Comprehensive Fire Protection and Life Safety Evaluation of the

Robotic Manufacturing Science and Engineering Laboratories (RMSEL) Facility

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June 12, 2015

California Polytechnic State University – Fire Protection Engineering

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Keywords:

Fire Protection Engineering, performance based design, fire modeling, RSET, ASET.

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Executive Summary

A comprehensive fire protection and life safety evaluation has been performed for the Robotic Manufacturing Science and Engineering Laboratory (RMSEL) at Sandia National Laboratories (SNL). The evaluation considered both prescriptive and performance based aspects.

Current codes, such as the 2012 International Building Code and the 2013 version of NFPA 13 – Standard for the Installation of Sprinkler Systems, are generally the basis for the prescriptive evaluation even though they are not the code of record for the building. Use of current codes for this evaluation is mostly for academic reasons. Nevertheless, the facility is generally compliant with the provisions of the current codes.

Fire modeling has been used to evaluate the performance of the smoke control system in the atrium. RMSEL is a three-story building with an atrium that communicates with all three floors. As such, the atrium is required to have a smoke control system designed in accordance with "generally accepted and well-established principles of engineering relevant to the design." The smoke control system for RMSEL essentially transitions the heating, venting, and air conditioning (HVAC) system to supply 100% outside air and exhaust 100%. As designed, it is not certain that the smoke control will maintain a tenable environment. For this reason, fire modeling has been used to characterize the conditions resulting from a fire in the atrium.

To characterize the benefit of the smoke control system, four runs scenarios have been evaluated. The first scenario assumed the fire burned unmitigated. The second scenario assumed that the sprinklers controlled the heat release rate of the fire. A third scenario considered only the smoke control system activated (i.e., no sprinklers) and the last scenario considered both sprinklers and smoke control.

Results of the fire modeling, combined with results from simulated egress times, shows that in general, it takes more time than available to safely egress certain area prior to the loss of tenability. Nevertheless, the smoke control system combined with sprinkler control of the fire extended the available safe egress time longer than the required safe egress time for all but the areas in the immediate vicinity of the fire. The smoke control system provides benefit.

This analysis assumed tenability is lost when visibility is less than 13 m, a conservative value. Fire modeling was conservative as it assumed a higher than expected heat release rate, and the soot yield was an average of yields for different foams.

It is recommended that the facility stakeholders address the backup power deficiency for the smoke control. Consideration should also be given to running the fire models with less conservatism to better characterize the egress times.

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Acknowledgements

First and foremost, I express my sincere thanks to Perry D'Antonio and Sandia Corporation. It was Perry who encouraged me to pursue this degree. Perry led by example and completed this program shortly after I joined Sandia. He continues to encourage others to further their education. I thank Sandia Corporation, a Lockheed Martin subsidiary, for the financial assistance they provided me. Sandia is a great company to work for and their investment in their employees is remarkable.

Secondly, I would like to thank Professor Frederick Mowrer and Professor Chris Pascual. Throughout my time with Cal Poly they have demonstrated a high commitment to the success of the students and to the Fire Protection Engineering Program.

Finally, I am grateful for the love and patience my family has given me while I pursued this degree. Having obtained a master degree while working full time before, my wife was well aware of the sacrifices I was asking to do it again. It was tougher this time since we have a beautiful daughter now whose words "Play with me" weighed on me while I worked. It is time to play.

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Acronyms

ASET	available safe egress time
CFAST	Consolidated Model of Fire and Smoke Transport
CFD	computational fluid dynamics
CFM	cubic feet per minute
dBA	decibel A-weighted
DOE	U.S. Department of Energy
FACP	fire alarm control panel
FATC	fire alarm terminal cabinet
FDS	Fire Dynamics Simulator
ft	feet
gpm	gallons per minute
HRR	heat release rate
HVAC	heat, ventilation, and air conditioning
IBC	International Building Code
ICC	International Code Council
IFC	International Fire Code
IDC	initiating device circuit
ITM	inspection, testing, and maintenance
KAFB	Kirtland Air Force Base
LSC	Life Safety Code®
NAC	notification appliance circuit
NFPA	National Fire Protection Association
psi	pounds per square inch
RMSEL	Robotic Manufacturing Science and Engineering Laboratory
RSET	required safe egress time
SLC	signal line circuit
SFPE	Society of Fire Protection Engineers
UBC	Uniform Building Code
UFC	Uniform Fire Code

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1 Introduction

The purpose of this effort has been to perform and document a comprehensive fire protection and life safety evaluation of the Robotic Manufacturing Science and Engineering Laboratory (RMSEL). The primary motivation for this effort has been in partial fulfillment of academic requirements for an advanced degree. Nevertheless, this effort has evaluated RMSEL against prescriptive requirements and performance based criteria.

Prescriptive requirements that have been used in this evaluation are those that were generally in place around 2012. These requirements are clearly not the basis for the design and construction of the facility, as it was built approximately two decades ago. However, evaluating to the current codes allowed gaps to be identified and, if needed, a chance to provide recommendations to alleviate fire protection and life safety concerns. Being a U.S. Department of Energy (DOE) facility, other prescriptive requirements were included in the design that may have exceeded requirements in the model building codes. The following is a list of the primary codes and standards that have been used as part of the prescriptive evaluation.

- *2012 International Building Code*
- *2012 International Fire Code*
- NFPA 101-2012, *Life Safety Code*®
- NFPA 13-2013, *Standard for the Installation of Sprinkler Systems*
- NFPA 72-2013, *National Fire Alarm and Signaling Code*

The performance-based evaluation of RMSEL is focused on the atrium. Atriums present additional challenges, as fires are more readily able to adversely impact occupants on different floors due to the common opening. Fire modeling using a computational fluid dynamics (CFD) code is performed to characterize the environment of a fire in the atrium and assess the performance of the fire protection features.

This document starts with a description of the facility and the classification of the occupancies. Building upon this information, the document evaluates the prescriptive requirements and ends with the performance-based evaluation and recommendations.

1.1 Facility Description

RMSEL provides the office space and laboratories of engineers whose primary focus is research and development of cutting edge robotic and manufacturing technology. RMSEL is located on land owned by the DOE that resides within the fenced area of Kirtland Air Force Base (KAFB). Built in 1997 per the 1994 Uniform Building Code (UBC) (Ref. 1) and Uniform Fire Code (UFC) (Ref. 2). The facility was constructed as a Type II—N meaning the facility is of noncombustible construction.

RMSEL is primarily office space and research and development laboratories meeting the UBC criteria for business occupancy. The facility consists of three stories and a partial basement. An interesting architectural feature that presents several fire protection challenges is the atrium that provides communicating space from the first story to the third. First and second floors consist

mainly of office space, conference rooms, and laboratories. The third floor, which has a much smaller footprint than the first and second, is used to house the four large heating, ventilation, and air conditioning (HVAC) units, including the four large smoke exhaust fans. Each HVAC unit is contained within its own room. The only portion of the third floor open to the atrium is the walkway between the rooms. Figure 1-1 shows the outside wall of a mechanical room on the third floor and how the atrium communicates with the second floor.

Figure 1-1. Third floor atrium and mechanical room

Laboratories are generally located along the central and west portions of the building. Large laboratories on the far west end are high bays and their ceiling extends to the second floor. Office space occupies the east and north portions. Small conference rooms are also located on the north end. Figures 1-1 through 1-4 provide a layout for each of the four levels.

