CALIFORNIA POLYTECHNIC STATE UNIVERSITY
FIRE PROTECTION ENGINEERING PROGRAM
CUMULATIVE PROJECT
SPRING 2015

JARED MATTERN E.I.T.

STATEMENT OF DISCLAIMER

This project report is a result of a class assignment; it has been graded and accepted as fulfillment of the course requirements. Acceptance of this report in fulfillment of the course requirements does not imply technical accuracy or reliability. Any use of information in this report is done at the risk of the user. These risks may include, but may not be limited to, catastrophic failure of the device or infringement of patent or copyright laws. California Polytechnic State University at San Luis Obispo and its staff cannot be held liable for any use or misuse of the project.

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

Email Address: Jfmattern@gmail.com

ABSTRACT

This report analyzes a hotel located San Francisco, CA for compliance with prescriptive and performance based requirements in accordance with the California Building Code. The first-half of the report addresses the prescriptive-based code requirements of the building. This report outlines the design is compliant with the referenced standards. The performance based portion of the report evaluates if the enclosed parking garage located on Level 1 of the building will maintain tenability in the event of a car fire. Three tenability conditions were evaluated to define a tenable environment, carbon monoxide levels, temperature, and visibility limits. Selecting the location of the fire required analyzing the fuel load therefore the fire scenario selected was based on SFPE Handbook Car fire data up to sprinkler activation where the fire growth to halt and this peak heat release rate is maintained for the remainder of the simulation. Through hand calculations and fire modeling using NIST's Fire Dynamic Simulator (FDS) the report concludes that the current system does not maintain tenable conditions for egress. Additional analysis to this case study would be required to further analyze the conditions provided to egressing occupants.

Contents

INTRODUCTION

The following report will analyze a hotel located in San Francisco, CA for compliance with prescriptive and performance based fire safety standards. The building will accommodate roughly 1,400 guests and employees. The building will be seven stories with approximately 105,000 sq. ft. foot print. Level 1 includes an enclosed parking garage, residential units and business space to be built out on the ground level. Levels 2 through 7 comprise the residential tower which is located above the south half of the building footprint and is made up of guest rooms. Two stairways are located at each end of the interior residential corridor which connects all the guest rooms. This building is not a high rise building as it is less than 75 ft tall. The building will be protected by an automatic fire sprinkler system in accordance with CBC Section 903 and an automatic fire alarm system in accordance with CBC Section 907.

PROJECT CODES AND STANDARDS

The following are the applicable codes and standards which apply to this building with respect to fire and life safety issues:

- California Building Code (CBC), 2013 Edition
- California Fire Code (CFC), 2013 Edition
- NFPA 13 Standard for the Installation of Sprinkler Systems, 2013 Edition
- NFPA 14 Standard for the Installation of Standpipe and Hose Systems, 2013 Edition
- NFPA 72 National Fire Alarm and Signaling Code, 2013 Edition
- NFPA 101 Life Safety Code, 2012 Edition

BUILDING CONSTRUCTION (STRUCTURAL)

Determination of the required construction type for this occupancy is based on Table 503 of the CBC seen in Figure 1. The table indicates that, for the 7-story R-1 building, the minimum allowable construction type for an occupied floor higher than five stories (including sprinkler story increase) are Types 1-A and 1-B. Both of these Type I construction types do not have floor area limitations; therefore, an analysis of the floor area and area/height increases using sprinklers and frontage is not required. A construction type of 1-B has been selected for this building. Due to no limitations on area, the building can be a non-separated mixed use building.

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

GROUP		TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
	HEIGHT (feet)	UL	160	65	55	65	55	65	50	40
				STORIES(S) AREA (A)						
A-1	S A	UL UL	5 UL	3 15,500	2 8,500	3 14,000	2 8,500	3 15,000	2 11,500	1 5,500
A-2	S A	UL UL	11 UL	3 15,500	2 9,500	3 14,000	2 9,500	3 15,000	2 11,500	1 6,000
A-3	S A	UL UL	11 UL	3 15,500	2 9,500	3 14,000	2 9,500	3 15,000	2 11,500	1 6,000
A-4	S A	UL UL	11 UL	3 15,500	2 9,500	3 14,000	2 9,500	3 15,000	2 11,500	1 6,000
A-5	S A	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL
B	S A	UL UL	11 UL	5 37,500	3 23,000	5 28,500	3 19,000	5 36,000	3 18,000	2 9,000
E	S A	UL UL	5 UL	3 26,500	2 14,500	3 23,500	2 14,500	3 25,500	1 18,500	1 9,500
F-1	S A	UL UL	11 UL	4 25,000	2 15,500	3 19,000	2 12,000	4 33,500	2 14,000	1 8,500
F-2	S A	UL UL	11 UL	5 37,500	3 23,000	4 28,500	3 18,000	5 50,500	3 21,000	2 13,000
R-1	S A	UL UL	11 UL	4 24,000	4 16,000	4 24,000	4 16,000	4 20,500	3 12,000	2 7,000
R-2	S A	UL UL	11 UL	4 24,000	4 16,000	4 24,000	4 16,000	4 20,500	3 12,000	2 7,000
R-2.1	*S* *A*	*UL* *UL*	*6[f]* *55,000*	*3[e]* *19,000*	*NP* *NP*	*3[e]* *16,500*	*NP* *NP*	*NP* *NP*	*3[e]* *16,500*	*NP* *NP*
R-3/*R-3.1*	S A	UL UL	11 UL	4 UL	4 UL	4 UL	4 UL	4 UL	3 UL	3 UL
R-4	S A	UL UL	11[f] UL	4[e] 24,000	4[g] 16,000	4[e] 24,000	4[g] 16,000	4[g] 20,500	3[e] 12,000	2[g] 7,000
S-1	S A	UL UL	11 48,000	4 26,000	2 17,500	3 26,000	2 17,500	4 25,500	3 14,000	1 9,000
S-2	S A	UL UL	11 79,000	5 39,000	3 26,000	4 39,000	3 26,000	5 38,500	4 21,000	2 13,500

FIGURE 1: California Building Code Table 503

OCCUPANCY GROUP CLASSIFICATION

The mid-rise hotel project is classified as a Residential R-1 (occupancy). The ground floor includes an enclosed Parking Garage (S-2 occupancy) and Office (B occupancy). These areas have been considered accessory to the primary occupancy and will meet the requirements of the most stringent occupancy, in this case, R-1. The Group R-1 occupancy classification is described by CBC section 310.3. The hotel's highest occupied floor is 70 feet above the level of fire department vehicle access since the highest occupied floor level is less than 75 feet, the building is not considered to be a high-rise building by the CBC and is not required to meet any additional requirements found in CBC Section 403. Section 603.1 describes combustible materials that are permitted to be used for caulking and sealing around joints, penetrations, and openings in rated assemblies.

The CBC indicates the following occupancy classifications for areas in the building:

USE OF THE AREA	OCCUPANCY CLASSIFICATION
Hotels	R-1
Office	B
Enclosed Parking/Storage Areas	S-2
Mechanical/Electrical Room	S-2

Based on the allowable floor area for Type I-B construction seen above, the following actual floor areas, levels, and uses are as acceptable.

LEVEL	GROSS FLOOR AREA (SF)	OCCUPANCY DESCRIPTIONS
1	105,000	R-1, B, S-2, Accessory Use
2	26,745	R-1, Accessory Use
3	26,745	R-1, Accessory Use
4	26,745	R-1, Accessory Use
5	26,745	R-1, Accessory Use
6	26,745	R-1, Accessory Use
7	26,745	R-1, Accessory Use

STRUCTURAL FIRE PROTECTION REQUIREMENTS

The fire-resistance rating of the building structure and main elements are found in Tables 601 (Figure 2) and 602 (Figure 3) of the CBC.

For Type 1-B construction CBC Table 602 indicates that the primary structural frame of the building, and the interior and exterior load-bearing walls must have a minimum fire-resistance rating of 2-hours. The primary frame and interior bearing walls fire-resistance ratings are allowed to be reduced by 1-hour where it is only supporting the roof.
Floor construction and secondary members are indicated in Table 601 that they must have a minimum fire-resistance rating of 2-hours. The roof construction and secondary members must have a rating of 1-hour, and nonbearing interior walls and partitions are not required to have a rating.

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

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

For SI: 1 foot = 304.8 mm.

Figure 2: California Building Code Table 601: Fire-Resistance Rating Requirements For Building Elements

Table 602 provides information on fire-resistance rating for exterior nonbearing walls, based on the fire separation distance. Fire separation distance as defined by CBC is the distance measured from the building face to one of the following: the closest interior lot line, the centerline of the public way, or an imaginary line between two buildings on the property. For an R-1 occupancy and 1-B construction type, a 1-hour fire-resistance rating is required for any fire separation distance less than 30 feet. The proposed building has access to the public way on all sides and also fire separation distance on all sides greater than 30 feet.

TABLE 602
FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE[a, e]

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

For SI: 1 foot = 304.8 mm.

Figure 3: California Building Code Table 602: Fire-Resistance Rating Requirements for Exterior Walls Based on Fire Separation Distance

CONSTRUCTION MATERIALS

For a Type 1-B building, per CBC Section 602.2, the building elements listed in CBC Table 601 are to be constructed of noncombustible materials, except where permitted in CBC Section 603 and elsewhere in the code. CBC Section 603 allows fire-retardant-treat wood in the following locations:

1.1. Nonbearing partitions where the required fire-resistance rating is 2-hours or less.

1.2. Nonbearing exterior walls where fire-resistance rated construction is not required.

1.3. Roof construction, including girders, trusses, framing, and decking.

PRIMARY STRUCTURE

For this analysis, there was no access to structural plans and/or as-built drawings of the project building. Therefore, the following information is the best estimations that could be made.

The primary structure consists of steel wide-flange beams. Columns, support girders, beams, and joists are constructed in a simple frame set up. All primary structure are to be protected by spray applied fire-resistive material (SFRM) to provide the design rating of 2-hours. The building had no exposed columns.

All columns are to be covered by a layer of gypsum board assumed to be non-Type X. The SFRM thickness needs to be designed, but a minimum of 0.375 inches is required for each member to provide a fire-resistance rating of 2 hrs. Due to the limited information, it is expected that the steel was covered by SFRM to bring it up to the minimum requirement of 2-hours.

FLOOR AND ROOF ASSEMBLIES

The floor/ceiling and roof assemblies are to be steel joist construction with a poured reinforced concrete slab on metal lath forms with a ceiling of gypsum wallboard. In the Prescriptive Fire-resistance section, Table 721.1(2) “Rated Fire-resistance Periods for Various Walls and Partitions” indicates that this assembly is required to meet a 2-hour fire-resistance rating. The slab is required to be a minimum of 2.5-in. thick, while the ceiling is required to be a minimum of 5/8-in. thick for the floor/ceiling and roof assemblies to meet the 2-hour fire-resistance rating requirement.

EXTERIOR AND INTERIOR WALLS AND PARTITIONS

The exterior and interior walls and partitions of the hotel are non-load bearing and constructed of 2 in. x 4 in. fire-retardant-treat wood studs spaced 16-inch on center, with insulation that meets the requirements of CBC Section 603. Both sides of the wall assembly are provided with 5/8-inch gypsum wallboard. In the Prescriptive Fire-resistance section Table 721.1(2) “Rated Fire-resistance Periods for Various Walls and Partitions” provides several examples of where the addition of 5/8 in. gypsum wall board Type X where properly installed can provide additional ratings of 2-in. x 4-in. framed walls. For all exterior walls on all sides of the building there are no fire separations of less than 30 feet; therefore no rating is required. Per CBC Table 602 interior non-load bearing walls and partitions are unrated.

DOOR OPENINGS, JOINTS, AND PENETRATIONS

The interior walls in this building are non-rated, except for corridor walls separating rooms and the interior corridors. No opening protection is required for doors, except for rated shaft enclosures and other fire rated barriers. This includes the exit enclosure shaft, electrical shaft, and trash room shaft. The electrical and trash rooms were built in shafts to avoid providing opening protections for the penetrations in the floor assembly to allow easier access for chutes, piping, and wires.

Doors in fire rated barrier are required to be 90-minute rated doors with 90-minute rated frames as required by Table 715.4 “Fire Door and Fire Shutter Fire Protection Ratings”.

Penetrations and joints in the floor assemblies and through other rated fire barriers are required to be fire stop to avoid compromising fire rated barrier continuity. When the penetration is duct work, it is expected that a fire/smoke damper will be provided but this was unable to be confirmed due to limited access during the inspection.

SHAFT ENCLOSURES

CBC Section 713.4 requires that vertical shaft enclosures have a fire-resistance rating of not less than 2-hours where connecting four or more stories and not less than 1-hour where connecting less than four stories. The number of stories connected by the shaft enclosure shall include any basements but not any mezzanines. Shaft enclosures shall have a fire-resistance rating not less than the floor assembly penetrated, but need not exceed 2-hours. Shaft enclosures shall meet the requirements of Section 703.2.1. All vertical shaft enclosures in this building connect four or more stories therefore are required to have a fire-resistance rating of not less than 2 hours.

INTERIOR FINISH

Interior finish needs to meet the requirements of Chapter 8 of the CBC. CBC Table 803.9 give wall and ceiling flame spread finish requirements by occupancy type for the room or area. For this project, the inclusion of an automatic sprinkler system allows the use of reduced wall and ceiling flame spread finish classes from CBC Table 803.9.

CBC Section 803.5 requirements for interior finishes are classified according to the ASTM E 84 Standard according to three classes for ASTM E 84 flame spread and smoke developed indices:

- Class A: Flame spread 0-25, smoke developed 0-450
- Class B: Flame spread 26-75, smoke developed 0-450
- Class C: Flame spread 76-200, smoke developed 0-450

The following are the flame spread classes for the occupancy classifications for this project:

	w/ Automatic Fire Sprinklers		
	Interior exit stairways, interior exit ramps and exit passageways	**Corridors and enclosures for exit access stairways and ramps**	**Rooms and enclosed spaces**
R-1	B	C	C
B	B	C	C
S-2	C	C	C

MEANS OF EGRESS

OCCUPANT LOAD

CBC Table 1004.1.2 provides occupant load factors (OLF) required for buildings. OLF which is the floor area per occupant based on the use of the area as opposed to the occupancy classification. When applied to the area of each space, you can calculate the occupant load of each space. OLF's are listed in "gross" and "net" calculations based on the use.

Gross calculations include all of the area inside of the exterior walls, while net calculations just include the specified area. The following OLFs were used in this project:

FUNCTION OF SPACE	FLOOR AREA PER OCCUPANT
Residential	200 gross
Business Areas	100 gross
Parking garage	200 gross
Accessory Storage, mechanical and electrical	300 gross

The following Figures 4, 5, and 6 identify the occupancy for each space of the building:

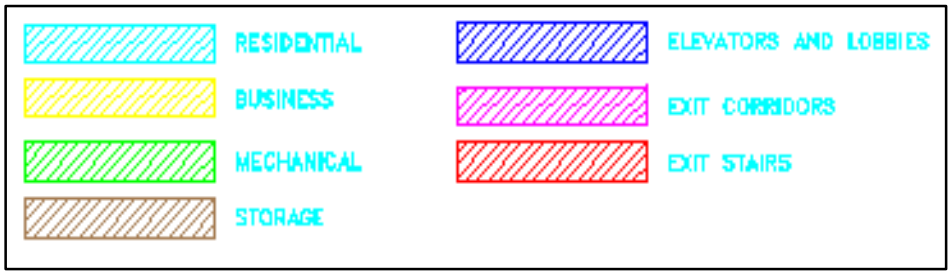


FIGURE 4: LEGEND FOR FIGURE 5 AND FIGURE 6

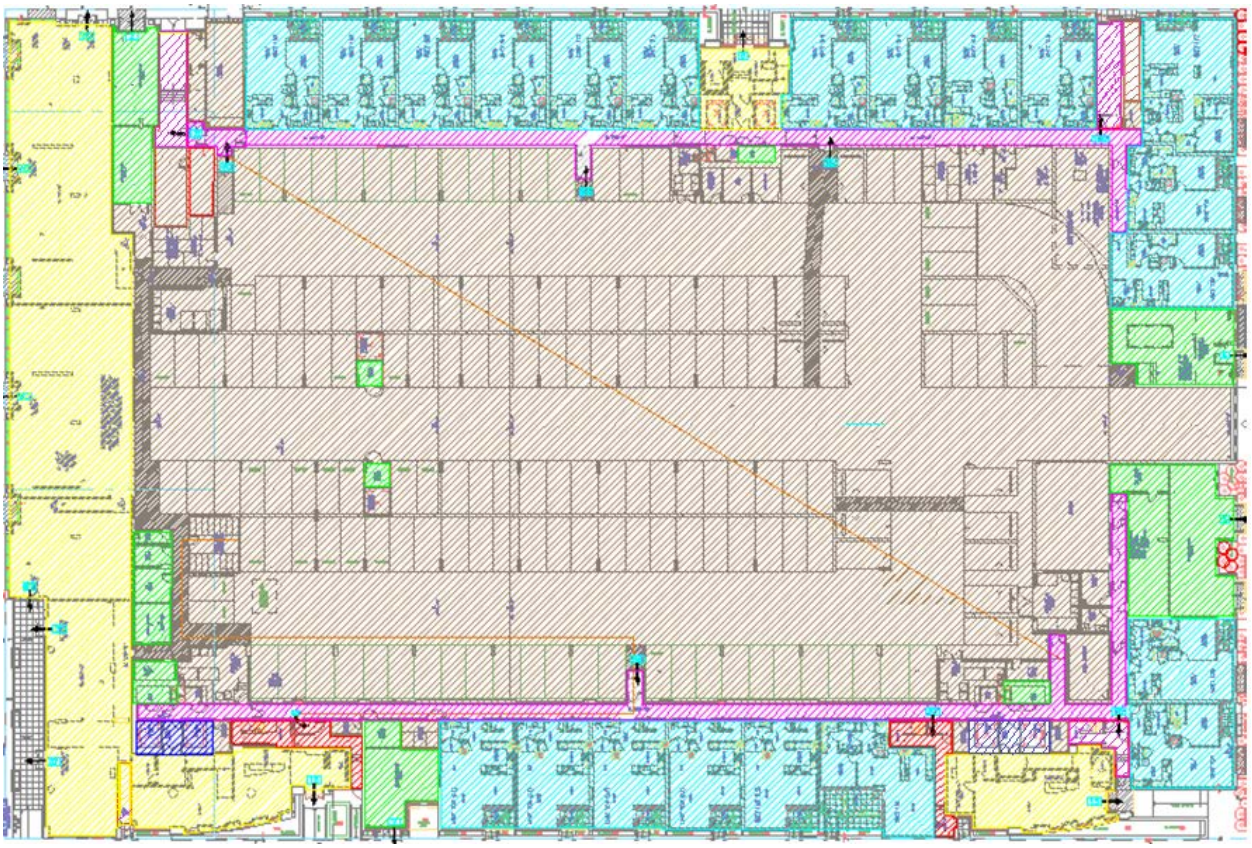


FIGURE 5: LEVEL 1 OCCUPANCY DRAWING

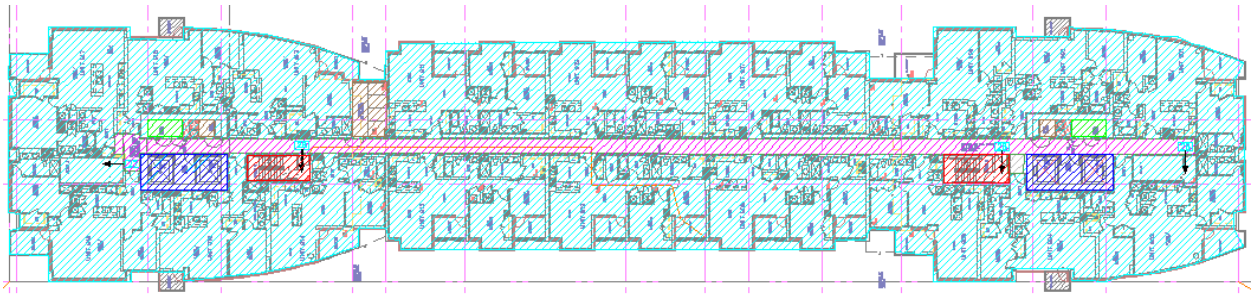


FIGURE 6: LEVEL 2-7 OCCUPANCY DRAWING

Occupant load breakdown per floor is as follows:

OCCUPANCY CALCULATIONS				
LEVEL	**USE**	**OCCUPANT LOAD FACTOR**	**FLOOR AREA (SQ. FT.)**	**OCCUPANT LOAD**
7th	Hotel	1/200 gross	26,745	134
6th	Hotel	1/200 gross	26,745	134
5th	Hotel	1/200 gross	26,745	134
4th	Hotel	1/200 gross	26,745	134
3rd	Hotel	1/200 gross	26,745	134
2nd	Hotel	1/200 gross	26,745	134
1st	Hotel	1/200 gross	25,000	125
	Business	1/100 gross	15,000	150
	Garage	1/200 gross	55,000	275
	Storage	1/300 gross	4,000	14
	Mechanical	1/300 gross	6,000	20
TOTAL			105,000	1,388

MEANS OF EGRESS SIZING

The exit capacity of egress components is based on the width of the egress component. CBC Section 1005 indicates that the minimum width is determined using the following factors:

1. Stairways: The capacity, in inches, of means of egress stairways shall be calculated by multiplying the occupant load served by such stairway by a means of egress capacity factor of 0.3-inch per occupant. Where stairways serve more than 1-story, only the occupant load of each story considered individually shall be used in calculating the required capacity of the stairways serving that story.

2. Other Egress Components (Doors): The capacity, in inches, of means of egress components other than stairways shall be calculated by multiplying the occupant load served by such component by a means of egress capacity factor of 0.2-inch per occupant.

Note: The building is equipped with an emergency voice/alarm system and automatic fire sprinkler system to allow the use of values of 0.2-inch per occupant for stairs and 0.15-inch per occupant for other egress components per CBC Section 1005.3.1 Exception 1 and CBC Section 1005.3.2 Exception 1.

Doors, when fully opened, shall not reduce the required width by more than 7 inches. Doors in any position shall not reduce the required width by more than one-half.

Where exits serve more than one floor level, only the occupant load of the most populated floor needs to be considered to size the exit. Increases for egress convergence are not an issue as the lowest level of the proposed building is the level of exit discharge.

Exit capacity calculation tables are provided below:

LEVEL	FLOOR AREA (SQ. FT.)	OCCUPANT LOAD	STAIR EXIT CAPACITY REQUIRED WIDTH	STAIR EXIT CAPACITY PROVIDED OCCUPANTS
7th	26,745	134	134 OCC * 0.2 in./OCC = 26.8 in.	32 in. X 2 = 64 in.
6th	26,745	134	134 OCC * 0.2 in./OCC = 26.8 in.	32 in. X 2 = 64 in.
5th	26,745	134	134 OCC * 0.2 in./OCC = 26.8 in.	32 in. X 2 = 64 in.
4th	26,745	134	134 OCC * 0.2 in./OCC = 26.8 in.	32 in. X 2 = 64 in.
3rd	26,745	134	134 OCC * 0.2 in./OCC = 26.8 in.	32 in. X 2 = 64 in.
2nd	26,745	134	134 OCC * 0.2 in./OCC = 26.8 in.	32 in. X 2 = 64 in.
			Door Exit Capacity Required	Door Exit Capacity Provided
1st	25,000	125	125 OCC * 0.15 in./OCC = 18.75 in.	(4)*32 in. + (7)*64 in. = 576 in.
	15,000	150	150 OCC * 0.15 in./OCC = 22.5 in.	
	55,000	275	275 OCC * 0.15 in./OCC = 41.25 in.	
	4000	14	14 OCC * 0.15 in./OCC = 2.1 in.	
	6000	20	20 OCC * 0.15 in./OCC = 3 in.	
TOTAL	105,000	1,388	175.2 in.	576 in.

MEANS OF EGRESS ILLUMINATION

CBC Section 1006 indicates that the means of egress are required to be illuminated at not less than 1 foot-candle (11 lux) at walking surface, except in Group R-1 dwelling and sleeping units. Therefore corridors, stairs, and other means of egress are required to meet this even in the event of a power supply failure. In the event of a power supply failure, an emergency system will illuminate the following areas:

1. Aisles and unenclosed egress stairways in rooms and spaces that require two or more means of egress.

2. Corridors, interior exit stairways, and ramps and exit passageways in buildings required to have two or more exits.

3. Exterior egress components at other than their levels of exit discharge until exit discharge is accomplished for buildings required to have two or more exits.

4. Interior exit discharge elements, as permitted in CBC Section 1027.1, in buildings required to have two or more exits.

5. Exterior landings as required by Section 1008.1.6 for exit discharge doorways in buildings required to have two or more exits.

ACCESSIBLE MEANS OF EGRESS

CBC Section 1007 requires accessible spaces shall be provided with not less than one accessible means of egress. Where more than one means of egress is required by Section 1015.1 or 1021.1 from any accessible space, each accessible portion of the space shall be served by not less than two accessible means of egress.

The stairwells in the building provide accessible means of egress as Section 1007.3, Exception 1 states the clear width of 48 inches (1,219 mm) between handrails is not required in buildings equipped throughout with an automatic sprinkler system installed.

This building has accessible floors four or more levels above the level of exit discharge and will be required to have at least one accessible elevator complying with Chapter 30. An elevator is not required to be accessed from an area of refuge or horizontal exit for a building with an automatic fire sprinkler system per CBC Section 1007.4 Exception 2.

DOORS

Doors serving as a means of egress must meet the requirements of CBC Section 1008. Per CBC Section 1008.1: Means of egress doors; shall be readily distinguishable from the adjacent construction and finishes such that the doors are easily recognizable as doors, shall not have mirrors or similar reflecting materials, and shall not be concealed by curtains, drapes, decorations, or similar materials. The minimum width of each door opening shall be sufficient for the occupant load or a clear width of 32 inches whichever is greater with a maximum allowable width of 48 inches and a height of at least 80 inches per CBC Section 1008.1.1.

Doors for the building provide the minimum of 32 inches of clear egress width. Means of egress doors will also be required to be set in motion when subject to 30-pound force or less to ensure that occupants who may be handicapped can make their way out of the building. The floor landing on each side of the door will be even (<2% slope) with no more than a 1/2-inch of drop.

If the door serves more than 50 occupants, the door must swing in the direction of egress travel.

