FIRE AND SAFETY ANALYSIS
ROBERT E. KENNEDY LIBRARY

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STATEMENT OF DISCLAMER

Keywords: Life Safety Code, RSET, ASET, Performance Based Design, Fire Dynamics Simulator (FDS).

EXECUTIVE SUMMARY

The Robert E. Kennedy Library is located on Cal Poly Campus. The Library is a five-story building with different occupancies which consists of library areas, offices, mechanical equipment and storage areas. The building has a total area of 178 702 ft². The original code of construction for the Library was the 1976 Uniform Building code (UBC). However, the fire and life safety analysis of the building in this report is performed using:

- Egress: NFPA 101 LSC 2015
- Water based suppression: NFPA 13
- Structural fire protection: 2015 IBC
- Fire detection, alarm and communication systems: NFPA 72
- Performance based design: NFPA 101 LSC 2015 and the SFPE handbook 5th edition

The prescriptive-based analysis in this report focuses on the egress features, fire alarm and detection systems, fire suppression systems and structural fire protection of the Robert E. Kennedy Library. The egress features built into the Library were found to mostly comply with the prescriptive requirements of the LSC. There is an automatic fire alarm and detection system as well as an emergency notification system installed in the Library, mostly in accordance with the LSC and NFPA 72. However, the notification devices do not cover all common use areas in the Library, which is not up to code. The Library does not have a water based suppression system, but it is designed in this report. The proposed suppression system is in accordance with IBC requirements, and was designed following the requirements of NFPA 13. The analysis demonstrates that the Library is in accordance with all of the requirements of the IBC for Type I-B construction.

The performance-based analysis in this report investigated the ability of the fire protection systems in the Library to perform satisfactorily in different fire scenarios. This analysis was completed using the Fire Dynamics Simulator (FDS) program, in conjunction with the Pyrosim graphical user interface and the Pathfinder evacuation simulator. The chosen design fire scenario was a fire with 8 bookshelves in the south west corner of the second floor. Two simulations were done, with and without functional sprinkler system. The data needed for the fire and combustion properties was taken from the SFPE handbook. The tenability criteria's was evaluated east of the fire, where the occupants first will be affected by the fire.

The simulations without functional sprinkler system indicated that RSET>ASET. The visibility was violated in less than half the required safety egress time (RSET).

The simulations with a functional sprinkler system indicated that ASET>RSET. The tenability criteria's was not violated and it was determined that the building is safe in respect to life safety with sprinklers.

It has been shown in the performance-based analysis portion of this report how a sprinklers system can reduce the effects of combustion byproducts in an area with a high fuel load and increase the life safety potential within a building. Sprinkler installation for the control of fires is the most common method of providing fire suppression. I would therefore recommend installing a sprinkler system in the Library for life safety.

I would also recommend providing notification devices in all common use areas throughout the Library as required by IBC 2015 edition

Table of contents

1. INTRODUCTION

This Fire and Life Safety report will describe in detail the required and provided fire and life safety features of the Robert E. Kennedy Library. The features discussed will include the structural fire protection, fire suppression system, fire alarm and detection system, and the egress system. Following the discussion of these prescriptive features, a performance-based analysis involving potential fire scenarios will be presented. A summary of both the prescriptive- and performance-based analyses, and their findings, will conclude this report.

1.1 Applicable Codes

The following is a list of the codes and handbooks which were used to perform a life safety analysis on the Robert E. Kennedy Library:

- Egress: NFPA 101 LSC 2015
- Water based suppression: NFPA 13
- Structural fire protection: 2015 IBC
- Fire detection, alarm and communication systems: NFPA 72
- Performance based design: NFPA 101 LSC 2015 and the SFPE handbook 5th edition

1.2 Building Description

The Robert E. Kennedy Library is a building that is part of California Polytechnic State University San Luis Obispo and is located on the west side of campus. The location of the building relative to the campus of Cal Poly can be seen in Figure 1.

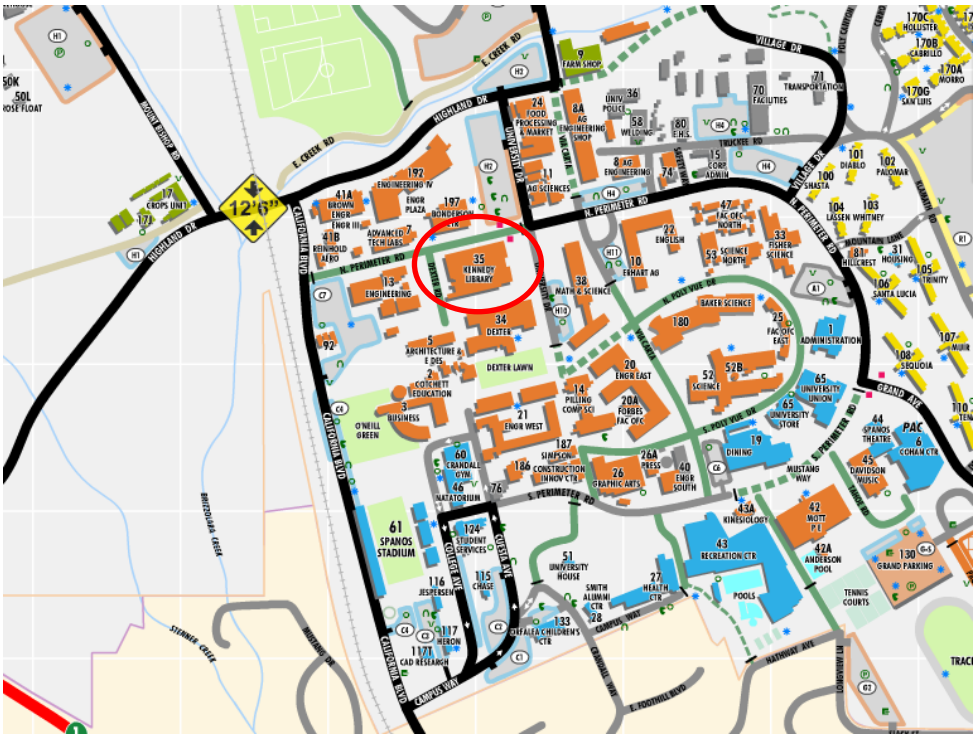

Figure 1 Location of The Robert E. Kennedy Library is marked with a red circle

The Robert E. Kennedy Library is a five-story building with different occupancies which consists of library areas, offices, mechanical equipment and storage areas. The building has a total area of 178702 ft². The original code of construction for the Library is the 1976 Uniform Building Code (UBC). Figure 2 shows the layout of the Library.

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Figure 2 Back side of the Library

The Library has four exit stairwells, shown in red squares in Figure 3.

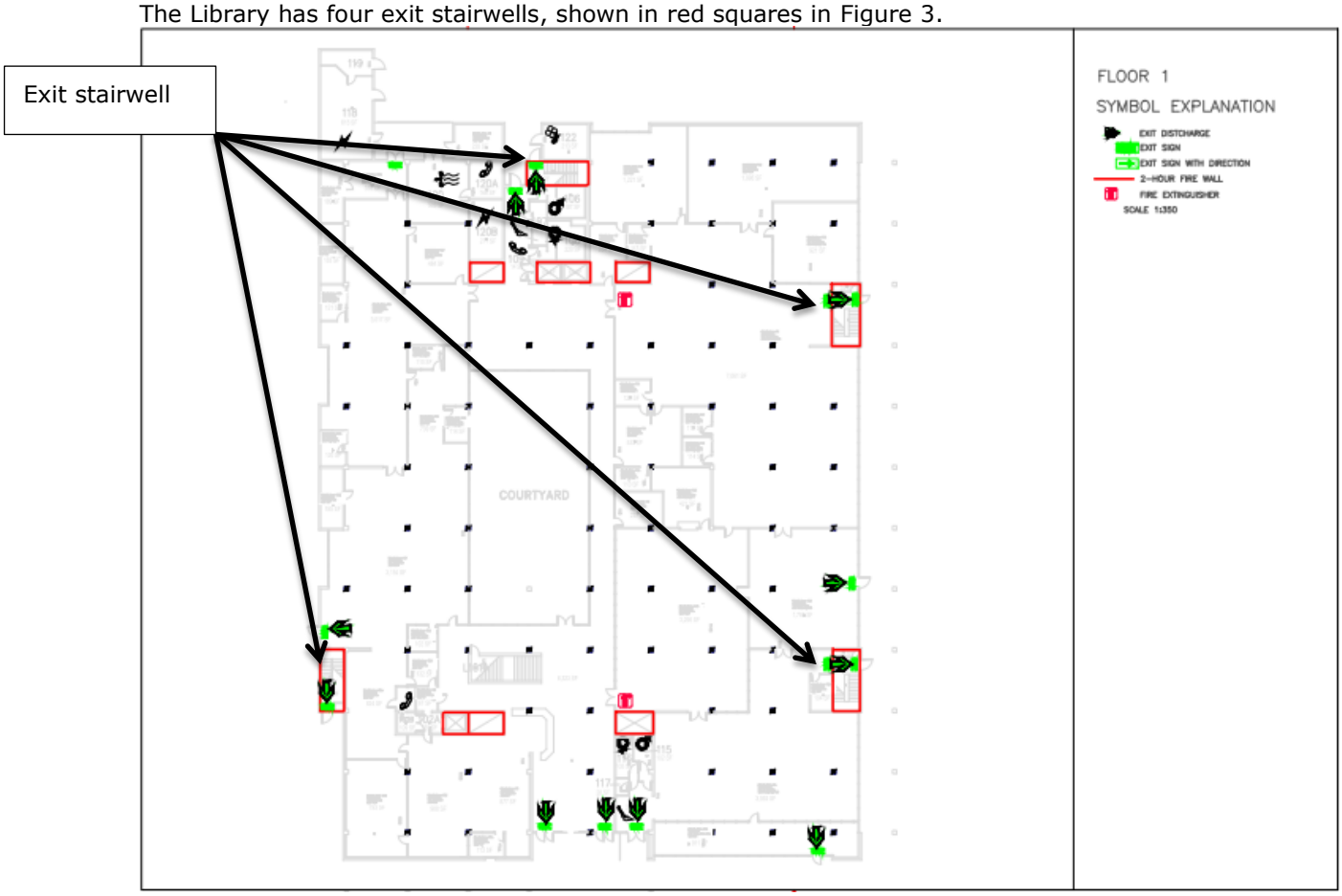

Figure 3 Floor One Layout

There is an outdoor courtyard in the centre of the building, with access via the first floor. There are also outside decks on floors above the first floor. A picture of the courtyard is shown in Figure 4.

Figure 4 Outdoor Courtyard

2. PRESCRIPTIVE ANALYSIS

3. EGRESS ANALYSIS AND DESIGN

3.1 Use and classification of occupancy

The Kennedy Library is a multiple occupancy building which is considered as a mixed occupancy in accordance to LSC section 6.1.14. The nonseparated occupancies must be individually classified in accordance with LSC 7.3.1. According to LSC section 6.1.14.3.2* the building shall comply with the most restrictive requirements of the occupancies involved.

The building consists of library areas, offices, mechanical equipment and storage areas. Floor plans with the different occupancies are shown below.

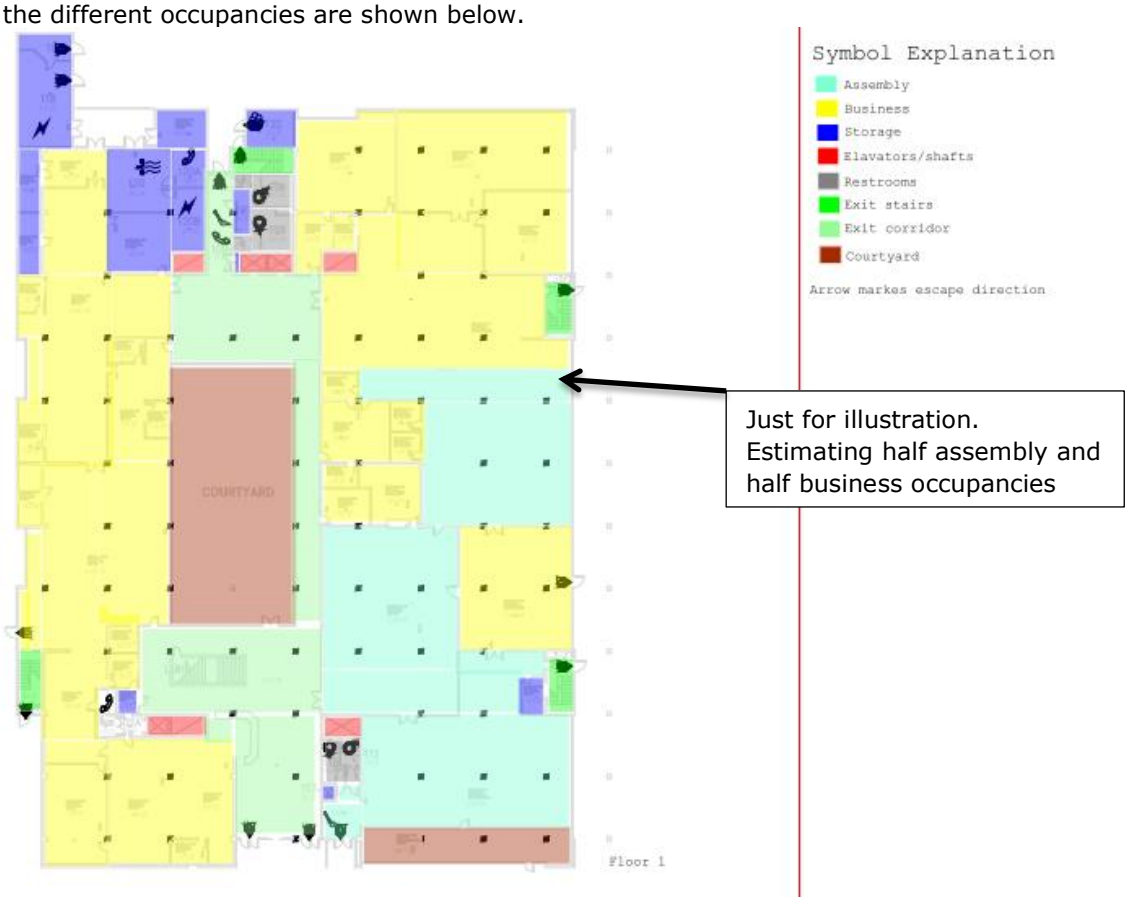

Figure 5 Floor One Occupancy Classifications

Figure 6 Floor 2 occupancy classifications

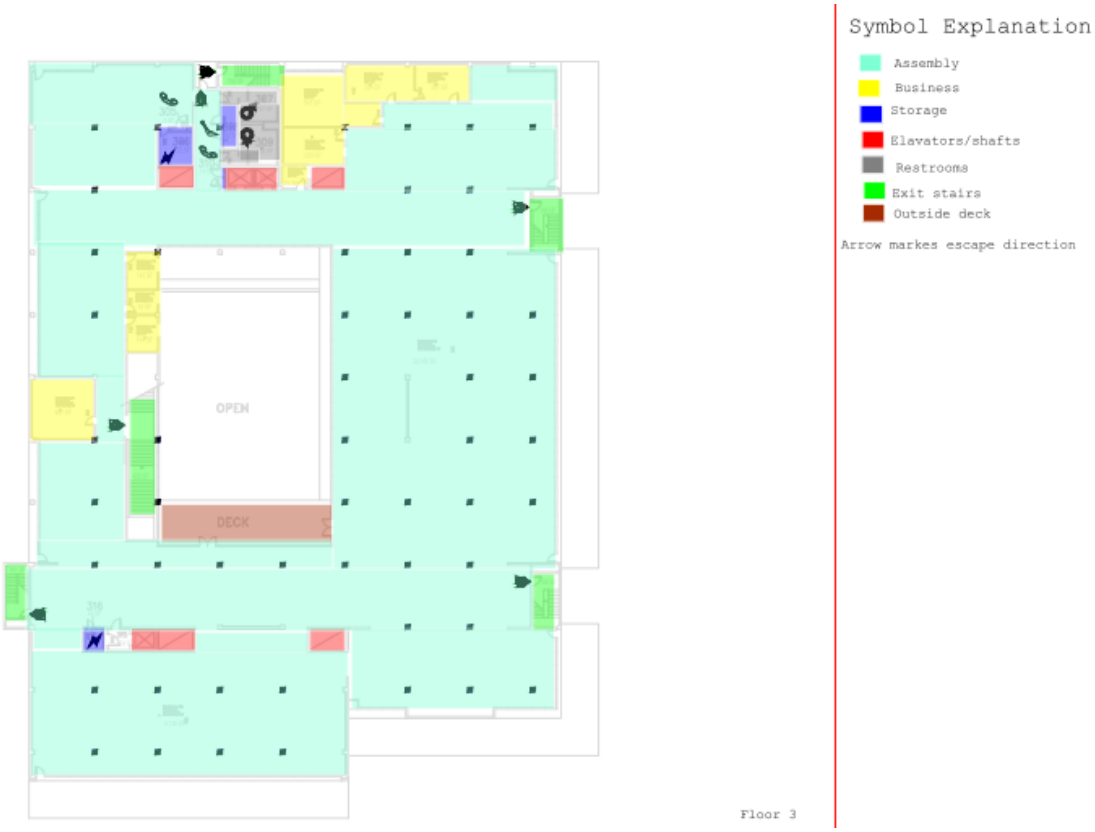

Figure 7 Floor 3 occupancy classifications

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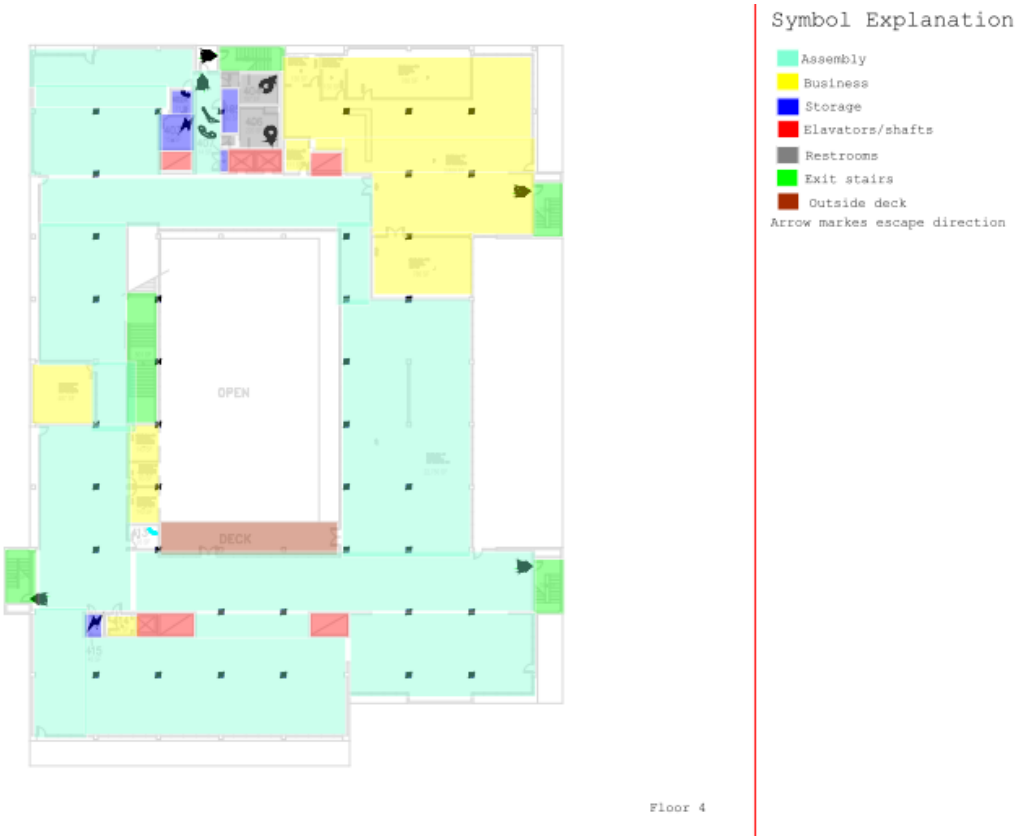

Figure 8 Floor four occupancy classifications

Figure 9 Floor five occupancy classifications

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The occupancy classification per LSC section 6.1 was given to each type of room, as well as a corresponding occupant load factor per LSC table 7.3.2.1 which will determine the total occupancy of the building. The occupancy classification and corresponding occupant load factor are summarized in Table 1.

The following table identifies applicable occupant load factors based on the occupancy and function of spaces in the scope of work of this project (Table 7.3.2.1).

Table 1 Occupancy load factor

Use	Occupancy load factor
Assembly use	
Library stack areas	100
Library reading rooms	50 net
Business	100
Storage use	
In storage occupancies	NA
In other than storage and mercantile occupancies	500

NA: Not applicable

Note that toilets do not have occupancy load, because these areas are used by the people in other spaces in the building.

3.2 Occupancy Load

The occupant load of the building was calculated using the occupant load factors (Table 1) along with the area of each room. The area of each room was divided by the occupant load factor to determine the number of occupants for whom means of egress facilities must be provided for.

$$\text{Occupancy Load} = \frac{\text{Area of room } (\text{ft}^2)}{\text{Occupancy load factor}(\text{ft}^2 \text{per occupant})}$$

The total occupant of each floor and the subsequent total occupant load of the building can be calculated by adding the occupant load of each room. The area and occupant load for each floor and the total building are summarized in Table 2.

Table 2 Occupancy Load

Floor	Area (ft^2)	Occupancy load
1	42583	599
2	40604	689
3	36966	465
4	30478	390
5	28071	280
Total	178702	2423

For occupant load for each space see Appendix A1.

3.3 Exit Capacity

The capacity factor is found in Table 7.3.3.1 in Life Safety Code and summarized in Table 3:

Table 3 Exit Capacity Factors

Stairway (in)	Level components and ramps (in)
0.3	0.2

The egress capacity of each egress component is determined by dividing the egress component's width by the egress capacity factor, unless the stairways are wider than 44 inches.
For the egress capacity for doors this equation was used:

$$\text{Egress capacity} = \frac{\text{Egress Component's Width (inches)}}{\text{Egress Capacity Factor}}$$

All the stairs are wider than 44 inches, so this equation was used:

$$C = 146.7 + \frac{Wn - 44}{0.218}$$

C = capacity, in persons, rounded to the nearest integer

Wn = nominal width of the stair as permitted by 7.3.2.2 (in.)

Egress capacity for each floor:

Table 4 Occupancy load vs egress capacity per floor

Floor	Occupancy load	Egress capacity
1	599	1320
2	689	1110
3	465	669
4	390	669
5	280	540

The calculations of egress capacity on each floor are shown in Appendix A2.

The occupancy load does not exceed egress capacity for any space in the Library.

All the requirements related to exit capacity are followed.

3.4 Sufficient Capacity

The means of egress shall be of such width and capacity that the loss of any one means of egress leaves available not less than 50 percent of the required capacity in accordance with LSC 7.3.1.1.2. It does not occur in the building that a single means of egress leaves more than 50 percent of the required capacity.

3.5 Number of means of egress

Per LSC 7.4.1.2 the number of means of egress from any story or portion thereof, shall be as follows:

- Occupant load more than 500, but not more than 1000 – not less than 3
- Occupant load more than 1000 – not less than 4

Table 5 shows the number of egress required and the number of egress each floor actually have.

Table 5 Number of exits

Floor	Occupancy load	Number of exits required	Number of exits
1	599	3	6
2	689	3	4
3	465	2	4*
4	390	2	4*
5	280	2	4

*Doors in the main entrance close when a fire is detected by the fire alarm system and occupants will not be able to open them.

In every floor there are more exits than it is required.

Fire doors that separate the main staircase on Floor three and four are so heavy that occupants will not be able to escape through them when they close. The fire doors close when a detector goes to alarm. For illustration see Figure 10 (the exits are marked with red squares).

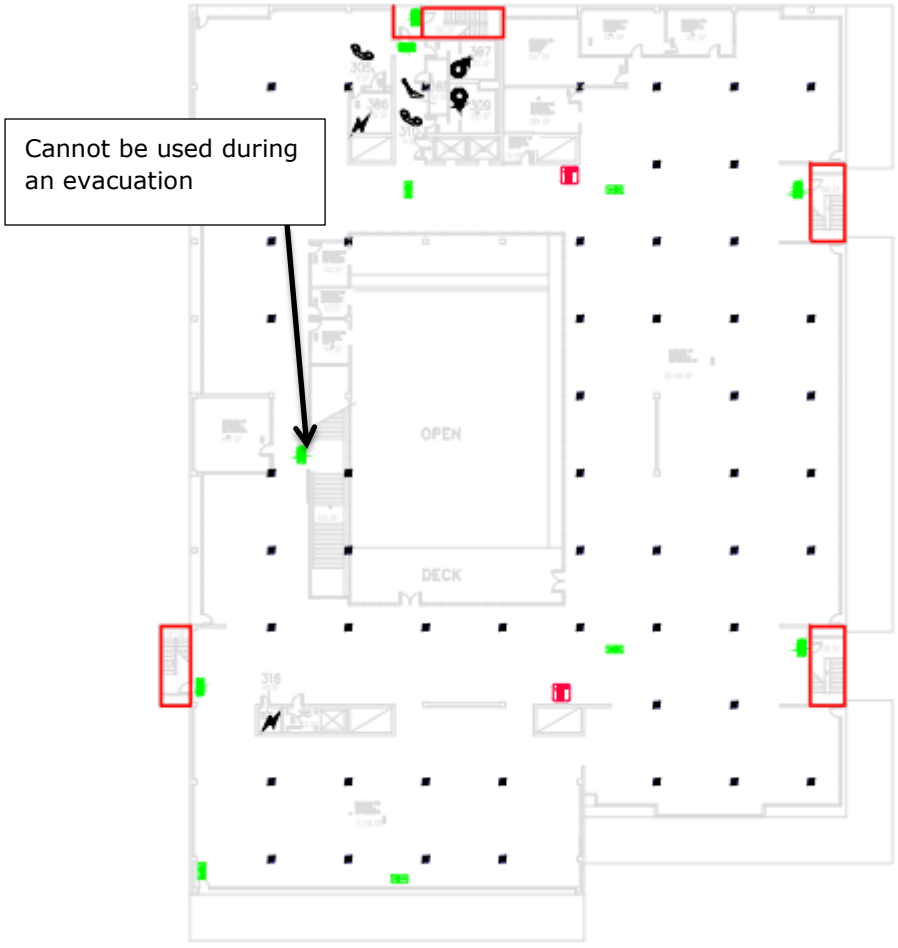

Figure 10 Floor 3, same concept on floor 4

Floor two has an exit passageway for occupants evacuating the fifth floor, shown in Figure 11.

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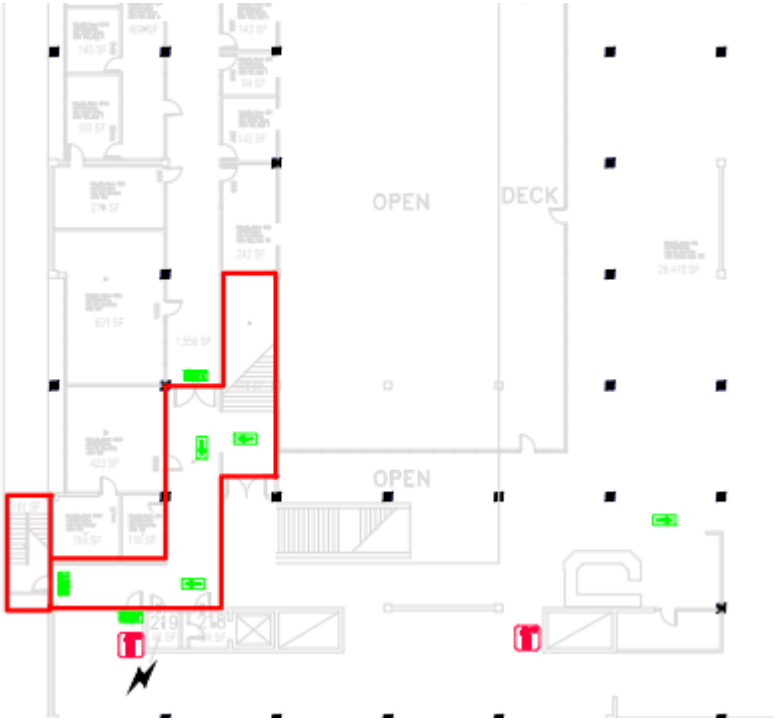


Figure 11 Passageway floor 2

The passageway is separated from adjacent areas with walls and doors with two hour fire rating. Not more than 50 percent of the required number and capacity of exits compromised of smokeproof enclosures shall discharge through building areas.

3.6 Remoteness of exits

LSC section 7.5.1.3 provides requirements about remoteness of exits. The requirements are for each space and floor.

For spaces with more than 50 people and floors 3-5 it is required to have at least 2 exits where the separation of the exits is required is to meet the one-half diagonal ½ D. Floors 1 and 2 is required to at least have 3 exits, where at least two of the required exit discharges be remote from each other with a one-half diagonal.

All of the requirements are met.

3.7 Common path of travel, dead-end limits, and travel distance

Table A.7.6 in the LSC shows the requirements for distance limits for different occupancies and for sprinkled and unsprinkled buildings. The table shows common path limit, dead-end limit and travel distance limit. For location of the different occupancies, see Appendix A1. The requirements for the library are listed in Table 6. Note that the requirements are for new unsprinkled buildings.

Table 6 Common path of travel, dead-end limit, and travel distance

Type of occupancy	Common Path Limit	Dead-End Limit	Travel Distance Limit
Assembly	[1]20/75 ft	20 ft	200 ft
Business	75 ft	20 ft	200 ft
Storage: Ordinary hazard	50 ft	50 ft	200 ft
Most restrictive requirement	20/75 ft	20 ft	200 ft

[1]Occupant load over 50 people→20 ft, occupant load less than 50 people→75 ft

[2] Assuming that there is ordinary hazard in the storage areas.

According LSC section 6.1.14.3.2*, the building shall comply with the most restrictive requirements of the occupancies involved.

None of the common path of egress travel distances was exceeded in the building.

No dead-end path or travel distance limits were exceeded in the library.

3.8 Egress through intervening spaces

According to LSC 7.5.1.6 exit access from rooms or spaces shall be permitted to be through adjoining or intervening rooms or areas, provided that such rooms or areas are accessory to the area served. Foyers, lobbies, and reception rooms constructed as required for corridors shall not be construed as intervening rooms. Exit access shall be arranged so that it is not necessary to pass through any area identified under Protection from Hazards.

No spaces within the library egress through intervening spaces with a greater hazard occupancy group.

3.9 Emergency lightning

The library needs emergency lightning. Emergency lightning shall be provided in accordance with section 7.9 in the LSC. Means of egress shall be provided with signs in accordance to 7.10 in accordance to section 12.2.10 and 32.2.10 in the LSC.

For requirements, see Table 7.

Table 7 Emergency lightning requirements

Emergency lightning	Section
Emergency illumination shall be provided for a minimum of 1 $^{1}/_{2}$ hours in the event of failure of normal lighting.	7.9.2.1
Exits, other than main exterior exit doors that obviously and clearly are identifiable as exits, shall be marked by an approved sign that is readily visible from any direction of exit access.	7.10.1.2.1*
A sign complying with 7.10.3, with a directional indicator showing the direction of travel shall be placed in every location where the direction of travel to reach the nearest exit is not apparent.	7.10.2.1
For placement of exit signs and directional indicator, see Appendix A3.	

3.10 Fire Resistance Rated Walls

The library has 5 floors, which is essential to the structural fire protection. The stairs can be defined as an exit, as explained in chapter 3.3.83 and A.3.3.83.

Per LSC 7.1.3.2 the required fire resistance rating for separating exits is minimum 2 hours.

Also:
(5) The minimum 2-hour fire resistance–rated separation required by 7.1.3.2.1(3) shall be constructed of an assembly of noncombustible or limited-combustible materials and shall be supported by construction having a minimum 2-hour fire resistance rating, unless otherwise permitted by 7.1.3.2.1(7).

For placement of the fire resisting separations, see Appendix A3.

3.11 Interior Finish

The interior finishes of the building cannot be more flammable than what is specified in Table 8. The requirements are in section 10 in LSC. The ratings used in table 8 are summarized below:

Class A interior wall and ceiling finish — flame spread index, 0–25 (new applications); smoke developed index, 0–450.
Class B interior wall and ceiling finish — flame spread index, 26–75 (new applications); smoke developed index, 0–450.
Class C interior wall and ceiling finish — flame spread index, 76–200 (new applications); smoke developed index, 0–450.
Class I interior floor finish — critical radiant flux, not less than 0.45 W/cm^2.
Class II interior floor finish — critical radiant flux, not more than 0.22 W/cm^2, but less than 0.45 W/cm^2 .

Table 8 Requirements for interior finishes

Use	Exit	Exit access corridors	Other spaces
Assembly – new >300 occupant load <300 occupant load	 A I or II A I or II	 A or B I or II A or B I or II	 A or B NA A, B or C NA
Business and Ambulatory Health Care	A or B I or II	A or B	A, B or C
Storage	A or B I or II	A, B or C	A, B or C NA

NA: Not applicable

3.12 Summary Egress Analysis

The Library is mostly in compliance with all applicable requirements of the LSC. The library has one room that exceeds the travel distance limit on the fifth floor. Occupant loads should be maintained below the maximum allowable for each space, exit access corridors should be kept free of obstructions, and doors should be easily accessible and also free of obstructions.

Maintaining the integrity of the egress system in this way will allow each component to perform its intended function, and set the stage for a successful evacuation in case of fire.

To get occupants to evacuate in the early stage of a fire the building needs a functional alarm and detection system, which is discussed in the next section.

4. FIRE DETECTION AND ALARM SYSTEMS

4.1 Overview of the alarm system

The Robert E. Kennedy Library is equipped with smoke detectors in specific areas. The Library also have Fire alarm control panel, remote annunciator, elevator control panel, pull-stations. The detection system is connected with different doors that can be significant in an evacuation situation.

The Life Safety Code (LSC) requires an approved fire alarm system in assembly occupancies with occupant loads of more than 300, which is the case for the Library. The system shall be in accordance with Section 9.6.1 and 12.3.4 in the LSC. Note that this is the only section where LSC is mentioned, the other requirements are based on NFPA 72.

The Cal Poly Library is monitored by a proprietary system where all alarm and trouble signal are relayed to the University Police Department (UPD) on campus. The dispatchers relay the information to the City of San Luis Obispo Fire Department. The personnel that receive alarm, supervisory and trouble signals are the police dispatchers that receive their training and certification through the State of California. The requirements in NFPA 72 section 6.4.2.1 are met by the personnel at the university's proprietary system.

The building where the police dispatch personnel receive alarm signals is located approximately 900 feet from the Kennedy Library- satisfying section 26.4.3.1. In accordance with 26.4.3.2, the alarm control center has restricted access to those directly concerned with the implementation and direction of emergency action and procedure- police officers, dispatch personnel, and administrators.

A full layout of the fire detection and alarm system can be found in Appendix B1.

4.2 Fire Alarm Control Panel

The Fire Alarm Control Panel (FACP) is located on the west side of the building on the first floor in Mechanical Room 120-B.

The FACP is a Simplex 4120 Fire Alarm Control. Access to this room is limited to Cal Poly facilities personnel.

All alarm, signal and trouble signals annunciate on the FACP interface panel.

4.3 Remote Annunciator

The remote annunciator is located in the west side of the building in the corridor leading to the emergency exit door. The annunciator is placed here to allow emergency responders to quickly observe which initiating devices have triggered an alarm.

4.4 Elevator Control Recall Panel

The elevator control recall unit is located on the fifth floor in the mechanical room north of the elevators (two passenger elevators located on the west side of the building). This system is isolated from the building's FACP; information of elevator recalls is transmitted to the Cal Poly's proprietary supervisory system. Per section 21.3.1, the fire fighters' service recall is connected to the buildings fire alarm system. When actuated, any detector that has initiated fire fighters' elevator recall is enunciated in the elevator control recall panel (section 21.3.8).

NFPA 72 requires a maximum distance of 21 feet from elevator door centreline to detector, and in the Library detectors are located 9 feet from the centreline.

4.5 Fault Isolator Module

Fault isolator modules are installed with addressable elevator recall fire control panel to protect the system against wire-to-wire short circuits on the Signalling Line Circuit (SLC) loop. The SLC is used by the main computer (Fire Alarm Control Panel) to communicate with all the sub-computers (Detectors and Modules).

The fault isolator modules allow other devices on the circuit to continue to operate normally in the event of a short-circuit.

There are 3 fault isolator modules, one for each of the SLC connecting the elevator lobby smoke detectors and the smoke detector above the elevator recall fire control panel and the smoke detector located in room 507B, behind the elevator shafts on the west side of the building.

4.6 Initiating devices

The following devices are present in the building and shown in the plans in Appendix B1.

4.6.1 Manual Pull Stations

According to NFPA 72 Section 17.14.8.4, manual fire alarm boxes shall be within 5 feet of each exit doorway on each floor. Also all manual pull-stations are within 200 feet travel distance from another manual pull-station- per section 17.14.8.

The manual fire alarm pull-stations are installed in tandem with a horn/strobe notification appliance.

4.6.2 Smoke Detectors

The smoke detectors located on all floors of the Library are spot- type photo electric detectors, Simplex 2098-9201 (Appendix B2). The detectors do not cover all areas. The detectors in the Library are used for elevator recall and to release fire-doors to prevent smoke propagation throughout the building.

Location and purpose of the smoke detectors is shown in Table 9.

Table 9 Smoke detectors location and purpose

Floor	Number of detectors	Location	Purpose
1	1	Elevator lobby in west	Elevator recall
	5	Southeast, three adjacent rooms (101D,101E and 101F)	One is for freight elevator recall, and the rest is for protection of computer server rooms for the Cal Poly Library PolyCat system.
	1	In FACP on the west side of the building	Protection of FACP
2	1	Elevator lobby in west	Elevator recall
	4	South, base of main staircase	Closing fire doors if a detector is detecting a fire anywhere in the building
3 and 4	1	Elevator lobby in west	Elevator recall
	2	Main staircase access to the floor, both sides of the fire door	Closing fire doors if a detector is detecting a fire anywhere in the building
5	1	Elevator lobby in west	Elevator recall
	2	Main staircase access to the floor, both sides of the fire door	Closing fire doors if a detector is detecting a fire anywhere in the building
	1	West for the two elevators on the west side of the building	Elevator recall
	1	Room 508, the FACP that monitors the smoke-detectors dedicated to elevator recalls	Protection of FACP

4.6.3 Requirements for Fire Doors smoke detectors and Duct smoke detectors

There are different requirements and information on the devices listed above, so they are explained here. Note that section 17.7.5.6.4, requires that smoke detectors near fire doors shall be photoelectric.

Fire Doors

Fire-doors with smoke detectors are located on the second floor at the base of main staircase and also at floor five at the same location. Both sides are covered with smoke detectors.

Figure 17.7.5.6.5.3(A) in NFPA 72 shows that for double-doors, the smoke-detectors shall be located on the centreline of the doorway and are 3 feet from the doorway (maximum distance 5 ft).

Sliding Fire Doors

The sliding fire door detectors are located at the main staircase on the third and the fourth floor.

Per section 17.7.5.6.5.1, the doors are to be closed if any initiating device is in alarm.
Per part 17.7.5.6.5.1 C, if the wall depth above the door is greater than 24 inches on both sides of the door then a ceiling smoke-detectors is required on both sides.

On the floor level of the sliding door there is a false ceiling made up of panels that decreases the interior wall depth above the sliding door to less than 24 inches. The actual ceiling height (without false ceiling panels) exceeds 24 inches. In this sliding door configuration, there is one ceiling smoke-detector on either side of the sliding door.

From Figure 17.7.5.6.5.1 (A), the detectors are not to exceed 5 feet from the vertical plane of the door. The detectors installed in the Library are 3 feet from the vertical plane of the sliding door.

Duct Smoke Detectors

As shown in Appendix B1, there are totally 25 duct smoke detectors located in rooms 503, 508 and 509. These detectors are Simplex 2098-9201. There are a total of 25 duct smoke-detectors located in rooms 503, 508 and 509.