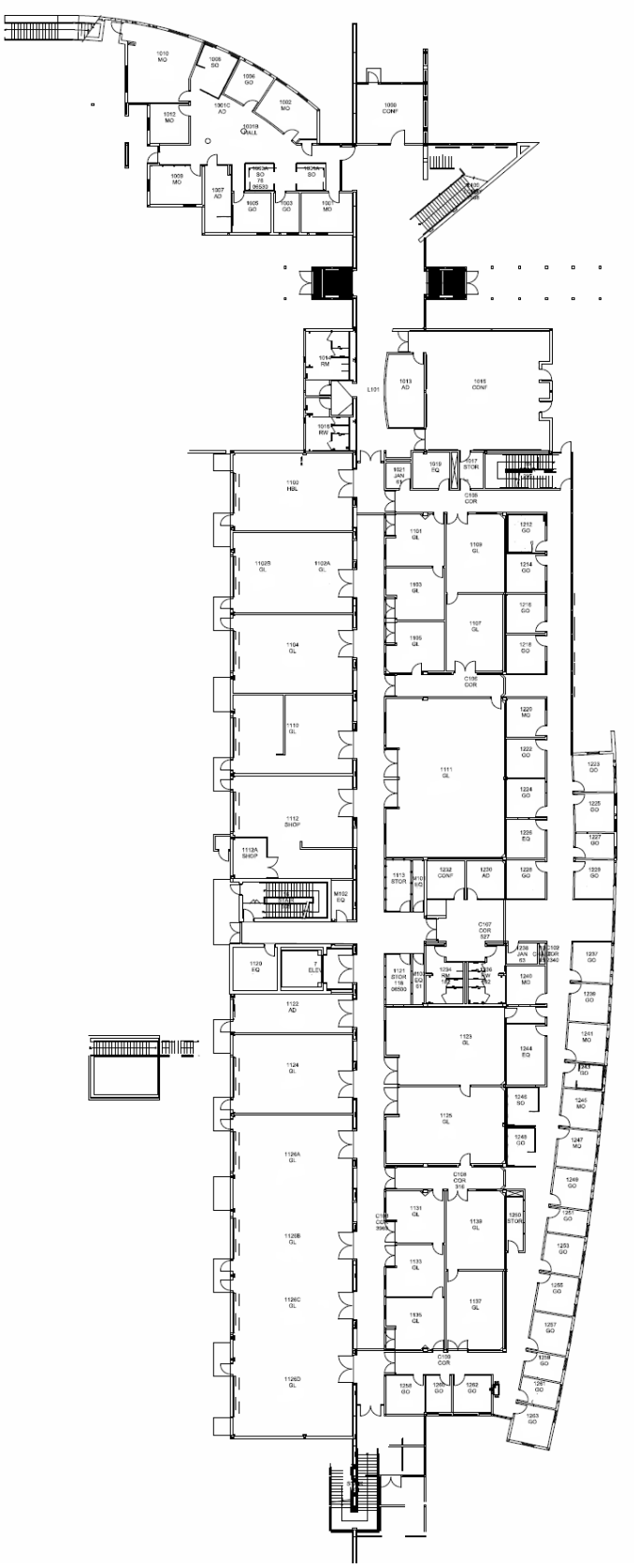

Figure 1-2. First floor layout

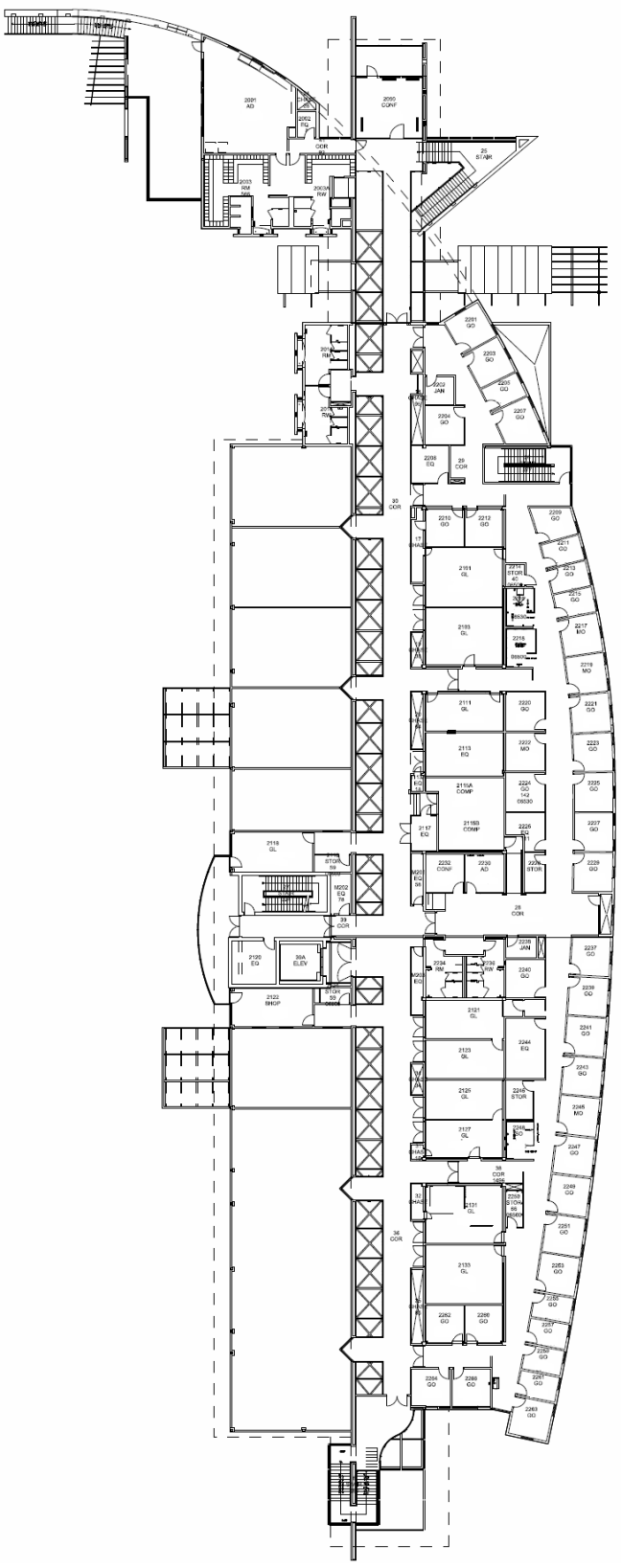

Figure 1-3. Second floor layout

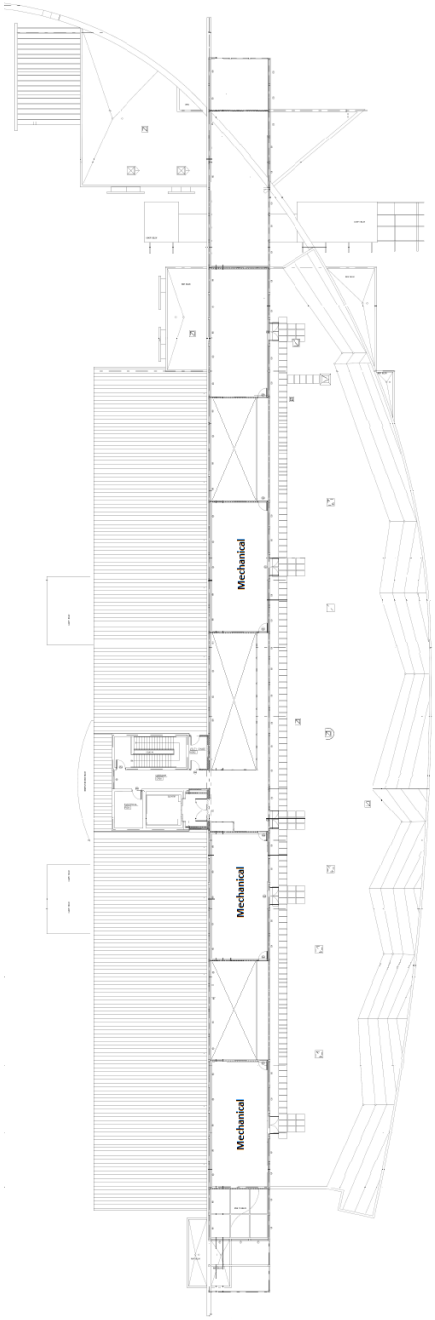

Figure 1-4. Third floor layout

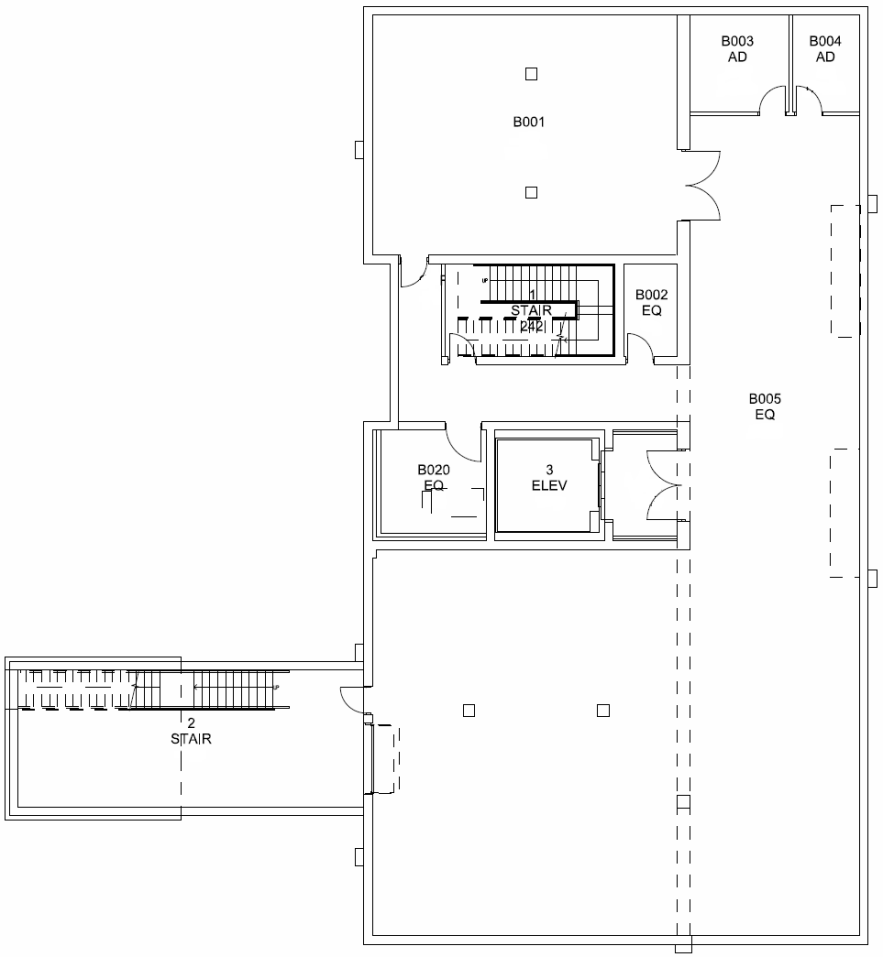

Figure 1-5. Basement layout

Approximate floor areas for each of the levels are given below.