STAIRWAYS / INTERIOR EXIT STAIRWAYS AND RAMPS

CBC Section 1022 and 1009 identifies that interior exit stairways shall lead directly to the exterior of the building or shall be extended to the exterior of the building with an exit passageway, which are 2 hr. to maintain fire resistance rating continuity for egress, and shall be enclosed in a 2 hr. fire-resistance rated exit enclosure. CBC Section 713.4 requires shaft enclosures should have a fire-resistance rating of not less than 2-hours where connecting four or more stories and not less than 1-hour where connecting less than four stories.

The width of stairways shall be determined as specified in Section 1005.1, but such width shall not be less than 44 inches and having a minimum height of 80 inches measured from the nosing. They can be as small as 36 inches when serving less than 50 occupants, but this does not apply to this project as all of the stairs serve a much larger load.

Stair riser heights shall be 7 inches maximum and 4 inches minimum. The riser height shall be measured vertically between the nosings of adjacent treads. Rectangular tread depths shall be 11 inches minimum measured horizontally between the vertical planes of the foremost projection of adjacent treads and at a right angle to the tread's nosing.

There shall be a floor or landing at the top and bottom of each stairway. The width of landings shall not be less than the width of stairways they serve. Every landing shall have a minimum width measured perpendicular to the direction of travel equal to the width of the stairway. Where the stairway has a straight run, the depth need not exceed 48 inches. Doors opening onto a landing shall not reduce the landing to less than one-half the required width.

EXIT SIGNS

CBC Section 1011 indicates exits and exit access doors shall be marked by an approved exit sign readily visible from any direction of egress travel. The path of egress travel to exits and within exits shall be marked by readily visible exit signs to clearly indicate the direction of egress travel in cases where the exit or the path of egress travel is not immediately visible to the occupants. Intervening means of egress doors within exits shall be marked by exit signs. Exit sign placement shall be such that no point in an exit access corridor or exit passageway is more than 100 feet or the listed viewing distance for the sign, whichever is less, from the nearest visible exit sign.

Exit signs are not required in the following locations for this project:

1. Exit signs are not required in rooms or areas that require only one exit or exit access.

2. Main exterior exit doors or gates that are obviously and clearly identifiable as exits need not have exit signs where approved by the Building Official.

3. Exit signs are not required in occupancies in individual sleeping units or dwelling units in Group R-1.

Exit signs shall be illuminated at all times. To ensure continued illumination for a duration of not less than 90 minutes in case of primary power loss, the sign illumination means shall be connected to an emergency power system provided from storage batteries, unit equipment, or an on-site generator.

Exit sign suggested locations can be found on the attached Occupancy and Egress Drawings.

EXIT ACCESS

CBC Chapter 10 layout guidelines for the arrangement of means of egress access pathways for the building's egress system. CBC Section 1014 specifically deals with egress through intervening spaces and common path of travel.

COMMON PATH OF EGRESS TRAVEL

Common path of travel is the distance to a separate and distinct route to another exit in the building. This ensures that there are alternative exit routes to minimize the chance that the path of egress becomes blocked and the occupants become trapped.

In accordance with CBC Table 1014.3, the following common path of egress travel distances are shown below.

CBC Table 1014.3

OCCUPANCY	WITH SPRINKLER SYSTEM (feet)
B, S	100
U	75
F	100
H-1, H-2, H-3	25
R-2	125
R-3	125
I-3	100
All others	75

EXIT AND EXIT ACCESS DOORWAYS

CBC Section 1015 indicates the number and acceptable locations of the provided exits or exit access doorways for any space. The following table indicates the maximum occupant load that requires only one exit or exit access doorway.

CBC Table 1015.1

OCCUPANCY	MAXIMUM OCCUPANT LOAD
A, B, E, F, M, U	49
H-1, H-2, H-3	3
H-4, H-5, I-1, I-2, I-3, I-4, R	10
S	29

When the values in the table above are exceeded, the space must be provided with a minimum of two exits or exit access doorways. A minimum of three exits or exit access doorways must be provided for spaces with an occupant load of 501-1,000, and a minimum of four exits or exit access doorways must be provided for spaces with an occupant load of more than 1,000.

Where two or more exits or exit access doorways are provided, at least two of the exits or exit access doorways must be placed at least 1/2 the distance of the maximum overall diagonal dimension of the space. For this project, we can use the exception for buildings provided with automatic sprinkler systems to reduce this minimum separation distance to 1/3 of the maximum overall diagonal dimension. The following table identifies the minimum exit separation distance for various zones. Figures 7 and 8 show that the Overall Diagonal Distance (Black) and Exit Separation Distance (Orange/Brown).

Level	Building Area Identification	Minimum Exit Separation Distance
Level 1	Residential	450 ft/3 = 150 ft
	Parking Garage	325 ft/3 = 108.3 ft
	Business	272 ft/3 = 90.6 ft
Level 2-7	Residential	372 ft/3 = 124 ft

FIGURE 7: EXIT ACCESS SEPARATION DISTANCE - OVERALL DIAGONAL DISTANCE (BLACK) AND EXIT SEPARATION DISTANCE (ORANGE/BROWN)

FIGURE 8: EXIT ACCESS SEPARATION DISTANCE - OVERALL DIAGONAL DISTANCE (BLACK) AND EXIT SEPARATION DISTANCE (ORANGE/BROWN)

EXIT ACCESS TRAVEL DISTANCE

CBC Section 1016 exit access travel distance limits the time it should take an occupant to reach a protected exit enclosure and in doing so, limit their exposure to a fire event. In different occupancies the exit travel distances measured along path of travel from the most remote point to an exit enclosure for this project shall not exceed the values in the following CBC Table 1016.2.

CBC Table 1016.2

OCCUPANCY	EXIT ACCESS TRAVEL DISTANCE WITH SPRINKLER SYSTEM
R	250
B	300
S-2	400

CORRIDORS SECTION 1018

CBC Section 1018 indicates to provide some level of protection to occupants traveling to an exit enclosure, for some occupancy classification, the corridor is required to be constructed with a fire-resistance rating. For this project, the dwelling units (R occupancy) are connected by a common corridor to themselves and the exit enclosures. For a fully sprinklered building, the corridor is required to have a minimum of 1-hour fire-resistance rating.

This section also requires a minimum width of the corridor to provide egress to the exit enclosures. For different occupancies, they must meet the requirements of the following CBC Table 1018.2.

CBC Table 1018.2

OCCUPANCY	WIDTH (minimum)
Any facilities not listed below.	44 inches
Access to and utilization of mechanical, plumbing, or electrical systems, or equipment.	24 inches
With a required occupancy capacity less than 50.	36 inches
Within a dwelling unit.	36 inches

EXIT

CBC Section 1020 indicates that an exit shall not be used for any purpose that interferes with its function as a means of egress. Once a given level of exit protection is achieved, such level of protection shall not be reduced until arrival at the exit discharge.

Buildings or structures used for human occupancy shall have at least one exterior door that meets the requirements of Section 1008.1.1. Exterior exit doors shall lead directly to the exit discharge or the public way. For this project, all exit stairs discharge directly to the public way without any reduction in level of protection that can be provided by Section 1027 exceptions.

NUMBER OF EXITS AND EXIT CONFIGURATION

The minimum number of exits that are required for an occupant load are outlined in the

following CBC Table 1021.3(1).

CBC Table 1021.3(1)

OCCUPANT LOAD	MINIMUM NUMBER OF EXITS
1-500	2
501-1000	3
1001 or more	4

Based on the occupant loads of the stories in this building, the first floor requires three exits, the second floor requires four exits, and the remaining floors require two exits. On all floors, significantly more than the minimum are provided.

STORIES WITH ONE EXIT OR ACCESS TO ONE EXIT

STORY	OCCUPANCY	MAXIMUM OCCUPANTS PER STORY	MAXIMUM EXIT ACCESS TRAVEL DISTANCE
First Story or Basement	A, B , E, F, M, U, S	49 occupants	75 feet
	H-2, H-3	3 occupants	25 feet
	H-4, H-5, I, R-1, R-2, R-4	10 occupants	75 feet
	S	29 occupants	100 feet
Second Story	B, F, M, S	29 occupants	75 feet
Third Story and Above	NP	NA	NA

EXIT PASSAGEWAY

CBC Section 1023 indicates exit passageways provide a means for stairs located in the center of the building to exit to the exterior. Exit passageways are of fire-resistance rated construction that continues from the discharge level of the stair to the exterior of the building and shall not be used for any purpose other than as a means of egress. The width will be calculated by Section 1005.1 but shall not be less than 44 inches, unless the occupant load served is less than 50 occupants. For this project, the occupant load served by all of the exit passageways is greater than 50 occupants, therefore a 36-inch exit passageway is not allowed.

The exit passageway's fire-resistance rating is required to be at least 1- hour, but not less than the required fire-resistance rating for any connected interior exit stairways or ramps. Exit passageways on the level of exit discharge will terminate at the exit discharge, while exit passageways on other levels will terminate at an exit.

EXIT DISCHARGE

CBC Section 1027 indicates exits shall discharge directly to the exterior of the building with access to the public way. Exit discharge will be at grade or shall provide direct access to

grade and should not re-enter the building. The occupants are discharged directly to the public way.

TIME EGRESS ANALYSIS (ENTIRE BUILDING)

Time egress analysis for the entire building was performed to evaluate the amount of time to egress the building. The occupants of the building are expected to be primarily adult guests, families, and trained employees at the hotel. The employees are very familiar with the facility and in case of an emergency would be able to help guide guests out of the building. With the relatively simple one corridor design, it could be expected that guests would become familiar with the facility relatively quickly and be able to use this knowledge in case of an emergency. For families with small children that may not be capable to efficiently evacuate the facility, it would be expected that the parents would be in close proximity to their children and able to guide them out of the building.

The occupant travel speed is expected to be around the average based on the expected occupant density. The hotel expected to have a varying cross section of occupants from families with younger children, to adults and seniors who may or may not be slightly injured. It is not expected that a sizable occupant group would be significantly movement impaired.

Occupants may be asleep at the time of the fire event which would require additional time for them to wake up and get dressed. The voice alarm will clearly instruct them to evacuate the building once they have dressed. Due to the transient nature of the facility, we can expect that the occupants' valuables will mostly be packed up and portable requiring minimal time to gather items, if necessary, prior to evacuation. Being a hotel where occupants may be asleep, unfamiliar with the building and evacuation procedures, or just a little less inclined to move immediately the pre-movement time can be expected to be slightly higher.

HAND CALCULATION ASSUMPTIONS

The following outlines the assumptions made to conservatively estimate evacuation time for the building:

1. The entire building is protected by system smoke detectors tied into the fire alarm system to establish a reasonable time to notification based on smoke detection.

2. The conservative delay from ignition to the alarm activation is 40 seconds. This approximation comes from some similar FDS modeling completed for 10 foot high ceiling office buildings which includes a 30 second delay from ignition to smoke detection and a conservative 10 second delay for the fire alarm system to trigger the alarm. This establishes the time from ignition to notification based on FDS modeling.

3. The alarm condition for the building includes nondirective voice messages (prerecorded) and/or informative warning visual display with trained staff. This establishes a set pre-movement time of 240 seconds from data taken directly from the SFPE Handbook.

4. The primarily controlling factor will be either egressing occupants down stairways or discharging them through exit doors. In our case, the exit door at the bottom of the stairs is the pinch point where queuing will begin. The queuing time will be the dominating factor that limits the time to egress the building. With occupants able to negotiate their way down the stairs, one story in 22 seconds, it can be expected that we will experience queuing at the exit discharge relatively quickly.

5. All stairs have 7-inch risers and 11-inch treads. This sets a standard stair type that allows use of the data in the tables to calculate speed of egress down the stairs.

6. All occupants start egress at the same time, and due to the trained staff, use the facilities in the optimum balance. It makes it more reasonable to calculate each stair evenly than to randomly apply an increase to one of the stairs. However, if one stair does become overloaded, it is possible that occupants at the end of the line may go search for another exit.

HAND CALCULATION

This analysis is used to give you a simple and conservative estimate of the amount of time it would take to evacuate the building. This analysis is limited in that it does not account for several of the more dynamic issues that would affect the evacuation time such as how many people does it take to fill the stair, how many occupants are left queued outside of the stair, exit convergence of occupants entering the stair, any gaps of time where the pinch point is not being used to its maximum capacity and more that could affect the evacuation time. Adding these element would give you a more accurate egress time.

Primary reference is SFPE Handbook Third Edition

Time to notification = 40 seconds (assumption b)

Pre-movement time = 240 seconds (SFPE Handbook)

Per SFPE Handbook Table 3-13.1"Estimated Delay Time to Start Evacuation in Minutes" indicates that for this scenario (assumption c.) the estimated delay time to start of evacuation is 4 minutes.

Travel Time = Time to reach Controlling element + Time to pass controlling element

Travel Time = (Movement time to reach stair + Stair Movement time) + Door/stair Queueing Time

The building has a relatively low occupant load. Per Table 4.2.7 "Maximum (Unimpeded) Exit Flow Speeds" occupant movement speed was taken as 235 ft/min. For a conservative estimation of evacuation time the travel time will be taken from the most remote point on the floor plan (worst case travel distance residential/assembly of approximately 250 feet to the exit).

Movement time: (250 ft)/(235 ft/min)= 1.06 min = 64 sec

Distance from bottom of stairs to public way = 56 feet

Movement time: (56 ft)/(235 ft/min)= .24 min = 15 sec

Stair

Table 4.2.8 indicates maximum specific flow through door is 18.5 persons/min/ft of effective width.

Effective width: 44 in. - 12 in. = 32 in. = 2.66 ft

Stair Flow: (2.66 ft) * (18.5 persons/min/ft) = 49.2 persons/min

Door

Table 4.2.8indicates maximum specific flow through door is 24 persons/min/ft of effective width.

Effective width: 32 in. - 12 in. = 20 in. = 1.67 ft

Door Flow: (1.67 ft) * (24 persons/min/ft) = 40 persons/min (Limiting Capacity/Controlling element)

Worst case scenario stair 2: 401 occupants

Door Queuing Time: (401 occupants) / (40 persons/min) = 10.025 min = 601.5 = 602 seconds

Stair Movement Time

Per Table 4.2.5 k=212 for 7in./11in. stairs and a=2.86 sq.ft./person Per Figure 4.2.7 (Module 7 Slide 28) D=.175 person/sq.ft.

S=k-akD
S=212-(2.86)*(212)*(.175) =105ft/min

Travel distance down stairs

D=distance between floors * 1.85(conversion factor Table 4.2.6) + 2*(landing travel distance 8 ft for 44" stair)

D=12*1.85+2*8 = 38.2 ft

Stair Movement Time = (38.2 ft)/(105 ft/min) = .36 min/floor = 22 sec/floor

Travel Time = (Movement time to reach stair + Stair Movement time) + Door/stair Queueing Time + Movement time to reach public way

Travel Time = 64 sec + 22 sec + 602 sec + 15 sec= 703 sec

Evacuation Time = Time to notification + Pre-movement time + Travel Time Evacuation Time = 40 sec + 240 seconds + 703 sec = 983 sec = 16.4 min

EGRESS MODEL

The egress modeling of this project was completed with Pathfinder 2012 Edition, which was developed by Thunderhead Engineering Consultants, Inc. Pathfinder is an agent-based egress simulator which has built in human behaviors including the SFPE Handbook Human Behaviors to model occupant motion.

The models were run in SFPE mode which implements the flow-based egress modeling techniques presented in the SFPE Handbook of Fire Protection Engineering [Nelson and Mowrer, 2002] and the SFPE Engineering Guide: Human Behavior in Fire [SFPE, 2003]. The SFPE calculation, as described in the Handbook, is a flow model, where walking speeds and flow rates through doors and corridors are defined.

In Pathfinder, navigation geometry can be grouped into three types of components: Doors, rooms, and stairs. Rooms are open spaces on which occupants can walk. Stairs can be thought of as specialized rooms in which the slopes of the stairs limit the speed of the occupants. Doors are flow limiters that connect rooms and stairs. There is no specialized corridor type as in the SFPE Guide. Instead, corridors are modeled as rooms with doors on either end. In this manner, corridors are handled in the same manner as rooms, with the flow being controlled by the doors.

The Pathfinder implementation of the SFPE calculation allows some incremental movement options to be added. For example, it is possible to retain the flow constraints through doors and add the option for Collision Handling, so that occupants will physically queue at a door.

The results of the model identify a 412.5 second egress time. This egress time is associated with the movement time only, it does not take into account notification or pre-movement time. If we apply all of the assumptions for notification time and pre-movement time from the hand calculation section above, we get the following total evacuation time:

Evacuation time = Notification time + Pre-movement time + Movement time
= 40 sec + 240 sec + 412.5 sec = 692.5 seconds = 11.5 min

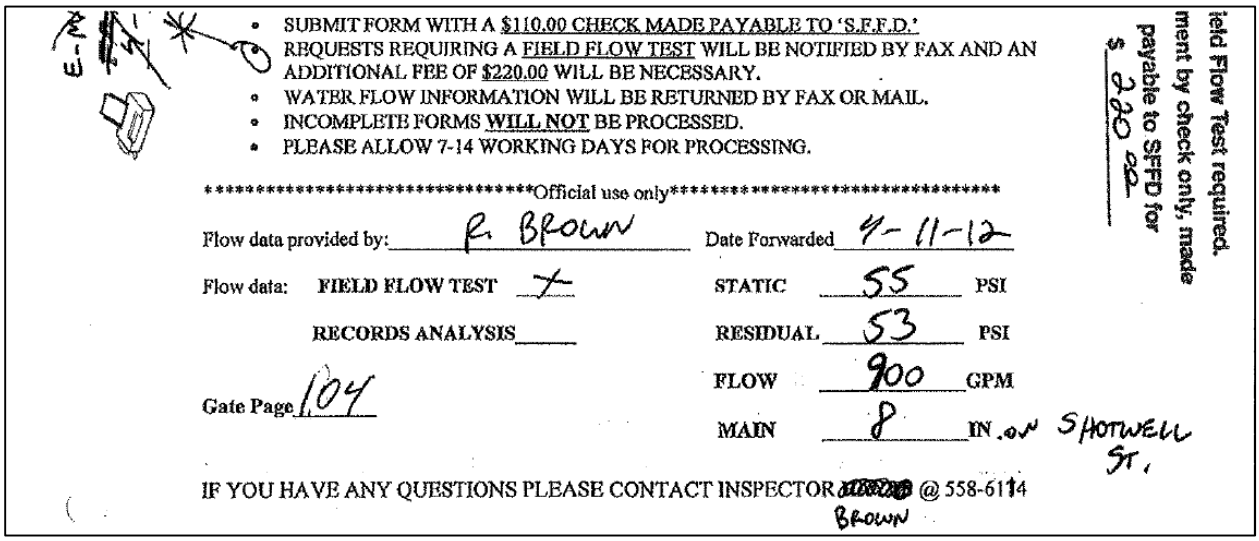
As expected, the modeled evacuation time of 692.5 seconds is smaller than the hand calculated evacuation time of 983 seconds. The Pathfinder model is able to more dynamically analyze the flow of occupants and as such, uses less conservative relationships of occupants flow through egress components. However, the egress model can take much long to complete than the simple hand calculation and the cost for the model itself is quite expensive. Pathfinder model is ideal for larger more complicated buildings where knowing a more realistic evacuation time is important to the design of the building.

AUTOMATIC FIRE SPRINKLER SYSTEM

This project building is provided with a wet pipe sprinkler system that provides fire sprinkler coverage to the entire building. The system is comprised of quick-response pendant heads and standpipes are provided in each stair vestibule.

WATER SUPPLY

Provided by San Francisco Fire Department, the following water supply data represents the results of the flow test that will be used to design the fire sprinkler system for this building. Sections of the form that may indicate the location of the project have been removed to keep the building's identity off public record.



- SUBMIT FORM WITH A $110.00 CHECK MADE PAYABLE TO 'S.F.F.D.'
- REQUESTS REQUIRING A FIELD FLOW TEST WILL BE NOTIFIED BY FAX AND AN ADDITIONAL FEE OF $220.00 WILL BE NECESSARY.
- WATER FLOW INFORMATION WILL BE RETURNED BY FAX OR MAIL.
- INCOMPLETE FORMS WILL NOT BE PROCESSED.
- PLEASE ALLOW 7-14 WORKING DAYS FOR PROCESSING.

ield Flow Test required. ment by check only, made payable to SFFD for $ 220.00

**********Official use only**********

Flow data provided by: R. BROWN Date Forwarded 4-11-12

Flow data: FIELD FLOW TEST X STATIC 55 PSI

RECORDS ANALYSIS ____ RESIDUAL 53 PSI

Gate Page 104 FLOW 900 GPM

MAIN 8 IN. ON SHOTWELL ST.

IF YOU HAVE ANY QUESTIONS PLEASE CONTACT INSPECTOR [redacted] BROWN @ 558-6114

Static Pressure = 55 psi
Residual Pressure = 53 psi Flow = 900 gpm

AUTOMATIC SPRINKLER SYSTEM

Summary of Occupancy Classifications

1. Parking Garage: Ordinary Hazard Group I
2. Offices: Light Hazard
3. Residential: Light Hazard
4. Corridor: Light Hazard

Parking Garage

The sprinkler system in the parking garage area is designed to the following specifications in accordance with NFPA 13. Please see the attached sprinkler cut sheet for additional sprinkler information. (Appendix x)

Occupancy Hazard Classification:	Ordinary Hazard Group I Density: 0.15 gpm/ft^2
Area of Operation:	1,500 sq.ft. Maximum Coverage per head = 130 sq.ft.
Sprinkler:	Reliable F1FR42 Quick-Response
Orifice:	1/2-inch
K:	5.6
Hose Stream Allowance:	250 gpm
Cross mains:	4 inches
Branch lines:	2 inches

Offices

The sprinkler system in the office areas is designed to the following specifications in accordance with NFPA 13. Please see the attached sprinkler cut sheet for additional sprinkler information. (Appendix x)

Occupancy Hazard Classification:	Light Hazard Density: 0.10 gpm/ft^2
Area of Operation:	1,500 sq.ft.
Maximum Coverage per head:	225 sq.ft.
Sprinkler:	Reliable F1FR42 Quick-Response
Orifice:	1/2-inch
K:	5.6
Hose Stream Allowance:	250 gpm
Cross mains:	4 inches
Branch lines:	2 inches

Residential

The sprinkler system in the residential areas is designed to the following specifications in accordance with NFPA 13. Please see attached sprinkler cut sheet for additional sprinkler information. (Appendix x)

Occupancy Hazard Classification:	Light Hazard Density: 0.10 gpm/ft^2
Area of Operation:	1,500 sq.ft.
Maximum Coverage per head:	225 sq.ft.
Sprinkler:	Reliable F1FR42 Quick-Response
Orifice:	1/2-inch
K:	5.6
Allowance:	250 gpm
Cross mains:	4 inches
Branch lines:	2 inches

Corridor

The sprinkler system in the corridor areas is designed to the following specifications in accordance with NFPA 13. Please see attached sprinkler cut sheet for additional sprinkler information. (Appendix x)

Occupancy Hazard Classification:	Light Hazard Density: 0.10 gpm/ft^2
Area of Operation:	1,500 sq.ft.
Maximum Coverage per head:	225 sq.ft.
Sprinkler:	Reliable F1FR42 Quick-Response
Orifice:	1/2-inch
K:	5.6
Hose Stream Allowance:	250 gpm
Cross mains:	4 inches
Branch lines:	2 inches

STANDPIPE SYSTEM

Standpipe design criteria

Size: 4 inches per NFPA 14.

Flow: 500 gpm minimum for the most remote standpipe.

Calculation: 250 gpm shall be provided at the two most remote hose connection, as well as maintain 100 residual psi at the top outlet.

HYDRAULIC CALCULATIONS

The most remote area of the building is located on the far end of 7th floor (top floor).
Per NFPA 13 systems operational area can be reduced by to 40% for a building with 10-foot ceilings and quick-response sprinklers. Our building meets these, along with the other requirements from the section with respect to this reduction.
n = 1,500(.6) / 225 ft^2 per sprinkler = 4 sprinklers

Per the attached hydraulic calculations (Appendix x), the following are the requirements at base of riser:

Flow:	90.12 gpm
Pressure:	50.67 psi

You will notice that the required pressure is only approximately 4 psi less than the pressure that can be supplied by the city water supply. The AHJ will typically require 10% of the required pressure or 10 psi, whichever was greater. This will require negotiation with the AHJ to provide their approval. A few options to fix this issue are as follow:

1. Reassess the flow test data. Generally, optimal flow test data is 6 months to a year old. The attached flow test data is dated 4-11-12. If it is suspected that the system has improved since this time another flow test may provide the additional 6 psi required.

2. Redesign the system to be 6 psi less hydraulically demanding.

3. Design a fire pump into the system. A fire pump could provide the required additional pressure and would not need to be very big as the flow and pressure increase are relatively small. But adding a fire pump to a system requires certain other requirements including a fire pump room that meets specific criteria, it must be on emergency power and much more. A sample fire pump curve for pump that could provide the required increase for the system, though a small one may be chosen for economic reasons.

INSPECTION, TESTING, AND MAINTENANCE

Additional information is provided in NFPA 13 Tables 5.1.1.2, 6.1.1.2, and 13.1.1.2.

SPRINKLERS

If the sprinklers are quick-response, they should be tested at 20 years and then every 10 years after. One percent of the sprinklers should be tested but never less than four sprinklers.

Annual inspection to be done by the contractor performing the maintenance and review the following:

1. Absence of sprinklers from any rooms.

2. Location of sprinklers.

3. Proper clearance and unobstructed.

4. Deflector distance should conform to NFPA 13.

5. The rating, type, and condition of the sprinklers.

Additional inspections should be done for any time occupancy changes or modifications to the building.

STANDPIPE AND HOSE SYSTEM

Inspection of the gauges should be done weekly by district staff.

Annual inspection and testing should be done by the contractor performing the maintenance.

SPRINKLER PIPING AND SUPPORTS

Annual inspection should be done by the contractor performing the maintenance. This inspection should cover the review of piping, fittings, and supports to verify that no hangers are loose or that objects are not being hung from any exposed piping, as well as seismic bracing, if required.

Additional inspections should be done for any time occupancy changes or modifications to the building.

VALVES

Valves should all be kept readily accessible and unobstructed so that they can be operated promptly and examined to see that they are open and in good operative condition, turn easily and do not leak. The post indicator valve outside the building by the riser should be open at all times.

Periodic inspection is done by the local fire department. District staff should visually inspect monthly.

WATERFLOW AND SUPERVISORY ALARMS

District staff should visually inspect monthly.

Water flow alarm devices, supervisory signals should be tested as part of the quarterly testing by the contractor performing the maintenance.