Section 17.7.5.5.2 explains that detectors are installed outside of the duct and the sampling tubes protrude into the duct.

The building HVAC system is also equipped with duct smoke-detectors. In the event of a fire alarm the HVAC system shuts down to prevent smoke from being transferred through the ducts to other zones and locations of the Library.

Smoke Control Features

The Library has a natural smoke vent placed on the fifth floor in the main staircase, for placement and illustration see Figure 12 and Figure 13. Unfortunately I was not able to get any information about the smoke vent on the fifth floor in the Library.

The stairwell is enclosed, so the vent has to mainly be for the fire fighters safety. A switch to turn the smoke vent open is located on the first floor of the Library.

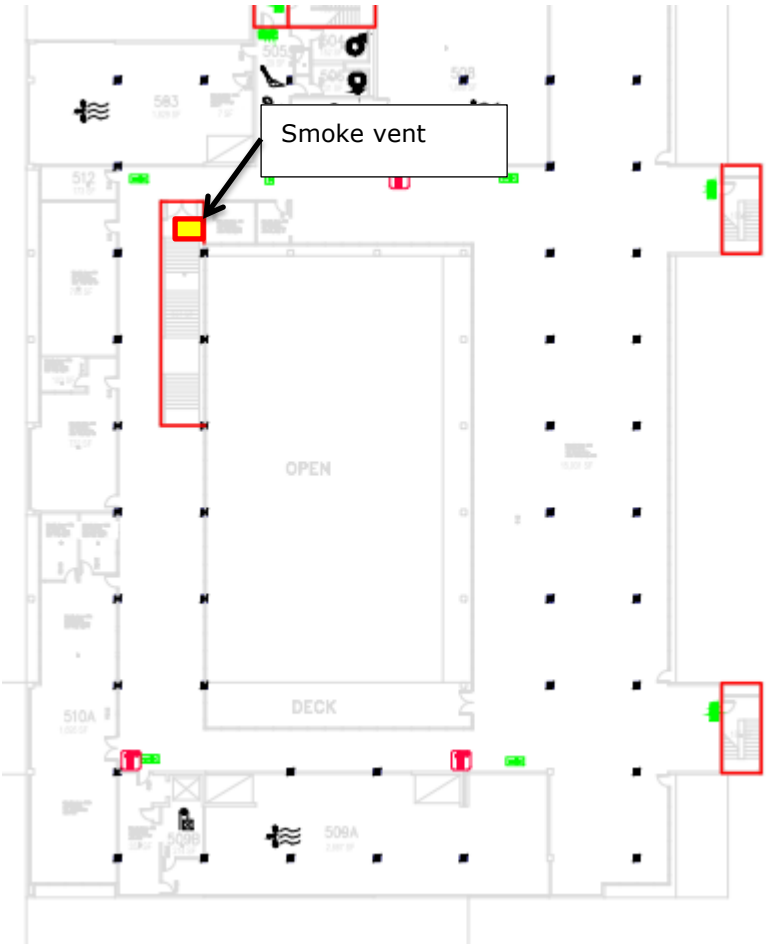


Figure 12 Placement of smoke vent

Figure 13 Illustration of the smoke vent

4.7 Notification Devices

4.7.1 Horn and Strobes

The Robert E. Kennedy Library is equipped with combination horn and strobe notification devices.

The building has two types of horn/strobe devices: Simplex 2901 /4054 (Appendix B3) , Gentex GEC3 Horn/Strobe (Appendix B4).

The Simplex horn/lights are the original notification devices installed in 1979. The Simplex horn/lights are installed on all floors.

Because of remodelling Gentex horn/strobe notification devices are installed on the northwest side of the second floor.

As illustrated in Figure 14, the primary evacuation signal follows a temporal scheme in accordance with section 10.7 and 18.4.2.1.

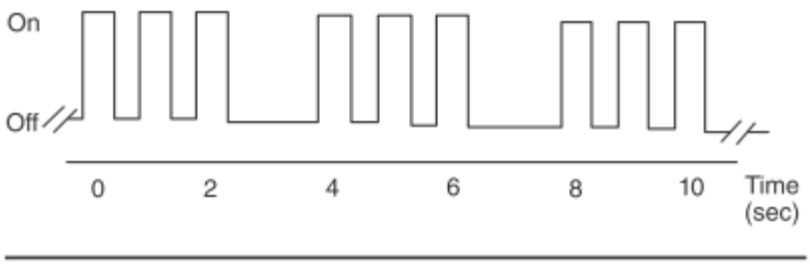


FIGURE A.18.4.2.1(a) *Temporal Pattern Imposed on Signaling Appliances That Emit Continuous Signal While Energized.*

Figure 14 Temporal pattern imposed on signalling appliances

Section 18.4.8.3 permits combination audible/visible appliances to be installed in accordance with Section 18.5.4 for visible notification appliances.

Table A.18.4.3 in NFPA 72 shows that places for assembly and business have an ambient sound level of 55 dBA. This level of ambient sound should be conservative because this is a Library. In section 18.4.3.1, the audible level of the horn appliance should be 15 dBA above the ambient level and also at least 5 dBA above maximum sound level having duration of at least 1 minute. The required decibel level of the horn appliances should be at minimum 70 dBA (55 dBA +15 dBA).

The horns in the Library are set to a decibel level of 75, which satisfied section 18.4.3.1. but do not satisfy the combination horn/strobe locations of Section 18.5.4 because all notification devices are not easily seen from all areas.

A layout with just speakers is shown in Appendix B5. In that case it is assumed that the horns are set to 90 dBA because no strobes are used. The 6 dB rule used:

10 feet: 90 dBA
20 feet: 84 dBA
40 feet: 78 dBA
80 feet: 72 dBA

The speakers can give sounds 80 feet straight forward and 40 feet on each side.

Section 18.5.4.1 requires that horn/ strobe appliances shall be at a height of 90 inches from the finished floor, and this requirement is met.

4.7.2 Power Supply

Per section 10.6.7, secondary power shall be provided to the fire alarm system by a storage battery or an automatic-starting, engine-driven generator. The Library uses storage batteries to provided secondary power to the fire alarm system.

Section 10.6.7.3.1 in NFPA 72 requires that the secondary power supply shall have sufficient capacity to operate the system under normal non-alarm load for a minimum of 24 hours and, at the end of that period, shall be capable of operating all alarm notification appliances for 5 minutes. The calculated secondary power supplied will also incorporate a 20 percent safety factor to account for battery deterioration.

Table 10 shows the secondary power supply calculations for the required storage battery capacity to serve the fire alarm devices currently installed in the Library.

Table 10 Sample Battery Calculation

Item	Description	Standby current per units (AMPS)		QTY		Standby current per units (AMPS)	Alarm current per units (AMPS)		QTY		System
A	FACP	0,12	X	1	=	0,12	1,500	X	1	=	1,500
B	Smoke det	0,0004	X	23	=	0,0092	0,086	X	23	=	1,978
C	Duct det	0,0004	X	25	=	0,01	0,086	X	25	=	2,15
D	Horn/Strobes	0	X	31	=	0	0,106	X	31	=	3,286
E	Strobe	0	X	4	=	0	0,08	X	4	=	0,320
F	Relay	0,007	X	3	=	0,021	0,007		3	=	0,021
		Total system standby current (AMPS)				0,1602	Total system Alarm current (AMPS)				9,255

The required operation time for secondary power source is shown in 10.6.7.3 in NFPA 72.

Standby: 24 Hours Alarm: 5 minutes X $1/60$ 0,0833 Hours

Required standby time (HOURS)		Total system standby current (AMPS)		Required standby capacity (AMP-HOURS)	Required alarm Time (HOURS)		Total system alarm current (AMPS)		Required alarm capacity (AMP-HOURS)
24	X	0,1602	=	3,8448	0,0833	X	9,255	X	0,77

Required standby capacity (AMP-HOURS)		Required alarm capacity (AMP-HOURS)		Total required capacity (AMP-HOURS)		Factor of safety		Required battery capacity (AMP-HOURS)
3,8448	+	0,77	=	4,61	X	1,2	=	5,54

Information about the battery in the Library was not found, but it should be accurate (Available battery capacity>Required battery capacity).

4.8 Disposition of Alarm, Supervisory and Trouble Signals

4.8.1 Alarm

Per section 26.4.6.6.1, upon receipt of an alarm signal, the proprietary supervising station operator shall initiate action to perform the following:

1. Notify the communications center, the emergency response team, and such other parties as the authority having jurisdiction requires in accordance with 26.2.1. Upon receipt of an alarm notification the proprietary supervising station notifies the City of San Luis Obispo Fire Department (SLOFD).
2. Dispatch a runner or technician to the alarm location to arrive within 2 hours after receipt of a signal
3. Restore the system as soon as possible after disposition of the cause of the alarm signal

4.8.2 Supervisory Signals

Per section 26.4.6.6.3, upon receipt of sprinkler system and other supervisory signals, the proprietary supervising station operator shall initiate action to perform the following, if required:

1. Communicate immediately with the designated person(s) to ascertain the reason for the signal. The State Fire Marshal requires that the fire department be notified upon receipt of the signal.
2. Dispatch personnel to arrive within 2 hours to investigate, unless supervisory conditions are promptly restored. Upon receipt of a supervisory signal- water flow switch for sprinkler system- the supervisory personnel dispatch UPD officers to investigate the signal. The Library's Manager is also called and notified to help in the reconnaissance of the motive for the activation of the flow switch.
3. Notify the fire department if required by the authority having jurisdiction
4. Notify the authority having jurisdiction when sprinkler systems are wholly or partially out of service for 8 hours or more
5. Provide written notice to the authority having jurisdiction as to the nature of the signal, time of occurrence, and restoration of service when equipment has been out of service for 8 hours or more

4.8.3 Trouble Signals

Per section 26.4.6.6.4, upon receipt of trouble signals or other signals pertaining solely to matters of equipment maintenance of the alarm system, the proprietary supervising station operator shall initiate action to perform the following, if required:

1. Communicate immediately with the designated person(s) to ascertain reason for the signal. When it is received a a trouble signal, supervisory personnel dispatch police officers to make sure the signal is only a trouble signal and that there is not an immediate danger to the occupants of the Library
2. Dispatch personnel to arrive within 4 hours to initiate maintenance, if necessary. Once it is determined that it is only a trouble signal, Cal Poly Facilities Department is notified and they send the appropriate technicians reestablish the appliance to its normal, non-alarm status
3. Notify the fire department if required by the authority having jurisdiction
4. Notify the authority having jurisdiction when interruption of service exists for 4 hours or more
5. When equipment has been out of service for 8 hours or more, provide written notice to the authority having jurisdiction as to the nature of the signal, time of occurrence, and restoration of service

4.9 Inspection, Maintenance and Testing

4.9.1 Inspection

The purpose for inspections is to ensure compliance with the approved design documents and to ensure installation is in accordance with NFPA 72 and other required installation standards. Visual inspections shall be performed in accordance with the schedules that can be found in NFPA 72 Table 14.3.1 or more often if required by authority having jurisdiction. Table 11 shows the requirements.

4.9.2 Maintenance

Maintenance requirements for fire alarm systems and components are listed in NFPA 72 Section 14.5. This section states that fire alarm system equipment shall be maintained in accordance with the manufacturer's published instructions at a frequency depending on the type of equipment and the local ambient conditions.

4.9.3 Testing

According to NFPA 72 Section 14.4.1, all new systems must be inspected and tested. Changes to systems require reacceptance testing in accordance with NFPA 72 Section 14.4.2. The testing frequencies of devices and components of the fire alarm system that are present in the building are shown in Table 35.

All requirements are form NFPA 72 Table 14.4.3.2, which also lists the methods for testing each component.

Table 11 Inspection and testing frequency requirements for fire alarm system components

Component	Inspection Frequency	Testing Frequency
Primary power supply	Annually	Annually
Trouble signals	Semi-annual	Annually
Digital alarm communicator transmitter	Annually	Annually
In-building emergency voice/alarm communication equipment	Semi-annual	
Batteries	Monthly/ Semi-annual	Annually
Duct detectors	Semi-annual	Annually
Electromechanical releasing devices	Semi-annual	Annually
Manual fire alarm boxes	Semi-annual	Annually
Smoke detectors	Semi-annual	Annually
Supervisory signal devices	Quarterly	Annually
Waterflow devices	Quarterly	Annually
Audible notification devices	Semi-annual	Annually
Visible notification devices	Semi-annual	Annually

A record of inspection, testing, and maintenance must be kept following the requirements of Section 7.8.2 of NFPA 72.

4.10 Summary Fire Detection and Alarm Systems

There is an automatic fire alarm and detection system as well as an emergency notification system installed in the Library, mostly in accordance with the LSC and NFPA 72. However, the notification devices do not cover all common use areas in the Library, which is not up to code.

The smoke detectors in the Library are mainly used for elevator recall and to release fire-doors to prevent smoke propagation throughout the building.

The Robert E. Kennedy Library is also equipped with combination horn and strobe notification devices. The building has two types of horn/strobe devices: Simplex 2901 /4054 (Appendix B3) , Gentex GEC3 Horn/Strobe (Appendix B4).

After alarming the occupants, a fire suppression system can help to either control or distinguish the fire. The next section is about water based suppression systems.

5. WATER-BASED FIRE SUPPRESSION

5.1 Overview of the sprinkler system

The Library does not have a sprinkler system, but a sprinkler system is designed in this section. Because the building does not have a sprinkler system, the system in this chapter is a proposed design.

The Robert E. Kennedy Library is going to be design with a wet pipe system. The building is also designed with quick response sprinklers.

Because of the symmetry of the building the most practical design is using a loop on each floor, but I didn't use a computer based sprinkler program for sprinkler calculations, so the system was not designed with a loop. The concept in Appendix C1 is followed on every floor.

Water supply is discussed in Section 5.3

5.2 Building occupancy classification and design criteria

The Library has occupancy classification OH1. The design is based on the control mode density area method (CMDA). The design criteria determined by these classifications are summarized in Table 12. The information is taken from Figure 11.2.3.1.1 and Table 11.2.3.1.2 in NFPA 13.

Table 12 Design criteria's

Density (gpm/ft^2)	Original area of sprinkler operation (ft^2)	Nominal water demand	Hose stream allowance (gpm)	Duration (min)
0,15	1500	225	250	60

The area of sprinkler operation and density are determined from NFPA 13 using the lowest possible area of sprinkler operation. Because the Library will be designed with quick-response sprinklers, the system area of operation shall be permitted to be reduced without revising the density as indicated in Figure 11.2.3.2.3.1 in NFPA 13. Note that it is assumed the Library has a flat celling. The celling height is 12,4 ft and with quick response sprinklers the design area can be reduced by 36%. New design area would be 960 ft^2.

The flow rate for the sprinklers will then be 144 gpm. Total flow rate will be 114 gpm+250=394 gpm.
The total water demand is:

$$\text{Total water demand} = 394\,{}^{gal}\!/_{\min} \times 60\,\min = 23\,640\ \text{gal}$$

5.3 Water Supply

The Robert E. Library is located on the California Polytechnic State University San Luis Obispo property and utilizes its closed loop water supply. The water supply details are guessed by using other buildings at campus. Values taken from a flow test on the Bonderson Engineering Project Center are used. There has not been any water supply test for the Library. The water supply as determined by the flow test is shown in Table 13 including a 10% safety margin.

Table 13 Water supply

Category Value	Flow test information	10% reduction
Static pressure	80 psi	72 psi
Residual	60 psi	54 psi
Water Flow	1200 gpm	1200 gpm

For water supply curve see Figure 18.

5.4 Sprinkler design

5.4.1 K-factor

The quick response sprinklers have a 5.6 K-Factor and an activation temperature of 155°F. For technical data, see Appendix C2.

5.4.2 Pipe type

The building utilizes two different piping with a size range between 1" and 4". The pipes from riser to branch line are black steel with C-factor 120. The C-factor for the pipe from the riser to the city main is 150, and this will affect the pressure and the equal length. The 1" to 2" piping is schedule 40 and the 3" to 4" piping is schedule 10. Table 14 summarizes the different parts of the sprinkler system.

Table 14 Different pipe types in the sprinkler system

Sprinkler system section	Nominal size (in)	Inside diameter (in)
Schedule 10		
To city main	4	4,26
Riser	4	4.26
Feed main	3	3.26
Schedule 40		
Cross main	2	2.067
Branch line	2	2.067
	1.5	1.610
	1.25	1.380

5.4.3 System protection area limitations

The maximum floor area on any one floor to be protected by sprinklers supplied by any one sprinkler system riser or combined system riser shall be maximum 52000 ft^2. None of the floor plans exceeds 52 000 ft^2, so one riser can be used in the library. Notice that location of the riser will have a big impact on design area.

5.4.4 Design area and distances

The riser up to the 5th floor is located at the south-west corner. The city main connection is located 60 ft from the bottom of the riser, see Figure 15.

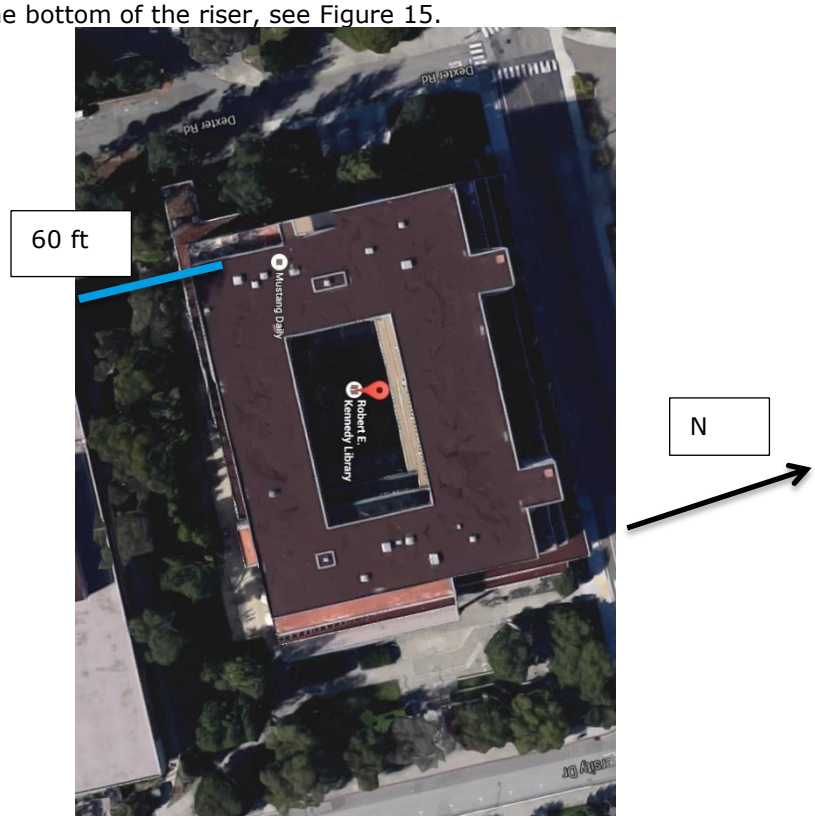


Figure 15 Location of riser

The elevation is 78 feet from top to the bottom of the rise, see Figure 16.

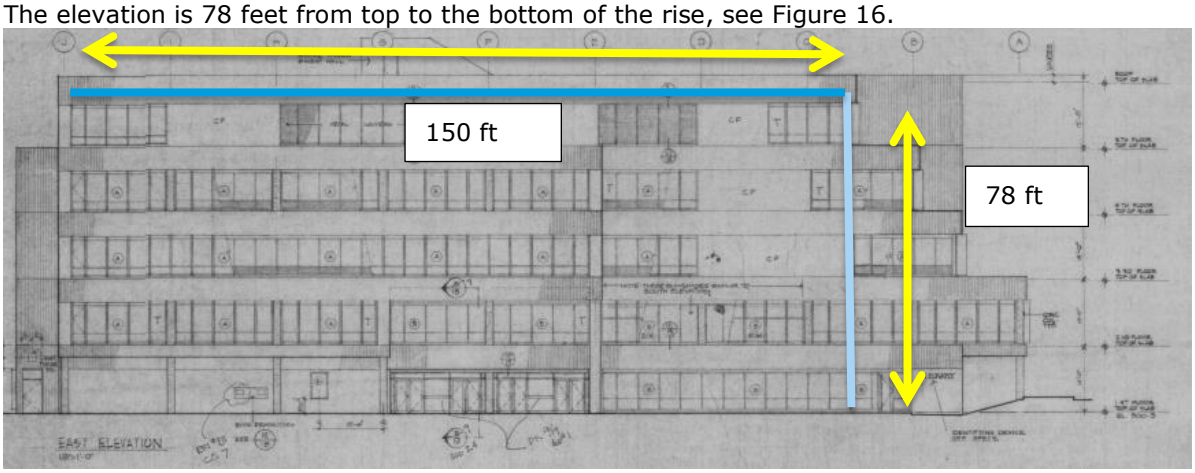


Figure 16 East of elevation. Placement of riser is marked with light blue and horizontal pipe is marked with a darker blue

The area with the most hydraulically demanding area is the north-east side of Floor 5. For showing of exact demanding area and distances, see Appendix C3.

As mentioned the design area is 960 ft^2.

In accordance with Table 8.6.2.2.1 (b) in NFPA 13, the maximum area of coverage per sprinkler for ordinary hazard is 130 ft^2. The spacing between sprinklers on the same branch line is 13 ft and between branch lines is the spacing 10 ft. The area of coverage per sprinkler is 130 ft^2. Appendix C3 shows the design area with exact dimensions.

The number of sprinklers used in the design area is:

$$N_s = \frac{960\ \text{ft}^2}{130\ \text{ft}^2} = 7,4 \approx 8\ \text{sprinklers}$$

The number of sprinklers per branch line:

$$\text{Number of sprinklers per branch line} = \frac{1.2\sqrt{960\ ft^2}}{13\ ft} = 2,9 \approx 3 sprinklers$$

For density/area method, design area shall be a rectangular area with the dimension parallel to the branch lines (L) at least 1.2 times the square root of the area of sprinkler operation (A) used (23.4.4.1.1.1).

$$L \geq 1,2\sqrt{A} = 1,2\sqrt{960} = 37,18$$

5.4.5 Sprinkler spacing from walls and other obstacles

In accordance with section 8.5.3.2.1, the distance from sprinklers to walls shall not exceed one-half of the allowable maximum distance between sprinklers. In accordance to Table 8.6.2.2.1 (b) the maximum spacing from sprinklers is 15 ft for ordinary hazard. The maximum distance from walls is therefore 7,5 ft.

Section 8.6.5 explains obstructions to sprinkler discharge. Table 8.6.5.1.2 and Figure 8.6.5.1.2 (a) in NFPA 13 explains the maximum distance from sprinklers to the side of obstruction:

TABLE 8.6.5.1.2 Positioning of Sprinklers to Avoid Obstructions to Discharge [Standard Spray Upright/Standard Spray Pendent (SSU/SSP)]

Distance from Sprinklers to Side of Obstruction (A)	Maximum Allowable Distance of Deflector Above Bottom of Obstruction (B) [in. (mm)]
Less than 1 ft (300 mm)	0 (0)
1 ft (300 mm) to less than 1 ft 6 in. (450 mm)	2½ (65)
1 ft 6 in. (450 mm) to less than 2 ft (600 mm)	3½ (90)
2 ft (600 mm) to less than 2 ft 6 in. (750 mm)	5½ (140)
2 ft 6 (750 mm) in. to less than 3 ft (900 mm)	7½ (190)
3 ft (900 mm) to less than 3 ft 6 in. (1.1 m)	9½ (240)
3 ft 6 in. (1.1 m) to less than 4 ft (1.2 m)	12 (300)
4 ft (1.2 m) to less than 4 ft 6 in. (1.4 m)	14 (350)
4 ft 6 in. (1.4 m) to less than 5 ft (1.5 m)	16½ (420)
5 ft (1.5 m) to less than 5 ft 6 in. (1.7 m)	18 (450)
5 ft 6 in. (1.7 m) to less than 6 ft (1.8 m)	20 (510)
6 ft (1.8 m) to less than 6 ft 6 in. (2.0 m)	24 (600)
6 ft 6 in. (2.0 m) to less than 7 ft (2.1 m)	30 (750)
7 ft (2.1 m) to less than 7 ft 6 in. (2.3 m)	35 (875)

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m. Note: For *A* and *B*, refer to Figure 8.6.5.1.2(a).

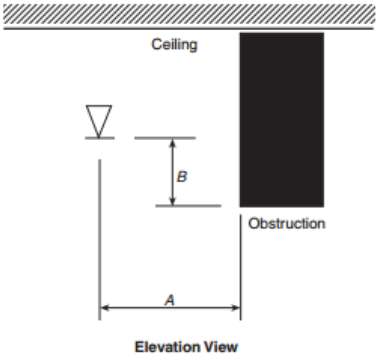


***FIGURE 8.6.5.1.2(a)** Positioning of Sprinkler to Avoid Obstruction to Discharge (SSU/SSP).*

Figure 17 Maximum distance

The closest sprinklers in the library are positioned 1 feet and 6 inch from the obstruction. The maximum allowable distance of deflector above bottom of obstruction is $3\frac{1}{2}$ inches.

NFPA 13, section 8.15.10 says the following about Library Stack Areas:
Where books or records are stored in fixed open book shelves, sprinklers shall be installed in accordance with one of the following:
(1) Sprinklers shall be permitted to be installed without regard to aisles where clearance between sprinkler deflectors and tops of stacks is 18 in. (457 mm) or more.

There is no place where the clearance between sprinkler deflectors and tops are less than 18 in.

5.4.6 Hydraulic calculations

Hydraulic calculations are shown in Appendix C3.

Because the pipes are not straight and have different types of components the following equal length are uses:

Table 15 Component

Components	$1\frac{1}{2}$ C-factor:120	2 C-factor:120	3 C-factor:120	4 C-factor:120	4 C-factor:150
Tee or cross (T)	8	10	15	20	30,2
45 elbow (E1)				4	
Long turn elbow(E2)					9,06
Gate valve				2	3,02

In pipes from riser to the sprinkler heads, the equal lengths do not need to be multiplied. The last pipe from bottom of the riser to the city main has a multiplication factor of 1,51 (C-factor is 150).

The required flow is 156,5 gpm and required pressure is 54,9 psi. As shown in Figure 18, the system should have adequate water supply from the city supply and will not need a fire pump. Note that this has to be proven by testing.

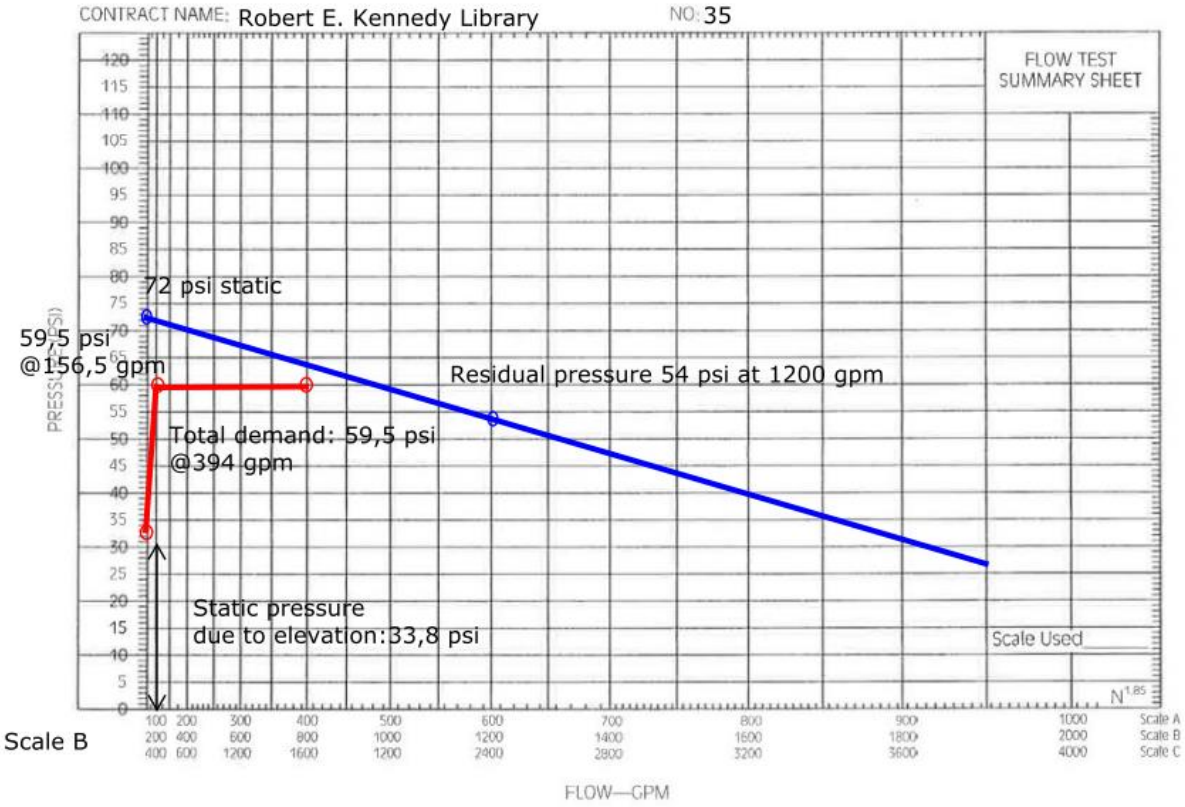


Figure 18 Water supply vs water demand

5.5 Inspection, Testing and Maintenance

The inspection, testing, and maintenance requirements come from NFPA 25 Standards for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems. The type of procedure for each component, as well as the frequency it must be performed, are shown in the sections under.

5.5.1 Inspection

Table 16 Inspection

Component	Inspection	Frequency
Sprinklers	Sprinklers should first be given a visual inspection for signs of mechanical damage, cleaning, painting, leakage in service, severe loading or corrosion. Then, sprinklers should be laboratory tested for sensitivity and functionality.	Annually
Pipes and fittings	In good condition, free of mechanical damage, leakage, corrosion, misalignment, and external loading.	Annually
Fire Department Connections	Verify FDC is visible and accessible, no damage, caps and gaskets are in place, ID signs are in place, check valve no leaking and drain valve is operating	Quarterly
Control Valves	Ensure in normal open or closed position, sealed or locked, accessible, provided with appropriate wrenches, free from leaks, and has proper identification	Weekly
Check Valves	Inspected internally to verify all components operate properly, move freely, and are in good condition.	5 years

5.5.2 Testing and Maintenance

Table 17 Testing and Maintenance

Component	Testing	Frequency	Maintenance
Sprinkler	Sprinklers have routine testing, but non-routine testing should be conducted to address unusual conditions. Sprinklers in this building (quick response sprinklers) shall be tested after 20 years in service, and then retested at 10 year intervals. For testing, this building must use a representative sample of no less than four sprinklers. If one sprinkler within the representative sample fails to meet the test requirement, all sprinklers within the area represented by that sample shall be replaced.	First 20 years, after that 10 years.	Replacement sprinklers shall have the same characteristics as installed sprinklers and shall be new and listed.
Standpipe sprinklers	Standpipe systems should be flow tested every 5 years at the most remote connection to verify that the system can supply the required flow and pressure. During commissioning the standpipe system must be hydrostatically tested at 200 psi for 2 hours.	5 years	
Pressure gauge	Pressure gauges must undergo a calibration test. During the calibration test gauges must be accurate to within 3 percent of the full scale. If it does not meet this requirement, the gauge must be recalibrated or replaced.	5 years	
Control valves	Operated through full range and returned to normal position. Post indicator valves shall be opened until torsion felt, then backed a quarter turn from open position.	Annually	Operating stems shall be lubricated annually then completely closed and reopened.
Check valves			Internal components shall be cleaned, repaired or replaced as necessary.
Fire Department Connections			Components shall be repaired or replaced as necessary. Any obstructions present shall be removed

5.6 Summary Water Based Suppression

The Library does not have a sprinkler system, but it is a proposed sprinkler system presented in this section.

The sprinkler system was designed in accordance with the applicable requirements of NFPA 13, and inspection, testing and maintenance was analysed by using NFPA 25.

If installed and maintained properly, the suppression system will provide an important active means of fire protection for the Library. The system should have adequate water supply from the city supply and will not need a fire pump. Note that this is an assumption, and has to be proven by testing.

Now the active systems have been discussed, the next section will discuss the passive system, the structural fire protection. Structural fire protection features are the main passive defence against the spread of fire in a building.

6. STRUCTURAL FIRE PROTECTION

6.1 Classification of occupancy

The Kennedy Library is a multiple occupancy building which is considered a mixed occupancy in accordance with IBC section 508. The non-separated occupancies must be individually classified. In accordance with IBC section 508.3.1 the building shall comply with the most restrictive requirements of the occupancies involved.

The building consists of library areas, offices, mechanical equipment and storage areas.

The Library contains assembly occupancy (Group A) with accessory business and storage occupancies (Group B and S-2).

Group A-3 occupancies include the book stack and reading areas of the Library and Group B occupancy areas include office spaces and classrooms. Group S-2 occupancies include general storage areas electrical/mechanical rooms.

6.2 Type of construction

The original certificate of occupancy shows that the Kennedy Library has a Type I Fire-Resistive (Type I-FR) construction, based on the 1976 UBC. Type I-FR construction requires more stringent fire-resistance ratings for structural elements and fire-protection ratings for openings of the building than the most stringent construction type in the 2015 IBC.

The structural fire protection is based on the most restrictive occupancy, which is A-3.
Table 18 shows relevant information about the Library.

Table 18 Structural fire protection

Robert E. Kennedy Library					
Sprinkler	Height (ft)	Nr. Stories	Most area per floor[1] (ft)	Perimeter (ft)	Total floor area, all stories
NO	71.8	5	42583	923	178702

[1]Shows the floor with the largest area, here floor 1

The building has more than three stories above grade plane, so the total building area shall be such that aggregate sum of ratios of the actual area of each story divided by the allowable area of such stories, determined in accordance with equation 5-3 in the IBC. The allowable area will be:

$$A_a = A_t + (NS \times I_f)$$

A_a = Allowable area (square feet)

A_t = Tabular allowable area factor in accordance with Table 506.2

NS= Tabular allowable factor in accordance with Table 506.2 for a nonsprinklered building

I_f = Area factor increase due to frontage (precent) as calculated in accoardance with Section 506.3

The amount of increase is calculated with this equation:

$$I_f = (F/P - 0.25)\frac{W}{30}$$

where

I_f =Area factor increase due to frontage

F=Building perimeter that fronts a public way or open space having a minimum distance of 20 feet

P=Perimeter of the entire building (feet)

W=Width of public way or open space in accordance with Section 506.3.2

$$W = (L_N \times w_N + L_W \times w_W) / F$$

Where

F is the building perimeter that fronts on a public way or open space having a width of 20 feet or more.

For these calculations, please see Appendix D1.

In accordance with the IBC, the type of construction should be Type I B.

Table 19 shows the fire-resistance rating requirements for the building elements as prescribed by Table 601 in the IBC and the existing fire-resistance rating provided for the structural elements:

Table 19 Fire-resistance rating requirements

Building element	Required (Type I B)	Provided
Primary Structural frame	2	>4
Bearing walls Exterior Interior	 2 2	 >4 >4
Nonbearing walls and partitions Exterior	See Section 4	See Section 4
Nonbearing walls and partitions Interior	0	0
Floor construction and associated secondary	2	3
Roof construction and associated secondary	1	2

6.3 Fire separation distance and fire-resistance of exterior walls

IBC 202 describes that the fire separation distance is the distance measured from the building face to one of the following:

- the closest interior lot line
- to the centerline of a street or public way
- to an imaginary line between two buildings on the property

The fire separation distance of the west, north, and east exterior walls of the Library are measured to the centerline of a road; the fire separation distance of the south exterior wall is measured to an imaginary lot line half-way between the Library's south wall and the north wall of the Dexter Building (Building 34). Figure 19 illustrates the fire separation distance measured from the face of building to their corresponding measurement limits.

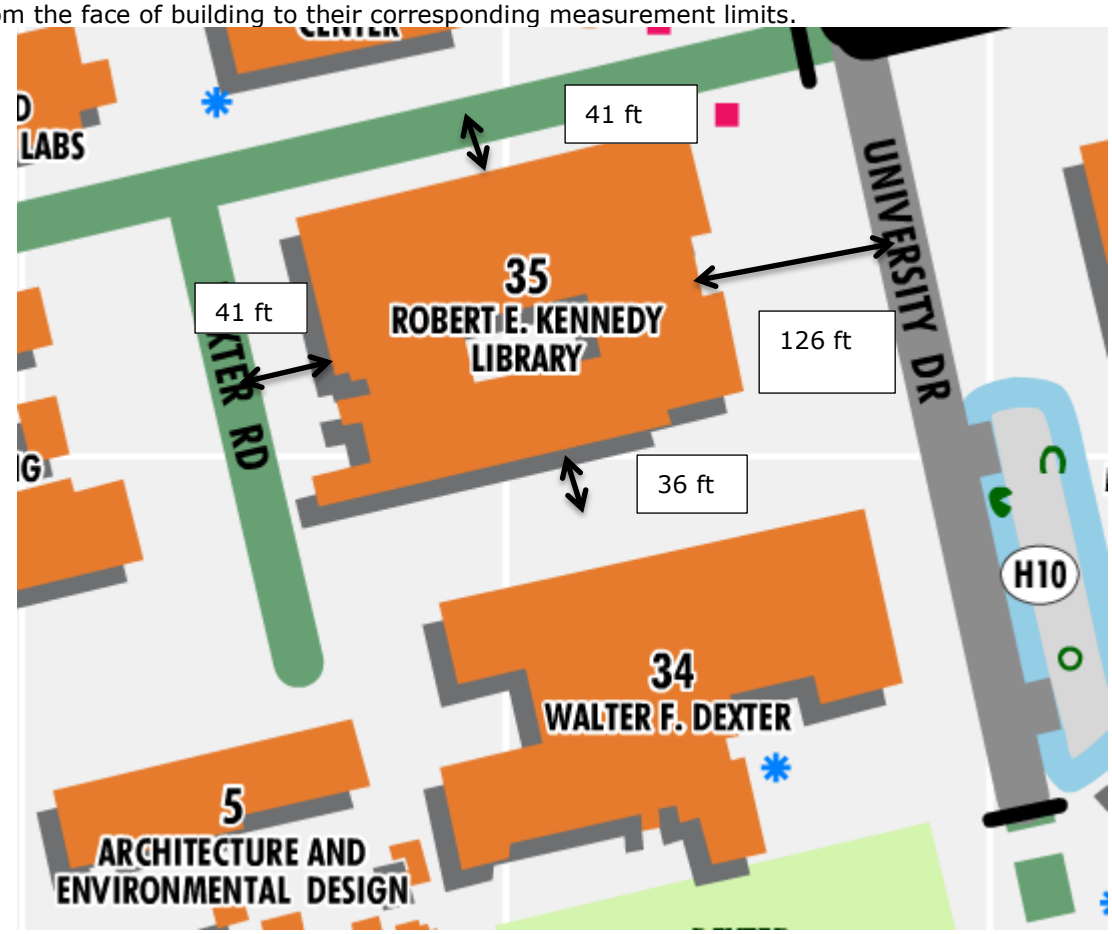


Figure 19 Fire Separation Distances

The fire-resistance requirement of the exterior walls is found in Table 602 in IBC. All exterior walls have a fire separation distance that exceeds 30 feet, so there are no requirements related to these walls.

6.4 Opening Protectives

The IBC has some requirements about open protectives in exterior walls, and this will be addressed in this section.

The exterior walls in the Library have a fire separation distance that is greater than 30 feet. In accordance with Table 705.8 in the IBC, the Library can have an unlimited amount of non-protected openings on exterior walls. The windows in the exterior walls in the Library are therefore unprotected.

Section 705.8.5 explains that openings in exterior walls in adjacent stories shall be separated vertically to protect against fire spread in the exterior of the buildings where the openings are within 5 feet of each other horizontally and the opening in the lower stories is not protected with a fire protection rating of not less than ¾ hour. The Library does not have fire-resistance rating requirements for the exterior walls. Such openings shall be separated not less than 3 feet by spandrel girders, exterior walls or other similar assemblies that have a fire-resistance of less than 1 hour.

