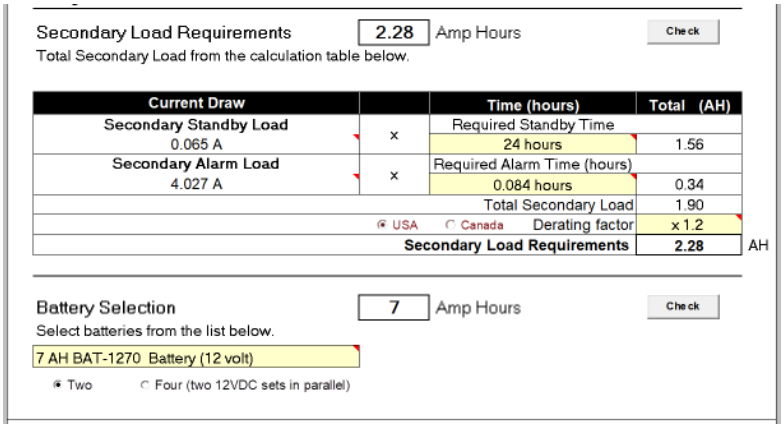
Battery Selection 7 Amp Hours Check

Select batteries from the list below.

7 AH BAT-1270 Battery (12 volt)

(•) Two ( ) Four (two 12VDC sets in parallel)

Figure 25. FCPS1 ACPS-2406 battery calculation



Secondary Load Requirements 2.28 Amp Hours Check

Total Secondary Load from the calculation table below.

Current Draw		Time (hours)	Total (AH)
Secondary Standby Load 0.065 A	x	Required Standby Time 24 hours	1.56
Secondary Alarm Load 4.027 A	x	Required Alarm Time (hours) 0.084 hours	0.34
		Total Secondary Load	1.90
		(•) USA ( ) Canada Derating factor	x 1.2
		Secondary Load Requirements	**2.28** AH

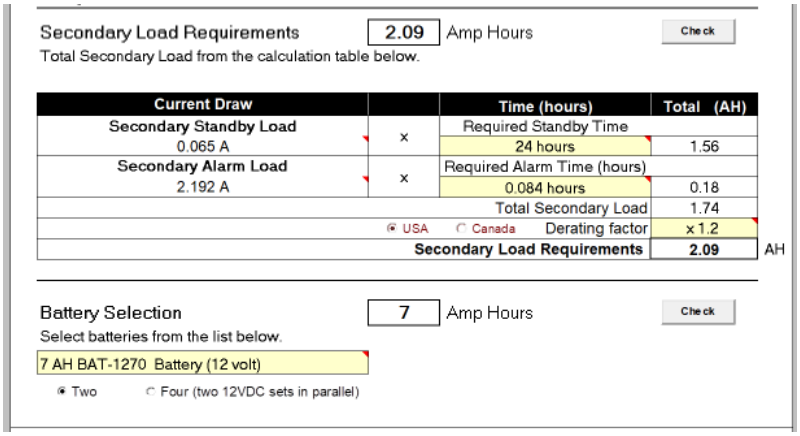
Battery Selection 7 Amp Hours Check

Select batteries from the list below.

7 AH BAT-1270 Battery (12 volt)

(•) Two ( ) Four (two 12VDC sets in parallel)

Figure 26. FCPS2 ACPS-2406 battery calculation



Secondary Load Requirements 2.09 Amp Hours Check

Total Secondary Load from the calculation table below.

Current Draw		Time (hours)	Total (AH)
Secondary Standby Load 0.065 A	x	Required Standby Time 24 hours	1.56
Secondary Alarm Load 2.192 A	x	Required Alarm Time (hours) 0.084 hours	0.18
		Total Secondary Load	1.74
		(•) USA ( ) Canada Derating factor	x 1.2
		Secondary Load Requirements	**2.09** AH

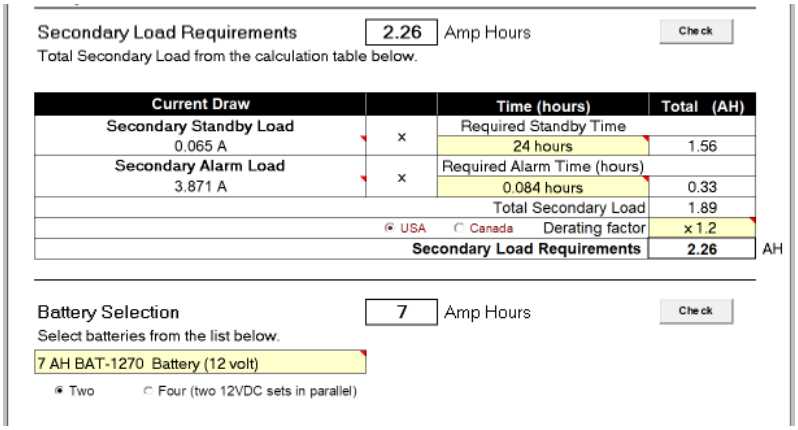
Battery Selection 7 Amp Hours Check

Select batteries from the list below.

7 AH BAT-1270 Battery (12 volt)

(•) Two ( ) Four (two 12VDC sets in parallel)

Figure 27. FCPS3 ACPS-2406 battery calculation



Secondary Load Requirements 2.26 Amp Hours Check

Total Secondary Load from the calculation table below.

Current Draw		Time (hours)	Total (AH)
Secondary Standby Load 0.065 A	x	Required Standby Time 24 hours	1.56
Secondary Alarm Load 3.871 A	x	Required Alarm Time (hours) 0.084 hours	0.33
		Total Secondary Load	1.89
		(•) USA ( ) Canada Derating factor	x 1.2
		Secondary Load Requirements	**2.26** AH

Battery Selection 7 Amp Hours Check

Select batteries from the list below.

7 AH BAT-1270 Battery (12 volt)

(•) Two ( ) Four (two 12VDC sets in parallel)

Figure 28. FCPS4 ACPS-2406 battery calculation

System Commissioning and Inspection, Testing, and Maintenance

Before the fire alarm system is ready to be installed and tested, the required documentation shall be approved by the authority having jurisdiction (AHJ) and system contractor. The documentation shall include as-built drawing, sequence of operations matrix, symbols legend & bill of material, battery calculations, notification appliance circuit voltage drop calculations, point-to-point connection, riser diagram, wiring details, equipment submittals, operational manuals and manufacturer's proper testing and maintenance requirements. After the installation is completed, the system also needs to pass the testing and inspection by AHJ. NFPA 72, Table 14.3.1 provides instruction for visual inspection in detail. And Table 14.4.3.2 provides testing instructions in detail. It includes the components that need to be tested, periodic frequency and methods to test the system.

The checklist of visual inspection summary for Engineering IV building is provided as below:

(1). Control equipment:

a. Fire alarm systems monitored for alarm

b. Fire alarm systems unmonitored for alarm, supervisory, and trouble signals

(2). Batteries:

a. valve-regulated lead-acid batteries

b. primary (dry cell) other than those used in low-power radio (wireless) systems

(3). Remote annunciators

(4). Notification appliance circuit power extenders

(5). Remote power supplies

(6). Initiating devices

a. Duct detectors

b. electromechanical releasing devices

c. Fire extinguishing system (s)

d. manual fire alarm box

e. smoke detectors

f. supervisory signal devices

g. waterflow devices

(7). Alarm control interface and emergency control function interface

(8). Notification appliances

a. audible appliances

b. visual appliances

(9). Exit marking audible notification appliances

(10). Supervising station alarm systems – receivers

a. signal receipt

b. receivers

To ensure the fire alarm system running properly over time, it requires the system to be carefully maintained. The owner can refer to the checklist above.

Conclusion

The section presents a prescriptive analysis of the Engineering IV building fire alarm system. It has been found the building adequately meets NFPA 72 requirements for initiating devices and notification appliances. The report also attaches to material submittals in Appendix J as a reference. The following section will discuss sprinkler system.

Sprinkler System Analysis

Type of Water-Based Fire Suppression System

The Engineering IV Building is protected by a wet pipe system. By the definition of NFPA 13, a wet pipe sprinkler system is a sprinkler system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by heat from a fire. In the wet pipe system, the basic component is as shown in Figure 29.

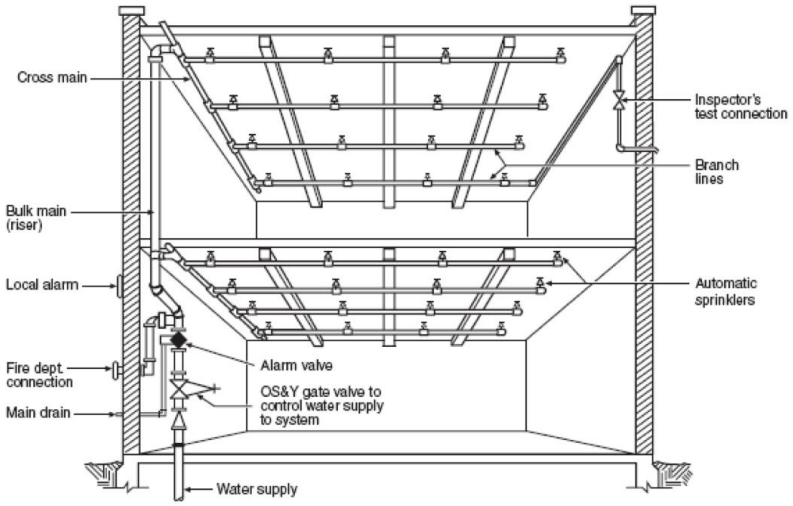


Figure 29. Basic Components of a Wet Pipe Sprinkler System

The wet pipe sprinkler system will be monitored by single monitor modules or double monitor modules. Once the pressure drops, it will send a signal to the Fire Alarm Control Unit to notice occupants for evacuation.

Water Supply Identification and Characterization

According to NFPA 13, Section 5.1.1, every automatic sprinkler system shall have at least one automatic water supply. The water supply of the Engineering IV Building is connected to the city water supply. The water source is located 175 ft away from the building in the south connected with an 8" main running water source. A control valve is connected between 6" feed line and 8" main. And there is a 6" double check valve assembly located in the south nearby the building. The locations are shown in Figure 30. The double-check valve and the control valve are connected by a 6" diameter line with a minimum depth of bury is 3'-0". One OS&Y gate valve is connected with the 6" feed, monitored by a double monitor module. And an FDC is installed next by the OS&Y gate valve in the south of the building.

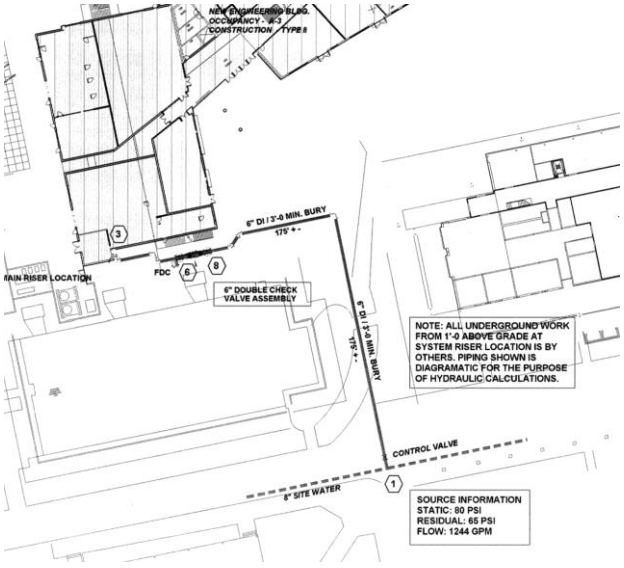


Figure 30. Location of water supply and double-check valve assembly.

The water supply information is provided in Table 20.

Table 20. Water Supply from The City

Static Pressure (psi)	Residual Pressure (psi)	Water Flow (GPM)
80	65	1244

Fire department connection requires to be provided if none of the systems meet the requirements in NFPA 13, Section 16.12.2. Therefore, Engineering IV Building is required to provide fire department connection and shall be provided as described in Figure 31.

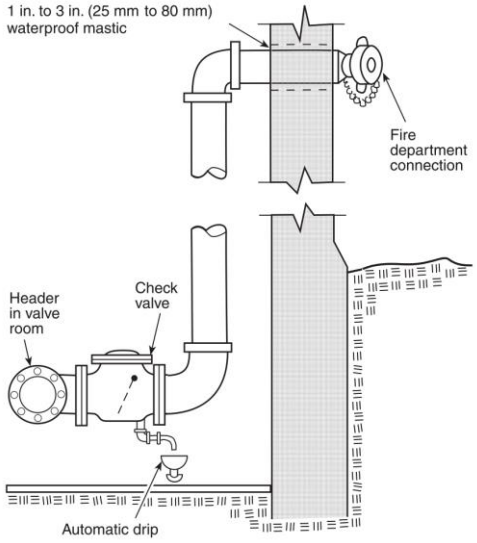


Figure 31. Fire Department Connection.

Occupancy Classification

The occupancy classification includes light hazard, ordinary hazard (Group 1), ordinary hazard (Group 2), extra hazard (Group 1), and extra hazard (Group 2). NFPA 13, Section 4.3.2 and 4.3.3 give the definition of light hazard and ordinary hazard (Group 1). The light hazard classification is defined as spaces with low quantity and combustibility of contents. The ordinary hazard classification is defined as spaces with moderate quantity and low combustibility of contents; stockpiles of contents with low combustibility that do not exceed 8 ft (2.4 m). Engineering IV Building shall be classified as a light hazard because most of the spaces are used for lecture and office, except BIOMED WET LAB located on the third floor shall be classified as an ordinary hazard (Group 1).

System Risers, Branch Lines, and Sprinklers

The feed main of the sprinkler system passes through the OS&Y gate valve, then goes through the underground by using a ductile iron pipe. The 6” ductile iron pipe connects with a flange 90. After that, the riser enters the Engineering IV Building and reduces to 4” pipe. Then the 4” pipe splits to two supplies each with a 4” pipe. One is connected to first-floor system and another one is connected to the second and third floor supply. There is also a butterfly valve with a tamper switch connects to the riser. The details of the rise are shown in Figure 32 and Figure 33.

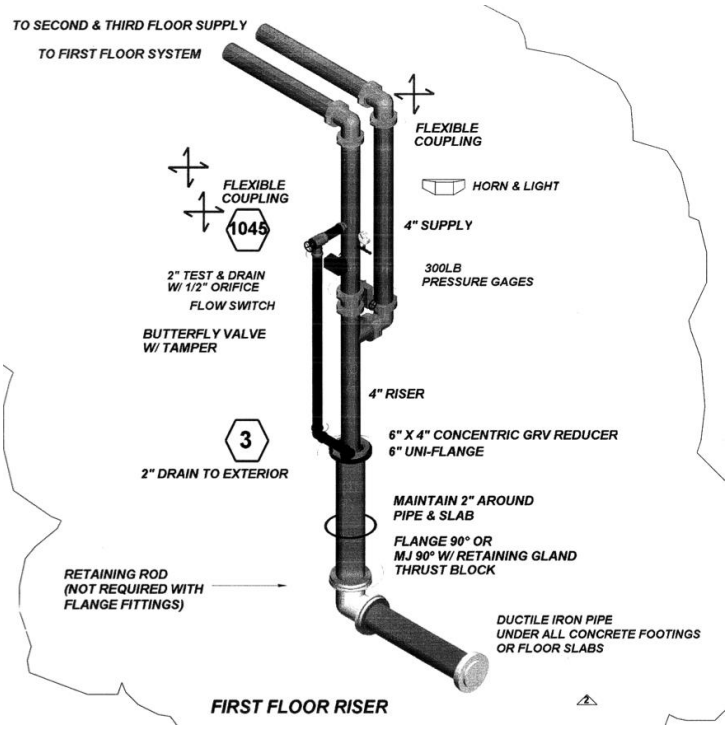


Figure 32. First-floor riser details

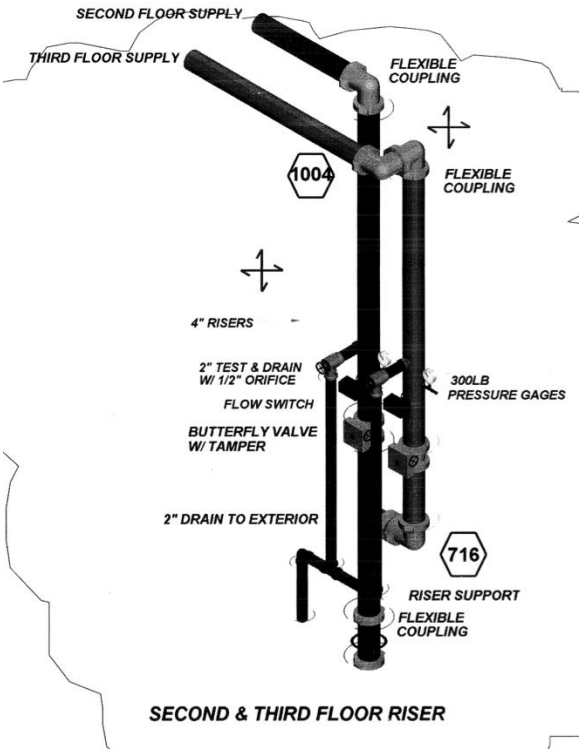


Figure 33. Second and third-floor riser details

4” cross main is running through all floors. The branch lines connect to the cross main are mainly 1-1/4”. For some special cases, 1” branch lines are also installed in the building. Typically, upright sprinklers are connected to the branch lines. A sample of shop drawings is shown in Figure 34.

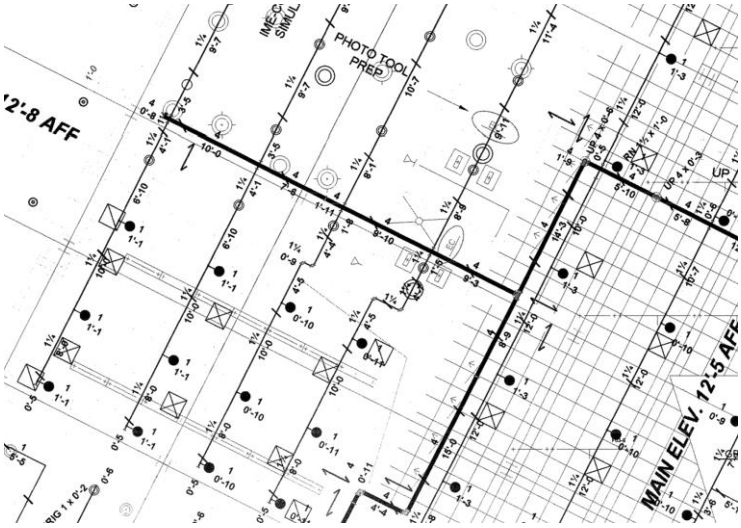


Figure 34. Engineering IV cross main and branch lines of sprinkler system shop drawing

Engineering IV building has installed a total of 920 sprinklers. The building is fully protected by the sprinkler system. There are five different types of sprinklers. Depending on the fire hazards and locations, different types of sprinklers have various applications. Table 21 shows the make and model, orifice, K-factor, head finish plate finish, activation temperature quantity of the sprinkler used in Engineering IV building.

Table 21. Summary of Sprinklers

Make and Model	Orifice	K-Factor	Head Finish	Activation Temperature	Quantity
Reliable F1FR Upright on 1” SPRIG / SIN# 3625	1/2”	5.6	Brass	155°F	242
Reliable F1FR Upright on 1” SPRIG / SIN# 3625	1/2”	5.6	Brass	200°F	28
Reliable G4A Concealed Pendent / SIN# 5415	1/2”	5.6	Brass	155°F	618
Reliable F1FR Horizontal Sidewall / SIN# 3635	1/2”	5.6	Brass	200°F	2
Tyco WS Vertical Pendant / SIN# TY3488	1/2”	5.6	Brass	155°F	30

Sprinkler System Calculations

Based on the shop drawing, the design density is 0.1 gpm/ft^2 for all light hazard classification; 0.15 gpm/ ft^2 for all ordinary hazard Group 1 classification. According to NFPA13, 2010 edition, Figure 11.2.3.1.1 as shown in Figure 36, design density 0.1 gpm/ft^2 corresponds to 1500 ft^2 area of sprinkler operation; design density 0.15 gpm/ft^2 corresponds to 1500 ft^2 area of sprinkler operation. Section 11.2.3.1.4 (1), for an area of sprinkler operation less than 1500 ft^2 used for light and ordinary hazard occupancies, the density for 1500 ft^2 shall be used. The area reduction is 40% for both light hazard and ordinary hazard 10’-0 ceiling height. Therefore, the design area can be reduced to 900 ft^2. All design areas in light hazard and ordinary hazard 1

classification rooms are greater than the reduced value. The larger design areas would be considered conservative since it could create a greater system demand. In addition, the supply and demand curve, attached in Attachment H (also shown in Figure 35), shows that the water source provides 1240 gpm at 65 psi (shown in Figure 30) and the hose stream requirement is 721 gpm. The most hydraulically isolated area of the building is located on the third floor and requires 210 gpm at 67.2 psi. Because, the water source supplies enough pressure and water flow at the most remote sprinkler, a fire pump is not required. Thus, the calculated system demand (pressure required, flow required) for all design areas meet the requirement. One sample hydraulic calculation for the hydraulically remote area on the first floor (Figure 37) is attached in Attachment I. The assumptions are made for the hydraulic calculation are the following: pipe is made of schedule 40 wet steel with a C-factor of 120, value for equivalent length is referenced from NFPA 13, density is 0.15 gpm/ft^2 and a design operation of 130 ft^2. Results of the sample calculation show that the required flow is 163.4 gpm and the require pressure is 49.7 psi. The safety margin of the pressure is 36%. Thus, the Engineering IV Building sprinkler system design is conservative. Attachment B includes all the design areas calculation.

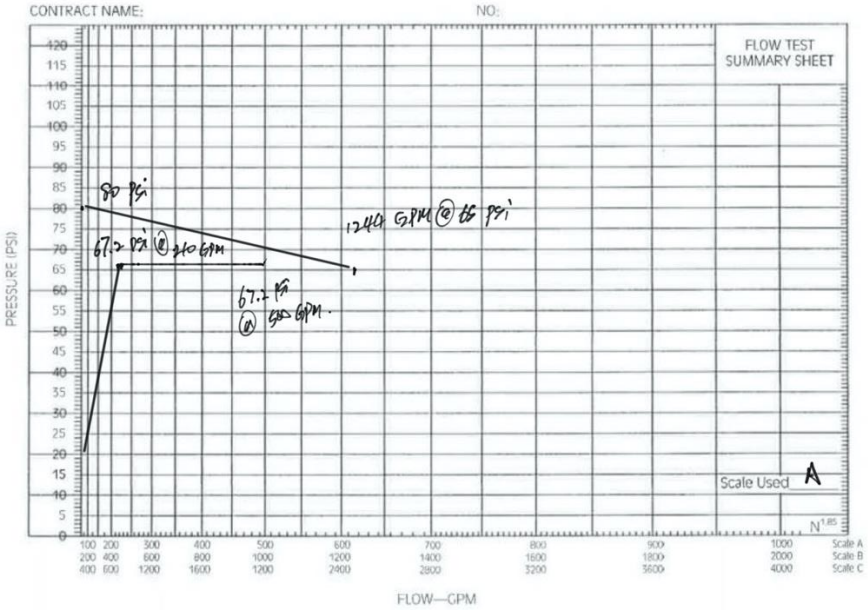


Figure 35. Supply and Demand Curve.

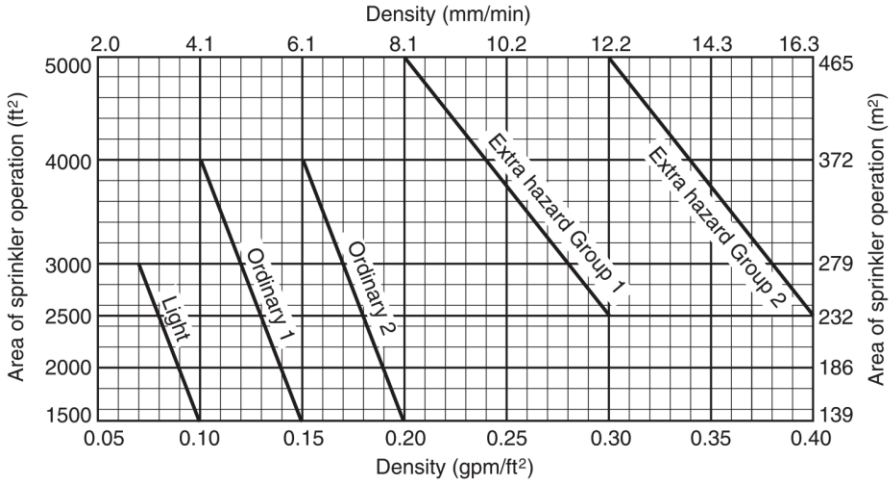


Figure 36. Density/Area Curves.

Figure 37. Hydraulically remote area on the first floor.

Conclusion

Based on the analysis of Engineering IV Building hydraulic calculation above, it proves that the city water supply provides adequate water flow and pressure for each design area. Therefore, the sprinkler system meets the requirement of sprinkler system demand based on the code requirements. Considering the pipe size selection and cost, this is a good design for efficiency. To make it more efficient, I would recommend considering replacing the ductile iron pipe to plastic pipe, since the plastic pipe is a cheaper and low level of leaching and corrosion. In long term use, this is probably a better solution to make the system more efficient. The flowing section will analyze the performance-based design within the Cal Poly Engineering IV building.

Performance-Based Design Analysis

The following section of this report discusses the performance-based design for the Engineering IV building. Based on assumptions, there are three fire scenarios considered. These scenarios are considered as the highest fire risk or may cause the worst damage. They are evaluated by Fire Dynamics Simulation (FDS) and Pyrosim. In the next subsections, the goals, assumptions, methods, and results of analyzing the fire scenarios will be discussed.

Performance-Based Design Goals

The worst-case design fires are intended to simulate the realistic fires in the designed space and to challenge the life safety system. In NFPA 101, Life Safety Code, Chapter 5 provides 8 design fire scenarios as references. In this report, the first selected design fire scenario is based on Life Safety Code Design Fire Scenario 1. As it is described in Section 5.5.3.1, it is an occupancy-specific fire representative of a typical fire for the occupancy. The second selected design fire scenario is based on Life Safety Code Design Fire Scenario 5, a slowly developing fire, shielded from fire protection systems, in close proximity to a high occupancy area (Section 5.5.3.5). And the last selected design fire scenario is based on Design Fire Scenario 6, which has the most severe fire resulting from the largest possible fuel load characteristic of the normal operation of the building. Furthermore, in the performance-based design analysis, a goal is to determine the

available safe egress time (ASET) and required safe egress time (RSET). Comparing the results and finding out which one takes less time for evacuation (Figure 38). To determine the RSET, SFPE Handbook 5th edition provides recommendations for tenability criteria. Based on that, FDS could present the time to reach untenable conditions. Only if ASET is greater than RSET, the life safety system in Engineering IV building could be considered adequate.

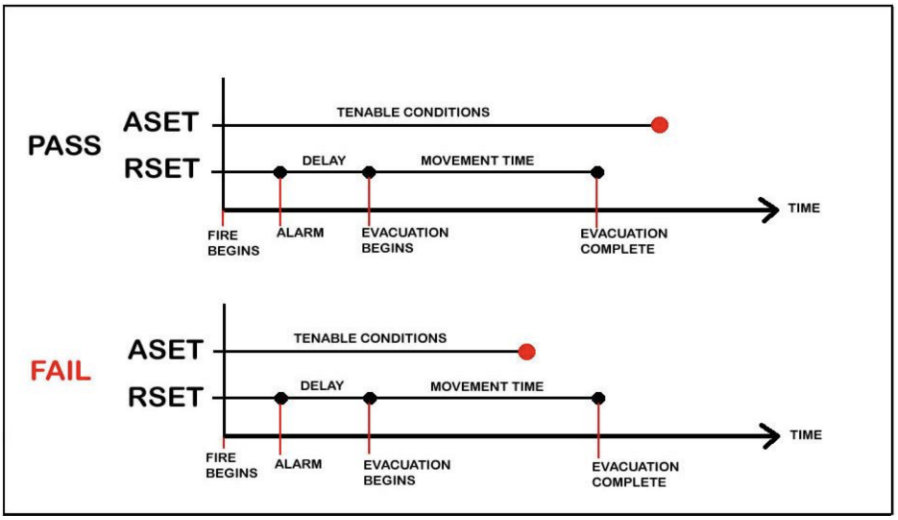


Figure 38. ASET vs. RSET

Tenability Criteria

To determine if the time reaches untenable conditions, SFPE Handbook and Life Safety Code (LSC) present the recommendation for visibility, carbon monoxide, and temperature. SFPE Handbook Table 61.3 (Table 22) states that for occupants who are unfamiliar with the building layout, the smoke density cannot exceed 0.15 1/m and visibility cannot less 13 meters; for those who are familiar with the building layout, the code suggests that the smoke density cannot exceed 0.5 1/m and visibility cannot less than 4 meters at 6 feet above the walking surface or any occupied rooms. The temperature shall not exceed 60 °C at that level. The assumptions apply to all fire scenarios. In my design fires, the occupants have different familiarities to their egress plan. Design Fire 1 and Design Fire 3 are occupied with mostly students who are potentially considered as unfamiliar with the building geometry. But Design Fire 2 has only one exit and the occupants are professors who are considered to be familiar with the egress plan. Thus, in Design Fire 1 and Design Fire 2, the tenability criteria correspond to a visibility of 13 meters at 6 feet above the walking surface. And in Design Fire 2, the tenability criteria correspond to visibility of 4 meters.

Table 22. SFPE Handbook 5th edition Table 61.3 Tenability criteria

Degree of familiarity with inside of building	Smoke density (extinction coefficient)	Visibility
Unfamiliar	0.15 1/m	13 m
Familiar	0.5 1/m	4 m

Required Safe Evacuation Time

The evacuation time includes premovement time and travel time. This is the total time between notification of occupants that they need to move to a safe place and the time that the last occupant reaches that place.

Pre-Movement Time

To calculate RSET, it requires to determine the time for detection systems to actuate and initiate notification sequence, occupant's reaction time and pre-evacuation. Time to notification appliance activates can be determined by FDS modeling results. When the smoke detector detects a fire, a signal will transmit to a fire control panel. Then a signal will be sent from the FACP to notification appliances. The transmitting time is considered negligible. Finally, the pre-evacuation varies for different fire scenarios based on different ages and genders. SFPE Chapter 64 Table 64.9 provides several experiments' data for different educational occupancies. They cannot completely represent the occupant's pre-evacuation time for Engineering IV building, but the mean data set is considered as a reasonable assumption to analyze it. There is a total of 25 experiment sets. The mean pre-evacuation time is 60 seconds as shown in Table 23 below.

Table 23. Mean Pre-Evacuation Time

Mean Pre-Evacuation Time for Educational Occupancies from Different Data Sets (sec)	
Trial 1	10
Trial 2	17
Trial 3	20
Trial 4	20
Trial 5	24
Trial 6	25
Trial 7	27
Trial 8	29
Trial 9	32
Trial 10	38
Trial 11	39
Trial 12	39
Trial 13	42
Trial 14	43
Trial 15	52
Trial 16	52
Trial 17	56

Trial 18	56
Trial 19	70
Trial 20	71
Trial 21	74
Trial 22	77
Trial 23	98
Trial 24	102
Trial 25	194
Average w/ 15% Safety Factor	60

Engineering IV building is mainly used for high education, the majority of occupants are students, professors, and facility maintenance faculties. Even though they have a wide range of ages, most students are young, and faculty are not retirement age. Some students or faculty may have physical disabilities which could be a factor to affect their movement time. Comparing with the whole population in the building, those individuals would be a minority group. Therefore, according to SFPE Chapter 54, Table 64.14, the walking speed for adults is assumed to be 1.2 m/s.

Hand Calculations Assumption

Instead of using Pathfinder, a hydraulic flow model is used to estimate the required safe egress time for different fire scenarios. The assumptions for the model are listed below:

a. The prime controlling factor will be either the stairways or the door discharging from them.
b. Queuing will occur only if the density is greater than 0.8 ppl/m^2; therefore, the specific flow, F_s, will be set to the maximum specific flow, F_{sm}.
c. If queuing does not occurr, the evacuation time will be simply determined by travel time (travel distance divided by travel speed) and pre-movement time.
d. All occupants start evacuating at the same time.
e. The population will use all facilities in the optimum balance.
f. In-office evacuations, delay times can be extremely short, and the largest proportion of RSET is accounted for by travel time.
g. In addition, the stair riser is not given, so I assume each stair risers are 7 in wide and treads are 11 in high.
h. floor-to-floor height is 15 ft. two 7 ft. by 11 ft. landings per floor of stairway travel.
i. All or most of the persons involved are free of disabilities that would significantly impede their ability to keep up with the movement of a group.
j. Occupant flow will not involve any interruptions caused by decisions of the individuals involved.
k. Exit door shall be not less than 36 inches in width and not less than 6'-8" in height.
l. All aisles shall be 44-inch minimum clear width to a public way.

Design Fire

Fire events have never stopped in our life. Every year, there are hundreds and thousands of people who die by fires. It is the fire protection engineers' responsibility to protect people's life and property. The aim is eliminating the risk of fire at the beginning of the design phase by analyzing the worst fire scenarios. One of the central factors of each design fire is the heat release rate (HRR), which is the main parameter that will be discussed in this section. HRR is a character that represents the size of fire. By knowing that, the initiating devices' activation time can be determined. To find an accurate HRR over time, there are two methods: 1) αt^2 2) experimental data. In the design fire scenarios, HRR is calculated from experimental data that has been collected from other researches. The data do not perfectly represent the given design scenario, but from a reasonable engineering judgment, the data are considered accurate enough. αt^2 is used to estimate the item rated CA TB 133 compliant, in which the highest HRR is 80 kW per item.