A spring inspection should be done after low temperatures have passed. This should include a flow test and review of alarm and tamper switch operation. This should be done as part of one of the scheduled quarterly visits by the contractor performing the service.

CITY SUPPLY MAIN

Maintained by the City. Water should be available at all times.

Visual review of connection should be done as part of quarterly testing by the contractor performing the maintenance.

FIRE ALARM SYSTEM

This project building is protected by a complete manual and automatic fire alarm system and mass notification system that provides coverage to the entire building.

CBC Section 907.2.8 was used to determine the requirements of the fire alarm system. The Fire Alarm Control Unit (FACU), a Simplex Model 4010, is located in admin office in the hotel lobby. The Fire Alarm Control Unit (FACU) receives alarm, trouble, and supervisory signals from the facility. Then through the use of the digital alarm communicator transmitter (DACT) this is sent to an off-site supervising center.

NFPA 72 Section 10.12 Fire Alarm Signals, Section 10.13 Fire Alarm Signal Deactivation, Section 10.14 Supervisory Signals, and Section 10.15 Trouble Signals provide the requirements for signals at the control panel. These sections provide information on delay times, from initiation to activation of occupant notification devices (audible and visual). It indicates when alarm, trouble, and supervisory signals can be cleared, silenced, or

cancelled, and that continued alarms must re-activate the alarms so that they cannot be ignored. Also, access to the fire alarm panel where these alarms can be silenced is locked to avoid any unauthorized silencing of fire alarm signals.

INITIATING DEVICES

The FA system is required by CBC Section 907.2.8 to initiated by the following:

1. Manual means (manual fire alarm boxes) in accordance with 9.6.2.

   Each manual fire alarm box (manual pull station) is required be securely mounted with the operable part not less than 42 inches (1.07 m), and not more than 48 inches (1.22 m) above floor level. (NFPA 72 – 2013 Section 17.14)

   Manual pull stations are also required to be located within 5 feet (1.52 m) of exit doorway openings at each exit on each floor. (NFPA 72 – 2013 Section 17.14)

   Additional pull stations are required to be provided so that the travel distance to the nearest pull station will not be in excess of 200 feet (61.0 m), measured horizontally on the same floor.(NFPA 72 – 2013 Section 17.14)

   Manual fire alarm boxes shall be mounted on both sides of grouped openings over 40 feet (12.2 m) in width, and within 5 feet (1.5 m) of each side of the grouped opening. (NFPA 72 – 2013 Section 17.14)

   The hotel in question is adequately covered by manual pull stations in all of the above-mentioned required locations.

2. Manual fire alarm box located at the hotel desk or other convenient central control point under continuous supervision by responsible employees. This is located at the front desk in the hotel lobby.

3. Required automatic sprinkler system.

   Upon activation of the automatic fire sprinkler system the flow of water will trigger waterflow switches which are incorporated into the fire sprinkler system riser. A delay in activation (typically, 30-90 seconds) is included in the waterflow switch to ensure the system is not accidentally activated by water surges.

   Activation of the initiating device shall occur within 90 seconds of waterflow at the alarm-initiating device when flow occurs that is equal to or greater than that from a single sprinkler of the smallest orifice size installed in the system. (NFPA 72 – 2013 Section 17.12)

4. Required automatic detection system other than sleeping room smoke detectors.

CBC Section 907.2.8.2 Automatic smoke detection system: A corridor smoke detection system which activates occupant notification systems in accordance with CBC Section 907.5 shall be provided.

CBC Section 907.2.8.3 Smoke Alarms: Single and multiple-station smoke alarms shall be installed in accordance with CBC Section 907.2.11.

The attached fire alarm drawings show that the spot-type smoke detectors meet the following location and spacing requirements.

Spot-type smoke detector are required to be located on the ceiling, or if on sidewall between the ceiling and 12 inches (300 mm) down from the ceiling to the top of the detector.(NFPA 72 – 2013 Section 17.7.3.2)

The smoke detector spacing for this project was based upon smooth ceilings protection for spot-type smoke detectors in accordance with NFPA 72 – 2013 Section 17.7.3.2.3.1

17.7.3.2.3.1* In the absence of specific performance-based design criteria, one of the following requirements shall apply:

(1) The distance between smoke detectors shall not exceed a nominal spacing of 30 feet (9.1 m) and there shall be detectors within a distance of one-half the nominal spacing, measured at right angles from all walls or partitions extending upward to within the top 15 percent of the ceiling height.

(2)*All points on the ceiling shall have a detector within a distance equal to or less than 0.7 times the nominal 30 foot (9.1 m) spacing (0.7S).

ANALYSIS OF FIRE DETECTOR RESPONSE TIME

The fire scenario for the hotel is as follows. A fire started accidentally by the guest igniting the bed and grows as a medium t-squared fire with a fire growth coefficient of $\alpha = 0.014$ kW/s^2. Until it activates the 165°F quick-response sprinklers with an RTI of 50 (m-s)^1/2. Assuming a bed height of 2 feet, ceiling height of 10 feet, and an ambient temperature of 68°F activation is estimated by the Detact model to be approximately 318 seconds. Which corresponds to a 1,185 kW fire at sprinkler activation.

NOTIFICATION APPLIANCES

The facility is provided with complete notification coverage by audio/visual appliances per CBC Section 907.5. Speaker strobes are located in accordance with NFPA 72 Section 18.4.8.1. If ceiling heights allow, and unless otherwise permitted by Sections 18.4.8.2 through 18.4.8.5, wall-mounted appliances shall have their tops above the finished floors at heights of not less than 90 inches. (2.29 m) and below the finished ceilings at distances of not less than 6 inches. (150 mm).

Per NFPA 72 Section 18.4.3 the audible devices are required to provide at least 15 dBA above average ambient sound level. Table A.18.4.3 indicates for residential occupancies an average ambient sound level is 35 dBA. Therefore, 35 dBA + 15 dBA = 50 dBA is required throughout the space.

In accordance with this 76 dBA at 10 feet Speaker-strobe has be specified. The 6 dBA rule-of- thumb method indicates that this Speaker-strobe would provide 70 dBA at 20 feet, 64 dBA at 40 feet, and 58 dBA at 80 feet from the Speaker-strobe. 58 dBA at 80 feet provides the sufficient coverage for all layout scenarios and therefore 76 dBA setting has been specified for all Speaker-strobes for this layout.

Section 18.5.5.5.5 indicates that "visible notification appliances shall be located not more than 15 feet (4.57 m) from the end of the corridor with a separation not greater than 100 feet (30.5 m) between appliances." The central corridor connects the guest rooms and is covered by 75 cd strobes that are space out every 45 feet in accordance with Table 18.5.4.3.

NFPA 72 Section 10.6.7 indicates that the secondary power for the NAC devices in the system is required to:

"The secondary power supply shall have sufficient capacity to operate the system under quiescent load (system operating in a non-alarm condition) for a minimum of 24 hours and at the end of that period, shall be capable of operating all alarm notification appliances used for evacuation or to direct aid to the location of an emergency for 5 minutes, unless otherwise permitted or required by the following:

(1) Battery calculations shall include a 20 percent safety margin to the calculated amp-hour rating."

BATTERY CAPACITY

DEVICE	STANDBY CURRENT PER UNIT (AMPS)	QUANTITY	TOTAL STANDBY CURRENT PER DEVICE TYPE (AMPS)
FACU	0.12	1	0.12
Manual Pull Station	.00023	33	.00759
Speaker Strobe 75 cd / 88 dBA	0	375	0
		TOTAL	**.1276**

DEVICE	ALARM CURRENT PER UNIT (AMPS)	QUANTITY	TOTAL ALARM CURRENT PER DEVICE TYPE (AMPS)
FACU	1.5	1	1.5
Manual Pull Station	. 00023	33	.00759
Speaker Strobe 75 cd / 88 dBA	.176	375	66
		TOTAL	**67.5076**

Required standby time = 24 hours
Required alarm time = 5 minutes or .0833 hours
Required Standby Capacity (Amp-Hours) = 24 hours * .1276 amps = 3.06 amp-hours
Required Alarm Capacity (Amp-Hours) = .0833 hour * 67.5076 amps = 5.62 amp-hours
Total Required Capacity = (3.06 + 5.62) * 1.2 = 10.416 amp-hours
Provided Capacity = 12 amp-hours

INSPECTION, TESTING, AND MAINTENANCE

Inspection, testing, and maintenance requirements are set by NFPA 72 Chapter 14. Visual inspection schedule is found in Table 14.3.1. The fire alarm control panel is required to be inspected annually. Trouble signals, smoke detectors, manual pull stations, and notification devices need to be checked semiannually. Supervisory switches (tamper switches) and waterflow switches need to be checked quarterly. Table 14.4.2.2 indicates the testing requirements for the system and Table 14.4.5 indicates the frequency of required testing. All of the components are required to be maintained at a level that allows them to function properly in the case of a fire emergency.

PERFORMANCE-BASED APPROACH

PERFORMANCE OBJECTIVE

An enclosed parking garage area is located centrally on the ground floor is designed to meet the prescriptive code requirements. The performance-based design will evaluate the tenability of the enclosed parking garage during a fire event. A car fire will be simulated to establish if occupants egressing the building will be exposed to untenable conditions. Location of the design fire is shown below.

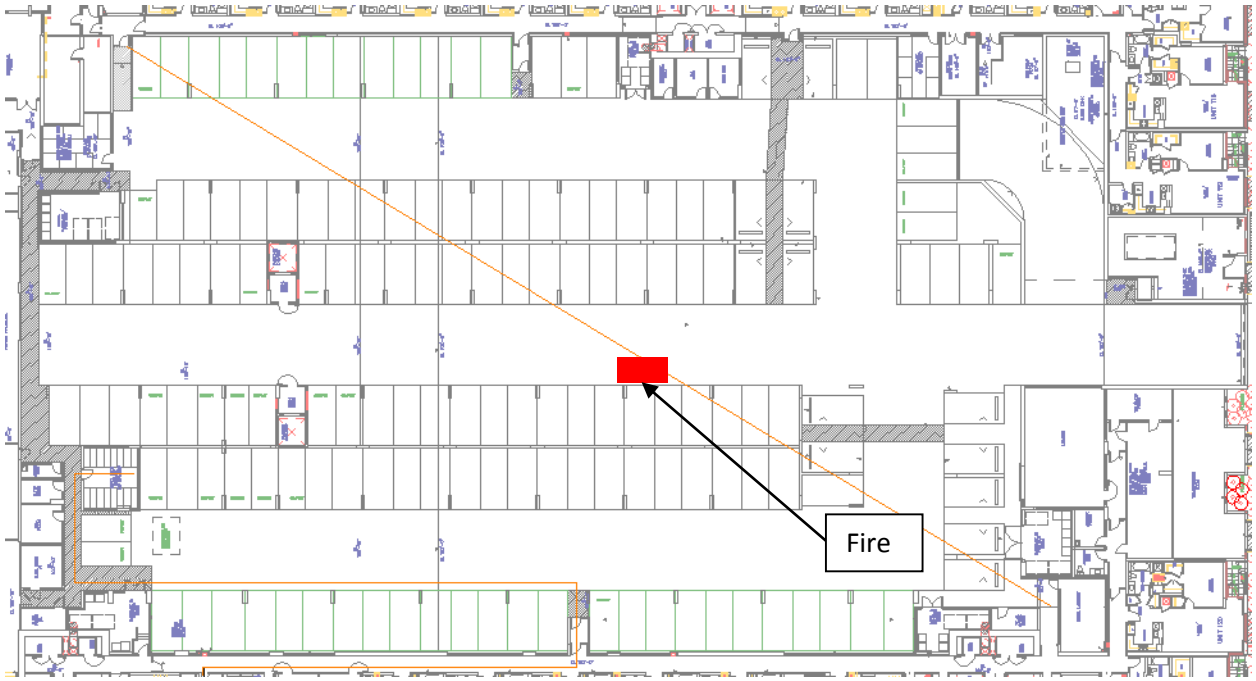


FIGURE 9: PARKING GARAGE CAR FIRE LOCATION

TENABILITY METHODOLOGY

Life Safety Code 5.2 provides four methods to determine if tenability is maintained for a building. Briefly explained they are as follows:

1. Method 1 – Use detailed performance criteria that ensure that occupants are not incapacitated by the fire.

2. Method 2 – Transient analysis of evacuation/smoke layer position.

3. Method 3 – Steady state analysis of smoke layer position (never below 6 feet).

4. Method 4 – No fire effects will reach an occupied room beyond room of origin.

With the nature of the building average height ceilings, no smoke control exhaust/make-up air and ample combustibles (cars), the most practical of the four is Method 2. With the low ceilings and no real smoke reservoir to contain the smoke, it makes sense to evaluate that though the tenability of the space may become compromised by the time the area will have already been evacuated.

Method 2 in full states "For each design fire scenario and the design specifications, conditions, and assumptions, the design team can 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 feet (1,830 mm) above the floor. The timing of such an evacuation means that no occupant is exposed to fire effects. Such an evacuation requires calculation of the locations, movement, and behavior of occupants, because fire effects and occupants are separated by moving the occupants. A level of 60 inches (1,525 mm) is often used in calculations, but, at that level, a large fraction of the population would not be able to stand, walk, or run normally and still avoid inhalation of toxic gases. They would have to bend over or otherwise move their heads closer to the floor level."

Using Method 2 the garage area would be modeled in FDS to evaluate when the smoke layer would descend lower than 6 feet, causing the occupants to be exposed to untenable conditions of the design fire scenario and then compared to the results of the egress modeling to see if the area would still be occupied at this time. Slice file could be place at 6 feet above the walking surface to record data such as temperature, visibility, carbon monoxide (CO)/other toxic gas concentrations and other parameters to see exactly what the occupants are being exposed to. The CO/other toxic gas concentrations evaluated against a tenability limit to establish the risk of incapacitation and if smoke control exhaust or the required separation would be required to maintain a tenable condition.

For this performance evaluation, the acceptable performance objectives are to maintain visibility, and to limit to a reasonable level the occupant exposure to products of combustion, including heat and CO. Specific design criteria were developed to provide threshold values in engineering terms such as temperatures, visibility distances, and exposure concentrations. These values provide a means to quantify the analysis. The design criteria used, and the engineering basis for this design criteria are described below. These criteria will be used to evaluate conditions for occupants not intimate with the fire. It is possible that the conditions in the immediate vicinity of the fire will exceed the criteria described below. However, the occupants immediately adjacent to the fire location will become aware of the hazardous conditions and will be able to move away from the immediate hazard prior to the fire growing to a size that could present a hazard.

REQUIRED SAFE EGRESS TIME (RSET)

A timed egress analysis of the garage area evaluated if occupant are exposed to untenable conditions during egress. The enclosed parking garage is not used as an intervening space for egressing the building. People egressing from the remainder of the building have other dedicated egress paths to exit the build therefore the required safe egress time for the space only include the occupants in the garage. The garage is very open and provides the necessary line of sight to quickly identify a car fire once prompted by fire alarm which would greatly reduce the pre-movement time for the space. Unfortunately bike storage is provided in separate enclosures located within the garage. In these spaces pre-movement time is essential as the occupant would not be exposed to additional stimulus from the fire that could cause them to evacuate immediately. With this additional 180 seconds of pre-movement from SFPE Handbook Table 3.13-1 the worst case egress time is evaluated for occupants located in the bike storage area during a fire event. The required safe egress time is calculated below.

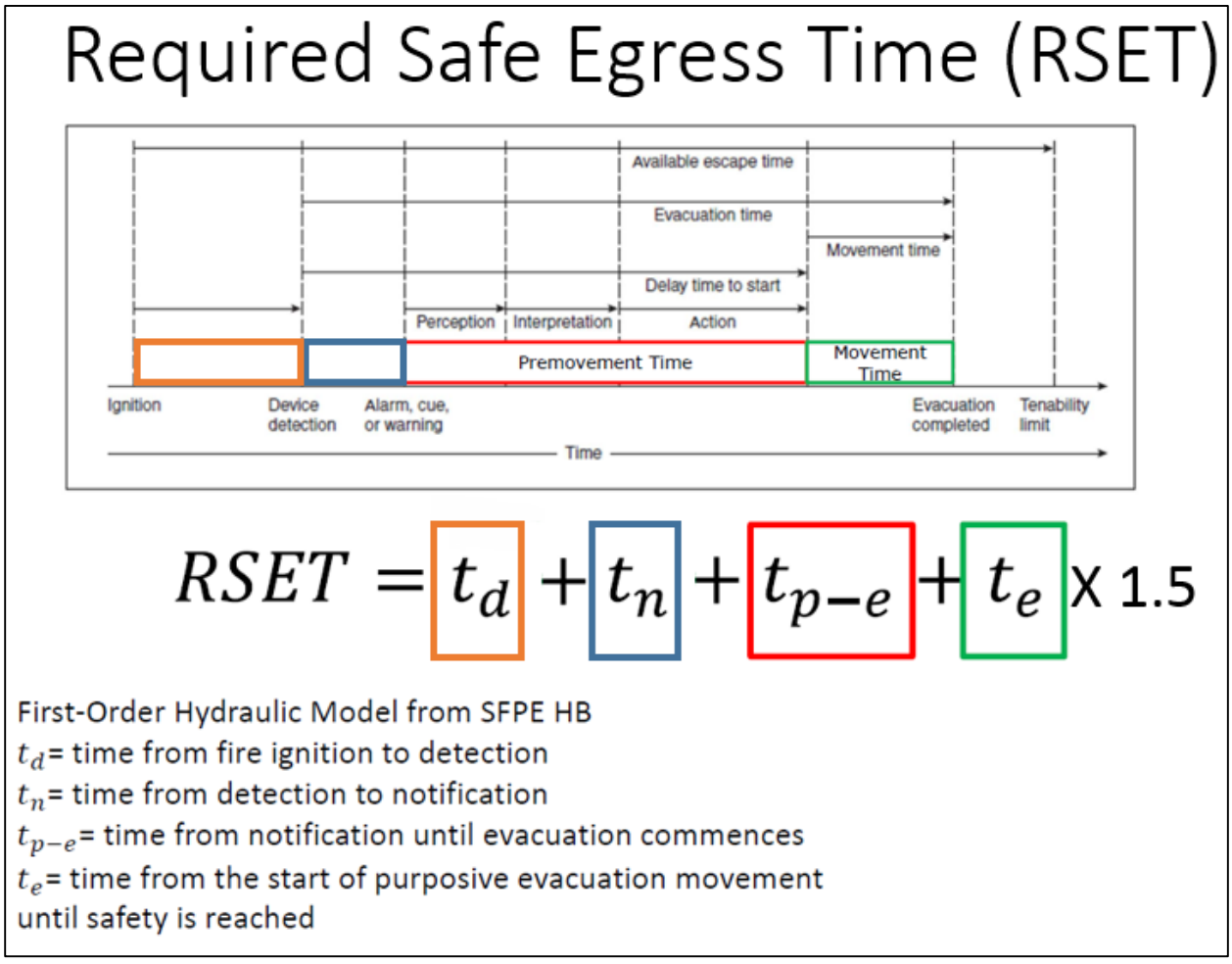


FIGURE 10: REQUIRED SAFE EGRESS TIME EQUATION

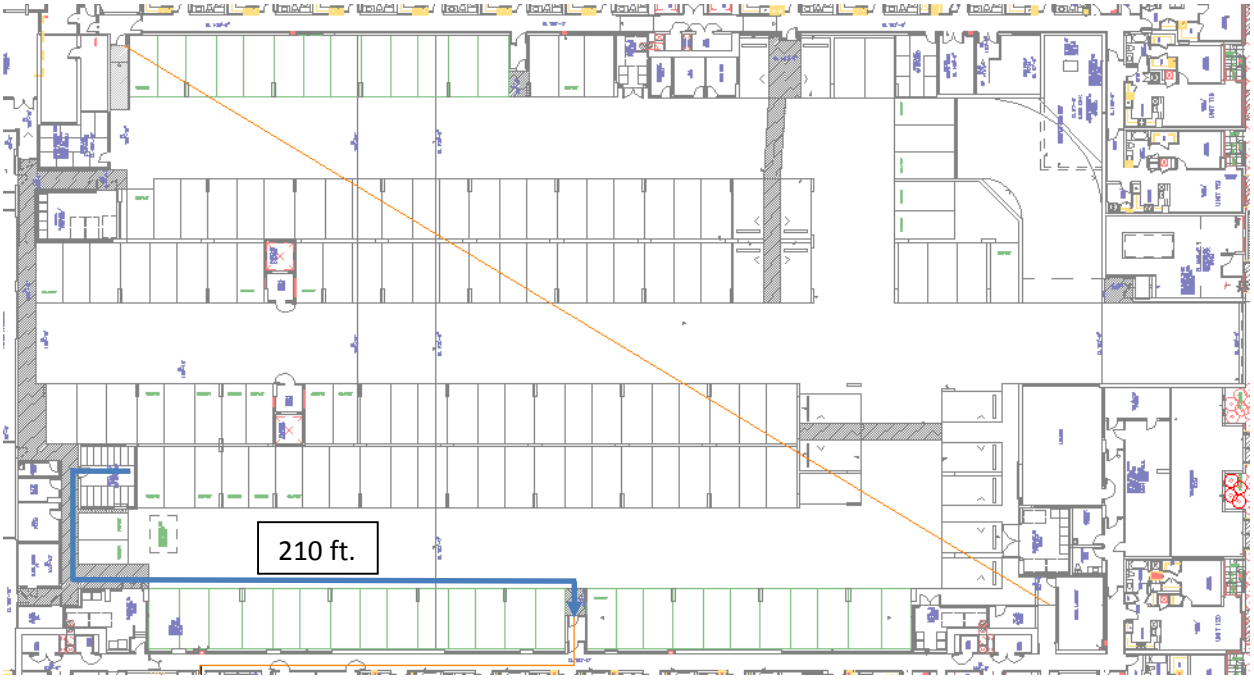


FIGURE 11: EXIT TRAVEL DISTANCE

t_d = 318 + 60 s (Sprinkler Activation and Waterflow Delay)
t_n = 10 s (Fire Alarm Delay)
t_{p-e} = 180 s (SFPE Handbook Table 3-13.1 Awake and Unfamiliar)
t_e = 210 ft / 235 ft/min = 54 s (SFPE Handbook Table 4.2.7 "Maximum (Unimpeded) Exit Flow Speeds" identifies movement speed of 235 ft/min)

RSET = (378s + 10s + 180s + 54s) x 1.5 = <u>978 s</u>

AVAILABLE SAFE EGRESS TIME (ASET)

This analysis consisted of determining the Available Safe Egress Time (ASET) value, or the time elapsed between the ignition of the fire and the time that building occupants would be exposed to untenable conditions. For the purposes of this analysis, the ASET value corresponds to the time at which the smoke layer drops to 6 feet above the highest walking surface.

FIRE DYNAMIC SIMULATOR (FDS)

Fire modeling of this project was completed using FDS software developed by NIST. FDS is a CFD model of fire-driven buoyant fluid flow that predicts the growth and spread of fire and its products of combustion. The software solves numerically a form of the Navier-Stokes equations appropriate for low-speed, thermally driven flow with an emphasis on smoke and heat transport from fires.

In FDS, each space of interest is divided into small rectangular control volumes or computational cells. The model is capable of computing the density, velocity, temperature, pressure, and species concentration of gas in each cell based on the conservation laws of mass, momentum, and energy to model the movement of fire gases. The resolution 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 available computing power. The input file for the Concourse has been created using an interactive, graphical user interface called Pyrosim. FDS simulations can be evaluated through the Smokeview program, which is a software tool designed to visualize numerical calculations generated by FDS. There is substantial documentation of this software and additional large scale and full scale fire testing which has been done to validate the model. More information on the model validation can be found in the FDS User's Guide that can be downloaded from the NIST website (http://www.bfrl.nist.gov/info/software.html).

DESIGN FIRE

The design fire scenario was developed for this analysis as a car fire in the enclosed parking garage. The design fire was characterized by fire data on cars in SFPE Handbook seen below. The fire would consist of a car that ignited and grew until activation of the automatic sprinkler system in the garage halted growth.

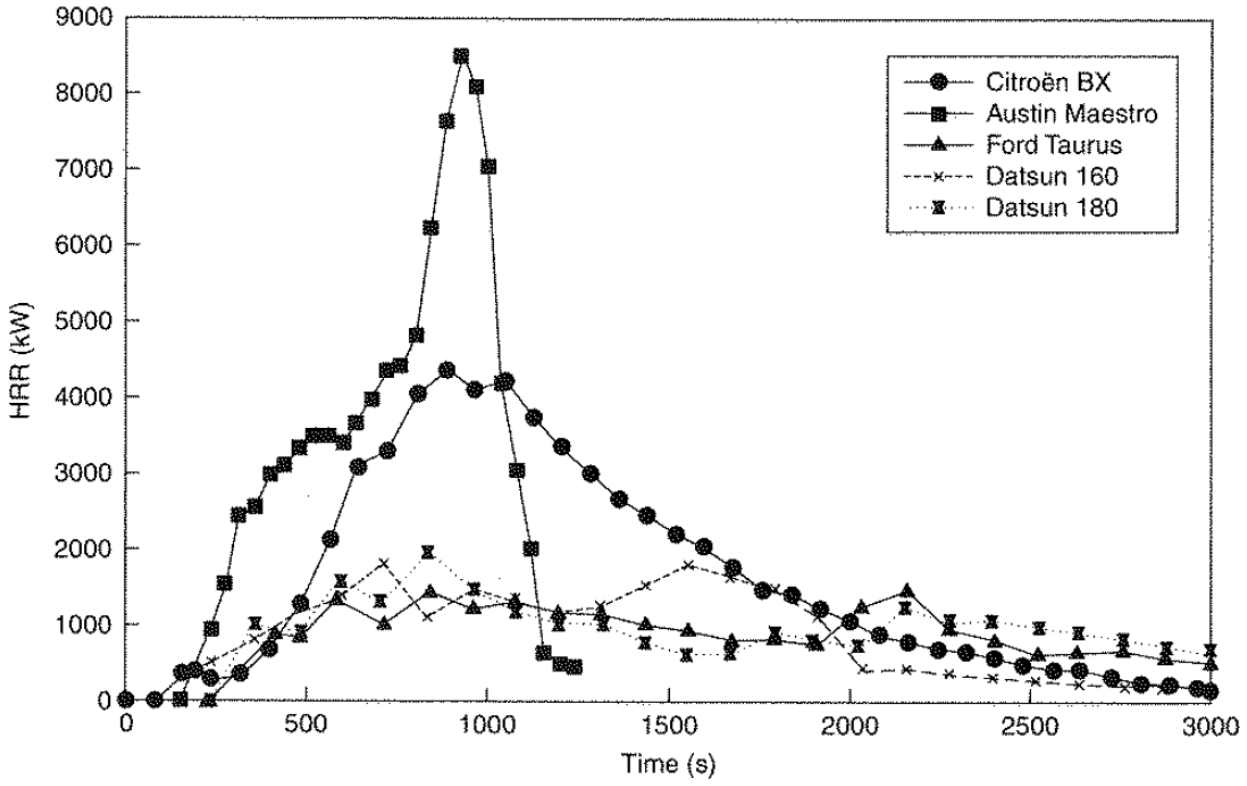


Figure 3-1.46. ***Passenger cars.***

FIGURE 12: SFPE HANDBOOK CAR FIRE DATA

After the fire hits its maximum heat release rate, it is commonly assumed as a conservative estimate that fire growth would be halted and the fire would behave as a steady-state fire with a constant heat release rate. Therefore, maintaining a steady-state and ignoring the extinguishing effects of the automatic fire sprinkler system provides a significant safety factor to the analysis. The time dependent heat release rate fire growth curve used in the model shown in Figure 13.