Openings of adjoining floors are separated by five feet concrete portions of the exterior walls. The exterior wall thickness at these locations is eight inches with an equivalent fire-resistance rating of three hours.

6.5 Fire-resistance barriers and Shaft enclosures

The fire-resistance rating of the fire barriers separating building areas from exit passageways shall have a minimum rating of 2 hours, in accordance with section 713.4 in the IBC. The section also addresses that shafts enclosures shall have a fire-resistance rating of not less than 2 hours where connecting four stories or more, and not less than 1 hour where connecting less than four stories.

All shaft enclosures in the Library are connecting more than four floors, so the minimum rating is 2 hours.

For placement of fire barriers of each floor, please see Appendix A3.

6.6 Concrete assemblies

The fire-resistance ratings of the structural elements within the Library are determined based on the prescriptive requirements of Section 721. The concrete columns in the Library have dimensions of 18 inches by 18 inches. The thickness is based on siliceous concrete columns. The library columns exceed the thickness required to achieve a two hour fire-resistance rating per Section 721.1 (1). Table 722.2.4 requires a column thickness of 10 inches to achieve a fire-resistance rating of two hours as required by Table 601 for a Type I B construction building.

The minimum thickness of cast-in-place or precast concrete wall – load bearing or nonload bearing- is determined by Table 722.2.1.1 in the IBC. Table 601 requires exterior and interior load bearing walls of a Type I-B construction building to have a minimum of two hour fire-resistance rating. Walls forming shafts and stair enclosures are required to have a fire-resistance rating of two hours. The minimum thickness of a concrete slab for a wall or partition to achieve a two hour fire-resistance rating is 5 inches (from one face of the wall to the other), per Table 722.2.1.1. The Table also requires a wall thickness of 5 inches to achieve a two hour fire-resistance rating for walls or partitions.

The original certificate shows that all concrete walls or partitions in the library have a minimum thickness of eight inches. Eight inches is more than the requirement of 5 inches, so this satisfies Type I B requirements.

6.7 Steel Assemblies

The roof assemblies of the Library are constructed of structural steel beams and girders supporting concrete slab. The fire-resistance rating of steel beams and girders is based on the size of the element and the protection provided by the spray-applied fire-resistant material (SFRM), as permitted by Section 722.5.2.2.

Documentation of the SFRM thicknesses provided to the roof assembly beams and girders in the Library was not available and therefore this report will determine the required SFRM thicknesses to achieve a one hour fire-resistance rating as required by Table 601. The SFRM thickness provided on the roof assemblies of the Library should be verified to have the minimum SFRM thickness provided in this report.

UL X772 is used to find the required spray-applied material for a one-hour fire- resistance rating. UL X772 has an associated thickness equation:

$$h = \frac{R}{1.05\left(\frac{W}{D}\right) + 0.61}$$

Table 20 shows the wide flange beams and girders provided for the roof assemblies in the Library and the required SFRM thickness to achieve the one-hour fire-resistance rating required by Table 601 (note that contour profile is used):

Table 20 Roof assemblies

Type of construction : I B			
W Size	W/D	Required Hours	Required Thickness (in)
W12x19	0.54	1	0.85
W12x22	0.623	1	0.79
W16x26	0.558	1	0.84
W16x36	0.702	1	0.74
W18x35	0.672	1	0.76
W21x44	0.746	1	0.72
W21x62	0.952	1	0.62
W21x68	1.04	1	0.59

6.8 Summary Structural Fire Protection

The primary structural frame, including the columns and the roof/floor structural members, are at least 4-hour rated. The exterior nonbearing walls do not have requirements because the fire separation distance exceeds 30 feet. The floor and roof assemblies are all 2-hour rated.

The Library is a non-separated, mixed-use building that must be designed based on the requirements for a 5-story Group A Occupancy. Therefore, it must either be classified as Type I-A or Type I-B construction. Based on the fire-resistance ratings information provided above, the Library complies with the 2015 requirements for Type I-B construction.

The prescriptive portion of this report has considered the design of the egress system, detection and alarm systems, water based suppression, in addition to the structural fire protection. The next section of this report will consider how these separate fire protection features would work together in a performance-based analysis.

7. PERFORMANCE BASED ANALYSIS

This section discusses the performance-based analysis. This type of analysis builds on the concepts of the prescriptive codes and applies the inputs specific to this building to arrive at a predicted outcome for a specific assumed fire. The desired outcome is primarily measured as Available Safe Egress Time (ASET) vs Required Safe Egress Time (RSET).

7.1 Design Brief

Goals
The primary goal of the performance based analysis is to evaluate the safety of the building occupants from fire dangers. A secondary goal for this analysis is to consider the preservation of property.

Objectives:
LSC Section 4.2.1 Occupant Protection.
A structure shall be designed, constructed, and maintained to protect occupants who are not intimate with the initial fire development have the time needed to evacuate, relocate, or defend in place.

LSC Section 4.2.2 Structural Integrity.
Structural integrity shall be maintained for the time needed to evacuate, relocate, or defend in place occupants who are not intimate with the initial fire development.

LSC Section 4.2.3 Systems Effectiveness.
Systems utilized to achieve the goals of Section 4.1 shall be effective in mitigating the hazard or condition for which they are being used, shall be reliable, shall be maintained to the level at which they were designed to operate and shall remain operational.

LSC Section 5.2.2 Performance Criteria
It is chosen to use LSC performance criterion 1 for the performance based design.
Method 1: *The design team can set detailed performance criteria that ensure that occupants are not incapacitated by fire effects*

Tenability criteria's has to be evaluated when using Method 1. See Section 7.2 for tenability criteria's. Method 1 is a more detailed analysis than Method 2, because Method 2 only requires occupants to be fully evacuated before the smoke and the toxic layer descends to a level lower than 6 ft (1.83 m).

Method 3 cannot be used because the smoke will descend lower than 6 ft (1.83 m) on floor two. There will be fire effects in occupied rooms, so Method 4 cannot be used.

7.2 Tenability criteria

The results of a fire that have the largest impact on occupant tenability are the visibility resulting from the density of smoke, high temperature, heat fluxes from the fire, and toxic products of combustion. These parameters will later be evaluated using Fire Dynamics Simulator (FDS) in order to determine when the tenable limits for occupants are exceeded in areas remote from the fire plume. The method that will be used later is method 2 in LSC section A5.2.2, where it is going to be made fire scenarios in accordance with 5.5 in the LSC. The method will hopefully demonstrate that each room or area will be fully evacuated before the smoke and toxic gas layer in that room descends to a level lower than 6 ft (1830 mm) above the floor. The timing of such an evacuation means that no occupant is exposed to fire effects. The tenability limits are now described.

7.2.1 Visibility

Visibility in a fire situation can be critical; because a loss of visibility can prevent occupants from locating exits. If an occupant is attempting to find an exit and the smoke becomes thick enough to prevent them from continuing forward, they will be forced to turn around or stop their egress altogether which can result in incapacitation or death.

Most of the occupants in the Robert E. Kennedy Library will be familiar with the egress routes, but the library can also have guests that are unfamiliar with the building. For the people that are unfamiliar with the exits, it is important that the building has good placement of exit and directional signs. For placement of signs see, Appendix A4.

The SFPE Handbook of Fire Protection Engineering, fourth edition, has values for visibility criteria for familiar occupants (4 m) and unfamiliar occupants (13 m). Because most of the occupants in the library are familiar with the egress routes, a conservative value of 10 m is used for visibility.

7.2.2 Temperature

Tenability criterion for temperature from a fire is evaluated based on what is tolerable for occupants. The SFPE Handbook describes that a skin temperature of 43°C causes pain and some cellular damage, while temperature of 60°C coagulates tissue protein. A brass block heated to 60°C will produce a partial thickness skin burn within 10 sounds, pain within 1 second and full thickness burn after approximately 100 seconds. At 80 °C pain occurs after 1 second. The temperature criterion is, therefore 60°C.

7.2.3 Toxicity

In this section, all the values that are not mentioned earlier in the report are taken from SFPE Guide to Human Behavior in Fire, second edition.

The analysis will predict concentration of CO 6 ft (1,83 m) above the walking surface. A Fire Dynamics Simulation (FDS) will be done in a later stage, where this is important.

Toxicity from the fire is essential for the tenability conditions. The primary toxins encountered in a fire scenario include carbon monoxide (CO) and hydrogen cyanide (HCN). The approach to addressing carbonmonoxide exposure outlined below is appropriate to also account for the minimal HCN exposure.

Carbon monoxide levels are of concern during a fire in enclosed spaces because CO combines with hemoglobin in the blood stream to form carboxyhemoglobin (COHb). When an occupant reaches 50 % COHb concentration in the blood, death is likely imminent. For 20-30 % concentration, individuals may experience headaches, nausea and loss of fine motor skills, and incapacitation happens between 30 and 40%. Therefore, a conservative value of 30%concentration is used further.

The Stewart equation has to be used to find concentration of CO limit. The calculation is shown next.

$$\%COHb = (3.317x10^{-5})(ppm\ CO)^{1,036}(V_E)(t)$$

%COHb= Concentration in the blood

ppm CO= CO concentration

V_E = Breathing rate

t= Exposure time

The value for breathing rate is from SFPE Guide to Human Behavior in Fire, and is for light work-walking to escape for a 70 kg human. This value is 25 L/min.

The report assumes that the fire doors that separate floor 2 and the floors above closes before any smoke or heat get into the stairwells.

The exposure time is the RSET for floor 1 and 2, RSET is shown in Section 7.3.

After rearranging the equation to solve for ppm CO, the concentration limit is 2662 ppm. This report will analyze the CO concentration 1,83 m above the walking surface.

7.2.4 Summary

The tenability limits are listed in Table 21.

Table 21 Summarized tenability criteria and limits

Tenability Criteria	Tenability Limit
Visibility	10 m
Temperature	60°C
Toxicity	2662 ppm CO

7.3 Computer based evacuation time, RSET

Pathfinder is used to do the computer based evacuation time. Pathfinder is a program created by Thunderhead Engineering used to time to egress for a prescribed building/layout. The user can import CAD files and create boundaries, to scale, of rooms, corridors, stairs, and exits.
This software also allows the user to program specific occupant characteristics based on age, sex, and cultural behavior. Where this is most noticeable is when occupants start to que in the simulation if an exit cannot egress occupants fast enough. Occupants will even make the decision to go to another exit while queued if they sense

The simulation is done in both steering and SFPE mode to find the most conservative value. Figure 20 shows people placement. Occupants are shown as cylinders for better visualization.

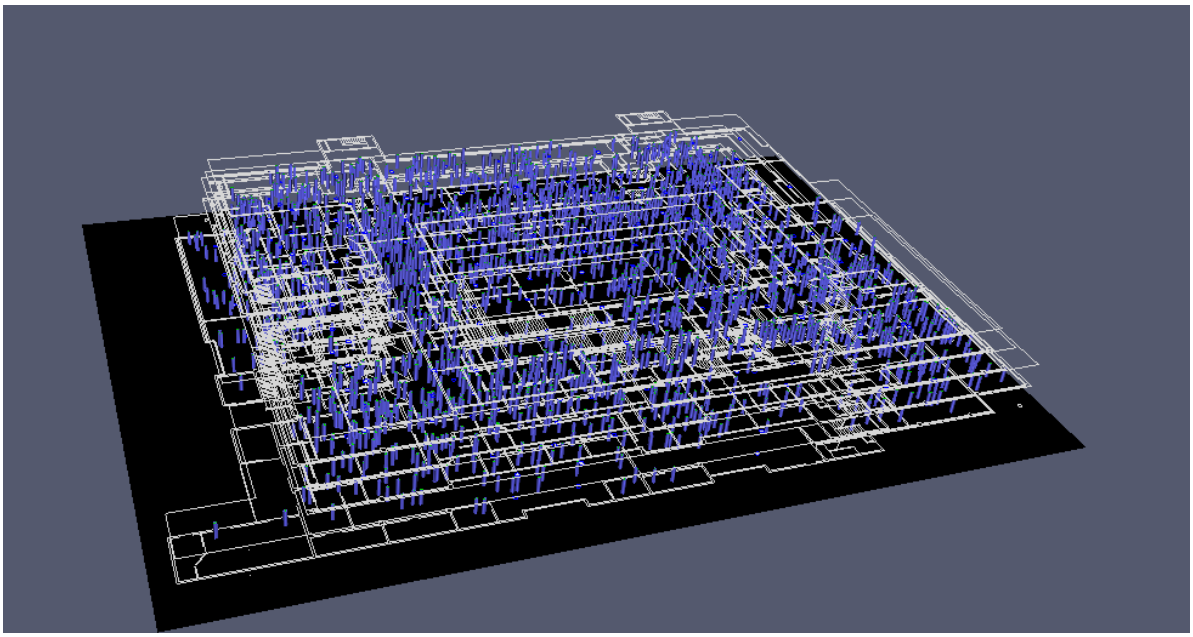


Figure 20 Simulation start

7.3.1 Assumptions

The main staircase is not available for floor 3 and 4 because the fire doors are heavy and hard to move. Occupants located on floor 5 can use the main staircase, see Figure 21 for illustration.

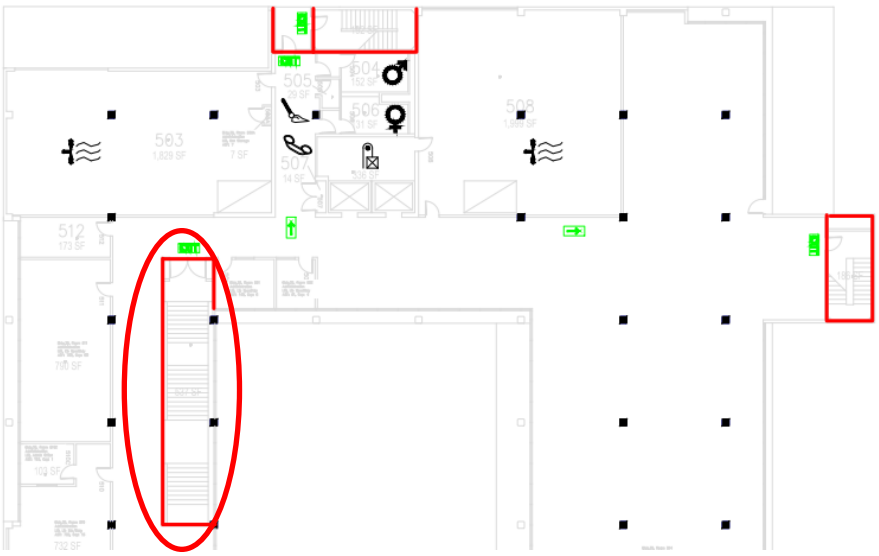


Figure 21 The main staircase is shown by red sircle

In steering mode, each occupant will have a path connecting their current position to a goal point. Factors as collisions among occupants may cause occupants to change their routes, but the motion of the occupant will roughly conform to their chosen path.

The steering mode often has longer evacuation time than the SFPE mode because the SFPE mode uses pre-defined values for movement through doors and stairs. That can vary because of occupants speed and the geometry of the building.

Occupant characteristics are important when doing evacuation calculations. Some of them are shown below.

- On floor one and two it is a lot of business occupancies, so it can be occupants in all ages.
- The assembly areas are mostly students in the range of 17-25
- Occupants are assumed to be responsible, educated people
- The people are awake
- Most occupants are familiar with emergency exits because they have been there more than once.
- Occupants can be self-involved with work, so it can take a bit longer for them to notice an alarm.

Occupants in the library are assumed to be healthy and without disability. Therefore the standard maximum speed in Pathfinder is used, which is 3,9 ft/s. This is less than what Table 3-13.2 in the SFPE handbook 4th edition shows, which is 4.1 m/s for occupants without disability.

The people are placed per the occupancy load in accordance to Appendix A2.

7.3.2 Model limit

The limits to the Pathfinder simulation are summarized in this section.

- The model only calculates evacuation time
- All the exits are available, none is covered by fire or smoke
- All occupants are moving in the same speed
- The occupants speed is not affected by toxicity or smoke
- The occupants will most likely walk to the nearest exit with the most effective manner
- All the occupants start to walk at the same time
- Placement of people is random in every room
- The shoulder width of all occupants is 17.95 inches, so there are no different body types in the simulation

7.3.3 Results

Table 22 shows the pathfinder results.

Table 22 Pathfinder results

Mode	Evacuation time
Whole building	
Steering	7 min and 34 seconds (454 seconds)
SFPE	7 min and 54 seconds (474 seconds)
Floor one and two	
Steering	3 min and 40 seconds (220 seconds)
SFPE	3 min and 18 seconds (198 seconds)

The mode with the longest evacuation time was SFPE mode and this is the value that is used further in the report. That is because the evacuation time is the most conservative. For occupancy placement see Figure 22 and Figure 23.

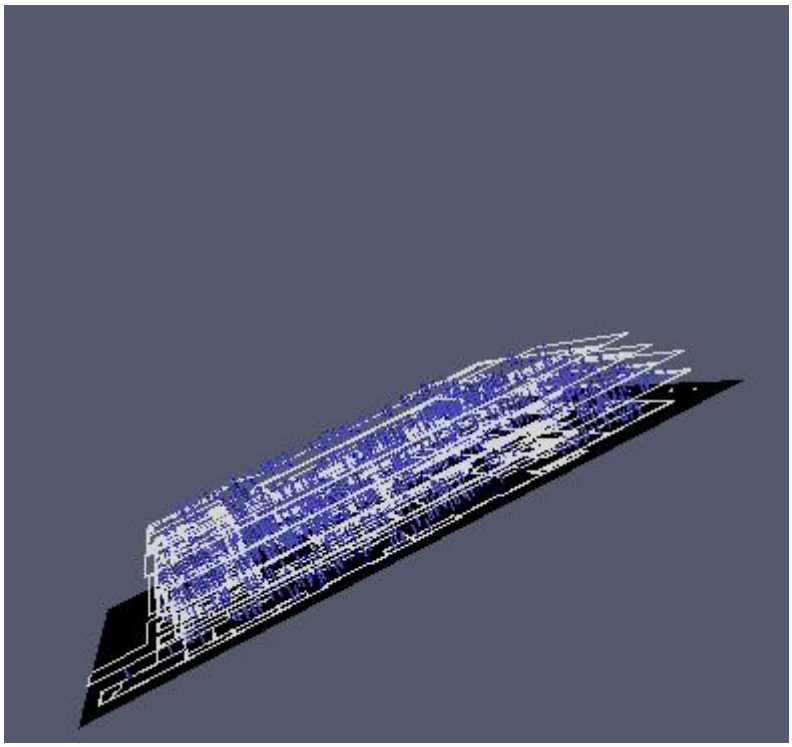


Figure 22 All occupants in the building for total RSET

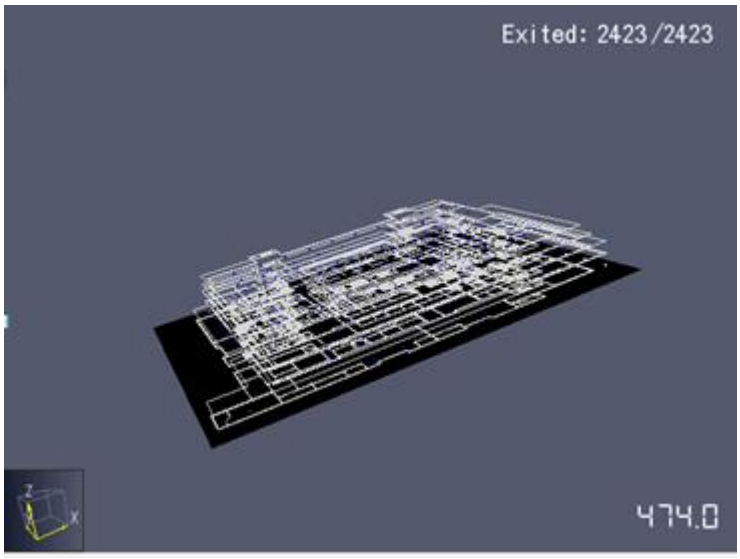


Figure 23 Results for SFPE mode total RSET

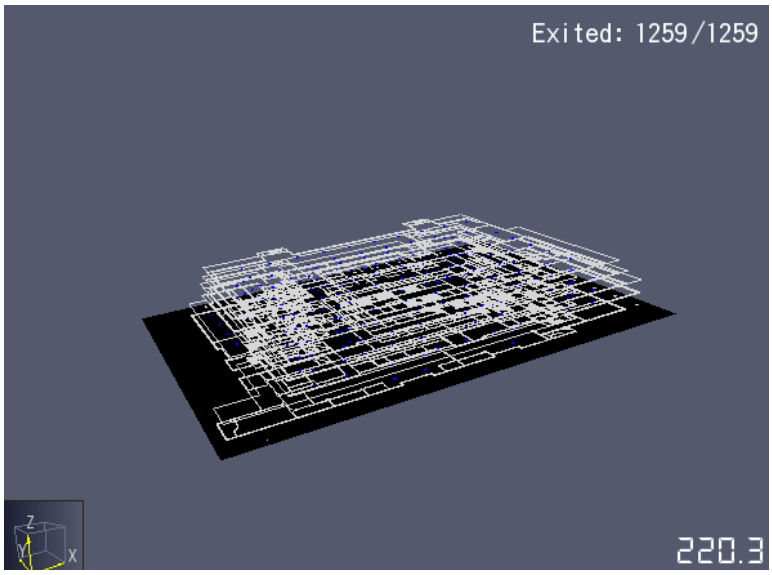


Figure 24 Results steering mode RSET floor 1 and 2

7.3.4 Total RSET

All the different time intervals have to be added together and adjusted with a safety factor. Occupants in the Library are self-involved with work, they can for example be doing homework while listening to music etc. The notification time is therefore estimated to be 15 seconds. Factors such as occupants packing their bags, finding their friends, etc., before evacuating are taken into consideration when talking about pre-evacuating time. The pre-evacuation time is estimated to be 60 seconds. Time for detection is taken from the FDS simulations, where it took 114 seconds. Pathfinder got the evacuation time to be 474 seconds. There is chosen to use a safety factor equal to 1,5.

$t_d = 114$ seconds

$t_n = 15$ seconds

$t_{p\text{-}e} = 60$ seconds

t_e for whole building= 474 seconds

t_e for floor 1 and 2 building= 220 seconds

$s_f = 1{,}5$

TOTAL RSET FOR THE BUIDLING=994.5 sec (16.6 min)

TOTAL RSET FOR FLOOR ONE AND TWO=613.6 sec (10.23 min)

7.4 Design Fire Scenarios and ASET

In this report it is chosen to use Fire Dynamics Simulator (FDS) to find Available Safety Egress Time (ASET). A computational fluid dynamics (CFD) analysis that simulates a severe fire scenario was conducted. Fire Dynamics Simulator (FDS v6.4.0) was utilized for modeling the spread of fire and its effects on occupants within floor one and two in the Library.

FDS was chosen based on its ability to model complex fire phenomenon such as the spread of heat, smoke, and other toxic gasses. FDS is a CFD model of fire-driven fluid flow developed by the National Institute of Standards and Technology (NIST). The software numerically solves a form of the Navier-Stokes equations appropriate for low-speed, thermally-driven flow with an emphasis on smoke and heat transportation from fires. In FDS, each room or area within a building of interest is divided into small rectangular control volumes or computational cells. The model then computes the density, velocity, temperature, pressure and species concentration of the gas in each cell, based on the conservation laws of mass, momentum, and energy, to model the movement of fire gases. The accuracy with which the fire dynamics can be simulated depends on the number of cells that can be incorporated into the simulation. This number is ultimately limited by the computing power available. A more detailed description of the FDS model can be found in the FDS User's Manual and Technical Reference Guide.

7.4.1.1 Design Fire Scenarios

For defining design fire scenarios, LSC 5.5.3 is used for guidance. LCS section 5.5.3 describes 8 design fire scenarios that should be considered. This report focuses mainly on Design Fire Scenarios 1, 6 and 8 in the LSC.

I have identified multiple possible fire scenarios in the Library:

- Library Stack area floor 2
  - The most severe fuel load in the Library
  - Occupant specific
  - Located on the floor with the most occupants
- Café floor 2
  - High HRR
  - Occupant specific
  - Located on the floor with the most occupants
- Other Library Stack areas
  - Severe fuel load

7.4.2 Main fire scenario

It is only chosen to evaluate one scenario in this report because of long simulation times. The fire scenario chosen to evaluate is a occupancy-specific scenario which has the most severe fire possibility. This is a fire in the Library Stack areas on floor 2. Two fire scenarios are presented, with the same ignition source; one scenario representing the existing non-sprinklered fire floor and the same scenario with sprinklers represented. The fire scenarios will comply with Design Fire Scenarios 1, 6 and 8 in the LSC, section 55.3. Below is a description of the different Design Fire Scenarios:

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

Design Fire Scenario 6:
(1) It is the most severe fire resulting from the largest possible fuel load characteristic of the normal operation of the building.
(2) It addresses the concern regarding a rapidly developing fire with occupants present

Design Fire Scenario 8:
(1) It is a fire originating in ordinary combustibles in a room or area with each passive or active fire protection system independently rendered ineffective.
(2)It addresses concerns regarding the unreliability or unavailability of each fire protection system or fire protection feature, considered individually.
(3)* It is not required to be applied to fire protection systems for which both the level of reliability and the design performance in the absence of the system are acceptable to the authority having jurisdiction.

The most possible ignition source for these fire scenarios is an overheated electrical wire, typically a charger. The ignition source ignites Library Stack areas in floor two:

Figure 25 Ignition source

Figure 26 Second item ignited: Library Stack areas

The location of the fire is in the stack area of floor 2(Figure 27 below). The second floor also has doors that lead into a stair enclosure and into an exit extension to the main stairwell. The door that leads into the stair enclosure and into the exit extension are maintained open with magnetic

door holders; the doors are released and automatically close when an alarm sequence is initiated anywhere in the Library.

The tenability criteria's are evaluated east of the fire, shown in Figure 27. This location is where the occupants first will be affected by the fire.

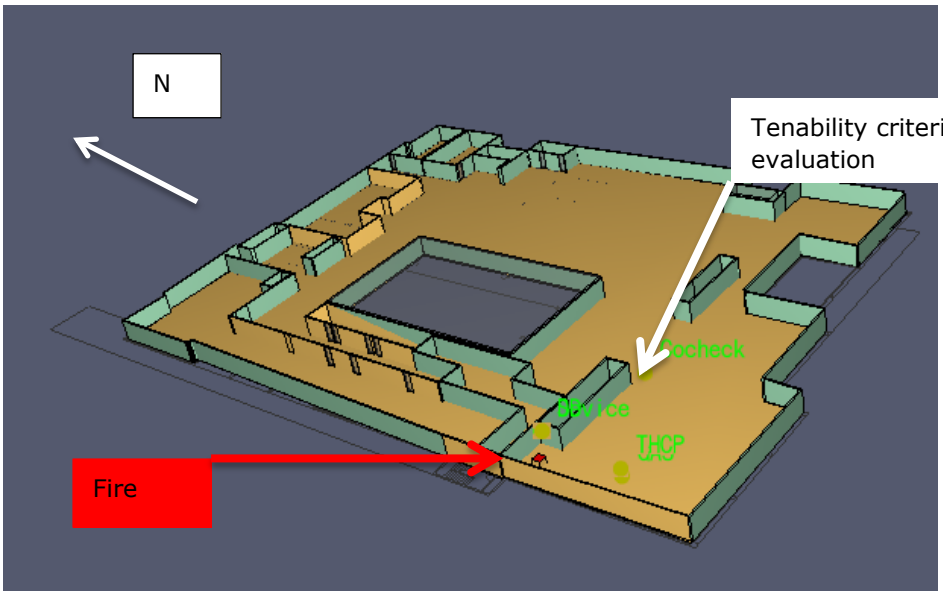


Figure 27 Location of fire on second floor

Combustion Properties

It is chosen to focus on the Library Stack areas. The paper in the books is largely made up of an organic compound called cellulose. The properties of combustion are taken from Table A.39 in the SFPE handbook for cellulosic materials and are shown in Table 23:

Table 23 Properties of combustion

Properties of combustion	
CO yield	0.004 g/g
Soot yield	0.015 g/g
Heat of combustion	14.4 kJ/g*

*Most conservative value for wood (newspaper is used)

Maximum HRR and Fire Growth for Fire Scenario without sprinklers

The Library book stacks are seven feet six inches tall with books arranged vertically side by side on the bookshelves. In total all 4 book shelves are evaluated.

The fire growth was modeled with experimental data conducted by Babrauskas in the SFPE handbook 5th edition. Each test contained 480 kg of paper fuel load in shelving units totalling 1.67 m^2 of floor area. See Figure 28 for peak heat release and fire growth extracted from experiment.

Fig. 26.17 HRR of storage units

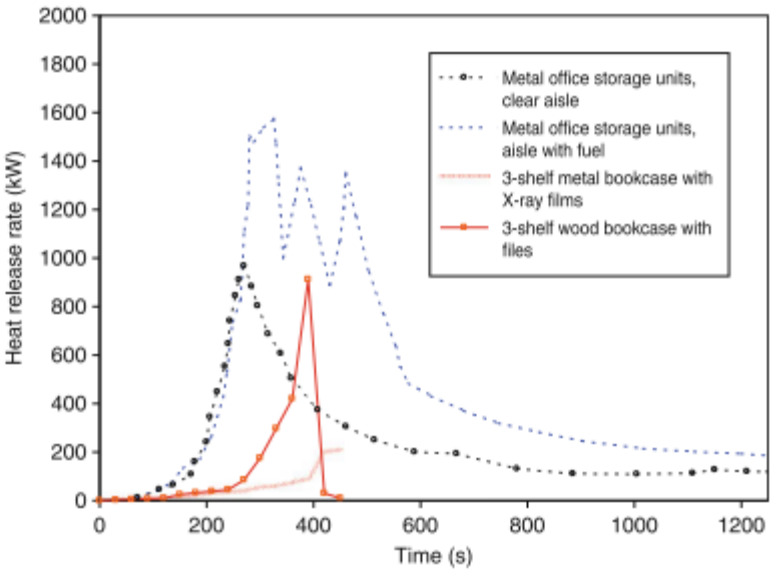


Figure 28 HRR for book shelfs

The values for metal office storage units with fuel are used. The peak HRR for one book shelf is 1.6 MW, but to be conservative it is assumed a max HRR of 2 MW is used. It is assumed equivalency of the four book shelves.

Max HRR will be:

$$\dot{Q}_{\max} = 4shelves * 2000kW = 8000kW = 8MW$$

The fire starts by growing to approximately 250 kW after 200 seconds. This fire growth is estimated to be the same as a medium growing fire. After 200 seconds, the fire grows as a fast growing fire. The fire will reach its peak at 540 seconds.

Figure 28 shows that the fire is on its peak for approximately 30 seconds. The fire will remain on its peak HRR for two minutes because it is assumed that four bookshelves are burning. The fire will be peaking throughout RSET.

Maximum HRR and Fire Growth for Fire Scenario with sprinklers

Installing sprinklers as a fire protection feature within a building can reduce the heat release rate and temperatures achieved by a fire. It is assumed that the sprinklers installed will only control the fire (i.e., stop the fire from growing) rather than extinguish the fire. This is a conservative assumption.

A controlled fire allows the occupants more time to exit the building and reduces the amount of harmful by-products of combustion. In this analysis, sprinklers were modeled to determine the effect sprinklers had on the fire size and on the tenability conditions within the second floor.

The same combustion properties and fire growth are used for the fire, but maximum HRR will have a smaller value due to sprinklers.

Sprinkler activation time is based on NFPA 72, Appendix F. The DETACT model is used to estimate sprinkler activation. The DETACT model is a first order response model for predicting fire detector activation based on convective heating and a lumped capacity analysis. Table 24 shows the input parameters used in the DETACT-model.

To conservatively estimate the time to sprinkler activation, the fire is placed in the middle of 4 sprinklers. This configuration will produce the greatest distance between sprinklers and the fire plume and thus increase the time to sprinkler activation.

Sprinkler spacing looks like this:

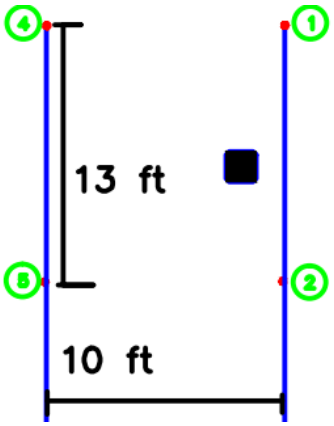


Figure 29 Sprinkler spacing

The celling height is 2,7 m. The sprinklers are quick response, so The Response Time Index (RTI) is chosen to be 50.

The sprinklers have a activation temperature at 68,33 Celcius.

The relevant fire scenario that is chosen is a fire starting in one of the stack areas, 1 m over the floor. The fire is growing as a medium t-squared fire with a growth coefficient $\alpha = 0,012 kW/s^2$.

Table 24 Input parameters from excel

INPUT PARAMETERS			CALC. PARAMETERS	
Ceiling height (H)	2.7	m	R/H	0.926
Radial distance (R)	2.5	m	dT(cj)/dT(pl)	0.316
Ambient temperature (To)	20	C	u(cj)/u(pl)	0.213
Actuation temperature (Td)	68.33	C	Rep. t2 coeff.	k
Response time index (RTI)	50	(m-s)1/2	Slow	0.003
Fire growth power (n)	2	-	Medium	0.012
Fire growth coefficient (k)	0.012	kW/s^n	Fast	0.047
Time step (dt)	2	s	Ultrafast	0.400

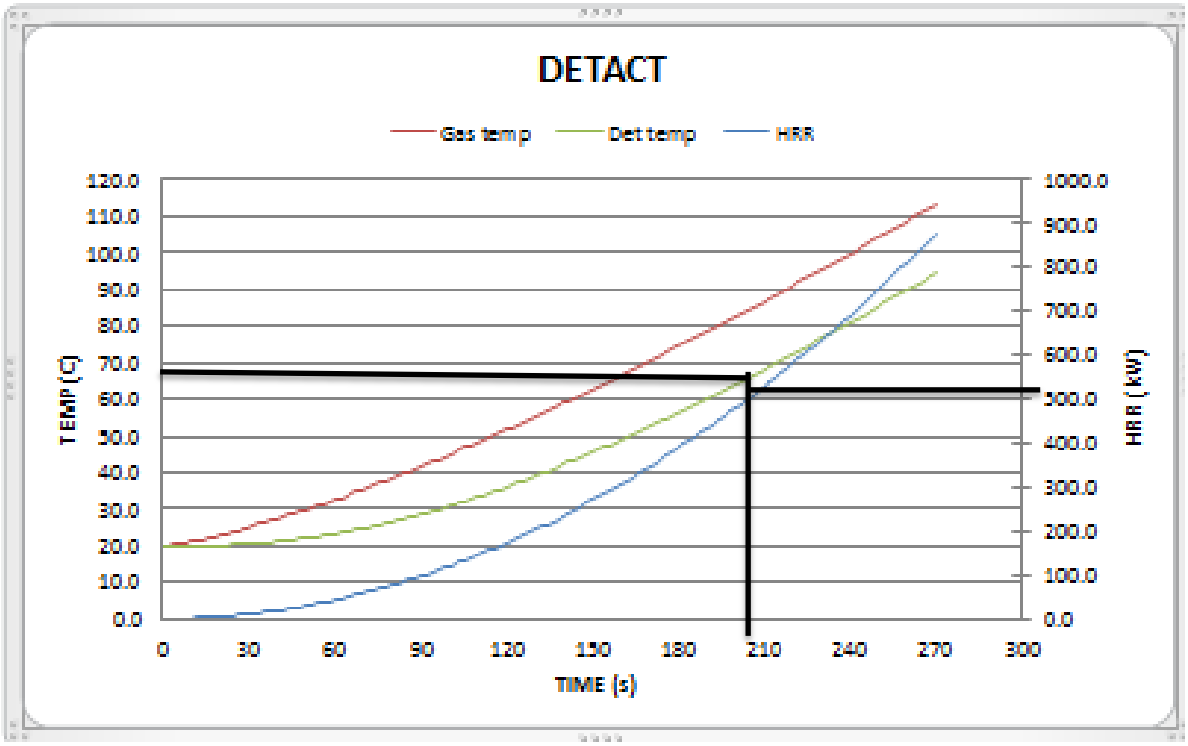


Figure 30 DETACT activation time

The sprinkler activation time is expected to be 212 seconds and maximum HRR is 540 kW. For the complete calculation, please see Appendix B6.

Comparison HRR for Sim 1 and 2

The sprinkler system reduces the heat release rate by 7460 kW and it also reduces the amount of byproducts produced by a fire.

Below is the heat release rate of the sprinklered building condition and the nonsprinklered condition of the Library.

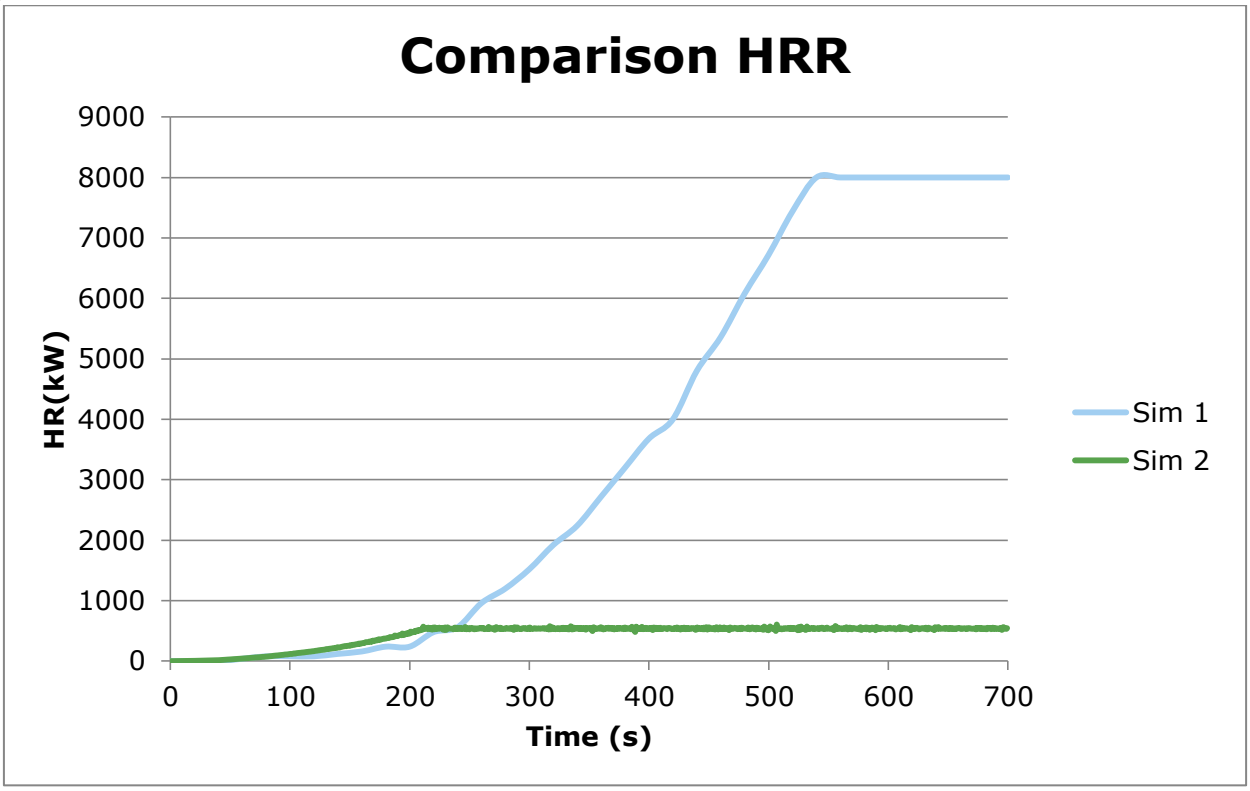


Figure 31 Comparison HRR

Mesh size of the model

The cell size (dx) for a given simulation can be related to the characteristic fire diameter (D^*), i.e., the smaller the characteristic fire diameter, the smaller the cell size should be in order to adequately resolve the fluid flow and fire dynamics.