Table 1-1. Approximate floor area (Ref. 3)

Level	Approximate Floor Area [ft^2]
Basement	4,500
First	36,000
Second	24,000
Third	6,500
Total	71,000

1.2 Occupancy Classification

The International Building Code (IBC) (Ref. 3) and NFPA 101 (i.e., *Life Safety Code®)* (Ref. 4) requires all spaces of the building be classified according to their use or occupancy type. Occupancy types are a major factor when determining the need for fire protection and life safety features. This section classifies the various spaces of RMSEL into their appropriate occupancies.

Per section 302 of the IBC, RMSEL contains multiple uses and occupancies. The office area, small conference rooms, and laboratories are classified as Business Group B occupancy. A large conference room on the first floor is classified Assembly Group A-3 since the space can support an occupant load greater than 49. Table 508.4 of the IBC requires a 1-hour fire-resistance rating barrier separation of the Assembly Group occupancy with the Business Group occupancy. One-hour fire-resistance rating barriers have been incorporated into the design of the large conference room.

The *Life Safety Code*® (LSC) classifies RMSEL as a multiple-separated occupancy, meaning the facility has two or more classes of occupancies that are separated by fire-rated assemblies. Offices and small conference rooms are classified as Business occupancy. The large conference room is classified as Assembly occupancy and the laboratories are classified as Industrial occupancy and sub classified as General Industrial occupancy, implying ordinary and low hazard operations.

Tables 6.1.14.4.1(a) and (b) of the LSC requires Assembly and Business occupancies be separated by 1 hour fire-rated barriers. Two hour-rated barriers are required to separate Business occupancies from Industrial, General Purpose occupancies. The table footnote allows a reduction of 1 hour, but in no case to less than 1 hour when an approved automatic sprinkler is provided throughout the building. The RMSEL Fire Hazards Analysis (Ref. 3) states the laboratories will be 1 hour fire-rated in accordance with UBC Section 901(a). The purpose of the fire rating is to allow multiple control areas for handling and storing hazardous chemicals, if needed. Separation of laboratories (i.e., Industrial) from the Business and Assembly occupancies per table 6.1.14.4.1(a) and (b) and the Assembly occupancy from the Business and Industrial occupancies confirms RMSEL is a multiple occupancy with separated occupancies.

Layouts of the various occupancies for the first and second floor of RMSEL are provided in the next two figures. The occupancies are color-coated. Exit locations are also depicted with red rectangles.

Figure 1-6. Occupancy designation and exits for the 1st floor

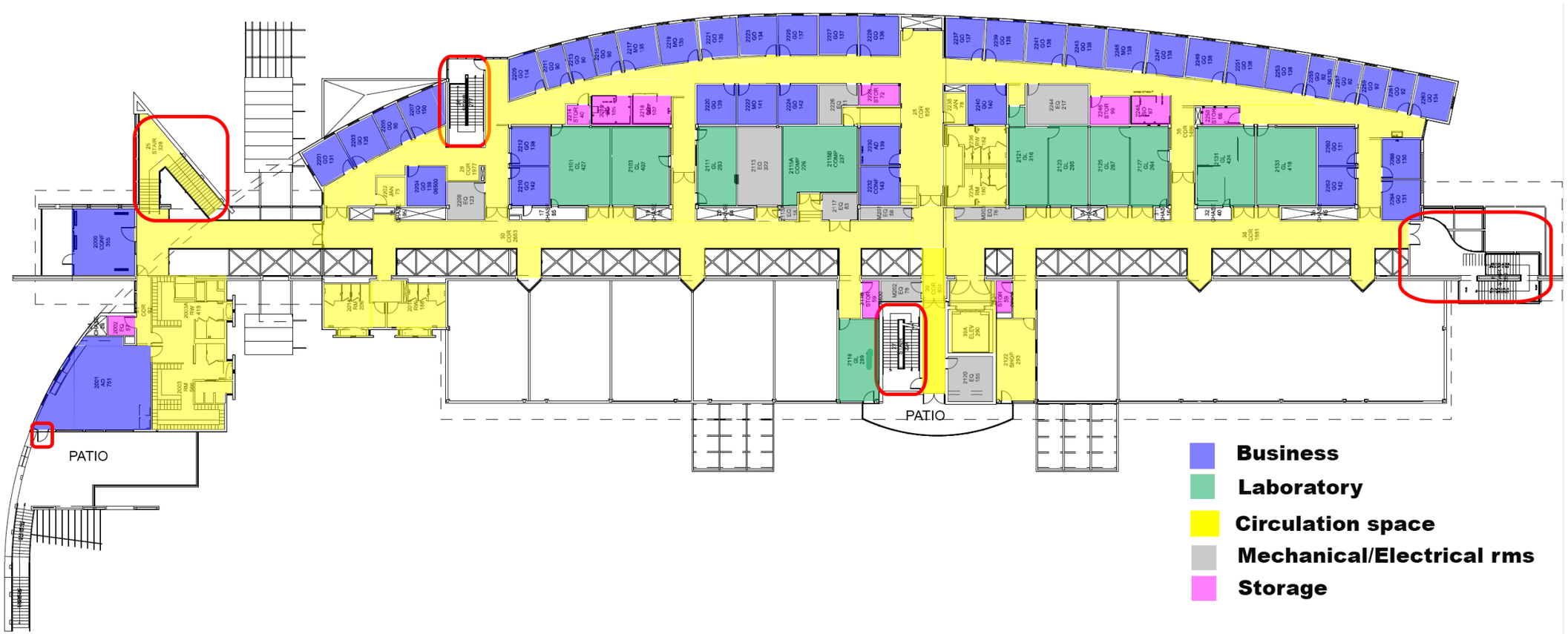

Figure 1-7. Occupancy designation and exits for the second floor

2 Structural Fire Protection

This section addresses the requirements for structural fire protection. Generally, provisions for structural fire protection are found in Chapter 4, 5, 6, and 7 of the 2012 IBC. Chapter 4 provides specific requirements for various occupancies, buildings types, and building features. Limitations on building heights, floor areas, and mixed occupancies are given in Chapter 5. Chapter 6 provides requirements for types of construction and Chapter 7 provides specific requirements for ensuring the building element is adequately fire rated.

RMSEL's construction type, fire resistance requirements for building elements, and fire separation for the various occupancies and atrium are addressed below.

2.1 RMSEL Construction Type

The requisite floor space, site location, desired use, and laboratory size requirements drove the design to a three-story building with a basement. RMSEL has been designed and constructed as Type II-B as defined by Table 601 of the IBC. The 1994 UBC defined the construction as Type II-N, which is the equivalent to II-B. This type of construction is noncombustible and does not require the building elements to be fire rated. Without any credit for fire suppression or frontage area, Table 503 limits Type II-B construction for a Business occupancy to a building height of 55 ft, floor areas of 23,000 ft^2, and a maximum of three floors.

An increase in height, floor area, and number of floors is allowable for RMSEL because it is equipped throughout with an approved automatic sprinkler system. Per Section 506.3 of the IBC, the building area can be increased and additional 200%, meaning the area could as much as 69,000 ft^2. The largest floor area of RMSEL is 36,000 ft^2 and is well below the 69,000 ft^2 maximum floor area.

An additional increase in building area for RMSEL could have also been allowed in accordance with Section 506.2, which states "where a building has more than 25 percent of the perimeter on a public way or open space having a width of not less than 20 ft, the frontage increase shall be determined in accordance with Equation 5-2." The north-south layout of RMSEL along 20th St SE and the open spaces next to the building means the See Figure 2-1 for an aerial photo depicting the open space along the perimeter of RMSEL.