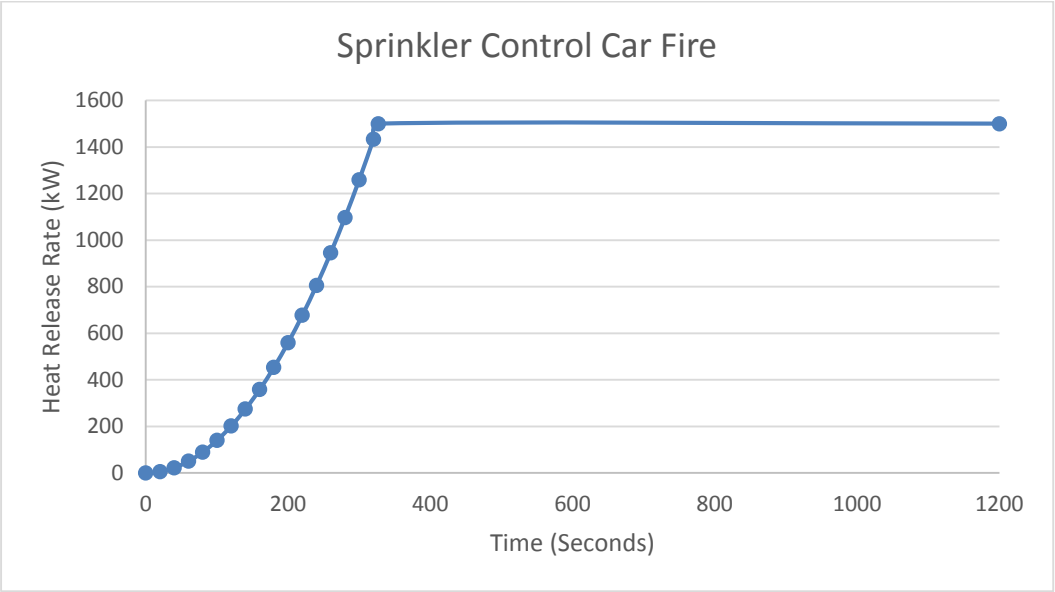


FIGURE 13: FIRE HEAT RELEASE RATE VS TIME GRAPH FOR MAILBAG DESIGN FIRE

The soot yield and CO yield are used by the FDS model to determine the amount of soot or CO produced by the fire. For this analysis, the following fuel properties were based on combustible load, such as the upholstery, associated with the car. SFPE Handbook Table 3-4.14 provided fuel load properties for foams that would be used in a car, GM31 provides a good basis to establish the reaction parameters for our design fire.

Table 3-4.14 ***Yields of Fire Products and Chemical, Convective, and Radiative Heats of Combustion for Well-Ventilated Fires[a] (Continued)***

Material	ΔH_T (kJ/g)	y_{CO_2} (g/g)	y_{CO} (g/g)	y_{ch} (g/g)	y_s (g/g)	ΔH_{ch}
Polyurethane (rigid) foams						
GM29	26.0	1.52	0.031	0.003	0.130	16.4
GM31	25.0	1.53	0.038	0.002	0.125	15.8
GM35	28.0	1.58	0.025	0.001	0.104	17.6
GM37	28.0	1.63	0.024	0.001	0.113	17.9

Average Polyurethane Foam Properties:
Heat of Combustion: 25-28 MJ/kg
Soot Yield: .104 - .130 kg/kg

A paper “Underground Parking Garages – Changing Perceptions on Smoke Control Criteria

and Combining an Integrated System for Smoke Control and Ventilation" by Donna and Netanel was presented at the 2011 Fire and Evacuation Modeling Technical Conference. This paper identifies that for a car fire in an enclosed parking garage a conservative soot yield of .1 kg/kg can be utilized to simulate the complicated fuel package of a car.

Therefore following values were utilized in this analysis:

Soot Yield	=	0.1 kg soot/kg fuel consumed
CO Yield	=	0.04 kg CO/kg fuel consumed
Heat of Combustion	=	25 MJ/kg

```
&REAC ID='Car Fire,
    FUEL='REAC_FUEL',
    C=1.0,
    H=1.7,
    O=0.3,
    N=.08,
    CO_YIELD=0.04,
    SOOT_YIELD=0.10,
    HEAT_OF_COMBUSTION=2.5E4/
```

```
&SURF ID='fire', RAMP_Q='tsquared', HRRPUA=1500, COLOR='RED' /
&RAMP ID='tsquared', T= 0.0, F=0.00 /
&RAMP ID='tsquared', T= 20.0, F=0.00 /
&RAMP ID='tsquared', T= 40.0, F=0.01 /
&RAMP ID='tsquared', T= 60.0, F=0.03 /
&RAMP ID='tsquared', T= 80.0, F=0.06 /
&RAMP ID='tsquared', T= 100.0, F=0.09 /
&RAMP ID='tsquared', T= 120.0, F=0.13 /
&RAMP ID='tsquared', T= 140.0, F=0.18 /
&RAMP ID='tsquared', T= 160.0, F=0.24 /
&RAMP ID='tsquared', T= 180.0, F=0.30 /
&RAMP ID='tsquared', T= 200.0, F=0.37 /
&RAMP ID='tsquared', T= 220.0, F=0.45 /
&RAMP ID='tsquared', T= 240.0, F=0.54 /
&RAMP ID='tsquared', T= 260.0, F=0.63 /
&RAMP ID='tsquared', T= 280.0, F=0.73 /
&RAMP ID='tsquared', T= 300.0, F=0.84 /
&RAMP ID='tsquared', T= 320.0, F=0.95 /
&RAMP ID='tsquared', T= 328.0, F=1.00 /
```

FIGURE 14: FDS FIRE INPUT AND RAMP FILE

TENABILITY CRITERIA

The tenability analysis completed on this facility evaluates visibility, temperature, and toxicity, to show that threshold levels of harmful fire by-products are not exceeded. General threshold levels are identified below. The tenability limits described below are based on the values or calculation methods found in various reference documents.

VISIBILITY

Reduced visibility can trap occupants within a building because they are unable to find their way to an exit. "Toxicity Assessment of Combustion Products," by Purser in the SFPE Handbook of Fire Protection Engineering references research from Rabash and Babrasand that suggest a 10 meter (33 feet) visibility limit. An article "Literature Review of Performance-Based Fire Codes and Design Environment" by Hadjisophocleous in The Journal of Fire Protection Engineering summarizes the tenability criteria adopted by New Zealand, which requires that the visibility in the smoke layer should not fall below 6 feet.

Based on the various references above, the worst case visibility threshold of 33 feet (10 meters) will be used as the visibility criterion for this analysis. The modeling will be completed to determine if occupants are exposed to conditions that will create visibilities below 33 feet (10 meters) during the evacuation of the facility.

TEMPERATURE

Incapacitation due to heat exposure develops over time. The time to incapacitation based

on exposure to a 65°C (149°F) convected heat source is 20 minutes, in accordance with Figure 2-6.26 in the SFPE Handbook of Fire Protection Engineering, 3rd Edition. To simplify the analysis and to add a layer of conservatism to the pass/fail criteria, it is assumed that occupants become incapacitated at an instantaneous exposure to a temperature of 65°C (149°F).

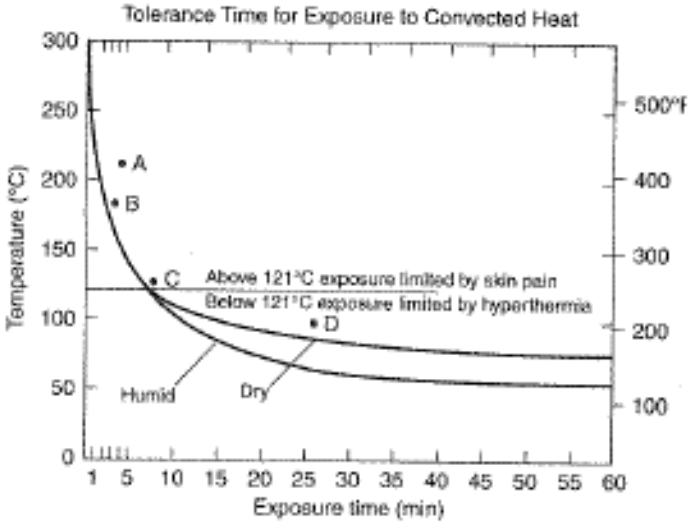


Figure 2-6.26. ***Thermal tolerance for humans at rest, naked skin exposed, with low air movement (less than 30 m/min). Adapted from Blockley.[113] See text and Table 2-6.16 for discussion of data points A to D.[112,115,116]***

FIGURE 15: SFPE HANDBOOK OF FIRE PROTECTION ENGINEERING, 3RD EDITION FIGURE 2-6.26

This is a conservative reference exposure time compared to the occupant movement time to exit from the building. It is anticipated that the total occupant egress time from the building will be less than 20 minutes, such that the likely exposure time for occupants exiting through or from the large space will be much shorter than 20 minutes.

TOXICITY

Toxicity levels in smoke are an important factor in maintaining the tenability conditions in a building fire. Generally, the toxicity of gaseous elements is taken to be an allowable exposure level over a specified amount of time. If a person is expected to be exposed to a toxin over a very long time, the acceptable exposure levels may be extremely low.

Conversely, the allowable exposure level to toxins may be higher if the exposure is to be for a very brief period of time.

“Toxicity Assessment of Combustion Products,” by Purser also indicates that exposure to CO is dangerous because it combines with hemoglobin in the blood to form carboxyhemoglobin (COHb), which results in toxic narcosis because it reduces the amount of oxygen supplied to the tissues of the body. As occupants are exposed to CO in the air,

the level of COHb in the blood increases, which will eventually lead to a loss of consciousness and eventually death. Death is predicted at concentrations of COHb between 50 and 70 percent. Loss of consciousness is typically predicted at COHb concentrations of about 40 percent, although loss of consciousness can occur at COHb concentrations as low as 30 percent. To maintain a conservative analysis, the lower threshold of COHb concentrations that could cause unconsciousness (30 percent) will be used to determine an acceptable CO concentration in the air for the time period described previously. The level of COHb in the blood is related to the CO exposure concentration, the exposure time, and the volume of air breathed by the occupants. For the purposes of this design, we have chosen to design to an exposure level that would allow a person to be exposed to CO for up to 20 minutes. This is based on the duration of operation requirements for smoke control systems described in Section 909.4.6 of the California Building Code (CBC).

Purser presented the equation below for predicting the effect of CO exposure based upon the factors listed above.

$$\%COHb = (3.317 \times 10^{-5}) \times (ppm\ CO)^{1.036} \times (RMV) \times (t)$$

where:
%COHb = Percentage of COHb in the blood
ppm CO = CO concentration in the air
RMV = Volume of air breathed (L/min)
RMV = 25 L/min for a person doing light work (such as walking)
t = exposure time (min) = 20 minutes

Rearranging:

$$ppm\ CO = [\%COHb / \{(3.317 \times 10^{-5}) \times (RMV) \times (t)\}]^{0.965}$$

$$ppm\ CO = [30 / \{(3.317 \times 10^{-5}) \times (25) \times (20)\}]^{0.965}$$

CO Concentration Criterion for a 20-Minute Exposure = 1,390 ppm

Cote and Bugbee in Principles of Fire Protection indicate that a simple rule of thumb for CO exposures is that if the product of the CO concentration in ppm multiplied by the exposure time in minutes exceeds about 35,000 ppm-min, then the exposure is likely to be hazardous. The exposure conditions described in the preceding paragraph and calculation results in an overall exposure-time product of about 27,800 ppm-min, which is lower than the value presented by Cote and Bugbee. Despite that occupants can be exposed to this CO concentration for an extended period of time prior to losing consciousness, the toxicity tenability criteria will be evaluated by determining the CO concentration at each time step. If the CO concentration at the prescribed measurement height exceeds 1,390 ppm at any time step, then the failure criteria will assume to have been exceeded. This is a conservative approach because occupants would need to be exposed to this concentration for a significant period of time prior to it posing a hazard.

TENABILITY LIMITS

The preceding paragraphs outline the tenability criteria that will be used in the evaluation of the building. Table 1 summarizes this information:

TENABILITY LIMITS

TENABILITY CRITERIA	METRIC UNITS	ENGLISH UNITS
Visibility	10 meters	33 feet
Temperature	65°C	149°F
Toxicity (CO)	1390 ppm	1390 ppm

These tenability criteria are typically evaluated at a height of 6 feet above the walking surfaces of the space.

MODEL RESULTS

The following pictorials are from Smokeview, a computer model that provides a graphic representation FDS. It shows the lobby layout at a distance of 6 feet above the floor. The pictorials show visibility, temperature, and toxicity levels at the 6 foot level. Model shows feasibility 20 minutes in all areas.

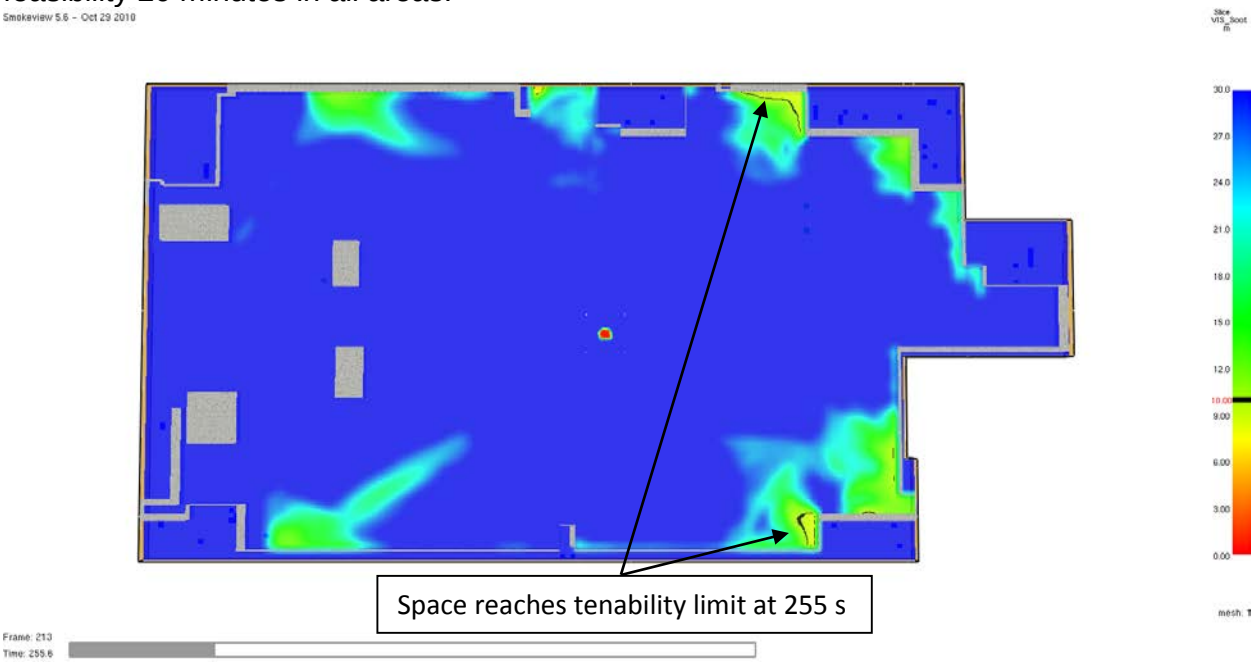


FIGURE 16: HORIZONTAL VISIBILITY SLICE FILE LOCATED 6 FEET ABOVE THE LOBBY WALKING SURFACE LOOKING DOWN. IT SHOWS THE VISIBILITY DISTANCE FOR THE SCENARIO WITH A FIRE IN MAILROOM AT 255 SECONDS. THE VISIBILITY SCALE IS SET TO BETWEEN 0 AND 30 METERS. THIS SCENARIO RESULTS IN THE LOBBY MAINTAINING ADEQUATE VISIBILITY ABOVE WALKING SURFACE FOR 255 SECONDS.

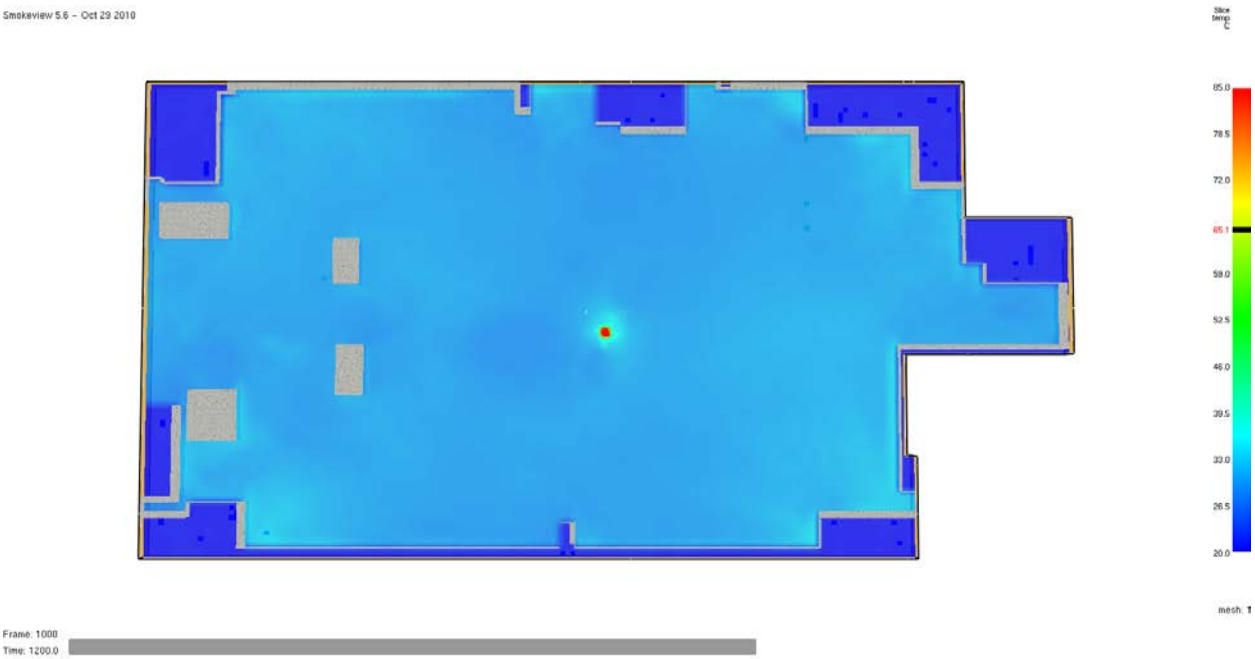


FIGURE 17: HORIZONTAL TEMPERATURE SLICE FILE LOCATED 6 FEET ABOVE THE LOBBY WALKING SURFACE LOOKING DOWN. IT SHOWS THE VISIBILITY DISTANCE FOR THE SCENARIO WITH A FIRE IN MAILROOM AT 1200 SECONDS. THE TEMPERATURE SCALE IS SET TO BETWEEN 20 AND 85 DEGREE C. THIS SCENARIO RESULTS IN THE LOBBY MAINTAINING ADEQUATE TEMPERATURE ABOVE WALKING SURFACE FOR 1200 SECONDS.

FIGURE 18: HORIZONTAL TOXICITY SLICE FILE LOCATED 6 FEET ABOVE THE LOBBY WALKING SURFACE LOOKING DOWN. IT SHOWS THE VISIBILITY DISTANCE FOR THE SCENARIO WITH A FIRE IN MAILROOM AT 1200 SECONDS. THE TOXICITY SCALE IS SET TO BETWEEN 0 AND 2000 PPM. THIS SCENARIO RESULTS IN THE LOBBY MAINTAINING ADEQUATE TOXICITY ABOVE WALKING SURFACE FOR 1200 SECONDS.

ASET VS RSET

Required Safe Egress Time (RSET)	Available Safe Egress Time (RSET)	Tenable (ASET > RSET)
978 seconds	**255 seconds**	**No**

CONCLUSION

The prescriptive code approach of this building identified the requirements of the active (Sprinkler, Fire alarm) and passive (fire barriers, egress) fire protection systems required to meet an acceptable level of life safety in the case of emergency. For this case. The building meets the prescriptive requirements of the reference codes and standards.

The performance-based evaluation of the enclosed parking garage determined that a conservative design fire, outlined above, due to the limited smoke reservoir, high smoke generation rate and late occupant notification the occupant are exposed to untenable conditions during egress. The analysis results in a required safe egress time of 978 second. Since ASET (255 seconds) < RSET (978 seconds) then there are three main options. One is to limit the combustible load of the space to acceptable level where we don't cause an untenable condition. This is unreasonable as the use of this space is strictly for the storage of cars. Second is to reduce the time from ignition to egress. This can be done by providing additional initiation devices such as heat or flame detectors to provide occupant notification faster than sprinkler water flow. Smoke detectors should not be utilized as the garage is very likely to cause false alarm to due to vehicle emission. Additionally occupant notification could be altered to provide live voice notification which has been shown to greatly reduce the pre-movement time of occupants. Third is to provide a smoke control system to maintain the tenability in the space. This report concludes that the occupants are provided with a tenable environment for egress for 255 seconds from ignition before the garage begins to become untenable. Additional analysis to this case study would be required to further analyze the conditions provided to egressing occupants.

Appendix A: Automatic Fire Sprinkler System

HYDRAULIC

CALCULATIONS

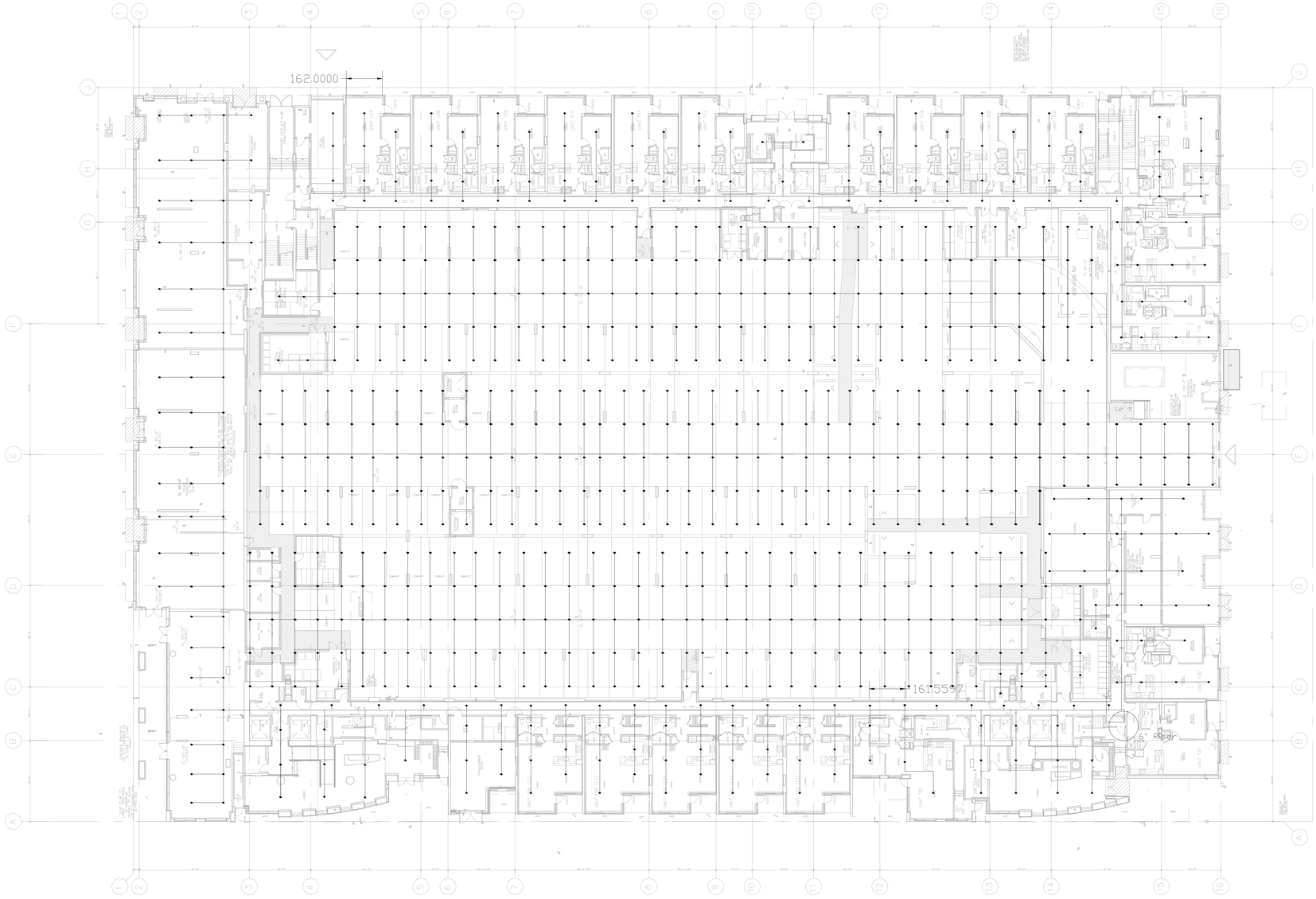
HYDRAULIC CALCULATIONS

CONTRACT NAME FPE 523 Project SHEET 1 OF 1

NOZZLE IDENT. AND LOCATION	FLOW IN GPM	PIPE SIZE	PIPE FITTINGS AND DEVICES	EQUIV. PIPE LENGTH	FRICTION LOSS PSI/FT	PRESSURE SUMMARY	NORMAL PRESSURE	NOTES .1 gpm/ft² k = 5.6
1 BL-1	q	2"		L 15.0	C=120	Pt 16.14	Pt	Q = 225 x .1 =
				F		Pe	Pv	$P = \left(\frac{22.5}{5.6}\right)^2 =$
	Q 22.5	2.068		T 15.0	.006	Pf .09	Pn	
2	q 22.56	2"		L 15.0		Pt 16.23	Pt	$q = 5.6\sqrt{16.23} =$
			1E5	F 5.0		Pe	Pv	
	Q 45.06			T 20.0	.021	Pf .42	Pn	
3/4 BL-2	q	2"		L		Pt 16.65	Pt	$K = \frac{45.06}{\sqrt{16.65}} =$
				F		Pe	Pv	
	Q 45.06			T		Pf	Pn	= 11.04
BL-2 to CM	q 45.06	2"		L 25		Pt 16.65	Pt	$q = 11.04\sqrt{16.65} =$
			1E5	F 5		Pe	Pv	
	Q 90.12			T 30	.077	Pf 2.32	Pn	
CM to BOR	q	4"	2E20	L 400		Pt 18.97	Pt	
			1T20	F 64		Pe 30.31	Pv	
	Q 90.12	4.03	CV22	T 464	.003	Pf 1.39	Pn	$P_e = 70 \times .433 =$
	q		GV2	L		Pt 50.67	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
						Pt		