Design Fire 1 – Office Fire

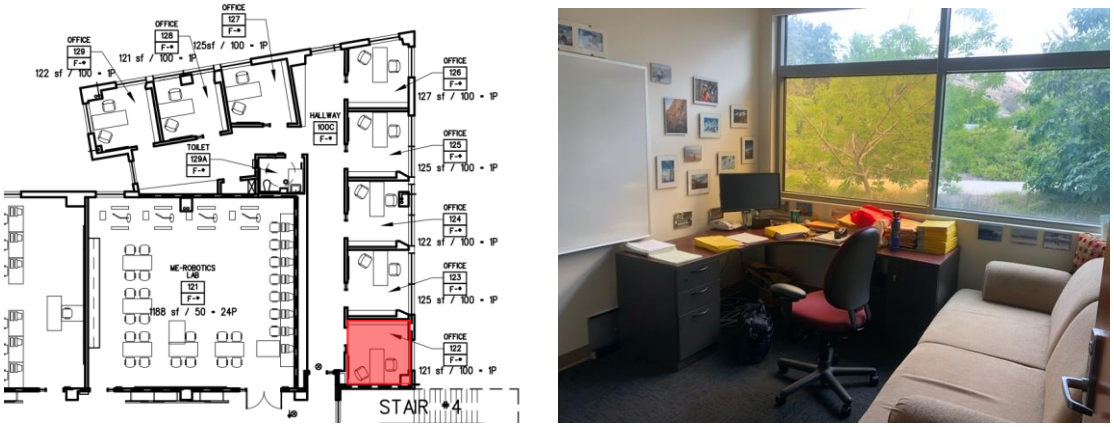


Figure 39. Location of fire (office compartment).

Office 122 is a very typical office room in dimension. But there are serval reasons for not choosing others. Foremost, if this room catches on fire, it is possible to block the egress path. As shown in Figure 39, there is only one exit door for these office spaces. Office 122 is the closest office to the exit door. Thus, this is the main reason to choose this compartment. In this section, FDS is used to determine the effect of the fire in the compartment on life safety. To be more specific, the goal is to determine whether the fire will allow people in the hallway and offices to escape before the space reaches untenable conditions.

In this compartment, the main source of fuel will be a computer workstation consisting of a computer desk and a bookcase. As described in the database, the experiment compartment is constructed with 5/8" thick particleboard covered with simulated wood, plastic laminate. The desk was loaded with 99 lb. of paper materials and the bookcase was loaded with 160 lb. of paper materials. This is a very typical office layout. Thus, it would be enough to represent the compartment fuel load. The dimension of the office is 3.5m x 3.2m x 4.6m.

In my Design Fire 1, the assumption has been made that all the items will ignite at the same time. The HRR data from the University of Maryland burning database [2] is seen in Figure 40.

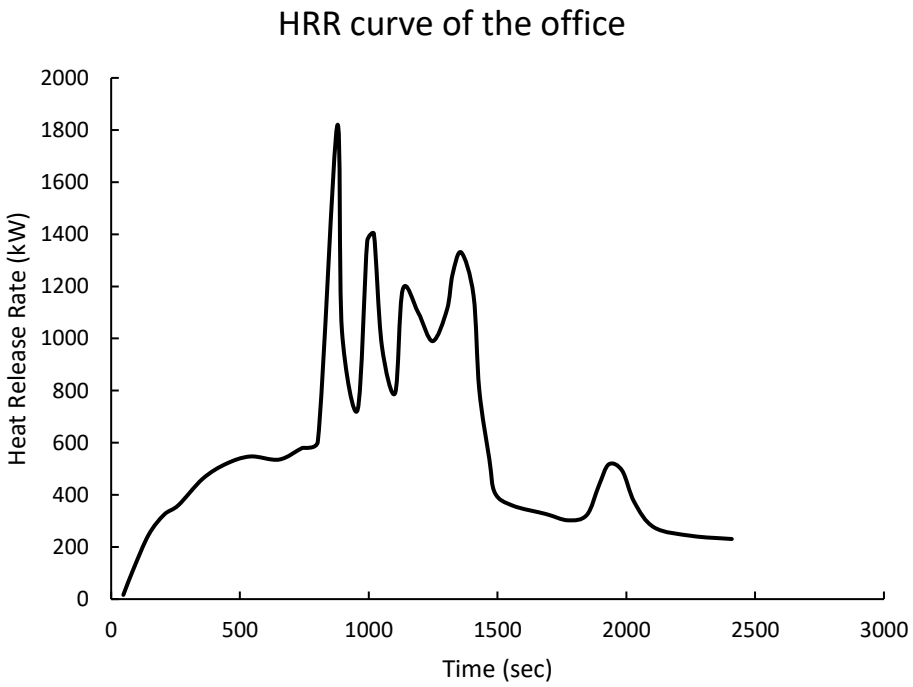


Figure 40. HRR curve of the office compartment. The maximum HRR is 1800 kW.

FDS Model

For this design fire, the door is assumed open. The assumption is made that the compartment occupied with a professor. When he or she leaves the office, the door is left open. As a result, it creates the possibility to spread the smoke to the hallway and increase the risk that other occupants may be stuck in the hallway by the fire. A sprinkler is placed 0.1 m below the ceiling and located as the shop drawing indicated. According to the manufacturer's specification, the quick response sprinkler has an RTI of 50 $(ms)^{1/2}$ and an activation temperature of 68 °C. A smoke detector is placed 0.1 m below the ceiling ad located as the shop drawing indicated as well. The obscuration is 3.28%/m based on the manufacturer's specifications. And the interior finished is assumed to be a gypsum board. Fuel load of the office contains mainly furniture that assumed to be made of wood and polystyrene foam. The fuel load is assumed to be composed of 50% of wood and 50% of polystyrene foam. Table 24 presents fuel parameters used for Design Fire Scenario 1 and FDS model. In addition, it also presents the product of combustions that has a big impact on visibility. The fuel parameters are based on the SFPE Handbook 5th edition in Table A.39. Figure 41 is the FDS layout shows below.

Table 24. Fuel Parameters used for Design Fire Scenario 1

Material	Chemical formula	Heat of combustion ($kJ.kg^{-1)}$	Soot yield	CO yield
Wood (pine)	-	17,900	0.015	0.005
Polystyrene foam[1]	C_8H_8	37,400	0.194	0.061
Fuel Parameters for FDS	C_3H_6	27,650	0.105	0.066
1: Average of polystyrene foams are taken from the SFPE Handbook 5th edition, Table A.39				

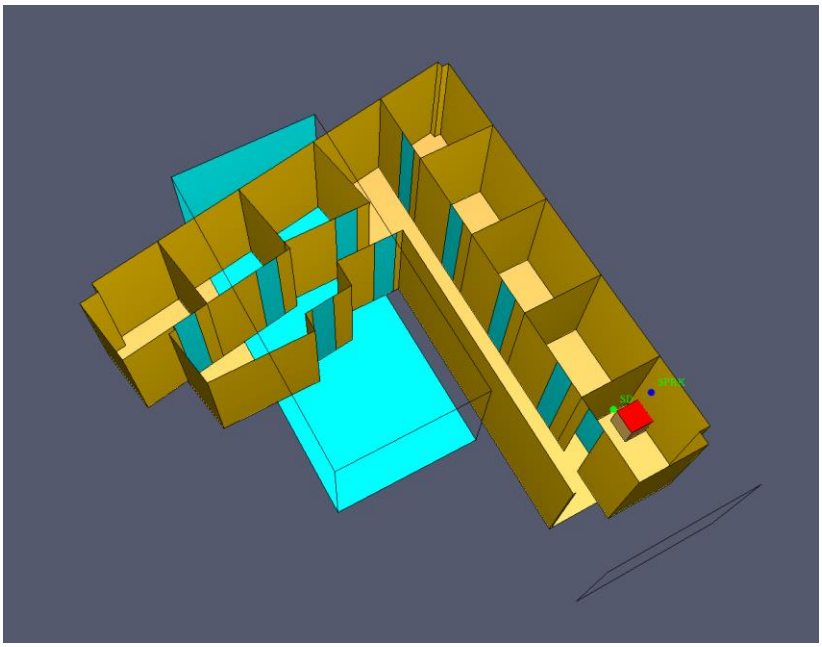


Figure 41. Design Fire 1 FDS layout.

FDS Results

After running the FDS model, the result shows that the smoke detector activates at about 40 seconds after source ignites. And the sprinkler activation time is about 123 seconds. The heat release rate has been controlled since then as shown in Figure 42.

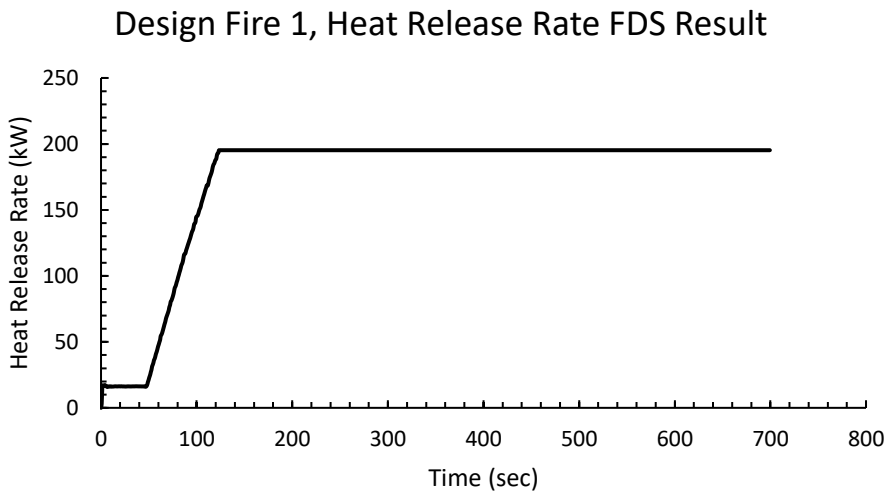


Figure 42. Heat release rate after sprinkler activates

A 2D slice of smoke density layer is set at 6 feet above the walking surface. As Figure 43 shows that the time reaches to untenable criteria for visibility is about 389 seconds. In addition, another 2D slice of temperature layer is set at the same height as a smoke layer. It indicates that the temperature reaches 60 °C is about 962 seconds, which is shown in Figure 44. Because the untenability criterion for carbon monoxide requires occupants expose to smoke conditions for a long time, an assumption is made to this fire scenario is professors' life safety will not be threatened by carbon monoxide. As states in SFPE Handbook,

whichever tenability criterion is exceeded first, taking that as the time reaches untenable condition. Therefore, the ASET is the time visibility reaches 4 meters which is 389 seconds.

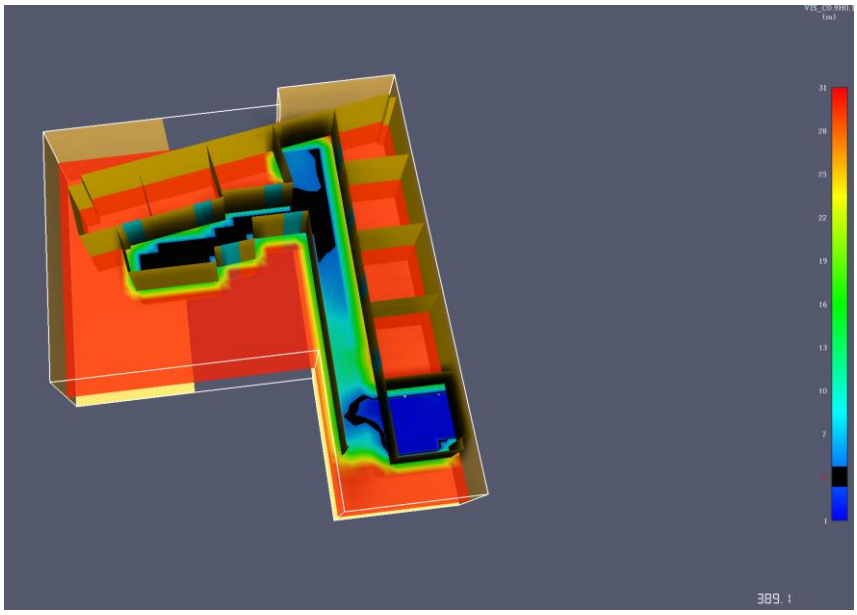


Figure 43. The smoke layer at 6 feet above a walking surface

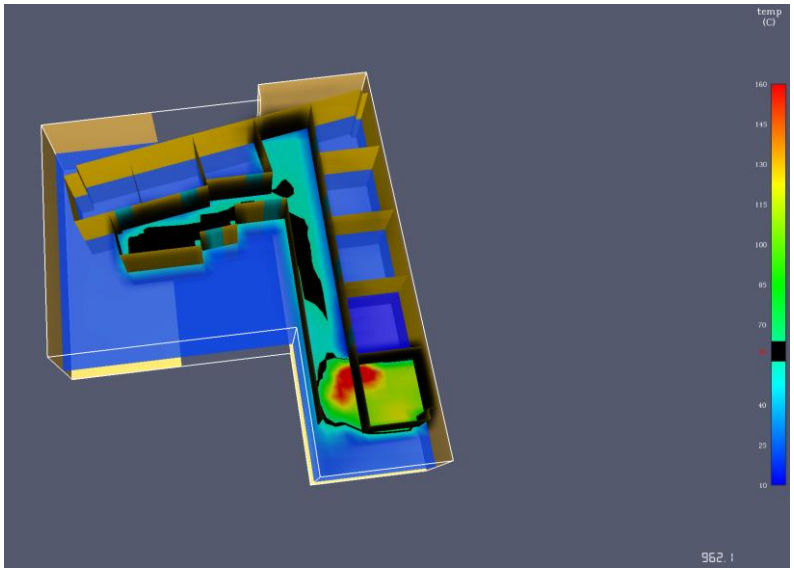


Figure 44. Temperature layer at 6 feet above walking surface

RSET Hand Calculation

First, to determine if queuing would happen, the density of people per square feet needs to be calculated. The total area of the hallway is 546 sf with 16 occupants. As calculated, the density is about 0.32 ppl/ft^2 which is less than 0.8 ppl/m^2. Thus, it would be simply found out the travel time (23 seconds) based on walking speed and travel distance. Calculation is shown below:

Travel Time:

$$27\ m/\ 1.2\ m/s = 23\ seconds$$

RSET combines travel time (23 seconds), pre-movement time (60 seconds) and alarm activation time (40 seconds). As the calculation shows below, the RSET for design fire scenario 1 is 123 seconds.

RSET:

$$23 + 60 + 40 = 123\ seconds$$

Conclusion

Based on the assumptions, the results indicate that ASET is much greater than RSET. Thus, the occupants in the Design Fire 1 shall have enough time to evacuate to the public space before they are stuck in the hallway by the smoke. The life safety design for this area can be considered adequate.

Design Fire 2 – Atrium Fire

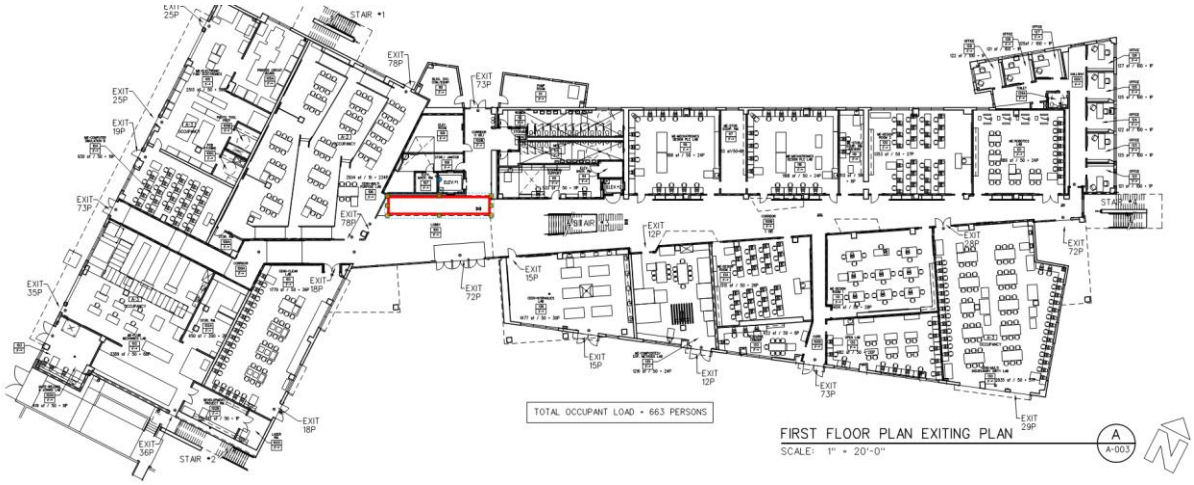


Figure 45. The layout of the first floor of the Engineering IV building. The red box is where the atrium catches on fire.

The reason the atrium (Figure 45) is chosen to be the second design fire scenario is that the Engineering IV is a three-story with a two-story atrium building. If a fire starts on the first floor, the smoke can spread to the second floor and increase the risk to challenge two floors' occupants to evacuate within a safe time. An important assumption made to the fire scenario is the furniture stays in the same place. Because there are smoke detectors and sprinklers located on an extension panel of the first floor as shown in Figure 46. Those initiating devices and notification appliances are specifically designed to protect the furniture area and allow them to detect the fire in the first place. The furniture used in this space is TB 133 *(note: TB 133 is a California regulation on public furniture. It limits the maximum HRR cannot be greater than 80 kW).* But in January 2019, California Fire Department repealed this regulation. For this design fire, TB 133 is applied to the fire source.

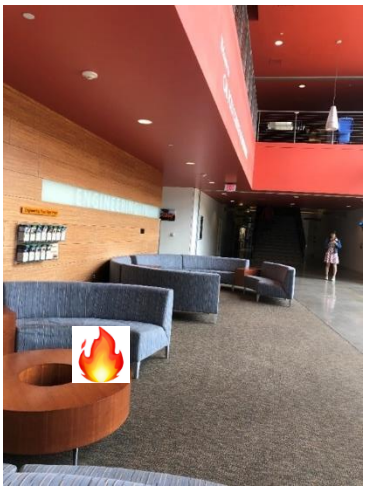


Figure 46. Location of the first design fire and extension panel above furniture's.

The fire will start on the table. Assuming that the table catches on fire by a computer charger, 30% of the HRR from the table will radiate to the sofas around it. When the heat flux reaches a critical value, those sofas will catch on fire. Then they will ignite the sofas on the other side. On each side, there are 5 sofas. As a result, when all fuel packages are on fire, there is a total of 10 sofas and one table. The table is assumed to be made of ½ inch thick Fir Plywood Board (Code: D3) (Table 25) and HRR is shown in Figure 47. Based on the research done by Kim, the alpha value is $0.4\frac{kW}{m^2}$. The sofas are made of metal frame, urethane foam, and plastic-coated fabric (Code: A30) (Table 26) and HRR is shown in Figure 48; the alpha value is $0.4\frac{kW}{m^2}$. The equation Kim used is shown below.

$$\dot{Q} = 0 \qquad 0 \le t_0$$

$$\dot{Q} = \alpha_g (t - t_0)^2 \qquad t_0 \le t \le t_{lo}$$

$$\dot{Q} = \alpha_g (t_{lo} - t_0)^2 \qquad t_{lo} \le t \le t_d$$

$$\dot{Q} = \alpha_d (t_{end} - t)^2 \qquad t_d \le t \le t_{end}$$

$$\dot{Q} = 0 \qquad t_{end} \le t \le Infinity.$$

where α_g and α_d are the fire-growth and fire-decay coefficient (kW/s^2); t_0 is the time to the onset of ignition; t_{lo} is the level-off time; t_d is the time at which HRR decay begins; t_{end} is the time at which HRR equals to zero and t_g is the growth time. In this design fire, the value of each term is listed as shown in Table 27.

Table 25. Fir Plywood Board 1 HRR inputs

	CODE		DESCRIPTION		t_0	$t_{1\,MW}$	t_{lo}	t_d	t_{end}	$\dot{Q}_{max}$	t_g	α_g	α_d
Fig. D1.	Cotton Fabric	CTN002	Cotton fabric,fr (test 803a)	Fabric	29	89	45	45	206	71.1	60	0.277778	0.002743
Fig. D2.	Fir Board	DFR003	Douglas fir (828)	Board	2	32	15	15	1502	187.8	30	1.111111	0.000085
Fig. D3.	Fir Plywood Board 1	DFP002	Douglas fir plywood,1/2in.thick (435)	Board	74	124	92	604	1193	129.6	50	0.400000	0.000374
Fig. D4.	Fir Plywood Board 2	DFP002	Douglas fir plywood,1/2in.thick (446)	Board	0	28	13	309	1829	215.6	28	1.275510	0.000093
Fig. D5.	Gypsum Board 1	GBD002	Gypsum board,1/2in.thick (434)		228	280	243	246	274	83.2	52	0.369822	0.106135
Fig. D6.	Gypsum Board 2	GBD002	Gypsum board,1/2in.thick (448)		6	66	30	30	102	160.0	60	0.277778	0.030864
Fig. D7.	Mattress Composite	MAT001	Mattress ass'y m05,pu foam,rayon ticking (test 296)	Composite	8	44	28	111	164	308.6	36	0.771605	0.109876

Table 26. Sofa 1 HRR inputs

Fig. A28.	Metal wardrobe 2	Metal wardrobe, clothing on 8 hangers	0	50	40	47	200	640.0	50	0.400000	0.027340
Fig. A29.	Patient lounge chair	Patient lounge chair, metal frame, urethane foam cushion	0	170	80	90	150	221.5	170	0.034602	0.061515
Fig. A30.	Sofa 1	Sofa, metal frame, urethane foam, plastic-coated fabric	0	500	260	460	800	270.4	500	0.004000	0.002339
Fig. A31.	Sofa 2	Sofa, wood frame, California foam, polyolefin fabric	0	100	170	250	430	2890.0	100	0.100000	0.089198
Fig. A32.	F21 Chair	F21 Chair, wood frame, polyurethane foam, olefin fabric	140	215	250	250	360	2151.1	75	0.177778	0.177778
Fig. A33.	F31 Loveseat	F31 Loveseat, wood frame, polyurethane foam, olefin fabric	90	165	215	265	390	2777.8	75	0.177778	0.177778
Fig. A34.	F32 Sofa	F32 Sofa, wood frame, polyurethane foam, olefin fabric	75	150	205	270	400	3004.4	75	0.177778	0.177778

Table 27. Clear data for Sofa and Fir Plywood Board HRR Inputs

	Sofa	Plywood
t_0	74	74
t_{l0}	154	92
t_d	211	604
t_{end}	283	1193
t_g	80	50
α_g	0.156	0.4
α_d	0.022	0.000374

The alpha value is too high compared with the data from SFPE handbook. But Kim explains in his article, "Notice that although data may well be available from careful laboratory experiments, the data may not apply directly to real-world fire situations. The laboratory data does not usually take into account the enhancement of burning rates because of radiation feedback".

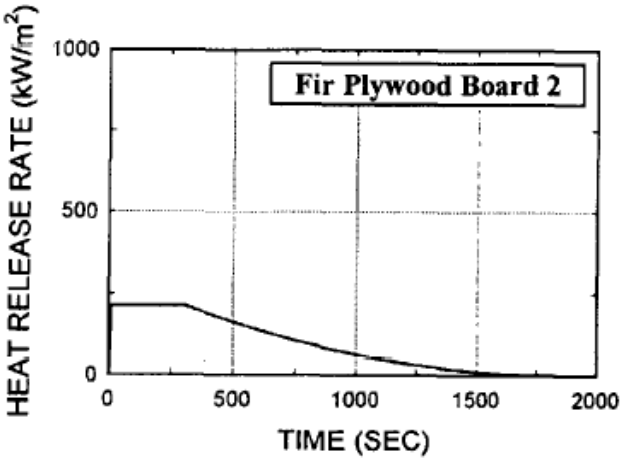


Figure 47. Douglas Fir Plywood, ½ in. thick (446) Board.

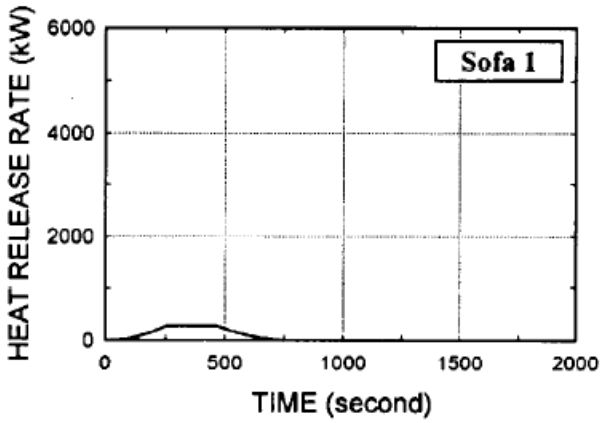


Figure 48. Sofa, metal frame, urethane foam, plastic-coated fabric HRR.

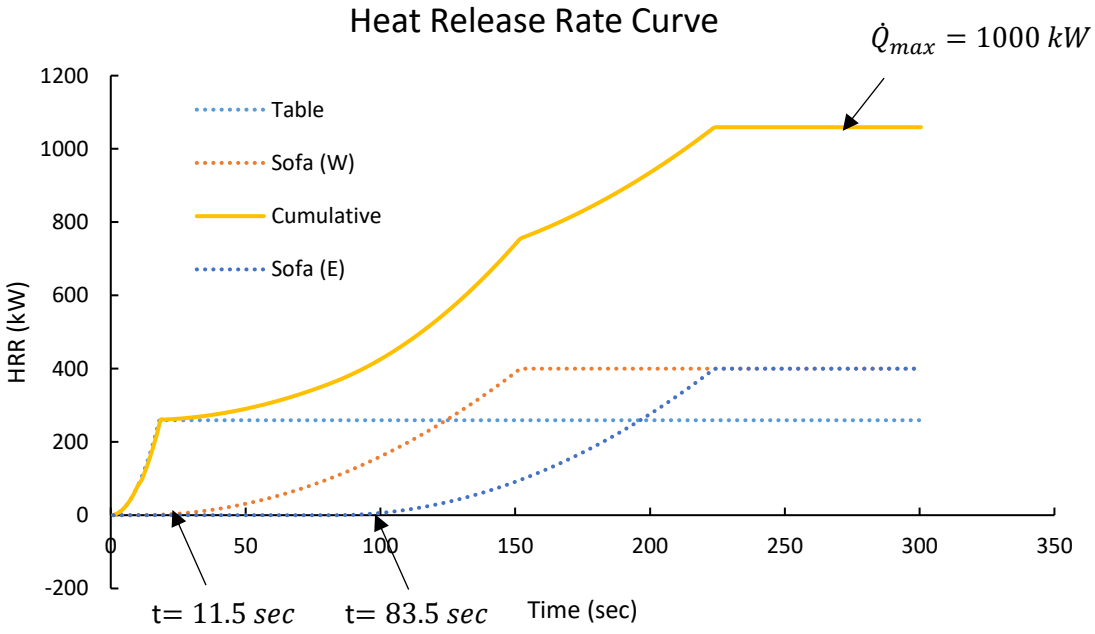


Figure 49. Each fuel package HRR curve and the time of each sofa start to ignite

Figure 49 shows the heat release rate of each package and the cumulative heat release rate. The maximum HRR it can reach is about 1000 kW. The calculation shows that the sofas around the table will ignite at 11.5 seconds. After 83.5 seconds, all the fuel packages are catching on fire. Because these tables and sofas are placed in a huge open space, it is less likely to experience flashover. Therefore, an analysis of flashover is not included.

FDS Model

Design Fire 2 FDS model layout is shown in Figure 50. The FDS model set up is similar to Design Fire 1, except the ventilation factor for this fire scenario is assumed to be the main entrance doors on the first floor and three open doors on the second floor. Since these doors will be used for evacuation during a fire, they will be open constantly. In addition, occupants in this space are not only limited to students or faculty. There could be visitors and tourists who are possibly unfamiliar with the building layout. Thus, the visibility

untenable criteria for this design fire would be 14 meters. Other than that, the type of sprinkler and smoke detector is the same as Design Fire 1. The location of sprinklers and smoke detectors follow the shop drawings. Fuel load of the atrium contains mainly furniture that assumed to be made of polystyrene foam. Table 28 presents fuel parameters and product of combustion used for Design Fire Scenario 2 and FDS model. The fuel parameters are based on the SFPE Handbook 5th edition in Table A.39. The FDS model building layout does not consider the third floor in this scenario. It is because the horizontal shutters will be closed in a fire. They will prevent the smoke spread to the third floor.

Table 28. Fuel Parameters used for Design Fire Scenario 2

Material	Chemical formula	Heat of combustion ($kJ.kg^{-1}$)	Soot yield	CO yield
Polyurethane foam[1]	$C_{27}H_{36}N_2O_{10}$	25,300	0.188	0.028
Fuel Parameters for FDS	$C_{27}H_{36}N_2O_{10}$	25,300	0.188	0.028
1: Average of polystyrene foams are taken from the SFPE Handbook 5th edition, Table A.39				

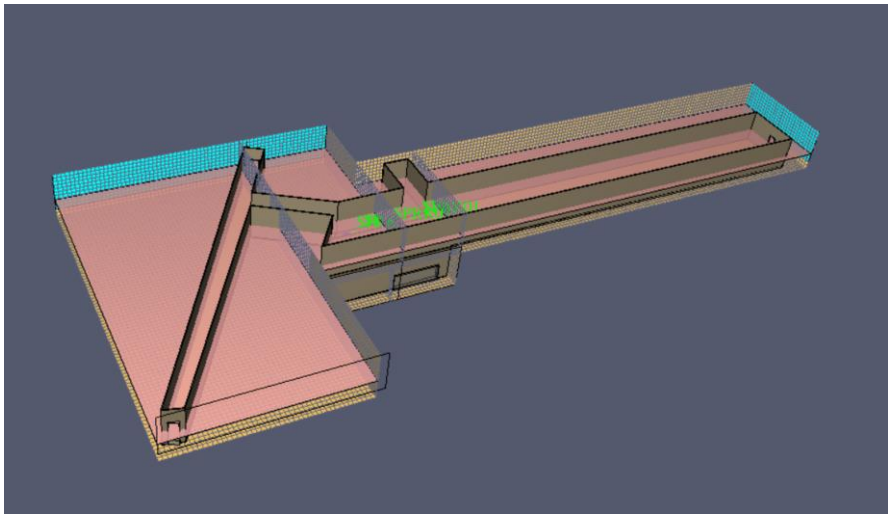


Figure 50. Fire scenario FDS model layout

FDS Results

After running the FDS model, the first sprinkler actives at about 156 seconds and the fire has been controlled since then. The heat release rate is shown in Figure 51. The first smoke detector activates at 18 seconds after the fire starts the ignition.

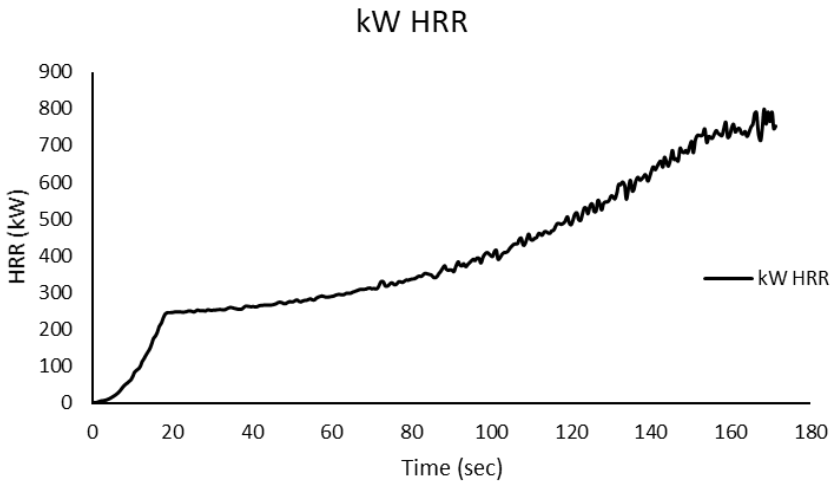


Figure 51. Heat release rate with sprinklers

As shown in Figure 52, the smoke spread to the second floor quickly and it fill out the west corridor at about 355 seconds. At that time, the visibility reaches to an untenable condition which is less than 14 meters at 6 feet (2.1 m) above the walking surface. Occupants who stay in that area will significantly increase the risk to challenge their life safety. At about 391 seconds, the east corridor reaches untenable conditions invisibility as shown in Figure 53. Another tenable criterion is temperature. According to Figure 54, the FDS results show that the second-floor atrium never reaches over 60 °C, which represents the temperature does not reach untenable conditions for this fire scenario-based on the assumptions. ASET is taking whichever the criterion reaches untenable condition first. Therefore, ASET is taking the time that the west corridor is unsuitable to stay, which is 355 seconds.