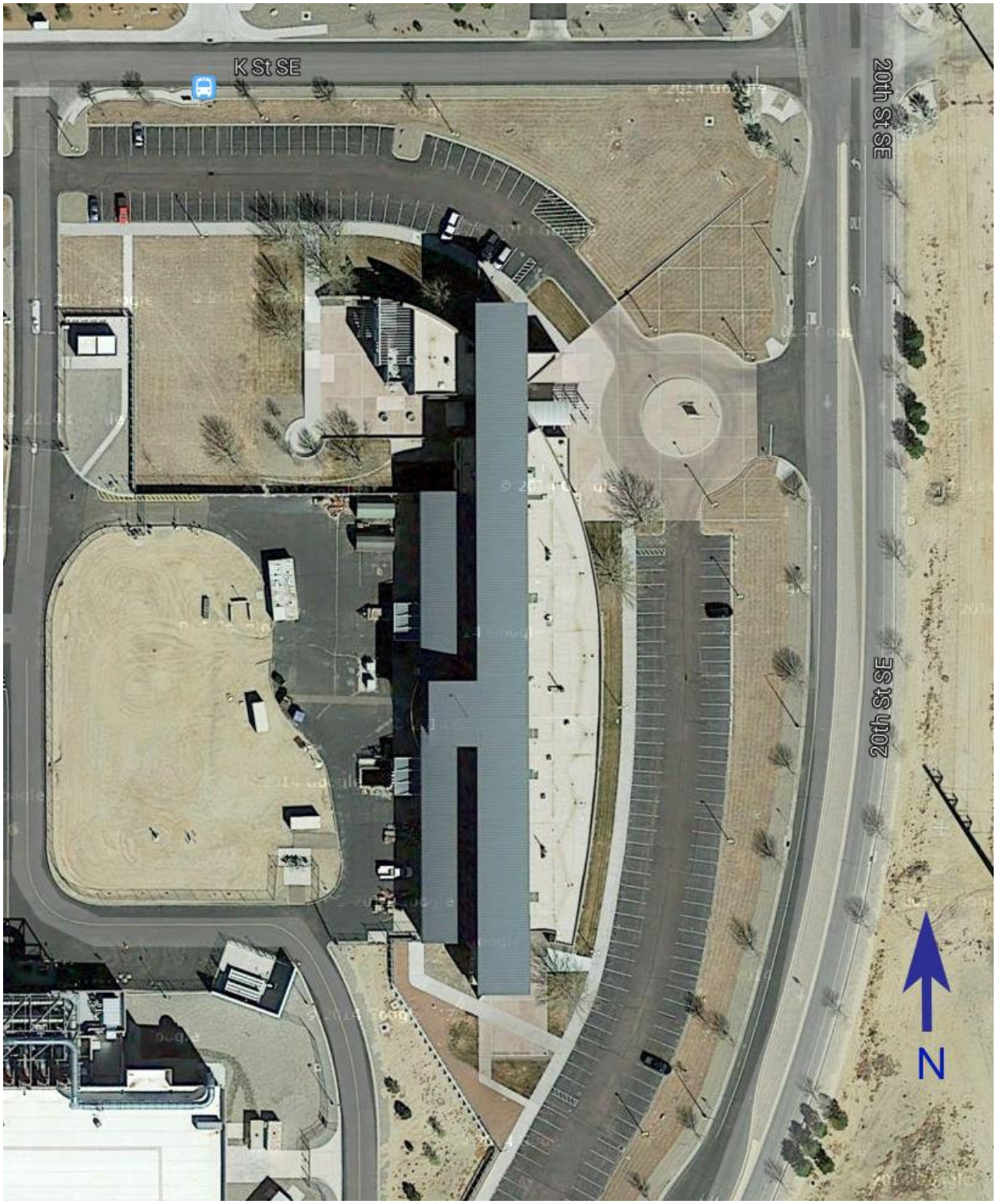

Figure 2-1. Aerial photo of RMSEL (image from Google Maps)

2.2 Fire Resistance Requirements for Elements

Requirements for fire resistance of structural elements are generally prescribed in Tables 601 and 602 as modified by the appropriate sections in Chapter 6 and elsewhere in the code.

RMSEL has been designed and constructed as a Type II-N (unprotected, noncombustible construction) similar to the IBC's Type II-B. Table 2-1 highlights the building elements that are considered in structural fire protection and the fire rating for Type II-B construction. It is important to note that other sections of the code require that some elements be rated. For example, the interior walls associated with the atrium is required to be 1-hour fire rated per Section 404.6 of the IBC.

Table 2-1. Fire resistance ratings from 2012 IBC Table 601 applicable to Type II-B

Building Element	Required Fire-Resistance Rating
Primary Structural Frame	0
Bearing walls Exterior Interior	 0 0
Nonbearing walls and partitions Exterior	0 0
Nonbearing walls and partitions Interior	 0
Floor construction and associated secondary members	0
Roof construction and associated secondary members	0

2.3 RMSEL Building Element Description

This section addresses the type of materials that have been used in RMSEL and also provides a brief explanation on how elements have been fire rated. Despite Type II-B construction, some of the elements may be protected with fire rated assemblies because other requirements of the model codes drove the protection.

Primary Structure

RMSEL's primary structure is made of steel. Wide-flange beams have been used for most columns, beams, and girders. Fire protection for columns is achieved through the use of boxing the column with 5/8 in. Type X gypsum. Structural tubing meeting the requirement of ASTM A-500, Grade B have been used in various areas throughout the facility.

Bearing walls and partitions

Bearing walls and partitions are generally constructed using a combination of wide flanged beams and structural tubing.

Floor construction and associated secondary members

The floor deck for the second and third floor are 2 in. deep, 18 gauge galvanized steel, with the deck connection to the supporting structure installed per the manufactures recommendations. Details about the concrete type and slab depth were unable to be determined, despite access to most of the project drawings.

Roof construction and associated secondary members

RMSEL roof consists of both flat and curved decks. The flat roof areas are constructed of 1-1/2 in. deep, 20 gage ribbed steel. The curved portion is 3 in deep, 20 gage galvanized deep rib Type 'N' deck (Ref. 6) These specifications were predicated on 3 span connections, implying heavier decking material may have been used if less than three connections were used.

2.4 Structural Fire Protection Code Compliance

RMSEL meets the intent of the requirements for Type II-B construction based on a review of construction documents. This is a difficult assessment to make since objective evidence is hidden and the as-built drawings are inconclusive. Wide-flanged beams account for most of the building elements with respect to primary structure.

The atrium mandates additional fire protection for the adjacent areas. Fire protection assessments, which are periodic walk-down of the facilities, have verified the 1-hour fire rating of the walls and fire doors. Periodic testing of the fire alarm system ensures that the magnetic door hold open devices are functional and release the doors upon an alarm.

Fire separation distance to other exposures is not an issue given the distance between the building and the roads on the north, east, and south sides. A large empty lot is to the west of the facility and will someday have something built upon it. Since it is all federal land, it will be important to remember the exterior fire resistance requirements for both the new structure and RMSEL.

3 Fire Suppression

This section evaluates the water based fire suppression system against the requirements of the 2012 IBC (Ref. 3) and NFPA 13-2013, *Standard for the Installation of Sprinkler Systems* (Ref. 7).

3.1 Water-Based Fire Suppression

The RMSEL is fully protected by two wet-pipe sprinkler systems. This is the only form of automatic fire suppression the RMSEL is equipped with. Two anti-freeze loops protect a ramp leading the basement and a canopy, which are each located on the east side of the building. The risers are divided into a north and south section as seen in Figure 3-1

Both the north and south riser are manifold systems that protect nine areas within RMSEL. The nine areas have been designed to two different density/area criteria. The two high bays have designed for an Extra Hazard (Group 1) at 0.30 gpm/ft^2 over 2,500 ft^2. Everything else, including the office spaces, has been designed as an Ordinary Hazard (Group 2) at 0.17 gpm/ft^2 over 3,000 ft^2. Table 3-1 has a description of each system and its accompanying design criteria.

Table 3-1. Riser coverage areas and design criteria

Area Protected	Design Density [gpm/ft^2]	Design Area [ft^2]	Sprinkler Head Coverage [ft^2]	Hose Stream [gpm]	Water Duration [min]	Total Water Demand [gal]*
System No 1A (North High Bay)	0.30	2,500	100	500	90	112,500
System No. 1B (North 1st & 2nd Floor offices)	0.17	3,000	130	250	60	76,500
System No. 1C (3rd Floor)	0.17	3,000	130	250	60	76,500
System No. 1D (1st Floor and North STP)	0.17	3,000	130	250	60	76,500
System No. 2A (South High Bay)	0.30	2,500	100	500	90	112,500
System No. 2B (STP-MID)	0.17	3,000	130	250	60	76,500
System No 2C (Basement)	0.17	3,000	130	250	60	76,500
System No. 2D (S 2nd & 3rd F offices)	0.17	3,000	130	250	60	76,500
System No. 2E (1st Floor South Offices)	0.17	3,000	130	250	60	76,500

* Sprinkler systems are supervised by the fire alarm system, which reports to a constantly attended location.