The characteristic fire diameter (D^*) is given by the following relationship:

$$D^* = \left(\frac{\dot{Q}}{\rho_\infty c_p T_\infty \sqrt{g}} \right)^{\frac{2}{5}}$$

The mesh sizes in the Pyrosim model were all set with coarse mesh sizes because of long simulation times. The mesh sizes where set as cubes with dimensions of 0.55 m. The Kristopher Overholt website where used for mesh size calculation.

7.5 Results

The FDS model calculates the results of the visibility, temperature, and toxicity through Slice files taken at six feet above the walking surface. For the purposes of this report, any increase above the tenability requirements for temperature and toxicity is considered failing. Any decrease below the tenability requirement for visibility is considered failing.

7.5.1 Detector activation

The exact location of the nearest smoke detector to the design fire location was included in the models, in order to produce an estimate of when the fire alarm system will activate. It is important to have an estimate of this time so that an estimate can be made of when egress will begin. The location of the smoke detector is shown in Figure 27. The smoke detector activates after 114 seconds. The detector will go to alarm before the sprinklers activate because photoelectric detectors in the model.

7.5.2 FDS simulation 1, without sprinklers

Visibility

The visibility dropped below the tenability criteria at 255 seconds as seen in Figure 32.

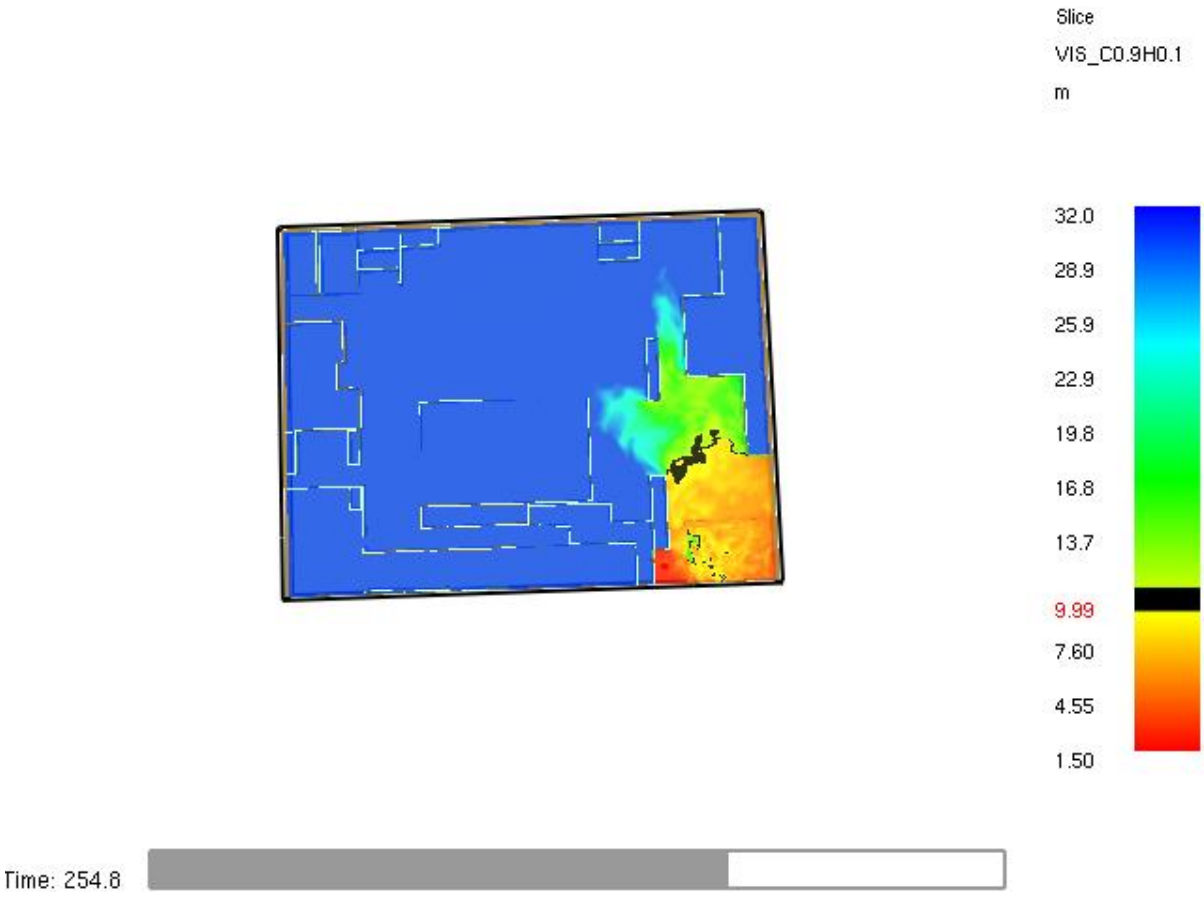


Figure 32 Visibility criteria exceeded

Temperature

The temperature will rise above the tenability criteria at approximately the 325 seconds.

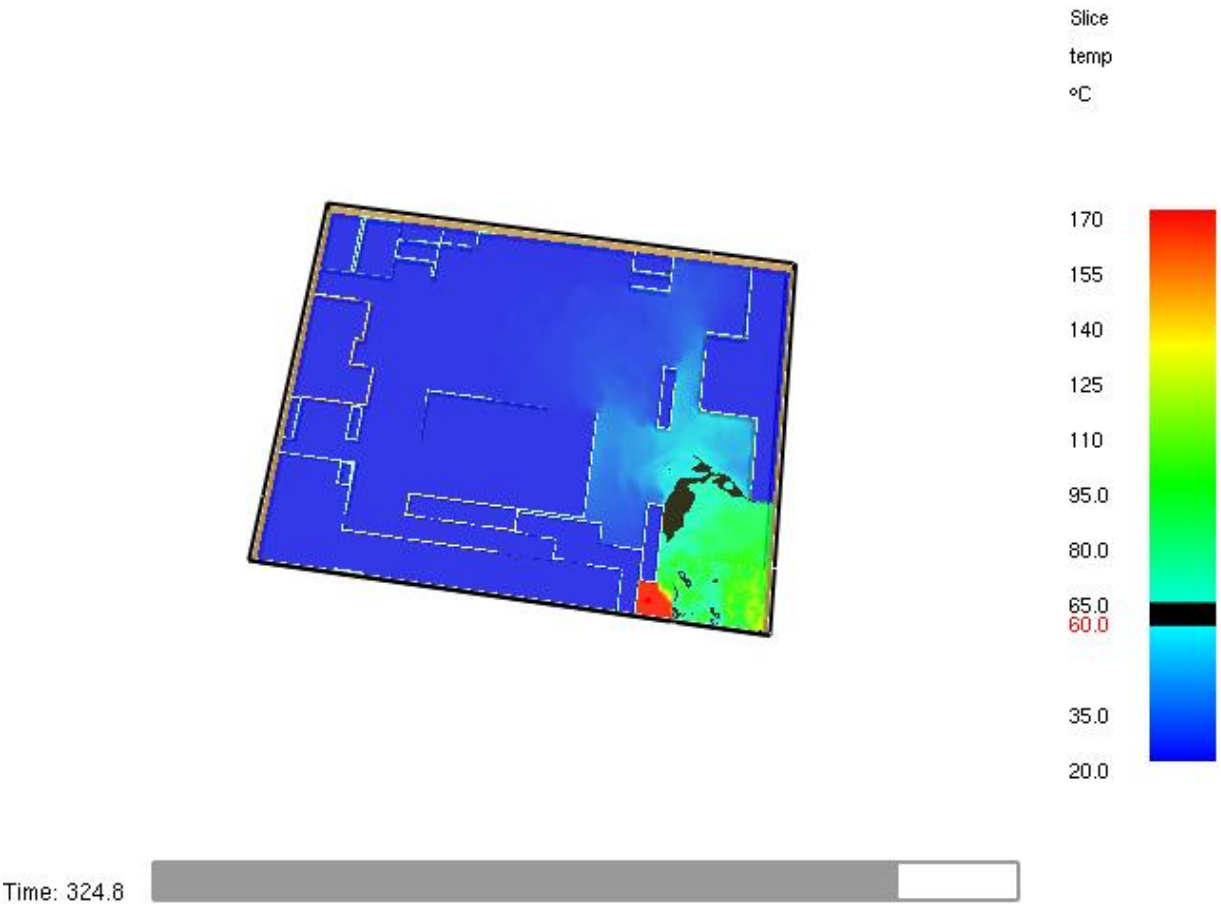


Figure 33 Temperature criteria exceeded

Toxicity

The toxicity does not rise above the tenability criteria during RSET.

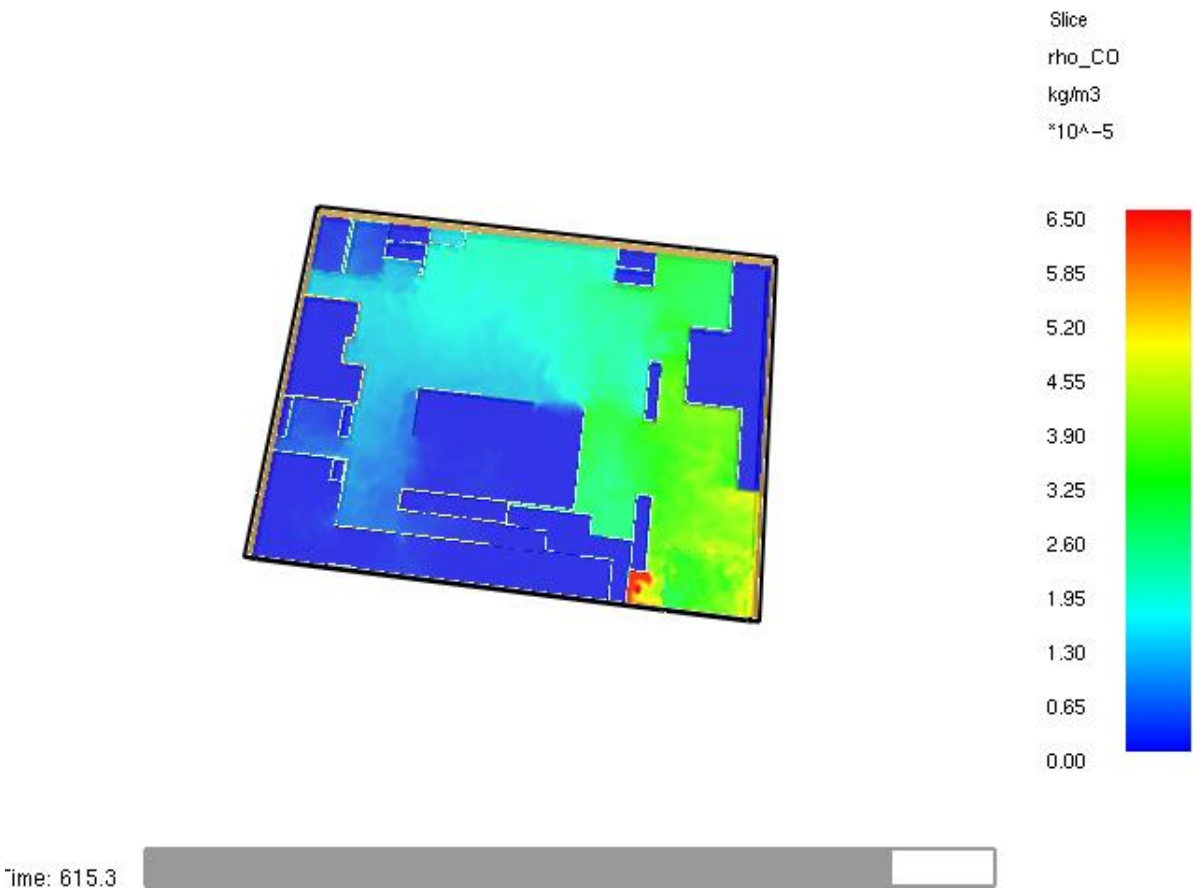


Figure 34 Toxicity after 614 seconds

The CO concentration present in the second floor does not reach untenable conditions for the duration required for evacuation for floor 1 and 2. The low level of CO concentration is due to low CO yield of cellulosic material such as paper. For this model, the soot yield of wood products- also cellulosic material- was used as the CO yield input in FDS.

7.5.3 FDS simulation 2, with sprinklers

Visibility

The visibility will not drop below the tenability criteria before occupants have evacuated the building.

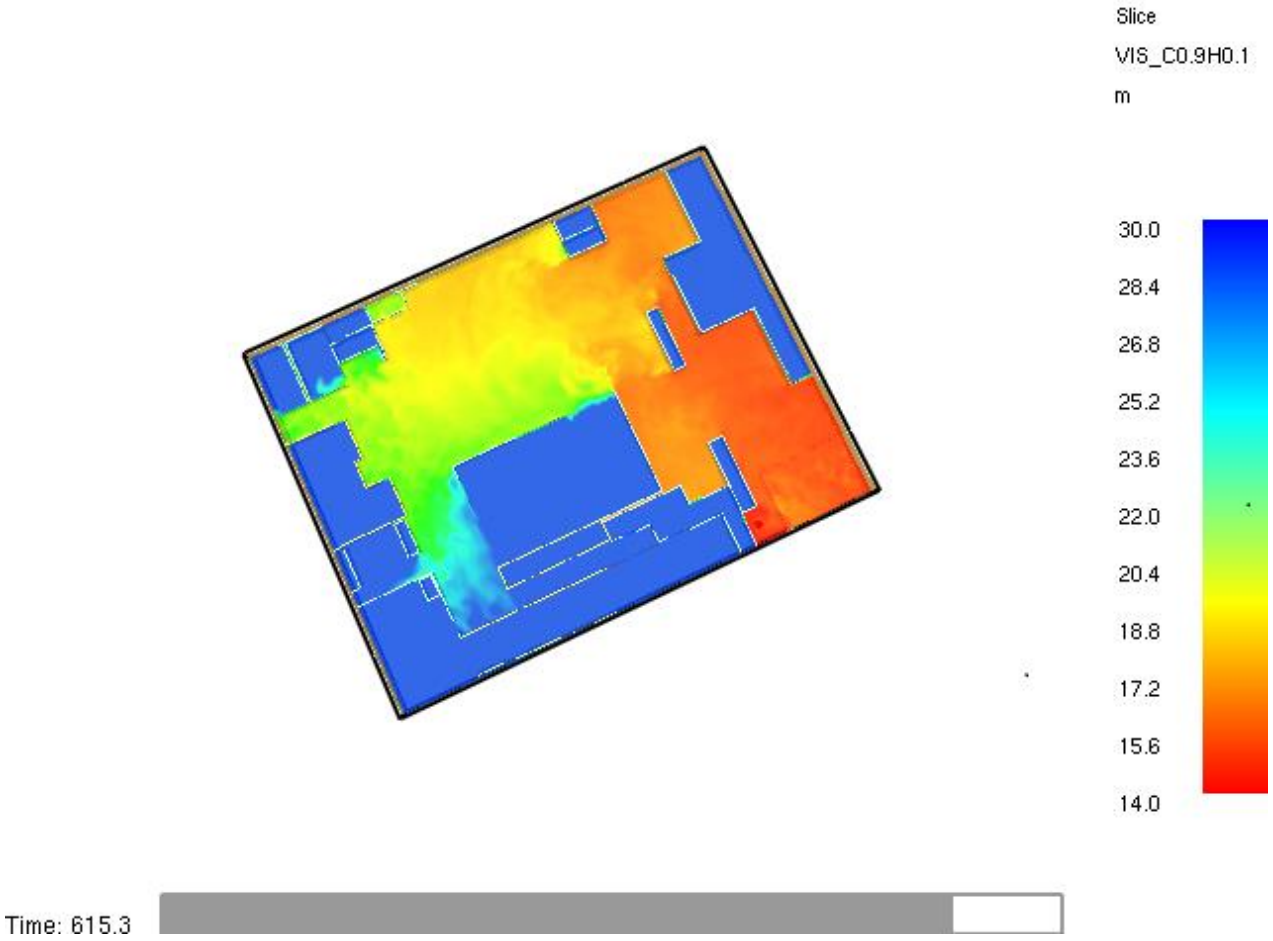


Figure 35 Visibility after 614 seconds

Temperature

The temperature criterion is not exceeded through the simulation.

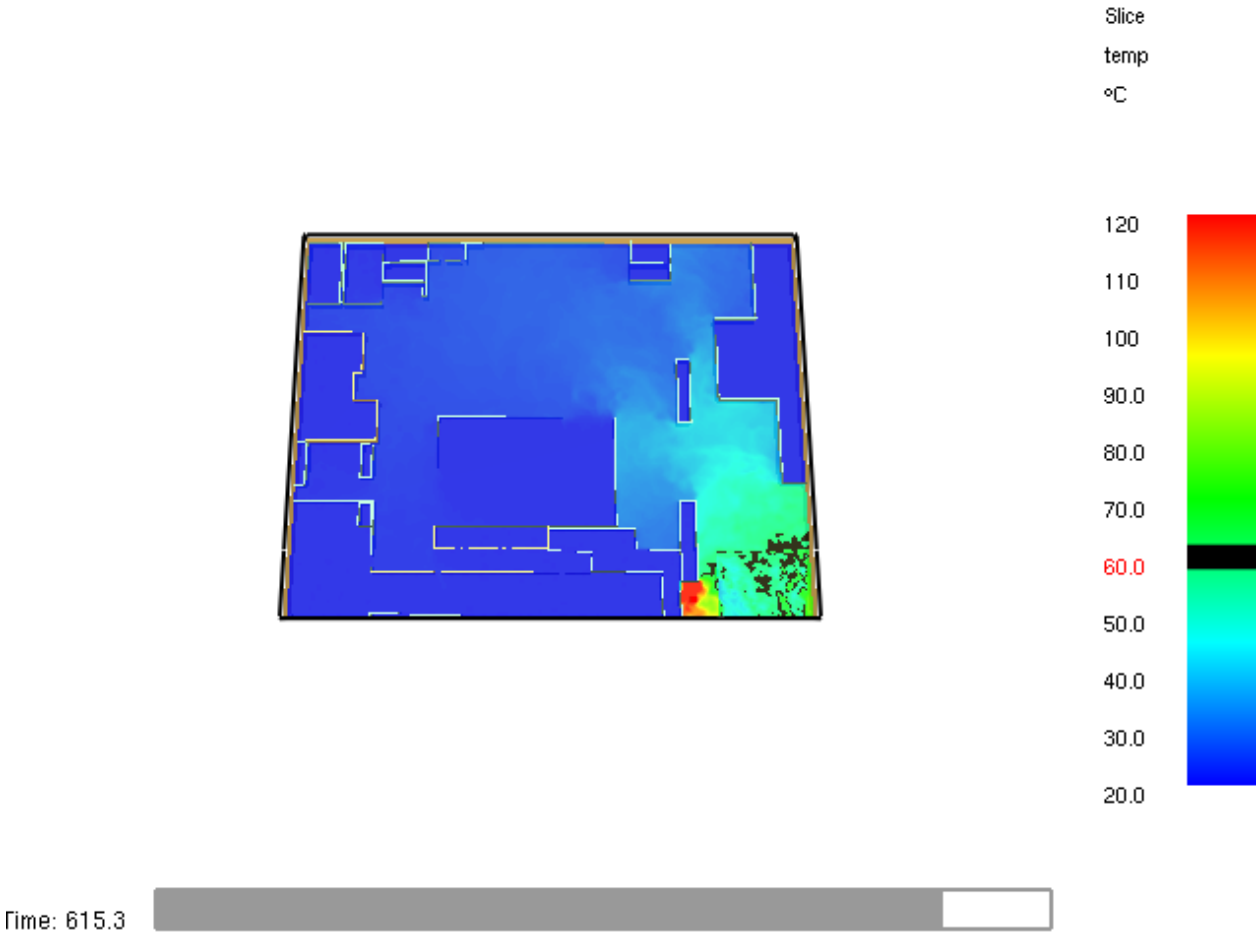


Figure 36 Temperature after 614 seconds

Toxicity

The toxicity does not rise above the tenability criteria during RSET, as shown in Figure 37.

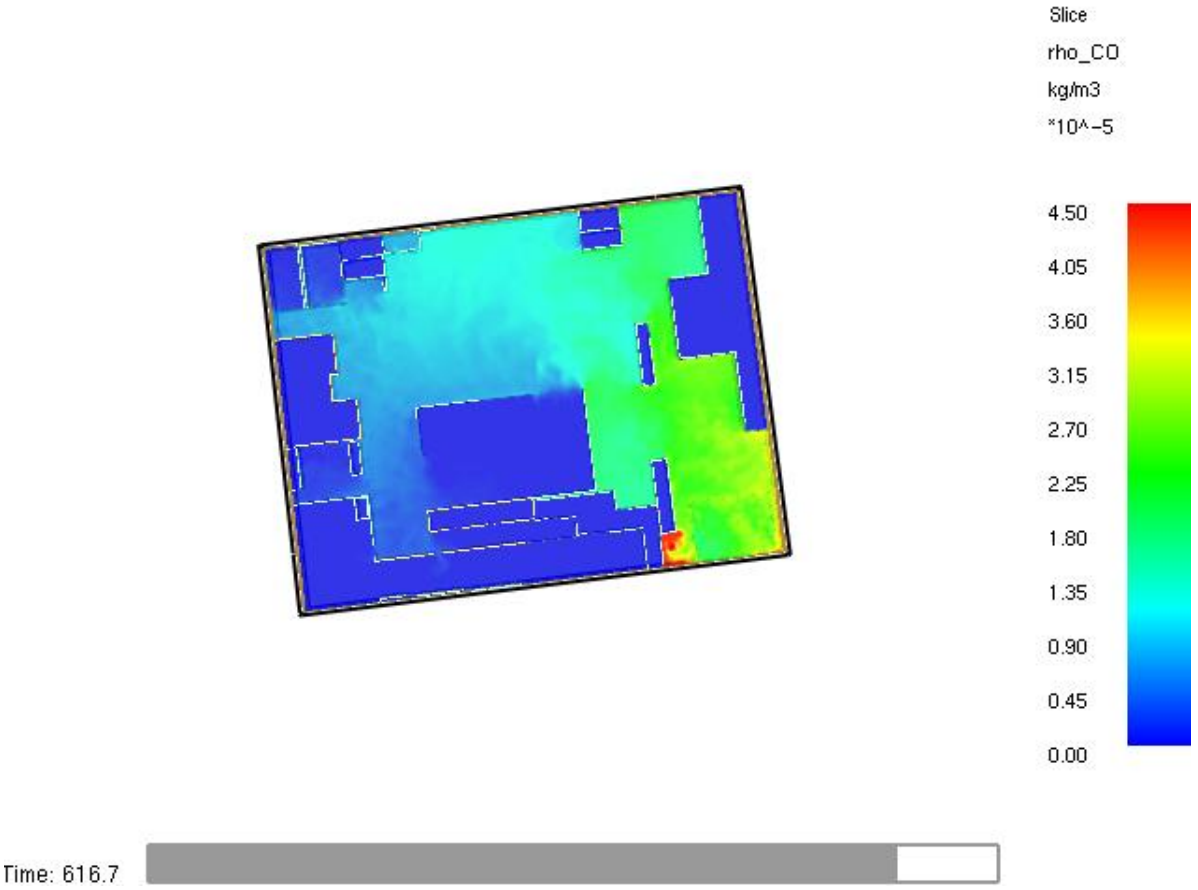


Figure 37 Toxicity after 614 seconds

7.5.4 Summary of tenability results

Table 25 shows a summary of the tenability results.

Table 25 Tenability results

	Simulation 1	Simulation 2
Input		
Sprinkler activation	No activation	212 sec
Peak HRR	8000 kW	540 kW
Fire growth	Medium until 200 sec, fast until 8 MW	Medium until 200 sec, fast until 540 kW
Occupants	1259	1259
Egress time	614 sec	614 sec
Output		
Visibility	255 sec	Pass
Temperature	325 sec	Pass
Toxicity	Pass	Pass

7.5.4.1 RSET vs ASET

If ASET is less than the RSET the building is unsafe for occupants to utilize. The figures below compare the time it takes to reach each tenability limit compared to the RSET for total building evacuation for the non-sprinklered building and sprinklered building conditions.

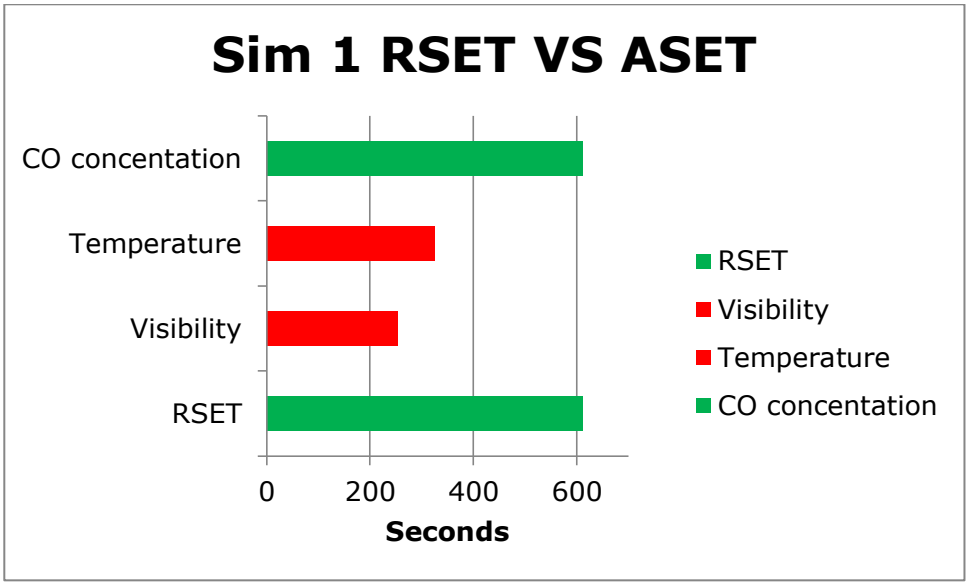


Figure 38 Simulation 1 results

Without sprinklers the tenability criteria's are exceeded. The tenability criteria's are violated, so the building unsafe for occupants to utilize.

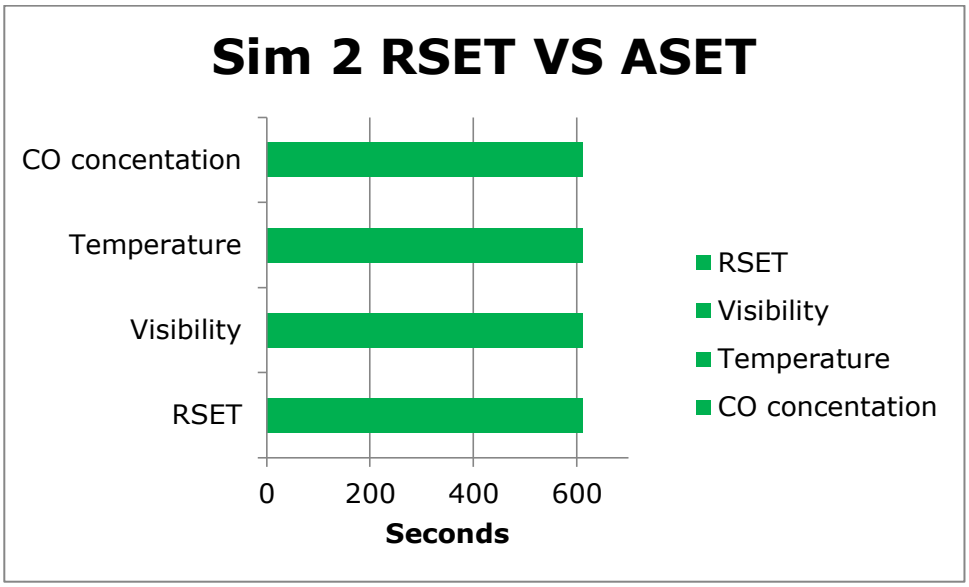


Figure 39 Simulation 2 results

With sprinklers the tenability criteria's are not violated during the simulation.

8. SUMMARY PERFORMANCE BASED ANALYSIS

The performance-based analysis in this report investigated the ability of the fire protection systems in the Library to perform satisfactorily in several different fire scenarios. This analysis was completed using the Fire Dynamics Simulator (FDS) program, in conjunction with the Pyrosim graphical user interface and the Pathfinder evacuation simulator. The chosen design fire scenario was a fire with 8 bookshelves in the south west corner of the second floor. Two different scenarios where analysed; one with functional sprinkler system and one without sprinkler system.
The data needed for the fire was taken from the SFPE handbook. The tenability criteria's was evaluated east of the fire, where the occupants first will be affected by the fire.

Total RSET is 1034 seconds and RSET for floor one and two it is 614 seconds.

The visibility criterion was exceeded without sprinklers after 255 seconds. With sprinklers the tenability criteria's where not violated throughout RSET.

9. SUMMARY AND RECOMMENDATIONS

This report presents a comprehensive evaluation of the fire protection and life safety features of the Robert E. Kennedy Library under the following codes and standards:

- Egress: NFPA 101 LSC 2015
- Water based suppression: NFPA 13
- Structural fire protection: 2015 IBC
- Fire detection, alarm and communication systems: NFPA 72
- Performance based design: NFPA 101 LSC 2015 and the SFPE handbook 5th edition

A prescriptive analysis was first performed, evaluating the requirements for the egress systems, detection and alarm systems, water based suppression systems and structural fire protection. The egress features built into the Library were found to mostly comply with the prescriptive requirements of the LSC. There is an automatic fire alarm and detection system as well as an emergency notification system installed in the Library, mostly in accordance with the LSC and NFPA 72. However, the notification devices do not cover all common use areas in the Library, which is not up to code. The Library does not have a water based suppression system, however a proposed suppression system was discussed in this report. The design suppression system is in accordance with IBC requirements, and was designed following the requirements of NFPA 13. The analysis demonstrates that the Library is in accordance with all of the requirements of the IBC for Type I-B construction.

The performance-based analysis in this report investigated the ability of the fire protection systems in the Library to perform satisfactorily in several different fire scenarios. This analysis was completed using the Fire Dynamics Simulator (FDS) program, in conjunction with the Pyrosim graphical user interface and the Pathfinder evacuation simulator. The chosen design fire scenario was a fire with 8 bookshelves in the south west corner of the second floor. Two simulations was done, with and without functional sprinkler system. The data needed for the fire was taken from the SFPE handbook. The tenability criteria's was evaluated east of the fire, where the occupants first will be affected by the fire.

The simulations without functional sprinkler system indicated that RSET>ASET. The visibility was violated in less than half the required safety egress time (RSET).

The simulations with a functional sprinkler system indicated that ASET>RSET. The tenability criteria's was not violated and it was determined that the building was safe in respect to life safety with sprinklers.

It has been shown in the performance-based analysis portion of this report how a sprinkler system can reduce the effects of combustion byproducts in an area with a high fuel load and increase the life safety potential within a building. Sprinkler installation for the control of fires is the most common method of providing fire suppression. I would, therefore, recommend installing a sprinkler system in the Library for life safety.

I would also recommend providing notification devices in all common use areas throughout the Library as required by LSC.

APPENDIX A

A1

Occupant loads
First floor:

Room	Room Type	Area (ft^2)	Classification	OLF (ft)	Occupancy Load
101	Library Svc	876	B	100	9
101A	Library Svc	112	B	100	2
101B	Library Svc	988	B	100	10
101C	Library Svc	824	B	100	9
101D	Library Svc	792	B	100	8
101E	Library Svc	227	S2	500	1
101F	Library Svc	437	S2	500	1
102	Storage	67	S1	NA	0
102B	Mechanical/electrical	109	S2	500	1
102C	Library Svc	131	B	100	2
103	Library Svc	3 153	B	100	32
103A	Admin Office	102	B	100	2
103B	Library Svc	185	B	100	2
104	Library Svc	749	B	100	8
104A	Admin Office	110	B	100	2
104B	Admin Office	113	B	100	2
105	Library Svc	3017	B	100	31
105A	Staff Offiice	119	B	100	2
105B	Admin Office	120	B	100	2
105C	Gen Storage	183	S1	NA	0
105D	Library Svc	309	B	100	4
105E	Gen Storage	188	S1	NA	0
105F	Gen Storage	483	S1	NA	0
110	Library Svc	253	B	100	3
111	Lib Stk/Stdy	3561	A2	50	72
111	Lib Stdy	3500	B	100	35
111A	Admin Office	112	B	100	2
111B	Library Svc	1221	A2	50	25
111C	Library Svc	1996	A2	50	40
111E	Admin Office	113	B	100	2
111F	Admin Office	113	B	100	2
111G	Staff Offiice	122	B	100	2
111H	Lib Stk/Stdy	921	A2	50	19
112	Library Svc	533	B	100	6
112A	Staff Offiice	110	B	100	2
113	Library Svc	226	B	100	3
114	Library Svc	3593	A2	50	72
114A	Corpration	910	B	100	10
114B	Lib Stk/Stdy	3295	A2	50	66
114C	Self Inc Cmp	1779	A2	50	36
114D	Library Svc	103	S2	500	1
114E	Support Office	421	B	100	5

117	Storage	28	S1	NA	0
118	Mechanical/electrical	615	S2	500	2
119	Storage	147	S1	NA	0
120	Mechanical/electrical	503	S2	500	2
120A	Mechanical/electrical	166	S2	500	1
120B	Mechanical/electrical	271	S2	500	1
121	Gen Storage	227	S1	NA	0
122	Mechanical/electrical	213	S2	500	1
Outdoor deck	NA	4137	A2	FIXED	60
	Total area	42583	Total occupant load		599

Second floor:

Room	Room Type	Area (ft^2)	Classification	OLF (ft)	Occupancy Load
201	Storage	116	S1	NA	0
202A	Lib SpecStdy	631	B	100	7
202B	Lib SpecStdy	422	B	100	5
202C	Gen Storage	184	S1	NA	0
203	Gen Storage	279	S1	NA	0
204	Staff Office	468	B	100	5
204A	Admin Office	182	B	100	2
204B	Admin Office	139	B	100	2
204C	Admin Office	139	B	100	2
204D	Support Office	91	B	100	1
204E	Staff Office	139	B	100	2
204F	Support Office	90	B	100	1
205	Staff Office	142	B	100	2
206	Staff Office	93	B	100	1
207	Admin Office	142	B	100	2
208	Office	241	B	100	3
209	Library Svc	1219	A1	100	13
209A	Mechanical/electrical	59	S2	500	1
209B	Staff Office	786	B	100	8
209C	Admin Office	139	B	100	2
210	Mechanical/electrical	152	S2	500	1
212	Storage	92	S1	NA	0
214	Storage	14	S1	NA	0
215	Library Svc	76	B	100	1
216	Lib Stk	6260	A1	100	63
216	Lib Stdy	22000	A2	50	440
216A	Lib SpecStdy	738	A2	50	15
216B	Lib SpecStdy	1272	A2	50	26
216C	Lib SpecStdy	110	A2	50	3
216D	Admin Office	108	B	100	2
216E	Admin Office	113	B	100	2
216F	Staff Office	112	B	100	2
216G	Admin Office	107	B	100	2
216H	Staff Office	117	B	100	2
216J	Staff Office	117	B	100	2
217	Lib SpecStdy	533	A2	50	11
217A	Staff Office	188	B	100	2
217C	Lib SpecStdy	740	A2	50	15
217D	Lib SpecStdy	767	A2	50	16
219	Mechanical/electrical	47	S2	500	1
Outdoor deck	NA	1240	A2	50	25
	Total area	40604	Total occupant load		689

Third floor:

Room	Room Type	Area (ft^2)	Classification	OLF (ft)	Occupancy Load
301	Lib SpecStdy	486	A2	50	10
302	Lib SpecStdy	143	A2	50	3
303	Lib SpecStdy	93	A2	50	2
304	Library Svc	143	A1	100	2
305	Storage	8	S1	NA	0
306	Mechanical/electrical	150	S2	500	1
308	Storage	92	S1	NA	0
310	Mechanical/electrical	14	S1	NA	0
311	Library Svc	74	B	100	1
312	Conf room	289	A2	50	6
313	Lounge	546	B	100	6
314	Lib SpecStdy	324	A2	50	7
314A	Lib SpecStdy	256	A2	50	6
316	Mechanical/electrical	48	S2	500	1
318	Lib Stk	17315	A1	100	173
318	Lib Stdy	10849	A2	50	217
318A	Lib Stdy	5136	A2	50	11
Outdoor deck	NA	1000	A2	50	20
	Total area	36966	Total occupancy load		465

Fourth floor:

Room	Room Type	Area (ft^2)	Classification	OLF (ft)	Occupancy Load
401	Lib SpecStdy	486	A2	50	10
402A	Mechanical	72	S2	500	1
403	Mechanical	152	S2	500	1
405	Storage	92	S1	NA	0
407	Storage	14	S1	NA	0
408	Staff Office	111	B	100	2
409	Lib Spec/Stdy	3 809	B	100	39
409A	Staff Office	135	B	100	2
409B	Admin office	129	B	100	2
409C	Library Svc	788	A1	100	8
409D	Library Svc	785	A1	100	8
410	Lib SpecStdy	146	A2	50	3
411	Lib SpecStdy	93	A2	50	2
412	Lib SpecStdy	142	A2	50	3
415	Mechanical	48	S2	500	1
417	Lib Stk	16175	A1	100	162
417	Lib Std	6575	A2	50	132
Outdoor deck	NA	735	A2	50	15
	Total area	30487	Total occupancy load		390

Fifth floor:

Room	Room Type	Area (ft^2)	Classification	OLF (ft)	Occupancy Load
501	Lib SpecStdy	139	A2	50	3
502	Lib SpecStdy	91	A2	50	2
503	Gen Storage	1 829	S1	NA	0
503A	Gen Storage	6	S1	NA	0
505	Storage	29	S1	NA	0
507	Storage	14	S1	NA	0
508	Mechanical	1 999	S2	100	4
509	Gen Storage	352	S1	NA	0
509A	Mechanical/electrical	2 887	S2	100	6
509B	Mechanical/electrical	214	S2	100	1
510	Lib Stk/Stdy	731	A2	50	15
510A	Support office	848	B	100	9
510B	Lib SpecStdy	834	A2	50	17
510C	Admin Office	103	B	100	2
510D	Admin Office	169	B	100	2
501E	Admin Office	149	B	100	2
511	Lib SpecStdy	789	A2	50	16
512	Storage	173	S1	NA	0
514	Lib Stk	13272	A1	100	133
514	Lib Std	2658	A2	50	54
Outdoor deck	NA	785	A2	50	16
	Total area	28071	Total occcupant load		280

A2

Egress capacity
First floor:

With per person: level components and ramps	0,2	
Exit capasity	Inches	People
North	48	240
South	216	1080
Total occupancy load		1320

Second floor

With per person: Stairways	0,3	
With per person: level components and ramps	0,2	
Exit capasity Stairways	Inches	People
South east stairway	48	165
North east stairway	48	165
North Stairway	50	174
West stairway	48	165
Internal stair	108	440
Total occupancy load		1110
Exit capasty stairway doors		
East stairway exit door	36	180
North east Stairway exit door	36	180
North Stairway exit door	36	180
West Stairway exit door	36	180
Internal exit stair*	108	540
Total Occupancy load		1260

Third floor

With per person: Stairways	0,3	
With per person: level components and ramps	0,2	
Exit capasity Stairways	Inches	People
South east stairway	48	165
North east stairway	48	165
North Stairway	50	174
West stairway	48	165
Total occupancy load		669
Exit capasty stairway doors		
East stairway exit door	36	180
North east Stairway exit door	36	180
North Stairway exit door	36	180
West Stairway exit door	36	180
Total Occupancy load		720