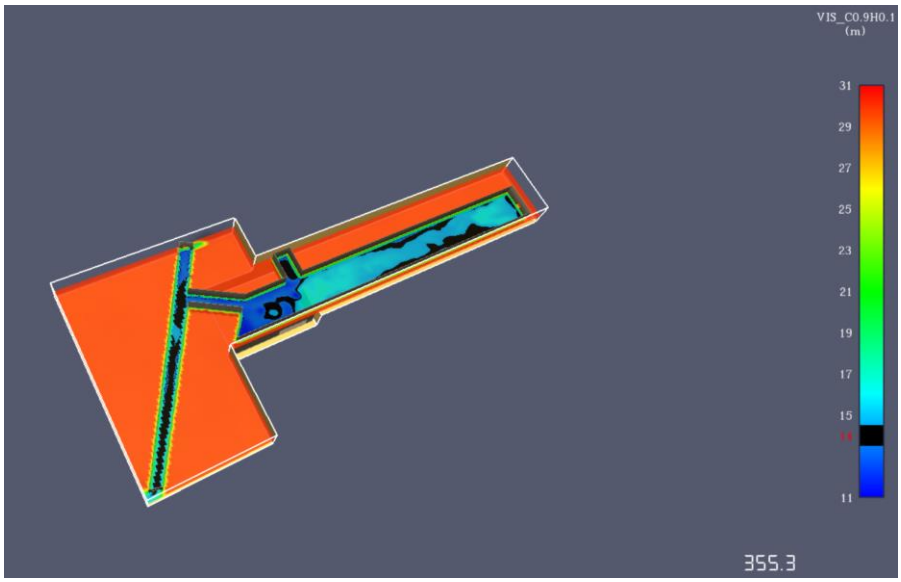


Figure 52. Visibility reaches untenable conditions at 355 seconds in west corridor on the second floor

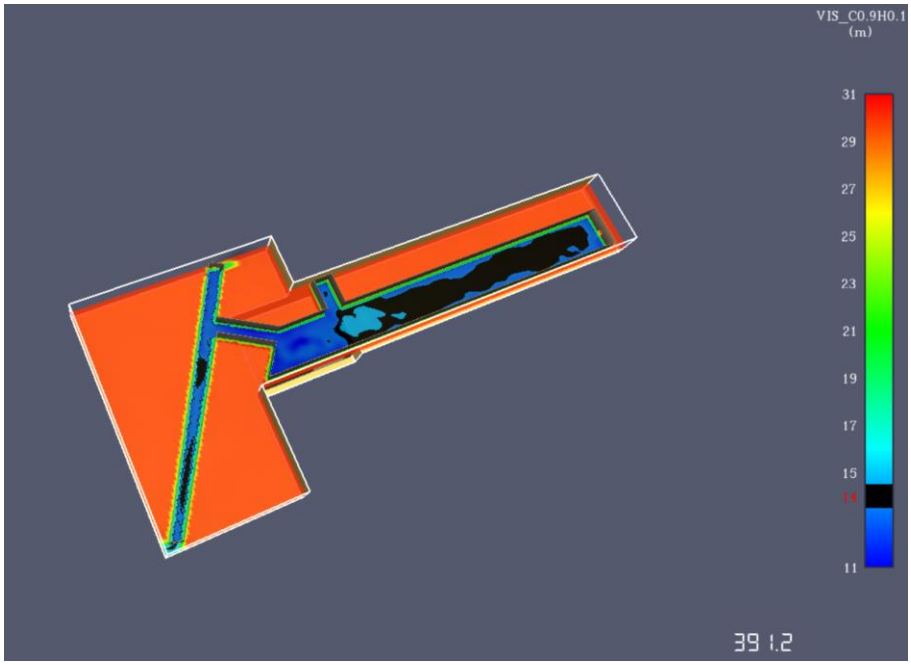


Figure 53. Visibility reaches untenable conditions at 391 seconds in the east corridor on the second floor

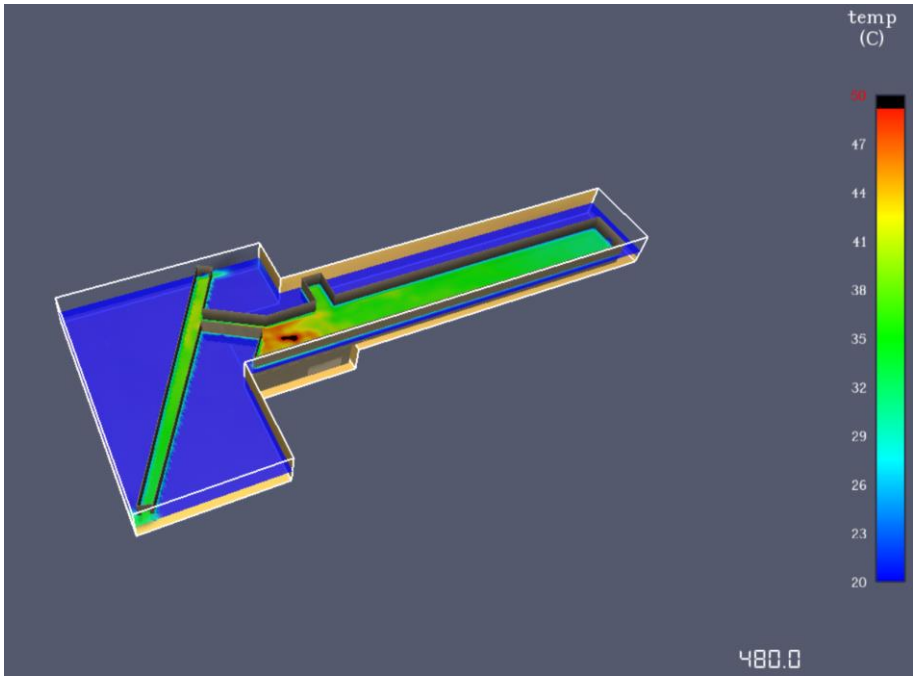


Figure 54. The temperature never reaches untenable conditions on the second floor.

RSET Hand Calculation

The atrium fire will spread the smoke to the second floor first, and the second floor will reach untenable conditions first compared with the first floor. Thus, only the evacuation time for second floor will be discussed in the RSET hand calculation. The method to determine the RSET is the same as Design Fire 1. The first thing is to determine if queuing will occur. The total corridor area on the second floor is 6080 ft^2

(564 m^2) with 521 occupants. The density is 0.9 ppl/m^2. Thus, queuing will occur in this situation. The hydraulic flow model is involved to calculate for the RSET.

Table 29. Maximum Specific Flow

Table 59.5 Maximum specific flow, Fsm

Exit route element		Maximum specific flow	
		Persons/min/ft of effective width	Persons/s/m of effective width
Corridor, aisle, ramp, doorway		24.0	1.3
Stairs			
Riser	Tread		
(in.)	(in.)		
7.5	10	17.1	0.94
7.0	11	18.5	1.01
6.5	12	20.0	1.09
6.5	13	21.2	1.16

Table 30. Boundary layer widths

Table 59.1 Boundary layer widths

Exit route element	Boundary layer	
	(in.)	(cm)
Stairways—wall or side of tread	6	15
Railings, handrails[a]	3.5	9
Theater chairs, stadium benches	0	0
Corridor, ramp walls	8	20
Obstacles	4	10
Wide concourses, passageways	<18	46
Door, archways	6	15

[a]Where handrails are present, use the value if it results in a lesser effective width

Table 31. Constant for calculating evacuation speed

Table 59.2 Constants for Equation 59.5, evacuation speed

Exit route element		k_1	k_2
Corridor, aisle, ramp, doorway		275	1.40
Stairs			
Riser (in.)	Tread (in.)		
7.5	10	196	1.00
7.0	11	212	1.08
6.5	12	229	1.16
6.5	13	242	1.23

1 in. = 25.4 mm

According to Table 29 to Table 31, the needed maximum specific flow (F_{sm}), boundary layer widths and evacuation constants for the hydraulic flow model are determined. These are summarized in Table 32.

Table 32. Hydraulic Flow Model Constants

	Doorway	Stairway
k (ft/min)	275	212
a (ft^2/ppl)	2.86	2.86
F_{sm} (p/min/ft)	24	18.5
D_{max} (p/ft^2)	0.175	0.175
Total Boundary Layer (in)	12	12
Stairway Conversion Factor	-	1.85

The flow rate on the second floor is driven by door width or stair width. Note that the second floor has three exits. Stair 2 is used for the second floor exit only, but Stair 1 and Stair 4 are sharing with the third floor. On the second floor, the door width is 36" and stair width is 66". On the third floor, the door width is 39" and stair width is 66". The calculations of flow rate limitation for doorways and stairways are shown below:

$$F_c = F_s W_e$$

36-inch door:

$$(24\ p/min/ft) * (36in - 12in) * \frac{ft}{12in} = 48\ persons/min$$

39-in door:

$$(24\ p/min/ft) * (39in - 12in) * \frac{ft}{12in} = 54\ persons/min$$

66-inch stair:

$$(18.5\ p/min/ft) * (66in - 12in) * \frac{ft}{12in} = 83\ persons/min$$

The results show that the Stair 2 flow rate is limited by the door width because it only passes through fewer persons in the same amount of time than stairs. However, for Stair 1 and Stair 4, the flow rate is governed by stairways. It is because the sum of doors flow rate (45+54=99 p/min) is greater than 66-inch stairs.

Assume all exits on the second floor are functional as normal, the evacuation time shall be determined as follows:

Stair 2 travel time:

$$\frac{521/3\ persons}{48p/min} = 3.6\ min$$

Stair 1 and Stair 4 travel time:

$$\frac{521/3persons + 367/2persons}{83p/min} = 4.3\ \min(258\ seconds)$$

Assume all occupants are distributed evenly in the building and evacuate simultaneously. Because the total evacuation time is only taking the maximum time, the total evacuation time (RSET) would be 343 seconds, including notification time (25 seconds – FDS result) and pre-movement time (60 seconds) and travel time (258 seconds).

Conclusion

Based on the assumptions, the results indicate that ASET is slightly greater than RSET. It passes the requirement of performance-based design. Thus, the occupants in the Design Fire 2 shall have enough time to evacuate to the public space before they are stuck in the hallway by the smoke. The life safety design for this area can be considered adequate.

According to the code requirements, Stair 3 in the atrium which connects the first floor to the second floor is not designed for means of egress; however, students may not recognize that it is unprotected and distinguish the difference between Stair 3 and other stairs. Thus, students may take that stair for evacuation in real life. As a result, it may increase the risk of challenging their life safety. On the other hand, it could also decrease overall evacuation time by avoiding queuing on the second floor.

Design Fire 3 – ME lab

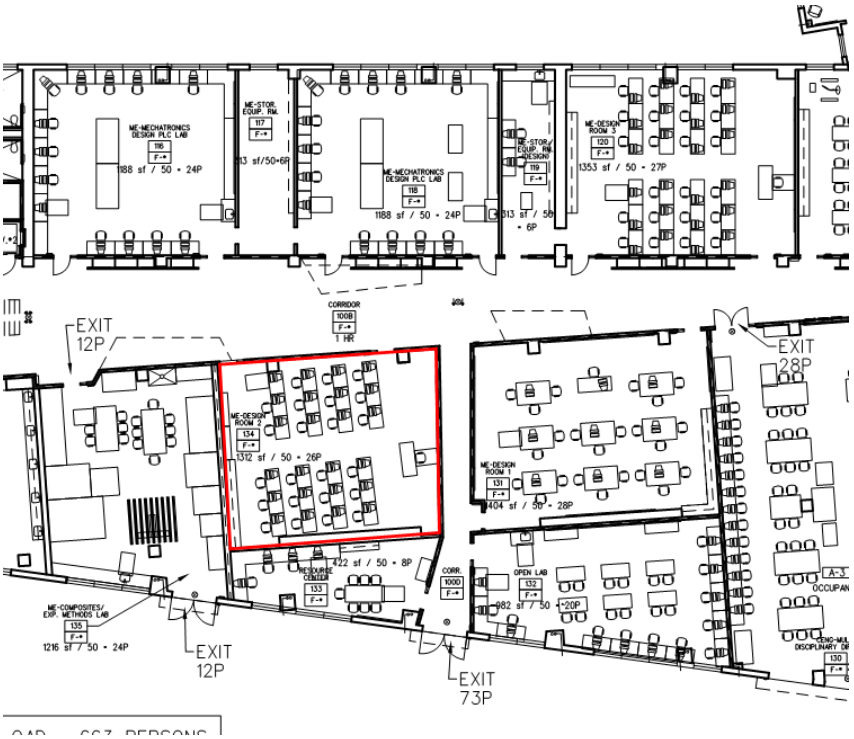


Figure 55. Location of design fire 3 (ME Lab).

Figure 55 is the location of design fire scenario 3. ME Lab 134 is one of the labs with students and computers. There is a large fuel load, which fire may grow rapidly and reach untenable conditions before occupants evacuate the room.

There are two stacks of the workstations as shown in Figure 56. The first assumption for this design fire is to consider one stack of workstation as one fuel package. The full load of the room consists of 4 rows on each side. Another assumption is that each stack's fuel load is about six times of one office fuel load discussed in Design Fire 1. The fire will start on the right-hand side. The distance between each stack is about 1.5 meters. Once the secondary item reaches the critical heat, it will also ignite.

Figure 56. Location of fire ignited in ME Lab.

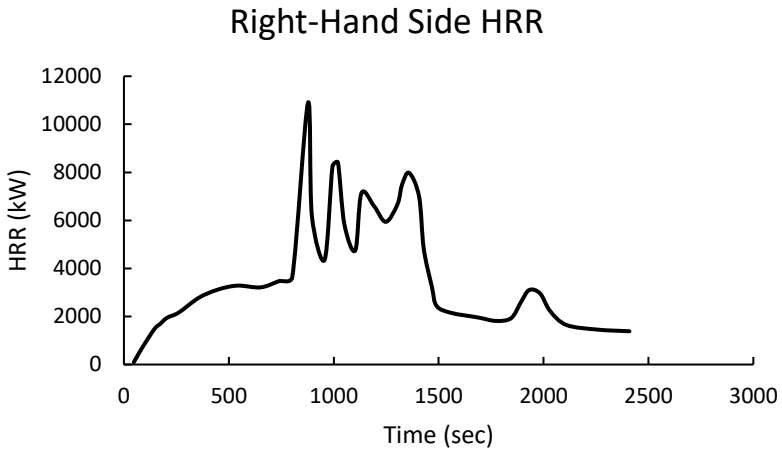


Figure 57. HRR of right-hand side stack of fuel package.

Figure 57 shows the HRR curve of the workstations on the right-hand side. After approximately 173 seconds, the second workstation stack catches on fire as shown in Figure 58. Because both stacks of fuel load are identified, the only difference between two HRR curves is the time start to ignite.

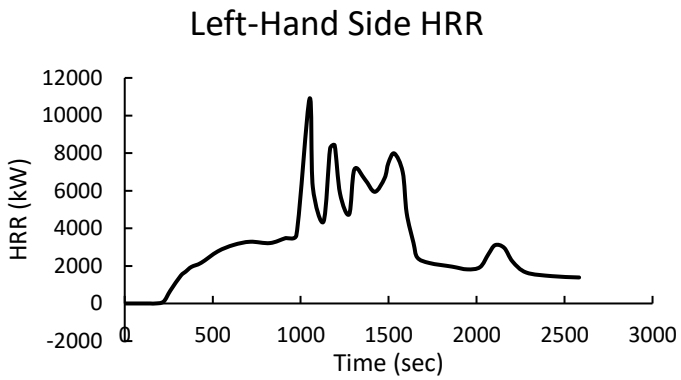


Figure 58. HRR of left-hand side stack of fuel package and delay time for ignition.

Finally, two HRR curves are added together can be seen in Figure 59. The cumulative HRR curve indicates the maximum HRR is about 19000 kW at about 1000 seconds. This is a reasonable value for a large compartment and rich fuel load.

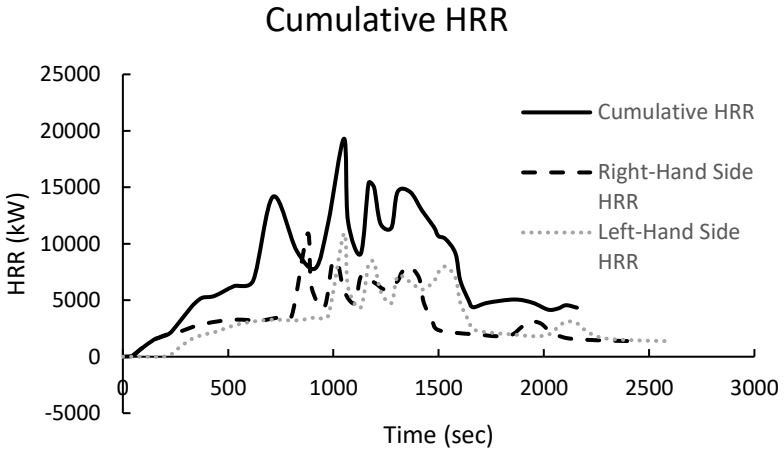


Figure 59. Cumulative HRR of ME Lab.

FDS Model

The FDS model set up is the same as Design Fire 1, except the ventilation factor becomes two opened doors. The sprinklers and smoke detectors are located as indicated in the shop drawing. The untenable criterion for this scenario would be 4 meters at 6 feet (2.1 m) above the walking surface and 60 °C. It is because this is a relatively small compartment and students or professors who are always taking lectures here shall be very much familiar with the compartment layout. The fuel load of the atrium is assumed to be furniture and computers that are mainly made of wood, polystyrene foam and silicone. It is assumed that the fuel load is composed equally of three materials. Table 33 presents fuel parameters and product of combustion used for Design Fire Scenario 3 and FDS model. The fuel parameters are based on the SFPE Handbook 5th edition in Table A.39. Figure 60 shows the FDS model layout.

Table 33. Fuel Parameters used for Design Fire Scenario 3

Material	Chemical formula	Heat of combustion ($kJ.kg^{-1}$)	Soot yield	CO yield
Wood (pine)	-	17,900	0.015	0.005
Polystyrene foam[1]	C_8H_8	37,400	0.194	0.061
Silicone/PVC	-	16,400	0.088	0.975
Fuel Parameters for FDS	C_3H_6	23,900	0.099	1.041
1, 2: Average of polystyrene foams are taken from the SFPE Handbook 5th edition, Table A.39				

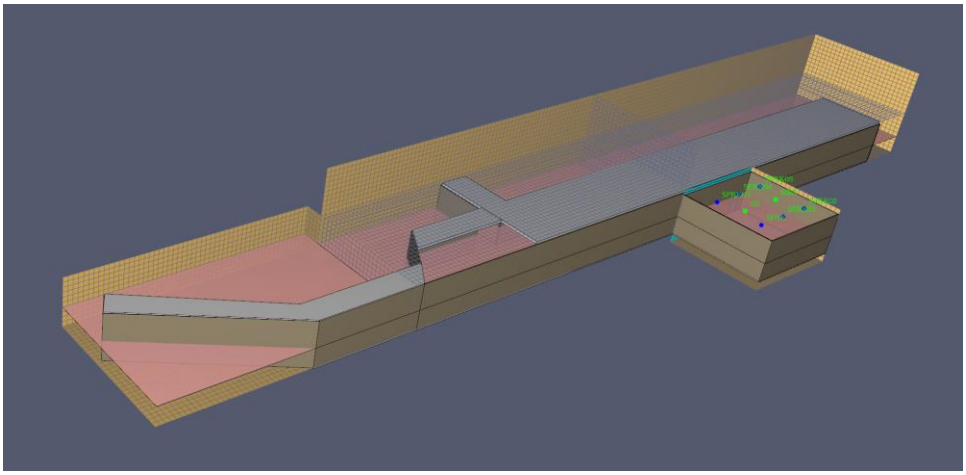


Figure 60. Fire scenario 3 FDS model layout

FDS Result

The fire grew rapidly in fire scenario 3. It is because the assumption of burning fuel is made to simplify the model and may not be realistic. Even with a rapid growth fire, the compartment still takes 154 seconds to reach visibility untenable condition (Figure 61) and the corridor on the first floor takes 356 seconds to reach untenable conditions (Figure 62). Note that the untenable conditions are different in the compartment and corridor because occupants are different. In the corridor, the occupants are a mix of students, faculty and visitors. In the comparison of ASET and REST, both compartment and corridor will be discussed.

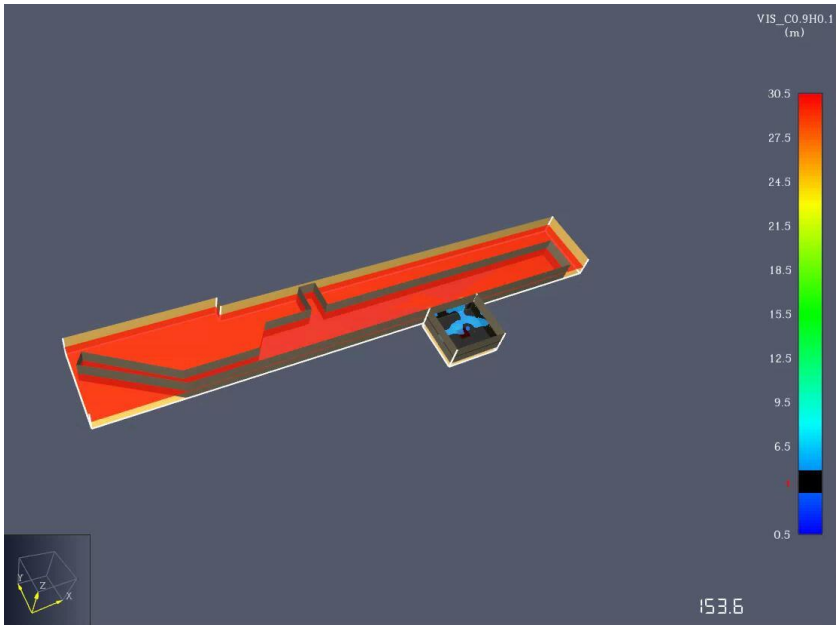


Figure 61. Visibility untenable condition in the compartment

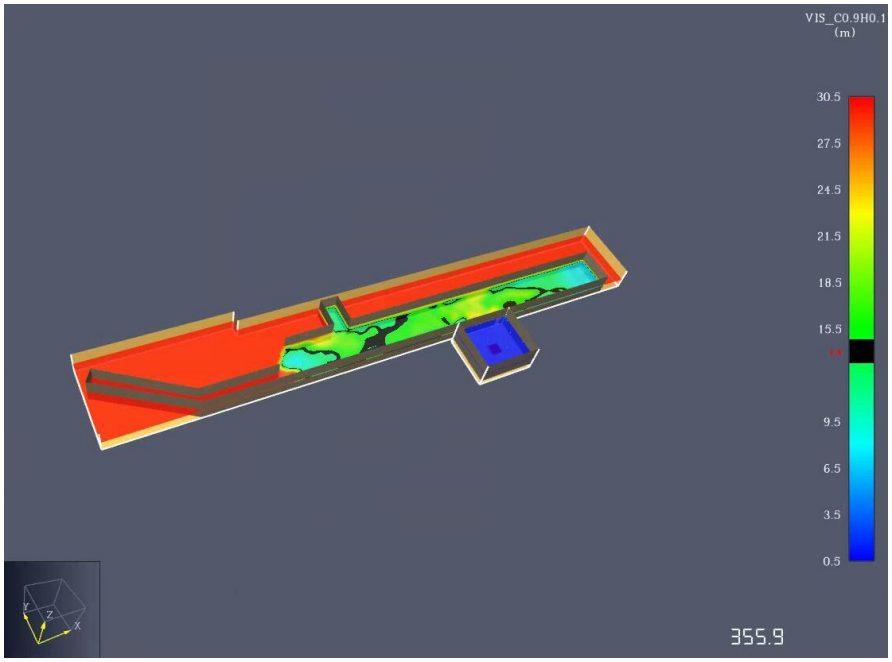


Figure 62. Visibility untenable condition in the first-floor corridor

Hand Calculation

The total area of this compartment (not include floor area and opening area) is 120 m^2. But in this space, many desktops and chairs are unmovable. Considering that, the gross area in this room would be 60 m^2 with 26 occupants. Then the density in this design fire is 0.4 $ppl.m^2$. Thus, the hydraulic flow model will not be applied for this situation. Evacuation time will be simply defined by travel time for the last occupant to move out to the compartment from the farthest position. Travel distance is about 43.5 feet (13.2 meters) as shown in Figure 63.

Figure 63. Travel distance for Design Fire 3.

Travel time:

$$\frac{13.2meters}{1.2m/sec} = 11\ seconds$$

The fire starts in a compartment. It will take a longer time reach untenable condition on the second floor than the atrium fire. As it was shown in the Design Fire 2, the atrium fire will not cause a critical issue to threat people's life. Thus, only the first-floor evacuation time will be considered in this fire scenario. Smoke detector activates at 38 seconds. In this fire scenario, students will notice the fire earlier than the smoke detector. And the notification time can be negligible. Therefore, assuming all occupants are distributed evenly in the building and evacuate simultaneously, the total evacuation time includes notification time (38 seconds) travel time (11seconds) and pre-movement time (60 seconds) which is 109 seconds. Thus, students and faculties will be safe to evacuate the compartment before it reaches to untenable condition.

In addition, since the smoke will spread into the corridor, it is important to determine if the corridor will reach to untenable condition before all the first-floor occupants evacuate. The hydraulic flow model (Table 30) is applied into the calculation. 290 occupants need to evacuate from 5 main exits (number of 7 72-inch doors). The density is 1.8 ppl/m^2. Queuing will occur. Thus, the flow rate on the first floor is only driven by door. Calculation is shown below:

72-inch door:

$$(24\ p/min/ft) * (72in - 12in) * \frac{ft}{12in} = 120\ persons/min$$

First floor travel time:

$$\frac{290/7\ persons}{120p/min} = 0.48\ \text{min}\ \ (21\ seconds)$$

Total evacuation time shall be determined as following:

$$notication\ time\ (38\ sec) +\ premovement\ time\ (60\ sec) + travel\ time\ (21\ sec) =\ 119\ seconds$$

Therefore, based on the assumptions, both RSET is less than ASET in Design Fire 3. The fire life safety design in ME Lab is adequate.

ASET vs. RSET Summary

Based on all assumptions, the performance-based designs have been successfully proved that RSET is greater than ASET for all fire scenarios. The comparison is shown in Table 34. Fire scenario 1 has a spare time of 216 seconds with a safety factor of 3.2, fire scenario 2 has 12 seconds of spare time with a safety factor of 1.0, fire scenario 3-compartment has 44 seconds spare time with a safety factor of 1.4, and fire scenario 3-corridor has 237 seconds spare time with a safety factor of 3.0.

Table 34. ASET vs. RSET

Scenarios #	ASET (seconds)	RSET (seconds)	Safety Factor
1	389	123	3.2
2	355	343	1.0
3-compartment	153	109	1.4
3-corridor	356	119	3.0

Conclusion

In this report, the life system systems have been reviewed in two main sections: prescriptive analysis and performance-based design. The prescriptive analysis is based on current code, including means of egress analysis, structure analysis, suppression system analysis, and fire alarm analysis. In the performance-based design, three fire scenarios were selected to compare ASET with RSET. Although the analysis may not perfectly simulate the real-life fire events, assumptions are made conservative. Based on those assumptions, the analysis of prescriptive and performance-based design shows that the Engineering IV building's life safety system is designed properly and adequately to meet the code and standard requirements. But there is an issue that may potentially threaten student and faculty's life. Stair 3 that connects the second floor and third floor is not designed for egress path. And all the design scenarios assumed that people did not use that as means of egress. In real life, however, someone who is not familiar with the building may use Stair 3 to escape. As a result, the fireproof door on the third floor may be open and the smoke probably will spread into third floor to threaten people's life safety. A recommendation made to avoid the tragedy happening is periodically holding a fire drill and put a striking sign on the fireproof door to notice student and faculty that Stair 3 is not used for egress. Furthermore, fire scenario 2 has a relatively small safety factor. ASET is closed to RSET. To make the Engineering IV building be safer, a conservative recommendation is enlarging the door width and stair width to reduce the travel time.

Reference

[1]. Hurley, M., Gottuk, D., Hall, J., Harada, K., Kulgowski, E., Puchovsky, M., Wieczorek, C. (2016). SFPE Handbook of Fire Protection Engineering (5th ed.)

[2]. University of Maryland Burning Database. http://www.firebid.umd.edu/database-sofas.php

[3]. Kim, Hyeong-Jin and David G. Lilley. "Heat Release Rates of Burning Items in Fires." AIAA 2000-0722. 38th Aerospace Sciences Meeeting & Exhibit. Reno, NV. January 2000.

[4]. M. Kimura and J.D. Sime, "Exit Choice Behavior During the Evacuation of Two Lecture Theatres," *Fire Safety Science—Proceedings of the Second International Symposium,* Hemisphere Publishing Corp., Washington, DC, pp. 541–550 (1989).

[5]. NFPA 72 National Fire Alarm and Signaling Code.

[6]. NFPA 72 Handbook, Notification Appliances, Chapter 3, Section 14

[7]. NFPA 13, Standard for Installation of Sprinkler System, 2019 edition.

Appendix A – Occupancy Load

First Floor Occupancy Load

Space	Classification	Area (sq ft)	Occupancy factor	Occupancy load
IME-Electronic Fab/electronics	A-3	2513	50	50
IME-Computer Simulation B	B	930	50	19
CENG-Multipurpose Lab	A-3	3504	15	234
ME-Fluid Mechanics Lab	A-3	3389	50	68
STOR.RM.	B	450	300	2
MATE-Welding & Joining Lab	B	419	50	9
Development Project RM.	B	312	50	7
CENG-Clean Lab	B	1779	50	36
Technical Support	B	533	30	18
ME-Mechatronics Design PLC Lab	B	1188	50	24
ME-STOR.EQUIP.RM.	B	513	50	6
ME-Design RM. 3	B	1353	50	27
ME-Robotics Lab	B	1188	50	24
Office 122	B	121	100	2
Office 123	B	125	100	2
Office 124	B	124	100	2
Office 125	B	125	100	2
Office 126	B	127	100	2
Office 127	B	125	100	2
Office 128	B	121	100	2
Office 129	B	122	100	2
CENG-Multi Disciplinary Dirty Lab	A-3	2835	50	57
ME-Design RM. 1	B	404	50	28
Open Lab	B	982	50	20
ME-Design RM. 2	B	1312	50	26
Resource Center	B	422	50	9
ME-Composites/EXP.Methods Lab	B	1216	50	25
CENG-Hydraulics	B	1477	50	30
Total				735

Second Floor Occupancy Load

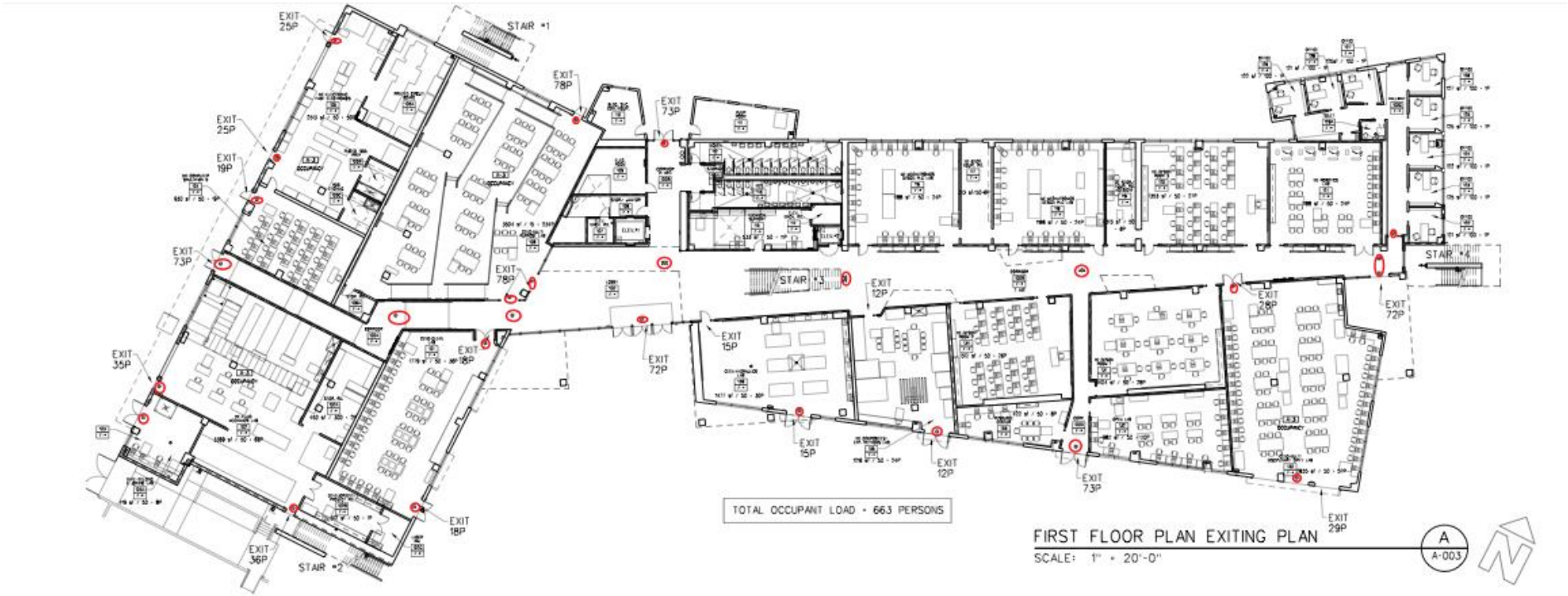
Space	Classification	Area (sq ft)	Occupancy factor	Occupancy load
CEEN-Chemical Wet Lab	B	1995	50	40
CEEN-CAD	B	1964	50	40
CEEN-Design Lab	B	1107	50	22