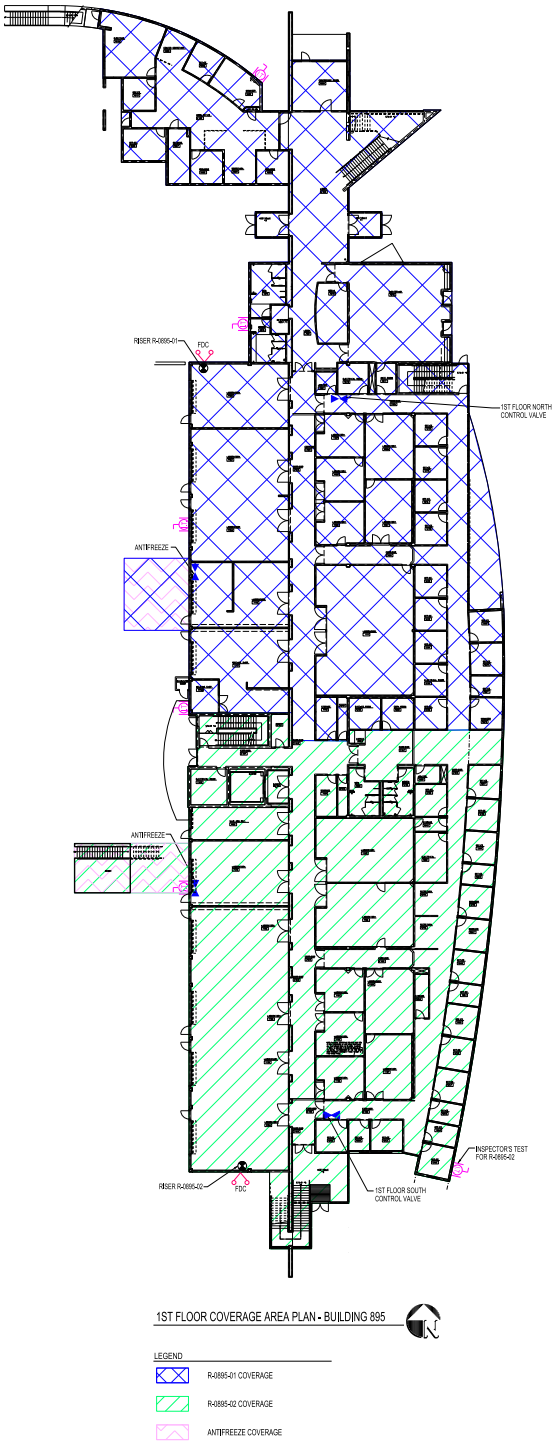

Figure 3-1. 1st floor riser coverage

Despite being a business occupancy, extra hazard was chosen for the high bays because at the time the building was designed the high bays were going to be used for robotic automobiles. This research never materialized or was discontinued sometime in the past. The high bays are not used in manner that warrants the Extra Hazard Group. They house workbenches, computer equipment, and various robotics. At times they will have foam plastics as they prepare to ship/receive prototypes for testing. The office spaces are typical and require light hazard.

The manifold riser approach appears to be a poor choice for this application as it requires each area to have an analysis of each of the remote locations. Unfortunately, the hydraulic evaluations of the nine areas are not retrievable so it is not clear what was evaluated. A traditional system would have required four evaluations, one of each high bay and one for the north and south section of the third floor. See Figure 3-2 for a layout of the north and south manifold.

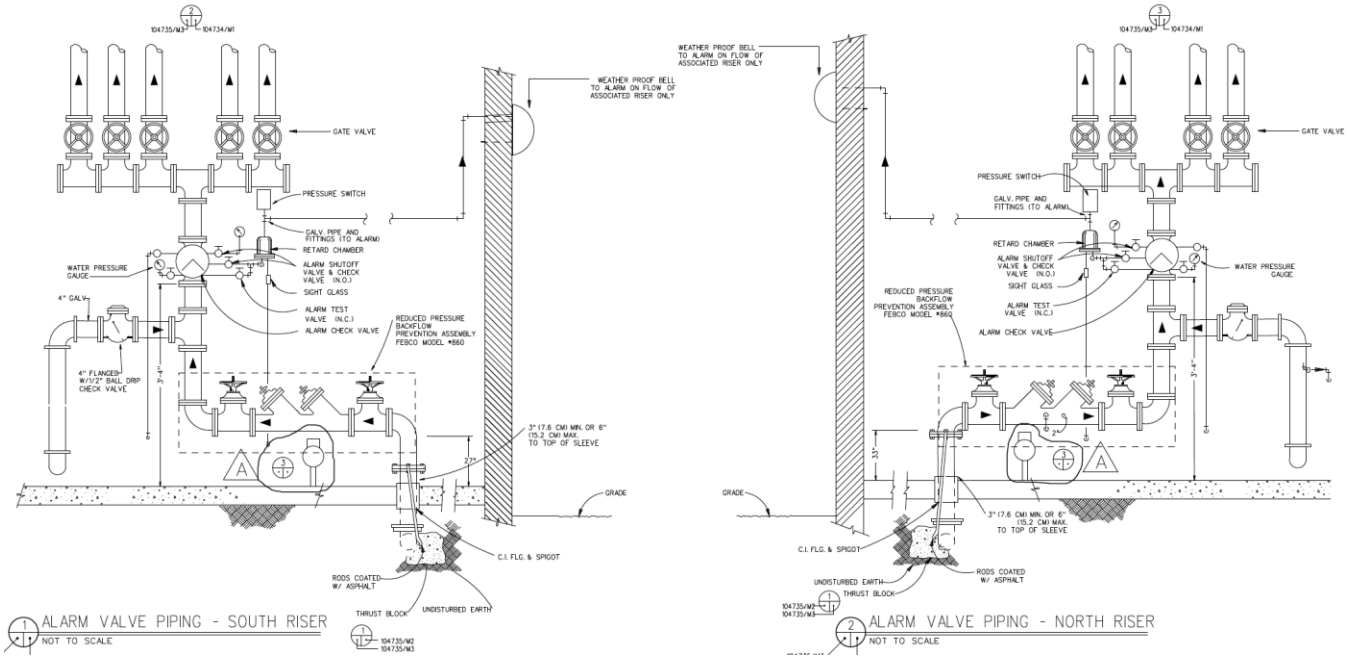

Figure 3-2. Manifold riser layout

3.2 Water Supply

RMSEL is sited on the main campus of SNL and has the benefit of a high volume water supply. Water supply serving RMSEL consists of a two U.S. Air Force owned gravity tanks, one with a 1,000,000 gallon capacity and the other with 500,000 gallon. The larger tank is approximately one mile from RMSEL and consists of 2,500 feet of 24 in diameter high-density polyethylene (HDPE) and 2,500 feet of HDPE that delivers water to an 8 in. PVC pipe that loops around RMSEL. A thousand feet of 12 in diameter HDPE and 1,500 ft of 10 in. diameter HDPE feed RMSEL water from the 500,000 gallon tank to the water loop. This is a gridded system around RMSEL. In addition to the water tanks RMSEL is feed by the City of Albuquerque, which is feed by three connection points on the gridded system. The minimum fire-flow and flow duration for RMSEL is

3,750 gpm for a duration of 3-hours based on Table B105.1 of the 2012 International Fire Code (IFC) (Ref. 8).

The last water test flow test in records was at 10:45 am on August 18, 2008. Given the data is out of date, a service request has been made for facilities to reevaluate the flows for this building. However, new data was not available in time for this report. The results of the flow test are for the southeast hydrant and are Table 3-2.

Table 3-2. Available water demand at southeast hydrant

Available Water	Outlet Diameter [in.]	Static [psi]	Residual [psi]	Coefficient	Pitot [psi]	Flow [gpm]
100%	4	85	80	0.90	37	2,613
85%	4	72	68	0.90	37	2,613

The number of fire hydrants required to serve RMSEL is four based on the Table C105.1 of the 2012 IFC and the required fire flow rate. Furthermore, the average spacing for hydrants should be less than 350 ft. See Figure 3-3 for the location of fire hydrants serving RMSEL. Given the proximity to RMSEL and RMSEL's approximate length of 410 ft implies the average distance less than the required average.

Figure 3-3. Fire hydrants near RMSEL

Since RMSEL is equipped with two risers, there are two points of connection to the water supply. The point of connection for the north riser is from the east in line with hydrant FH895NW and the south riser ties into the line that spans between the two southern hydrants. These lines are all part of the 8 in. loop around RMSEL.