SPINKLER

DRAWINGS



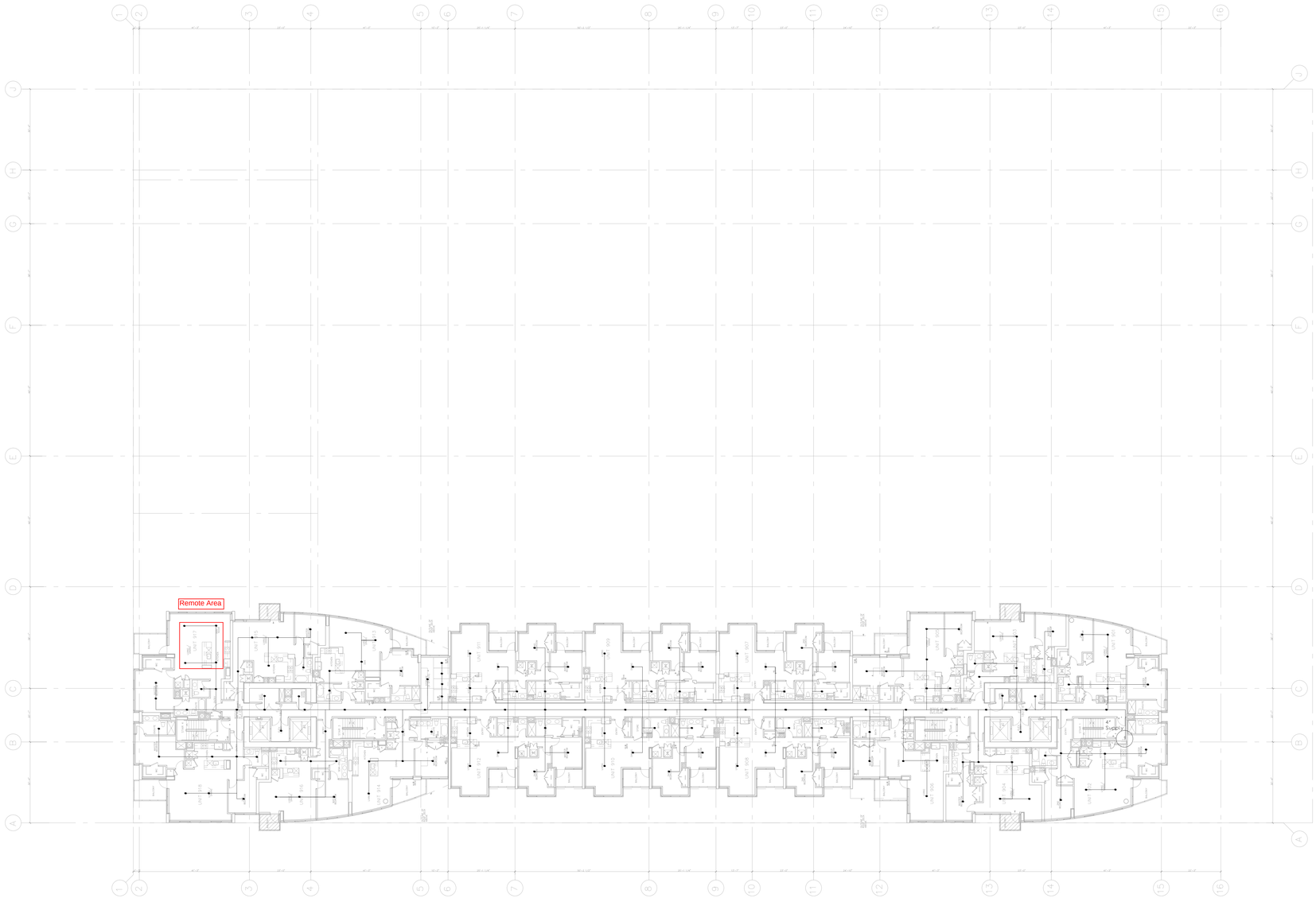
16' 8' 0 16' 32'

SPRINKLER DRAWINGS

DRAWING TITLE
LEVEL 1 PLAN

SCALE
1" = 16'-0"

DRAWING NO.
LS.01



Typ. Level 2-7

N

16' 8' 0 16' 32'

SPRINKLER DRAWINGS

DRAWING TITLE
LEVEL 2-7 PLAN

SCALE
1" = 16'-0"

DRAWING NO.
LS.02

EXAMPLE FIRE PUMP CURVE

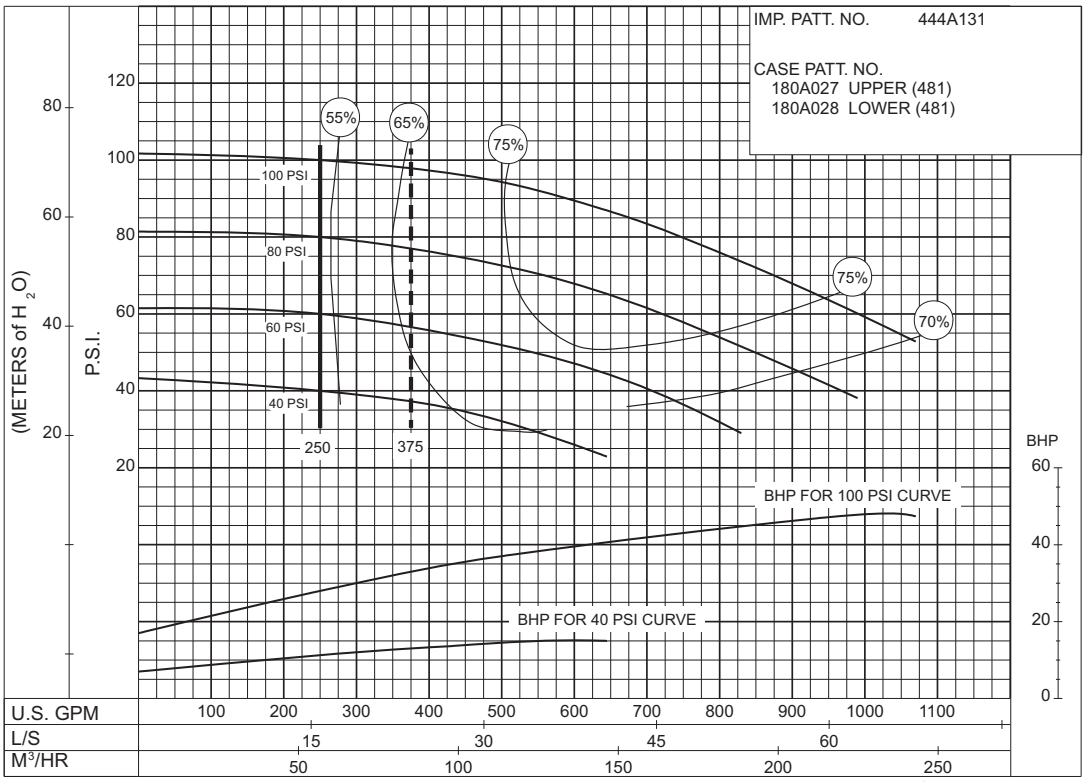
AURORA® 250 GPM 913 SERIES

DIESEL ENGINE DRIVE

Supersedes Section 913 Page 402
Dated September 2009

40 to 100 P.S.I.

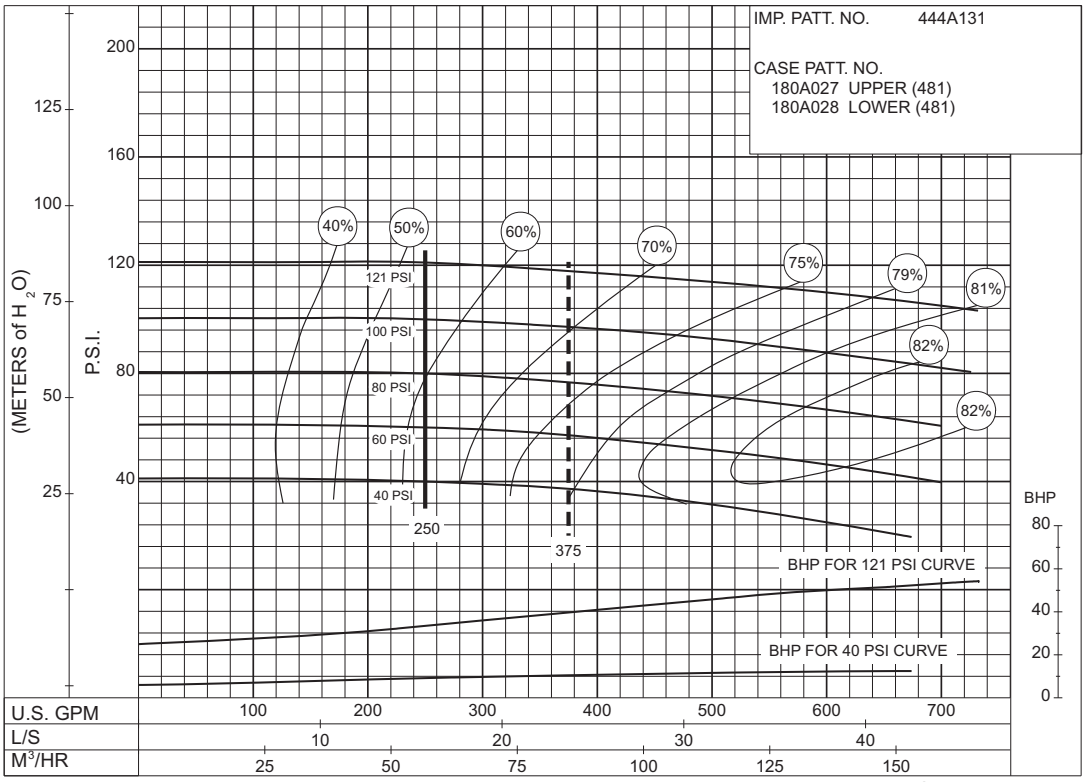
SIZE : 3-481-10 **MODEL: 480** **IMPELLER : Enclosed** **R. P. M. : 3550**



PC-149088

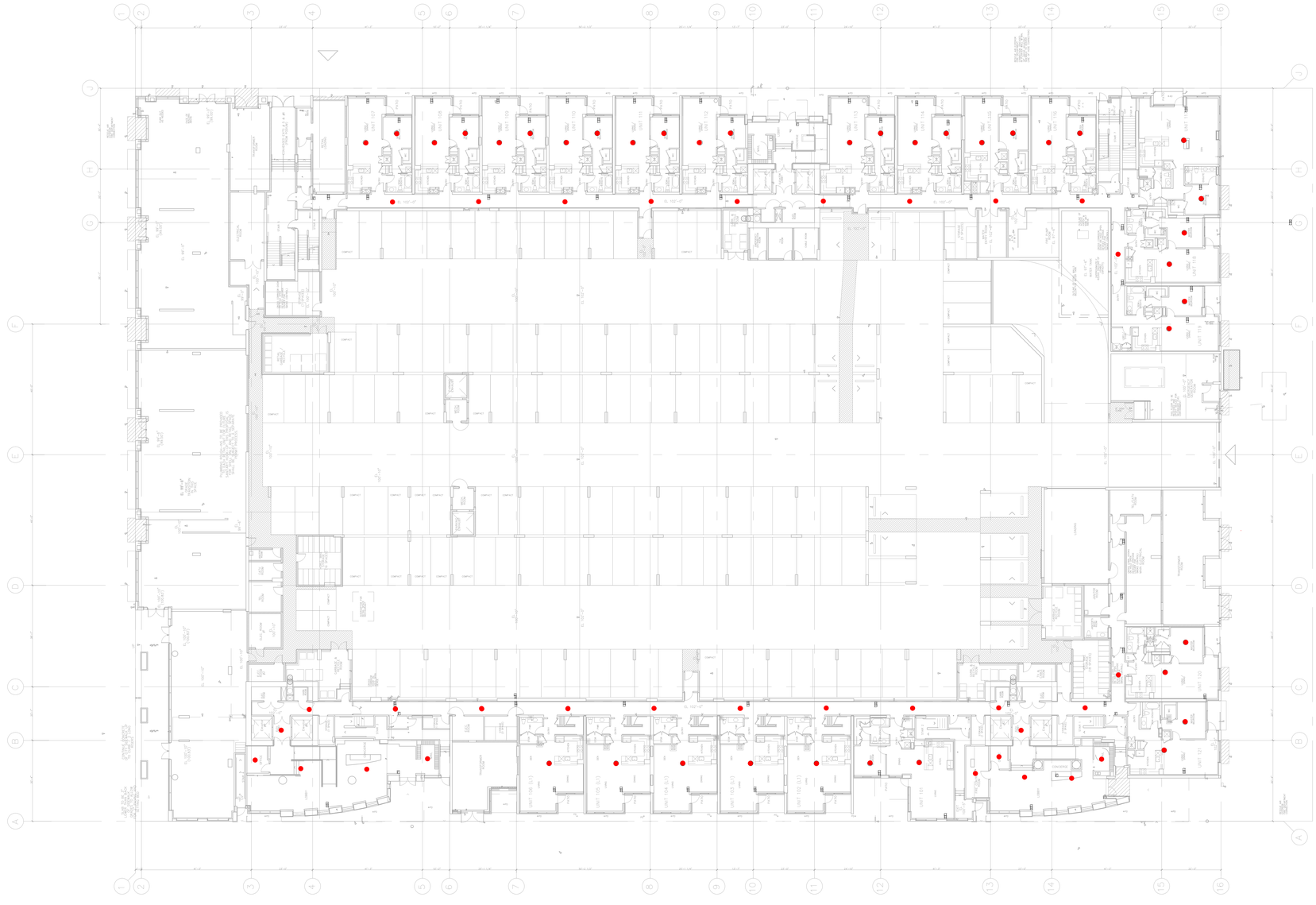
40 to 121 P.S.I.

SIZE : 3-481-10B **MODEL: 480** **IMPELLER : Enclosed** **R. P. M. : 3000**



PC-147563

Appendix B: Fire Alarm System



N

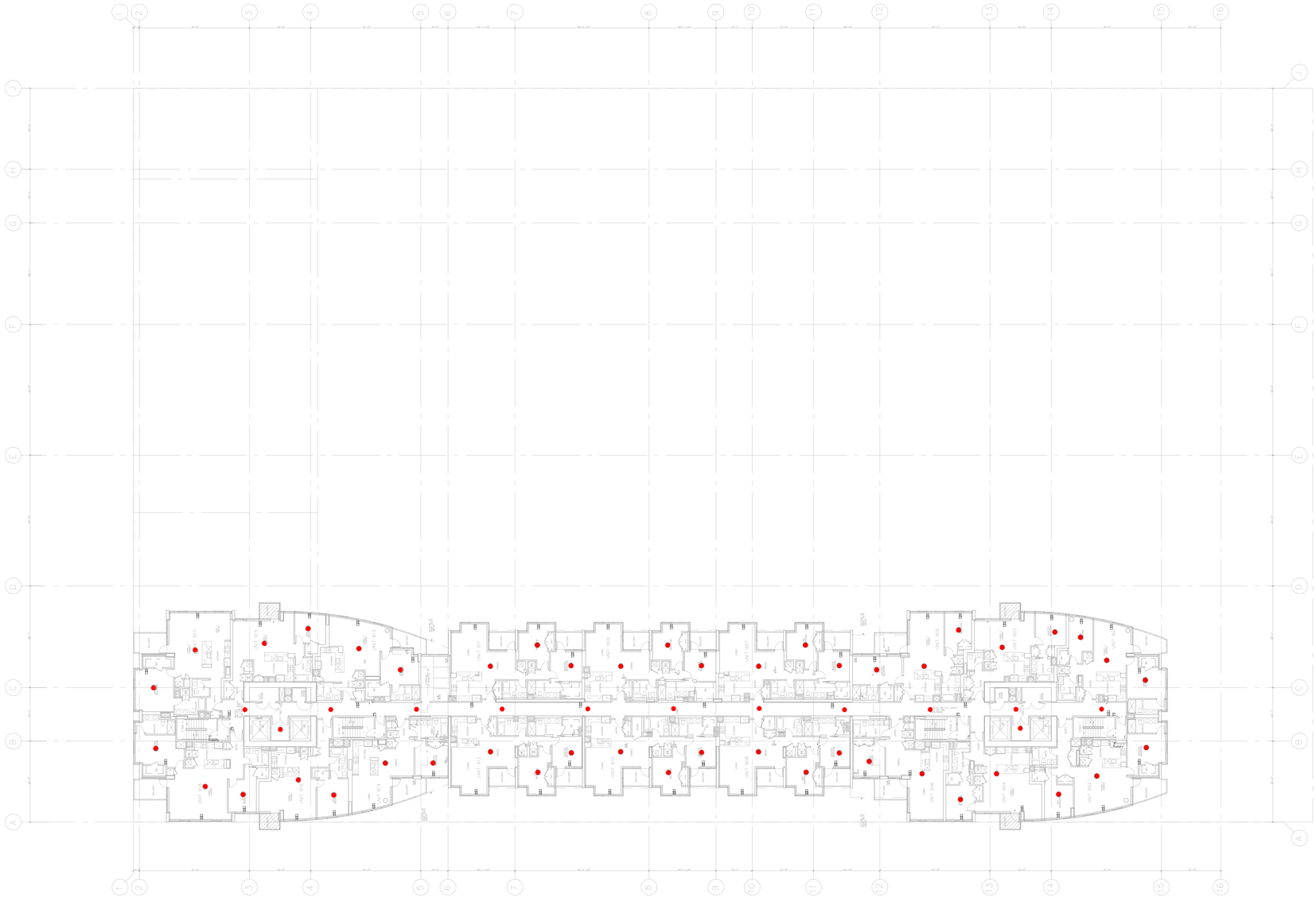
16' 8' 0 16' 32'

SPRINKLER DRAWINGS

DRAWING TITLE
LEVEL 1 PLAN

SCALE
1" = 16'-0"

DRAWING NO.
LS.01



Typ.
Level 2-7

N

16' 8' 0 16' 32'

SPRINKLER
DRAWINGS

DRAWING TITLE
LEVEL 2-7 PLAN

SCALE
1" = 16'-0"

DRAWING NO.
LS.02

Selectable Output Horns, Strobes, and Horn/Strobes

SpectrAlert® Advance selectable-output horns, strobes, and horn/strobes are rich with features guaranteed to cut installation times and maximize profits.

The SpectrAlert Advance series of notification appliances is designed to simplify installations, with features such as plug in designs, instant feedback messages to ensure correct installation of individual devices, and 11 field-selectable candela settings for wall and ceiling strobes and horn/strobes.

When installing Advance products, first attach a universal mounting plate to a four-inch square, four-inch octagon or double-gang junction box. The two-wire mounting plate attaches to a single-gang junction box.

Next, connect the notification appliance circuit wiring to the SEMS terminals on the mounting plate.

Finally, attach the horn, strobe or horn/strobe to the mounting plate by inserting the product's tabs in the mounting plate's grooves. The device will rotate into position, locking the product's pins into the mounting plate's terminals. The device will temporarily hold in place with a catch until it is secured with a captured mounting screw.

The SpectrAlert Advance series includes outdoor notification appliances. Outdoor strobes and horn/strobes (two wire and four wire) are available for wall or ceiling. Outdoor horns are available for wall only. All System Sensor outdoor products are rated between minus 40 degrees Fahrenheit and 151 degrees Fahrenheit in wet or dry applications.

Features

- Electrically compatible with existing SpectrAlert products
- Automatic selection of 12- or 24-volt operation at 15 and 15/75 candela
- Plug-in design
- Field selectable candela settings on wall and ceiling units: 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, 185
- Same mounting plate for wall- and ceiling-mount units
- Shorting spring on mounting plate for continuity check before installation
- Tamper resistant construction
- Outdoor wall and ceiling products rated from –40°F to 151°F
- Design allows minimal intrusion into the back box
- Horn rated at 88+ dbA at 16 volts
- Rotary switch for horn tone and three volume selections
- Outdoor products UL listed to UL 1638 (strobe) and UL 464 (horn) outdoor requirements
- Outdoor products rainproof per UL 50 (NEMA 3R)
- Compatible with MDL sync module

Agency Listings

SIGNALING UL LISTED
S4011
S5512
S3593

FM APPROVED
3023572

MEA approved
MEA452-05-E

7125-1653:186 (indoor strobes)
7300-1653:187 (outdoor strobes)
7125-1653:188 (horn/strobes, chime/strobes)
7135-1653:189 (horns, chimes)

SpectrAlert Advance Specifications

Architect/Engineer Specifications

General

SpectrAlert Advance horns, strobes and horn/strobes shall mount to a standard 4 × 4 × 1½-inch back box, 4-inch octagon back box or double-gang back box. Two-wire products shall also mount to a single-gang 2 × 4 × 1⅞-inch back box. A universal mounting plate shall be used for mounting ceiling and wall products. The notification appliance circuit wiring shall terminate at the universal mounting plate. Also, SpectrAlert Advance products, when used with the Sync•Circuit™ Module accessory, shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts. When used with the Sync•Circuit Module, 12-volt rated notification appliance circuit outputs shall operate between nine and 17.5 volts; 24-volt rated notification appliance circuit outputs shall operate between 17 and 33 volts. Indoor SpectrAlert Advance products shall operate between 32 and 120 degrees Fahrenheit from a regulated DC, or full-wave rectified, unfiltered power supply. Strobes and horn/strobes shall have field-selectable candela settings including 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, 185.

Strobe

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

Horn/Strobe Combination

The horn/strobe shall be a System Sensor SpectrAlert Advance Model _____ listed to UL 1971 and UL 464 and shall be approved for fire protective service. The horn/strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1Hz over the strobe's entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. The horn shall have three audibility options and an option to switch between a temporal three-pattern and a non-temporal (continuous) pattern. These options are set by a multiple position switch. On four-wire products, the strobe shall be powered independently of the sounder. The horn on horn/strobe models shall operate on a coded or non-coded power supply.

Outdoor Products

SpectrAlert Advance outdoor horns, strobes and horn/strobes shall be listed for outdoor use by UL and shall operate between minus 40 degrees and 151 degrees Fahrenheit. The products shall be listed for use with a System Sensor outdoor/weatherproof back box with half inch and three-fourths inch conduit entries.

Synchronization Module

The module shall be a System Sensor Sync•Circuit model MDL listed to UL 464 and shall be approved for fire protective service. The module shall synchronize SpectrAlert strobes at 1Hz and horns at temporal three. Also, while operating the strobes, the module shall silence the horns on horn/strobe models over a single pair of wires. The module shall mount to a 4 11/16 × 4 11/16 × 2⅛-inch back box. The module shall also control two Style Y (class B) circuits or one Style Z (class A) circuit. The module shall synchronize multiple zones. Daisy chaining two or more synchronization modules together will synchronize all the zones they control. The module shall not operate on a coded power supply.

Physical/Electrical Specifications

Standard Operating Temperature	32°F to 120°F (0°C to 49°C)
K Series Operating Temperature	–40°F to 151°F (–40°C to 66°C)
Humidity Range	10 to 93% non-condensing (indoor products)
Strobe Flash Rate	1 flash per second
Nominal Voltage	Regulated 12DC/FWR or regulated 24DC/FWR[1]
Operating Voltage Range[2]	8 to 17.5 V (12V nominal) or 16 to 33 V (24 nominal)
Input terminal wire gauge	12 to 18 AWG
Ceiling mount dimensions (including lens)	6.8″ diameter × 2.5″ high (173 mm diameter × 64 mm high)
Wall mount dimensions (including lens)	5.6″L × 4.7″W × 2.5″D (142 mm L × 119 mm W × 64 mm D)
Horn dimensions	5.6″L × 4.7″W × 1.3″D (142 mm L × 119 mm W × 33 mm D)
Wall-mount back box skirt dimensions (BBS-2, BBSW-2)	5.9″L × 5.0″W × 2.2″D (151 mm L × 128 mm W × 56 mm D)
Ceiling-mount back box skirt dimensions (BBSC-2, BBSCW-2)	7.1″ diameter × 2.25″ high (180 mm diameter × 57 mm high)
Wall-mount weatherproof back box dimensions (SA-WBB)	5.7″L × 5.1″W × 2.0″D (145 mm L × 130 mm W × 51 mm D)
Ceiling-mount weatherproof back box dimensions (SA-WBBC)	7.1″ diameter × 2.0″ high (180 mm diameter × 51 mm high)

Notes:

1. Full Wave Rectified (FWR) voltage is a non-regulated, time varying power source that is used on some power supply and panel outputs.
2. P, S, PC, and SC products will operate at 12 V nominal only for 15 and 15/75 cd.