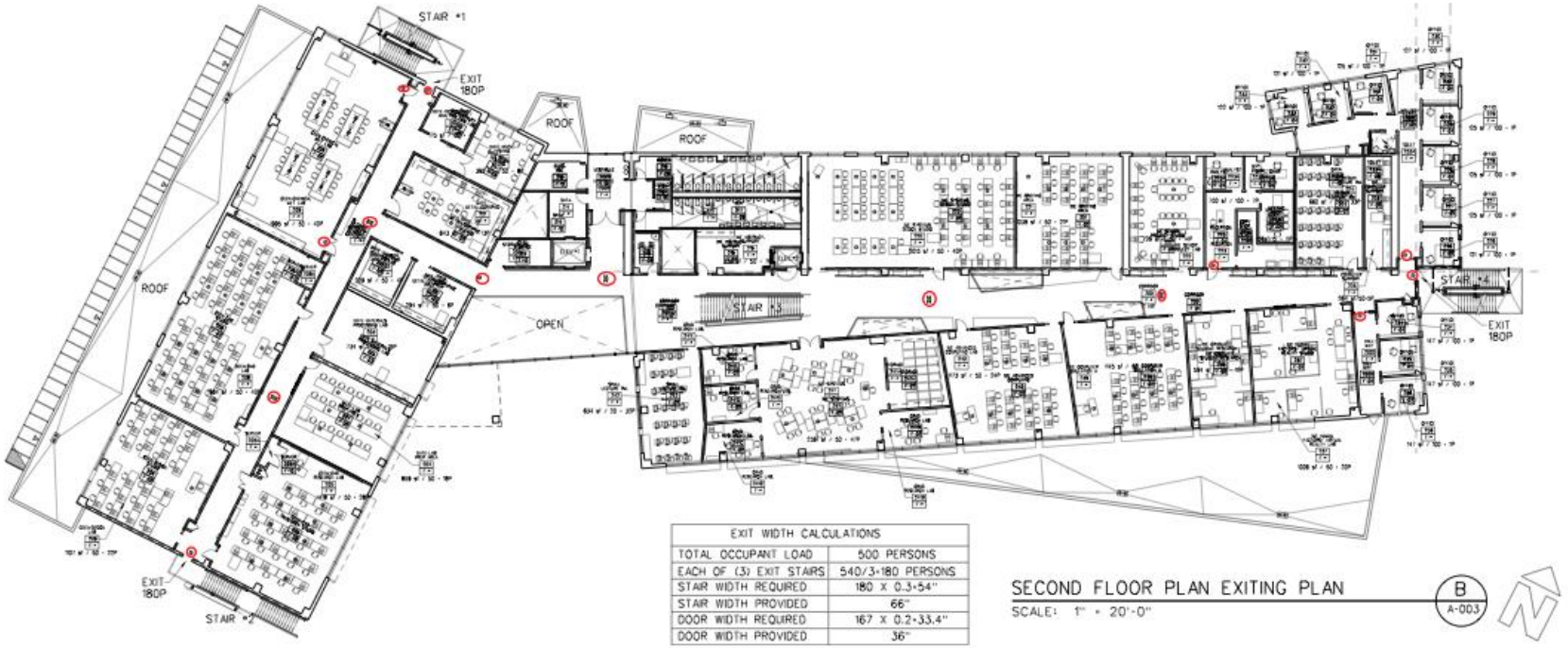
CEEN-CAD Research Lab	B	1418	50	28
MATE-Lab Prep Area	B	859	50	18
MATE-Material Processing Lab	B	734	50	15
MATE-Thermal Analysis Lab	B	209	50	5
MATE-Metallographic	B	294	60	6
MATE-Metallographic	B	643	50	13
MATE-MECH.Testing	B	390	50	8
MATE-Microstructure Analysis Lab	B	175	50	4
IME Instruct Support	B	356	50	8
IME System Design Studio	B	2013	50	41
IME Briefing Area	B	1039	50	21
IME Senior Project Studio	B	726	50	14
Reception	B	700	100	7
Medium Lecture RM.	B	660	20	33
Computer Support	B	264	50	6
Office 226	B	121	100	2
Office 227	B	125	100	2
Office 228	B	125	100	2
Office 229	B	125	100	2
Office 230	B	127	100	2
Office 231	B	125	100	2
Office 232	B	121	100	2
Office 233	B	122	100	2
Office 234	B	147	100	2
Office 235	B	147	100	2
Office 236	B	147	100	2
IME Human Factors/Virtual Reality Studio	B	1008	50	21
IME Graduate Student Research	B	594	50	12
IME Computer Simulation A	B	1145	50	23
IME Advanced Computing Lab	B	1173	50	24
IME Systems	B	2361	50	48
Small Lecture RM.	B	634	20	32
Total				521

Third Floor Occupancy Load

Space	Classification	Area (sq ft)	Occupancy factor	Occupancy load
Dean	B	322	100	4
Small CONF. RM.	B	233	15	16
Budget Analyst	B	213	100	3
ASSOC. Dean 305	B	196	100	2
ADMIN.ASSTS.	B	205	100	3
Dean's suite	B	567	100	6
ASSOC. Dean 302	B	231	100	3
ASSOC. Staff	B	187	100	2
AOA. Staff	B	185	100	2
Dean-CENG Conference RM.	B	504	15	34
Dev. RM.	B	195	100	2
Work RM.	B	170	100	2
Dean College Relations	B	507	100	6
Aero 03 Sophomore Design Lab 321	B	1273	50	26
Aero 03 Sophomore Design Lab	B	1273	50	26
Aero Spacecraft Design Lab 323	B	1782	50	36
Office 324	B	137	100	2
Office 325	B	147	100	2
Office 326	B	147	100	2
Aero Aircraft Design Lab 327	B	1781	50	36
Biomed Wet Lab	B	886	50	18
Biomed Design Lab	A-3	1144	20	58
Medium LECT. RM.	B	755	20	38
Dean 02 DEV. Office	B	621	100	7
Group Study	B	422	20	22
Total				367

Appendix B – Exit Signs

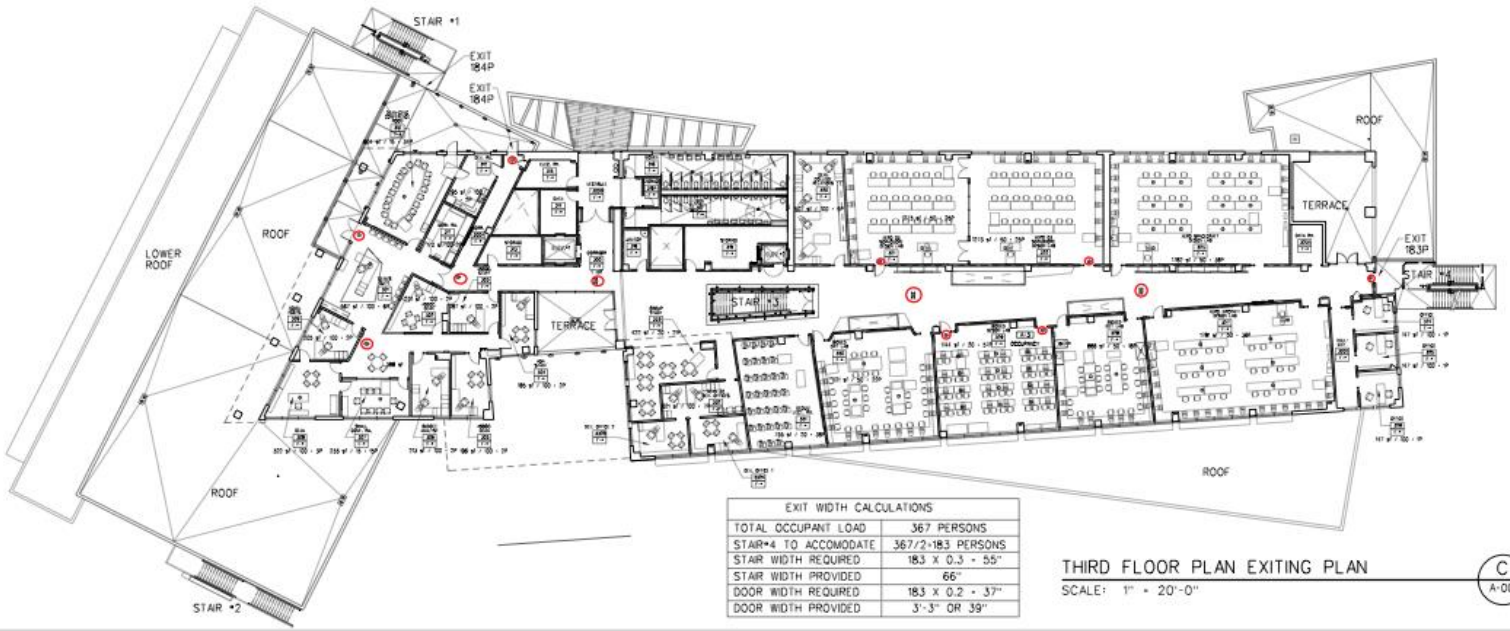




EXIT WIDTH CALCULATIONS	
TOTAL OCCUPANT LOAD	500 PERSONS
EACH OF (3) EXIT STAIRS	540/3=180 PERSONS
STAIR WIDTH REQUIRED	180 X 0.3=54"
STAIR WIDTH PROVIDED	66"
DOOR WIDTH REQUIRED	167 X 0.2=33.4"
DOOR WIDTH PROVIDED	36"

SECOND FLOOR PLAN EXITING PLAN
SCALE: 1" = 20'-0"

B
A-003



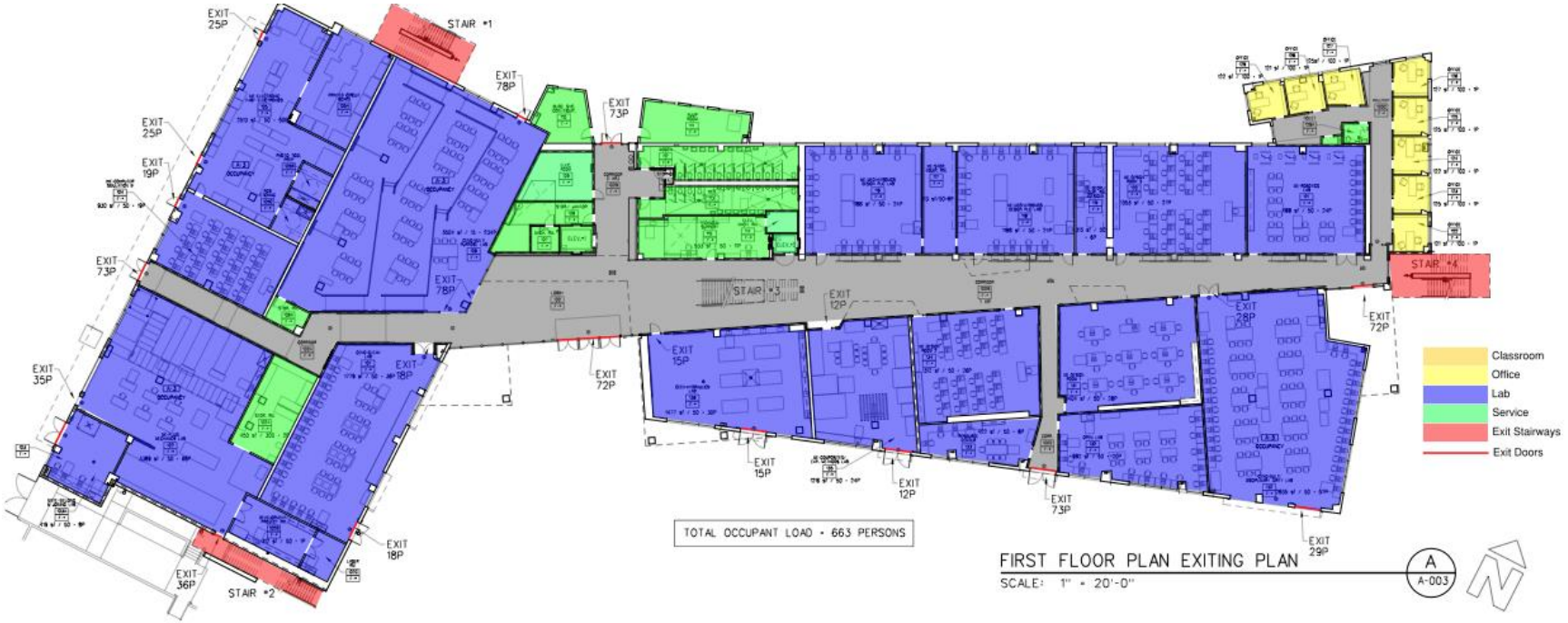
EXIT WIDTH CALCULATIONS	
TOTAL OCCUPANT LOAD	367 PERSONS
STAIR#4 TO ACCOMODATE	367/2=183 PERSONS
STAIR WIDTH REQUIRED	183 X 0.3 = 55"
STAIR WIDTH PROVIDED	66"
DOOR WIDTH REQUIRED	183 X 0.2 = 37"
DOOR WIDTH PROVIDED	3'-3" OR 39"

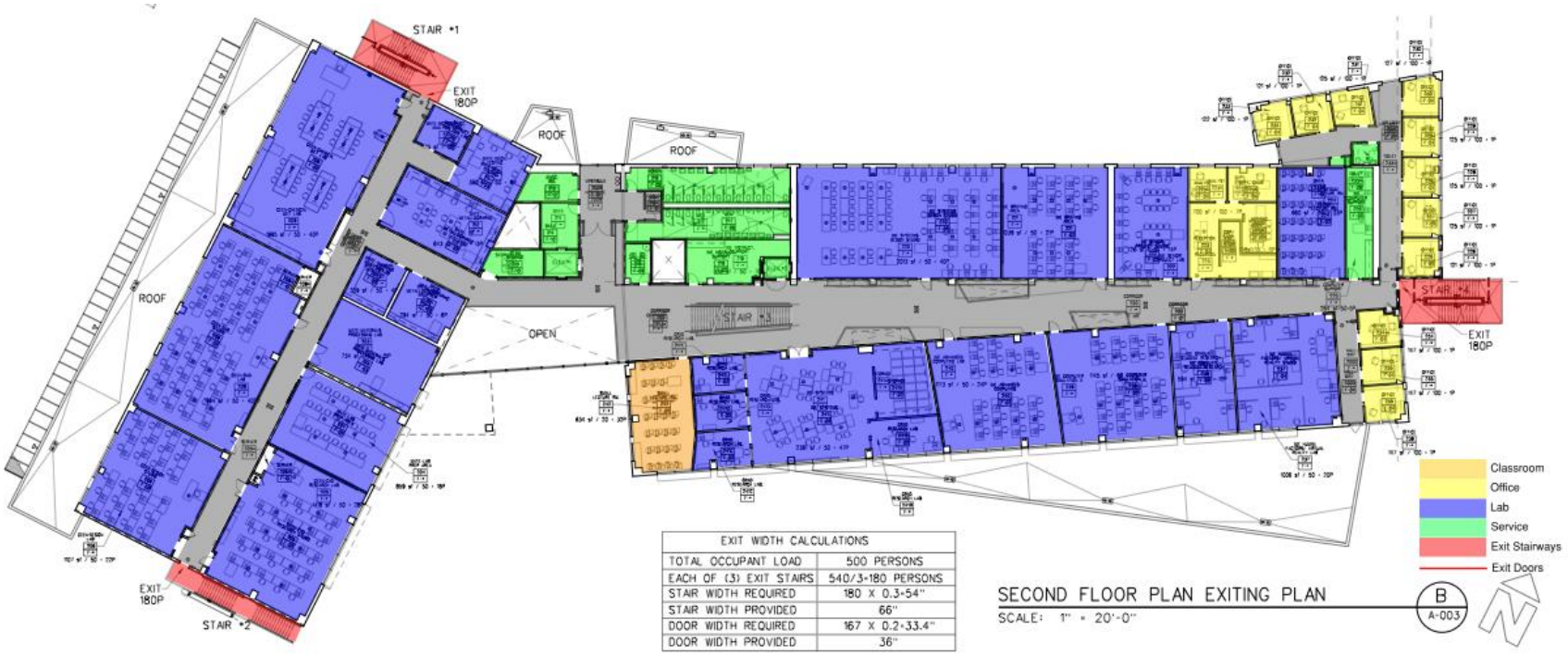
THIRD FLOOR PLAN EXITING PLAN

SCALE: 1" = 20'-0"

C
A-003

Appendix C – Color Code Floor Plan



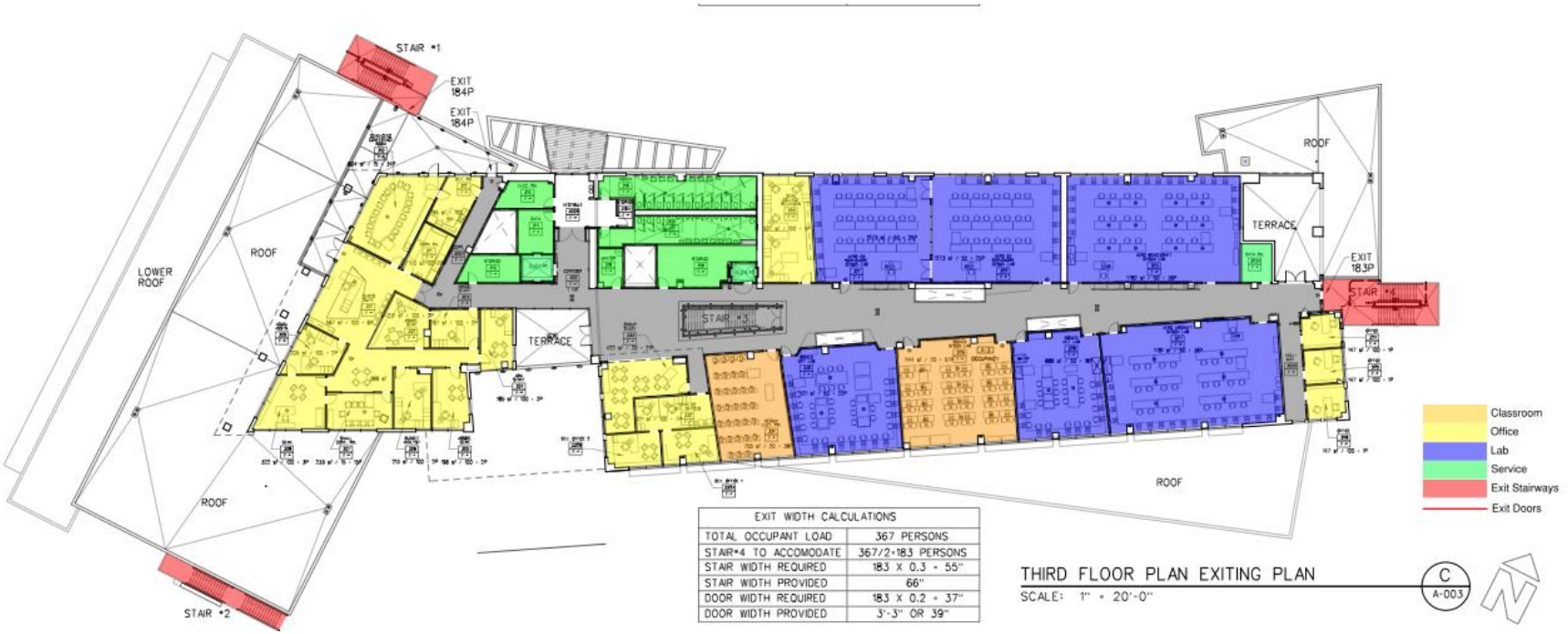


EXIT WIDTH CALCULATIONS	
TOTAL OCCUPANT LOAD	500 PERSONS
EACH OF (3) EXIT STAIRS	540/3=180 PERSONS
STAIR WIDTH REQUIRED	180 X 0.3=54"
STAIR WIDTH PROVIDED	66"
DOOR WIDTH REQUIRED	167 X 0.2=33.4"
DOOR WIDTH PROVIDED	36"

SECOND FLOOR PLAN EXITING PLAN

SCALE: 1" = 20'-0"

B
A-003



EXIT WIDTH CALCULATIONS	
TOTAL OCCUPANT LOAD	367 PERSONS
STAIR#4 TO ACCOMODATE	367/2=183 PERSONS
STAIR WIDTH REQUIRED	183 X 0.3 = 55"
STAIR WIDTH PROVIDED	66"
DOOR WIDTH REQUIRED	183 X 0.2 = 37"
DOOR WIDTH PROVIDED	3'-3" OR 39"

THIRD FLOOR PLAN EXITING PLAN

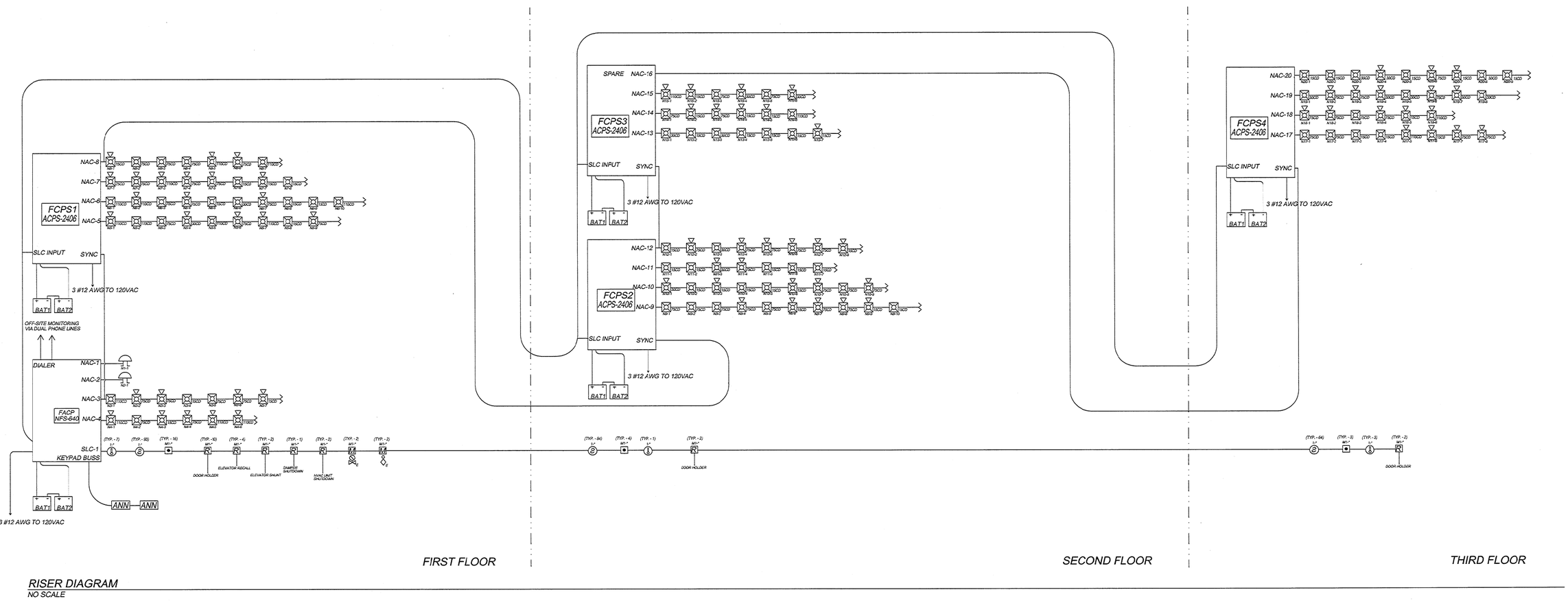
SCALE: 1" = 20'-0"

C
A-003

Appendix D – Sequence of Operation

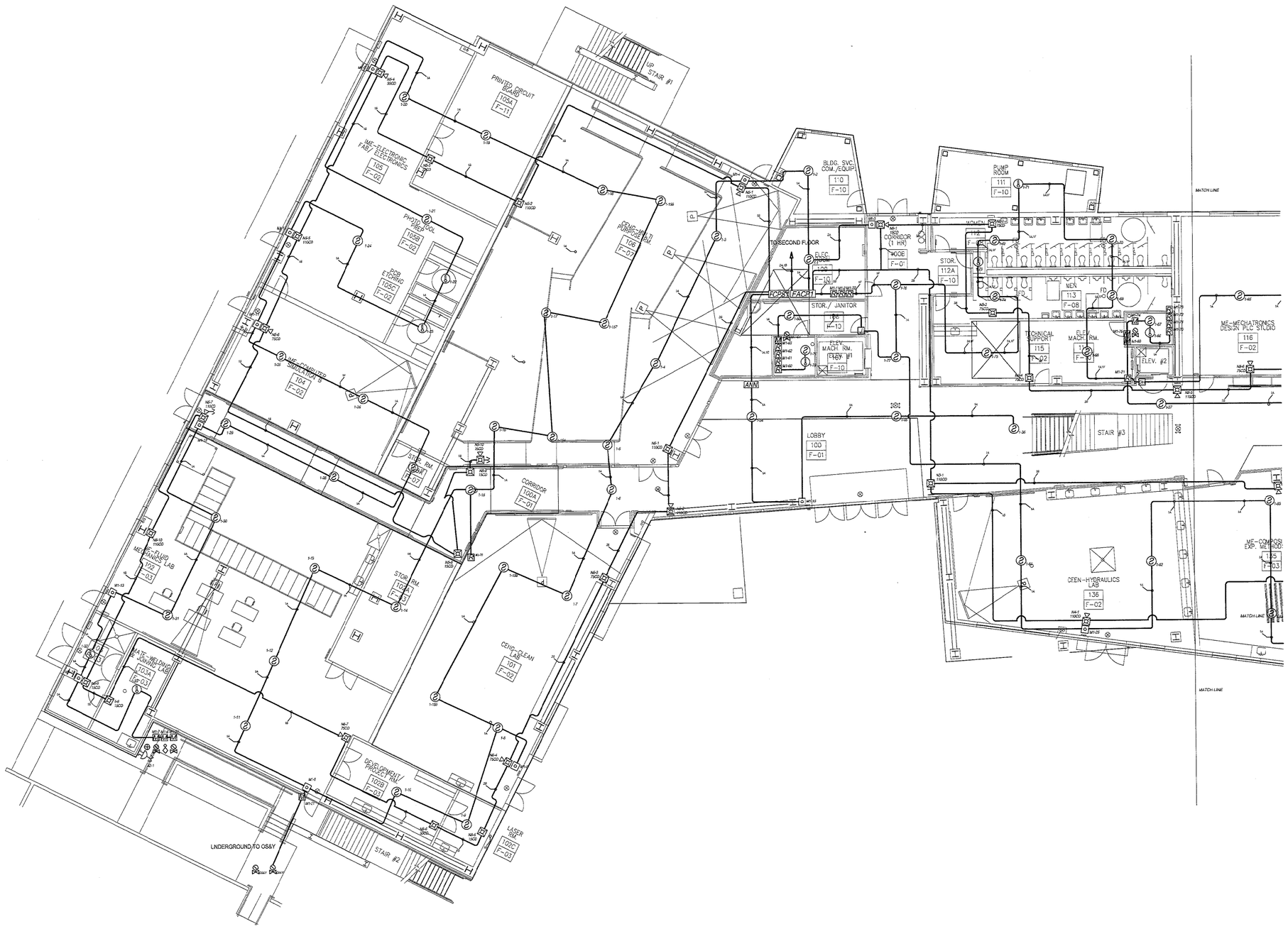
	Manual Pull Station	Area Smoke Detector	Area Heat Detector	Duct Smoke Detector	Elevator Smoke Detector	Elevator Heat Detector	Sprinkler Flow Switch	Sprinkler Tamper Switch	Interruption of Normal Power
Annunciate Alarm Signal at FACP	YES	YES	YES	YES	YES	YES	YES	NO	NO
Annunciate Trouble Signal at FACP	YES	YES	YES	YES	YES	YES	YES	YES	YES
Transmit Signal to Central Station via Digital Communicator	YES	YES	YES	YES	YES	YES	YES	YES	YES
Transmit Signal to BMS	YES	YES	YES	YES	YES	YES	YES	YES	YES
Initiate Building Audible Alarm Signal	YES	YES	YES	YES	YES	YES	YES	NO	NO
Initiate Building Visual Alarm Signal	YES	YES	YES	YES	YES	YES	YES	NO	NO
Shutdown Associated Air Handling Systems	NO	YES	YES	YES	YES	YES	YES	NO	NO
Activate Associated Fire Smoke Dampers	NO	YES	YES	YES	YES	YES	YES	NO	NO
Recall Elevators to Designated Level	NO	NO	NO	NO	YES	NO	NO	NO	NO
Recall Elevators to Alternate Level	NO	NO	NO	NO	YES	NO	NO	NO	NO
Disconnect Power to Elevator Controllers	NO	NO	NO	NO	NO	YES	NO	NO	NO

Appendix E – Riser Diagram



RISER DIAGRAM
NO SCALE

Appendix F – Fire Alarm Floor Plan



FIRST FLOOR WEST FIRE ALARM PLAN
1/8" = 1'0"

ALPHA FIRE
ALPHA CORPORATION

REV#	DATE	ISSUED FOR:
1	4/18/2005	A.H.J. APPROVAL
2	08/12/2005	A.H.J. APPROVAL
3	08/26/2005	

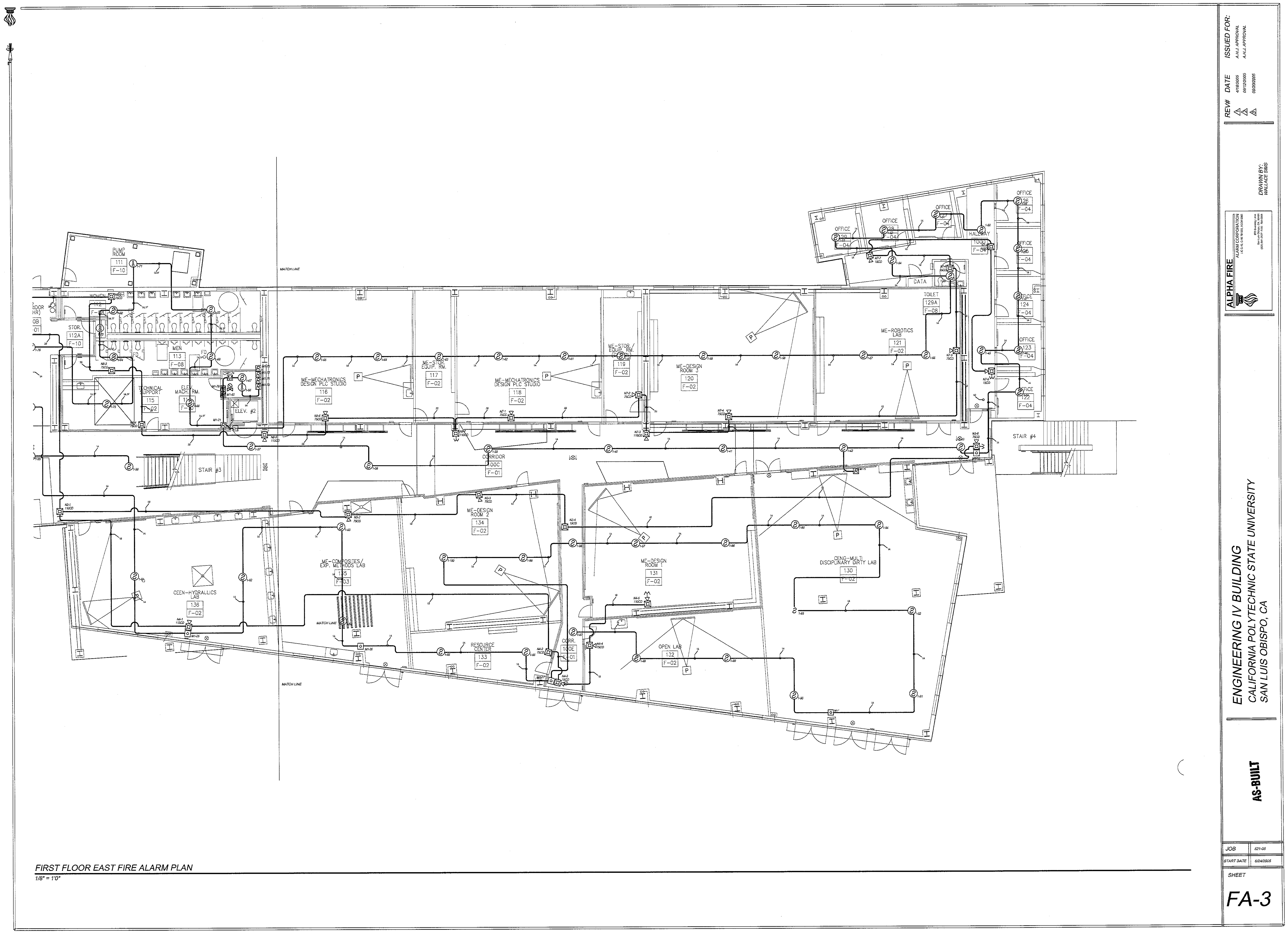
DRAWN BY:
WALLACE BASE

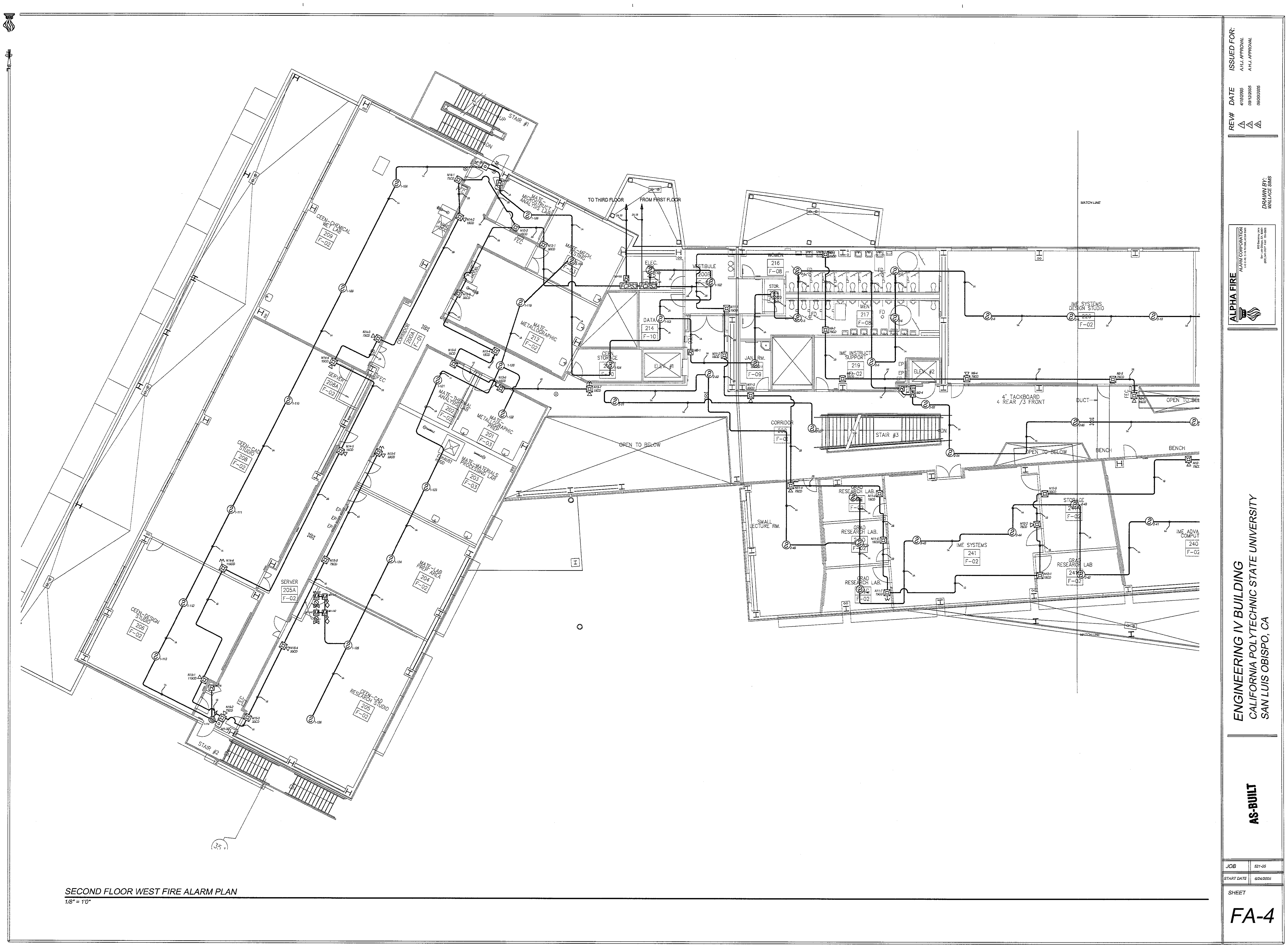
ENGINEERING IV BUILDING
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA

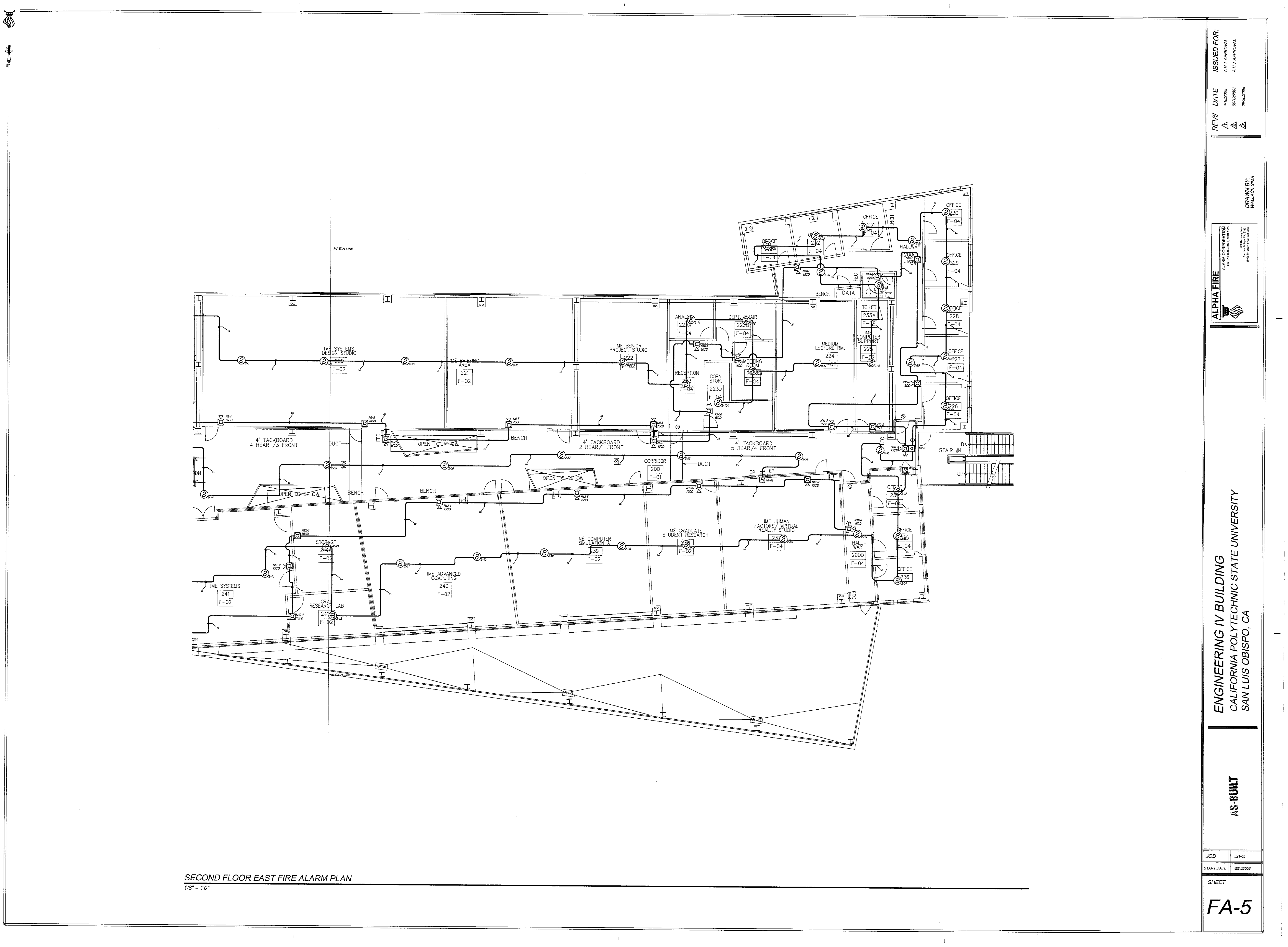
AS-BUILT

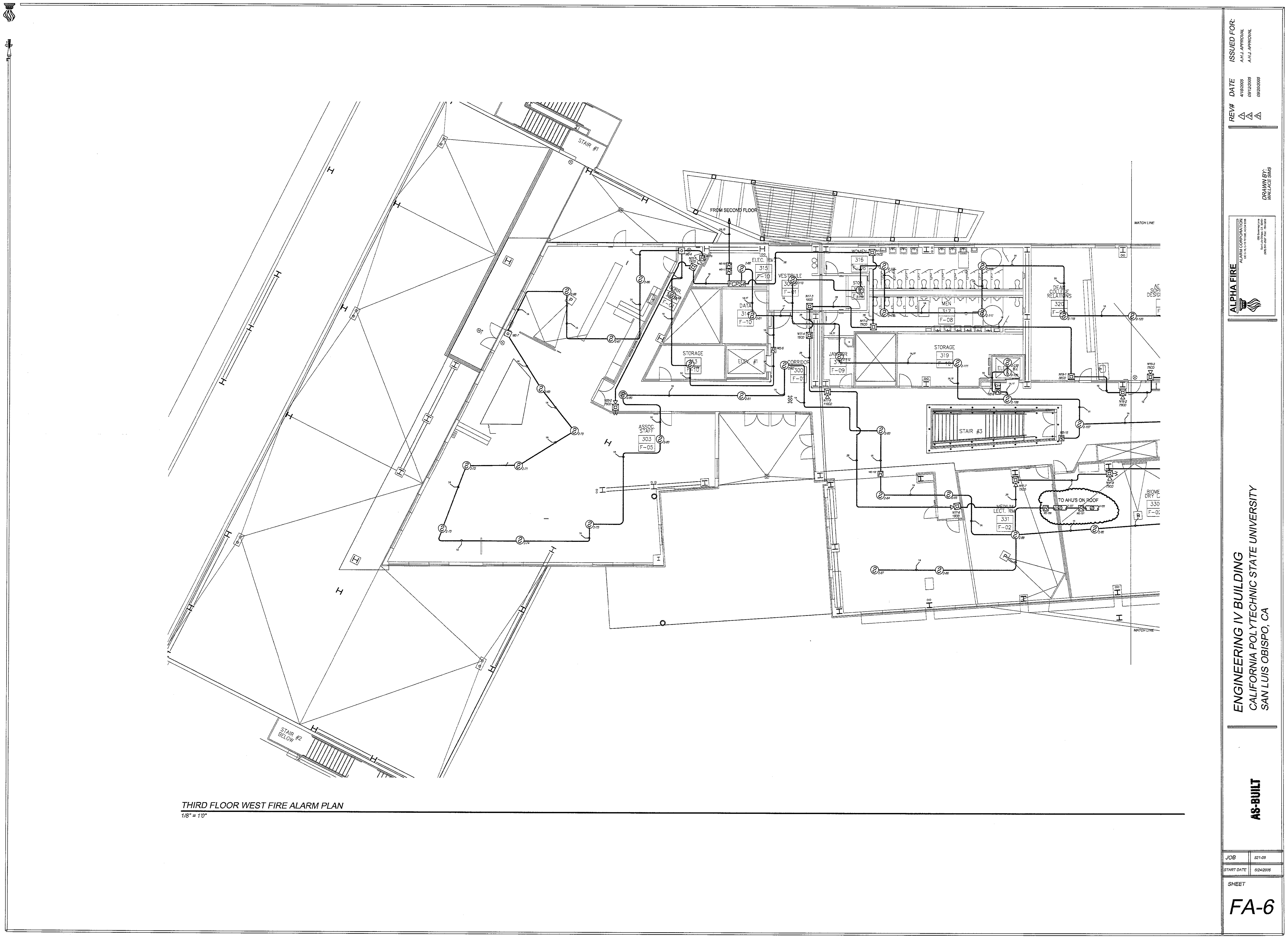
JOB	521-05
START DATE	6/24/2005

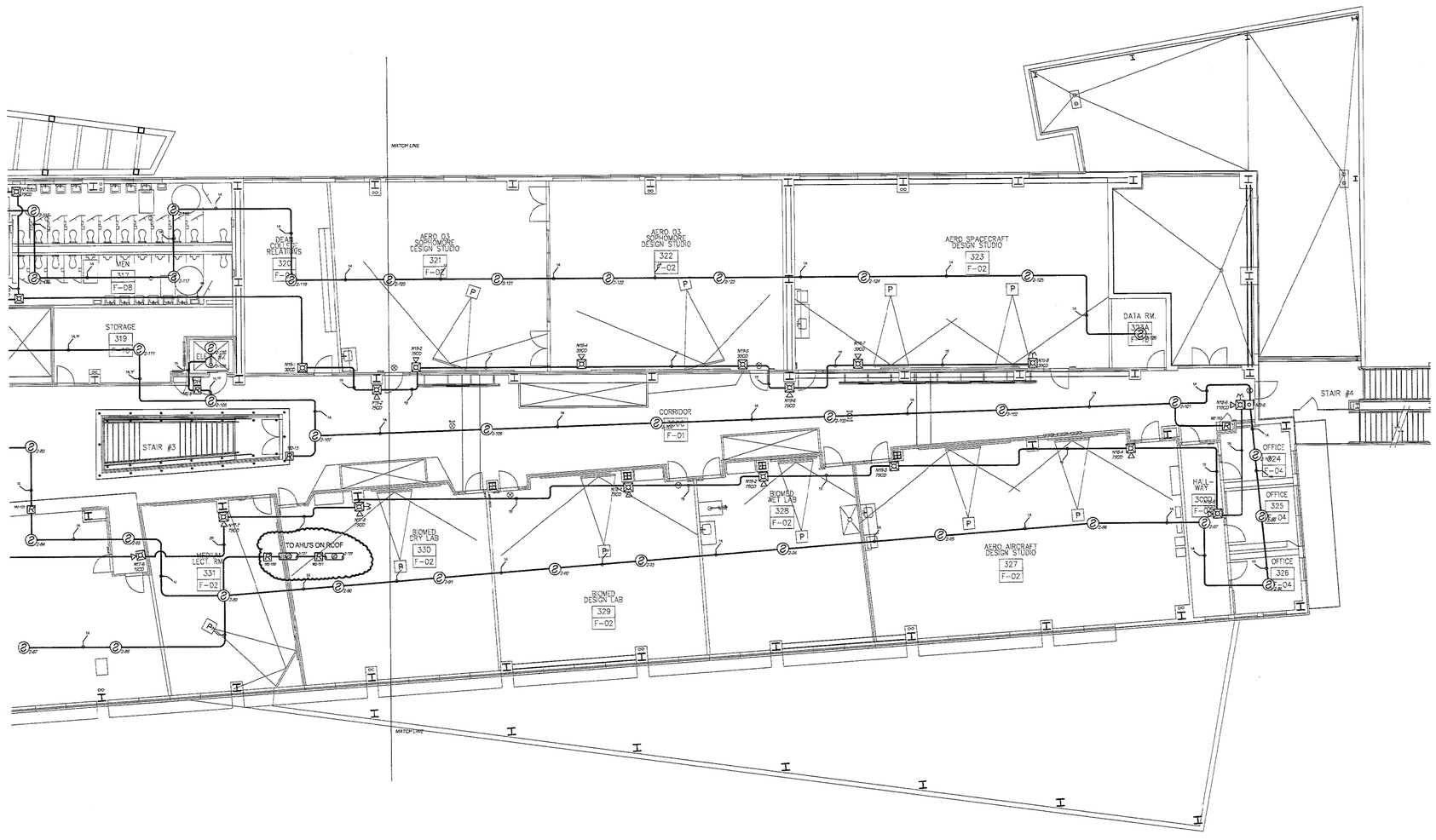
SHEET
FA-2


FIRST FLOOR EAST FIRE ALARM PLAN
1/8" = 1'0"
ENGINEERING IV BUILDING
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA
ALPHA FIRE
AS-BUILT
FA-3


SECOND FLOOR WEST FIRE ALARM PLAN
1/8" = 1'0"
ENGINEERING IV BUILDING
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA
AS-BUILT
ALPHA FIRE
FA-4
TO THIRD FLOOR
FROM FIRST FLOOR
OPEN TO BELOW
STAIR #1
STAIR #2
STAIR #3
4' TACKBOARD
4 REAR /3 FRONT


SECOND FLOOR EAST FIRE ALARM PLAN
1/8" = 1'0"
ENGINEERING IV BUILDING
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA
AS-BUILT
ALPHA FIRE
SHEET
FA-5


THIRD FLOOR WEST FIRE ALARM PLAN
1/8" = 1'0"
ENGINEERING IV BUILDING
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA
AS-BUILT
ALPHA FIRE
DRAWN BY: WALLACE SIMS
FA-6



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

ALPHA FIRE
ALARM CORPORATION

DRAWN BY:
WALLACE SIMS

REV#	DATE	ISSUED FOR:
1	4/18/2005	A.H.J. APPROVAL
2	09/19/2005	A.H.J. APPROVAL
3	09/20/2006	

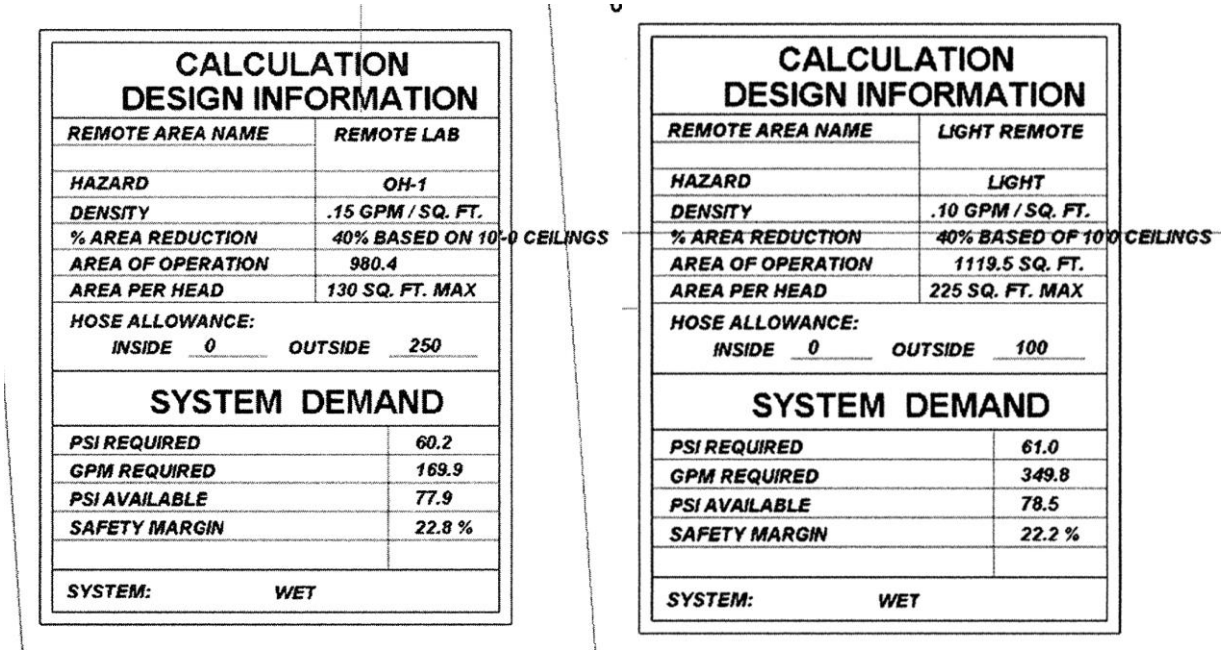
ENGINEERING IV BUILDING
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA

AS-BUILT

JOB	521-05
START DATE	6/24/2005

SHEET
FA-7

Appendix G – Hydraulic



CALCULATION DESIGN INFORMATION

REMOTE AREA NAME	REMOTE LAB
HAZARD	OH-1
DENSITY	.15 GPM / SQ. FT.
% AREA REDUCTION	40% BASED ON 10'-0 CEILINGS
AREA OF OPERATION	980.4
AREA PER HEAD	130 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0 OUTSIDE 250	

SYSTEM DEMAND

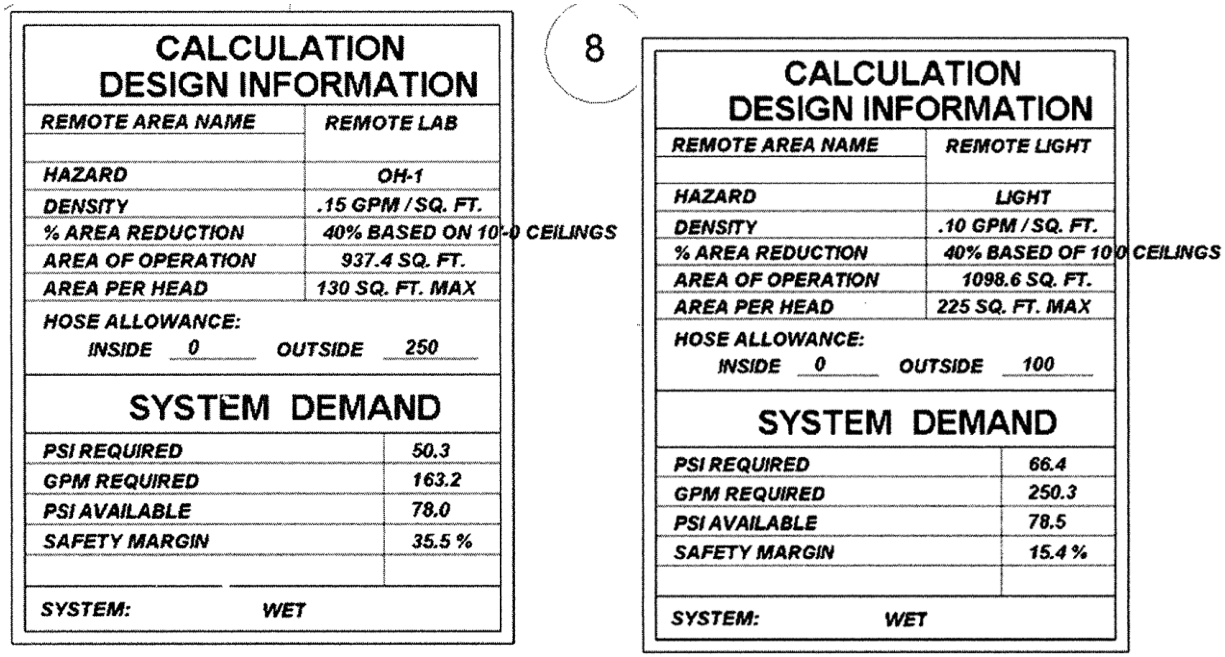
PSI REQUIRED	60.2
GPM REQUIRED	169.9
PSI AVAILABLE	77.9
SAFETY MARGIN	22.8 %
SYSTEM: WET	

CALCULATION DESIGN INFORMATION

REMOTE AREA NAME	LIGHT REMOTE
HAZARD	LIGHT
DENSITY	.10 GPM / SQ. FT.
% AREA REDUCTION	40% BASED OF 10'0 CEILINGS
AREA OF OPERATION	1119.5 SQ. FT.
AREA PER HEAD	225 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0 OUTSIDE 100	

SYSTEM DEMAND

PSI REQUIRED	61.0
GPM REQUIRED	349.8
PSI AVAILABLE	78.5
SAFETY MARGIN	22.2 %
SYSTEM: WET	



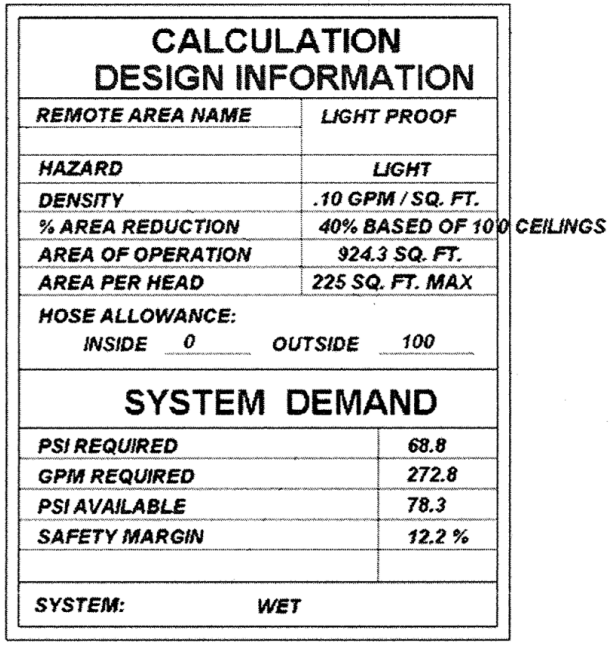
CALCULATION DESIGN INFORMATION	
REMOTE AREA NAME	REMOTE LAB
HAZARD	OH-1
DENSITY	.15 GPM / SQ. FT.
% AREA REDUCTION	40% BASED ON 10'-0 CEILINGS
AREA OF OPERATION	937.4 SQ. FT.
AREA PER HEAD	130 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0	OUTSIDE 250

SYSTEM DEMAND	
PSI REQUIRED	50.3
GPM REQUIRED	163.2
PSI AVAILABLE	78.0
SAFETY MARGIN	35.5 %
SYSTEM:	WET

8

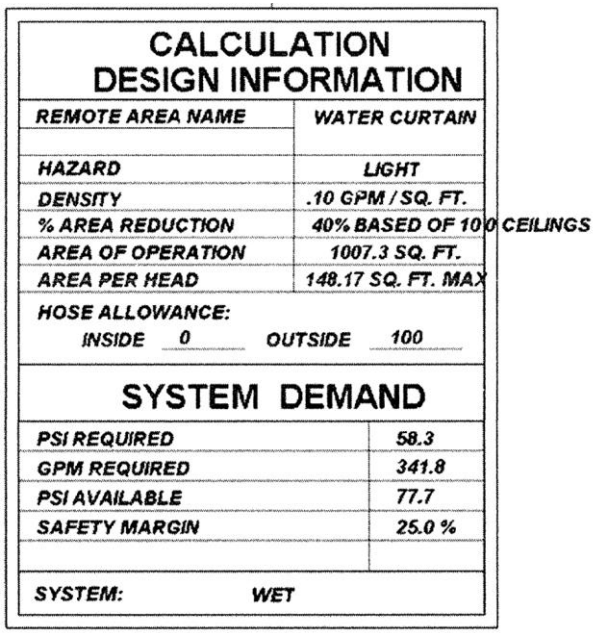
CALCULATION DESIGN INFORMATION	
REMOTE AREA NAME	REMOTE LIGHT
HAZARD	LIGHT
DENSITY	.10 GPM / SQ. FT.
% AREA REDUCTION	40% BASED OF 10'0 CEILINGS
AREA OF OPERATION	1098.6 SQ. FT.
AREA PER HEAD	225 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0	OUTSIDE 100

SYSTEM DEMAND	
PSI REQUIRED	66.4
GPM REQUIRED	250.3
PSI AVAILABLE	78.5
SAFETY MARGIN	15.4 %
SYSTEM:	WET



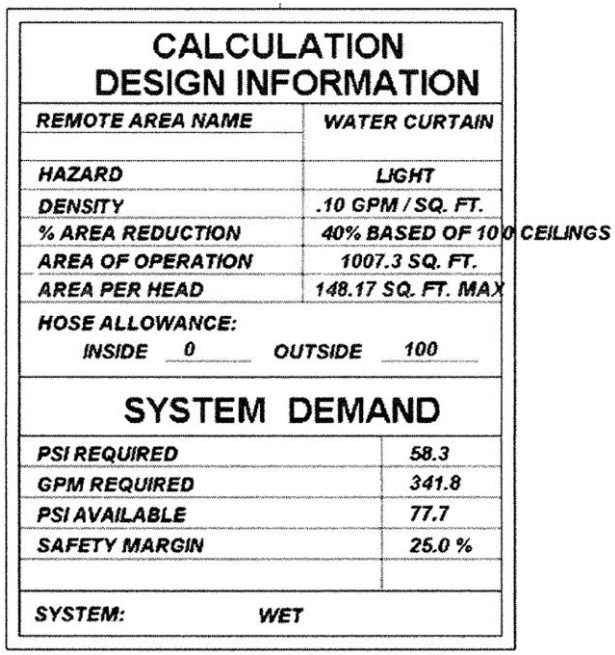
CALCULATION DESIGN INFORMATION	
REMOTE AREA NAME	LIGHT PROOF
HAZARD	LIGHT
DENSITY	.10 GPM / SQ. FT.
% AREA REDUCTION	40% BASED OF 100 CEILINGS
AREA OF OPERATION	924.3 SQ. FT.
AREA PER HEAD	225 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0 OUTSIDE 100	

SYSTEM DEMAND	
PSI REQUIRED	68.8
GPM REQUIRED	272.8
PSI AVAILABLE	78.3
SAFETY MARGIN	12.2 %
SYSTEM:	WET



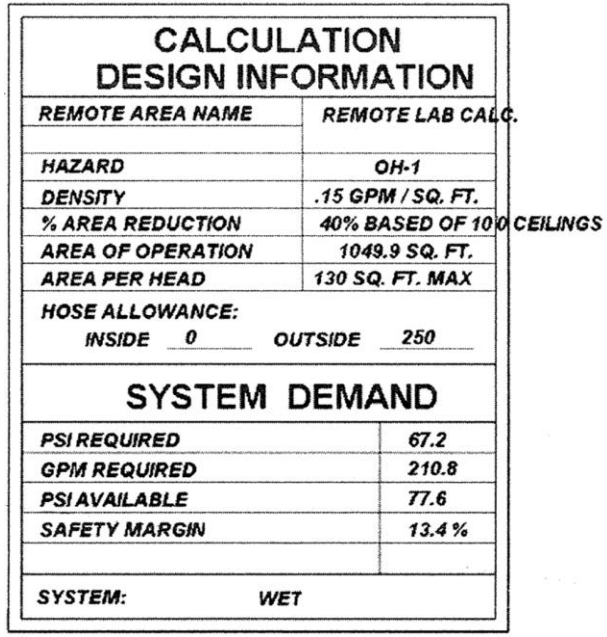
CALCULATION DESIGN INFORMATION	
REMOTE AREA NAME	WATER CURTAIN
HAZARD	LIGHT
DENSITY	.10 GPM / SQ. FT.
% AREA REDUCTION	40% BASED OF 100 CEILINGS
AREA OF OPERATION	1007.3 SQ. FT.
AREA PER HEAD	148.17 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0 OUTSIDE 100	

SYSTEM DEMAND	
PSI REQUIRED	58.3
GPM REQUIRED	341.8
PSI AVAILABLE	77.7
SAFETY MARGIN	25.0 %
SYSTEM:	WET



CALCULATION DESIGN INFORMATION	
REMOTE AREA NAME	WATER CURTAIN
HAZARD	LIGHT
DENSITY	.10 GPM / SQ. FT.
% AREA REDUCTION	40% BASED OF 100 CEILINGS
AREA OF OPERATION	1007.3 SQ. FT.
AREA PER HEAD	148.17 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0 OUTSIDE 100	

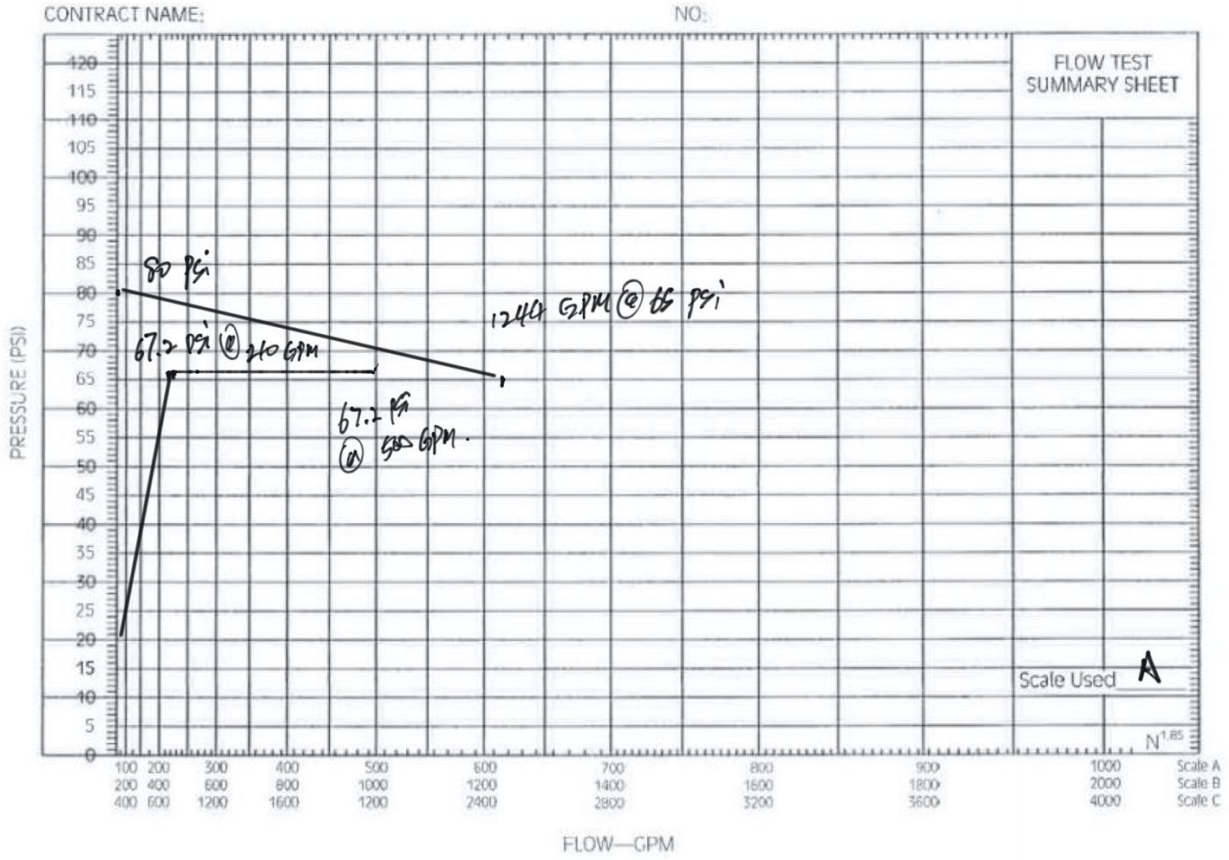
SYSTEM DEMAND	
PSI REQUIRED	58.3
GPM REQUIRED	341.8
PSI AVAILABLE	77.7
SAFETY MARGIN	25.0 %
SYSTEM:	WET



CALCULATION DESIGN INFORMATION	
REMOTE AREA NAME	REMOTE LAB CALC.
HAZARD	OH-1
DENSITY	.15 GPM / SQ. FT.
% AREA REDUCTION	40% BASED OF 100 CEILINGS
AREA OF OPERATION	1049.9 SQ. FT.
AREA PER HEAD	130 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0 OUTSIDE 250	

SYSTEM DEMAND	
PSI REQUIRED	67.2
GPM REQUIRED	210.8
PSI AVAILABLE	77.6
SAFETY MARGIN	13.4 %
SYSTEM:	WET

Appendix H – Supply and Demand Curve



Appendix I – Sample Hydraulic Calculation

Project name:	Engineering IV building sample hydraulic calculation															Date:	
Step No.	Nozzle Ident and Location	Flow in gpm		Pipe size	Pipe Fittings and Devices	Equivalent Pipe Length		Friction loss (psi/ft)		Pressure Summary		Normal Pressure		Notes D=0.15 gpm/ft2 k=5.6	
1	1442 to 1005	q	19.5	1		L	0.6	C=	0.124	Pt	12.1	Pt		k=	Q=A*D
						F				Pe		Pv			q = k * (Pt)^1/2
		Q	19.5			T	0.6	pf		Pf	0.1	Pn		Pt=	P=(Q/k)^2
2	1005 to 999	q	19.6	1.25		L	6	C=	0.118	Pt	12.2	Pt		k=	
						F				Pe		Pv			
		Q	39.1			T	6	pf		Pf	0.7	Pn			
3	999 to 1447	q	20.1	1.25		L	12.5	C=	0.255	Pt	12.9	Pt		k=	
						F				Pe		Pv			
		Q	59.2			T	12.5	pf		Pf	3.2	Pn			
4	1447 to 994	q	22.5	1		L	1.5	C=	1.756	Pt	16.1	Pt		k=	
						F				Pe		Pv			
		Q	81.6			T	1.5	pf		Pf	2.6	Pn			
5	994 to 1445	q	24.2	1.25		L	6	C=	0.747	Pt	18.7	Pt		k=	
						F				Pe		Pv			
		Q	105.9			T	6	pf		Pf	4.5	Pn			
	1445 to 990	q	27.0	1		L	1.5	C=	4.322	Pt	23.2	Pt		k=	**21.97781903**
						F				Pe		Pv			
		Q	132.9			T	1.5	pf		Pf	6.5	Pn			
	990 to 1441	q	30.5	1.25		L	12	C=	1.666	Pt	29.7	Pt			
						F				Pe		Pv			
		Q	163.4			T	12	pf		Pf	20.0	Pn			
		q				L		C=		Pt	49.7	Pt			
						F				Pe		Pv			
		Q				T		pf		Pf		Pn			

Appendix J – Material Submittal

NFS-640

Intelligent Addressable Fire Alarm System

NOTIFIER® by Honeywell

Intelligent Fire Alarm Control Panels

General

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

As a stand-alone small-to-large system, or as a large network, the ONYX® Series of products meets virtually every application requirement.