3.3 Hydraulic Analysis

The manifold riser and complicated geometry of the facility requires evaluation of multiple hydraulically remote areas. Essentially, each riser from the manifold would need a hydraulic evaluation because each area is slightly different. Extended coverage sprinkler heads were used in the office spaces to limit piping and lower costs. Furthermore, the hydraulic calculations, sprinkler layout drawings for the third floor, and equipment submittals could not be retrieved for this building.

Each riser has a 6 in pipe of unknown schedule that rises through the floor and ties into a reduced pressure backflow preventer (RPBP), FEBCO Model 860. Six-inch line continues from the RPBP up to the fire alarm check valve. From the check valve the line enters a manifold where four riser on the north or five risers on the south branch out. With one exception, all lines leaving the manifold are 4 in. The exception is the south high bay, which has is fed from a 6 in. line.

For the purpose of this project, the hydraulic analysis will evaluated the water demand for the south high bay. The south high bay has been chosen since it is extra hazard group 1, and has an elevation that extends to the second floor RMSEL, approximately 34 ft on the east side of the bay. The ceiling is slanted and the branch line on the west end is approximately 29 ft. Four branch lines approximately 120 ft long and are spaced 10.5 ft apart. Sprinkler spacing along the branch lines is 8 ft. The end lines are approximately 2 ft and 7 in away from the wall. A layout of remote area is given in.

The protection area for each sprinkler is then

$$A_S = (10.5 ft)(8 ft) = 84 ft^2 \tag{3-1}$$

The protection area and sprinkler spacing of 15 ft meets the requirements of Table 8.6.2.2.1(c) of NFPA 13-2013. The number of sprinklers on the branch line is then

$$BranchLineSprinklers = \frac{1.2\sqrt{2500}}{8} = 8 sprinklers \tag{3-2}$$

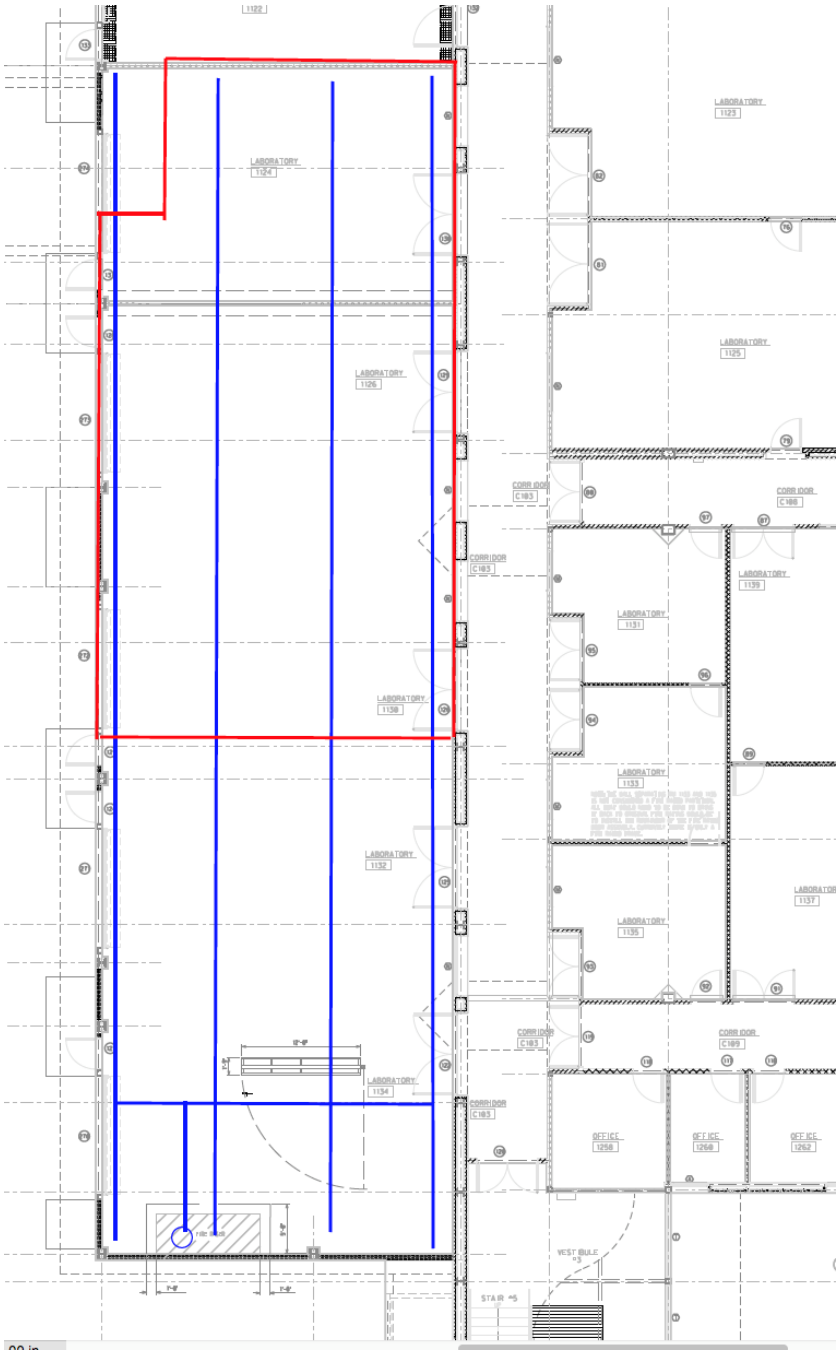

Figure 3-4. South high bay most remote area

The make and model of the sprinkler are unknown. However, the shop drawing indicate the sprinklers are 1/2 in. pendants and have an activation temperature of 160°F. For this analysis it is assumed the K-factor for the sprinklers are 5.6 and all pipe is schedule 40 new with a C-Factor of 120. The most hydraulically remote 2,500 ft^2 has 30 sprinklers, which means the west branch, which is closest to the riser will only have 6 sprinklers flowing. See the following screenshots for the analysis.

Building 895 - South Highbay																Date: 3/20/15	
Step No.	Nozzle Ident and Location	Flow in gpm		Pipe size	Pipe Fittings and Devices	Equivalent Pipe Length		Friction loss (psi/ft)		Pressure Summary		Normal Pressure				Notes	
1	1 BL-1	q	25.2	3		L	8	C=	120	Pt	20.3	Pt		k=		Q=84*0.3=25.2gpm	
						F				Pe		Pv					
		Q	25.2			T	8	pf	0.001	Pf	0.0	Pn		Pt=		P=(25.2/5.6)^2=20.3	
2	2 BL-1	q	25.2	3		L	8	C=	120	Pt	20.3	Pt		k=		q=5.6*(20.3)^0.5	
						F				Pe		Pv					
		Q	50.4			T	8	pf	0.004	Pf	0.0	Pn					
3	3 BL-1	q	25.2	3		L	8	C=	120	Pt	20.3	Pt		k=		q=5.6*(20.3)^0.5	
						F				Pe		Pv					
		Q	75.6			T	8	pf	0.008	Pf	0.1	Pn					
4	4 BL-1	q	25.3	3		L	8	C=	120	Pt	20.4	Pt		k=		q=5.6*(20.4)^0.5	
						F				Pe		Pv					
		Q	100.9			T	8	pf	0.014	Pf	0.1	Pn					
5	5 BL-1	q	25.3	3		L	8	C=	120	Pt	20.5	Pt		k=		q=5.6*(20.5)^0.5	
						F				Pe		Pv					
		Q	126.2			T	8	pf	0.021	Pf	0.2	Pn					
6	6 BL-1	q	25.4	3		L	8	C=	120	Pt	20.6	Pt		k=		q=5.6*(20.6)^0.5	
						F				Pe		Pv					
		Q	151.7			T	8	pf	0.030	Pf	0.2	Pn					
7	7 BL-1	q	25.6	3		L	8	C=	120	Pt	20.9	Pt				q=5.6*(20.9)^0.5	
						F				Pe		Pv					
		Q	177.3			T	8	pf	0.040	Pf	0.3	Pn					
8	8 BL-1 to CM@1	q	25.8	3	Tee 90 Elbow	L	45	C=	120	Pt	21.2	Pt				Branchline K factor K=Q/P^0.5 K=38.9	
						F	22			Pe	2.6	Pv					
		Q	203.0			T	67	pf	0.051	Pf	3.4	Pn					
9	CM@1 to CM@2	q	205.7	4		L	10.5	C=	120.000	Pt	27.2	Pt					
						F				Pe		Pv					
		Q	408.7			T	10.5	pf	0.049	Pf	0.5	Pn					
10	CM@2 to CM@3	q	221.5	4		L	10.5	C=	120.000	Pt	27.7	Pt					
						F				Pe		Pv					
		Q	630.2			T	10.5	pf	0.110	Pf	1.2	Pn					
11	CM@3 to 6in	q	167.5	6		L	3	C=	120.000	Pt	28.9	Pt				Pick up fourth BL. K Factor found in separate calc (31.5)	
						F				Pe		Pv					
		Q	797.7			T	3	pf	0.023	Pf	0.1	Pn					
12	6 in to hydrant	q	0.0	6	3 gate 1 check 4 tee 1RDBP	L	82	C=	120.000	Pt	28.9	Pt					
						F	161			Pe	12.1	Pv					
		Q	797.7			T	243	pf	0.023	Pf	5.6	Pn					
		q				L		C=		Pt	46.7	Pt					
						F				Pe		Pv					
		Q				T	0	pf		Pf		Pn					