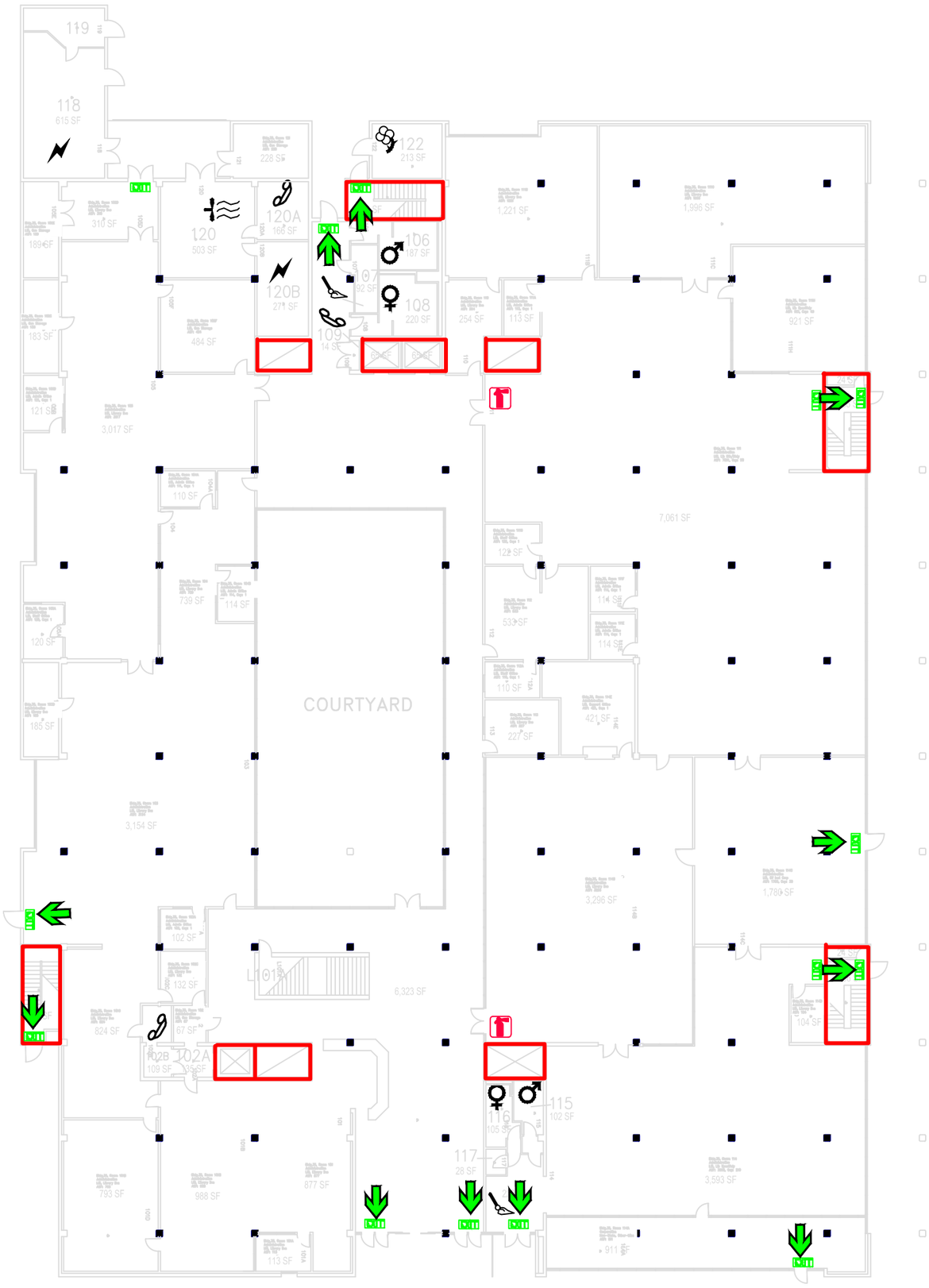
Fourth floor

With per person: Stairways	0,3	
With per person: level components and ramps	0,2	
Exit capasity Stairways	Inches	People
South east stairway	48	165
North east stairway	48	165
North Stairway	50	174
West stairway	48	165
Total occupancy load		669
Exit capasty stairway doors		
East stairway exit door	36	180
North east Stairway exit door	36	180
North Stairway exit door	36	180
West Stairway exit door	36	180
Total Occupancy load		720

Fifth floor

With per person: Stairways	0,3	
With per person: level components and ramps	0,2	
Exit capasity Stairways	Inches	People
South east stairway	48	165
North east stairway	48	165
North Stairway	50	174
Total occupancy load		504
Exit capasty stairway doors		
East stairway exit door	36	180
North east Stairway exit door	36	180
North Stairway exit door	36	180
Total Occupancy load		540

A3

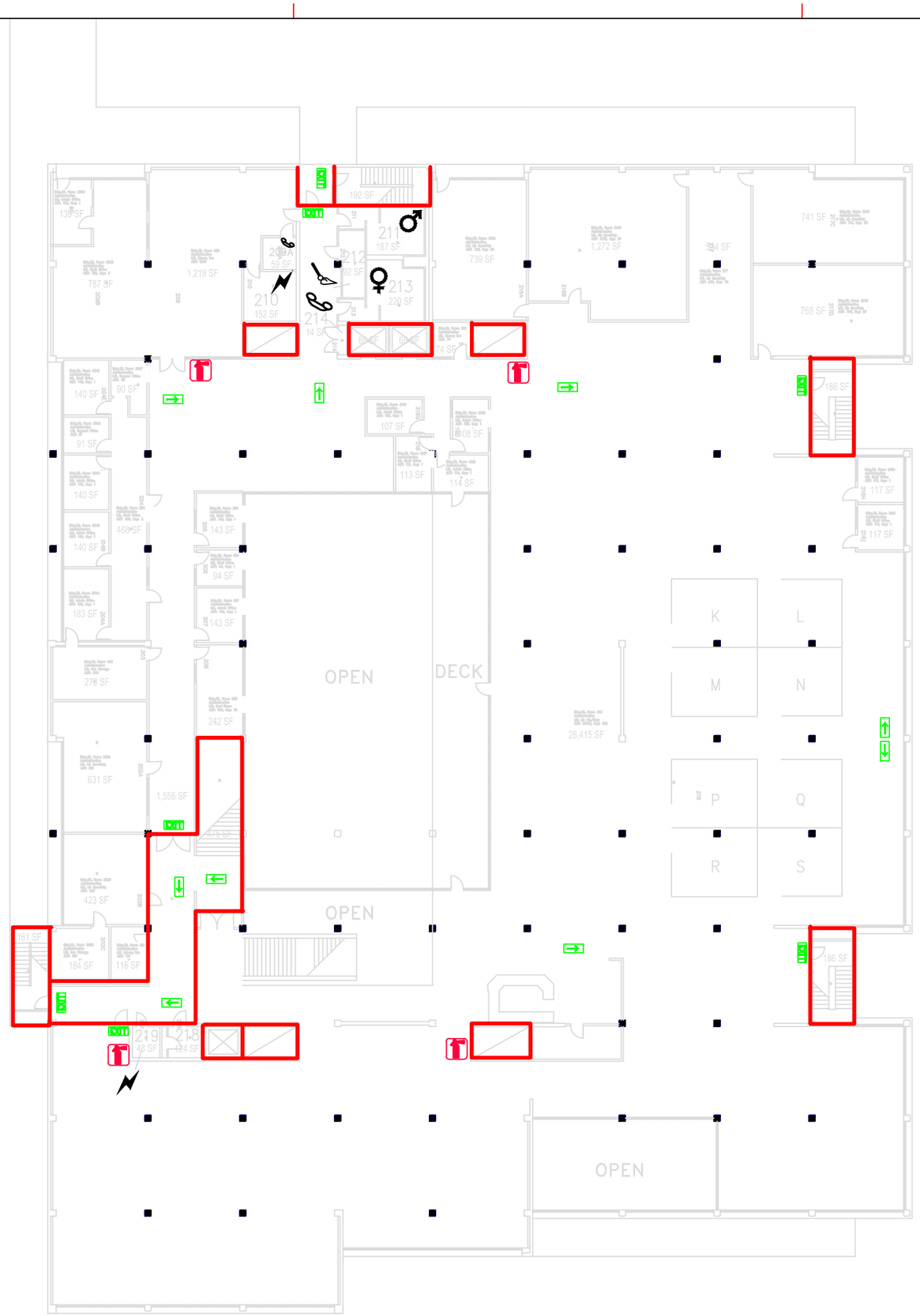


FLOOR 1

SYMBOL EXPLANATION

- EXIT DISTCHARGE
- EXIT SIGN
- EXIT SIGN WITH DIRECTION
- 2-HOUR FIRE WALL
- FIRE EXTINGUISHER

SCALE 1:350



FLOOR 2

SYMBOL EXPLANATION

- EXIT SIGN
- EXIT SIGN WITH DIRECTION
- 2–HOUR FIRE WALL
- FIRE EXTINGUISHER

SCALE 1:350

FLOOR 3

SYMBOL EXPLANATION

EXIT EXIT SIGN

EXIT SIGN WITH DIRECTION

2–HOUR FIRE WALL

FIRE EXTINGUISHER

SCALE 1:350

FLOOR 4

SYMBOL EXPLANATION

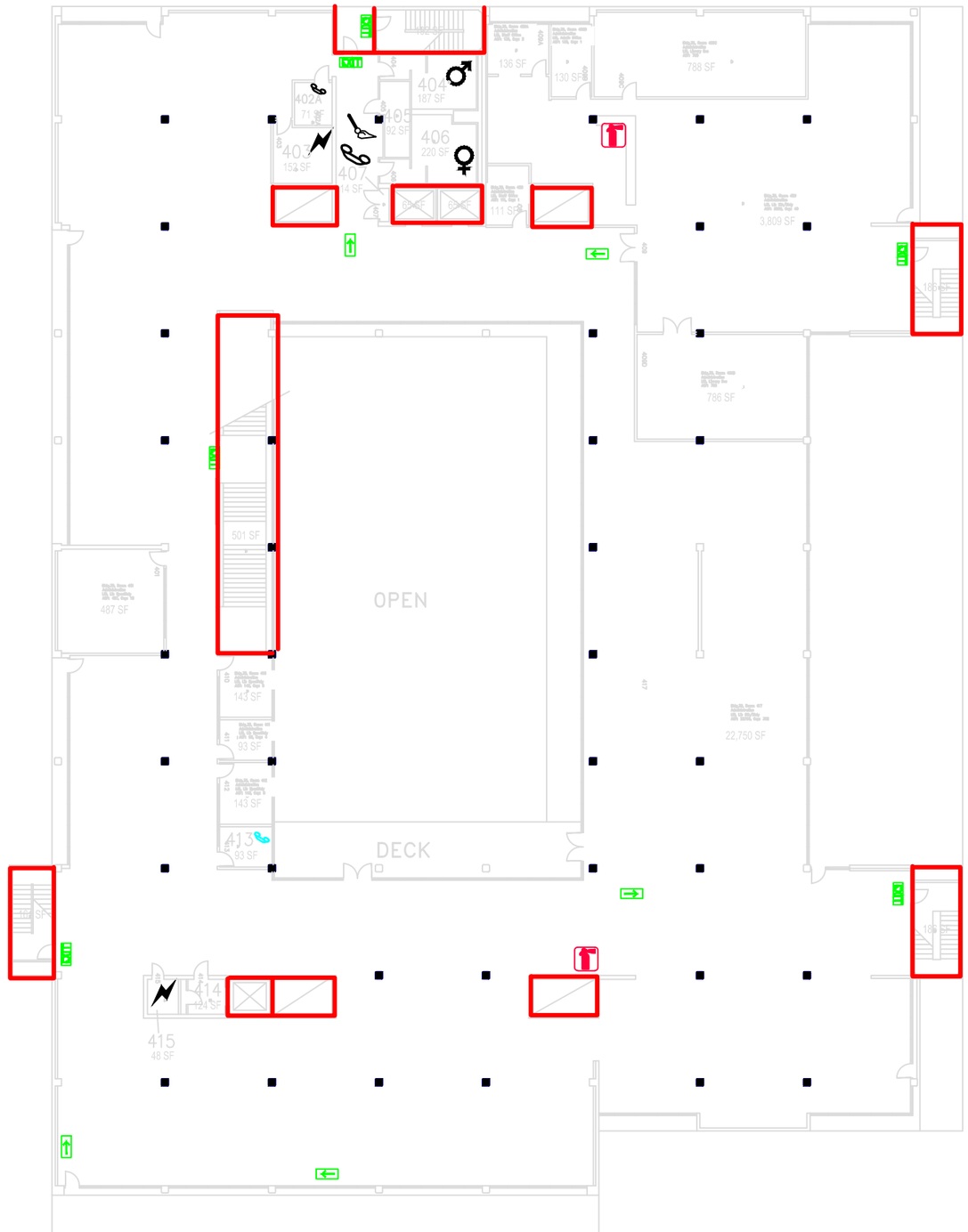
EXIT EXIT SIGN

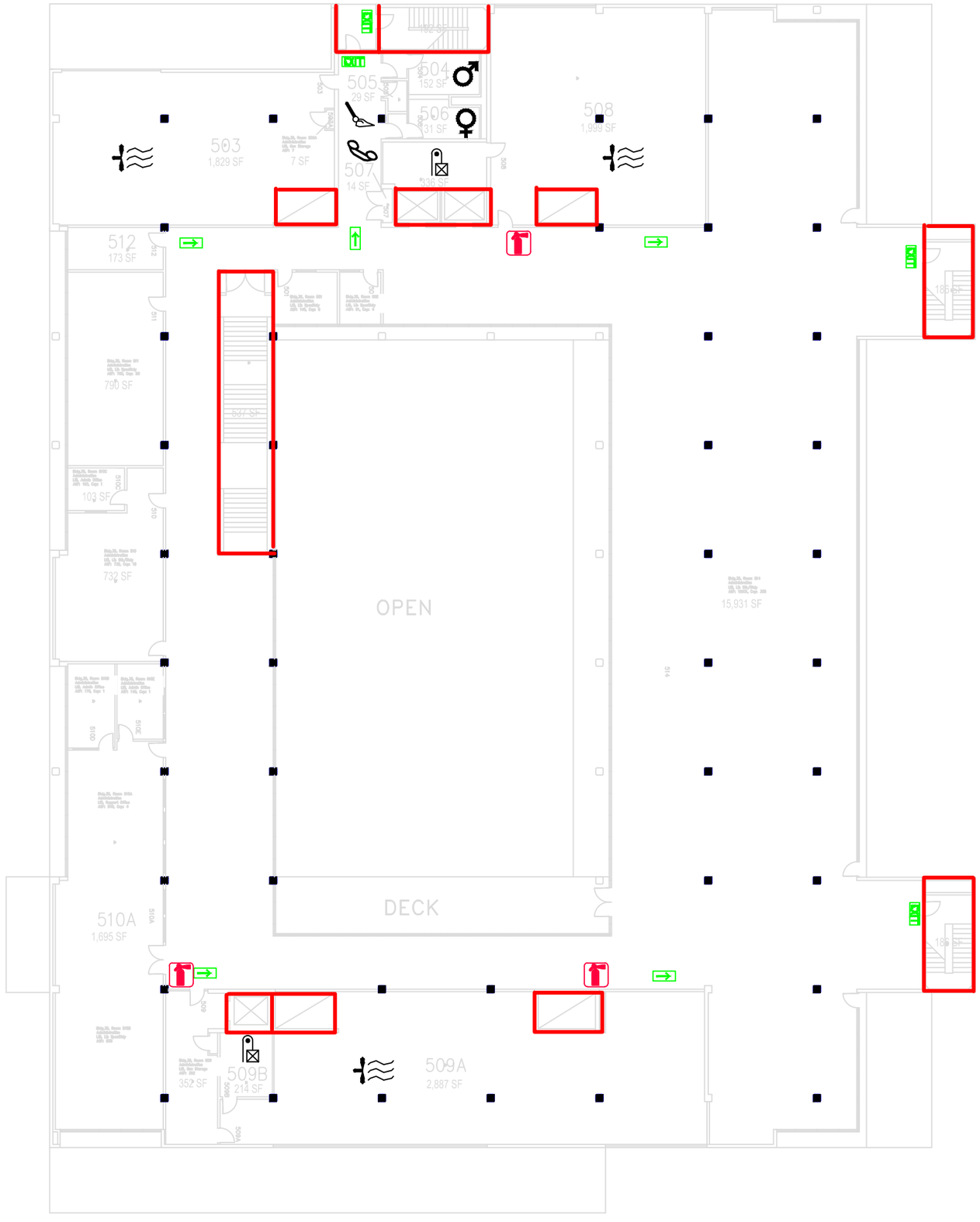
EXIT SIGN WITH DIRECTION

2-HOUR FIRE WALL

FIRE EXTINGUISHER

SCALE 1:350





FLOOR 5

SYMBOL EXPLANATION

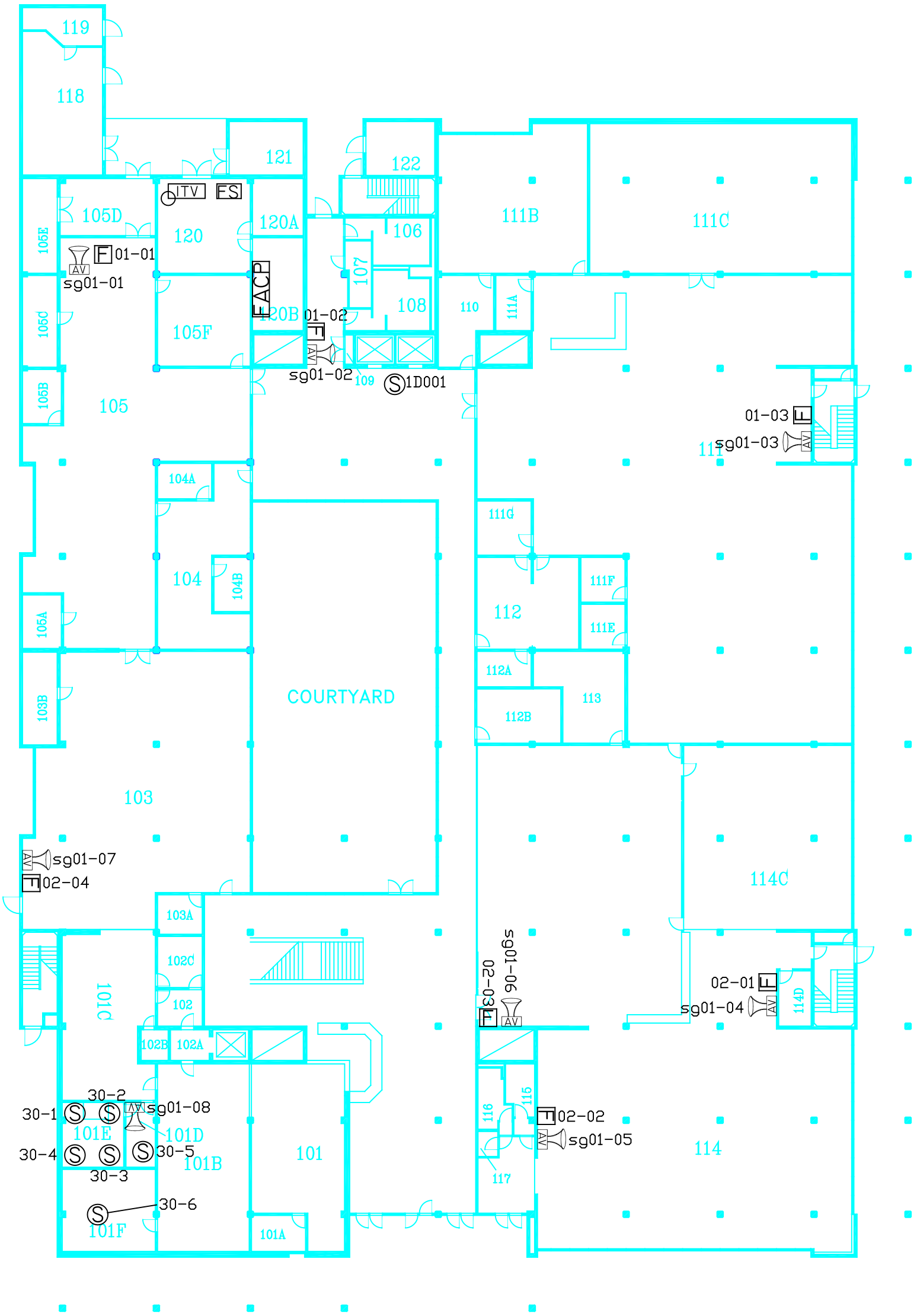
- EXIT SIGN
- EXIT SIGN WITH DIRECTION
- 2–HOUR FIRE WALL
- FIRE EXTINGUISHER

SCALE 1:350

APPENDIX B

B1

Robert E. Kennedy Library 035 Floor 1



CAL POLY COMMUNICATIONS SERVICES	ROBERT E. KENNEDY LIBRARY (035) First Floor			Panel # n16
DATE	REVISED BY	FILENAME	NOTES	SCALE
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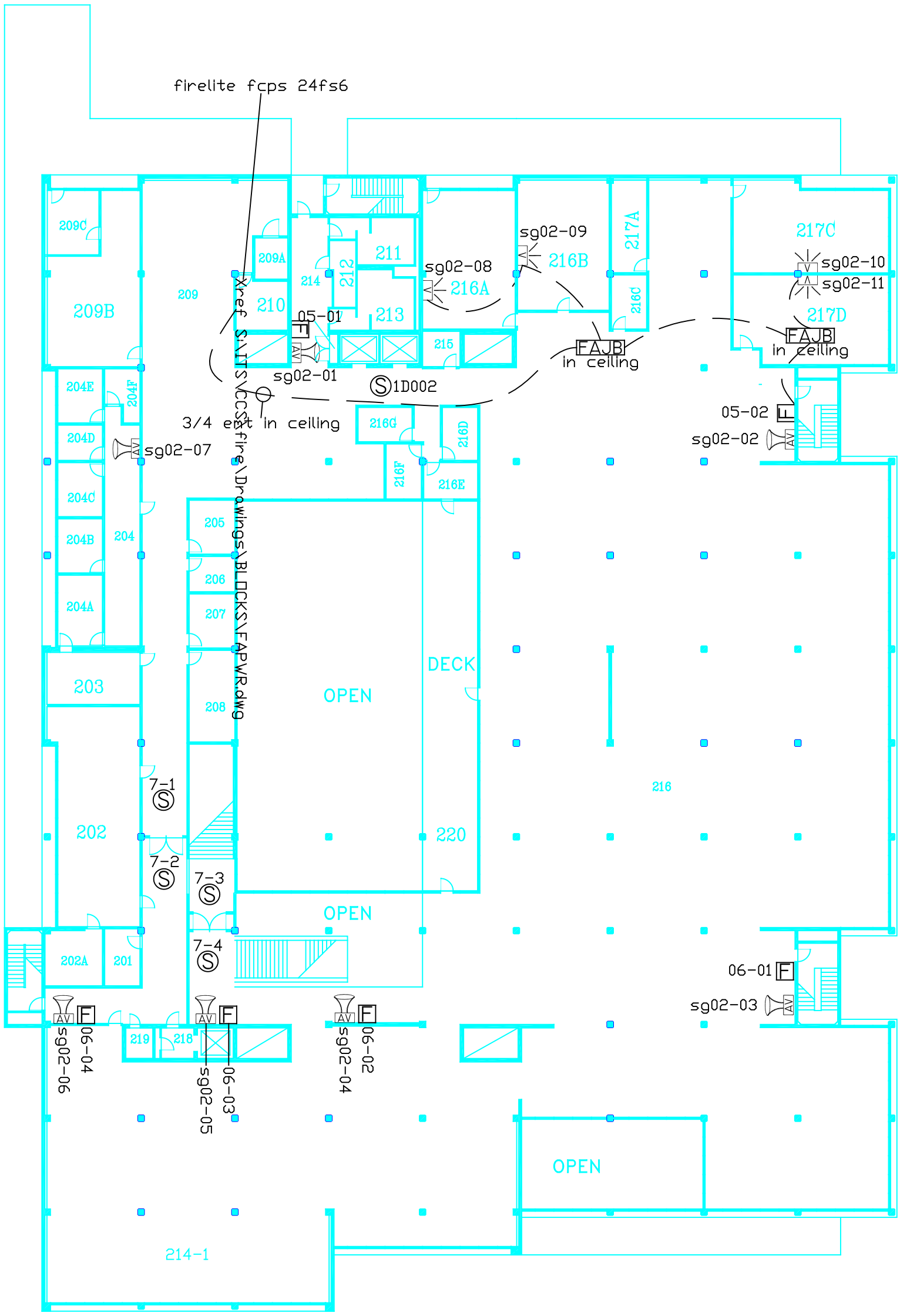
NORTH

Robert E. Kennedy Library 035 Floor2



CAL POLY
COMMUNICATIONS SERVICES

ROBERT E. KENNEDY LIBRARY (035)

Second Floor — Panel # n16

DATE	REVISED BY	FILENAME	NOTES	SCALE
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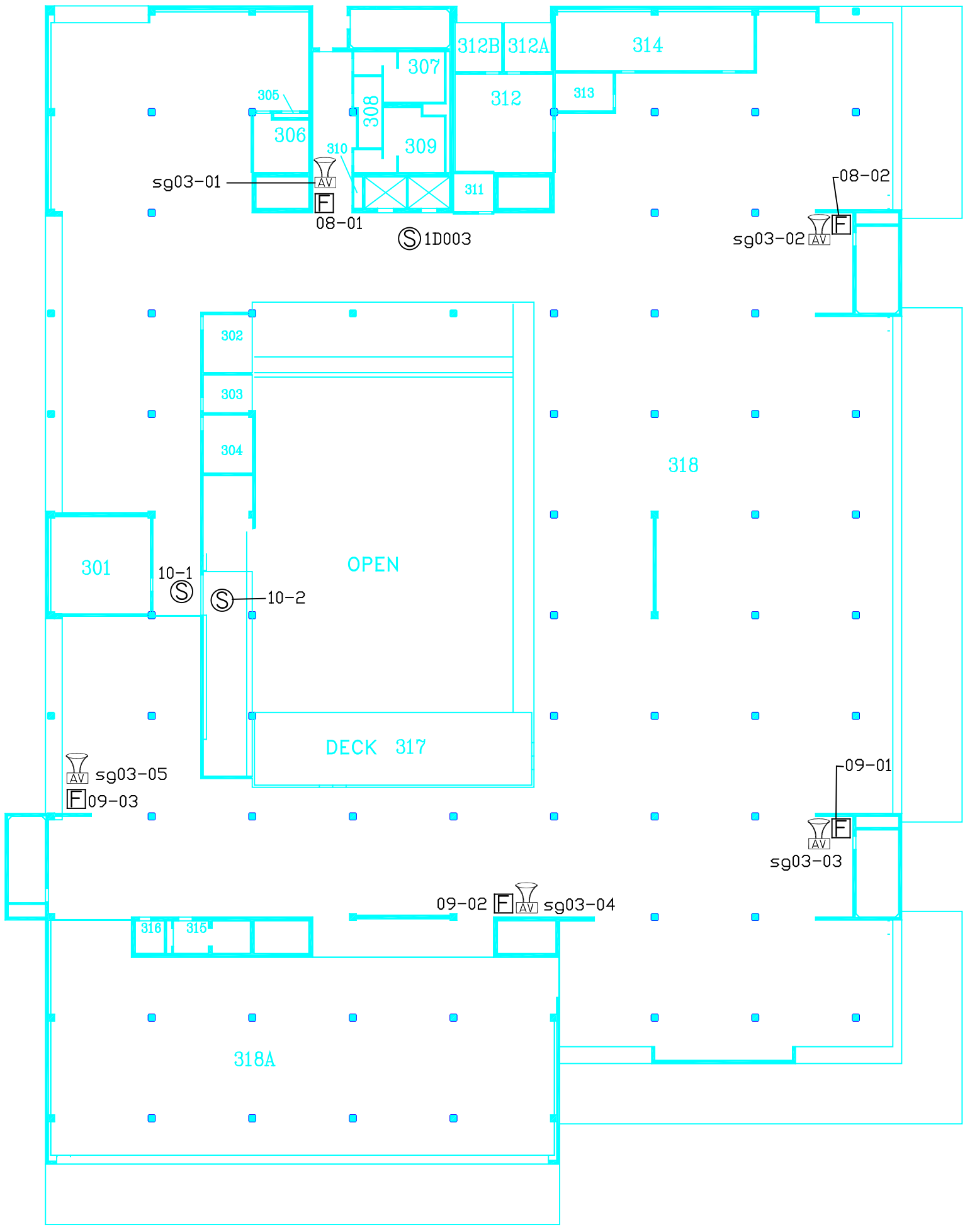
NORTH

Robert E. Kennedy Library 035 Floor3



CAL POLY
COMMUNICATIONS SERVICES

ROBERT E. KENNEDY LIBRARY (035)

Third Floor — Panel # n16

DATE	REVISED BY	FILENAME	NOTES	SCALE
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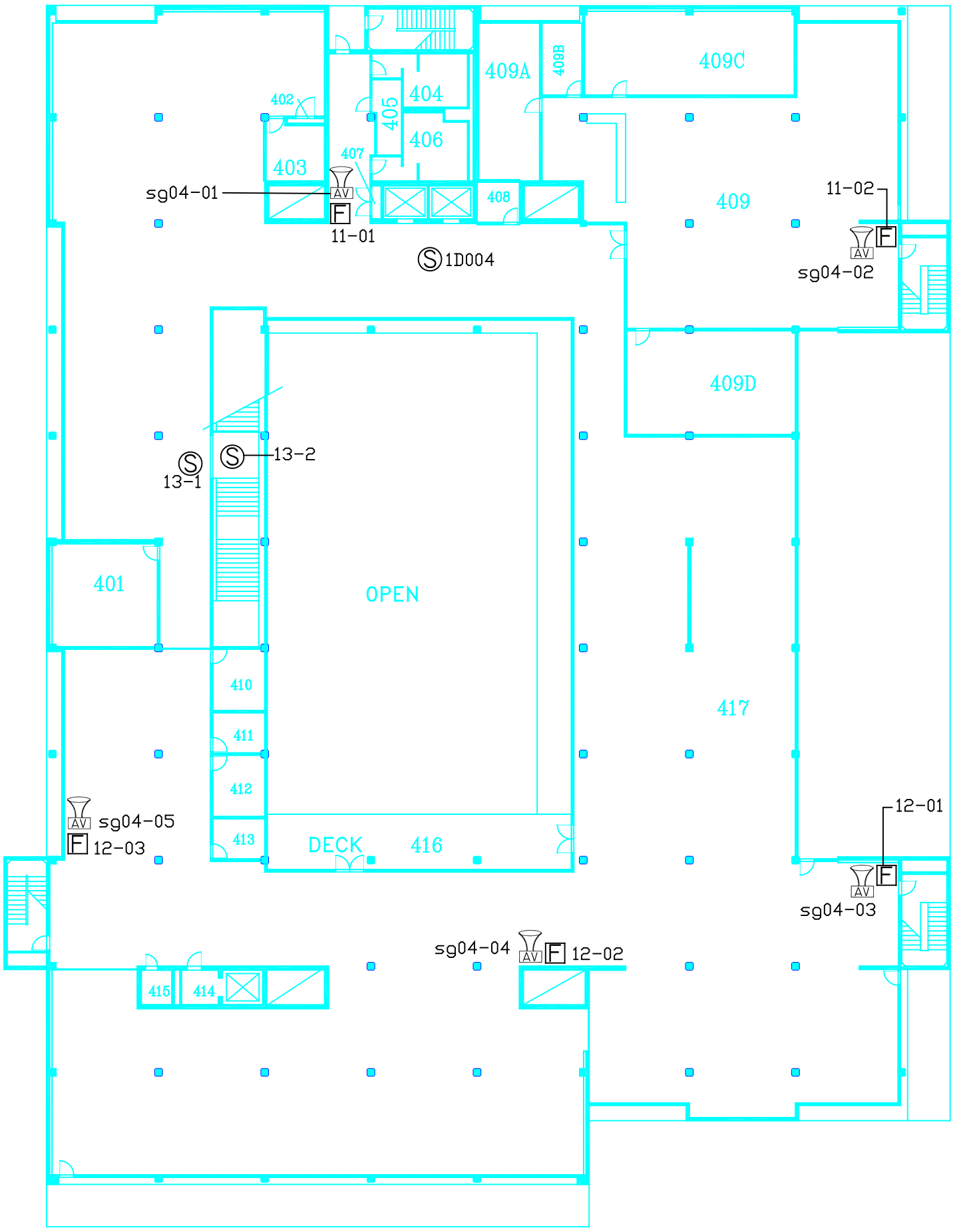
NORTH N

Robert E. Kennedy Library 035 Floor4



CAL POLY
COMMUNICATIONS SERVICES

ROBERT E. KENNEDY LIBRARY (035)

Fourth Floor — Panel # n16

NORTH

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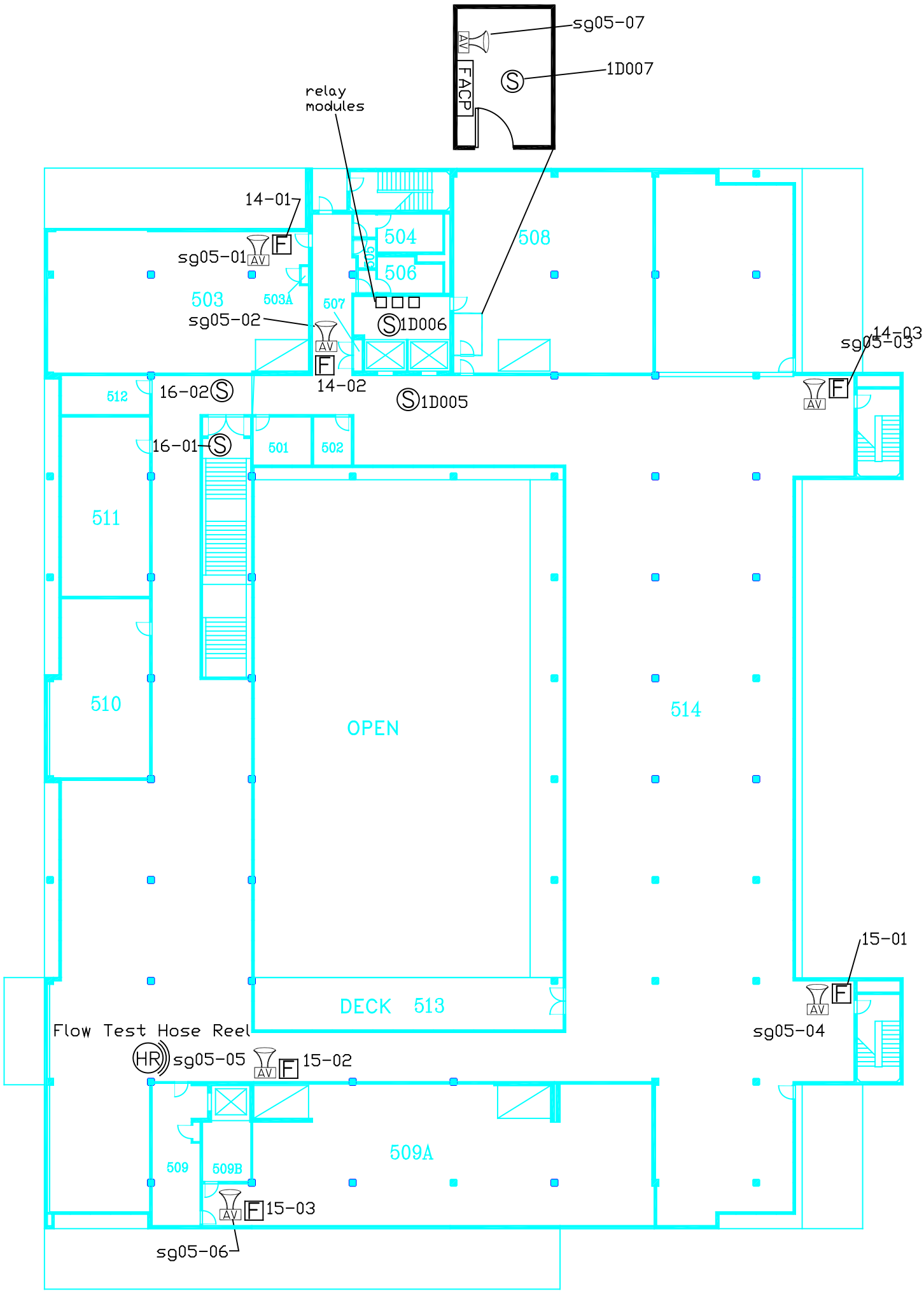
Robert E. Kennedy Library 035 Floor5



CAL POLY
COMMUNICATIONS SERVICES

ROBERT E. KENNEDY LIBRARY (035)

Fifth Floor — Panel # n16

NORTH

DATE	REVISED BY	FILENAME	NOTES	SCALE
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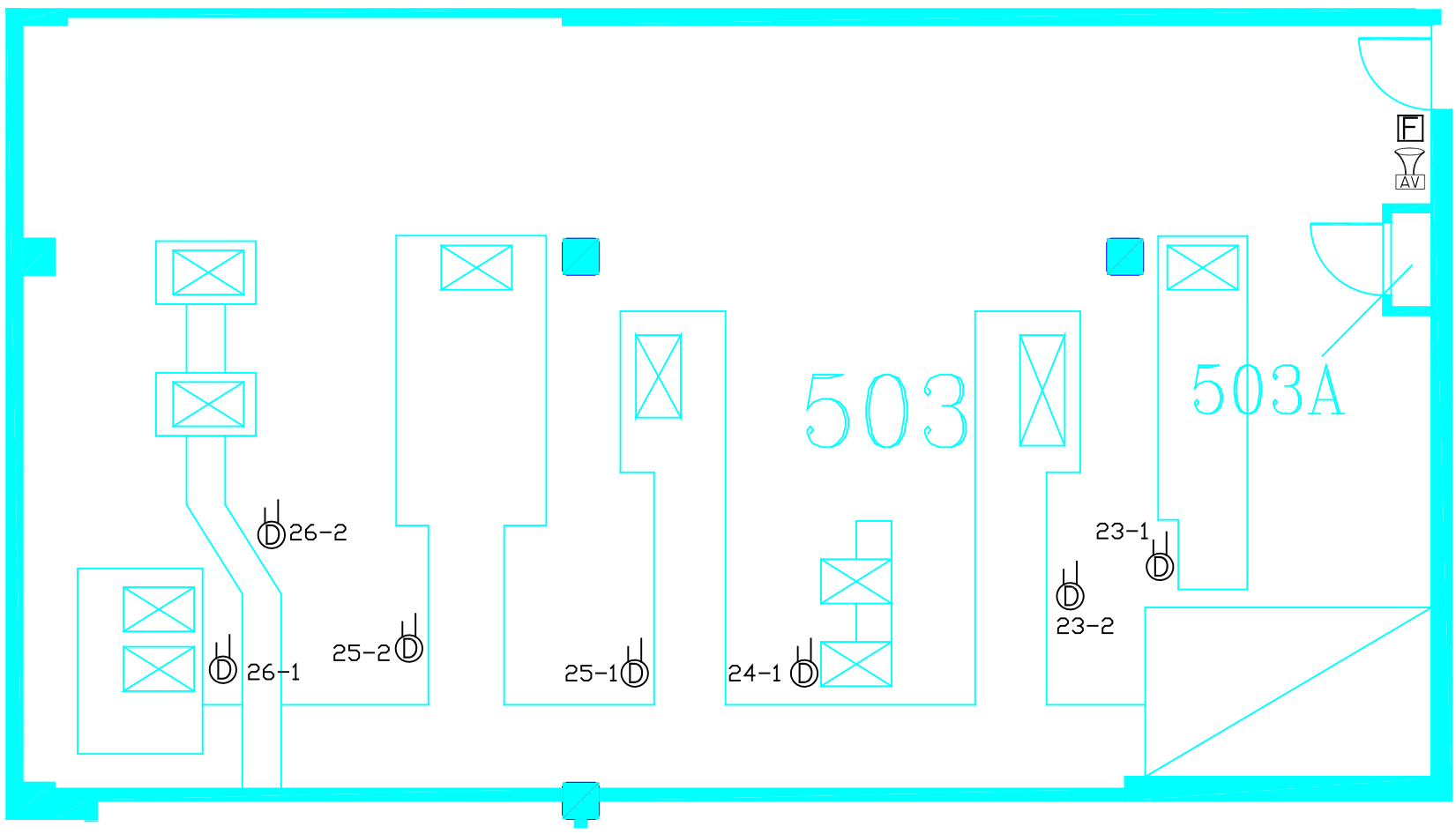
Robert E. Kennedy Library 035 Floor5

Room 503



CAL POLY
COMMUNICATIONS SERVICES

ROBERT E. KENNEDY LIBRARY (035)