Designed with modularity and for ease of system planning, the NFS-640 can be configured with just a few devices for small building applications, or for a large campus or high-rise application. Simply add additional peripheral equipment to suit the application.

Features

- 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 (N.O. manual stations, 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, or display-less (a node on a network).
- Network option – 103 nodes supported (NFS-640, NCA Network Annunciator, or NCS Network Control Station) using wire or fiber-optic connections.
- 6.0 amp switch mode power supply with four Class A/B built-in Notification Appliance Circuits (NAC). Selectable System Sensor strobe synchronization.
- Built-in Alarm, Trouble, and Supervisory relays.
- Up to 64 output circuits per FACP or network node; circuits configurable online.
- ***VeriFire® Tools*** offline program option. Sort Maintenance Reports by compensation value (dirty detector), peak alarm value, or address.
- Autoprogramming and Walk Test reports.
- Optional universal 636-point DACT.
- 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.
- Autoprogramming and Walk Test reports.
- Positive Alarm Sequence (PAS) Presignal.
- 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.
- Charger for up to 90 hours of standby power.
- 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.

NFS-640 shown in CAB-B4 with NCA 640-character display.

- Powerful Boolean logic equations.

NCA 640-CHARACTER DISPLAY FEATURES:

- Backlit, 640-character display.
- Supports SCS Series smoke control system in both HVAC or FSCS modes (not UL-Listed for FSCS).
- Printer and CRT EIA-232 ports.
- EIA-485 annunciator and terminal mode ports.
- Alarm, Trouble, Supervisory, and Security relays.

FLASHSCAN® INTELLIGENT FEATURES:

- Poll 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.
- Fully digital, high-precision protocol (U.S. Patent 5,539,389).
- Manual sensitivity adjustment — nine levels.
- Pre-alarm intelligent sensing — nine levels.
- Day/Night automatic sensitivity adjustment.
- Sensitivity windows:
  - **Ion –** 0.5 to 2.5%/foot obscuration.
  - **Photo –** 0.5 to 2.35%/foot obscuration.
  - **Laser (VIEW®) –** 0.02 to 2.0%/foot obscuration.
  - **Acclimate Plus™ –** 0.5 to 4.0%/foot obscuration.
  - **HARSH™ –** 0.5 to 2.35%/foot obscuration.
- Drift compensation (U.S. Patent 5,764,142).
- Degraded mode — in the unlikely event that the CPU-640 microprocessor fails, FlashScan® detectors revert to degraded operation and can activate the CPU-640 NAC circuits and alarm relay. Each of the four built-in panel circuits includes a Disable/Enable switch for this feature.

- Multi-detector algorithm involves nearby detectors in alarm decision (U.S. Patent 5,627,515).
- Automatic detector sensitivity testing.
- Maintenance alert (two levels).
- Self-optimizing pre-alarm.

VIEW® (VERY INTELLIGENT EARLY WARNING) SMOKE DETECTION TECHNOLOGY:

- Revolutionary spot laser design.
- Advanced intelligent sensing algorithms differentiate between smoke and non-smoke signals (U.S. Patent 5,831,524).
- Addressable operation pinpoints the fire location.
- No moving parts to fail or filters to change.
- Early warning performance comparable to the best aspiration systems at a fraction of the lifetime cost.

ACCLIMATE PLUS™ LOW-PROFILE INTELLIGENT MULTI-SENSOR:

- Detector automatically adjusts sensitivity levels without operator intervention or programming. Sensitivity increases with heat.
- Microprocessor-based technology; combination photo and thermal technology.
- FlashScan® or classic mode compatible with NFS-640.
- Low-temperature warning signal at 40°F ± 5°F (4.44°C ± 2.77°C).

HARSH™ HOSTILE-AREA SMOKE HEAD:

- Provides early warning of smoke detection in environment where traditional smoke detectors are not practical.
- The detector's filters remove particulates down to 30 microns in size.
- Intake fan draws air into photo chamber, while airborne particles and water mist are removed.
- Requires auxiliary 24 VDC from system or remote power supply.

RELEASING FEATURES:

- Ten independent hazards.
- Sophisticated cross-zone (three options).
- Delay timer and Discharge timers (adjustable).
- Abort (four options).
- Low-pressure CO_2 listed.

VOICE AND TELEPHONE FEATURES:

- Solid state message generation.
- Hard-wired voice control module options.
- Firefighter telephone option.
- 30- to 120-watt high-efficiency amplifiers (AA Series).
- Backup tone generator and amplifier option.
- Multichannel voice transponder (XPIQ).

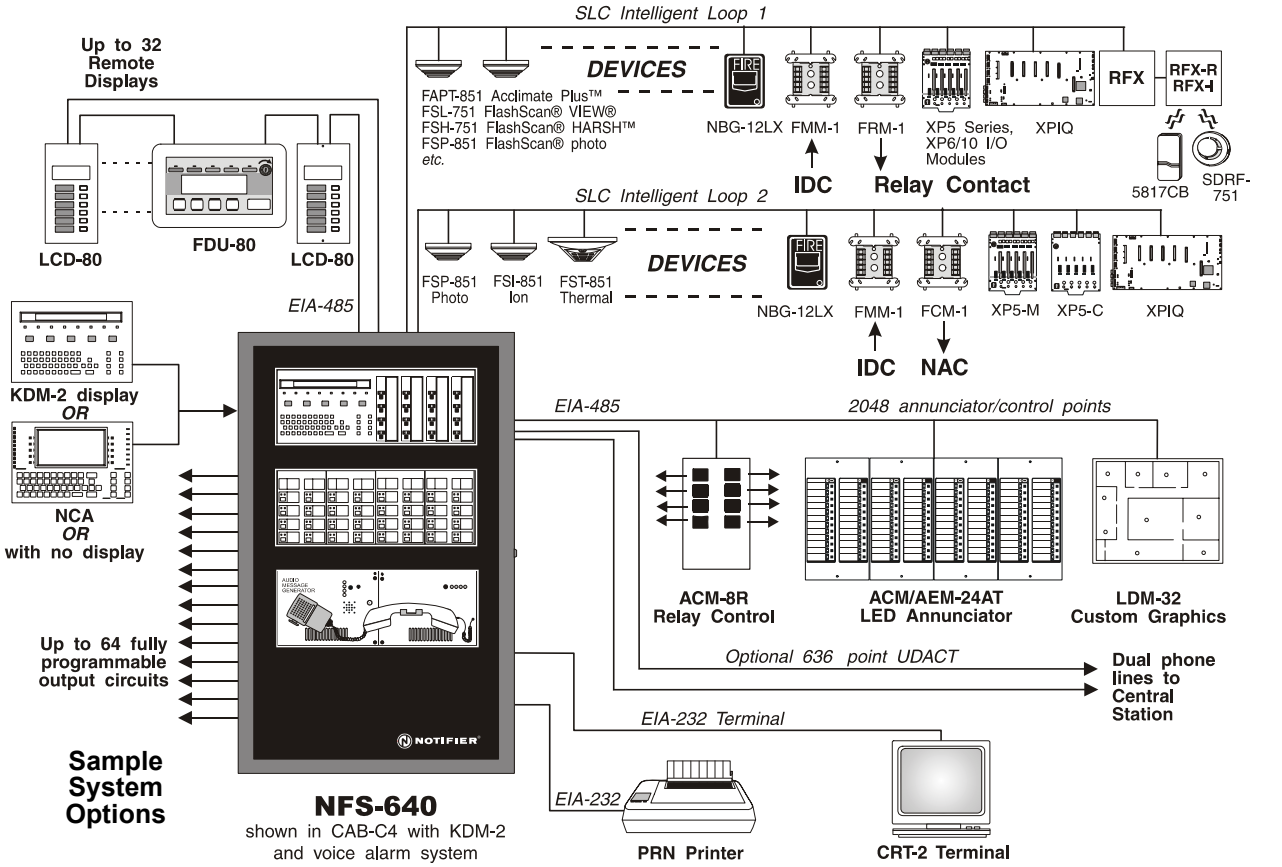
HIGH-EFFICIENCY OFFLINE SWITCHING 3.0 AMP POWER SUPPLY (6.0 A IN ALARM):

- 120 or 220/240 VAC.
- Displays battery current/voltage on panel (with display).

FlashScan® Exclusive World-Leading Detector Protocol

At the heart of the NFS-640 is a set of detection devices and device protocol — FlashScan® (U.S. Patent 5,539,389). FlashScan® is an all-digital protocol that gives superior precision and high noise immunity.

In addition to providing quick identification of an active input device, this protocol can also activate many output devices in a fraction of the time required by competitive protocols. This high



speed also allows the NFS-640 to have the largest device per loop capacity in the industry — 318 points — yet every input and output device is sampled in less than two seconds. The microprocessor-based FlashScan® detectors have bicolor LEDs that can be coded to provide diagnostic information, such as device address during Walk Test.

Intelligent Sensing

Intelligent sensing is a set of software algorithms that provide the NFS-640 with industry-leading smoke detection capability. These complex algorithms require many calculations on each reading of each detector, and are made possible by the very-high-speed microcomputer used by the NFS-640.

Drift Compensation and Smoothing: Drift compensation allows the detector to retain its original ability to detect actual smoke, and resist false alarms, even as dirt accumulates. It reduces maintenance requirements by allowing the system to automatically perform the periodic sensitivity measurements required by NFPA 72. Smoothing filters are also provided by software to remove transient noise signals, such as those caused by electrical interference.

Maintenance Warnings: When the drift compensation performed for a detector reaches a certain level, the performance of the detector may be compromised, and special warnings are given. There are three warning levels: (1) Low Chamber value, usually indicative of a hardware problem in the detector; (2) Maintenance Alert, indicative of dust accumulation that is near but below the allowed limit; (3) Maintenance Urgent, indicative of dust accumulation above the allowed limit.

Sensitivity Adjust: Nine sensitivity levels are provided for alarm detection. These levels can be set manually, or can change automatically between day and night. Nine levels of pre-alarm sensitivity can also be selected, based on predetermined levels of alarm. Pre-alarm operation can be latching or self-restoring, and can be used to activate special control functions.

Self-Optimizing Pre-Alarm: Each detector may be set for "Self-Optimizing" pre-alarm. In this special mode, the detector "learns" its normal environment, measuring the peak analog readings over a long period of time, and setting the pre-alarm level just above these normal peaks.

Cooperating Multi-Detector Sensing: A patented feature of this intelligent sensing is the ability of a smoke sensor to consider readings from nearby sensors in making alarm or pre-alarm decisions. Without statistical sacrifice in the ability to resist false alarms, it allows a sensor to increase its sensitivity to actual smoke by a factor of almost two to one.

Field Programming Options

Autoprogram is a timesaving feature of the NFS-640. It is a special software routine that allows the NFS-640 to "learn" what devices are physically connected and automatically load them in the program with default values for all parameters. Requiring less than one minute to run, this routine allows the user to have almost immediate fire protection in a new installation, even if only a portion of the detectors are installed.

Keypad Program Edit (with KDM-2) The NFS-640, like all NOTIFIER intelligent panels, has the exclusive feature of program creation and editing capability from the front panel keypad, ***while continuing to provide fire protection***. The architecture of the NFS-640 software is such that each point entry carries its own program, including control-by-event links to other points. This allows the program to be entered with independent per-point segments, while the NFS-640 simultaneously monitors other (already installed) points for alarm conditions.

VeriFire® Tools is an offline programming and test utility that can greatly reduce installation programming time, and increase confidence in the site-specific software. It is Windows® based and provides technologically advanced capabilities to aid the installer. The installer may create the entire program for the NFS-640 in the comfort of the office, test it, store a backup file, then bring it to the site and download from a laptop into the panel.

```
ENTER PROG OR STAT PASSWORD, THEN ENTER
<ESCAPE TO ABORT> *****
```

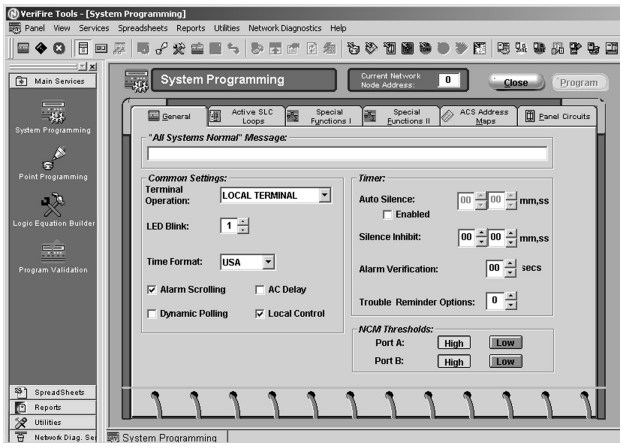
```
0=CLR 1= AUTO 2=POINT 3=PASSWORD 4=MESSAGE
```

Above: Keypad program editing.

Below: Autoprogram function.

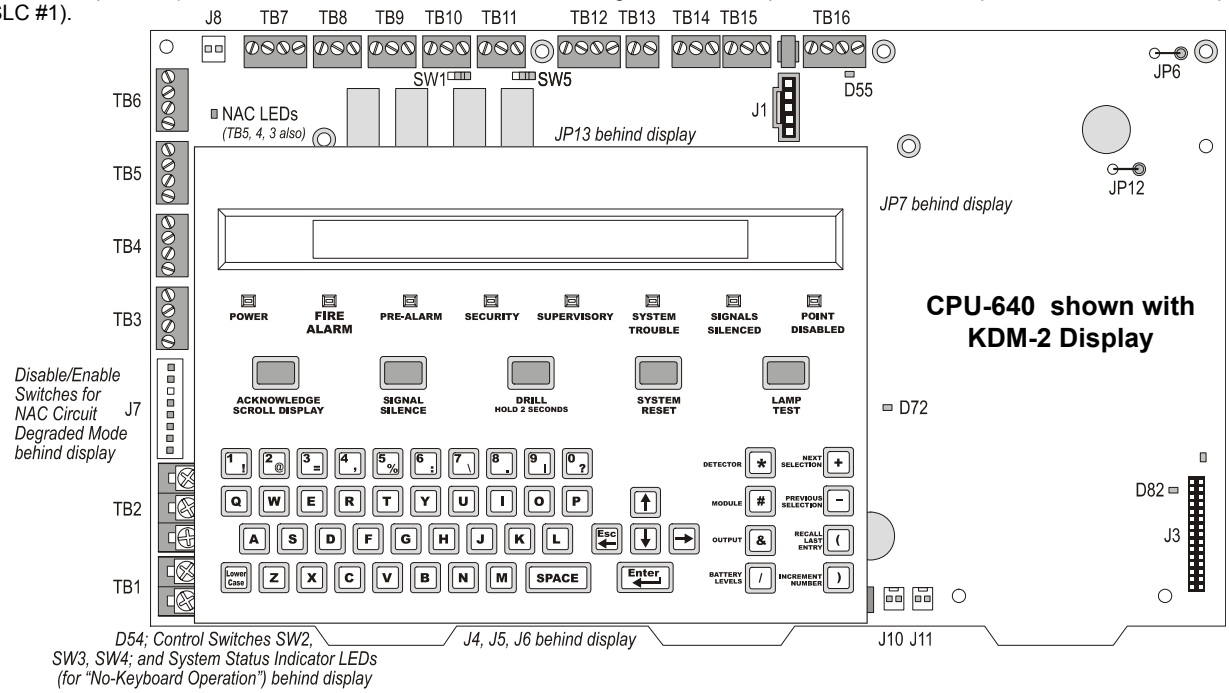
```
AUTOPROGRAM   PLEASE WAIT
```

```
L1:80 DETS, 15 MODS L2:93 DETS, 35 MODS
 PANEL OUTPUTS:24      BELLS:  04
```



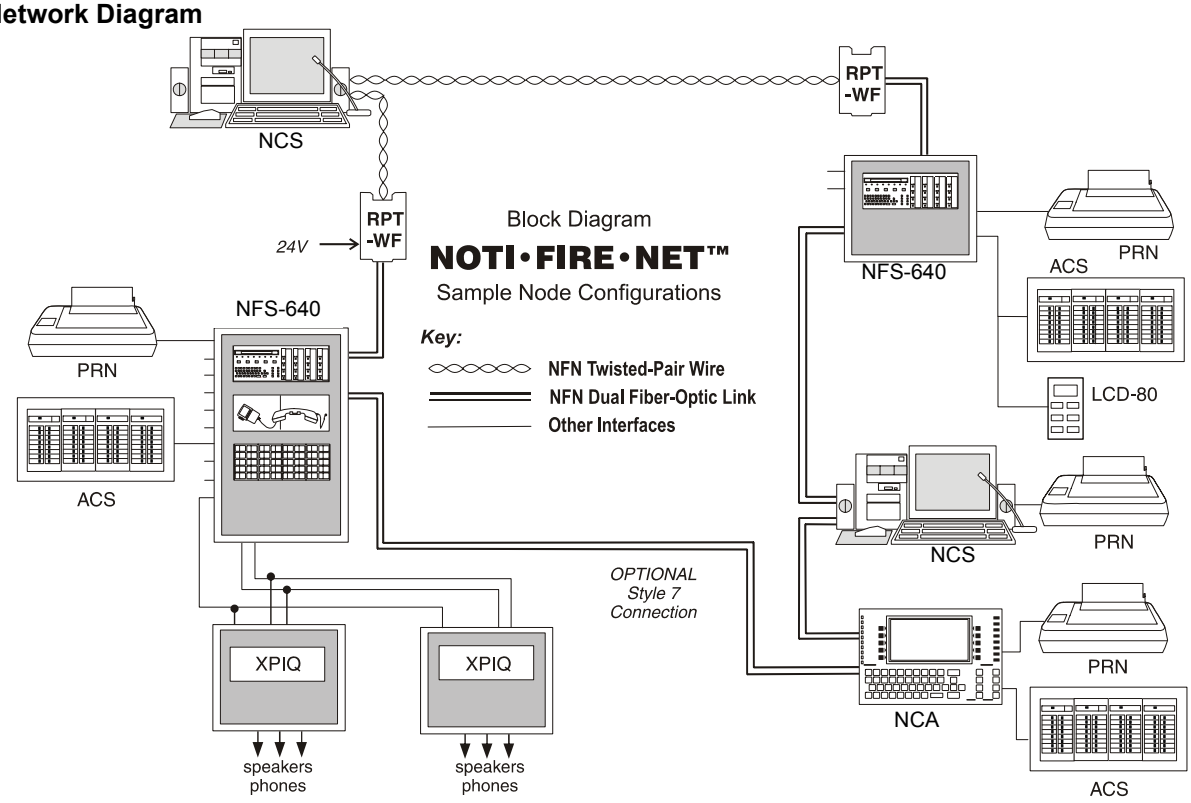
VeriFire ToolsSystem Programming screen

TOP, LEFT to RIGHT: **J8** Zone Code Input; **TB7** DC Power (24 VDC power-limited, both resettable and non-resettable available); **TB8** Alarm Relay; **TB9** Trouble Relay; **TB10** Supervisory Relay; **TB11** Security Relay; **SW1**, **SW5** Relay Switches; **JP13** General Board Earth Fault Jumper; **TB12** EIA-485 Terminal Mode (supervised); **TB13** EIA-485 ACS Mode (supervised); **TB14** EIA-232 Printer; **TB15** EIA-232 PC Terminal; **J1** NUP (network/service connection: power-limited, supervised); **TB16** SLC #1 Connections (detectors, modules; supervised); **D55** Main SLC Ground Fault LED; **JP7** Charger Disable Jumper; **JP12** 200MA Jumper; **JP6** Earth Fault Jumper (SLC #1).



LEFT SIDE, TOP to BOTTOM: **TB6** NAC #1, **TB5** NAC #2, **TB4** NAC #3, **TB3** NAC #4 (all NAC circuits power-limited and supervised, and each NAC TB has an NAC LED to the right of it); **J7** Accessory Power; Disable/Enable Switches for Degraded Mode; **TB2** AC Power Connection; **TB1** Battery Connection (overcurrent protected). ***BOTTOM, LEFT to RIGHT:*** D54 AC On LED; System Status Indicator LEDs for "No-Keyboard Operation"; System Switches **SW2** (Acknowledge), **SW3** (Silence), **SW4** (Reset) for "No-Keyboard Operation"; **J4** KDM-2 Connector; **J5**, **J6** Panel Circuits (ONYX® Panel Output Modules, supervised); **D72** General Board Ground Fault LED; **J10** Security Tamper Switch; **J11** Auxiliary Trouble Input; **D82** AC Power LED; **J3** LEM-320 Connector (SLC Loop #2).

Network Diagram



Placement of Equipment in Chassis and Cabinet

The following guidelines outline the NFS-640's flexible system design.

Rows: The first row of equipment in the cabinet mounts in chassis **CHS-M2**. Mount the second, third, or fourth rows of equipment in chassis **CHS-4MB** (see NFS-640 Installation Manual regarding panel output modules) or **CHS-4L** (for voice components, see Voice Alarm System Manual).

Wiring: When designing the cabinet layout, consider separation of power-limited and non-power-limited wiring as discussed in the NFS-640 Installation Manual.

Positions: A chassis offers four basic side-by-side positions for components; the number of modules that can be mounted in each position depends on the chassis model and the size of the individual module. There are a variety of standoffs and hardware items available for different combinations and configurations of components.

It is critical that all mounting holes of the NFS-640 are secured with a screw or standoff to ensure continuity of Earth Ground.

Layers: The CHS-M2 accepts four layers of equipment, including the control panel. The **CPU-640** fills three positions (left to right) in the first-installed layer (the back of the chassis); its integral power supply occupies (the left) two positions in the next two layers; the optional display occupies (the left) two positions at the front, flush with the door. Panel output modules can be mounted in several layers with standoffs or an L-bracket as required. Some equipment, such as the **NCA**, may be door-mounted directly in front of the control panel. The NCA mounts onto the DP-DISP or ADP-4B. The NCA can be used as a primary display for the NFS-640 by directly connecting their network ports (required in Canadian stand-alone applications).

Expansion: Installing an **LEM-320** Loop Expander Module adds a second SLC loop to the control panel. The LEM-320 is mounted onto the CPU-640, occupying the middle-right, second (back) slot on the chassis. If networking two or more control panels, each unit requires a **NCM-W** (wire) or **NCM-F** (fiber) Network Control Module. The NCM-W/-F can be installed in any panel output module position (see manual); the default position is at the back of the chassis next to the control panel. **Option boards** can be mounted in front of the LEM-320 or NCM modules; for ease of access, complete installation of those devices before mounting another layer.

KDM-2 Controls and Indicators

Program Keypad: QWERTY type (keyboard layout).

8 LED indicators: Power; Fire Alarm; Pre-Alarm; Security; Supervisory; System Trouble; Signals Silenced; Points Disabled.

Membrane Switch Controls: Acknowledge/Scroll Display; Signal Silence; Drill; System Reset; Lamp Test.

LCD Display: 80 characters (2 x 40) with long-life LED backlight.

Configuration Guidelines

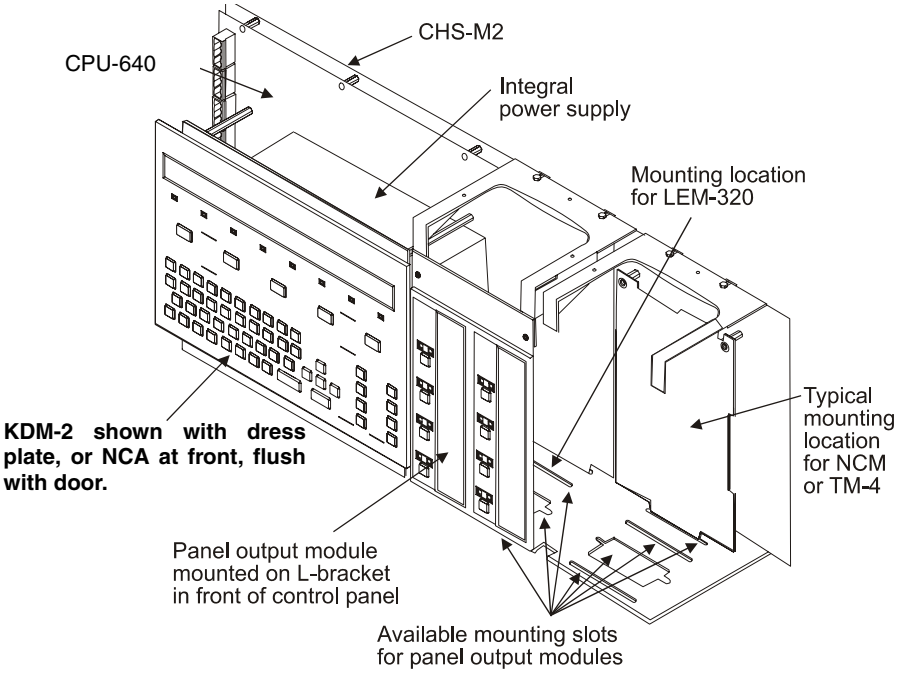
Stand-alone and network systems require a main display. On single-CPU systems (one CPU-640/-640E), display options are the KDM-2 or the NCA. On network systems (two or more CPU-640/-640Es), at least one NCA or NCS annunciation device is required. Other options listed as follows:

KDM-2: 80-character backlit LCD display with QWERTY programming and control keypad. Order two BMP-1 blank modules and DP-DISP mounting plate separately. *Requires top row of a cabinet. Required for each stand-alone 80-character display system. The KDM-2 may mount in network nodes to display "local" node information as long as at least one NCA or NCS network display is on the system to display network information.*

NCA: Network Control Annunciator, 640 characters. On single CPU-640/-640E systems, the NCA is the Primary Display for the panel and connects directly to the CPU-640/-640E. On network systems (two or more CPU-640/-640Es), one network display (either NCA or NCS) is required for every system. On network systems, the NCA connects (and requires) an NCM network communications module. Mounts in a row of FACP node or in two annunciator positions. Mounting options include the DP-DISP, ADP-4B, or in an annunciator box, such as the ABS-2D. In CAB-4 top-row applications, a DP-DISP and two BMP-1 blank modules are required for mounting. *See NCA data sheet DN-6858.*

CPU-640: Central processing unit with integral 3.0 amp (6.0 A in alarm) power supply for an NFS-640 system. Includes CPU; one Signaling Line Circuit expandable to two; installation, programming and operating manuals. *Order one per system or as necessary (up to 103 network nodes) on a network system.*

CPU-640E: Same as CPU-640 but requires 220 VAC, 1.5 amp, (3.0 A in alarm).



CHS-M2: Mounting chassis for CPU-640. One required for each CPU-640/-640E.

DP-DISP: Dress panel for top row in cabinet with CPU-640/-640E installed.

BMP-1: Blank module for unused module positions.

System Modules

The NFS-640 includes the ability to communicate with up to eight conventional modules each with up to eight circuits. Any mix of notification, relay, speaker, or telephone may be used. Choose any combination of up to eight output modules: ICM/ICE, CRM/CRE, DCM-4 or VCM/VCE. Panel modules mount on either: the two far-right positions of the DP-DISP (next to the primary display); or on any of the four positions on the CHS-4N chassis (CHS-4MN kit required).

NOTES: *1) These modules/expanders are NOT to be used for releasing applications. 2) For additional information on these panel output modules and expanders, see data sheet DN-6859.*

CHS-4MB: Expansion Chassis. Mounts up to four modules. Includes CHS-4N, MP-1B (Module Dress Panel), and Expander Ribbon Cable.

ICM-4RK: Notification Appliance Circuit Module, provides four Style Y (Class B) or Style Z (Class A) alarm Notification Appliance Circuits. Maximum signaling current is 3.0 amps per circuit or 6.0 amps per module, subject to power supply limitations (includes auxiliary power harness, ELRs and slide-in labels).

Includes ON/OFF controls and ON/OFF LEDs.

ICE-4: Notification Appliance Circuit Expander, expands ICM-4 to provide a total of eight Style Y or Style Z alarm Notification Appliance Circuits. Circuit ratings are same as ICM-4.

NOTE: *Maximum of one per ICM-4RK. May also be used to add four Notification Appliance Circuits to VCM-4.*

CRM-4RK: Control Relay Module, four Form-C relay contacts, rated at 5.0 A, 120 VAC or 28 VDC (resistive) per circuit. Includes manual ON/OFF controls and LEDs.

CRE-4: Control Relay Expander, expands CRM-4 to provide a total of eight Form-C relay contacts. Note: maximum of one per CRM-4RK. May also be connected to add four relays to ICM-4, TCM-2, TCM-4, or VCM-4.

VCM-4RK: Voice Control Module provides four Style Y (25 and 70 Vrms) and Style Z (25 Vrms only) speaker circuits, eight manual select switches and indicators, slide-in labels, and plug-in terminal blocks. Move jumper to convert to telephone circuits with remote ring signal and local call-in flash. May be expanded to eight circuits with VCE-4, ICE-4, or CRE-4.

VCE-4: Voice Control Expander adds four circuits to VCM-4. Note: VCM-4/ VCE-4 combination must be eight speaker or eight phone circuits.

DCM-4RK: Dual Channel Module pro-vides four Class B (Style Y, 25 & 70 Vrms) or Class A (Style Z, 25 Vrms only) speaker circuits plus four channel A/B select relays. Not expandable.

OTHER OPTION MODULES

ARM-4: Auxiliary Relay Module, four Form-C relays controlled by a relay module (CRM-4 or CRE-4). N.O. contacts rated 20 amps; N.C. contacts rated 10 amps at 125 VAC and 30 VDC.

NOTE: *Maximum of one for each CRM-4 or CRE-4.*

VCC-1B: Voice Control Center. Provides a variety of user-selectable tones on a single channel. Up to two different tones or messages may be selected on a single channel. Also provides optional digital voice message capability and **on-site** programmable voice messages. Includes Audio Message Generator (AMG-1) microphone, cables, dress panels, and instructions.

VTCC-1B: Voice/Telephone Control Center. Provides all that the VCC-1 provides plus two-way Fire Fighters Telephone (FFT-7) capability.

TCC-1B: Telephone Control Center. Provides a stand-alone two-way Fire Fighters telephone (FFT-7S).

Includes cables, dress panel and instructions.

RM-1/RM-1SA: Remote microphone assemblies, mount on ADP-4 (RM-1) dress panel or CAB-RM/-RMR (RM-1SA) stand-alone cabinets. *See DN-6728.*

AMG-E: Audio Message Generator (without microphone). Order in addition to VCC-1 or VTCC-1 if two-channel system is required.

FFT-7/FFT-7S: Fire Fighters Telephone control with master handset.

FTM-1: Firephone Control Module connects a remote firefighter telephone to a centralized telephone console. Reports status to panel. Wiring to jacks and handsets is supervised.

AA-30: Audio Amplifier, 30 watts. Switch-mode power. Includes amplifier and audio input supervision, backup input, and automatic switchover, power supply, cables. *See AA Series data sheet, DN-3224.*

AA-120/AA-100: Audio Amplifier provides up to 120 watts of 25 Vrms audio power for the NFS-640. The amplifier contains an integral chassis for mounting to a CAB-B4, -C4, or -D4 backbox (consumes one row). Switch-mode power. Includes audio input and amplified output supervision, backup input, and automatic switchover to backup tone. Order the AA-100 for 70.7 Vrms systems and 100 watts of power. *See AA Series data sheet, DN-3224.*

VROM-(n): Factory-programmed message for installation in AMG-1. Provides up to 24 seconds of evacuation message on nonvolatile memory chip. Choose one of many standard messages available. Up to two of these messages may be installed in one AMG. Includes VROM, instructions for installation and operation, and written text of message. *See VROM data sheet, DN-3576.*

VRAM-1: Field-programmed memory to be installed in AMG-1. Provides up to 24 seconds of field-programmable evacuation message on nonvolatile memory chip. Message is programmed from microphone or cassette tape. Up to two of these nonvolatile memory chips may be installed in one AMG. Includes VRAM and instructions for installation and operation.