UL Current Draw Data

UL Max. Strobe Current Draw (mA RMS)

		8–17.5 Volts		16–33 Volts	
	Candela	DC	FWR	DC	FWR
Standard Candela Range	15*	123	128	66	71
	15/75*	142	148	77	81
	30*	NA	NA	94	96
	75*	NA	NA	158	153
	95*	NA	NA	181	176
	110	NA	NA	202	195
	115	NA	NA	210	205
High Candela Range	135	NA	NA	228	207
	150	NA	NA	246	220
	177	NA	NA	281	251
	185	NA	NA	286	258

UL Max. Horn Current Draw (mA RMS)

		8–17.5 Volts		16–33 Volts	
Sound Pattern	dB	DC	FWR	DC	FWR
Temporal	High	57	55	69	75
Temporal	Medium	44	49	58	69
Temporal	Low	38	44	44	48
Non-temporal	High	57	56	69	75
Non-temporal	Medium	42	50	60	69
Non-temporal	Low	41	44	50	50
Coded	High	57	55	69	75
Coded	Medium	44	51	56	69
Coded	Low	40	46	52	50

UL Max. Current Draw (mA RMS), 2-wire Horn/Strobe, Standard Candela Range (15–115 cd)

	8–17.5 Volts		16–33 Volts						
DC Input	15	15/75	15	15/75	30	75	95	110	115
Temporal High	137	147	79	90	107	176	194	212	218
Temporal Medium	132	144	69	80	97	157	182	201	210
Temporal Low	132	143	66	77	93	154	179	198	207
Non-temporal High	141	152	91	100	116	176	201	221	229
Non-temporal Medium	133	145	75	85	102	163	187	207	216
Non-temporal Low	131	144	68	79	96	156	182	201	210
FWR Input									
Temporal High	136	155	88	97	112	168	190	210	218
Temporal Medium	129	152	78	88	103	160	184	202	206
Temporal Low	129	151	76	86	101	160	184	194	201
Non-temporal High	142	161	103	112	126	181	203	221	229
Non-temporal Medium	134	155	85	95	110	166	189	208	216
Non-temporal Low	132	154	80	90	105	161	184	202	211

UL Max. Current Draw (mA RMS), 2-wire Horn/Strobe, High Candela Range (135–185 cd)

	16–33 Volts					16–33 Volts			
DC Input	135	150	177	185	FWR Input	135	150	177	185
Temporal High	245	259	290	297	Temporal High	215	231	258	265
Temporal Medium	235	253	288	297	Temporal Medium	209	224	250	258
Temporal Low	232	251	282	292	Temporal Low	207	221	248	256
Non-temporal High	255	270	303	309	Non-temporal High	233	248	275	281
Non-temporal Medium	242	259	293	299	Non-temporal Medium	219	232	262	267
Non-temporal Low	238	254	291	295	Non-temporal Low	214	229	256	262

Candela Derating

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

Strobe Output (cd)

Listed Candela	Candela rating at –40°F
15	Do not use below 32°F
15/75	
30	
75	44
95	70
110	110
115	115
135	135
150	150
177	177
185	185

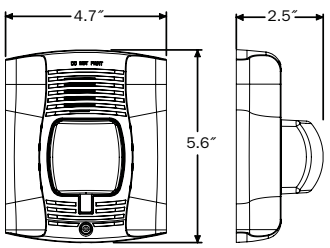
Horn Tones and Sound Output Data

Horn and Horn/Strobe Output (dBA)

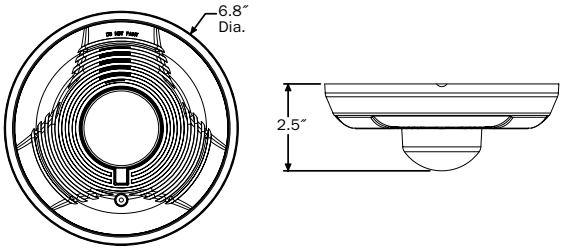
			8–17.5 Volts		16–33 Volts		24 Volt Nominal			
							Reverberant		Anechoic	
Switch Position	Sound Pattern	dB	DC	FWR	DC	FWR	DC	FWR	DC	FWR
1	Temporal	High	78	78	84	84	88	88	99	98
2	Temporal	Medium	74	74	80	80	86	86	96	96
3	Temporal	Low	71	73	76	76	83	80	94	89
4	Non-temporal	High	82	82	88	88	93	92	100	100
5	Non-temporal	Medium	78	78	85	85	90	90	98	98
6	Non-temporal	Low	75	75	81	81	88	84	96	92
7†	Coded	High	82	82	88	88	93	92	101	101
8†	Coded	Medium	78	78	85	85	90	90	97	98
9†	Coded	Low	75	75	81	81	88	85	96	92

†Settings 7, 8, and 9 are not available on 2-wire horn/strobe.

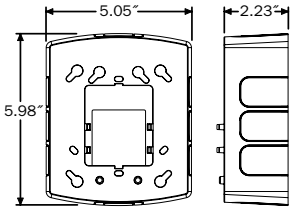
SpectrAlert Advance Dimensions



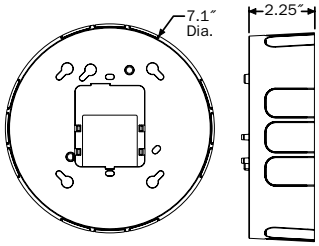
Wall-mount horn/strobes



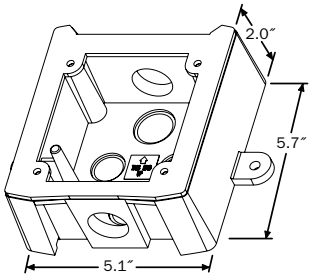
Ceiling-mount horn/strobes



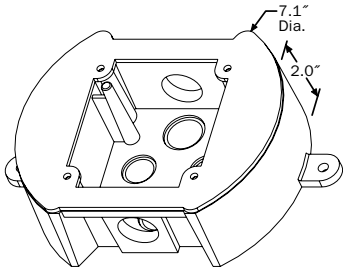
Wall back box skirt



Ceiling back box skirt



Wall weatherproof back box



Ceiling weatherproof back box

SpectrAlert Advance Ordering Information

Model	Description
Wall Horn/Strobes	
P2R*†	2-wire Horn/Strobe, Standard cd‡, Red
P2RH*	2-wire Horn/Strobe, High cd, Red
P2RK*	2-wire Horn/Strobe, Standard cd, Red, Outdoor
P2RHK*	2-wire Horn/Strobe, High cd, Red, Outdoor
P2W*	2-wire Horn/Strobe, Standard cd, White
P2WH*	2-wire Horn/Strobe, High cd, White
P4R*	4-wire Horn/Strobe, Standard cd, Red
P4RH*	4-wire Horn/Strobe, High cd, Red
P4RK	4-wire Horn/Strobe, Standard cd, Red, Outdoor
P4RHK	4-wire Horn/Strobe, High cd, Red, Outdoor
P4W*	4-wire Horn/Strobe, Standard cd, White
P4WH*	4-wire Horn/Strobe, High cd, White
Wall Strobes	
SR*†	Strobe, Standard cd, Red
SRH*†	Strobe, High cd, Red
SRK	Strobe, Standard cd, Red, Outdoor
SRHK	Strobe, High cd, Red, Outdoor
SW*	Strobe, Standard cd, White
SWH*	Strobe, High cd, White
Ceiling Horn/Strobes	
PC2R*	2-wire Horn/Strobe, Standard cd, Red
PC2RH*	2-wire Horn/Strobe, High cd, Red
PC2RK	2-wire Horn/Strobe, Standard cd, Red, Outdoor
PC2RHK	2-wire Horn/Strobe, High cd, Red, Outdoor

Model	Description
Ceiling Horn/Strobes (cont'd.)	
PC2W*†	2-wire Horn/Strobe, Standard cd, White
PC2WH*†	2-wire Horn/Strobe, High cd, White
PC4R	4-wire Horn/Strobe, Standard cd, Red
PC4RH	4-wire Horn/Strobe, High cd, Red
PC4RK	4-wire Horn/Strobe, Standard cd, Red, Outdoor
PC4RHK	4-wire Horn/Strobe, High cd, Red, Outdoor
PC4W	4-wire Horn/Strobe, Standard cd, White
PC4WH	4-wire Horn/Strobe, High cd, White
Ceiling Strobes	
SCR*	Strobe, Standard cd, Red
SCRH*	Strobe, High cd, Red
SCRK	Strobe, Standard cd, Red, Outdoor
SCRHK	Strobe, High cd, Red, Outdoor
SCW*†	Strobe, Standard cd, White
SCWH*†	Strobe, High cd, White
Horns	
HR	Horn, Red
HRK	Horn, Red, Outdoor
HW	Horn, White
Accessories	
BBS-2	Back Box Skirt, Wall, Red
BBSW-2	Back Box Skirt, Wall, White
BBSC-2	Back Box Skirt, Ceiling, Red
BBSCW-2	Back Box Skirt, Ceiling, White

Notes:

* Add "-P" to model number for plain housing (no "FIRE" marking on cover), e.g., P2R-P

† Add "-SP" to model number for "FUEGO" marking on cover, e.g., P2R-SP

‡ "Standard cd," refers to strobes that include 15, 15/75, 30, 75, 95, 110, and 115 candela settings. "High cd," refers to strobes that include 135, 150, 177, and 185 candela settings.

All outdoor units ending in "K" include a weatherproof back box.

SYSTEM SENSOR®

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

A05-0395-003 • 12/06 • #1676

Simplex®

True*Alarm* Fire Alarm Controls

*UL, ULC, CSFM Listed; FM Approved; MEA (NYC) Acceptance**

Model 4010 Fire Alarm Control Panel for TrueAlarm Analog Sensors and IDNet Addressable Devices

Features

Standard features include:

- Up to 250 addressable TrueAlarm sensor or addressable device points using IDNet communications that operate *with either shielded or unshielded* twisted pair wiring
- Four, 2 A notification appliance circuits (NACs) with solid state current protection
- Power supply/battery charger with 4 A available for NACs and auxiliary power
- Internal event reporting DACT module (standard on models 4010-9101, 4010-9102, & 4010-9150)
- UL listed to Standard 864

Installation convenience features:

- Power-limited design provides electronic modules on a one-piece chassis with up-front terminal blocks for wiring access
- Compact NEMA 1 rated cabinet is available in beige or red and can be pre-shipped for early installation

Setup, programming, and maintenance features:

- Device level ground fault search, locate, and isolate
- *Auto Program* for general alarm operation
- TrueAlarm individual analog sensing with front panel information and selection access
- "Dirty" TrueAlarm sensor maintenance alerts, service and status reports including "almost dirty"
- Default TrueAlarm sensor device type operation
- TrueAlarm sensor peak value performance report
- Duplicate address error detection
- Front panel or PC programming
- WALKTEST silent or audible system test
- Software verification simulation mode

Supports the following IDNet devices:

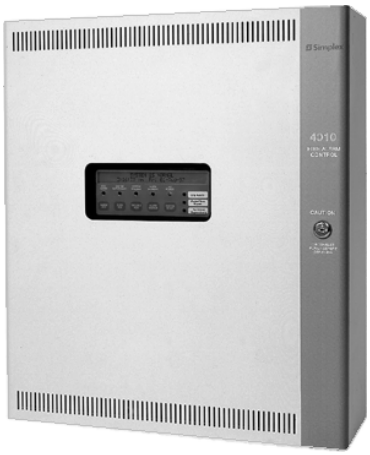
- Addressable manual stations; TrueAlarm sensor bases, duct housings, and isolator bases
- Quad-state zone adapter modules (ZAMs) for initiating device monitoring
- Quad-state line powered individual addressable modules (IAMs) for initiating device monitoring and relay control
- 4009 IDNet NAC Extenders and accessories

Available option modules include:

- Door mounted 24 LED annunciator (std. on ULC models)
- Network connection, or Point Reporting DACT
- Class A, NAC adapter module
- RS-232 ports for printer and maintenance PC
- Expansion power supply; Auxiliary Relay Module or City Interface
- Equipment for Suppression Release Applications (refer to data sheet S4010-0003)

Compatible with Simplex® auxiliary panels:

- 4003 Voice Control Panel
- 4081 Battery Cabinet with charger for 50 Ah batteries



4010 Fire Alarm Control Panel (with standard door)

Description

TrueAlarm fire alarm control panels have the ability to provide location accuracy for monitoring and control. When equipped with TrueAlarm analog sensing for smoke and heat detection, the processing power of the control panel also has the ability to analyze conditions at each location to provide accurate detection with significantly reduced maintenance costs.

The 4010 TrueAlarm Fire Alarm Control Panel has been specifically designed to provide addressable operation and analog detection in a cost-effective package for application sizes that previously were considered only appropriate for conventional zoned monitoring.

Installation and Service Ease. The 4010 mounts on a single chassis for quick installation and removal. Terminal blocks are large and up-front for easy access and inspection. Optional modules are easily and quickly installed, and programmed as required.

The 4010 cabinet provides convenient stud markers for drywall thickness and nail-hole knockouts for quicker mounting. Smooth cabinet surfaces are provided for locally cutting conduit entrance holes exactly where required. 4010 cabinets and electronics can be ordered separately, allowing early cabinet installation.

Ground Fault Assistance. Ground fault problems often occur during installation. The 4010 provides isolating circuitry, control of isolator bases, and software-controlled sequencing to isolate ground faults to specific identified locations. This assistance helps the installer to accurately locate the wiring problem for quicker repair.

* Refer to page 6 for listing details. This product has been approved by the California State Fire Marshal (CSFM) pursuant to Section 13144.1 of the California Health and Safety Code. See CSFM Listing 7170-0026:226 for allowable values and/or conditions concerning material presented in this document. Accepted for use – City of New York Department of Buildings – MEA35-93E. Additional listings may be applicable; contact your local Simplex product supplier for the latest status. Listings and approvals under Simplex Time Recorder Co. are the property of Tyco Safety Products Westminster.

4010 Operator Control Summary

Extensive Feature List. The 4010 Fire Alarm Control Panel provides access to an extensive feature list that includes:

- Providing easy and powerful operator information with a logical, menu-driven display
- Extensive and automatic diagnostics for maintenance reduction
- History Logs available from the LCD or capable of (optionally) being printed
- Software Verification, allowing detailed logic programming simulation to be conducted without activating connected outputs
- Control Panel (or service PC) label editing
- Password access control
- Auto Program Quick Configuration (Quick-CFIG) of connected modules and IDNet devices for general alarm operation to quickly get the system up and running

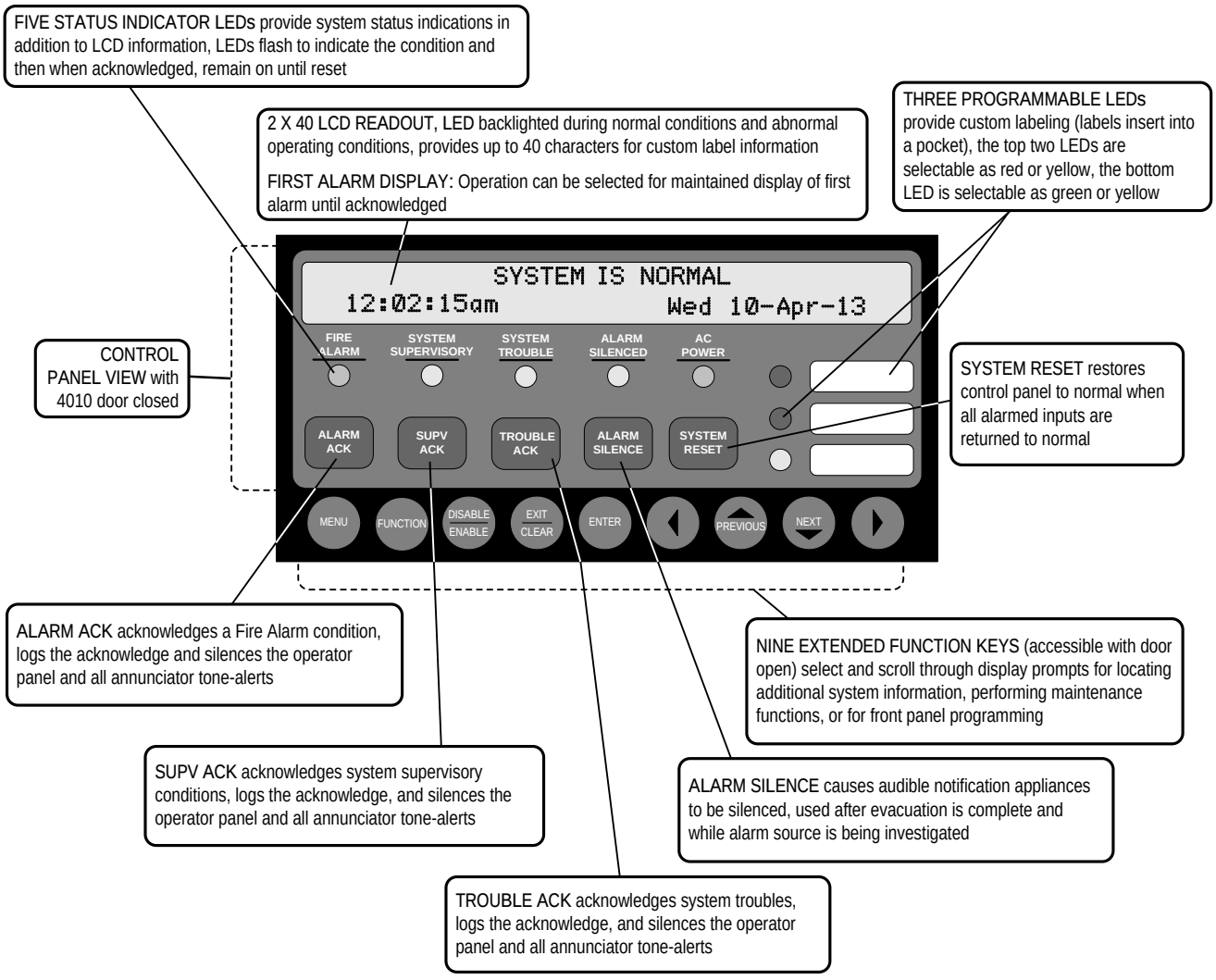
4010 Display Panel and Diagnostic Mode

Convenient Status Information. With the locking door closed, a window allows viewing of the status display. The 4010 status panel provides a two line by 40 character, super-twist LCD information display and eight status LED indicators as shown in the illustration below.

From this display, the LED indicators will describe the general category of activity being displayed with the LCD providing more detail. For the authorized user, unlocking the door will provide access to the control switches and allow further inquiry by scrolling the display for additional detail. (Refer to control panel functional illustration below.)

WALKTEST Diagnostic Operation Mode. The WALKTEST process allows a single person to perform system test. The system records test inputs such as intentional alarms or trouble and either logs the response (silent WALKTEST operation) or outputs a brief, recognizable audible notification signal (audible WALKTEST operation).

Extended Operator Control Panel Functions



IDNet Addressable Interface

Overview. The 4010 provides IDNet addressable device communications. Using a two-wire circuit, individual devices such as manual fire alarm stations, TrueAlarm sensors, and sprinkler waterflow switches can be directly connected (or interfaced) to the IDNet controller to communicate their identity and status. This addressability allows the location and condition of the connected device to be displayed on the 4010 panel LCD and on system annunciators. Additionally, control circuits (fans, dampers, etc.) may be individually controlled by using a relay IAM (individual addressable module). The 4009 IDNet NAC Extender can be controlled for local or remote notification appliance expansion. (Refer to compatible device lists on document S4090-0011 and to individual device documentation for further details.)

Capacity. A total of 250 addressable monitor and control points may be intermixed on the same pair of wires. By using Zone Adaptor Modules (ZAMs) or Individual Addressable Modules (IAMs), conventional initiating devices can be connected to the IDNet circuit.

IDNet Addressable Operation. The IDNet controller continuously interrogates each addressable device on the communication channel for status condition such as: normal, off-normal, alarm, supervisory, or trouble. Sophisticated poll and response communication techniques ensure supervision integrity and allow for "T-tapping" of the circuit for Class B operation.

Wiring Requirements. Refer to the specifications chart below. Distances are for shielded or unshielded wire. Shielded wire may provide protection from unexpected sources of interference and may be required for some applications.

Wiring Specifications

Size		18 AWG (0.82 mm^2)
Wire	Preferred	Shielded twisted pair (STP)
	Acceptable	Unshielded twisted pair (UTP)
Farthest Distance from Control Panel to Device		Up to 2500 feet (762 m)
Total Wire Length Allowed With “T” Taps for Class B Wiring		Up to 10,000 ft (3 km).

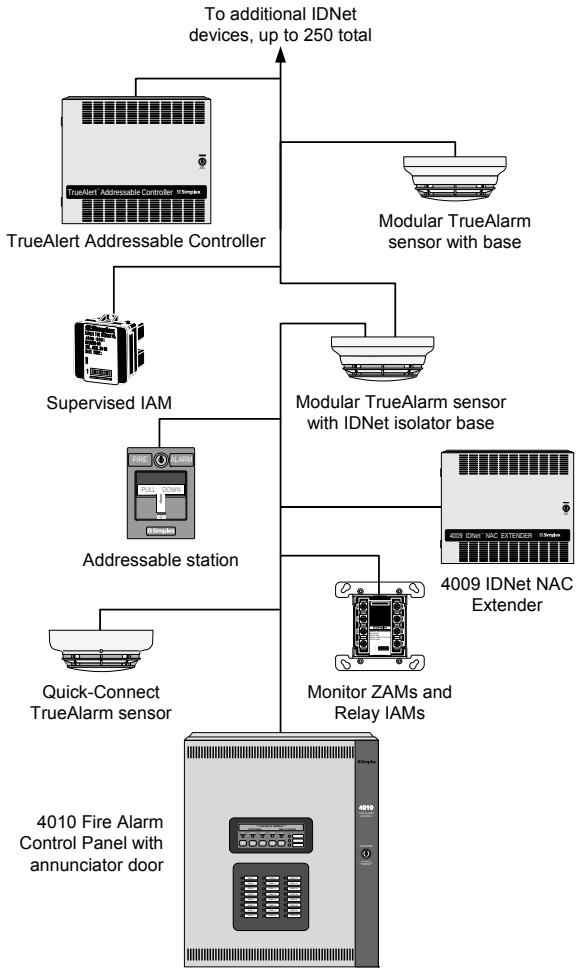
TrueAlarm Analog Sensors

TrueAlarm System Operation. IDNet communications are used for TrueAlarm smoke and temperature sensors. Every four seconds, smoke sensors transmit an output value based on their smoke chamber condition. The 4010 CPU maintains a current value, peak value, and an average value of each sensor's output. Status is determined by comparing the current sensor value to its average value. Tracking this average value as a continuously shifting reference point filters out environmental factors that cause shifts in sensitivity.

Programmable Sensitivity. The sensitivity of each sensor can be field programmed at the 4010 Control Panel for different levels of smoke obscuration (in percent) or for specific heat detection levels. In order to evaluate whether the sensitivity should be revised, the peak value is stored in memory and can be easily read and compared to the alarm threshold directly in percent.

TrueAlarm Analog Sensors *(Continued)*

TrueAlarm heat sensors can be selected for rate-of-rise detection as either 15° F (8.3° C) or 20° F (11.1° C) per minute with an independent fixed limit of 135° F (57° C) or 155° F (68° C). TrueAlarm heat sensors can also be programmed as a utility device to monitor for temperature extremes in the range from 32° F to 155° F (0° C to 68° C). This feature can provide freeze warnings or alert to HVAC system problems.



4010 Control Panel with Typical IDNet Devices

Diagnostics and Default Device Type

TrueAlarm operation gives the 4010 system the ability to automatically indicate when a sensor is almost dirty, dirty, and excessively dirty. The NFPA 72 (*National Fire Alarm and Signaling Code*) requirement for a test of the sensitivity range of the sensors is fulfilled by the TrueAlarm ability to maintain the sensitivity level of each sensor.

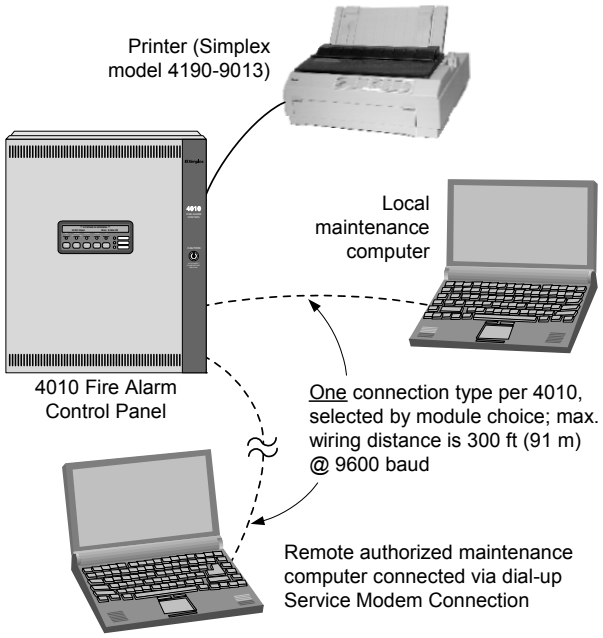
Modular TrueAlarm sensors use the same base and different sensor types (photoelectric smoke sensor, or heat sensor) can be easily interchanged to meet specific location requirements. This feature also allows intentional sensor substitution during building construction. When conditions are temporarily dusty, instead of covering the smoke sensors (causing them to be disabled), heat sensors may be installed without reprogramming the control panel. Although the control panel will indicate an incorrect sensor type, the heat sensor will operate at a default sensitivity to provide heat detection for building protection at that location.

TrueAlarm Information Details

True Alarm sensor data can be displayed on the system LCD, on a remote maintenance PC, or printed on a remote printer. With the proper operator access, a TrueAlarm Service Report can be generated to list the specific details of each TrueAlarm device. This report, as well as the Status Report can either be displayed on the remote maintenance PC or captured permanently by using a remote 80 character printer.

Status and Service Reports. The report samples below illustrate the format provided on either the remote maintenance PC or a printer. This information is available at the system LCD by identifying the specific point of interest and reading one point at a time.

Compatible Printer. Model 4190-9013 is a UL Standard 864 listed 80 column, 24 pin dot matrix printer (refer to data sheet S4190-0011).