Fifth Floor (Room 503) Panel # n16

NORTH

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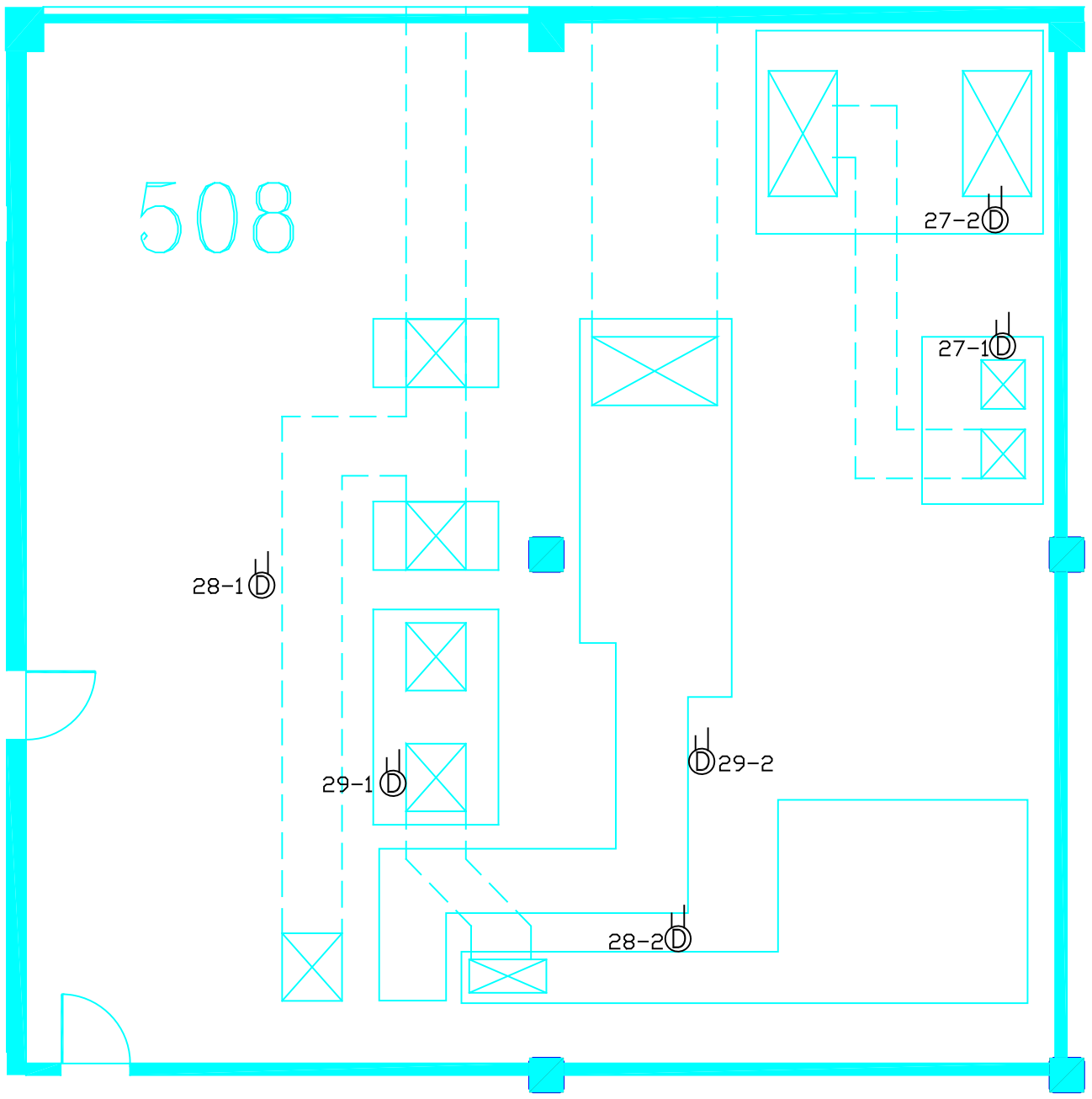

Robert E. Kennedy Library 035 Floor5

Room 508

CAL POLY
COMMUNICATIONS SERVICES

ROBERT E. KENNEDY LIBRARY (035)

Fifth Floor (Room 508) Panel # n16

NORTH N

DATE	REVISED BY	FILENAME	NOTES	SCALE
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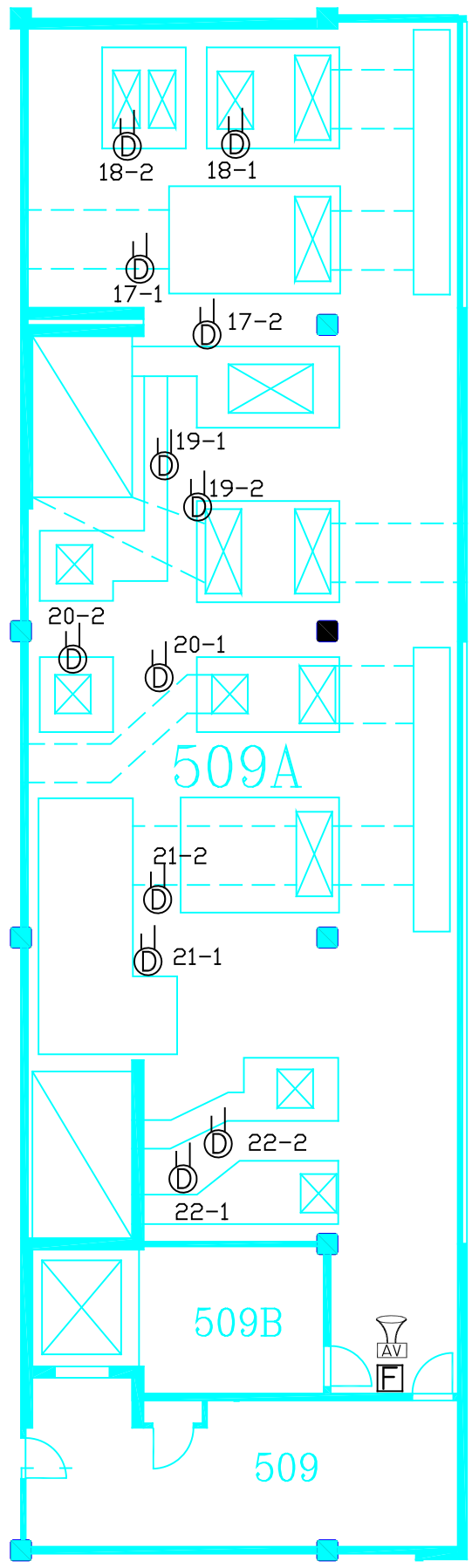

Robert E. Kennedy Library 035 Floor5

Room 509

CAL POLY
COMMUNICATIONS SERVICES

ROBERT E. KENNEDY LIBRARY (035)

Fifth Floor (Room 509) Panel # n16

NORTH

DATE	REVISED BY	FILENAME	NOTES	SCALE
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B2

2098-9201, -9203, & -9208 Photoelectric Detectors, 2098-9202 Photo w/Heat Detector, and 2098-9576 Ionization Detector Installation Instructions

GENERAL INFORMATION

Before installing there detectors, make a survey of the area to be covered in accordance with information provided in NFPA 72 E, Sections 4-1 through 4-6 (an overview of which is provided below). For specific applications, refer to Simplex publication "Common Code Requirements For Fire Alarm Systems" — Publication No. FA2-91-010. For additional information, refer to NFPA 72 E and the NEMA Guide For Proper Use of System Smoke Detectors.

SPECIAL CONSIDERATIONS

- Is there human occupancy?
- Contents to be protected.
- Type of construction and use.
- Burning characteristics of contents.
- Air movement - stratification.
- Deflections and obstructions.
- Height of ceilings.
- Surface conditions of ceilings.
- Type of ceiling construction.
- Total area.
- Vent locations - velocities - dilution.

APPLICATIONS

Each detector is capable of providing from 450 to 900 square feet (42 to 84 square meters) of coverage, depending on:

1. Requirements of local codes.
2. Results of engineering evaluation.
3. Physical characteristics of protected area.

   Examples:

   a. Smooth, flat ceiling
      - Detectors may be spaced 30 feet (9 meters) apart.

   b. Ceiling divided by beams of more than 18 in. (46 cm) depth
      - At least one detector will be required in the space between every two beam.

   c. Ceiling divided by beams of more than 8 in. (20 cm) but less than 18 in. (46 cm) depth
      - Reduce the coverage area for each detector, and mount the detector to the bottom of the beams.

Important

Smoke must enter the chamber of the detector. Thus, air flow, air stratification, air velocity, air stagnation, and air migration will affect detector efficiency. Therefore:

- Do not install detectors in areas where temperatures are likely to exceed 100°F (38°C) or fall below 32°F (0°C).
- Do not install detectors on a ceiling within 4 inches (10 cm) of a wall.
- Do not install detectors where forced air ventilation may dilute the smoke before it reaches the detector.
- Do not install detectors in areas where smoke is normally present (kitchens, furnace rooms, laundry rooms, loading docks, rooms with fireplaces, rooms with candles, soldering rooms, etc.).

Suffix "C" following an 8-digit Product ID number denotes ULC-listed product.

PER-21-007 (575-285)
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- Do not install detectors in areas where there is likely to be steam (in hospital patient rooms with vaporizers, near shower rooms, above large sinks, etc.).
- Do not install detectors above ashtrays in elevator lobbies.
- Wall-mounted detectors should be located 4 to 12 inches (10-30.5 cm) from the ceiling to detector head.
- Protect all detector heads during construction to avoid infiltration of construction debris!

MAINTENANCE

The minimal requirement for detector maintenance should consist of cleaning surface dust by using a vacuum cleaner. Cleaning programs should comply with NFPA and local environments. Cleaning of the internal chamber should be done by Simplex technical representative only.

TEST EQUIPMENT AVAILABLE

2098-9822 (553-394) Extendable Smoke Generator
2098-9809 (553-533) Sensitivity Tester
2098-9814 (553-536) Test and Removal Tool (for use with 2098-9201, -9202, -9203, & -9576)
2098-9815 (553-553) Test and Removal Tool Holder (for use with 553-536 & 553-574)
(553-574) Test and Removal Tool (for use with 2098-9208)

TESTING

Before testing, disconnect city, release devices, and extinguish systems. Notify all appropriate personnel of test. The preferred test is with smoke using a 553-394 Extendable Smoke Generator. If this method is not acceptable or practical, a functional test can be performed by using a Test and Removal Tool. To test the detector, place the test tool around the detector body. This will alarm the detector. To clear the detector, remove the test tool and reset the fire alarm panel.

TABLE 1

SPECIFICATIONS	SMOKE DETECTOR DATA				
Detector	2098-9576	2098-9201	2098-9202	2098-9203	†2098-9208
Type of Detector	Ionization	Photoelectric	Photoelectric with Heat	Photoelectric	Photoelectric
Working Voltage (2-Wire)	15-36.3 VDC	15-36.3 VDC	15-36.3 VDC	15-36.3 VDC	15-32 VDC
Rated Voltage (4-Wire)	17.7-33.0 VDC	17.7-33.0 VDC	17.7-33.0 VDC	17.7-33.0 VDC	17.7-33.0 VDC
Voltage Waveform	Filtered DC * 18V Ripple Max.	Filtered DC * 18V Ripple Max.	Filtered DC * 18V Ripple Max.	Filtered DC * 18V Ripple Max.	Filtered DC † 18V Ripple Max.
Max. Alarm Current	86 mA	86 mA	86 mA	86 mA	86 mA
Surge Current	200 uA	200 uA	200 uA	200 uA	200 uA
Standby Current	40 uA	40 uA	40 uA	40 uA	50 uA
Heat Element Rating	N/A	N/A	135 Degrees F	N/A	N/A
** Compatibility Identifier	2098-9576	2098-9201	2098-9202	2098-9203	2098-9208
Test Procedure	Magnet or 553-536	Magnet or 553-536	Magnet or 553-536	Magnet or 553-536	Magnet or 553-574
Max. Qty. Per Initiating Circuit	See Table 4	See Table 4	See Table 4	See Table 4	See Table 4

† **CAUTION:** Do not use the 2098-9208 detector with the 2098-9734 power pack. The 2098-9208 does not operate from a full wave, rectified (unfiltered) DC power source.

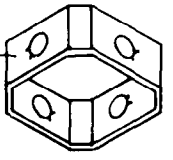
* When using 2098-9536 four-wire base, full wave, rectified DC can be used.

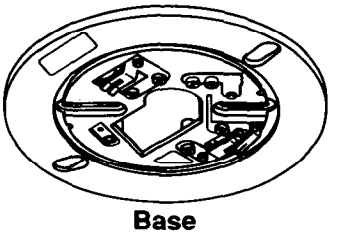
** Compatibility identifier is the PID (model number) found on the panel or module and detector base.

TABLE 2

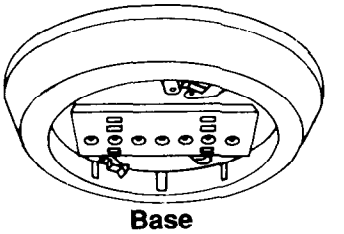
BASE	BOX MOUNTING		
	3 1/2" OCTAGONAL	4" OCTAGONAL	4" SQUARE
2098-9211	Yes	Yes	Yes
2098-9637	Yes	Yes	Yes
2098-9536	Yes	Yes	No

4" (10.16 CM) Octagonal Outlet Box Not Furnished by Simplex Wire per NEC Article 370

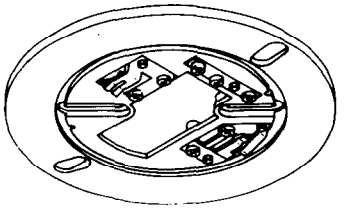




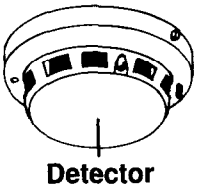
Base 2098-9211



Base 2098-9536



2098-9637 Base



Detector 2098-9201, 2098-9203, OR 2098-9576

Detector 2098-9202

Detector 2098-9208

TABLE 3

INITIATING CIRCUITS OR PANEL PID (MODEL NO.)
2120-7012
2120-7013
2120-7014
2120-7015
2120-7019
2120-7023
2120-7024
2120-7031
2120-7032
2120-7033
4002-5001
4002-5002
4002-5003
4002-5004
4020-0305
4020-7003
4100-5001
4100-5002
4100-5011
4100-5012

TABLE 4

DETECTOR HEADS	COMPATIBLE 2-W BASE	MAX. QTY. OF BASES PER INITIATING CIRCUIT
2098-9201, 2098-9202, 2098-9203, 2098-9208, or 2098-9576	2098-9211	30 (SeeTable 3 and Note 5)
	or	
	2098-9211 with 2098-9738 or 2098-9827	1 (See Note 1)
	2098-9637	30 (SeeTable 3 and Note 5)
	or	
	2098-9637 with 2098-9738 or 2098-9827	1 (See Note 1)

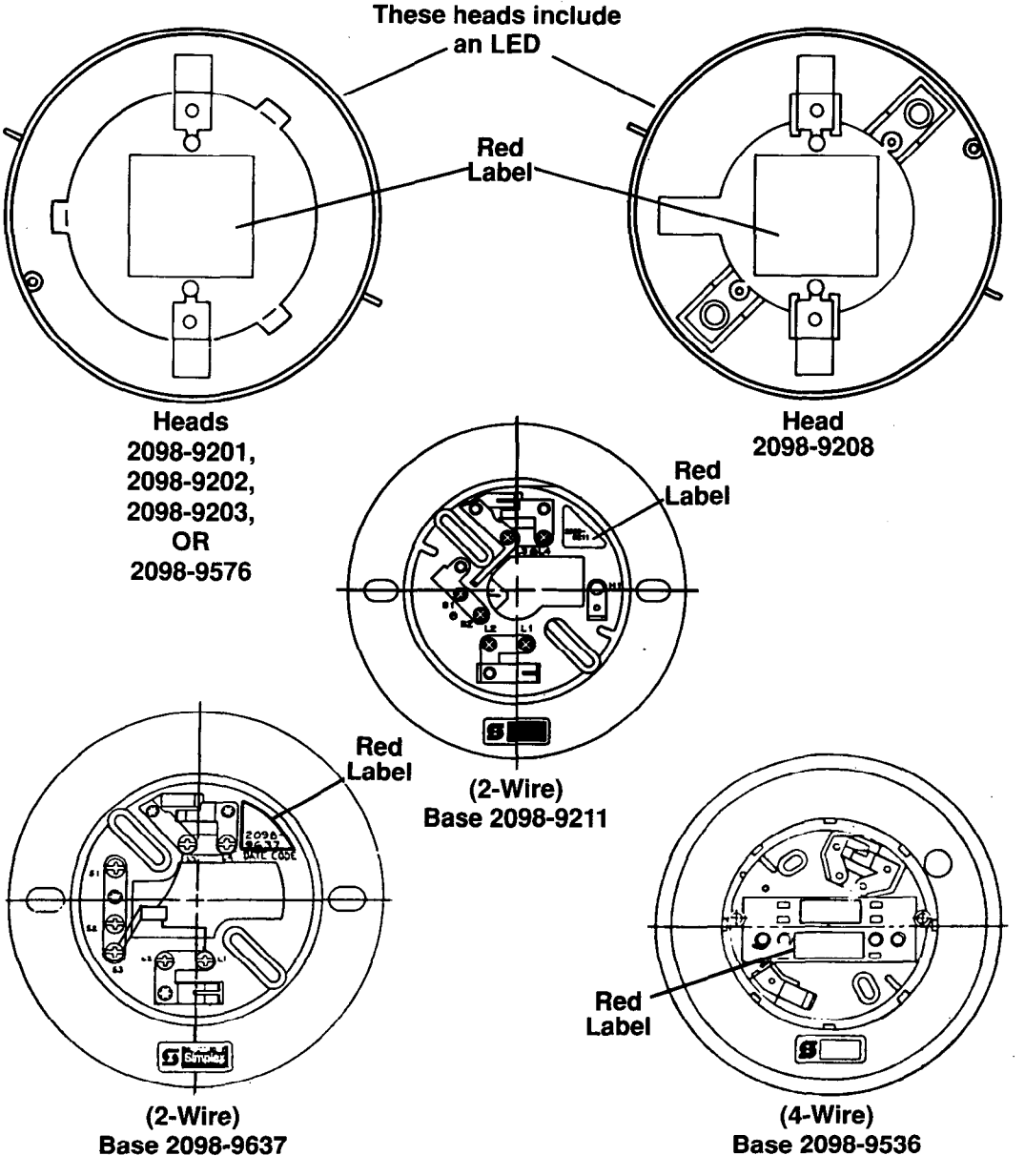
Notes

1. Relay operation cannot be guaranteed unless it is the only device on that zone.
2. Panel compatibility identification marker is the model number of the module or panel.
3. Detector compatibility identification marker is the model number found on the detector label.
4. For detailed interconnection data, see wiring diagrams in Document 841-687.
5. Exceptions for the maximum quantity of 30 bases per initiating circuit are as follows:

Initiating Circuit	Qty. of Bases
2120-0523	20
2120-0527	20
2120-7011	18
2120-7022	18
2120-7805	25
2120-7806	25
4001-9403	18
4001-9404	18
4001-9813	18

WARNING

Red-labeled detector heads MUST only be used with red-labeled bases. Use in any other base will result in a non-functioning detector.

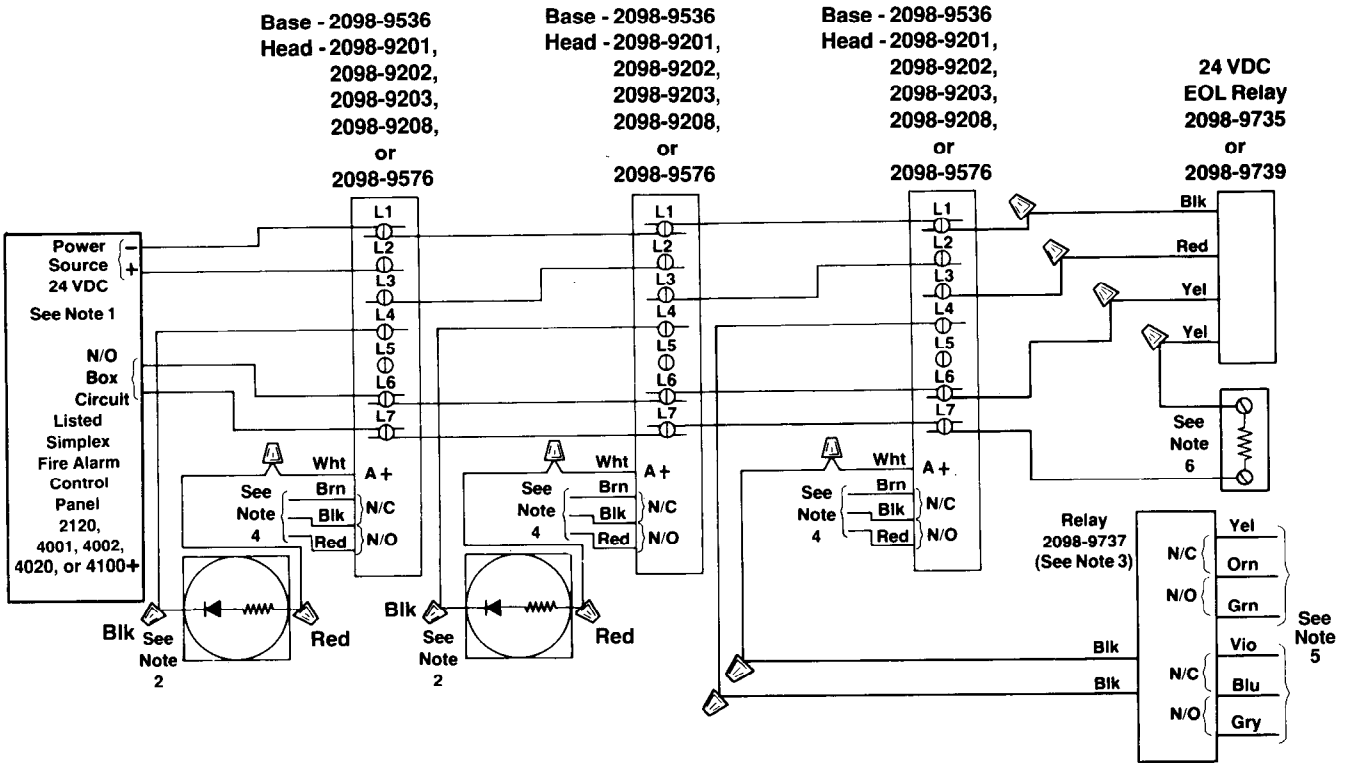


CAUTION

Install the bases in this instruction in accordance with applicable NFPA standards, local codes, and the authorities having jurisdiction. Failure to follow these instructions may result in failure of the detector to initiate an alarm condition. Simplex is not responsible for detectors that have been improperly installed, tested, or maintained.

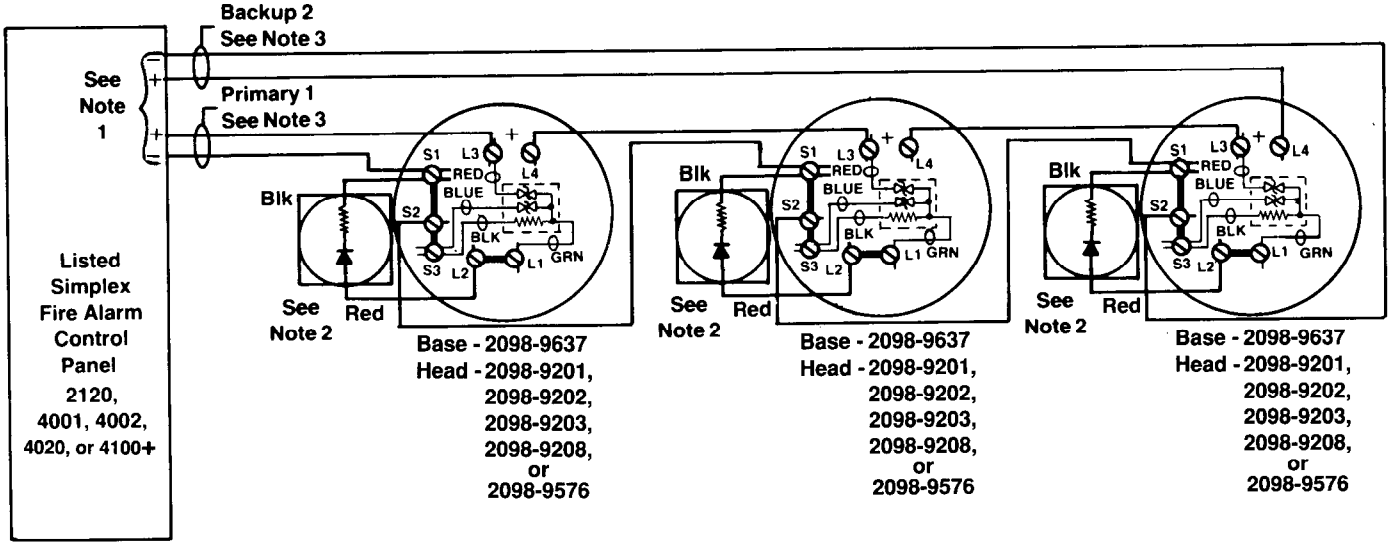
CAUTION

CONNECT WIRING TO TERMINALS AS SHOWN. DO NOT LOOP WIRE UNDER TERMINALS. BREAK WIRE RUN TO PROVIDE SUPERVISION OF CONNECTIONS.



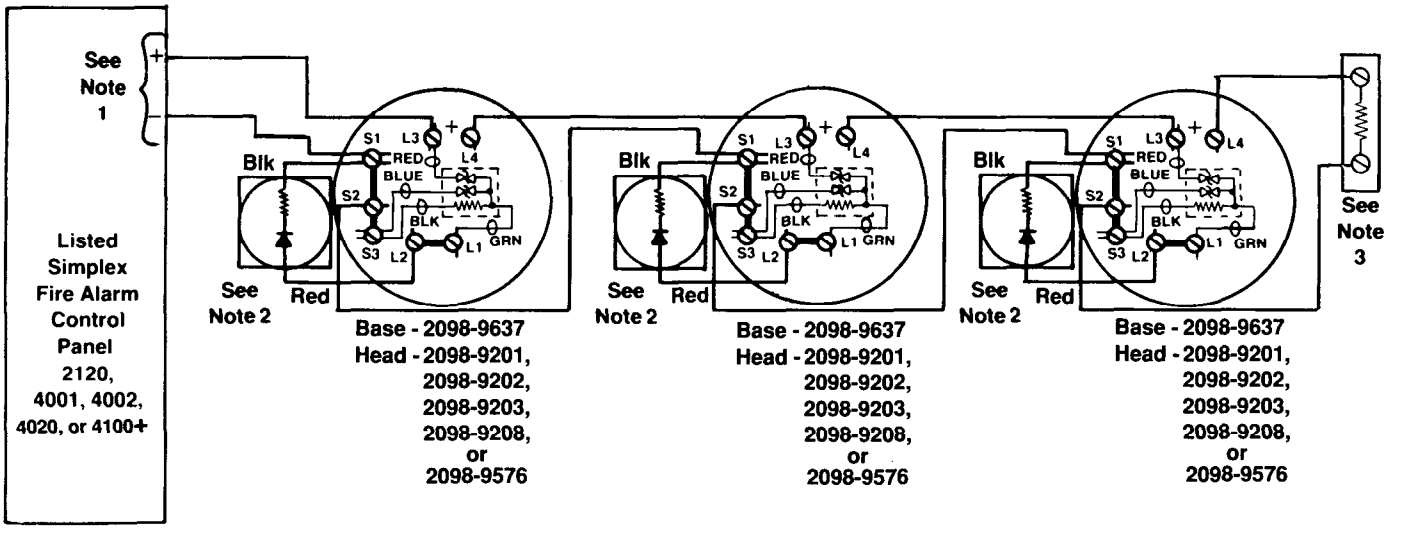
Notes: 1. Refer to wiring diagrams (841-687) provided with system panel for proper panel connections.
2. If used, remote LED (2098-9808) is polarized; observe color-coded wiring. DO NOT USE RELAY if LED is used.
3. DO NOT USE REMOTE LED when relay (2098-9737) is used.
4. Aux. alarm contacts – form C – each rated 1A @ 24VDC or 115VAC, resistive.
5. Aux. alarm contacts – two form C – each rated 3A @ 24VDC or 115VAC, resistive.
6. Refer to wiring diagrams provided with system panel for proper end-of-line resistor value.

2098-9536 BASE CONNECTIONS



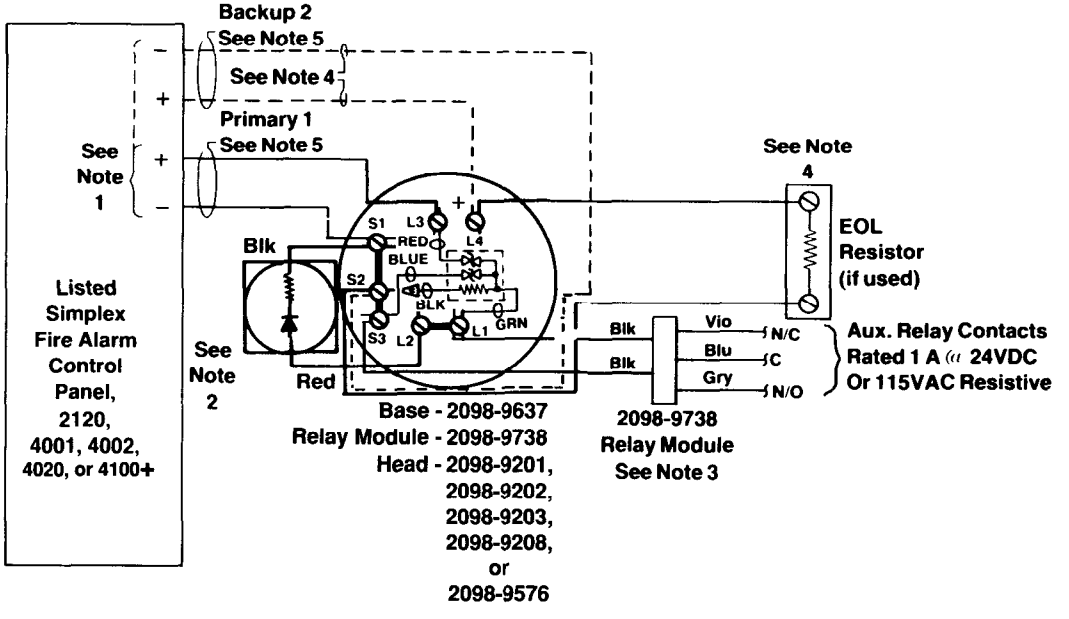
Notes: 1. Refer to wiring diagrams (841-687) provided with system panel for proper panel connections.
2. If used, remote LED (2098-9808) is polarized; observe color-coded wiring.
3. It is recommended that the primary-1 and the backup-2 lines be in separate wire runs and in compliance with local requirements.

2098-9637 BASE CONNECTIONS FOR STYLE D (FORMERLY CLASS A) INITIATE CIRCUIT



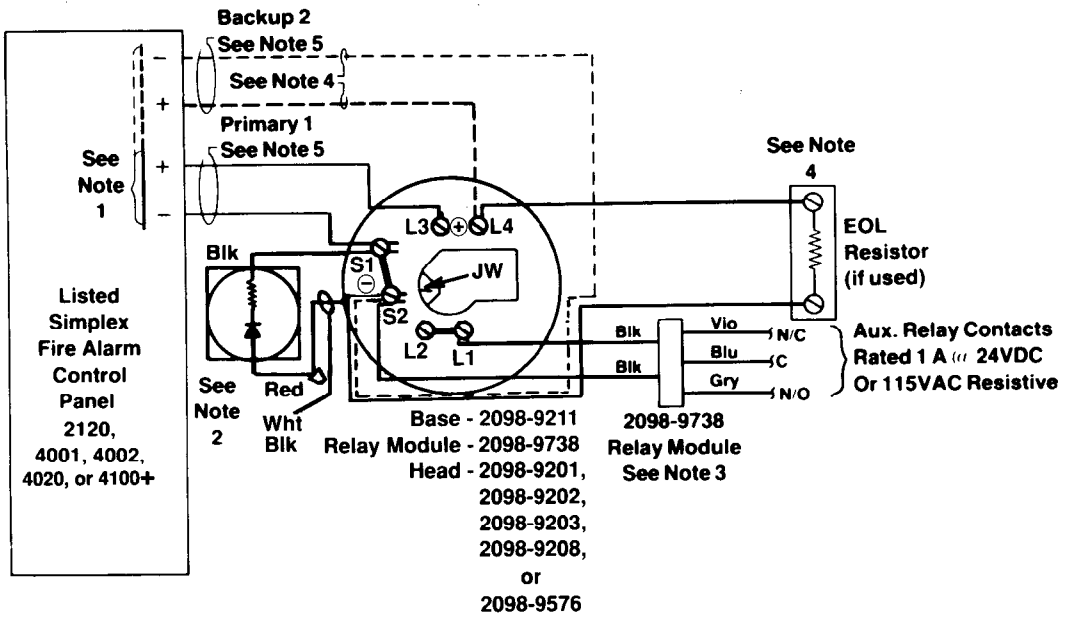
Notes: 1. Refer to wiring diagrams (841-687) provided with system panel for proper panel connections.
2. If used, remote LED (2098-9808) is polarized; observe color-coded wiring.
3. Refer to wiring diagrams provided with system panel for proper end-of-line resistor value.

2098-9637 BASE CONNECTIONS FOR STYLE B (FORMERLY CLASS B) INITIATE CIRCUIT



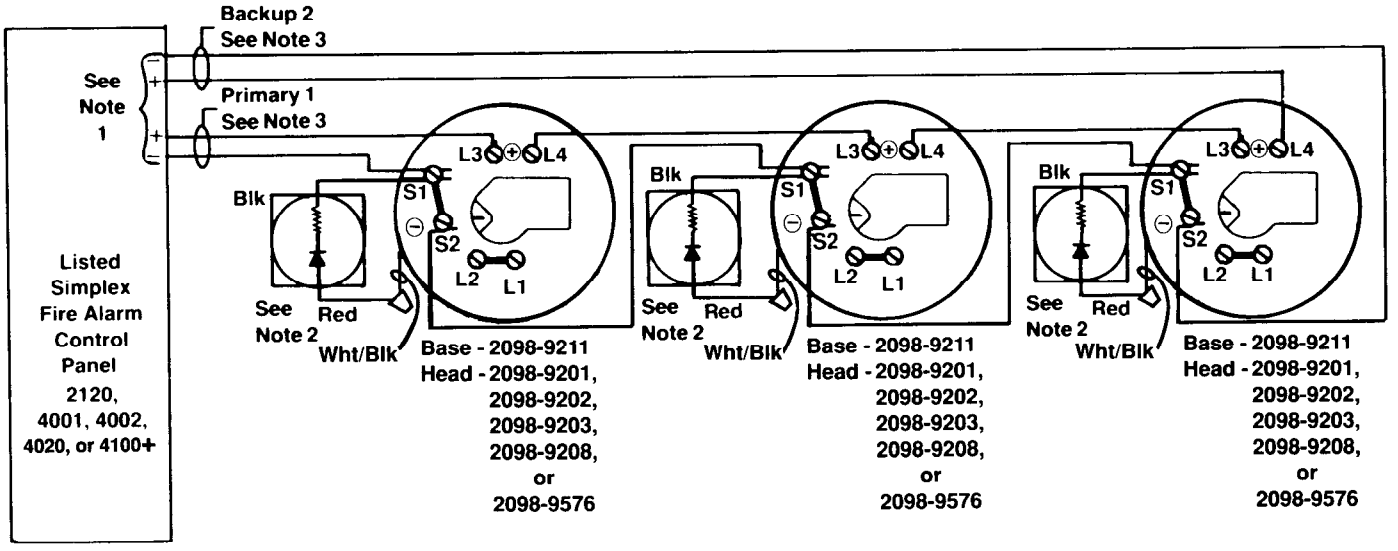
Notes: 1. Refer to wiring diagrams (841-687) provided with system panel for proper panel connections.
2. If used, remote LED (2098-9808) is polarized; observe color-coded wiring.
3. When wiring relay to base, remove resistor (black wire) from base terminal S3. Wire only one base/relay per initiate circuit.
4. For Style D (formerly Class A) initiate circuit, wire per dotted lines and do not use EOL resistor. If Style B (formerly Class B) initiate circuit, refer to wiring diagrams provided with system panel for proper EOL resistor value.
5. For Style D (formerly Class A) wiring, it is recommended that the primary-1 and the backup-2 lines be in separate wire runs and in compliance with local requirements.

2098-9637 WITH 2098-9738
BASE AND RELAY CONNECTIONS FOR STYLE B (FORMERLY CLASS B) OR STYLE D (FORMERLY CLASS A) INITIATE CIRCUIT



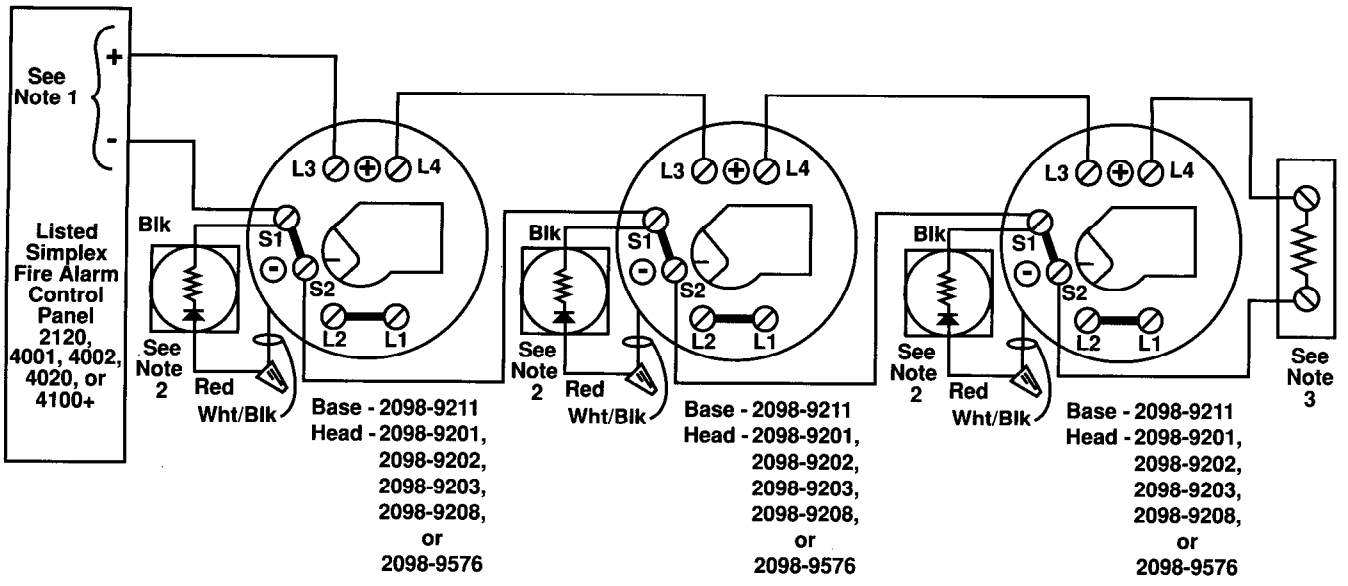
Notes: 1. Refer to wiring diagrams (841-687) provided with system panel for proper panel connections.
2. If used, remote LED (2098-9808) is polarized; observe color-coded wiring.
3. When wiring relay to base, cut JW. Wire only one base/relay per initiate circuit.
4. For Style D (formerly Class A) initiate circuit, wire per dotted lines and do not use EOL resistor. If Style B (formerly Class B) initiate circuit, refer to wiring diagrams provided with system panel for proper EOL resistor value.
5. For Style D (formerly Class A) wiring, it is recommended that the primary-1 and the backup-2 lines be in separate wire runs and in compliance with local requirements.