APS-6R: Auxiliary Power Supply (expander). Provides up to 6.0 amperes of regulated power for compatible Notification appliance circuits. Includes battery input and transfer relay, and overcurrent protection. Mounts on one of four positions on a CHS-4L or CHS-4 chassis. *See APS-6R data sheet, DN-5952.*

ACPS-2406: 6.0 amp addressable charger power supply. *See ACPS-2406 data sheet, DN-6834.*

FCPS-24: The FCPS-24 is a remote six-amp (four-amp continuous) repeater/power supply. *See FCPS-24 data sheet, DN-5132.*

FCPS-24S6/-24S8: Remote six-amp and eight-amp power supplies with battery charger. *See FCPS-24S6/-24S8 datasheet, DN-6927.*

UZC-256: Programmable Universal Zone Coder provides positive non-interfering successive zone coding. Microprocessor-controlled, field-programmable from IBM®-compatible PCs (requires optional programming kit). *See UZC-256 data sheet, DN-3404.*

LCD-80/LCD-80TM/FDU-80: 80-character, backlit LCD display. Mounts up to 6,000 ft. (1828.8 m) from panel. Up to 32 per NFS-640. *See LCD-80/-80TM (DN-3198) and FDU-80 (DN-6820) data sheets.*

ACS: Annunciator Control Modules ACM-16AT, AEM-16AT, ACM-32A, and AEM-32A. *See data sheets, DN-0524 and DN-6862..*

AFM: Annunciator Fixed Modules AFM-16A, AFM-16AT, and AFM-32A. *See AFM data sheet, DN-0056.*

LDM: Lamp Driver Modules LDM-32, LDM-E32, and LDM-R32. *See LDM data sheet, DN-0551.*

ACM-8R: Remote Relay Module with eight Form-C contacts. Can be located up to 6,000 ft. (1828.8 m) from panel on four wires. *See ACM-8R data sheet, DN-3558.*

SCS: Smoke control station; eight (expandable to 16) circuits. *See SCS data sheet, DN-4818.*

RPT-485: Repeats EIA-485 over twisted pair or converts to fiber-optic medium. *See RPT data sheet, DN-4737.*

XP5: The XP5-M and XP5-C provide FlashScan® transponder points. *See XP5 data sheet, DN-6625.*

XP: The XP Series Transponder provides conventional monitor and control points (CLIP mode only). *See XP Series data sheet, DN-0759.*

XPIQ: The XPIQ quad intelligent voice transponder for distributed multichannel voice evacuation systems, an integrated audio amplification and distribution subsystem controlled by FACP. Capable of playing up to four simultaneous messages. Accepts up to four 25-watt amplifiers. *See XPIQ data sheet, DN-6823.*

CHS-4: Chassis for mounting up to four APS-6Rs.

CHS-4L: Low-profile four-position Chassis. Mounts two AA-30 amplifiers or one AMG-E and one AA-30.

DP-1B: Blank Dress panel. Provides dead-front panel for unused tiers or to cover AA-30, AA-120, or one AMG-E and one AA-30.

CAB-4 Series: The CAB-4 Series cabinets are fabricated from 16-gauge steel with unique full-front LEXAN®, reverse-silk-screened for durability. The cabinet assembly consists of two basic parts: a Backbox (SBB-_4), and a Locking Door (DR-_4) that may hinge right or left. Cabinets are available in four sizes, "A" through "D", with one to four tiers. A trim ring option is available for semi-flush mounting. *See CAB-4 Series data sheet, DN-6857.*

CAB-M Series: Marine cabinets required for Lloyd's Register or U.S. Coast Guard listed use. *See DN-5063.*

COMPATIBLE DEVICES, EIA-232 PORTS

PRN-5: 80-column printer. *See DN-6769.*

PRN-6: 80-column printer. *See DN-6956.*

VS4095/S2: Printer, 40-column, 24 V. Mounted in external backbox. *Order from Keltron, Inc. See DN-3260.*

CRT-2: Video display terminal. *See DN-3756.*

COMPATIBLE DEVICES, EIA-485 PORTS

ACS Series: Remote serial annunciator/control systems. *See DN-0524.*

FDU-80: Remote LCD display, 80 characters, with LEDs. *See DN-6820.*

LCD-80: Remote LCD display, 80 characters. *See DN-3198.*

LCD-80TM: Remote LCD display, 80 characters, terminal mode. *See DN-3198.*

LDM Series: Remote custom graphic driver modules. S*ee DN-0551.*

ACM-8R: Remote relay module. 8 Form-C relays. *See DN-3558.*

RPT-485 Series: Repeater, isolator and/or fiber-optic modem. *See DN-4737.*

UDACT: Universal Digital Alarm Communicator Transmitter, 636 channel. *See DN-4867.*

UZC-256: Zone Coder. Up to 256 programmable codes. *See DN-3404.*

COMPATIBLE INTELLIGENT DEVICES

BEAMHK: Heating kit for transmitter/receiver unit of FSB-200(S) below. *See DN-6985.*

BEAMHRK: Heating kit for use with the reflector of FSB-200(S) below. *See DN-6985.*

BEAMLRK: Long-range accessory kit, FSB-200(S) below.

BEAMMRK: Multi-mount kit, FSB-200(S) below.

BEAMSMK: Surface-mount kit, FSB-200(S) below.

FSB-200: Intelligent beam smoke detector. *See DN-6985.*

FSB-200S: Intelligent beam smoke detector with integral sensitivity test. *See DN-6895.*

FSI-851: Low-profile FlashScan® ionization detector, will replace FSI-751. *See DN-6934.*

FSI-751: Low-profile FlashScan® ionization detector. *See DN-6714.*

FSP-851: Low-profile FlashScan® photoelectric detector, will replace FSP-751. *See DN-6935.*

FSP-751: Low-profile FlashScan® photoelectric detector. *See DN-6714.*

FSP-851T: Low-profile FlashScan® photoelectric detector with 135°F (57°C) thermal, will replace FSP-751T. *See DN-6935.*

FSP-751T: Low-profile FlashScan® photoelectric detector with 135°F (57°C) thermal. *See DN-6714.*

FST-851: FlashScan® thermal detector 135°F (57°C), will replace FST-751. *See DN-6936.*

FST-751: FlashScan® thermal detector 135°F (57°C). *See DN-6716.*

FST-851R: FlashScan® thermal detector 135°F (57°C) with rate-of-rise, will replace FST-751R. *See DN-6936.*

FST-751R: FlashScan® thermal detector 135°F (57°C) with rate-of-rise. *See DN-6716.*

FST-851H: FlashScan® 190°F (88°C) high-temperature thermal detector. *See DN-6936.*

FSD-751P: FlashScan® photo duct detector with housing. *See DN-6821.*

FSD-751PL: Low-flow FlashScan® photo duct detector with housing, will replace FSD-751P. *See DN-6955.*

FSD-751RP: FlashScan® photo duct detector with relay and housing.

FSD-751RPL: Low-flow FlashScan® photo duct detector with relay and housing, will replace FSD-751RP. *See DN-6955.*

FAPT-851: FlashScan® Acclimate Plus™ low-profile multi-sensor detector, will replace FAPT-751. *See DN-6937.*

FAPT-751: Acclimate Plus™ low-profile multisensor detector. *See DN-6833.*

FSH-751: FlashScan® HARSH™ Hostile Area Smoke Head. *See DN-6875.*

FSL-751: FlashScan® VIEW® laser photo detector, will replace LPX-751. *See DN-6886.*

LPX-751: Low-profile VIEW® laser photo detector. *See DN-5306.*

B224RB: Low-profile relay base.

B224BI: Isolator base for low-profile detectors.

B710LP: Low-profile base. Standard U.S. style.

B501: European-style, 4" (10.16 cm) base.

B501BH: Sounder base, includes B501 base above. Constant tone.

B501BHT: Sounder base, includes B501 base above. Temporal three tone.

FMM-1: FlashScan® monitor module. *See DN-6720.*

FDM-1: FlashScan® dual monitor module. *See DN-6720.*

FZM-1: FlashScan® two-wire detector monitor module. *See DN-6720.*

FMM-101: FlashScan® miniature monitor module. *See DN-6720.*

FCM-1: FlashScan® NAC control module. *See DN-6724.*

FRM-1: FlashScan® relay module. *See DN-6724.*

FSM-101: FlashScan® pull station monitor module.

NBG-12LX: Manual fire alarm station, addressable. *See DN-6726.*

ISO-X: Isolator module. *See DN-2243.*

XP Series: Transponder. *See DN-0759.*

XP5-M: FlashScan® transponder, five monitor points. *See DN-6625.*

XP5-C: FlashScan® transponder, five control points or Form-C relays. *See DN-6625.*

XP6-C: FlashScan® six-circuit supervised control module. *See DN-6924.*

XP6-MA: FlashScan® six-zone interface module; connects intelligent alarm system to two-wire conventional detection zone. *See DN-6925.*

XP6-R: FlashScan® six-relay (Form-C) control module. *See DN-6926.*

XP10-M: FlashScan® ten-input monitor module. *See DN-6923.*

XPIQ: Intelligent quad transponder. *See DN-6823.*

OTHER OPTIONS

DPI-232: Direct Panel Interface, specialized modem for extending serial data links to remotely located FACPs and/or peripherals. *See DN-6870.*

LEM-320: Loop Expander Module. Expands each 640 to two Signaling Line Circuits. *See DN-6881.*

TM-4: Transmitter Module. Includes three reverse-polarity circuits and one municipal box circuit. Mounts in panel module position (single-address-style) or in CHS-M2 position. *See DN-6860.*

NCM-W: Network Communications Module, Wire. Order one NCM per network node (CPU-640 or NCA). *See DN-6861.*

NCM-F: Network Communications Module, Fiber. Order one NCM per network node (CPU-640 or NCA). *See DN-6861.*

NCS5-W-ONYX: Network Control Station, Wire. UL-Listed graphics PC with mouse, 17" color flat-screen LCD monitor. Order as necessary for network systems. Each NCS consumes one of 103 network addresses. *See DN-6868 (previous NCS-W), ONYX® DN-6869.*

NCS5-F-ONYX: Network Control Station, Fiber. UL-Listed graphics PC with mouse, 17" color flat-screen LCD monitor. Order as necessary for network systems. Each NCS consumes one of 103 network addresses. *See DN-6868 (previous NCS-F), ONYX® DN-6869.*

VeriFire-TCD: VeriFire® Tools CD-ROM. Contains programming software for the NFS-640, NCA, and XPIQ. Includes local panel connection cable. Programming PC requires a serial port connection. *See DN-6871.*

ACM-24AT: ONYX® Series ACS annunciator – up to 96 points of annunciation with Alarm or Active LED, Trouble LED, and switch per circuit. Active/Alarm LEDs can be programmed (by powered-up switch selection) by point to be red, green, or yellow; the Trouble LED is always yellow. *See DN-6862.*

AEM-24AT: Same LED and switch capabilities as ACM-24AT, expands the ACM-24AT to 48, 72, or 96 points. *See DN-6862.*

ACM-48A: ONYX® Series ACS annunciator – up to 96 points of annunciation with Alarm or Active LED per circuit. Active/Alarm LEDs can be programmed (by powered-up switch selection) in groups of 24 to be red, green, or yellow. Expandable to 96 points with one AEM-48A. *See DN-6862.*

AEM-48A: Same LED capabilities as ACM-48A, expands the ACM-48A to 96 points. *See DN-6862.*

BAT Series: Batteries. NFS-640 utilizes two 12 volt, 12 to 55 AH batteries. *See DN-6933.*

PS Series: Batteries. NFS-640 utilizes two 12 volt, 12 to 55 AH batteries. *See DN-1109.*

NFS-LBB: Battery Box (required for batteries over 25 AH).

BR: Same as above but red.

SYSTEM SPECIFICATIONS

System Capacity

- Intelligent Signaling Line Circuits .....1 expandable to 2
- Intelligent detectors .....159 per loop
- Addressable monitor/control modules .....159 per loop
- Programmable internal hardware and output circuits (4 standard) 68
- Programmable software zones 99
- Special programming zones 14
- LCD annunciators per CPU-640/-640E and NCA *(observe power)*.....32
- ACS annunciators per CPU-640/-640E .....32 address x 64 points
- ACS annunciators per NCA .....32 address x 64 or 96 points

NOTE: *The* NCA *supports up to 96 annunciator address points per ACM-24/48.*

Specifications

- Primary input power, **CPU-640 board:** 120 VAC, 50/60 Hz, 3.0 amps. **CPU-640E board:** 220/240 VAC, 50/60 Hz, 1.5 Amps.
- **Total** output 24 V power: 6.0 A in alarm.

NOTE: *The power supply has a total of 6.0 Amps of available power. This is shared by all internal modules.*

- Standard notification circuits (4): 2.5 A each.
- Four-wire detector power: 1.25 A.
- Non-resettable regulated power outputs: 1.25 A each.
- Battery charger range: 12 AH – 55 AH. Use separate cabinet for batteries over 25 AH.
- Optional high-capacity (25 – 120 AH) battery charger: CHG-120 (see CHG-120 data sheet, DN-6040).
- Float rate: 27.6 V.

Temperature and Humidity Ranges

This system meets NFPA requirements for operation at 0 – 49ºC/32 – 120ºF and at a relative humidity 93% ± 2% RH (noncondensing) at 32ºC ± 2ºC (90ºF ± 3ºF). However, the useful life of the system's standby batteries and the electronic components may be adversely affected by extreme temperature ranges and humidity. Therefore, it is recommended that this system and its peripherals be installed in an environment with a normal room temperature of 15 – 27ºC/60 – 80ºF.

Agency Listings and Approvals

The listings and approvals below apply to the basic NFS-640 control panel. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL:** S635
- **ULC:** CS118
- **FM APPROVED** *Exceptions – CPU-640E, PRN-5, Proprietary service*
- **CSFM:** 7165-0028:214, 7170-0028:216
- **MEA:** 317-01-E
- **City of Chicago**
- **City of Denver**
- **Lloyd's Register:** 02/60007
- **U.S. Coast Guard:** 161.002/42/1
- **China Classification Society (CCS):** #NL05T00001 *(NFS-640E)*
- **CCCF:** Certif. # 2003081801600815

Standards

The NFS-640 complies with the following UL Standards and NFPA 72 Fire Alarm Systems requirements :

- **UL 864** (Fire)
- **UL 1076** (Burglary)
- **LOCAL** (Automatic, Manual, Waterflow and Sprinkler Supervisory).
- **AUXILIARY** (Automatic, Manual and Waterflow) (requires 4XTMF).
- **REMOTE STATION** (Automatic, Manual and Waterflow) (requires 4XTMF).
- **PROPRIETARY** (Automatic, Manual and Waterflow). *Not applicable for FM.*
- **EMERGENCY VOICE/ALARM**.

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This document is not intended to be used for installation purposes.
We try to keep our product information up-to-date and accurate.
We cannot cover all specific applications or anticipate all requirements.
All specifications are subject to change without notice.

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www.notifier.com

NOTIFIER® by Honeywell

FCPS-24S6 & FCPS-24S8 Series Remote Power Supplies

The FCPS-24S6 Series (6-amp) and FCPS-24S8 Series (8-amp) are remote power supplies with battery charger. The FCPS-24S6/-24S8 may be connected to any 12 or 24 volt fire alarm control panel (FACP) or may be used as stand-alone supplies. Primary applications include notification appliance circuit (NAC) expansion (to support ADA requirements and NAC synchronization) or auxiliary power to support 24 volt system accessories. The FCPS-24S6/-24S8 provides regulated and filtered 24 VDC power to four notification appliance circuits configured as either four Class B (Style Y) or Class A (Style Z, with ZNAC-4 option module). Alternately, the four outputs may be configured as all non-resettable, all resettable or two non-resettable and two resettable. The FCPS-24S6/-24S8 also contains a battery charger capable of charging up to 18 AH batteries. The FCPS-24S6C and FCPS-24S8C are ULC-listed.

NOTE: *Unless otherwise specified, the terms FCPS-24S6 and FCPS-24S8 used in this document refers to the FCPS-24S6 and FCPS-24S8, FCPS-24S6C and FCPS-24S8C, the FCPS-24S6E and FCPS-24S8E.*

Features

- UL-Listed NAC synchronization using System Sensor®, Wheelock®, or Gentex® "Commander^2" appliances
- Operates as a "sync-follower" or as a "sync-generator" (default) *See note on page 2.*
- Contains two fully-isolated input/control circuits - triggered from FACP NAC (NAC expander mode) or jumped permanently "ON" (stand-alone mode)
- Four Class B (Style Y) or four Class A (Style Z, with ZNAC-4 module) NACs
- 6-amp (FCPS-24S6) or 8-amp (FCPS-24S8) full load output, with 3 amps maximum/circuit, in NAC expander mode (UL 864)
- 4-amp (FCPS-24S6) or 6-amp (FCPS-24S8) continuous output in stand-alone mode (UL 1481)
- Compatible with coded inputs; signals passed through
- Optional power-supervision relay (EOLR-1)
- In stand-alone mode, output power circuits may be configured as: resettable, (reset line from FACP required), non-resettable, or a mix of two and two
- Fully regulated and filtered power output - optimal for powering four-wire smoke detectors, annunciators, and other system peripherals requiring regulated/filtered power
- Power-limiting technology meets UL power-limiting requirements
- Form-C normally-closed trouble relay
- Fully supervised power supply, battery, and NACs
- Selectable earth fault detection
- AC trouble report selectable for immediate 2-hour delay
- Works with virtually any UL 864 fire alarm control which utilizes an industry-standard reverse-polarity notification circuit (including unfiltered and unregulated NAC power)
- Requires input trigger voltage of 9 - 32 VDC
- Self-contained in compact, locking cabinet - 15"H x 14.5"W x 2.75"D (cm: 38.1H x 36.83W x 6.985D)
- Includes integral battery charger capable of charging up to 18 AH batteries. Cabinet capable of housing 7.0 AH batteries
- Battery charger may be disabled via DIP switch for applications requiring larger batteries
- Fixed, clamp-type terminal blocks accommodate up to 12 AWG (3.1mm^2) wire

Specifications

Primary (AC) Power:

- **FCPS-24S6/-24S8:** 120 VAC, 60 Hz, 3.2A maximum
- **FCPS-24S6C/-24S8C:** 120 VAC, 60 Hz, 3.2A maximum
- **FCPS-24S6E/-24S8E:** 240 VAC, 50 Hz, 1.6A maximum
- Wire Size: minimum #14 AWG (2.0mm^2) with 600 V insulation

Control Input Circuit:

- **Trigger Input Voltage:** 9 to 32 VDC
- **Trigger Current:** 2.0 mA (16 - 32 V); Per Input: 1.0 mA (9 - 16 V)

Trouble Contact Rating: 5 A at 24 VDC

Auxiliary Power Output: Special application power 500 mA maximum

Output Circuits:

- +24 VDC filtered, regulated
- 3.0 A maximum for any one circuit
- Total continuous current for all outputs (stand-alone mode):
  - FCPS-24S6: 4.0 A maximum
  - FCPS-24S8: 6.0 A maximum
- Total short-term current for all outputs (NAC expander mode):
  - FCPS-24S6: 6.0 A maximum
  - FCPS-24S8: 8.0 A maximum

Secondary Power (Battery) Charging Circuit:

- Supports lead-acid batteries only
- Float-charge voltage: 27.6 VDC
- Maximum current charge: 1.5 A
- Maximum battery capacity: 18 AH

Applications

Example 1: Expand notification appliance power an additional 6.0 A (FCPS-24S6) or 8.0 A (FCPS-24S8). Use up to four Class B (Style Y) outputs or four Class A (Style Z) outputs (using ZNAC-4). For example, the FACP notification appliance circuits will activate the FCPS when reverse-polarity activation occurs. Trouble conditions on the FCPS are sensed by the FACP through the notification appliance circuit.

Example 2: Use the FCPS to expand auxiliary regulated 24-volt system power up to 4.0 A (FCPS-24S6) or up to 6.0 A (FCPS-24S8). Both resettable and non-resettable power options are available. Resettable outputs are created by connecting the resettable output from the FACP to one or both of the FCPS inputs.

Example 3: Use addressable control modules to activate the FCPS instead of activating it through the FACP notification appliance circuits. This typically allows for mounting the FCPS at greater distances* away from the FACP while expanding system architecture in various applications.

For example, an addressable control module is used to activate the FCPS, and an addressable monitor module is used to sense FCPS trouble conditions. Local auxiliary power output from the FCPS provides power to the addressable control module.

NOTE: *Addressable FACPs are capable of locating control and monitor modules at distances of up to 12,500 feet (3,810 meters).*

Sync Follower/Generator Note

In some installations, it is necessary to synchronize the flash timing of all strobes in the system for ADA compliance. Strobes accomplish this by monitoring very short timing pulses on the NAC power which are created by the FACP. When installed at the end of a NAC wire run, the FCPS-24S6/-24S8 can track (i.e. "follow") the strobe synchronization timing pulses on the existing NAC wire run. This maintains the overall system flash timing of the additional strobes attaches to the FCPS.

When the FCPS-24S6/-24S8 is configured (via DIP switch settings) as a "sync follower," the FCPS' NAC outputs track the strobe synchronization pulses present at the FCPS' sync input terminal. The pulses originate from an upstream FACP or other power supply.

When the FCPS-24S6/-24S8 are configured (via DIP switch settings) as a "sync generator," the FCPS' sync input terminals are not used. Rather, the FCPS is the originator of the strobe synchronization pulses on the FCPS' NAC outputs. In "sync generator" mode, the sync type (System Sensor, Wheelock, or Gentex) is selectable via DIP switch settings.

Standards and Codes

The FCPS-24S6 and FCPS-24S8 comply with the following standards:

- **NFPA 72** National Fire Alarm Code
- **UL 864** Standard for Control Units for Fire Alarm Systems (NAC expander mode)
- **UL 1481** Power Supplies for Fire Alarm Systems

Agency Listings and Approvals

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

- **UL Listed:** S635, S674
- **ULC Listed:** S635 (FCPS-24S6C & FCPS-24S8C)
- **CSFM Approved:** 7315-0028:0225
- **MEA:** 299-02-E
- **FM Approved**

Ordering Information

FCPS-24S6: 6.0 A, 120 VAC remote charger power supply. Includes main printed circuit board, transformers, enclosure (15"H x 14.5"W x 2.75"D [cm: 38.1H x 36.83W x 6.985D]), and installation instructions

FCPS-24S6C: Same as above, ULC-listed

FCPS-24S6R: Same as FCPS-24S6 with red enclosure

FCPS-24S6E: 6.0 A, 240 VAC remote charger power supply. Includes main printed circuit board, transformers, enclosure (15"H x 14.5"W x 2.75"D [cm: 38.1H x 36.83W x 6.985D]), and installation instructions

FCPS-24S8: 8.0 A, 120 VAC remote charger power supply. Includes main printed circuit board, transformers, enclosure (15"H x 14.5"W x 2.75"D [cm: 38.1H x 36.83W x 6.985D]), and installation instructions

FCPS-24S8C: Same as above, ULC-listed

FCPS-24S8R: Same as FCPS-24S8 with red enclosure

FCPS-24S8E: 8.0 A, 240 VAC remote charger power supply. Includes main printed circuit board, transformers, enclosure (15"H x 14.5"W x 2.75"D [cm: 38.1H x 36.83W x 6.985D]), and installation instructions

ZNAC-4: Class A (Style Y) NAC option module

EOLR-1: 12/24 VDC end-of-line relay for monitoring four-wire smoke detector power

BAT-1270: Battery, 12-volt, 7.0 AH (two required, see BAT Series data sheet DN-6933)

PS-1270: Battery, 12-volt, 7.0 AH (two required)

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Country of Origin: USA

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NOTIFIER® by Honeywell

FDU-80

80 Character Liquid Crystal Display

NOTIFIER® by Honeywell

Annunciators

General

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

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

Features

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

Operation

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

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

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

Installation

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

6820fdu8.jpg

Ordering Information

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

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

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

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

Agency Listings And Approvals

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

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

NOTE: For ULC-listed version, see DN-60573.

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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 0.65" (1.651 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 communication protocols.

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 (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: 375 µA (LED flashing), 1 communication every 5 seconds, 47k EOL.

Maximum IDC wiring resistance: 1500 Ohms.

Maximum IDC Voltage: 11 Volts.

EOL resistance: 47K Ohms.

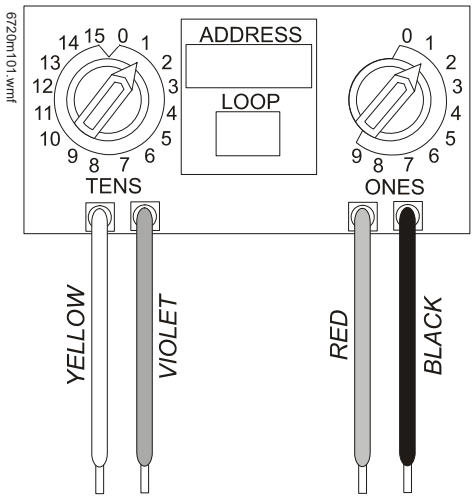
Temperature range: 32°F to 120°F (0°C to 49°C).

Humidity range: 10% to 93% noncondensing.

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

FMM-101(A) Mini Monitor Module

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



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

FMM-101(A) Applications

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

FMM-101(A) Operation

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

FMM-101(A) Specifications

Nominal operating voltage: 15 to 32 VDC.

Average operating current: 350 µA, 1 communication every 5 seconds, 47k EOL; 600 µA Max. (Communicating, IDC Shorted).

Maximum IDC wiring resistance: 1500 Ohms.

Maximum IDC Voltage: 11 Volts.

Maximum IDC Current: 450 µA.

EOL resistance: 47K Ohms.

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

Humidity range: 10% to 93% noncondensing.

Dimensions: 1.3" (3.302 cm) high x 2.75" (6.985 cm) wide x 0.65" (1.651 cm) deep.

Wire length: 6" (15.24 cm) minimum.

FZM-1(A) Interface Module

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

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

FZM-1(A) Applications

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

FZM-1(A) Operation

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

FZM-1(A) Specifications

Nominal operating voltage: 15 to 32 VDC.

Maximum current draw: 5.1 mA (LED on).

Maximum IDC wiring resistance: 25 Ohms.

Average operating current: 270 µA, 1 communication and 1 LED flash every 5 seconds, 3.9k eol.

EOL resistance: 3.9K Ohms.

External supply voltage (between Terminals T10 and T11):

- DC voltage: 24 volts power limited.
- Ripple voltage: 0.1 Vrms maximum.
- Current: 90 mA per module maximum.

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

Humidity range: 10% to 93% noncondensing.

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

FDM-1(A) Dual Monitor Module

The FDM-1(A) Dual Monitor Module is intended for use in intelligent, two-wire systems. It provides two independent two-wire initiating device circuits (IDCs) at two separate, consecutive addresses. It is capable of monitoring normally open contact fire alarm and supervisory devices; or either normally open or normally closed security devices. The module has a single panel-controlled LED.

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

FDM-1(A) Specifications

Normal operating voltage range: 15 to 32 VDC.

Maximum current draw: 6.4 mA (LED on).

Average operating current: 750 µA (LED flashing).

Maximum IDC wiring resistance: 1,500 Ohms.

Maximum IDC Voltage: 11 Volts.

Maximum IDC Current: 240 µA

EOL resistance: 47K Ohms.

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

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

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

FDM-1(A) Automatic Addressing

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

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

CAUTION:
Avoid duplicating addresses on the system.

Installation

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

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

Agency Listings and Approvals

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

- **UL:** S635.
- **ULC:** S635.
- **FM Approved.**
- **CSFM:** 7300-0028:0219, 7165-0028:0224, 7165-0028:0243.
- **MEA:** 457-99-E.
- **U.S. Coast Guard:** 161.002/50/0 (NFS2-640, NFS2-320, NFS2-3030).
- **Lloyd’s Register:** 11/600013 (NFS2-640, NFS2-320, NFS2-3030).
- **Fire Dept. of New York:** COA #6121 (NFS2-640, NFS-320), COA# 6114 (NFS2-3030).

Product Line Information

NOTE: *“A” suffix indicates ULC-listed model.*

FMM-1(A): Monitor module.

FMM-101(A): Monitor module, miniature.

FZM-1(A): Monitor module, two-wire detectors.

FDM-1(A): Monitor module, dual, two independent Class B circuits.

SMB500: Optional surface-mount backbox.

NOTE: *See installation instructions and refer to the SLC Wiring Manual, PN 51253.*

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We try to keep our product information up-to-date and accurate.
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All specifications are subject to change without notice.

For more information, contact Notifier. Phone: (203) 484-7161, FAX: (203) 484-7118.
www.notifier.com

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).

Applications

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

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

Construction

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

Operation

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

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

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

Specifications for FCM-1(A)

Normal operating voltage: 15 to 32 VDC.

Maximum current draw: 6.5 mA (LED on).

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

Maximum NAC Line Loss: 4 VDC.

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

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

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

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

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

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

Accessories: SMB500 Electrical Box; CB500 Barrier

Specifications for FRM-1(A)

Normal operating voltage: 15 to 32 VDC.

Maximum current draw: 6.5 mA (LED on).

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

EOL resistance: not used.

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

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

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

Accessories: SMB500 Electrical Box; CB500 Barrier

Agency Listings and Approvals

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

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

Contact Ratings for FRM-1(A)

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

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

Product Line Information

NOTE: *"A" suffix indicates ULC Listed model.*

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

FRM-1(A): Intelligent Addressable Relay Module.

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

SMB500: Optional Surface-Mount Backbox.

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

NOTE: *For installation instructions, see the following documents:*

- *FCM-1(A) Installation document I56-1169.*
- *FRM-1(A) Installation document I56-3502.*
- *Notifier SLC Wiring Manual, document 51253.*

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For more information, contact Notifier. Phone: (203) 484-7161, FAX: (203) 484-7118.
www.notifier.com

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.

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.

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

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

California State Fire Marshal
3240-0028:205

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

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

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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.

Relay contact ratings: 2 Form-C, DPDT, 10 A @ 250 VAC, 10 A @ 30 VDC (resistive). *Minimum switching current* of 100 mA @ 5 VDC.

Listed to UL 268A.

Programming specifications/requirements for intelligent system control panels:

The number of devices that can have their LEDs programmed to illuminate is limited by the features of the panel and the individual devices. The actual number of devices is determined by the control panel and its ability to supply LED current. Refer to the control panel installation manual for details.

INLET TUBE SELECTION

6821inlt.tbl

Outside Duct Width	Inlet Tube*
Up to 2 feet (0.6096 m)	ST-1.5
2 to 4 feet (0.6096 to 1.2192 m)	ST-3
4 to 8 feet (1.2192 to 2.4384 m)	ST-5
8 to 12 feet (2.4384 to 3.6576 m)	ST-10

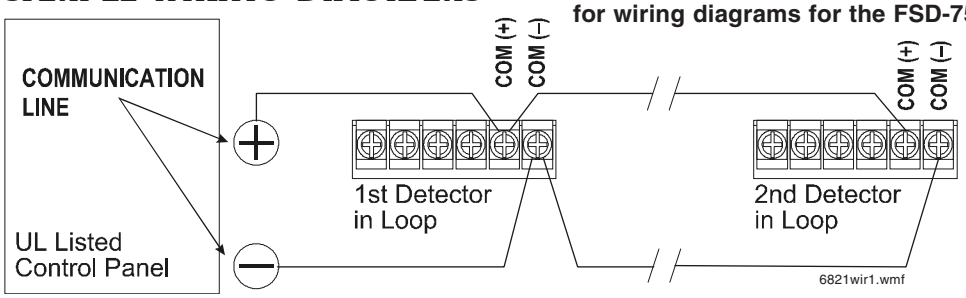
***NOTE:** Inlet tube is required and must be purchased separately. Order one inlet tube for each duct smoke detector ordered.*

PRODUCT LINE INFORMATION

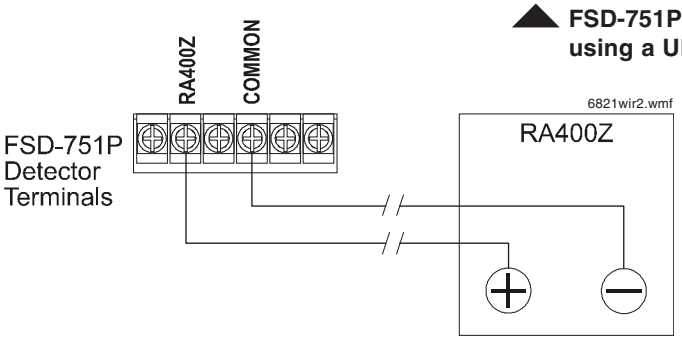
FSD-751P	Duct detector housing with FlashScan® photoelectric smoke detector.
FSD-751RP	Duct detector housing with FlashScan® photoelectric smoke detector, DPDT relay.
ST-1.5	Metal sampling tube, duct widths 1' to 2' (*see table at left for metric lengths).*
ST-3	Metal sampling tube, duct widths 2' to 4'.
ST-5	Metal sampling tube, duct widths 4' to 8'.
ST-10	Metal sampling tube, duct widths 8' to 12'.
RA400Z	Remote annunciator alarm LED.
RTS451	Remote test station. Mounts in single-gang box. Includes red alarm LED and magnet test switch.
RTS451KEY	Key-activated remote test station.
F36-09-00	Replacement filters.
M02-04-00	Replacement test magnet.
S08-39-01	Replacement photo insect screen.
P48-55-00	Replacement end cap for plastic sampling tube.
P48-21-00	Replacement end cap for metal sampling tube.
A5053FS	Replacement photoelectric sensor board.
A5067	Replacement power board (without relay).
A5060	Replacement power board (with relay).