Figure 3-5. Hydraulic analysis of south high bay

Building 895 - South Highbay, West branch without farthest 2 sprinklers															Date: 3/20/15	
Step No.	Nozzle Ident and Location	Flow in gpm		Pipe size	Pipe Fittings and Devices	Equivalent Pipe Length		Friction loss (psi/ft)		Pressure Summary		Normal Pressure			Notes	
1	3 BL-1	q	25.2	3		L	8	C=	120	Pt	20.3	Pt		k=		
						F				Pe		Pv				Q=84*0.3=25.2
		Q	25.2			T	8	pf	0.001	Pf	0.0	Pn		Pt=		P=(30/5.6)^2=20.3
2	4 BL-1	q	25.2	3		L	8	C=	120	Pt	20.3	Pt		k=		
						F				Pe		Pv				q=5.6*(41.3)^0.5
		Q	50.4			T	8	pf	0.004	Pf	0.0	Pn				
3	5 BL-1	q	25.2	3		L	8	C=	120	Pt	20.3	Pt		k=		
						F				Pe		Pv				q=5.6*(41.4)^0.5
		Q	75.6			T	8	pf	0.008	Pf	0.1	Pn				
4	6 BL-1	q	25.3	3		L	8	C=	120	Pt	20.4	Pt		k=		
						F				Pe		Pv				q=5.6*(41.5)^0.5
		Q	100.9			T	8	pf	0.014	Pf	0.1	Pn				
5	7 BL-1	q	25.3	3		L	8	C=	120	Pt	20.5	Pt		k=		
						F				Pe		Pv				q=5.6*(41.7)^0.5
		Q	126.2			T	8	pf	0.021	Pf	0.2	Pn				
8	8 BL-1 to CM@1	q	25.4	3	Tee 90 Elbow	L	45	C=	120	Pt	20.6	Pt				Branchline K factor
						F	22			Pe	0.4	Pv				K=Q/P^0.5
		Q	**151.7**			T	67	pf	0.030	Pf	2.0	Pn				K=31.6
		q				L		C=		Pt	**23.1**	Pt				
						F				Pe		Pv				
		Q				T		pf		Pf		Pn				

Figure 3-6. West branch line analysis - needed for different K-factor

The hydraulic analysis demonstrates the south high bay requires 798 gpm/ft^2 at a pressure of 45.7 psi. An addition 500 gpm is needed for the hose stream allowance. Water supply to the southwest hydrant is 2,163 gpm at 68 psi, which accounts for a 15% safety factor Sandia incorporates into its sprinkler specification. The water supply is capable of meeting the sprinkler system demand.

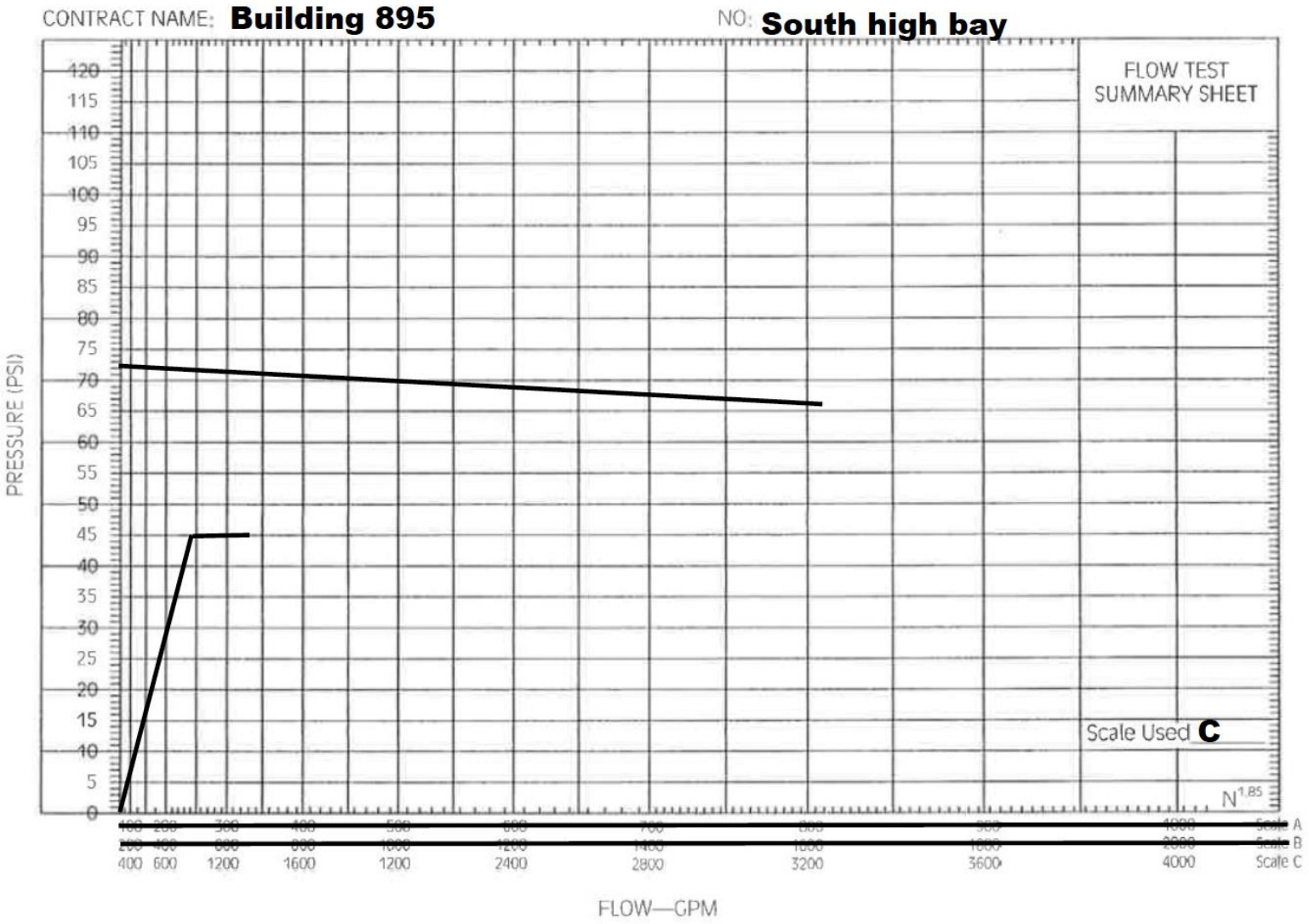

Figure 3-7. Water supply and sprinkler demand

3.4 Inspection, Testing and Maintenance

Sandia's Inspection, Testing, and Maintenance (ITM) program uses NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems* (Ref. 9) as the basis for its frequencies and required actions. In 2007 Sandia was granted an equivalency for changes inspection frequency associated with gauges (wet, dry, preaction, and deluge systems), valves (all types, including AFFF), and backflow prevention assemblies (reduced pressure) from monthly to quarterly to align with the quarterly test interval. As part of the 2007 equivalency, Sandia was allowed to change the inspection frequencies associated with hanger/seismic bracing, pipe and fittings, sprinklers, hose cabinets, and exposed water supply piping from annual to a 3 or 5 year interval depending on the fire protection assessment schedule for the building. A complete table listing the ITM for RMSEL wet-pipe suppression system is provided below.