RS-232 Connection Options
(refer to module selection on page 6)

TrueAlarm Status and Service Report Samples

```
Simplex 4010 Fire Alarm System                                          Page 1
REPORT 3 : TrueAlarm Status Report                    2:43:03 pm Mon 20-May-13


Zone                                                  Sensi-                    Almost
Name     Custom Label                                 tivity   Device Status     Dirty
M1-1     ANALOG PHOTO     CLEAN ROOM                   0.5 %   NORMAL
M1-2     ANALOG ION       CLEAN ROOM                   1.3 %   NORMAL
M1-3     ANALOG PHOTO     MAIN LOBBY                   2.5 %   NORMAL           *YES*
M1-4     ANALOG PHOTO     CONFERENCE ROOM 1            2.5 %   NORMAL
M1-10    HEAT DETECTOR    GARAGE                       135 F   NORMAL
M1-11    ANALOG PHOTO     KITCHEN                      3.7 %   NORMAL           *YES*

END OF REPORT
```

Typical TrueAlarm Status Report Information Printout and/or Maintenance PC Screen

```
Simplex 4010 Fire Alarm System                                          Page 1
REPORT 4 : TrueAlarm Service Report                   2:56:09 pm Mon 20-May-13


Dev                                              Alarm     Avg    Current/    Peak/   State
Num   Custom Label                               at:       val    % alarm    % alarm
1     ANALOG PHOTO - CLEAN ROOM                 0.5/ 83    67    68/ 1%      72/ 10%   NOR
2     ANALOG ION - CLEAN ROOM                   1.3/209    94    97/ 2%     101/  1%   NOR
3     ANALOG PHOTO - MAIN LOBBY                 2.5/185   117   117/ 0%     125/ 42%   NOR
4     ANALOG PHOTO - CONFERENCE ROOM 1          2.5/161    93    93/ 0%      93/  0%   NOR
10    HEAT DETECTOR - GARAGE                  135F/253    ---    63/-67F     66/ 69F   NOR
11    ANALOG PHOTO - KITCHEN                    3.7/216   116   116/ 1%     110/ 36%   NOR

END OF REPORT
```

Typical TrueAlarm Service Report Information Printout and/or Maintenance PC Screen

Standard Panel Features

N2 Communications for Serial Annunciator Control. Control for up to 6 remote Simplex Annunciator products including 24 Point I/O Module, and LCD Annunciator. Includes extensive troubleshooting diagnostics. (See list in next column for compatible devices.)

Access Port. RS-232 service port for connecting PC tools for service diagnostics and for programming the CPU Flash EPROM memory.

IDNet Addressable Communications Channel. Addressable channel provides communications for up to 250 remote addressable devices, including TrueAlarm analog sensors and isolator bases (see details on page 3).

Four NACs. Class B output is standard, rated for 2 A @ 24 VDC nominal, with solid state current protection. Class A operation is optional with the addition of an adapter module.

NAC operation can be selected for "on-until-Silence" or "on-until-Reset," and can be Continuous, Temporal pattern, or March Time pattern. ***(March Time is selectable for 20 bpm or 120 bpm for conventional appliances; or 60 bpm for SmartSync appliances.)*** NACs are individually selectable to control Simplex synchronized strobes or for Simplex SmartSync control that provides separate horn and synchronized strobe control using a 2-wire circuit.

Two Auxiliary Output Circuits. Operation is programmable for trouble, alarm, supervisory, or other fire response functions. Output is one Form "C" dry contact each, rated 2 A @ 24 VDC. An optional relay kit is available for switching up to 0.5 A at 120 VAC.

Standard Power Supply. Output is rated 4 A for "Special Application" appliances and for "Regulated 24 DC" appliance power. ***(Special Application appliances include Simplex 4901, 4903, 4904, and 4906 Series horns, strobes, horn/strobes, and speaker/strobes. See page 7 for additional information.)*** Internal system power is provided separately, allowing the 4 A to be available for NAC and auxiliary power tap functions. Over-current protection is solid state and self-resetting.

Auxiliary Power Tap. Provides up to 0.5 A of the standard power supply voltage, over-current protected. Compatible uses include power for: remote LCD annunciators, 24 Point I/O modules, sensor bases and duct housings that require external power, and addressable devices requiring external power.

Battery Charger. Capable of charging up to 25 Ah sealed lead-acid batteries (4010 cabinet mounted). A recharge time of 24 hours is typical with stable 120 VAC input. For applications requiring larger batteries, external charger/cabinet assemblies are available.

A depleted battery cutout feature is programmable to advise and/or to reduce current when battery voltage is low.

Optional Expansion Slot Modules

(The 4010 is available with a Simplex Network Interface. 4010 points can be declared "public.")

Network Interface, Modular Media. Available for wired connections or fiber optic. Require separate media modules. May be both wired, both fiber optic, or one of each.

Optional Expansion Slot Modules *(Cont'd)*

Network Interface, Fixed Media. Available for wired applications.

DACT, Point Reporting Module. Provides serial output information that can send location details to a remote receiving station.

DACT, Event Reporting Module. For applications where simple event status information is required (Alarm, Trouble, Supervisory, and AC power failure).

Dual RS-232 Module. Available for interfacing to a printer and a maintenance PC.

Single RS-232 Module with Service Modem Connection. Provides one port dedicated for connection to a printer, and a second port dedicated for dial-in from a service computer, typically located off-site. With an off-site computer, programming changes and system diagnostics can be performed remotely, reducing service time for repair or reprogram. Security is maintained by password protection.

Optional Chassis Mount Modules

4 A Expansion Power Supply provides two taps of 2 A each, 28 VDC, filtered, non-regulated. Output rating is 4 A for auxiliary power, 4 A for "Special Application" appliances and 2 A for "Regulated 24 DC" appliance power.

Battery Meter Module provides panel mounted ammeter and voltmeter for power supply monitoring.

Dual Circuit Class A NAC Adapter Module mounts on the main 4010 printed circuit assembly and provides the additional circuitry needed for Class A operation.

Dual Circuit City Connect Module provides the interface required for direct wired reporting to conventional city connection circuits. (Available with or without disconnect switches.)

Expansion Power Distribution Module provides two additional termination points for the 0.5 A auxiliary power output, or for one tap of the expansion power supply.

Relay Option Module provides three relays, one each for Alarm, Supervisory, and Trouble. Relay contacts are selectable for normally open or normally closed and are rated 2 A @ 32 VDC maximum.

N2 Communications Modules

Up to six of the following modules may be connected to the Simplex N2 serial communications bus.

4606-9101 LCD Annunciators provide remote acknowledge, reset, and alphanumeric status display. First Alarm display will work same as for the panel when selected (see page 2). (Refer to data sheet S4606-0001.)

24 LED Annunciator Doors are standard on ULC listed models and are available as door-only assemblies for electronics only packages or other aftermarket applications. This option uses the 24 Point I/O module with all points pre-assembled as LED outputs, with individual labels and each LED is selectable as red or yellow.

4605 Series 24 Point I/O Modules are available for remote mounting and provide 24 points that can be programmed as either general purpose switch inputs or system controlled outputs. Typical applications are for remote annunciators and monitoring and control of other related processes. (Refer to data sheet S4010-0002.)

4010 Fire Alarm Control Selection Chart and Module Location Rules (refer to diagrams on page 8)

Category	Model	Description	Voltage	Color
Control Panel Assembly (select one)	4010-9101	**UL Listed 4010 Fire Alarm Control Panel** with: door, cabinet, power supply/battery charger, IDNet interface, 4 NACs, 2 programmable auxiliary relays, and external N2 communications interface; 4010-9101 and 4010-9102 include internal common event reporting DACT	120 VAC	Beige
	4010-9102			Red
	4010-9201		240 VAC	Beige
	4010-9202			Red
	4010-9101C	English **ULC Listed 4010 Fire Alarm Control Panel**; same as above except: with 24 LED Annunciator door; and without DACT	120 VAC	Beige
	4010-9101CF	French		
	4010-9150	UL Listed **4010 Fire Alarm Control Panel, Electronics Only;** for pre-shipped cabinets, requires door and cabinet ordered separately; 120 VAC input; 4010-9150 has event reporting DACT; C & CF suffix models delete DACT		
	4010-9150C	ULC Listed English		
	4010-9150CF	ULC Listed French		

Optional Expansion Slot Features (two slots are available, select modules as required)

Category	Model	Description
Reporting and Network Modules (select one)	4010-9810	DACT Module (Common Event Reporting) — Includes two, 7 ft (2.1 m) long RJ45 cables
	4010-9816	DACT Module (Point Reporting)
	4010-9821	Network Interface Module with fixed, wired connections
	4010-9817	Network Interface Module, Modular; requires 2 (In/Out) media modules (see below)
Media Modules	4010-9818	Network Wired Media Module — Media modules mount on the 4010-9817 module without impact to slot allocation space.
	4010-9819	Network Fiber Optic Media Module
RS-232 Communications (select one)	4010-9811	Dual RS-232 Interface Module
	4010-9812	Single RS-232 Interface Module with Service Modem connection

Chassis Mounted Expansion Modules (select as required)

Category	Model	Description	
Expansion Power Supply (select one)	4010-9813	120 VAC input — 4 A Expansion Power Supply; rated 4 A for "Special Application" appliances; rated 2 A for "Regulated 24 DC" appliance power	
	4010-9823	240 VAC input	
Optional Features (select one)	4010-9820	Battery Meter Module (ammeter and voltmeter)	
	4010-9825	24 VDC Expansion Power Distribution Module, provides two additional termination points for an expansion power supply tap or the auxiliary power output	
Optional Features (select as indicated)	4010-9806	Dual Circuit Class A NAC Adapter Module, **two maximum**	
	4010-9809	Dual Circuit City Connect Module	**Select one maximum**
	4010-9829*****	Dual Circuit City Connect Module w/o disconnect switches	
	4010-9803	Relay Option Module	

Accessories

Category	Model	Description	
Optional Features	4010-9826	120 VAC Auxiliary Relay Kit, allows **one** auxiliary relay to control up to 0.5 A @120 VAC, select as required; **2 maximum**	
	4010-9830 (CAF)	Suppression Release Appliqué, required for suppression release applications; suffix CAF selects a French appliqué	
	2975-9801	Semi-flush trim, beige, 1 7/16" (37 mm) wide	
	2975-9802	Semi-flush trim, red, 1 7/16" (37 mm) wide	
Batteries (required if batteries are internal; select one size; **two batteries are required**)	2081-9272	6.2 Ah Battery, 12 VDC	
	2081-9274	10.0 Ah Battery, 12 VDC	
	2081-9288	12.7 Ah Battery, 12 VDC	
	2081-9275	18 Ah Battery, 12 VDC; **NOTE: This battery size will not allow bottom entry conduit**	
	2081-9287	25 Ah Battery, 12 VDC	
Cabinets (select one if pre-shipped)	2975-9215	Red Cabinet — Dimensions: 22" H x 18" W x 5 5/8" D (559 mm x 457 mm x 137 mm)	
	2975-9214(CF)	Beige Cabinet; CF suffix has French labels	
Doors (select one if pre-shipped or for use with 4010-9150)	4010-9858	Red Door with dress panel — Dimensions: 22" H x 18" W x 5/8" D (559 mm x 457 mm x 16 mm)	
	4010-9857(CF)	Beige Door with dress panel; CF has French labels	
	4010-9860*	Beige Door with 24 LED Annunciator and dress panel — Dimensions: 22" H x 18" W x 1 23/32"D (559 mm x 457 mm x 44 mm) [see also S4010-0002]	
	4010-9861*	Red Door with 24 LED Annunciator and dress panel	

***** As of document revision date: 4010-9829 is not ULC listed;
4010-9860 and 4010-9861 are listed by UL, ULC, and CSFM; and FM approved;

4010 Operating Specifications

Input Power Requirements	Voltage Range	Frequency	Maximum Current
AC Input, 120 VAC base models	102 to 132 VAC	60 Hz	2 A
AC Input, 240 VAC base models	204 to 264 VAC	50/60 Hz	1 A
AC Input with 120 VAC expansion power supply	102 to 132 VAC	60 Hz	4 A
AC Input with 240 VAC expansion power supply	204 to 264 VAC	50/60 Hz	2 A

Environmental	
Operating Temperature Range	32° to 120°F (0° to 49° C)
Operating Humidity Range	up to 93% RH, non-condensing @ 100.4° F (38° C) maximum

Output Ratings		
Standard Power Supply Output		Rated 4 A for "Special Application" appliances and for "Regulated 24 DC" appliance power; Battery charger for up to 25 Ah sealed lead-acid batteries
Notification Appliance Reference	Special Application	Simplex 4901, 4903, 4904, and 4906 Series horns, strobes, and combination horn/strobes and speaker/strobes (contact your Simplex product representative for compatible appliances)
	Regulated 24 DC	Power for other UL listed appliances; use associated external synchronization modules where required
Auxiliary Power Output Tap from Standard Power Supply		Rated 0.5 A maximum @ 19.4 to 32 VDC; subtract current used from standard power supply output
Expansion Power Supply Output		Rated 4 A for "Special Application" appliances and auxiliary power; Rated 2 A for "Regulated 24 DC" appliance power; Two output taps of 2 A each are provided
NAC Ratings		2 A each maximum; up to 33 synchronized strobes maximum per NAC

Current Ratings for Optional Modules and Remote LCD Annunciator

Model	Module	Supervisory Current	Alarm Current
4010-9810	DACT (Common Event Reporting)	40 mA	40 mA
4010-9816	DACT (Point Reporting)	40 mA	40 mA
4010-9821	Network, wired communications	125 mA	125 mA
4010-9817	Network Modular, add media cards separately	24 mA	24 mA
4010-9818	Network Wired Media	47 mA	47 mA
4010-9819	Network Fiber Optic Media	36 mA	36 mA
4010-9811	Dual RS-232	75 mA	75 mA
4010-9812	Single RS-232 with Service Modem	100 mA	100 mA
4010-9806	Dual Class A NAC Adapter	0 mA	0 mA
4010-9809	Dual Circuit City Connect	20 mA	36 mA
4010-9829	Dual Circuit City Connect w/o disconnect switches	20 mA	36 mA
4010-9803	Relay Option Module	10 mA	37 mA
4010-9860 4010-9861 & ULC 4010s	24 LED Annunciator door	60 mA	83 mA (all LEDs on)
4606-9101	Remote LCD Annunciator (refer to data sheet S4606-0001)	65 mA	140 mA

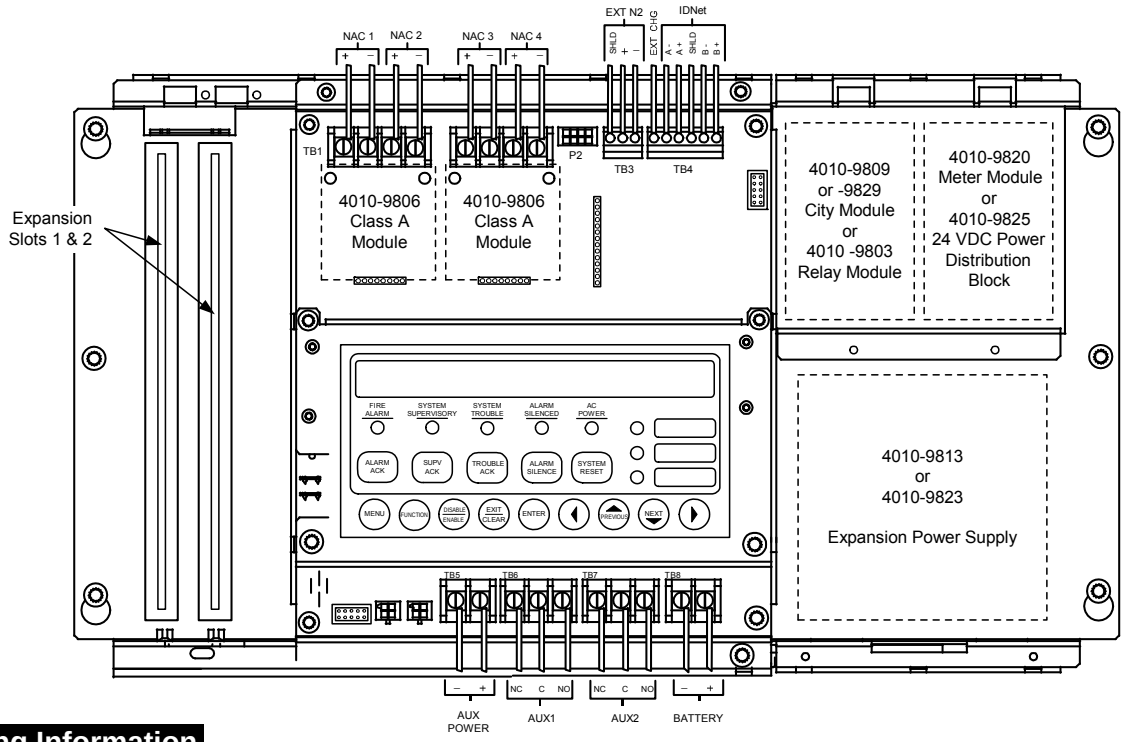
System Current (supplied separate from power supply output)

Base System with:	Supervisory Current**	Alarm Current**
no IDNet devices	195 mA	295 mA
50 IDNet devices	230 mA	330 mA
100 IDNet devices	265 mA	365 mA
150 IDNet devices	300 mA	400 mA
200 IDNet devices	335 mA	435 mA
250 IDNet devices	370 mA	470 mA

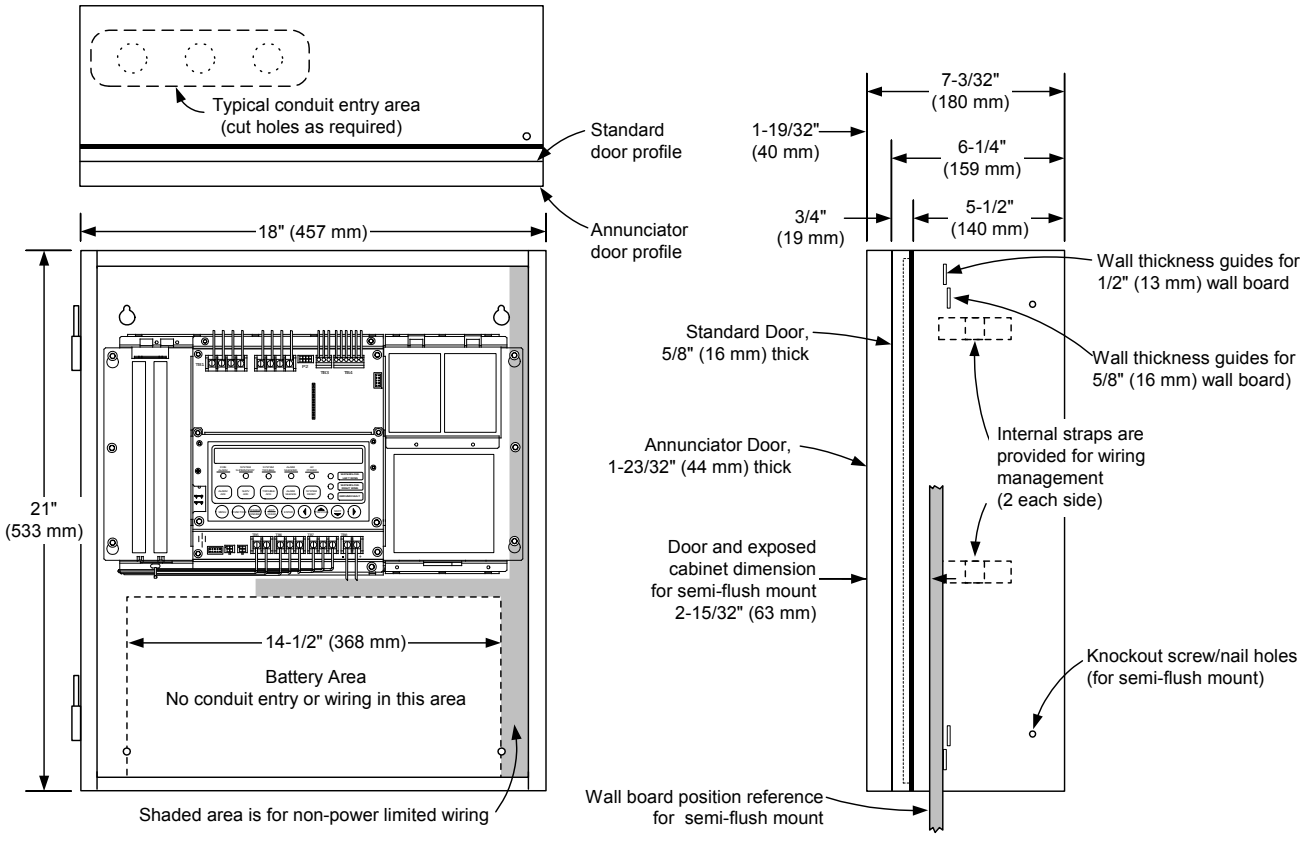
**** Current Calculation Information:**

1. To determine total supervisory current, add currents of modules in panel to base system value **and** all auxiliary loads.
2. To determine total alarm current, add currents of modules in panel to base system alarm current **and** add all panel NAC loads **and** all auxiliary loads.

4010 Module Layout Reference



Mounting Information



100 Series™ Low-Profile Plug-in Smoke Detectors

System Sensor 100 Series Plug-in Smoke Detectors offer superb performance and reliability in a profile which is just 2˝ (5.1 cm) deep.

Features

- Sleek, low-profile design
- Compatible with 400 Series product
- Two LEDs blink in standby, providing 360° visibility
- Broad range of adapter bases available with built-in shorting spring
- Hand-held sensitivity reader available

Model 2151 (photoelectric sensor) and model 2151T (photoelectric sensor with thermal) can be used with a variety of adapter bases in several wiring configurations and voltages. Other features include: low current draw, stable performance in high air velocities, built-in tamper resistant base design, remote LED option, removable cover and built-in test switch.

The 100 series is designed to meet the performance criteria designated by UL. The sensing chamber is sealed against back pressure air flow. The chamber top is covered by a one piece molded screen which minimizes the entry of dirt and insects. This screen can be removed for cleaning. Additional key features include a variety of mounting bases and a full line of accessories.

All 100 Series photoelectric smoke detectors contain a unique optical sensing chamber designed to sense smoke particles produced by a wide range of combustion sources. A custom integrated circuit incorporates signal processing to reduce false alarms.

Model 2151 photoelectric detector's unique optical sensing chamber is engineered to sense smoke by a wide range of combustion sources. Dual electronic thermistors add 135°F fixed temperature thermal sensing on model 2151T.

Agency Listings

UL LISTED S911 | ULC CS308 | 7272-1653:0122 | FM APPROVED 3025009 | MSFM approved 2180

100 Series Plug-in Smoke Detector Specifications

Operating Voltage/Alarm Current	See Adapter Base Selection Guide following
Standby Current	120μA Standby (when mounted in a B110LP base)
Sensitivity	1 – 3.18%/ft.
Height	2.0″ in B401
Diameter	4.1″ installed in B401; 6.2″ installed in B110LP
Shipping Weight	5.2 oz
Construction	Flame retardant thermoplastic
Temperature	Photo: 32°F to 120°F (0° to 49°C); Photo/thermal: 32°F to 100°F (0° to 38°C)
UL Listed Velocity Range	Photo: 0 – 3000 fpm (0 – 15.2 m/s)
Humidity Range	10% – 93% RH non-condensing
Smoke Detector Spacing	On smooth ceilings (as defined in NFPA 72), spacing of 30 feet (900 sq. ft.) may be used as a guide. Other spacing may be used depending on ceiling height, high air movements, and other conditions or response requirements.

Adapter Base Selection Guide

Base Model Number	Loop Type	Current Limit Resistor	Contact Type	Nominal Voltage	Current Draw on Alarm (mA)
B110LP	2-wire*	No	—	12/24VDC	10–130†
B110RLP	2-wire*	Yes	—	24VDC	10–62
B112LP	4-wire	Yes	Form A&C	24VDC	17–36
B114LP	4-wire	Yes	Form A&C + A Supervisory	120VAC	75 mA AC Max
B116LP	2-wire*	No	Form C	24VDC	20–100†
B401††	2-wire*	No	—	12/24VDC	10–130†

*Functionality contingent on panel compatibility †Must be limited by control panel ††Flangeless base

Relay Contact Ratings:	Resistive or Inductive (60% power factor) load.
Form A:	2.0A at 30 VAC/DC
Form C:	0.6A at 110VDC, 2.0A at 30VDC
	1.0A at 125VAC, 2.0A at 30VAC

Junction Box Selection Guide*

Base Model Number	Single Gang	3½″ Octagon	4″ Octagon	4″ Square	50 mm	60 mm	75 mm
B401	No	No	No	No	Yes	Yes	No
B110LP/RLP	Yes	Yes	Yes	Yes	No	No	No
B112LP/B116LP	Yes	Yes	Yes	Yes	Yes	Yes	Yes
B114LP	No	No	Yes	Yes	No	No	No

*Box depth contingent on base and wire size. Refer to National Electrical Code or local applicable codes for appropriate recommendations.

Ordering Information

Part No.	Description
2151	Low-profile photoelectric detector. Must be mounted to one of the B100 Series or B400 Series bases listed in the Adapter Base Selection Guide.
2151T	Low-profile photoelectric detector with thermal. Must be mounted to one of the B100 Series or B400 Series bases listed in the Adapter Base Selection Guide.
Accessories	
F110	Accessory Flange Ring for 6″ Base
RA100Z	Remote annunciator for 2 or 4 wire systems, 3–32V. Fits standard single gang electrical box.
SENS-RDR	Hand-held sensitivity reader.
SMB600	Surface mounting kit (flanged)
EOLR-1	End of line relay for power supervision, 12/24 VDC systems.
M02-04-01	Test magnet.
M02-09-00	Test magnet with 32″ telescoping handle.
XR-2B	Detector removal tool. Allows installation and/or removal of 100 Series detector heads from base in high ceiling installations when used with XP-4.
XP-4	Extension pole for XR-2B. Comes in three 5 ft. sections.
C58-227-01	Replacement dust cover for 100 Series smoke detectors.

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

A05-0182-015 • 11/11 • #2709

VSR
VANE TYPE WATERFLOW ALARM SWITCH WITH RETARD

UL, CUL and CSFM Listed, FM Approved, LPCB Approved, For CE Marked (EN12259-5) / VdS Approved model use VSR-EU

Service Pressure: 450 PSI (31 BAR) - UL

Flow Sensitivity Range for Signal:
4-10 GPM (15-38 LPM) - UL

Maximum Surge: 18 FPS (5.5 m/s)

Contact Ratings: Two sets of SPDT (Form C)
10.0 Amps at 125/250VAC
2.0 Amps at 30VDC Resistive
10 mAmps min. at 24VDC

Conduit Entrances: Two knockouts provided for 1/2" conduit. Individual switch compartments suitable for dissimilar voltages.

Environmental Specifications:

- NEMA 4/IP54 Rated Enclosure suitable for indoor or outdoor use with factory installed gasket and die-cast housing when used with appropriate conduit fitting.
- Temperature Range: 40°F - 120°F, (4.5°C - 49°C) - UL
- Non-corrosive sleeve factory installed in saddle.

Service Use:

Automatic Sprinkler	NFPA-13
One or two family dwelling	NFPA-13D
Residential occupancy up to four stories	NFPA-13R
National Fire Alarm Code	NFPA-72

Specifications subject to change without notice.