SAMPLE WIRING DIAGRAMS

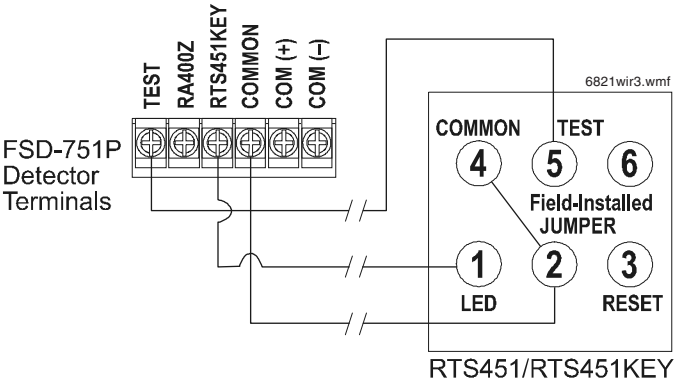
See product *Installation Intructions* for wiring diagrams for the FSD-751RP.



FSD-751P Duct Smoke Detector using a UL Listed control panel



FSD-751P Duct Smoke Detector with optional RA400Z



FSD-751P Duct Smoke Detector with RTS451/ RTS451KEY

NOTE: ***For RTS451,*** Terminal 3 is not used. RTS451 does not have a Terminal 6.

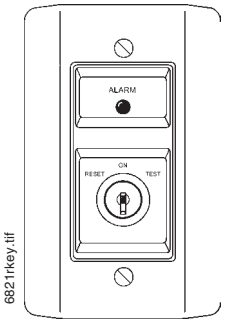
For RTS451KEY, Terminals 3 and 6 are not used.

3242ra4z.jpg

The RA400Z

3242rts4.jpg

The RTS451



6821rkey.tif

The RTS451KEY

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.

B210-2951.jpg

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

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.
- **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 sheet I56-1380 for device limitations between isolator modules and isolator bases.*

Agency Listings and Approvals

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

- **UL Listed:** S1115.
- **ULC Listed:** S1115 (FSP-851A, FSP-851RA, FSP-851TA).
- **MEA Listed:** 225-02-E .
- **FM Approved.**
- **CSFM:** 7272-0028:0206 .
- **Maryland State Fire Marshal:** Permit # 2122 **.**
- **BSMI:** CI313066760036.
- **CCCF:** Certif. # 2004081801000017 (FSP-851T) Certif. # 2004081801000016 (FSP-851).
- **U.S. Coast Guard:** 161.002/42/1 (NFS-640); 161.002/50/0 (NFS2-640/NFS-320/NFS-320C, excluding B210LP(A)).
- **Lloyd's Register:** 11/600013 (NFS2-640/NFS-320/NFS-320C, excluding B210LP(A)).

Product Line Information

NOTE: *"A" suffix indicates ULC Listed model.*

FSP-851: Low-profile intelligent photoelectric sensor. Must be mounted to one of the bases listed below.

FSP-851A: Same as FSP-851 but with ULC listing.

FSP-851T: Same as FSP-851 but includes a built-in 135°F (57°C) fixed-temperature thermal device.

FSP-851TA: Same as FSP-851T but with ULC listing.

FSP-851R: Low-profile intelligent photoelectric sensor, remote test capable. For use with DNRA/DNRW.

FSP-851RA: Same as FSP-851R but with ULC listing. For use with DNRA.

Intelligent Bases

NOTE: *"A" suffix indicates ULC Listed model.*

NOTE: *For details on intelligent bases, see DN-60054.*

B210LP(A): Standard U.S. flanged low-profile mounting base.

B210LPBP: Bulk pack of B210LP; package contains 10.

B501(A): Standard European flangeless mounting base.

B501BP: Bulk pack of B501; package contains 10.

B200S(A): Intelligent, programmable sounder base capable of producing sound output in high or low volume with ANSI Temporal 3, ANSI Temporal 4, continuous tone, marching tone, and custom tone.

B200SR(A): Intelligent sounder base capable of producing sound output with ANSI Temporal 3 or continuous tone. Replaces B501BH series bases in retrofit applications.

B224RB(A): Plug-in System Sensor **relay** base. Screw terminals: up to 14 AWG (2.0 mm^2). Relay type: Form-C. Rating: 2.0 A @ 30 VDC resistive; 0.3 A @ 110 VDC inductive; 1.0 A @ 30 VDC inductive.

B224BI(A): Plug-in System Sensor ***isolator*** detector base. Maximum 25 devices between isolator bases.

Accessories

F110: Retrofit flange to convert B210LP(A) to match the B710LP(A) profile, or to convert older high-profile bases to low-profile.

F110BP: Bulk pack of F110; package contains 15.

F210: Replacement flange for B210LP(A) base.

RA100Z(A): Remote LED annunciator. 3 – 32 VDC. Mounts to a U.S. single-gang electrical box. For use with B501(A) and B210LP(A) bases only.

SMB600: Surface mounting kit

M02-04-00: Test magnet.

M02-09-00: Test magnet with telescoping handle.

XR2B: Detector removal tool. Allows installation and/or removal of detector heads from bases in high ceiling applications.

XP-4: Extension pole for XR2B. Comes in three 5-foot (1.524 m) sections.

T55-127-010: Detector removal tool without pole.

BCK-200B: Black detector covers for use with FSP-851(A) only; box of 10.

WCK-200B: White detector covers for use with FSP-851(A) only; box of 10.

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We cannot cover all specific applications or anticipate all requirements.
All specifications are subject to change without notice.

For more information, contact Notifier. Phone: (203) 484-7161, FAX: (203) 484-7118.
www.notifier.com

FST-851(A) Series

Intelligent Thermal (Heat) Detectors with FlashScan®

NOTIFIER® by Honeywell

Intelligent / Addressable Devices

General

Notifier FST-851(A) Series intelligent plug-in thermal detectors with integral communication has features that surpass conventional detectors. Point ID capability allows each detector's address to be set with rotary, decimal address switches, providing exact detector locations. FST-851(A) Series thermal detectors use an innovative thermistor sensing circuit to produce 135°F/57°C fixed-temperature (FST-851/A) and rate-of-rise thermal detection (FST-851R/A) in a low-profile package. FST-851H(A) provides fixed high-temperature detection at 190°F/88°C. These thermal detectors provide effective, intelligent property protection in a variety of applications. FST-851(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 Engineering that greatly enhances the speed of communication between analog intelligent devices and certain NOTIFIER systems. Intelligent devices communicate in a grouped fashion. If one of the devices within the group has new information, the panel's CPU stops the group poll and concentrates on single points. The net effect is response speed greater than five times that of earlier designs.

Features

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

B210-2251.jpg

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

- 94-5V plastic flammability rating.
- Remote LED output connection to optional RA100Z(A) remote LED annunciator.
- Optional sounder, relay, and isolator bases.
- Optional flanced surface mounting kit.

Specifications

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.
- **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: 4.8 oz. (137 g).

Operating temperature range: FST-851(A) Series, FST-851R(A): –20°C to 38°C (–4°F to 100°F); FST-851H(A): –20°C to 66°C (–4°F to 150°F).

Detector spacing: UL approved for 50 ft. (15.24 m) center to center. FM approved for 25 x 25 ft. (7.62 x 7.62 m) spacing.

Relative humidity: 10% – 93% noncondensing.

Thermal ratings: fixed-temperature setpoint 135°F (57°C), rate-of-rise detection 15°F (8.3°C) per minute, high temperature heat 190°F (88°C).

ELECTRICAL SPECIFICATIONS

Voltage range: 15 - 32 volts DC peak.

Standby current (max. avg.): 300 µA @ 24 VDC (one communication every 5 seconds with LED enabled).

LED current (max.): 6.5 mA @ 24 VDC ("ON").

Applications

Use thermal detectors for protection of property. For further information, go to systemsensor.com for manual I56-407-00, Applications Manual for System Smoke Detectors, which provides detailed information on detector spacing, placement, zoning, wiring, and special applications.

Installation

The FST Series plug-in intelligent thermal detectors use a separate base to simplify installation, service, and maintenance. Installation instructions are shipped with each detector. 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 the inherent supervision provided by the SLC loop, end-of-line resistors are not required. Wiring "T-taps" or branches are permitted for Style 4 (Class "B") wiring.* ***2)*** *When using relay or sounder bases, consult the ISO-X(A) installation sheet I56-1380 for device limitations between isolator modules and isolator bases.*

Agency Listings and Approvals

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

- **UL Listed:** S747.
- **ULC Listed:** S6978.
- **MEA Listed:** 383-02-E.
- **FM Approved.**
- **CSFM:** 7270-0028:0196.
- **BSMI:** CI313066760025.
- **CCCF:** Certif. # 2004081801000018.
- **U.S. Coast Guard:** 161.002/42/1 (NFS-640); 161.002/50/0 (NFS2-640/NFS-320/NFS-320C, excluding B210LP(A)).
- **Lloyd's Register:** 11/600013 (NFS2-640/NFS-320/NFS-320C, excluding B210LP(A)).

Product Line Information

NOTE: *"A" suffix indicates ULC Listed model.*

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

FST-851A: Same as FST-851 but with ULC Listing.

FST-851R: Intelligent thermal detector with rate-of-rise feature.

FST-851RA: Same as FST-851R but with ULC Listing.

FST-851H: Intelligent high-temperature thermal detector.

FST-851HA: Same as FST-851H but with ULC Listing.

INTELLIGENT BASES

NOTE: *"A" suffix indicates ULC Listed model.*

NOTE: *For details about intelligent bases and their mounting, see DN-60054.*

B210LP(A): Standard U.S. flanged low-profile mounting base.

B210LPBP: Bulk pack of B210LP; package contains 10.

B501(A): Standard European flangeless mounting base.

B501BP: Bulk pack of B501; package contains 10.

B200S(A): Addressable Intelligent, programmable sounder base capable of producing sound output in high or low volume with ANSI Temporal 3, ANSI Temporal 4, continuous tone, marching tone, and custom tone.

B200SR(A): Intelligent sounder base capable of producing sound output with ANSI Temporal 3 or continuous tone. Replaces B501BH series bases in retrofit applications.

B224RB(A): Intelligent relay base. Screw terminals: up to 14 AWG (2.0 mm²). Relay type: Form-C. Rating: 2.0 A @ 30 VDC resistive; 0.3 A @ 110 VDC inductive; 1.0 A @ 30 VDC inductive.

B224BI(A): Intelligent isolator base. Isolates SLC from loop shorts. Maximum: 25 devices between isolator bases; see Note 2 under Installation.

ACCESSORIES

F110: Retrofit flange to convert B210LP(A) to match the B710LP(A) profile, or to convert older high-profile bases to low-profile.

F110BP: Bulk pack of F110; package contains 15.

F210: Replacement flange for B210LP(A) base.

RA100Z(A): Remote LED annunciator. 3 – 32 VDC. Fits U.S. single-gang electrical box. Supported by B210LP(A) and B501(A) bases only.

SMB600: Surface mounting kit, flanged.

M02-04-00: Test magnet.

M02-09-00: Test magnet with telescoping handle.

XR2B: Detector removal tool. Allows installation and/or removal of FlashScan® Series detector heads from base in high ceiling installations. Includes T55-127-010.

T55-127-010: Detector removal tool without pole.

XP-4: Extension pole for XR2B. Comes in three 5-foot (1.524 m) sections.

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Made in the U.S. A.

For more information, contact Notifier. Phone: (203) 484-7161, FAX: (203) 484-7118.
www.notifier.com

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

4" (10.16 cm) square electrical box, and shall be installed within the limits defined by the Americans with Disabilities Act (ADA) or per national/local requirements. Manual Stations shall be Underwriters Laboratories listed.

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

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

Product Line Information

NBG-12LX: Dual-action addressable pull station. Includes key locking feature. (Listed for Canadian and non-Canadian applications.)

NBG-12LXSP: Spanish/English labelled version.

NBG-12LXP: Portuguese labelled version.

SB-10: Surface backbox; metal.

SB-I/O: Surface backbox; plastic.

BG12TR: Optional trim ring.

17021: Keys, set of two.

NY-Plate: New York City trim plate.

Agency Listings and Approvals

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

- **UL/ULC Listed:** S692 (listed for Canadian and non-Canadian applications).
- **MEA:** 67-02-E.
- **CSFM:** 7150-0028:0199.
- **FDNY:** COA #6085 (NFS2-640), COA #6098 (NFS2-3030).
- **BSMI:** CI313066760047.
- **U.S. Coast Guard.**
- **Lloyd's Register.**
- **FM Approved.**

Patented: U.S. Patent No. D428,351; 6,380,846; 6,314,772; 6,632,108.

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For more information, contact Notifier. Phone: (203) 484-7161, FAX: (203) 484-7118.
www.notifier.com

SPECTRAlert®

Selectable Output Strobe and Horn/Strobes

SYSTEM SENSOR®

Models Available

Strobes

Red	White
S1224MC	S1224MCW
S1224MCP	S1224MCPW
S1224MCK	
S1224MCSP	

Horn/Strobes

Red	White
P1224MC	P1224MCW
P1224MCP	P1224MCPW
P1224MCK	
P1224MCSP	

Horns

Red	White
H12/24	H12/24W
H12/24K	

Product Overview

Operates on either 12V or 24V

Widest range of candela options:
12V: 15 and 15/75 candela
24V: 15, 15/75, 30, 75, 110 candela

Easy candela selection

Lower current draw

Easy DIP switch selection for horn options

Easy mounting with QuickClick™

Synchronizable with MDL Sync•Circuit™ module

Meets UL1971, NFPA72, and ADA signaling requirements

All strobe and horn/strobe models incorporate a new 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.

7125-1209:222
7135-1209:223

LISTED
S5512
S4011

FM APPROVED
3014150

MEA approved
122-02-E
126-02-E

SpectrAlert® Selectable Output Horns, Strobes, and Horn/Strobes offer enhanced features that include the widest range of candela options available and the capability to recognize and self-adjust for either 12 or 24 volt operation. With an overall feature set that combines performance, installation ease, flexibility, and a consistent, aesthetically pleasing appearance, the SpectrAlert Selectable Output devices provide both the innovation and efficiency synonymous with the SpectrAlert name.

Performance. SpectrAlert selectable output wall-mount horns, strobes, and horn/strobes offer key performance features long associated with the SpectrAlert name. The selectable candela strobes and horn/strobes offer average current draws that are not only lower than conventional fixed-candela SpectrAlert products, but also lower than similar selectable candela products. By consuming less current, the ability to connect even more devices per loop is possible, resulting in a lower installed cost.

Installation. SpectrAlert selectable output horns, strobes, and horn/strobes offer the same installation-friendly features synonymous with the SpectrAlert name, such as the option of 2- and 4-wire operation; the ability to use standard size backboxes with no encroachment into the box; and universal mounting incorporating the labor-saving QuickClick™ feature. Such labor-savings features make wire connections simple and fast, further reducing installed cost.

Flexibility. SpectrAlert selectable output strobes and horn/strobes offer the broadest range of candela options. In addition, the selectable output strobes and horn/strobes can operate on either 12V or 24V, with no setting required; the device recognizes and self-adjusts to the correct current automatically. Temporal 3 or Continuous tone options continue to be available, in either an Electromechanical or 3kHz pattern.

Aesthetics. SpectrAlert selectable output horns, strobes, and horn/strobes incorporate the same stylish, low profile design of the conventional SpectrAlert products, for a consistent and aesthetically pleasing appearance across the entire product line.

Engineering Specifications

General

SpectrAlert horns, strobes and horn/strobes shall be capable of mounting to a standard 4″ × 4″ × 1 1/2″ back box or a single gang 2″ × 4″ × 1 7/8″ back box using the universal mounting plate included with each SpectrAlert product. Also, SpectrAlert products, when used in conjunction with the accessory Sync•Circuit Module, shall be powered from a non-coded power supply and shall operate on 12 or 24 volts. 12 volt rated devices shall have an operating voltage range of 9–17.5 volts. 24-volt rated devices shall have an operating voltage range or 17–33 volts. SpectrAlert products shall have an operating temperature of 32° to 120°F and operate from a regulated DC or full wave rectified, unfiltered power supply.

Strobe

Strobe shall be a System Sensor SpectrAlert Model _____ listed to UL 1971 and be approved for fire protective service. The strobe shall be wired as a primary signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1Hz over the strobe's entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflector system.

Horn/Strobe Combination

Horn/Strobe shall be a System Sensor SpectrAlert Model _____ listed to UL 1971 and UL 464 and shall be approved for fire protective service. Horn/strobe shall be wired as a primary signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1Hz over the strobe's entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. The horn shall have two tone options, two audibility options (at 24 volts) and the option to switch between a temporal 3 pattern and a non-temporal continuous pattern. Strobes shall be powered independently of the sounder with the removal of factory installed jumper wires. The horn on horn/strobe models shall operate on a coded or non-coded power supply (the strobe must be powered continuously).

Synchronization Module

Module shall be a System Sensor Sync•Circuit _____ listed to UL 464 and shall be approved for fire protective service. The module shall synchronize SpectrAlert strobes at 1Hz and horns at temporal 3. Also, the module shall silence the horns on horn/strobe models, while operating the strobes, over a single pair of wires. The module shall be capable of mounting to a 4 11/16″ × 4 11/16″ × 2 1/8″ back box and shall control two Style Y (class B) or one Style Z (class A) circuit. Module shall be capable of multiple zone synchronization by daisy chaining multiple modules together and re-synchronizing each other along the chain. The module shall not operate on a coded power supply.

Specifications

Walk Test
SpectrAlert horn/strobe and horn only work on "walk tests" with time durations of 4 seconds or greater

Input Terminals
12 to 18 AWG

Dimensions
Strobe and horn/strobe with universal plate
5″ × 5 5/8″ × 2 15/16″

Strobe and horn/strobe with small footprint plate
3 3/8″ × 5 5/8″ × 2 5/16″

Horn with universal mounting plate
5″ × 5 5/8″ × 1 5/16″

Horn without mounting plate
2 15/16″ × 5 5/16″ × 1 5/16″

Weight, horn only
7.2 oz.

Weight, strobe and horn/strobe
8.8 oz.

Mounting
4″ × 4″ × 1 1/2″ or 2″ × 4″ × 1 7/8″ standard boxes

Operating Temperature (Indoor)
32°F to 120°F (0°C to 49°C)

Maximum humidity (Indoor)
95% as tested per UL464

Outdoor (K Series) Operating Temperature
–40°F to 151°F
(–40°C to 66°C)

Outdoor rating
NEMA 3R (per UL 50)

Voltages
12 or 24VDC and FWR[1] unfiltered

Operating voltage range
12V: 8–17.5V; 24V: 16–33V

Operating voltage range (with Sync•Circuit module, MDL)[2]
12V: 9–17.5V; 24V: 17–33V

U.S. Patent Numbers
5,593,569
5,914,665
6,049,446

Notes:
1. Full Wave Rectified (FWR) voltage is a non-regulated, time-varying power source that is used on some power supply and panel outputs.
2. The MDL causes a one-volt voltage drop in the notification appliance circuit.

Table 1-A: SpectrAlert Strobe UL Max. Current Draw

Candela Setting	FWR Operating Current–Strobe (mA RMS)		DC Operating Current–Strobe (mA RMS)	
	8-17.5V	16-33V	8-17.5V	16-33V
15	112	64	127	59
15/75	135	74	127	69
30		93		90
75		158		160
110		208		209

Table 1-B: Horn UL Max. Current Draw Measurements (mA RMS)

Selectable Horn Tones			DC		FWR	
			8-17.5V	16-33V	8-17.5V	16-33V
Temporal	Low Volume	Electromechanical	15	23	13	23
		3000 Hz Interrupted	15	33	13	23
	High Volume	Electromechanical	36	53	20	44
		3000 Hz Interrupted	43	57	21	40
Non-Temporal	Low Volume	Electromechanical	16	37	19	29
		3000 Hz Interrupted	16	32	18	33
	High Volume	Electromechanical	38	49	46	49
		3000 Hz Interrupted	44	56	42	58

Table 1-C: 12VDC Horn/Strobe UL Max. Current Draw Measurements (mA RMS)

	Temporal			
	Low Volume		High Volume	
Candela Setting	Electromechanical	3000 Hz	Electromechanical	3000 Hz
15	111	111	112	112
15/75	127	127	126	129
	Non-Temporal			
15	113	112	114	115
15/75	128	128	130	134

Table 1-D: 24VDC Horn/Strobe UL Max. Current Draw Measurements (mA RMS)

	Temporal			
	Low Volume		High Volume	
Candela Setting	Electromechanical	3000 Hz	Electromechanical	3000 Hz
15	71	70	73	75
15/75	86	85	87	88
30	99	98	100	100
75	166	166	167	170
110	209	209	210	213
	Non-Temporal			
15	74	74	79	82
15/75	86	88	93	96
30	101	101	107	110
75	167	167	173	176
110	213	213	218	222

Explanation of Published Voltage, Current, and SPL Specifications

In May 2004 Underwriters Laboratories changed standard UL 1971 to require that operating current measuremments are made using RMS (root mean square) instead of peak or average values. RMS measurements more accurately predict the power consumption of a device since they take into account the entire current draw profile including surge, repetitive surge, and peak values. The published RMS current is the maximum operating current of that device within its operating voltage range. This current maximum may or may not occur at the endpoints of the voltage range.

Similarly, UL tests the audibility of devices in accordance with UL 464 by measuring them across the operating voltage range to determine the minimum sound pressure level produced at any particular setting.

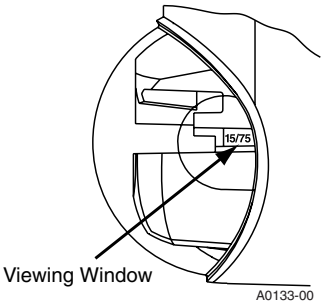
During May 2004, UL also changed the way they list the voltage range of a device. All 12V products will be listed between 8 – 17.5V and all 24V products will be listed between 16 – 33V. Those devices are considered “regulated”. Any product that does not operate within these ranges will be listed as a “special application” with its operating voltage specified on the device.

Notes

1. Current draw for strobe-only products is shown in Table 1-A.
2. Current draw for horn-only products is shown in Table 1-B.
3. 12VDC 2-wire horn/strobe current is shown in Table 1-C.
4. 24VDC 2-wire horn/strobe current draw is shown in Table 1-D.
5. Current draw for other horn/strobe power supplies can be calculated by adding the strobe current in Table 1-A to the horn current in Table 1-B from the chosen settings.

SpectrAlert Strobe Candela Selections

For strobe candela selection, adjust slide switch located on the rear of the product while watching the viewing window on the side of the reflector.



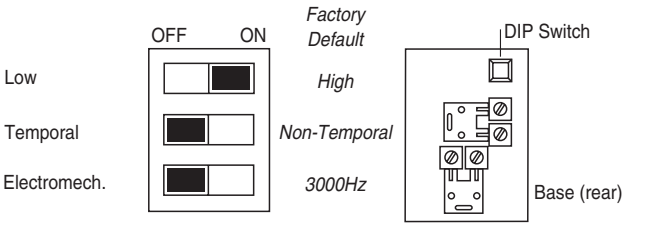
Permissible Candela Settings

Candela Setting	Operating Voltage	
	12V	24V
15	OK	OK
15/75	OK	OK
30		OK
75		OK
110		OK

SpectrAlert Horn Sound Measurements (dBA)

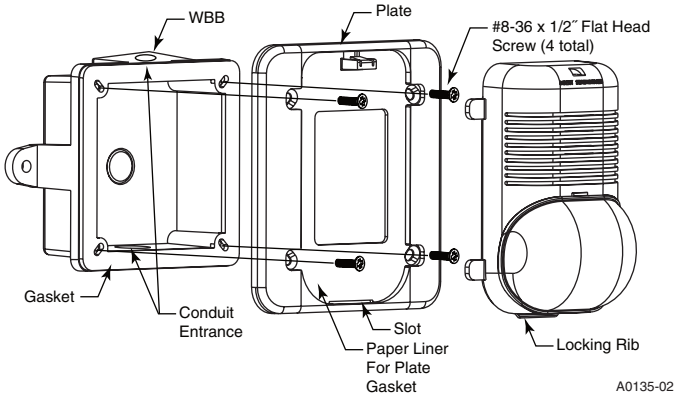
Selectable Horn Tones			8-17.5V	16-33V
Temporal	Low Volume	Electromechanical	67	75
		3000 Hz Interrupted	68	75
	High Volume	Electromechanical	71	80
		3000 Hz Interrupted	72	81
Non-Temporal	Low Volume	Electromechanical	71	79
		3000 Hz Interrupted	72	79
	High Volume	Electromechanical	76	84
		3000 Hz Interrupted	77	86

DIP Switch Operation on P1224MC



A0110-00

Typical weatherproof mounting with universal plate



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SpectrAlert Ordering Information

Model	Description
P1224MC	Selectable Output Horn/Strobe, 12/24 volt, red
P1224MCW	Selectable Output Horn/Strobe, 12/24 volt, white
P1224MCP	Selectable Output Horn/Strobe, 12/24 volt, red, plain housing
P1224MCPW	Selectable Output Horn/Strobe, 12/24 volt, white, plain housing
P1224MCK	Selectable Output Horn/Strobe, 12/24 volt, red, outdoor
P1224MCSP	Selectable Output Horn/Strobe, 12/24 volt, red, "FUEGO" housing
S1224MC	Selectable Output Strobe, 12/24 volt, red
S1224MCW	Selectable Output Strobe, 12/24 volt, white
S1224MCP	Selectable Output Strobe, 12/24 volt, red, plain housing
S1224MCPW	Selectable Output Strobe, 12/24 volt, white, plain housing
S1224MCK	Selectable Output Strobe, 12/24 volt, red, outdoor
S1224MCSP	Selectable Output Strobe, 12/24 volt, red, "FUEGO" housing

Model	Description
H12/24	Horn, 12/24 volt, red
H12/24W	Horn, 12/24 volt, white
H12/24K	Horn, 12/24 volt, red, outdoor
Accessories	
MDL	Sync•Circuit Module, red
MDLW	Sync•Circuit Module, white
MDLWA	Sync•Circuit Module, white, Canadian model
S-MP	Small Footprint Mounting Plate, red, for single-gang back box
S-MPW	Small Footprint Mounting Plate, white, for single-gang back box
BBS	Surface Mount Back Box Skirt, red
BBSW	Surface Mount Back Box Skirt, white
D-MP	Universal Mounting Plate (replacement), red
D-MPW	Universal Mounting Plate (replacement), white
WBB	Weatherproof Back Box

Notes

All of these SpectrAlert products are designed for wall mount only. All outdoor models must use weatherproof back box model WBB. Installation of less than 75 candela strobes may be permissible under the equivalent facilitation clause of the ADAAG (Sec. 2.2). However, it is the responsibility of the person or entity designing the fire alarm system to determine the acceptability of less than 75 candela strobes. All 15/75 candela strobes or horn/strobes are recommended for 20′ × 20′ rooms or less.

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A05-0325-006•9/05•#1526

Wheelock MB Series
Motor Bells

Description

Wheelock's Series MB Motor Bells provide a better engineered motor bell for fire and life safety alarm systems. The Wheelock Series MB Bells include higher dBA, low current draw, built-in trimplate for semi-flush mounting, low frequency aluminum shells, and low RFI noise. The motor for Series MB Bells is a durable, high torque permanent magnet motor selected for its high performance and long life.

Series RSSP Sync/Non-Sync retrofit plates are used in conjunction with the Series MB Motor Bell when combination appliances are required. The Series RSSP retrofit plates are available with either Multi-Candela or single candela strobes and easily mount to a 4" square or Wheelock SBL-2 backbox. All Series RSSP strobe appliances meet or exceed the requirements of NFPA 72 (National Fire Alarm Code), ANSI 117.1 (American National Standard for Accessible and Usable Buildings and Facilities), ADA (Americans with Disabilities Act) and UL Standard 1971 (Signaling Devices for the Hearing Impaired).

The Series RSSP retrofit plates may be synchronized when installed with the Wheelock Series SM, DSM, Sync Modules or a Power Supply with Wheelock's patented sync protocol. Wheelock's synchronized strobes offer an easy way to comply with ADA requirements concerning photo-sensitive epilepsy.

Engineer's Specification

The alarm appliances shall be Wheelock Series MB vibrating Motor Bells or approved equal. They shall be UL Standard 464 Listed for Fire Protective Service. Shells shall be aluminum in 6" or 10" diameter. Sound output at 10 feet shall be 92 dBA. The bells shall incorporate a permanent magnet motor and suppression circuitry to minimize RFI. They shall include a built-in trimplate for semi-flush mounting to a standard 4" square backbox, or surface mounting to Wheelock's indoor BB backbox or outdoor WBB backbox. For bell strobe applications, retrofit plates Wheelock Series RSSP with Multi-Candela or Single Candela strobes shall be used. All bell models shall be polarized for line supervision and shall have screw terminals for in-out field wiring of #12 to #18 AWG wire. Operating voltage shall be nominal 24 VDC or 12 VDC. Finish on all models shall be red enamel.

Features

- High sound output with low current draw.
- Low frequency aluminum shells for better audibility through walls, doors and other structures.
- 6" and 10" shell sizes in 12 or 24 VDC models.
- Integral RFI suppression to minimize included noise on the NAC circuit.
- Mounting options for surface, semi-flush, outdoor, and concealed conduit installation.
- Built-in trimplate makes semi-flush mounting simpler and less expensive
- Polarized for DC supervision of NAC circuits.
- Operates on filtered or unfiltered DC.

Listings

Listings and approvals below apply to Wheelock MB Series Motor Bells. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- UL Listed: file E5946
- ULC Listed: file CS243
- FM approved.
- MEA approved: file 151-92-E.
- CSFM approved: files 7135-0785:113.

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Ordering Information

MODEL NUMBER	SHELL SIZE	INPUT VOLTAGE (VDC)	INPUT CURRENT
MB-G6-12-R	6"	12	0.060
MB-G6-24-R	6"	24	0.030
MB-G10-12-R	10"	12	0.060
MB-G10-24-R	10"	24	0.030

NOTES:
1. Typical dBA at 10 feet is 92, measured in an anechoic chamber.
2.Mounting options are: D,E,J,K,N,R,S,Z
3. For bells at 12 VDC models are UL rated for 9.0 to 15.6 VDC and all 24 VDC models for 18.0 to 31.0

MODEL NUMBER	NOMINAL VOLTAGE (VDC)	STROBE CANDELA	AVERAGE CURRENT (amps) @ LISTED VDC
RSSP-24MCW-FR	24	15/30/75/110	.050/.081/.133/.161
RSSP-241575W-FR	24	15 (75 on axis)	0.065
RSSP-121575W-FR	12	15 (75 on axis)	0.170

1. Mounting options are: D,E,Z

2. Average current per actual Wheelock product testing at listed VDC. For rated average and peak current across UL regulated voltage range for both filtered DC and unfiltered VRMS, see Installation instructions.

SYNC MODELS/POWER SUPPLY			
MODEL NUMBER	**INPUT VOLTAGE (VDC)**	**AVERAGE MEAN CURRENT @ 24 VDC**	**MOUNTING OPTIONS****
SM-12/24-R	24	.028	W
DSM-12/24-R	24	.035	W

SM Sync Module is rated for 3.0 amperes @ 24VDC.

DSM Sync Module is rated for 3.0 amperes per circuit. The maximum number of interconnected DSM modules is twenty (20).

** Refer to mounting options data sheet.

Wiring Diagram

Fig. 1 Bell Models

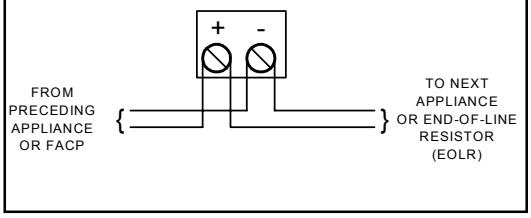
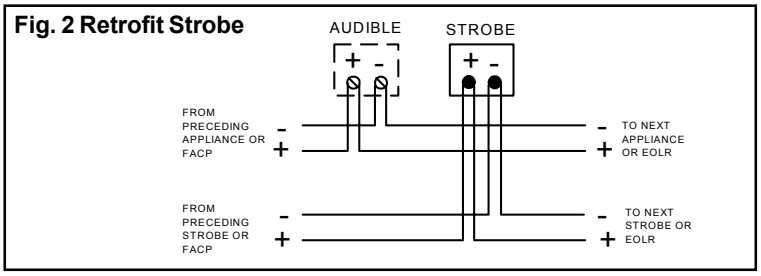


Fig. 2 Retrofit Strobe



Wheelock products must be used within their published specifications and must be PROPERLY specified, applied, installed, operated, maintained and operationally tested in accordance with their installation instructions at the time of installation and at least twice a year or more often and in accordance with local, state and federal codes, regulations and laws. Specification, application, installation, operation, maintenance and testing must be performed by qualified personnel for proper operation in accordance with all of the latest National Fire Protection Association (NFPA), Underwriters' Laboratories (UL), National Electrical Code (NEC), Occupational Safety and Health Administration (OSHA), local, state, county, province, district, federal and other applicable building and fire standards, guidelines, regulations, laws and codes including, but not limited to, all appendices and amendments and the requirements of the local authority having jurisdiction (AHJ).

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