2098-9211 WITH 2098-9738
BASE AND RELAY CONNECTIONS FOR STYLE B (FORMERLY CLASS B) OR STYLE D (FORMERLY CLASS A) INITIATE CIRCUIT



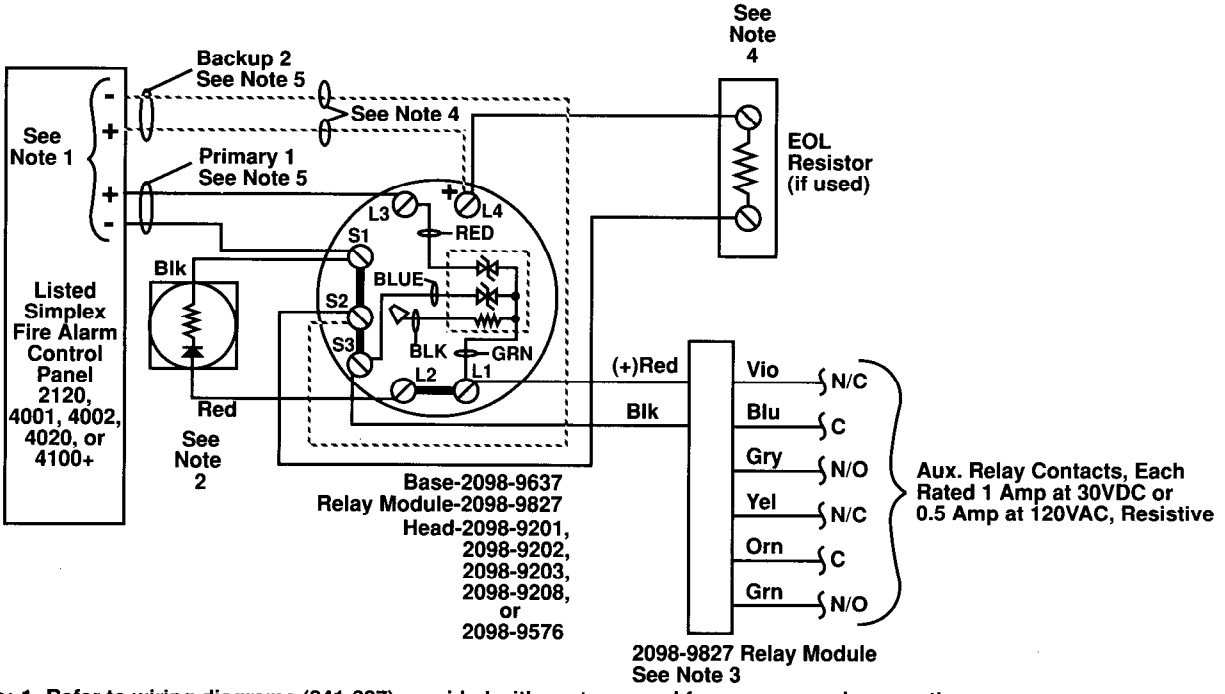
Notes: 1. Refer to wiring diagrams (841-687) provided with system panel for proper panel connections.
2. If used, remote LED (2098-9808) is polarized; observe color-coded wiring.
3. It is recommended that the primary-1 and the backup-2 lines be in separate wire runs and in compliance with local requirements.

2098-9211 BASE CONNECTIONS FOR STYLE D (FORMERLY CLASS A) INITIATE CIRCUIT



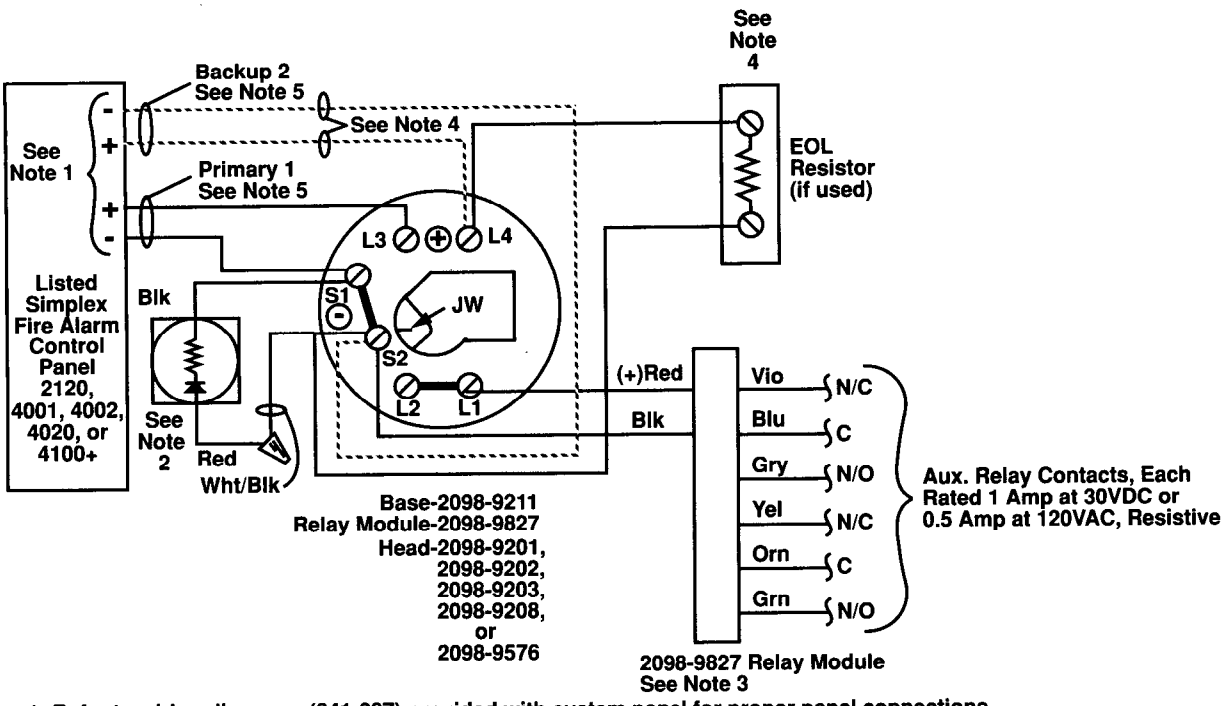
Notes: 1. Refer to wiring diagrams (841-687) provided with system panel for proper panel connections.
2. If used, remote LED (2098-9808) is polarized; observe color-coded wiring.
3. Refer to wiring diagrams provided with system panel for proper end-of-line resistor value.

2098-9211 BASE CONNECTIONS FOR STYLE B (FORMERLY CLASS B) INITIATE CIRCUIT



Notes: 1. Refer to wiring diagrams (841-687) provided with system panel for proper panel connections.
2. If used, remote LED (2098-9808) is polarized; observe color-coded wiring.
3. When wiring relay to base, remove resistor (black wire) from base terminal S3. Wire only one base/relay per initiate circuit.
4. For Style D (formerly Class A) initiate circuit. wire per dotted lines and do not use EOL resistor. If Style B (formerly Class B) initiate circuit, refer to wiring diagrams provided with system panel for proper EOL resistor value.
5. For Style D (formerly Class A) wiring, it is recommended that the primary-1 and the backup-2 lines be in separate wire runs and in compliance with local requirements.

2098-9637 with 2098-9827
BASE AND RELAY CONNECTIONS FOR STYLE B (FORMERLY CLASS B) OR STYLE D (FORMERLY CLASS A) INITIATE CIRCUIT



Notes: 1. Refer to wiring diagrams (841-687) provided with system panel for proper panel connections.
2. If used, remote LED (2098-9808) is polarized; observe color-coded wiring.
3. When wiring relay to base, cut JW. Wire only one base/relay per initiate circuit.
4. For Style D (formerly Class A) initiate circuit. wire per dotted lines and do not use EOL resistor. If Style B (formerly Class B) initiate circuit, refer to wiring diagrams provided with system panel for proper EOL resistor value.
5. For Style D (formerly Class A) wiring, it is recommended that the primary-1 and the backup-2 lines be in separate wire runs and in compliance with local requirements.

2098-9211 WITH 2098-9827
BASE AND RELAY CONNECTIONS FOR STYLE B (FORMERLY CLASS B) OR STYLE D (FORMERLY CLASS A) INITIATE CIRCUIT

LIMITATIONS OF SMOKE DETECTORS

The smoke detectors used with these bases are designed to activate and initiate emergency action, but will do so only when used in conjunction with other equipment. They are designed for installation in accordance with NFPA standards 72-1990 and 72E.

Smoke detectors will not work without power. AC or DC powered smoke detectors will not work if the power supply is cut off for any reason.

Smoke detectors will not sense fires which start when smoke does not reach the detectors. Smoke from fires in chimneys, in walls, on roofs or on the other side of closed doors may not reach the smoke detector and alarm it.

A detector may not detect a fire developing on another level of a building. For this reason, detectors should be located on every level of a building.

Smoke detectors have sensing limitations, too. Ionization detectors are better at detecting fast, flaming fires than slow, smoldering fires. Photoelectric detectors sense smoldering fires better than flaming fires. Because fires develop in different ways, and are often unpredictable in their growth, neither type of detector is always best, and a given detector may not always provide warning of a fire. In general, detectors cannot be expected to provide warning for fires resulting from inadequate fire protection practices, violent explosions, escaping gases, improper storage of flammable liquids like cleaning solvents, other safety hazards, or arson.

Smoke detectors cannot last forever. Smoke detectors contain electronic parts. Even though detectors are made to last for many years, any of these parts could fail at any time. Therefore, test your smoke detector system per NFPA 72E & 72H at least semi-annually. Clean and take care of your smoke detectors regularly.

B3

Multi-Application Peripherals and Accessories

ULC Listed

Bells, Chimes, and Buzzers
2901 Series
Bells

FEATURES:

- Modular Design
- Low Operating Current
- DC Operation
- Standard 4” (10.2 cm) Outlet Box Mounting
- High Output Level

6” (15.2 cm) Bell

10” (25.4 cm) Bell

DESCRIPTION:

The Simplex 2901 series bells are modular in design and provide a loud penetrating sound output that is easily heard over most ambient noise levels.

The 2901 series bells are designed for installation on a standard four inch square electrical box or two inch (gangable or non-gangable) switch box.

Bell guards, which cover the entire unit, are also available for any bell size. The 826 yard hood is designed for outdoor use to mount a bell mechanism with bell gong on a weatherproof box. It is designed to allow a maximum amount of signal level to radiate from the hood outwards, yet protect the audible device from the elements.

Weatherproof applications require a weatherproof back box, Model BBX-4.

SELECTION CHART

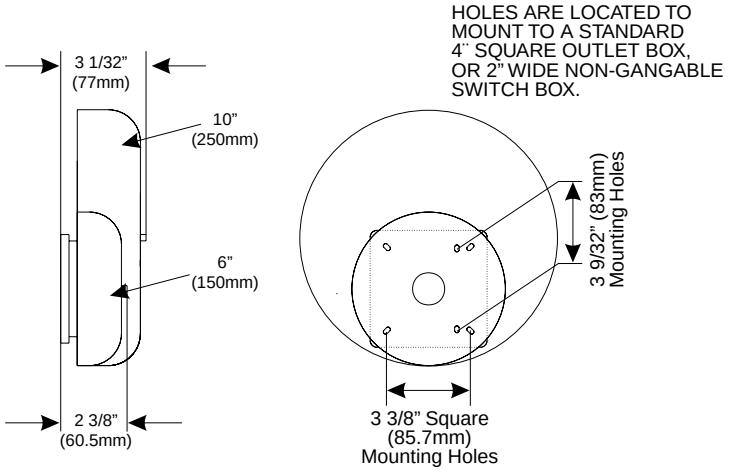
PID #	Gong Size	Rated Voltage	Rated Current	Starting Voltage	Operating Voltage Range	Sound Pressure UL dB Rating	Sound Pressure Indoor Typical
2901-9723	6”	24VDC	25 mA	16VDC	19.2 – 28.8VDC	85 dB	86 - 91 dB
2901-9724	10”	24 VDC	35 mA	16 VDC	19.2 – 28.8 VDC	88 dB	89 - 95 dB

Sound level measurements are made in accordance with UL Standard 484. The sound power output is measured in a reverberant room qualified for pure tones under methods for the Determination of Sound Power Level of Small Sources in Reverberation Rooms, ANSI S1, 21. Bell shall be capable of providing a sound output equivalent to that of an omni-directional source with an A-weighted sound pressure level of at least the level specified in the unit marking but not less than 75 decibels in any case.

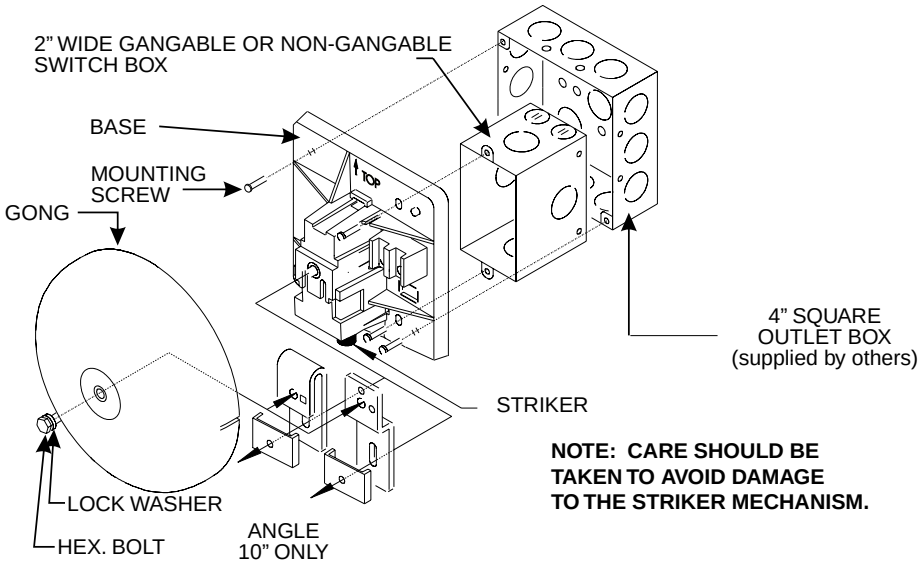
INDOOR MEASUREMENT

Sound level in indoor installation may vary depending on the bell spacing.

BASIC MECHANISM AND GONGS

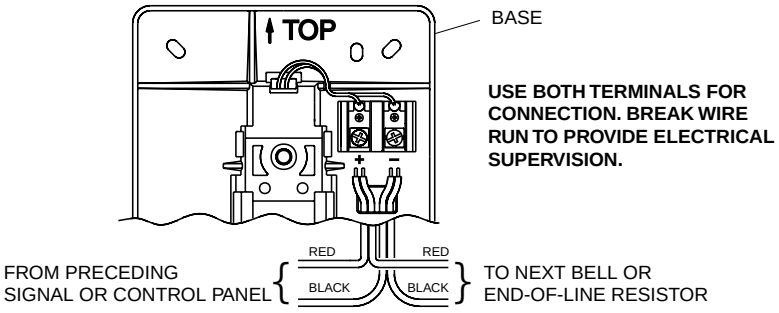


SURFACE INSTALLATION



NOTE: CARE SHOULD BE TAKEN TO AVOID DAMAGE TO THE STRIKER MECHANISM.

WIRING (FRONT VIEW) OBSERVE POLARITY



USE BOTH TERMINALS FOR CONNECTION. BREAK WIRE RUN TO PROVIDE ELECTRICAL SUPERVISION.

S12901-0003-1 11/00
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Offices and Representatives Throughout the World.
Visit us on the world wide web at ***www.simplexnet.com***

B4

GENTEX CORPORATION

Commander³ Series Selectable Candela Evacuation Signals

GEC3/GES3 12 & 24 VDC SERIES

Applications

The Commander³ Series is a low profile strobe and horn/strobe combination that offers dependable audible and visual alarms and the absolute lowest current available.

The GE3 Series 24VDC offers tamperproof field selectable candela options of 15, 30, 60, 75, and 110 candela. The 12VDC offers tamperproof field selectable candela options of 15, 30, 60, and 75 candela.

The Commander³ Series horn offers a continuous or synchable temporal three in 2400Hz and mechanical tone, a chime and whoop tone. All tones are easy for the professional to change in the field by the use of switches.

The GE3 Series has a minimal operating current and has a minimum flash rate of 1Hz regardless of input voltage.

The Commander³ Series is shipped with a standard 4" metal mounting plate which incorporates the popular Super-Slide® feature that allows the installer to easily test for supervision. The product also features a locking mechanism which secures the product to the bracket without any screws showing.

The Commander³ also features the patented Checkmate® - Instant Voltage Verification feature which allows the installer to check the voltage drop draw and match it to the blueprint.

The GE3 Series appliances are ANSI/UL 464 and ANSI/UL 1971, listed for use with fire protective systems and are warranted for three years from date of purchase.

Standard Features

- Nominal voltage 12VDC and 24VDC
- 24VDC units have field selectable candela options of 15, 30, 60, 75 & 110
- 12VDC units have field selectable candela options of 15, 30, 60 & 75
- GEH horn is available in 12VDC or 24VDC
- Unit Dimensions: 5” (12.7 cm) high x 4.5” (11.43 cm) wide x 2.5” (6.35 cm) deep
- Super-Slide® Bracket - Ease of Supervision Testing
- Checkmate® - Instant Voltage Verification
- Synchronize strobe and/or horn with Gentex AVSM Control Module
- Prewire entire system, install mounting bracket, then install signals
- Documented lower installation and operating costs
- Input terminals accept 12 to 18 AWG
- Switch selection for high or low dBA
- Switch for chime, whoop, mechanical and 2400Hz tone
- Tamperproof re-entrant style grill
- Switch for continuous or temporal 3 tone (not available on whoop tone)
- Surface mount with the GSB (Gentex Surface Mount Box)
- Silence audible while visual appliance will remain flashing (for use in accepted jurisdictions)
- Faceplate available in red or off-white

Product Listings

SIGNALING UL LISTED

- ANSI/UL 464 & ANSI/UL 1971 Listed
- CSFM: 7135-0569:122 (GEC3-24 & GEH-24)
  7125-0569:123 (GES3-24)
  7125-0569:129 (GES3-12)
  7135-0569:130 (GEC3-12 & GEH-12)
- MEA: 285-91-E (GEC3-24 & GES3-24)
  580-06-E (GEC3-12 & GES3-12)

Patents

- 7,375,617 May 20, 2008

Product Compliance

- NFPA 72
- Americans with Disabilities Act (ADA)
- IBC/IFC/IRC
- Quality Management System is certified to: ISO 9001:2008

NEMA MEMBER

ASSEMBLED IN THE USA

GEH 12VDC or 24VDC Low Profile Evacuation Horn

Model Number	Part Number	Nominal Voltage	Reverberant dBA at 10ft., per ANSI/UL 464	In Anechoic Room dBA at 10ft.
GEH12-R	904-1239-002	12VDC	62-82	100
GEH12-W	904-1241-002	12VDC	62-82	100
GEH24-R	904-1205-002	24VDC	62-82	100
GEH24-W	904-1207-002	24VDC	62-82	100

GES3 12VDC or 24VDC Selectable Candela, Low Profile Evacuation Strobe

Model Number	Part Number	Nominal Voltage	Candela (ANSI/UL 1971)
GES3-12WR	904-1235-002	12 VDC	15, 30, 60, 75
GES3-12WW	904-1237-002	12 VDC	15, 30, 60, 75
GES3-24WR	904-1321-002	24 VDC	15, 30, 60, 75, 110
GES3-24WW	904-1319-002	24 VDC	15, 30, 60, 75, 110

GEC3 12VDC or 24VDC Selectable Candela, Low Profile Evacuation Horn/Strobe

Model Number	Part Number	Nominal Voltage	Candela (ANSI/UL 1971)	Reverberant dBA at 10ft., per ANSI/UL 464	In Anechoic Room dBA at 10ft.
GEC3-12WR	904-1231-002	12 VDC	15, 30, 60, 75	62-82	100
GEC3-12WW	904-1233-002	12 VDC	15, 30, 60, 75	62-82	100
GEC3-24WR	904-1317-002	24 VDC	15, 30, 60, 75, 110	62-82	100
GEC3-24WW	904-1315-002	24 VDC	15, 30, 60, 75, 110	62-82	100

GE3 Product Strobe Current Ratings (mA)

	12 VDC (8-17.5 Volts)		24 VDC (16-33 Volts)	
Candela	12VDC	UL Max[1]	24VDC	UL Max[1]
15cd	106mA	92mA	30mA	42mA
30cd	131mA	141mA	35mA	58mA
60cd	186mA	260mA	66mA	97mA
75cd	237mA	312mA	80mA	116mA
110cd			103mA	161mA

Model Designations:

W = Wall mount
R = Red Faceplate W = White Faceplate

All units are available in plain (no lettering).
Plain units are non-returnable.

ALERT bezel available for order
AGENT bezel available for order

GE3-12 Product Horn Current Ratings

	Horn Decibel Levels		Horn Current Ratings
Horn Mode	Minimum SPL at 10ft., per ANSI/UL 464 (HIGH)	Minimum SPL at 10ft., per ANSI/UL 464 (LOW)	Regulated 12VDC Max. Operating @ High Setting (mA)
Temp 3 2400Hz	76 dBA	69* dBA	29mA
Temp 3 Mechanical	75 dBA	68* dBA	26mA
Temp 3 Chime	62* dBA	60* dBA	13mA
Continuous 2400Hz	79 dBA	74* dBA	29mA
Continuous Mechanical	78 dBA	72* dBA	26mA
Continuous Chime	63* dBA	61* dBA	13mA
Whoop	78 dBA	71* dBA	55mA

GE3-24 Product Horn Current Ratings

	Horn Decibel Levels		Horn Current Ratings
Horn Mode	Minimum SPL at 10ft., per ANSI/UL 464 (HIGH)	Minimum SPL at 10ft., per ANSI/UL 464 (LOW)	Regulated 24VDC Max. Operating @ High Setting (mA)
Temp 3 2400Hz	78 dBA	71* dBA	28mA
Temp 3 Mechanical	76 dBA	70* dBA	25mA
Temp 3 Chime	70* dBA	66* dBA	15mA
Continuous 2400Hz	81 dBA	74* dBA	28mA
Continuous Mechanical	80 dBA	72* dBA	25mA
Continuous Chime	70* dBA	66* dBA	15mA
Whoop	82 dBA	69* dBA	56mA

NOTES:

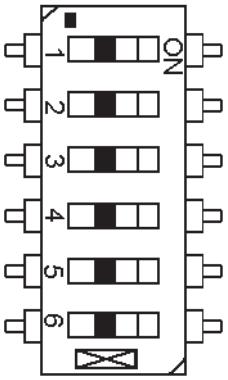
- Operating temperature: 32°to 120°F (0° to 49°C). The GEC3 and GES3 Series is **not** listed for outdoor use.
- For nominal and peak current across ANSI/UL regulated voltage range for filtered DC power and unfiltered (FWR [Full Wave Rectified]) power, see installation manual. 12VDC models are DC only.
- **Gentex does not recommend using a coded or pulsing signaling circuit with any of our strobe products (see Technical Bulletin Number 014).**
- The sound output for the temporal 3 tone is rated lower since the time the horn is off is averaged into the sound output rating. While the horn is producing a tone in the temporal 3 mode its sound pressure is the same as the continuous mode.

* Operating the horn in this mode at this voltage will result in not meeting the minimum ANSI/UL 464 reverberant sound level required for public mode fire protection service. These settings are acceptable only for private mode fire alarm use. Use the high dBA setting for public mode application (not applicable when using the chime tone. The chime tone is always private mode).

[1] RMS current ratings are per ANSI/UL average RMS method. ANSI/UL max current rating is the maximum RMS current within the listed voltage range (16-33VDC for 24VDC units) (8-17VDC for 12VDC units). For strobes the UL max current is usually at the minimum listed voltage (16VDC for 24VDC units) (8VDC for 12VDC units). For audibles the max current is usually at the maximum listed voltage. For unfiltered FWR ratings, see installation manual.

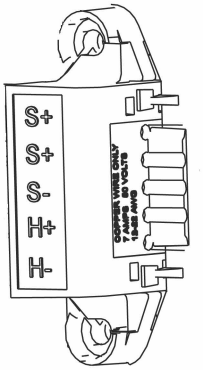
Tone Switch Locations

TONE	SWITCH POSITION		
	3	4	5
Mechanical Temporal 3	ON	ON	ON
Mechanical - Continuous	OFF	ON	ON
2400Hz - Temporal 3	ON	OFF	ON
2400Hz - Continuous	OFF	OFF	ON
Chime - Temporal 3	ON	ON	OFF
Chime - Continuous	OFF	ON	OFF
Whoop	ON	OFF	OFF
Whoop	OFF	OFF	OFF



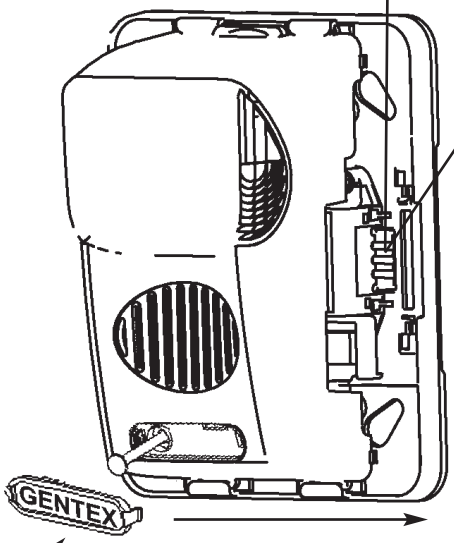
NOTE:

- Switch Positions 1 and 2 in the OFF position to select isolated horn and strobe power inputs
- Switch Position 6 ON = HIGH dBA
- Switch Position 6 OFF = LOW dBA



Gentex Super-Slide® Mounting Bracket

Allows the installer to pre-wire the system, test for system supervision, remove the signal head until occupancy, switch out Gentex signals without changing mounting brackets and has locking edge connector for snap-in-place installation.



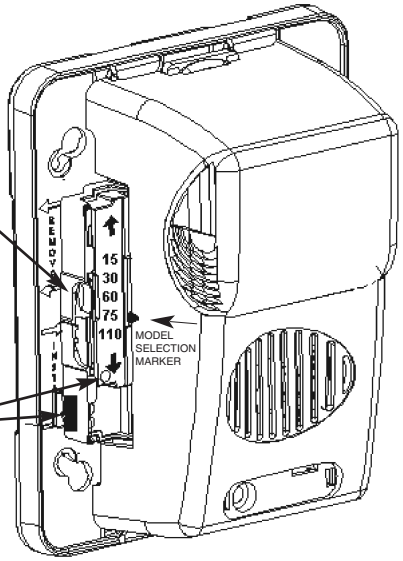
Gentex Checkmate® Instant Voltage Verification

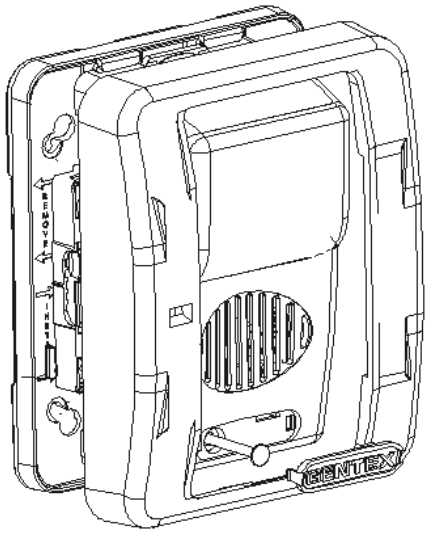
It is often necessary to confirm the voltage drop along a line of devices. The access holes are provided in the back of the terminal block to allow the voltage to be measured directly without removing the device. Typically this would be done at the end of the line to confirm design criteria. Most measurements will be taken using the S+ and S- locations although access is provided to other locations.

NOTE: Care should be taken to not short the test probes.

Candela selection slider switch. Depress center and slide switch to desire brightness level.

Break off pin and insert into hole at the bottom of the selector to lock candela setting. Signal must be removed from bracket and pin pushed forward from backside out of hole to change candela.

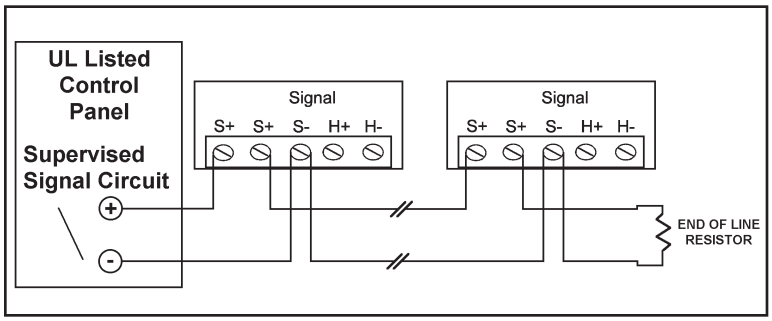


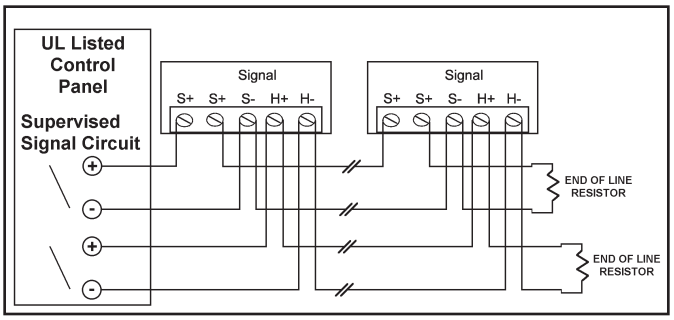


To remove bezel, grip both sides of bezel and pull in a downward and outward motion.

GEC3/GES3
12 & 24 VDC
S E R I E S

Conventional Wiring Diagrams for Emergency Notification Evacuation Series





NOTES:

- All strobes are designed to flash as specified with continuous applied voltage. Strobes should not be used on coded or pulsing signaling circuits. However, use of the Gentex AVSM control module or Gentex synchronization protocol is permitted to synchronize the strobe, horn and/or mute the horn. See Technical Bulletin 014 for additional information.
- **FOR SYNCHRONIZATION WIRING INFORMATION, REFERENCE AVSM CONTROL MODULE DATA SHEET (551-0031) AND/OR AVSM CONTROL MODULE MANUAL (550-0284) FOR SYNCHRONIZATION MODULE WIRING DIAGRAMS. AVSM CONTROL MODULE DATA SHEET AND MANUAL CAN BE OBTAINED AT http://www.gentex.com OR CALL GENTEX CORPORATION AT 1-800-436-8391.**
- **When synchronizing the GE3 12VDC Series, the Gentex AVSM control module or Gentex synchronization protocol MUST be used.**

Architect & Engineering Specifications

The audible and/or visible signal shall be Gentex GEH, GES3, GEC3 Series or approved equal and shall be listed by Underwriters Laboratories, Inc. per ANSI/UL 1971 and/or ANSI/UL 464. The notification appliance shall also be listed with Factory Mutual Listing Service (FM) and the California State Fire Marshal (CSFM).

The notification appliance (combination audible/visible) shall produce a peak sound output of 100dBA or greater at 12VDC or 24VDC as measured in an anechoic chamber. The signaling appliance shall also have the capability to silence the audible signal while leaving the visible signal energized with the use of a single pair of power wires. Additionally, the user shall be able to select either continuous or temporal tone output with the temporal signal having the ability to be synchronized.

Unit shall be capable of being installed so that any unauthorized attempt to change the candela setting will result in a trouble signal at the fire alarm control panel.

The audible/visible and visible signaling appliance shall also maintain a minimum flash rate of 1Hz or up to 2Hz regardless of power input voltage. The strobe appliance shall have an operating current of 42mA or less at 24VDC for the 15Cd strobe circuit and 92mA or less at 12VDC for the 15Cd strobe circuit.

The appliance shall be polarized to allow for electrical supervision of the system wiring. The unit shall be provided with a mounting bracket with terminals and barriers for input/output wiring and be able to mount to a single gang or double gang box or double workbox without the use of an adapter plate. The unit shall have an input voltage range of 16-33 volts with either direct current or full wave rectified power for 24VDC models or a voltage range of 8-17.5 volts for 12VDC models.

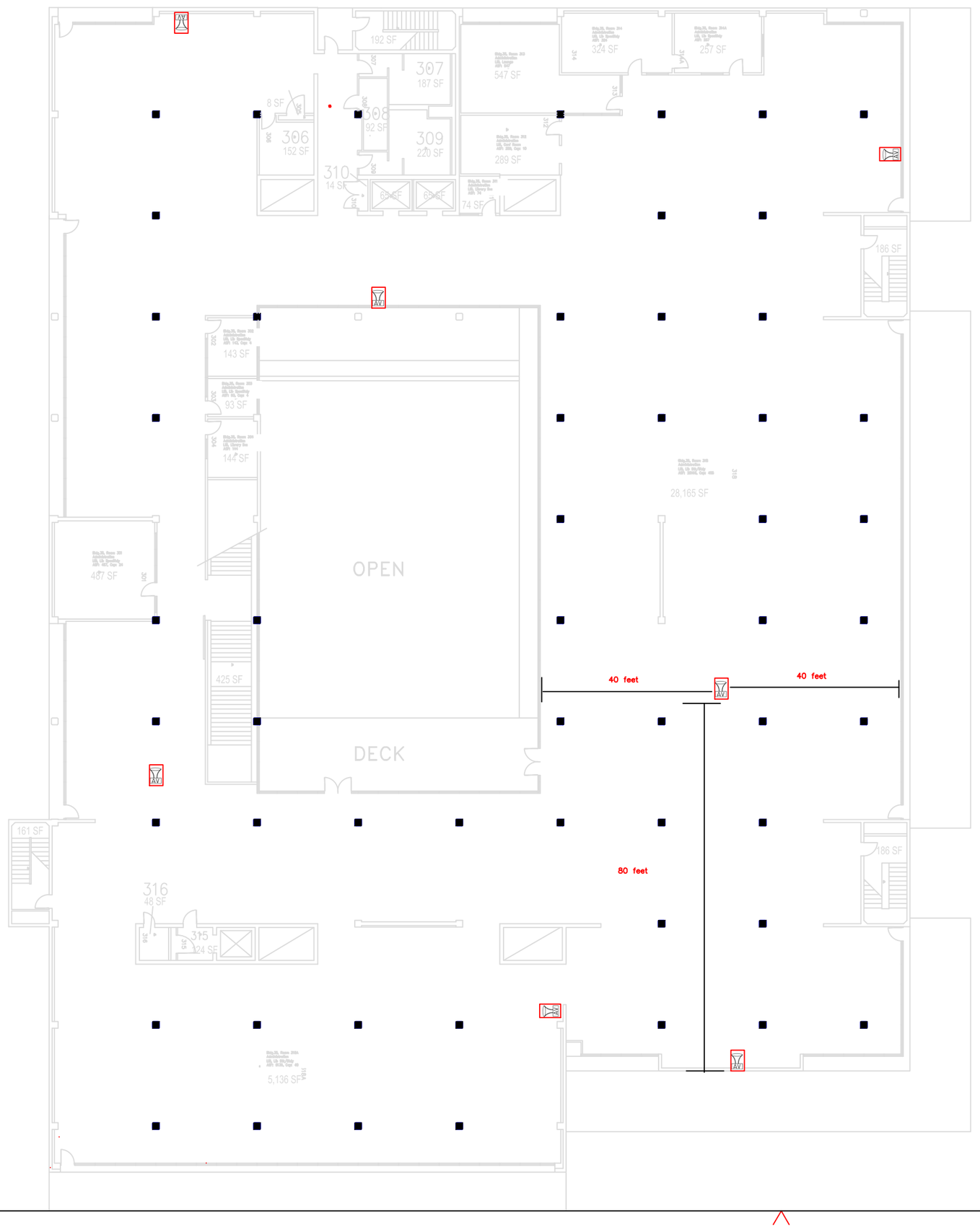
The appliance shall be capable of testing supervision without disconnecting wires, verify voltage without removing unit and be capable of mounting to a surface back box.