Ordering Information			
Nominal Pipe Size		Model	Part Number
2"	DN50	VSR-2	1144402
2 1/2"	DN65	VSR-2 1/2	1144425
3"	DN80	VSR-3	1144403
3 1/2"	-	VSR-3 1/2	1144435
4"	DN100	VSR-4	1144404
5"	-	VSR-5	1144405
6"	DN150	VSR-6	1144406
8"	DN200	VSR-8	1144408

Optional: Cover Tamper Switch Kit, stock no. 0090148
Replaceable Components: Retard/Switch Assembly, stock no. 1029030

⚠ WARNING

- Installation must be performed by qualified personnel and in accordance with all national and local codes and ordinances.
- Shock hazard. Disconnect power source before servicing. Serious injury or death could result.
- Risk of explosion. Not for use in hazardous locations. Serious injury or death could result.

CAUTION

Waterflow switches that are monitoring wet pipe sprinkler systems shall not be used as the sole initiating device to discharge AFFF, deluge, or chemical suppression systems. Waterflow switches used for this application may result in unintended discharges caused by surges, trapped air, or short retard times.

General Information

The Model VSR is a vane type waterflow switch for use on wet sprinkler systems. It is UL Listed and FM Approved for use on steel pipe; schedules 10 through 40, sizes 2" thru 8" (50 mm thru 200 mm). LPC approved sizes are 2" thru 8" (50 mm thru 200 mm). See Ordering Information chart.

The VSR may also be used as a sectional waterflow detector on large systems. The VSR contains two single pole, double throw, snap action switches and an adjustable, instantly recycling pneumatic retard. The switches are actuated when a flow of 10 GPM (38 LPM) or more occurs downstream of the device. The flow condition must exist for a period of time necessary to overcome the selected retard period.

Enclosure

The VSR switches and retard device are enclosed in a general purpose, die-cast housing. The cover is held in place with two tamper resistant screws which require a special key for removal. A field installable cover tamper switch is available as an option which may be used to indicate unauthorized removal of the cover. See bulletin number 5401103 for installation instructions of this switch.

VSR
VANE TYPE WATERFLOW ALARM SWITCH WITH RETARD

Installation (see Fig. 1)

These devices may be mounted on horizontal or vertical pipe. On horizontal pipe they shall be installed on the top side of the pipe where they will be accessible. The device should not be installed within 6" (15 cm) of a fitting which changes the direction of the waterflow or within 24" (60 cm) of a valve or drain.

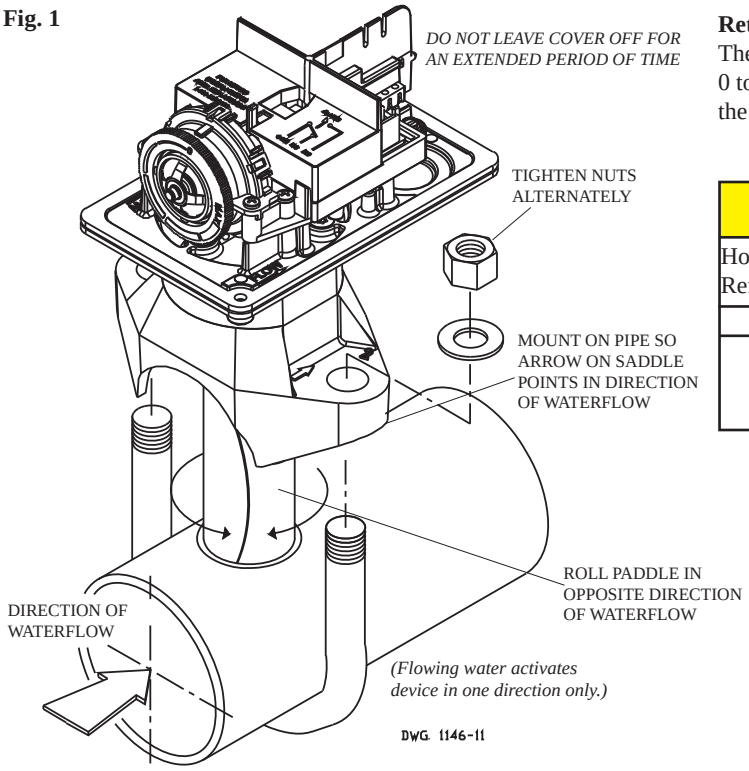
NOTE: Do not leave cover off for an extended period of time.

Drain the system and drill a hole in the pipe using a hole saw in a slow speed drill (see Fig. 1). Clean the inside pipe of all growth or other material for a distance equal to the pipe diameter on either side of the hole. Roll the vane so that it may be inserted into the hole; do not bend or crease it. Insert the vane so that the arrow on the saddle points in the direction of the waterflow. Take care not to damage the non-corrosive bushing in the saddle. The bushing should fit inside the hole in the pipe. Install the saddle strap and tighten nuts alternately to required torque (see the chart in Fig. 1). The vane must not rub the inside of the pipe or bind in any way.

⚠ CAUTION

Do not trim the paddle. Failure to follow these instructions may prevent the device from operating and will void the warranty.

Fig. 1

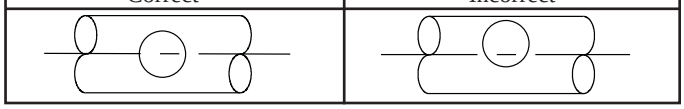


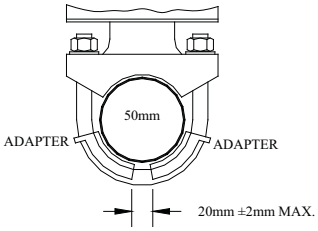
Retard Adjustment

The delay can be adjusted by rotating the retard adjustment knob from 0 to the max setting (60-90 seconds). The time delay should be set at the minimum required to prevent false alarms

CAUTION

Hole must be drilled perpendicular to the pipe and vertically centered. Refer to the Compatible Pipe/Installation Requirements chart for size.





DN50 ONLY

USE (2) 5180162 ADAPTERS AS SHOWN ABOVE

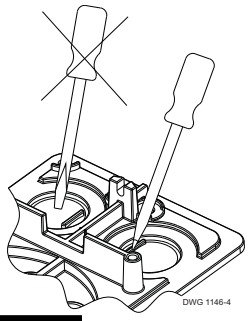
DWG# 1146-1F

Compatible Pipe/ Installation Requirements

Model	Nominal Pipe Size		Nominal Pipe O.D.		Pipe Wall Thickness								Hole Size		U-Bolt Nuts Torque	
					Schedule 10 (UL)		Schedule 40 (UL)		BS-1387 (LPC)		DN (VDS)					
	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	ft-lb	n-m
VSR-2	2	DN50	2.375	60.3	0.109	2.77	0.154	3.91	0.142	3.6	0.091	2.3	1.25 + .125/-.062	33.0 ± 2.0	20	27
VSR-2 1/2	2.5	-	2.875	73.0	0.120	3.05	0.203	5.16	-	-	-	-				
VSR-2 1/2	-	DN65	3.000	76.1	-	-	-	-	0.142	3.6	0.102	2.6				
VSR-3	3	DN80	3.500	88.9	0.120	3.05	0.216	5.49	0.157	4.0	0.114	2.9	2.00 ± .125	50.8 ± 2.0		
VSR-3 1/2	3.5	-	4.000	101.6	0.120	3.05	0.226	5.74	-	-	-	-				
VSR-4	4	DN100	4.500	114.3	0.120	3.05	0.237	6.02	0.177	4.5	0.126	3.2				
VSR-5	5	-	5.563	141.3	0.134	3.40	0.258	6.55	-	-	-	-				
VSR-6	6	DN150	6.625	168.3	0.134	3.40	0.280	7.11	0.197	5.0	0.157	4.0				
VSR-8	8	DN200	8.625	219.1	0.148	3.76	0.322	8.18	0.248	6.3	0.177	4.5				

NOTE: For copper or plastic pipe use Model VSR-CF.

Fig. 2
To remove knockouts: Place screwdriver at inside edge of knockouts, not in the center.



NOTICE
Do not drill into the base as this creates metal shavings which can create electrical hazards and damage the device. Drilling voids the warranty.

Fig. 3
Break out thin section of cover when wiring both switches from one conduit entrance.

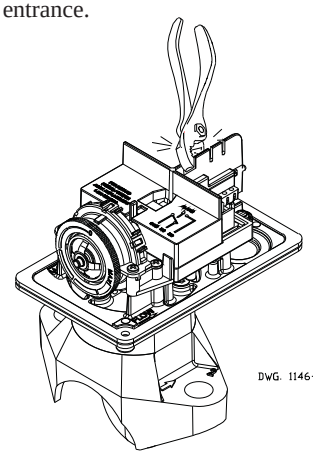
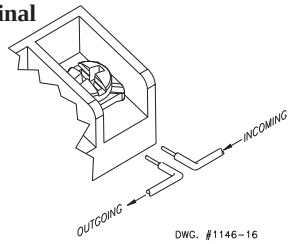


Fig. 4 Switch Terminal Connections Clamping Plate Terminal

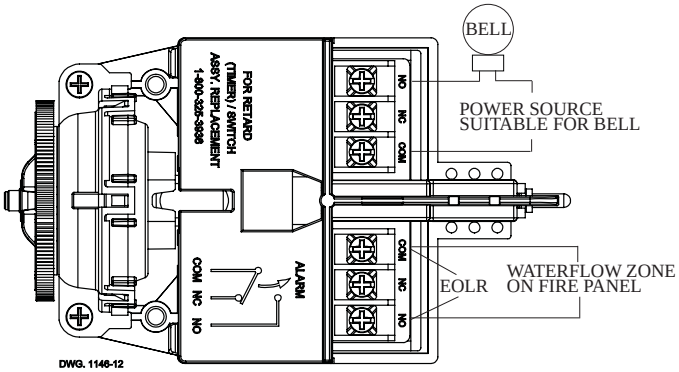


WARNING
An uninsulated section of a single conductor should not be looped around the terminal and serve as two separate connections. The wire must be severed, thereby providing supervision of the connection in the event that the wire become dislodged from under the terminal. Failure to sever the wire may render the device inoperable risking severe property damage and loss of life.

Do not strip wire beyond 3/8" of length or expose an uninsulated conductor beyond the edge of the terminal block. When using stranded wire, capture all strands under the clamping plate.

Fig. 5 Typical Electrical Connections

Notes:
1. The Model VSR has two switches, one can be used to operate a central station, proprietary or remote signaling unit, while the other contact is used to operate a local audible or visual annunciator.
2. A condition of LPC Approval of this product is that the electrical entry must be sealed to exclude moisture.
3. For supervised circuits, see "Switch Terminal Connections" drawing and warning note (Fig. 4).

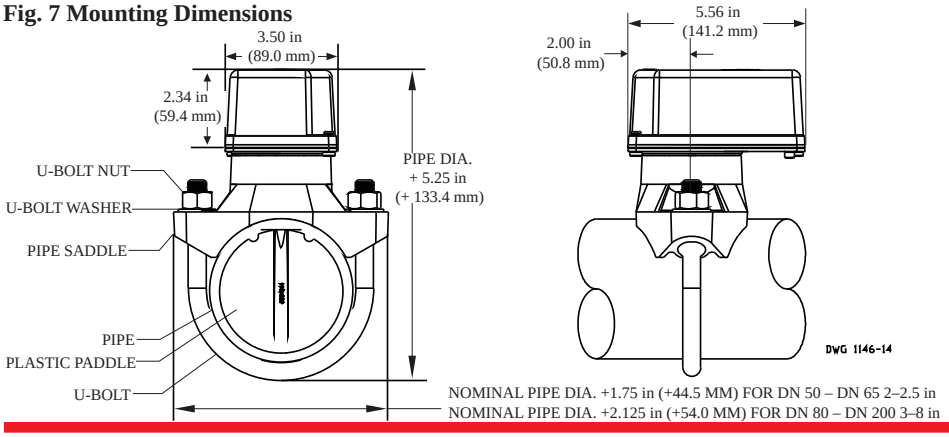


Testing
The frequency of inspection and testing for the Model VSR and its associated protective monitoring system shall be in accordance with applicable NFPA Codes and Standards and/or the authority having jurisdiction (manufacturer recommends quarterly or more frequently).

If provided, the inspector's test valve shall always be used for test purposes. If there are no provisions for testing the operation of the flow detection device on the system, application of the VSR is not recommended or advisable.
A minimum flow of 10 GPM (38 LPM) is required to activate this device.

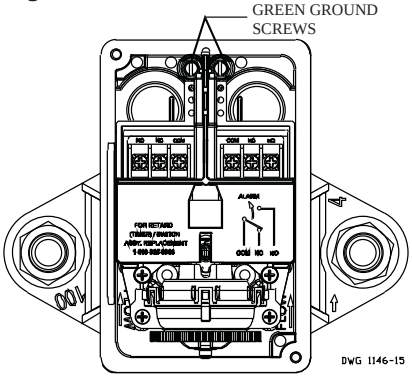
NOTICE Advise the person responsible for testing of the fire protection system that this system must be tested in accordance with the testing instructions.

Fig. 7 Mounting Dimensions



NOMINAL PIPE DIA. +1.75 in (+44.5 MM) FOR DN 50 – DN 65 2–2.5 in
NOMINAL PIPE DIA. +2.125 in (+54.0 MM) FOR DN 80 – DN 200 3–8 in

Fig. 8



Maintenance

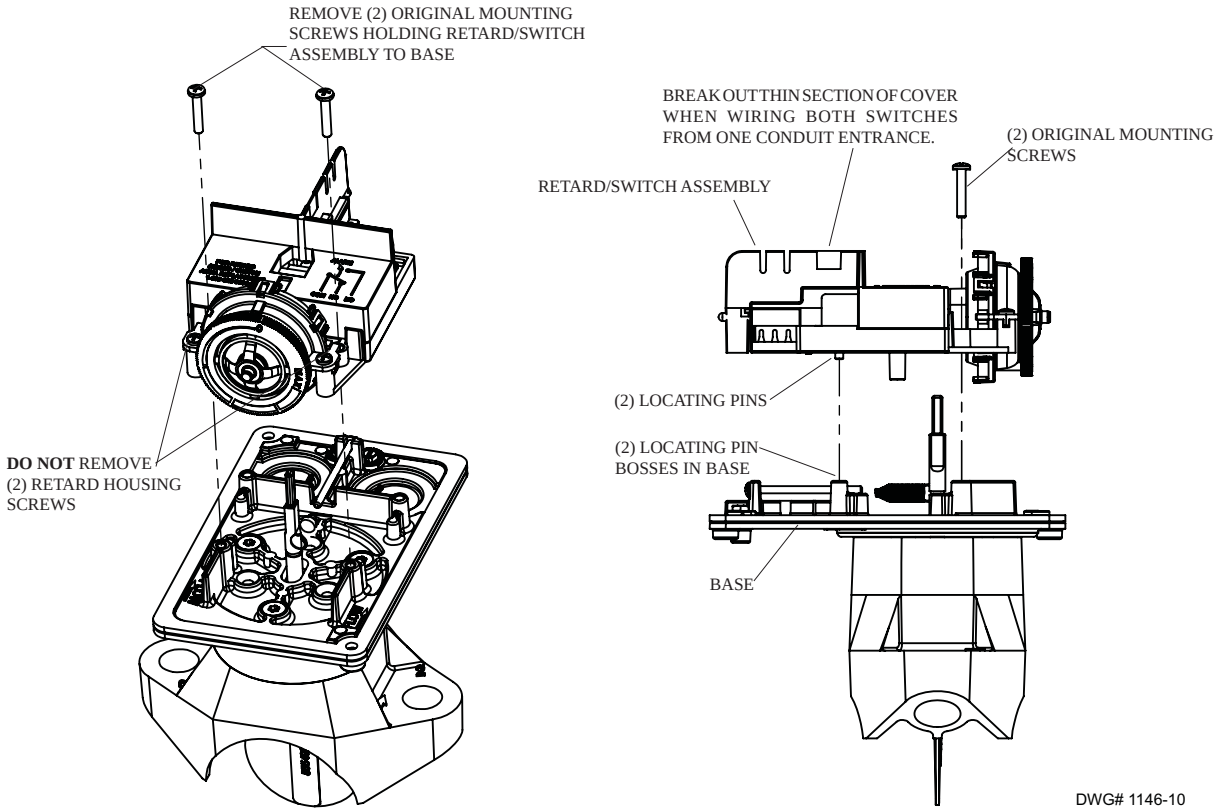
Inspect detectors monthly. If leaks are found, replace the detector. The VSR waterflow switch should provide years of trouble-free service. The retard and switch assembly are easily field replaceable. In the unlikely event that either component does not perform properly, please order replacement retard switch assembly stock #1029030 (see Fig. 6). There is no maintenance required, only periodic testing and inspection.

Retard/Switch Assembly Replacement (See Fig. 6)

NOTICE The Retard/Switch Assembly is field-replaceable without draining the system or removing the waterflow switch from the pipe

1. Make sure the fire alarm zone or circuit connected to the waterflow switch is bypassed or otherwise taken out of service.
2. Disconnect the power source for local bell (if applicable).
3. Identify and remove all wires from the waterflow switch.
4. Remove the (2) mounting screws holding retard/switch assembly to the base. **Do not** remove the (2) retard housing screws.
5. Remove the retard assembly by lifting it straight up over the tripstem.
6. Install the new retard assembly. Make sure the locating pins on the retard/switch assembly fit into the locating pin bosses on the base.
7. Re-install the (2) original mounting screws.
8. Reconnect all wires. Perform a flow test and place the system back in service.

Fig. 6



Removal of Waterflow Switch

- To prevent accidental water damage, all control valves should be shut tight and the system completely drained before waterflow detectors are removed or replaced.
- Turn off electrical power to the detector, then disconnect wiring.
- Loosen nuts and remove U-bolts.
- Gently lift the saddle far enough to get your fingers under it. With your fingers, roll the vane so it will fit through the hole while continuing to lift the waterflow detector saddle.
- Lift detector clear of pipe.

Intelligent Manual Pull Stations

E-270, E-278

Overview

Edwards intelligent manual pull stations are engineered to deliver high-performance features, superb reliability, and unbeatable quality. From control of ancillary equipment, to enhanced signaling functionality, these products add flexibility and powerful options to Edwards Signaling intelligent systems.

Designed expressly for small buildings, Edwards Signaling pull stations are addressable modules that are uniquely identified on the system by means of familiar rotary switches. Once registered, they share data and update status information that determines how the system behaves and how connected devices interact with one another.

Edwards Signaling intelligent manual pull stations also offer contractors and installers simple setup and installation, while delivering options that take full advantage of intelligent fire alarm processing. With a microprocessor in each device, intelligence is distributed throughout the system so that command decisions are made instantly at the individual pull station, rather than bottlenecking at the control panel.

This not only speeds event processing, it also makes a more robust and reliable system – so robust, in fact, that when upgrading from a conventional panel to a Edwards Signaling intelligent system, you can usually use existing wiring – no twisted or shielded cable required!

Standard Features

- **Traditional familiar appearance**
  Single action models feature our familiar teardrop design with simple positive pull action and sturdy die-cast metal body.
- **Single action (GA) and double action models**
  Double action feature rugged Lexan housings with keyed reset.
- **Break glass operation**
  An up-front visible glass rod on the E-270 discourages tampering.
- **Intelligent device with integral microprocessor**
  All decisions are made at the station allowing lower communication speed while substantially improving control panel response time. Less sensitive to line noise and loop wiring properties; twisted or shielded wire is not required.
- **ADA Compliant**
  Meets ADA requirements for manual pull stations.
- **Rotary Addressing**
  Familiar easy-to-set wheels.
- **Diagnostic LEDs**
  Status LEDs; flashing GREEN shows normal polling; flashing RED shows alarm state.
- **Designed for high ambient temperature operation**
  Install in ambient temperatures up to 120 °F (49 °C).

DATA SHEET S85001-0612
Not to be used for installation purposes. Issue 1

Operation

A single input mini module mounted on the back of the unit (factory installed) supervises the station and sends an alarm signal to the control panel when the switch is closed (i.e. when the handle is pulled).

The device address is set using the two rotary switches located on the back of the unit. One device address is required.

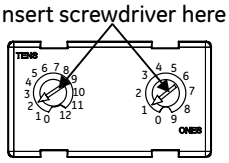
The pull station is configured for alarm latching operation. When the pull lever is activated, an alarm signal is sent to the control panel and the alarm condition is latched at the pull station.

The E-270 pull station is a normally open dry contact initiating device that requires one action by the user to initiate an alarm.

The E-278 pull station is a normally open dry contact initiating device that requires two actions by the user to initiate an alarm. First, the upper door marked LIFT THEN PULL HANDLE must be raised to access the alarm handle. Second, the alarm handle must be pulled to initiate an alarm.

Device Addressing

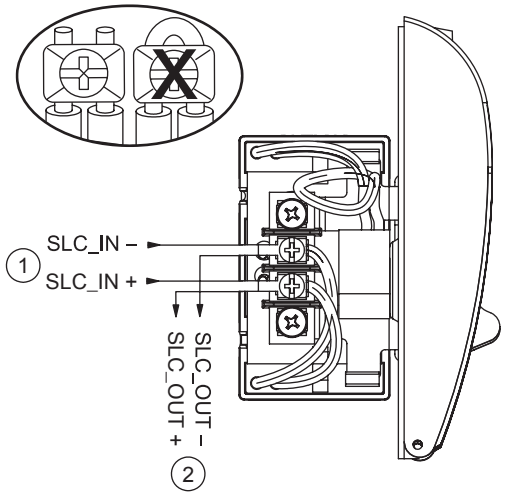
Use a screwdriver to adjust the two rotary switches on the front of the module. Set the TENS rotary switch (0 through 12) for the 10s digit and the ONES rotary switch for the 0 through 9 digit.



Example: device address 21, set TENS rotary switch to 2 and set the ONES rotary switch to 1.

Refer to the Specifications Table for available address numbers.

Wiring

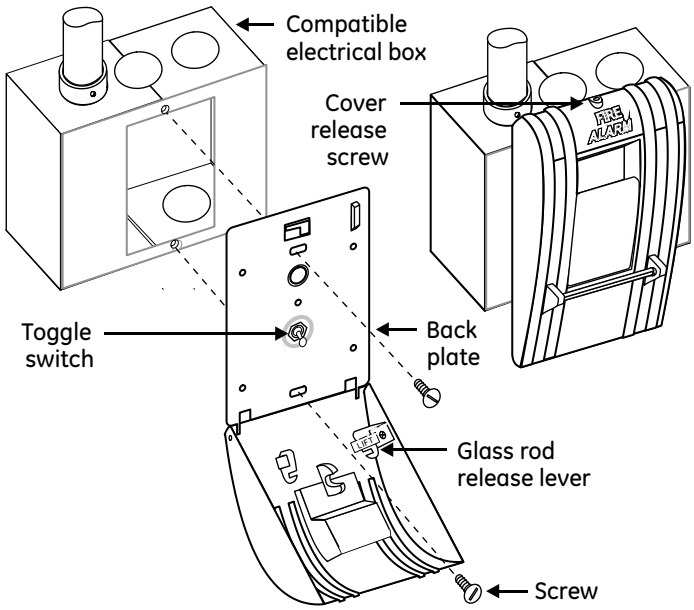


1. From previous device or control panel
2. To next device or EOL resistor

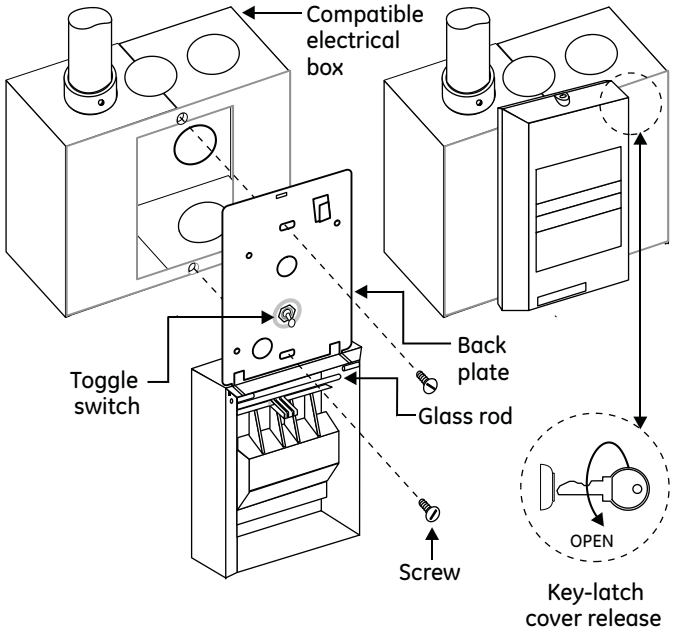
Installation

Mount in a North American 2-1/2 in. (64 mm) deep 1 gang box, or standard 4 in. square box 1-1/2 in. (38 mm) deep box with 1 gang cover.

E-270 Single Action Pull Station



E-278 Double Action Pull Station



Specifications

Communication line voltage	Maximum 20 V peak-to-peak
Current Standby Activated	 350 µA 500 µA
Operating environment Temperature Humidity	 32 to 120°F (0 to 49°C) 0 to 93% RH, noncondensing at 90°F (32°C)
Storage temperature range	–4 to 140°F (–20 to 60°C)
Compatible electrical boxes	North American 2-1/2 in. (64 mm) deep 1 gang box Standard 4 in. square box 1-1/2 in. (38 mm) deep box with 1 gang cover
Wire size	12, 14, 16, or 18 AWG wire (2.5, 1.5, 1.0, or 0.75 sq. mm) (Sizes 16 and 18 AWG are preferred)
Device address	01 to 64 (64 point control panel) 01 to 127 (127 point control panel)

Ordering Information

Catalog Number	Description	Ship Wt. lbs (kg)
E-270	One Stage Fire Alarm Station	1 (0.5)
E-278	Double Action Fire Alarm Station	
Accessories		
276B-RSB	Surface Backbox, Red	0.1 (0.05)
276-K1	Station Reset Key, Supplied with all Key Reset Stations	0.1 (0.05)
27165	12 Glass Rods - for E-270 series (CANADA ONLY)	0.1 (0.05)
270-GLR	20 Glass Rods - for E-270 series (USA ONLY)	0.1 (0.05)
276-GLR	20 Glass Rods - for E-278 series	0.1 (0.05)

Warning
These pull stations will not operate without electrical power. As fires frequently cause power interruption, you should discuss further safeguards with your local fire protection specialist.

Caution
Wire in accordance with NFPA 72 and CAN/ULC-S524. Be sure to observe the polarity of the wires as shown in the diagram.

Contact us...

Phone: 1-800-336-4206
Web: *www.edwardssignaling.com*

Edwards Signaling is
an **EDWARDS** brand.

3 Farm Glen Boulevard
Farmington, CT 06032

In Canada, contact Chubb Edwards...
Email: inquiries@chubbedwards.com
Web: *www.chubbedwards.com*