24 units per carton
28 pounds per carton

GENTEX CORPORATION
Fire Protection Products Group • www.gentex.com
10985 Chicago Drive • Zeeland, Michigan 49464
616.392.7195 • 1.800.436.8391 • 616.392.4219 Fax

551-0050-06

B5



Audio appliance placement
Floor 3
Scale 1:300

Symbol Explenation

HORN

B6

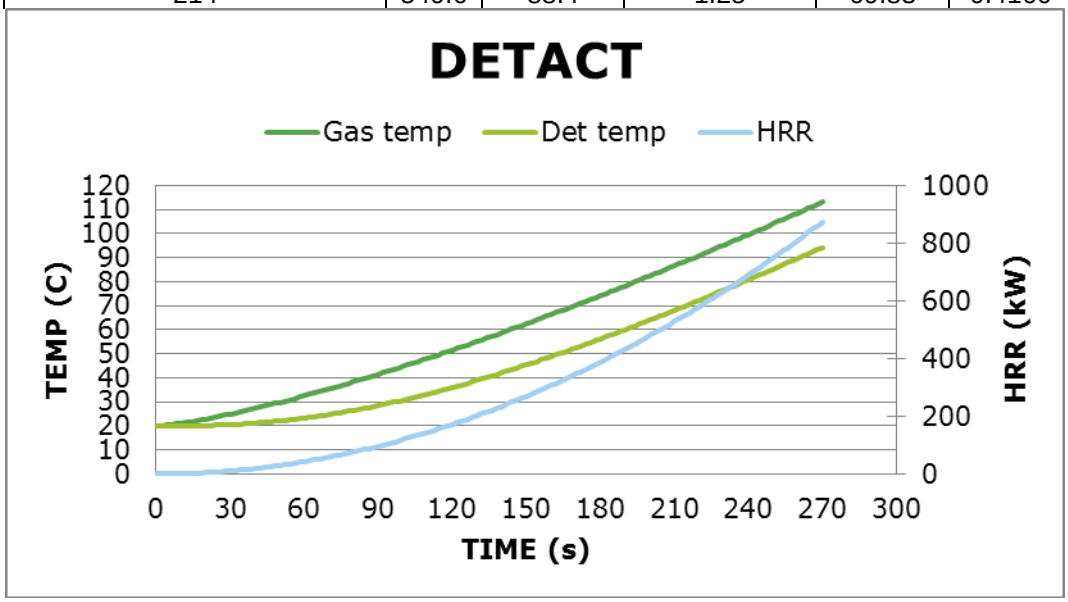
DETACT.XLS: Estimate of the response time of ceiling mounted fire detectors

INPUT PARAMETERS			CALC. PARAMETERS	
Ceiling height (H)	2.7	m	R/H	0.926
Radial distance (R)	2.5	m	dT(cj)/dT(pl)	0.316
Ambient temperature (To)	20	C	u(cj)/u(pl)	0.213
Actuation temperature (Td)	68.33	C	Rep. t2 coeff.	k
Response time index (RTI)	50	(m-s)1/2	Slow	0.003
Fire growth power (n)	2	-	Medium	0.012
Fire growth coefficient (k)	0.012	kW/s^n	Fast	0.047
Time step (dt)	2	s	Ultrafast	0.400

Calculation time (s)	HRR	Gas temp	Gas velocity	Det temp	dT/dt
0	0.0	20.0	0.00	20.00	0.0000
2	0.0	20.1	0.06	20.00	0.0006
4	0.2	20.3	0.09	20.00	0.0020
6	0.4	20.6	0.12	20.01	0.0039
8	0.8	20.9	0.14	20.01	0.0063
10	1.2	21.2	0.16	20.03	0.0091
12	1.7	21.5	0.18	20.04	0.0122
14	2.4	21.8	0.20	20.07	0.0157
16	3.1	22.2	0.22	20.10	0.0194
18	3.9	22.5	0.24	20.14	0.0234
20	4.8	22.9	0.26	20.19	0.0276
22	5.8	23.3	0.28	20.24	0.0320
24	6.9	23.7	0.29	20.30	0.0367
26	8.1	24.1	0.31	20.38	0.0415
28	9.4	24.5	0.32	20.46	0.0464
30	10.8	25.0	0.34	20.55	0.0515
32	12.3	25.4	0.35	20.66	0.0567
34	13.9	25.9	0.37	20.77	0.0621
36	15.6	26.4	0.38	20.89	0.0675
38	17.3	26.8	0.40	21.03	0.0730
40	19.2	27.3	0.41	21.18	0.0786
42	21.2	27.8	0.42	21.33	0.0842
44	23.2	28.3	0.44	21.50	0.0899
46	25.4	28.8	0.45	21.68	0.0956
48	27.6	29.3	0.46	21.87	0.1014
50	30.0	29.8	0.48	22.07	0.1072
52	32.4	30.4	0.49	22.29	0.1130
54	35.0	30.9	0.50	22.52	0.1188
56	37.6	31.4	0.51	22.75	0.1246
58	40.4	32.0	0.53	23.00	0.1304
60	43.2	32.6	0.54	23.26	0.1362
62	46.1	33.1	0.55	23.54	0.1420
64	49.2	33.7	0.56	23.82	0.1477

66	52.3	34.3	0.57	24.11	0.1535
68	55.5	34.8	0.58	24.42	0.1591
70	58.8	35.4	0.60	24.74	0.1648
72	62.2	36.0	0.61	25.07	0.1704
74	65.7	36.6	0.62	25.41	0.1760
76	69.3	37.2	0.63	25.76	0.1815
78	73.0	37.8	0.64	26.13	0.1870
80	76.8	38.4	0.65	26.50	0.1924
82	80.7	39.0	0.66	26.88	0.1977
84	84.7	39.7	0.67	27.28	0.2031
86	88.8	40.3	0.68	27.69	0.2083
88	92.9	40.9	0.69	28.10	0.2135
90	97.2	41.6	0.70	28.53	0.2186
92	101.6	42.2	0.71	28.97	0.2236
94	106.0	42.8	0.72	29.41	0.2286
96	110.6	43.5	0.74	29.87	0.2336
98	115.2	44.1	0.75	30.34	0.2384
100	120.0	44.8	0.76	30.81	0.2432
102	124.8	45.5	0.77	31.30	0.2479
104	129.8	46.1	0.78	31.80	0.2525
106	134.8	46.8	0.79	32.30	0.2571
108	140.0	47.5	0.80	32.82	0.2616
110	145.2	48.2	0.81	33.34	0.2660
112	150.5	48.9	0.81	33.87	0.2704
114	156.0	49.5	0.82	34.41	0.2747
116	161.5	50.2	0.83	34.96	0.2789
118	167.1	50.9	0.84	35.52	0.2831
120	172.8	51.6	0.85	36.09	0.2871
122	178.6	52.3	0.86	36.66	0.2912
124	184.5	53.0	0.87	37.24	0.2951
126	190.5	53.8	0.88	37.83	0.2990
128	196.6	54.5	0.89	38.43	0.3028
130	202.8	55.2	0.90	39.04	0.3065
132	209.1	55.9	0.91	39.65	0.3102
134	215.5	56.6	0.92	40.27	0.3138
136	222.0	57.4	0.93	40.90	0.3174
138	228.5	58.1	0.94	41.53	0.3208
140	235.2	58.8	0.95	42.17	0.3243
142	242.0	59.6	0.95	42.82	0.3276
144	248.8	60.3	0.96	43.48	0.3309
146	255.8	61.1	0.97	44.14	0.3341
148	262.8	61.8	0.98	44.81	0.3373
150	270.0	62.6	0.99	45.48	0.3404
152	277.2	63.3	1.00	46.16	0.3435
154	284.6	64.1	1.01	46.85	0.3465
156	292.0	64.9	1.02	47.54	0.3495
158	299.6	65.6	1.02	48.24	0.3524

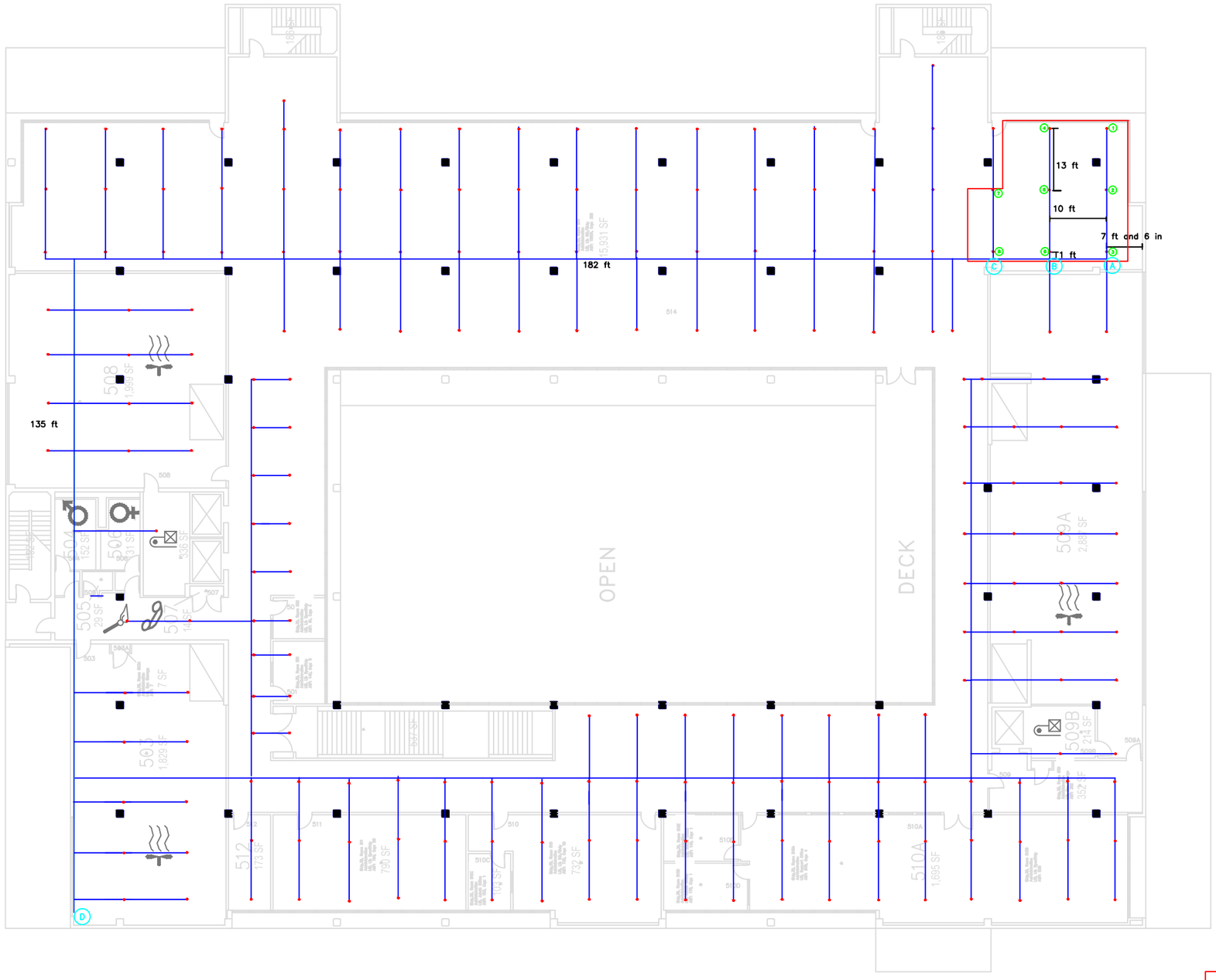
160	307.2	66.4	1.03	48.95	0.3552
162	314.9	67.2	1.04	49.66	0.3580
164	322.8	68.0	1.05	50.37	0.3608
166	330.7	68.8	1.06	51.09	0.3635
168	338.7	69.5	1.07	51.82	0.3661
170	346.8	70.3	1.08	52.55	0.3687
172	355.0	71.1	1.08	53.29	0.3713
174	363.3	71.9	1.09	54.03	0.3738
176	371.7	72.7	1.10	54.78	0.3762
178	380.2	73.5	1.11	55.53	0.3787
180	388.8	74.3	1.12	56.29	0.3810
182	397.5	75.1	1.13	57.05	0.3834
184	406.3	75.9	1.13	57.82	0.3857
186	415.2	76.7	1.14	58.59	0.3879
188	424.1	77.6	1.15	59.37	0.3902
190	433.2	78.4	1.16	60.15	0.3924
192	442.4	79.2	1.17	60.93	0.3945
194	451.6	80.0	1.18	61.72	0.3966
196	461.0	80.8	1.18	62.51	0.3987
198	470.4	81.7	1.19	63.31	0.4007
200	480.0	82.5	1.20	64.11	0.4028
202	489.6	83.3	1.21	64.92	0.4047
204	499.4	84.2	1.22	65.73	0.4067
206	509.2	85.0	1.22	66.54	0.4086
208	519.2	85.9	1.23	67.36	0.4105
210	529.2	86.7	1.24	68.18	0.4124
212	539.3	87.6	1.25	69.00	0.4142
214	549.6	88.4	1.25	69.83	0.4160



CAL POLY
SAN LUIS OBISPO

APPENDIX C

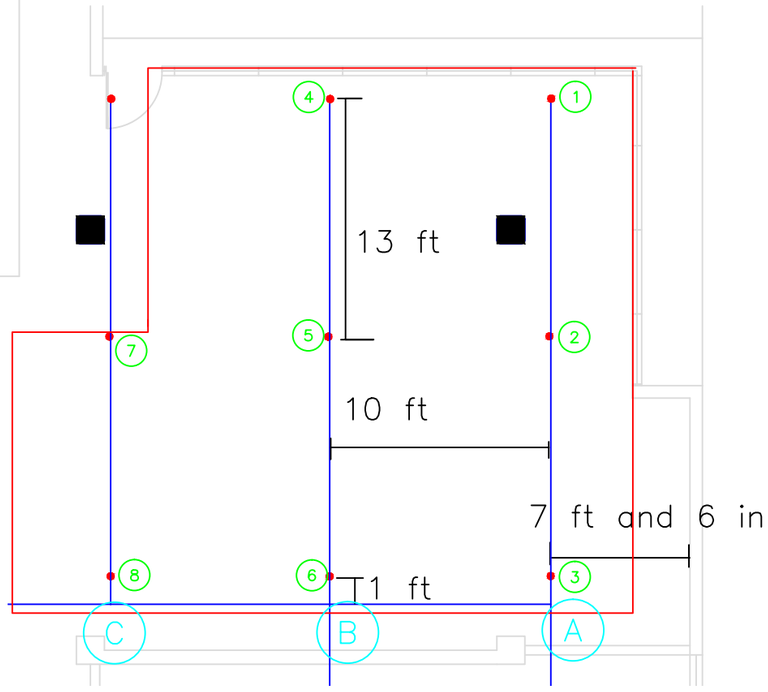
C1



SYMBOL EXPLANATION:

- SPRINKLER HEAD
- PIPES
- 1 — SPRINKLER NUMBER
- A — REFERENCE LETTER

DESIGN AREA



C2

VIKING®

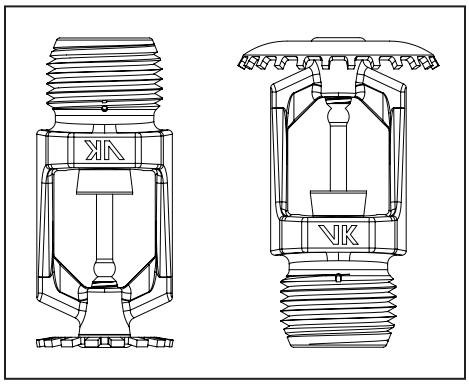
TECHNICAL DATA

QUICK RESPONSE UPRIGHT AND PENDENT SPRINKLERS

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

1. DESCRIPTION

Viking Quick Response Upright and Pendent Sprinklers are small thermosensitive glass bulb spray sprinklers available with various finishes and temperature ratings to meet design requirements. The special Polyester and Teflon® coatings can be used in decorative applications where colors are desired. In addition, these coatings have been investigated for installation in corrosive atmospheres and are cULus listed as corrosion resistant as indicated in Approval Chart 1. (Note: FM Global has no approval classification for Teflon® and Polyester coatings as corrosion resistant.)



2. LISTINGS AND APPROVALS

cULus Listed: Category VNIV

FM Approved: Classes 2002 and 2020

Refer to Approval Chart 1 and Design Criteria on page 41x for cULus Listing requirements, and refer to Approval Chart 2 and Design Criteria on page 41y for FM Approval requirements that must be followed.

3. TECHNICAL DATA

Specifications:

Available since 2004.
Minimum Operating Pressure: 7 psi (0.5 bar)
Rated to 175 psi (12 bar) water working pressure
Factory tested hydrostatically to 500 psi (34.5 bar)
Thread size: Refer to the Approval Charts
Nominal K-Factor: Refer to the Approval Charts
Glass-bulb fluid temperature rated to -65 °F (-55 °C)
Overall Length: 2-1/4" (58 mm)

Viking Technical Data may be found on The Viking Corporation's Web site at http://www.vikinggroupinc.com. The Web site may include a more recent edition of this Technical Data Page.

Material Standards:

Frame Casting: Brass UNS-C84400 for Sprinkler 17508. Brass UNS-C84400 or QM Brass for all other Sprinklers.
Deflector: Brass UNS-C23000 or Copper UNS-C19500 for Sprinklers 12978 and 12984. Phosphor Bronze UNS-C51000 or Copper UNS-C19500 for Sprinklers 12979 and 17508. Brass UNS-C26000 for all other Sprinklers.
Bushing (for Sprinklers 12981 and 12980): Brass UNS-C36000
Bulb: Glass, nominal 3 mm diameter
Belleville Spring Sealing Assembly: Nickel Alloy, coated on both sides with Teflon Tape
Screw: Brass UNS-C36000
Pip Cap and Insert Assembly: Copper UNS-C11000 and Stainless Steel UNS-S30400
Pip Cap Attachment (for Sprinkler 12980): Brass UNS-C36000
For Teflon® Coated Sprinklers: Belleville Spring-Exposed, Screw-Nickel Plated, Pip Cap-Teflon® Coated
For Polyester Coated Sprinklers: Belleville Spring-Exposed

Ordering Information: (Also refer to the current Viking price list.)

Order Quick Response Upright and Pendent Sprinklers by first adding the appropriate suffix for the sprinkler finish and then the appropriate suffix for the temperature rating to the sprinkler base part number.
Finish Suffix: Brass = A, Chrome-Enloy® = F, White Polyester = M-/W, Black Polyester = M-/B, and Black Teflon® = N
Temperature Suffix: 135 °F (68 °C) = A, 155 °F (68 °C) = B, 175 °F (79 °C) = D, 200 °F (93 °C) = E, 286 °F (141 °C) = G
For example, sprinkler VK300 with a Brass finish and a 155 °F (68 °C) temperature rating = Part No. 12978AB

Available Finishes And Temperature Ratings: Refer to Table 1.

Accessories: (Also refer to the "Sprinkler Accessories" section of the Viking data book.)

Sprinkler Wrenches:

A. Standard Wrench: Part No. 10896W/B (available since 2000).
B. Wrench for Recessed Pendent Sprinklers: Part No. 16036W/B** (available since 2011)
C. Optional Protective Sprinkler Cap Remover/Escutcheon Installer Tool*** Part No. 15915 (available since 2010)

**A ½" ratchet is required (not available from Viking).
***Allows use from the floor by attaching a length of 1" diameter CPVC tubing to the tool. Ideal for sprinkler cabinets. Refer to Bulletin F_051808.

Replaces page 41u-z, dated December 2, 2011.
(New protective sprinkler cap.)

VIKING®

TECHNICAL DATA

QUICK RESPONSE UPRIGHT AND PENDENT SPRINKLERS

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

Sprinkler Cabinets:

A. Six-head capacity: Part No. 01724A (available since 1971)
B. Twelve-head capacity: Part No. 01725A (available since 1971)

4. INSTALLATION

Refer to appropriate NFPA Installation Standards.

5. OPERATION

During fire conditions, the heat-sensitive liquid in the glass bulb expands, causing the glass to shatter, releasing the pip cap and sealing spring assembly. Water flowing through the sprinkler orifice strikes the sprinkler deflector, forming a uniform spray pattern to extinguish or control the fire.

6. INSPECTIONS, TESTS AND MAINTENANCE

Refer to NFPA 25 for Inspection, Testing and Maintenance requirements.

7. AVAILABILITY

Viking Quick Response Upright and Pendent Sprinklers are available through a network of domestic and international distributors. See The Viking Corporation web site for the closest distributor or contact The Viking Corporation.

8. GUARANTEE

For details of warranty, refer to Viking's current list price schedule or contact Viking directly.

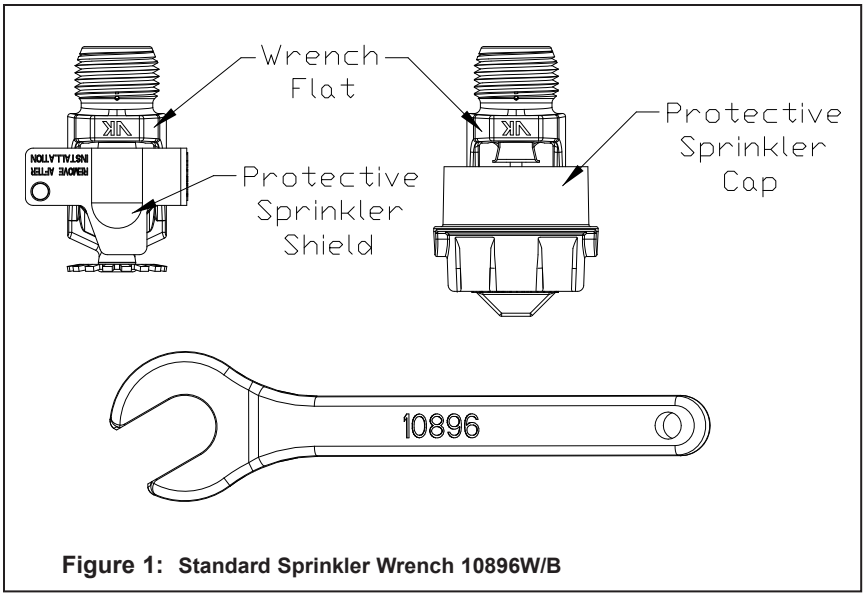


Figure 1: Standard Sprinkler Wrench 10896W/B

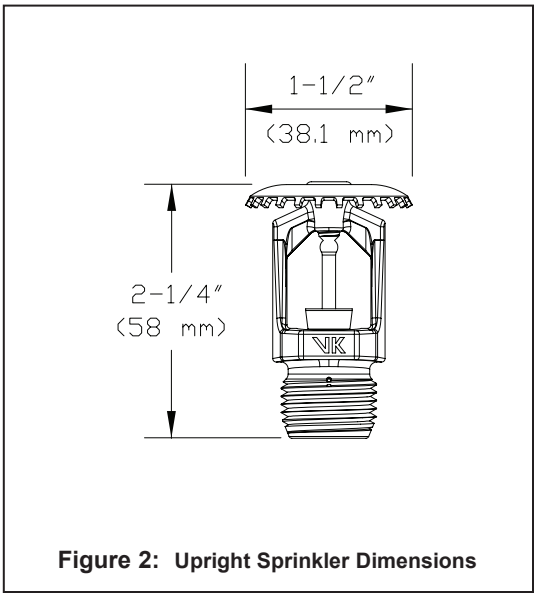


Figure 2: Upright Sprinkler Dimensions

TECHNICAL DATA

QUICK RESPONSE UPRIGHT AND PENDENT SPRINKLERS

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

TABLE 1: AVAILABLE SPRINKLER TEMPERATURE RATINGS AND FINISHES

Sprinkler Temperature Classification	Sprinkler Nominal Temperature Rating[1]	Maximum Ambient Ceiling Temperature[2]	Bulb Color
Ordinary	135 °F (57 °C)	100 °F (38 °C)	Orange
Ordinary	155 °F (68 °C)	100 °F (38 °C)	Red
Intermediate	175 °F (79 °C)	150 °F (65 °C)	Yellow
Intermediate	200 °F (93 °C)	150 °F (65 °C)	Green
High	286 °F (141 °C)	225 °F (107 °C)	Blue

Sprinkler Finishes: Brass, Chrome-Enloy®, White Polyester, Black Polyester, and Black Teflon®

Corrosion-Resistant Coatings[3]: White Polyester, Black Polyester, and Black Teflon®

Footnotes

[1] The sprinkler temperature rating is stamped on the deflector.

[2] Based on NFPA-13. Other limits may apply, depending on fire loading, sprinkler location, and other requirements of the Authority Having Jurisdiction. Refer to specific installation standards.

[3] The corrosion-resistant coatings have passed the standard corrosion test required by the approving agencies indicated in the Approval Charts. These tests cannot and do not represent all possible corrosive environments. Prior to installation, verify through the end-user that the coatings are compatible with or suitable for the proposed environment. For automatic sprinklers, the coatings indicated are applied to the exposed exterior surfaces only. Note that the spring is exposed on sprinklers with Polyester and Teflon® coatings.

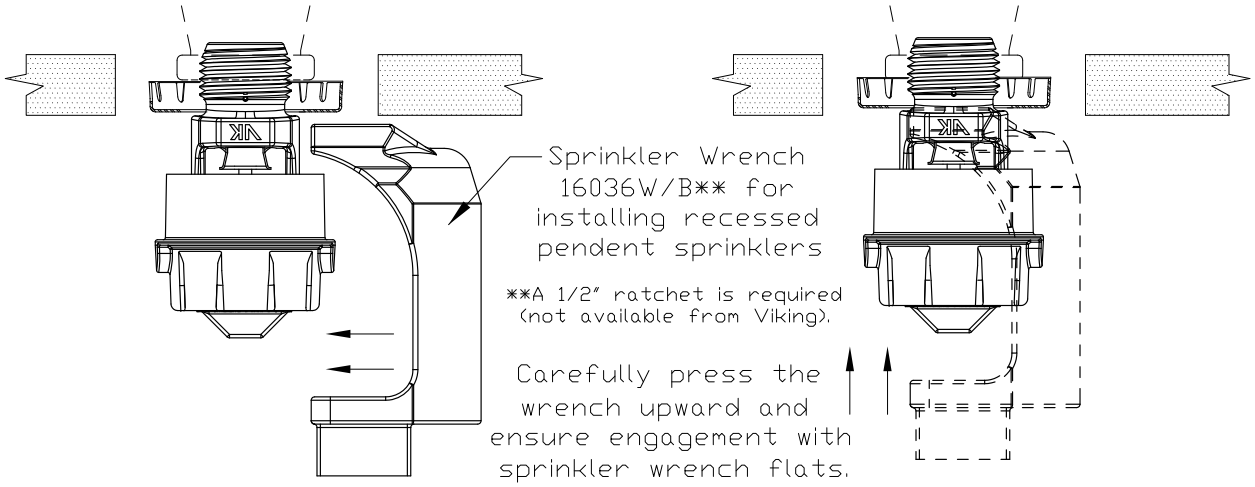


Figure 3: Wrench 16036W/B for Recessed Pendent Sprinklers

VIKING®

TECHNICAL DATA

QUICK RESPONSE UPRIGHT AND PENDENT SPRINKLERS

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

Approval Chart 1 (UL)

Quick Response Upright and Pendent Sprinklers
Maximum 175 PSI (12 Bar) WWP

KEY: A1X — Temperature, Finish, Escutcheon (if applicable)

Base Part Number[1]	SIN	Sprinkler Style	Thread Size		Nominal K-Factor		Overall Length		Listings and Approvals[3] (Refer also to Design Criteria below.)					
			NPT	BSP	U.S.	metric[2]	Inches	mm	cULus[4]	NYC	VdS	LPCB	CE	
Standard Orifice														
12978	VK300	Upright	1/2”	15 mm	5.6	80.6	2-1/4	58	A1	--	--	--	--	--
12984	VK345	Upright	--	15 mm	5.6	80.6	2-1/4	58	--	--	--	--	--	--
12979	VK302	Pendent	1/2”	15 mm	5.6	80.6	2-1/4	58	A1Z, B1Y	--	--	--	--	--
Small Orifice[6]														
12980[5]	VK325	Upright	1/2”	15 mm	2.8	40.3	2-1/4	58	A1	--	--	--	--	--
12981[5]	VK329	Pendent	1/2”	15 mm	2.8	40.3	2-1/4	58	A1Z, B1Y	--	--	--	--	--

Approved Temperature Ratings

A - 135 °F (57 °C), 155 °F (68 °C), 175 °F (79 °C), 200 °F (93 °C), 286 °F (141 °C)
B - 135 °F (57 °C), 155 °F (68 °C), 175 °F (79 °C), and 200 °F (93 °C)

Approved Finishes

1 - Brass, Chrome-Enloy®, White Polyester[7], Black Polyester[7], and Black Teflon®

Approved Escutcheons

Y - Standard surface-mounted escutcheon or the Viking Microfast® Model F-1 Adjustable Escutcheon, or recessed with the Viking Micromatic® Model E-1 or E-2 Recessed Escutcheon
Z - Standard surface-mounted escutcheon or the Viking Microfast® Model F-1 Adjustable Escutcheon

Footnotes

[1] Base part number shown. For complete part number, refer to Viking’s current price schedule.

[2] Metric K-factor measurement shown is when pressure is measured in Bar. When pressure is measured in kPa, divide the metric K-factor shown by 10.0.

[3] This table shows the listings and approvals available at the time of printing. Other approvals may be in process.

[4] Listed by Underwriters Laboratories Inc. for use in the U.S. and Canada.

[5] The sprinkler orifice is bushed.

[6] Listings and Approvals limited to Light Hazard Occupancies where allowed by the installation standards being applied, with hydraulically calculated wet systems only.

[7] cULus Listed as corrosion-resistant.

DESIGN CRITERIA - UL

(Also refer to Approval Chart 1 above.)

cULus Listing Requirements:

Standard Upright and Pendent Sprinklers are cULus Listed as indicated in the Approval Chart for installation in accordance with the latest edition of NFPA 13 for standard spray sprinklers.

- Designed for use in Light, Ordinary, and Extra Hazard occupancies *(exception: small orifice sprinklers are limited to Light Hazard where allowed by the installation standards being applied, with hydraulically calculated wet systems only).*
- The sprinkler installation rules contained in NFPA 13 for standard spray upright and pendent sprinklers must be followed.

IMPORTANT: Always refer to Bulletin Form No. F_091699 - Care and Handling of Sprinklers. Also refer to page QR1-3 for general care, installation, and maintenance information. Viking sprinklers are to be installed in accordance with the latest edition of Viking technical data, the appropriate standards of NFPA, LPCB, APSAD, VdS or other similar organizations, and also with the provisions of governmental codes, ordinances, and standards, whenever applicable.

VIKING®

TECHNICAL DATA

QUICK RESPONSE UPRIGHT AND PENDENT SPRINKLERS

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

Approval Chart 2 (FM)

Quick Response Upright and Pendent Sprinklers
Maximum 175 PSI (12 Bar) WWP

KEY: A1X — Temperature, Finish, Escutcheon (if applicable)

Base Part Number[1]	SIN	Sprinkler Style	Thread Size		Nominal K-Factor		Overall Length		FM Approvals[3] (Refer also to Design Criteria below.)
			NPT	BSP	U.S.	metric[2]	Inches	mm	
Standard Orifice									
12978	VK300	Upright	1/2”	15 mm	5.6	80.6	2-1/4	58	A1
12984	VK345	Upright	--	15 mm	5.6	80.6	2-1/4	58	A1
12979	VK302	Pendent	1/2”	15 mm	5.6	80.6	2-1/4	58	A1Z, B1Y
Large Orifice									
17508	VK352	Pendent	1/2”	15 mm	8.0	115.2	2-1/4	58	A2Z, B2Y
Small Orifice[4]									
12980[6]	VK325	Upright	1/2”	15 mm	2.8	40.3	2-1/4	58	A2
12981[6]	VK329	Pendent	1/2”	15 mm	2.8	40.3	2-1/4	58	A2Z

Approved Temperature Ratings

A - 135 °F (57 °C), 155 °F (68 °C), 175 °F (79 °C), 200 °F (93 °C), 286 °F (141 °C)
B - 135 °F (57 °C), 155 °F (68 °C), 175 °F (79 °C), and 200 °F (93 °C)

Approved Finishes

1 - Brass, Chrome-Enloy®, White Polyester[5], and Black Polyester[5]
2 - Brass and Chrome-Enloy®

Approved Escutcheons

Y - Standard surface-mounted escutcheon or the Viking Microfast® Model F-1 Adjustable Escutcheon, or recessed with the Viking Micromatic® Model E-1 or E-2 Recessed Escutcheon
Z - Standard surface-mounted escutcheon or the Viking Microfast® Model F-1 Adjustable Escutcheon

Footnotes

[1] Base part number shown. For complete part number, refer to Viking’s current price schedule.

[2] Metric K-factor measurement shown is when pressure is measured in Bar. When pressure is measured in kPa, divide the metric K-factor shown by 10.0.

[3] This table shows the FM Approvals available at the time of printing. Other approvals may be in process.

[4] FM Approved as quick response **Non-storage** upright and pendent sprinklers. For specific application and installation requirements, reference the latest applicable FM Loss Prevention Data Sheets (including Data Sheet 2-0).

[5] Other colors are available on request with the same Approvals as the standard colors.

[6] The sprinkler orifice is bushed.

DESIGN CRITERIA - FM

(Also refer to Approval Chart 2 above.)

FM Approval Requirements:

The sprinklers in Approval Chart 2 are FM Approved as quick response **Non-storage** upright and pendent sprinklers as indicated in the FM Approval Guide. For specific application and installation requirements, reference the latest applicable FM Loss Prevention Data Sheets (including Data Sheet 2-0). FM Global Loss Prevention Data Sheets contain guidelines relating to, but not limited to: minimum water supply requirements, hydraulic design, ceiling slope and obstructions, minimum and maximum allowable spacing, and deflector distance below the ceiling.

NOTE: The FM installation guidelines may differ from cULus and/or NFPA criteria.

IMPORTANT: Always refer to Bulletin Form No. F_091699 - Care and Handling of Sprinklers. Also refer to page QR1-3 for general care, installation, and maintenance information. Viking sprinklers are to be installed in accordance with the latest edition of Viking technical data, the appropriate standards of NFPA, FM Global, LPCB, APSAD, VdS or other similar organizations, and also with the provisions of governmental codes, ordinances, and standards, whenever applicable.

VIKING®

TECHNICAL DATA

QUICK RESPONSE UPRIGHT AND PENDENT SPRINKLERS

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

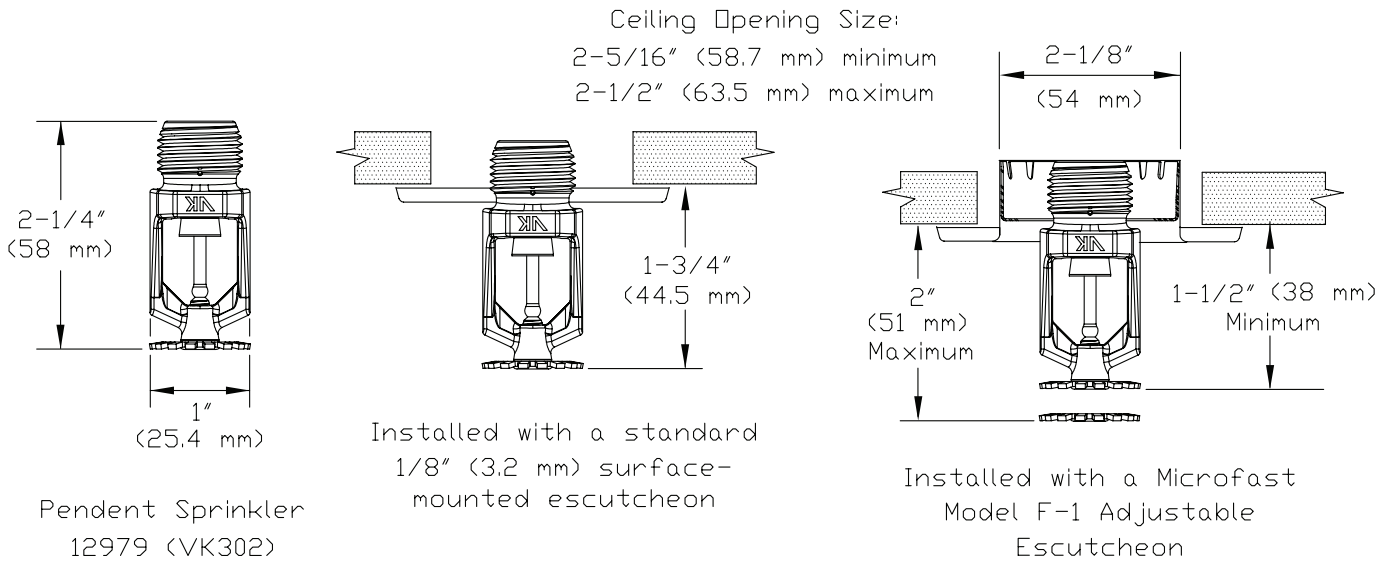


Figure 4: **Pendent Sprinkler VK302 Dimensions with a Standard Escutcheon and the Model F-1 Adjustable Escutcheon**

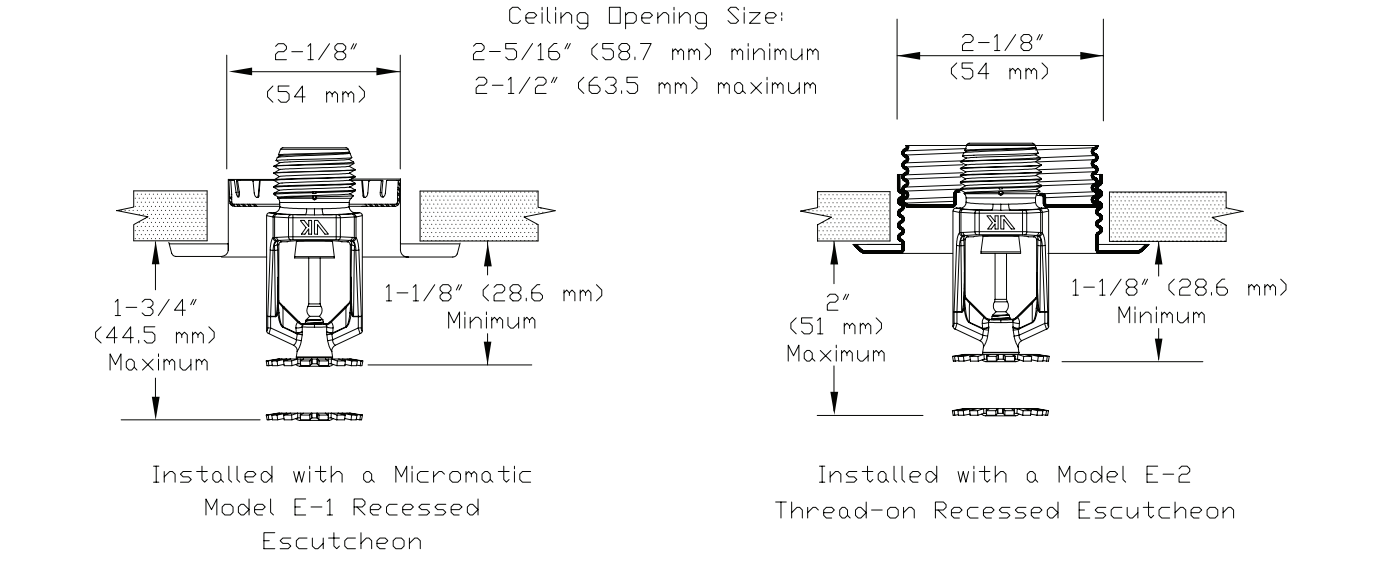


Figure 5: **Pendent Sprinkler VK302 Dimensions with the Model E-1 and E-2 Recessed Escutcheons**

Replaces page 41u-z, dated December 2, 2011.
(New protective sprinkler cap.)

C3

Hydraulic calculations:

K-Factors at Cross Main from Branch lines at design area

Project name:		Robert E. Kennedy Library												Date: 03.03.16	
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	
For A and B		q		1,,25		L	13	C=	120	Pt	10,3	Pt		k=	5,6
1 and 4				1,38		F				Pe		Pv		Q	18
		Q	18			T	13	pf	0,0282	Pf	0,4	Pn		Pt=	10,3
		q	18,3	1,25		L	13	C=	120	Pt	10,7	Pt		k=	5,6
2 and 5				1,38		F				Pe		Pv		Q	36,3
		Q	36,3			T	13	pf	0,1032	Pf	1,34	Pn		Pt=	10,7
		q	19,4	1,5		L	1	C=	120	Pt	12,0	Pt		k=	5,6
3 and 6				1,61	2t-16	F	16			Pe		Pv		Q	55,7
		Q	55,7			T	17	pf	0,1076	Pf	1,83	Pn		Pt=	12,0
		q	20,9	2		L	10	C=	120	Pt	13,9	Pt			
A and B				2,067		F				Pe		Pv			
		Q	55,7			T	10	pf	0,0319	Pf	0,32	Pn		K=	15,0
For C		q		1,25		L	13	C=	120	Pt	10,3	Pt		k=	5,6
7				1,38		F				Pe		Pv		Q	18
		Q	18			T	13	pf	0,0282	Pf	0,366	Pn			
		q	18,3	1,5		L	1	C=	120	Pt	10,7	Pt		k=	5,6
8				1,61	2t-16	F	16			Pe		Pv		Q	36,3
		Q	36,3			T	17	pf	0,0487	Pf	0,828	Pn			
		q				L		C=	120	Pt	11,5	Pt			
C						F				Pe		Pv			
		Q	36,3			T		pf		Pf		Pn		K=	10,7

CAL POLY
SAN LUIS OBISPO

Pipe Flow at Reference Points Throughout Sprinkler System

Project name: Robert E. Kennedy Library															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		
A		q		2		L	10	C=	120	Pt	13,8	Pt				
				2,067	T-10	F	10			Pe		Pv		K=	15	
		Q	55,7			T	20	pf	0,032	Pf	0,6365	Pn		Q	55,7	
B		q	57,0	2		L	10	C=	120	Pt	14,4	Pt		k=		
				2,067	T-10	F	10			Pe		Pv		K=	15	
		Q	112,7			T	20	pf	0,117	Pf	2,3	Pn		Q	112,7	
C		q	43,8	3		L	317	C=	120	Pt	16,8	Pt		k=		
				3,26	T-15	F	15			Pe		Pv		K=	10,7	
		Q	156,5			T	332	pf	0,023	Pf	7,8	Pn		Q	156,5	
D		q		4	T-20	L	78	C=	120	Pt	24,5	Pt		k=		
				4,26	E1-4	F	26			Pe	33,8	Pv				
		Q	156,5		GV-2	T	104	pf	0,006	Pf	0,7	Pn				
E	Trough underground to city main	q		4	E2-9,06	L	60	C=	150	Pt	59,0	Pt		k=		
				4,26	GV-3,02	F	42,28			Pe		Pv				
		Q	156,5		T-30,2	T	102,28	pf	0,0042	Pf	0,4	Pn				
		q				L		C=		Pt	59,4	Pt		k=		
						F				Pe		Pv				
		Q				T		pf		Pf		Pn				

APPENDIX D

D1

Allowable Height, and Building Areas for Occupancy Type A-3 (derived from IBC 2015 edition, table 504.3 and 504.4)

Perimeter in front of the building:

Exterior wall	Fire separation distance (ft)	Length (ft)	Perimeter (ft)
North	41	270.67	623.34
South	36	207.67	487.34
West	41	190.83	463.66
East	126	190.83	633.6
Tot,F			2207.94

Allowable Height, and Building Areas for Occupancy Type A-3

P	923
F	2207.94

Allowable Height, and Building Areas for Occupancy Type A-3 (derived from IBC 2015 edition, table 504.3 and 504.4)							
Constr. Type	Sprinkler	Height (ft)	Nr. Stories	I	Allowable area (ft^2) per 506.2	Allowable Area	Allowable
I A	NO	UL	UL	1.63129386	UL	UL	YES
I B	NO	160	11	1.63129386	UL	UL	YES
II A	NO	65	3	1.63129386	15500	40785.05	NO
II B	NO	55	2	1.63129386	9500	24997.29	NO
III A	NO	65	3	1.63129386	14,000	36838.11	NO
III B	NO	55	2	1.63129386	9,500	24997.29	NO
IV	NO	65	3	1.63129386	15,000	39469.41	NO
V A	NO	50	2	1.63129386	11,500	30259.88	NO
V B	NO	40	1	1.63129386	6,000	15787.76	NO