Table 3-3. Sprinkler devices and associated ITM schedule

Sprinkler Component	Inspection	Testing	Maintenance
Backflow Preventer	Quarterly	Annually – Exercised by conducting a forward flow test	As needed
Control Valves	Quarterly – ensure normally open valves are open.	Annually – operated through full range and returned to its normal position	Annually – lubricate OSY valves; close and reopen to lubricate entire screw.
Check Valves	Interior every 5 years	NA	Internal components shall be cleaned, repaired, or replaced
Alarm check	Quarterly • Gauges indicate normal water pressure • Valve free of damage • Retarding chamber or alarm drains are not leaking 5 year – • Interior, verify strainers, filters, and restriction orficies are in good condition	NA	As needed
Waterflow alarm device/Signaling line Initiating Device	Quarterly – Verify that they are free of physical damage	Quarterly – Mechanical Semi-annual – Vane-type and pressure-type Tested by opening inspector's test connection	As needed
Valve supervisory	Quarterly – Verify that they are free of physical damage	Semi-annually	As needed

Sprinkler Component	Inspection	Testing	Maintenance
Gauges (wet pipe)	Quarterly – Ensure gauges are in good condition and that normal water supply is being maintained	5 years – Replaced or tested with calibrated gauge	As needed
Hydraulic nameplate	Quarterly – verify it is provided, attached securely to the sprinkler riser	NA	NA
Hanger/seismic bracing	3 or 5 year (depending on building) – Verify free from damage	NA	NA
Pipe and fittings	3 or 5 year (depending on building) – Verify in good condition and re of mechanical damage, leakage, and corrosion	NA	NA
Sprinklers	• 3 or 5 year (depending on building) • Verify in good condition and re of mechanical damage, leakage, and corrosion • Shall be installed in correct orientation • Escutcheons are present and installed correctly • Minimum distance to storage • Sprinkler obstructions	20 years – fast response sprinklers 50 years – sprinklers in service for 50 years shall be replaced or representative sample from on or more sample area shall be tested.	
Spare sprinklers	3 or 5 year– Correct number and type of sprinklers as required; a sprinkler wrench for each type of sprinkler	See sprinklers above	NA

Sprinkler Component	Inspection	Testing	Maintenance
Fire department connections	Quaterly – • Verify FDC is visible and accessible • Couplings or seivels are not damaged and rotate smoothly • Gaskets are in place and in good condition • Signs are in place • Auto drain valve in place and operating smoothly • FDC clappers are in place • Interior is free from obstructions	NA	NA
Obstruction, internal inspection of piping	Minimum 5 years – Inspect for the presence of foreign organic and inorganic material	NA	NA
Main Drain	NA	Annually – Determine if there has been a change to the water supply	NA

4 Fire Detection and Alarm

4.1 Types and Location of Fire Detection Devices

The fire alarm system is a Proprietary Supervising Station Alarm System. The fire alarm control panel (FACP) transmits alarm, supervisory, and trouble signals via dedicated telephone (POT) circuits to a dedicated server in a separate but on-site facility. Sandia Emergency Operations Center, Sandia's Protective Force, and KAFD each have monitors to the dedicated server and have personnel 24-hours a day, 365 days a year to process alarm signals. In the event of a fire, all these organizations respond. A monitor is also provided in the manager's office of Fire Protection Maintenance. Emergency response and maintenance monitor the supervisory and trouble signals.

An EST Quickstart QS4 serves as the FACP and annunciator. It is located on the south wall of the lobby of the main entrance, which is on the northeast side of the facility. The panel monitors approximately 140 input devices, such as smoke detectors and pull stations. Depending on the signal, the FACP will provide output signals to a variety of equipment (e.g., elevators, magnetic door holders) and notification appliances. The sequence of operations is shown in below in Figure 4-1.

4.2 Fire Detection Devices

The fire detection strategy for RMSEL is similar to many buildings used for general business, such as civic administration, print shops, and dentist offices. Since the facility is fully sprinkled, total coverage smoke detection is not required. The atrium portion of the building is required by the 1994 UBC to have smoke detection throughout. RMSEL meets this requirement as all corridors adjacent to the atrium have detection. One-hour fire rated barriers and corresponding fire doors with magnetic hold open devices separate the office and lab spaces from the atrium. The selection of detection devices that provide direct input to the FACP and indirect, such as sprinkler heads, provide redundancy and diversity. Each type of device is addressed below. The main source of data for this information is the fire alarm control panel schedule (Ref. 10), which is a Sandia maintained database that tracks each of the input and output devices, provides instructions for maintenance, and details the output of each device

4.2.1 Smoke Detectors

The largest number of devices connected to the FACP for any type of detection is smoke detectors. Approximately 52 detectors are installed in the facility. SNL underwent a revitalization project in 2006 that upgraded many of the building's FACPs, detection, and notification devices with EST products. The primary smoke detector in use at RMSEL is the EST Model SIGA-PS, a photoelectric detector. This addressable detector has a microprocessor that analyzes signals from the sensing element to historical data, which helps the detector determine if there is a fire. The detector is shown in Figure 3 1. EST photoelectric smoke detector, Model SIG-PS and a cut sheet is provided in Appendix A.

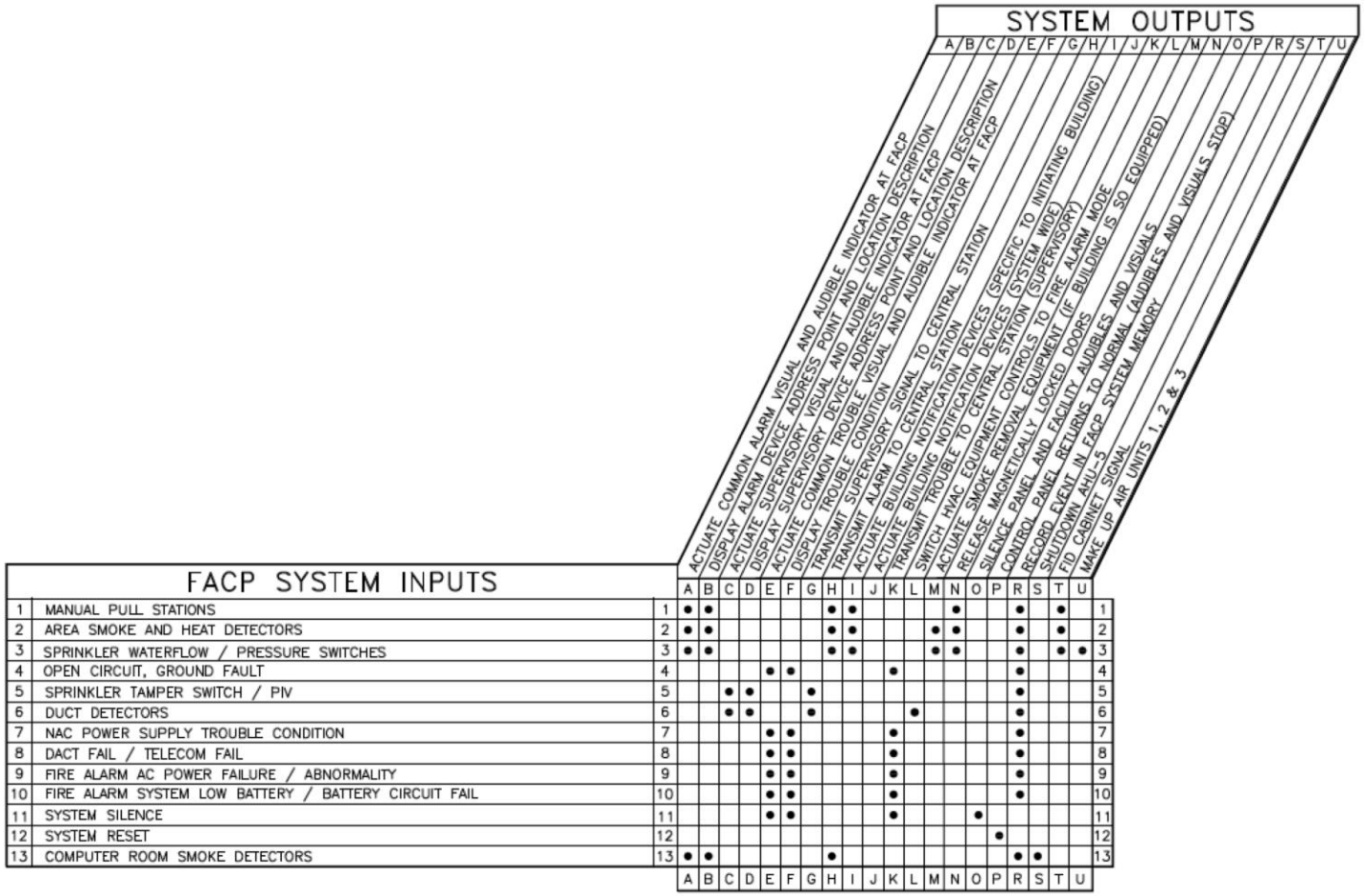

Figure 4-1. FACP Sequence of Operations (Ref. 11)

Figure 4-2. EST photoelectric smoke detector, Model SIG-PS (Ref.12)

4.2.2 Manual Pull Stations

The second largest number of devices connected to the FACP are manual pull stations. Approximately 35 EST SIGA-278 double action manual pull stations are provided throughout the facility. Appendix A contains the cut sheet for the device. The device is shown below.

Figure 4-3. EST SIGA-278 double action pull station (Ref. 13)

4.2.3 Heat Detectors

Four heat detectors are installed in RMSEL. Two are located in the freight elevator shaft and the others are installed in the penthouse electrical room and the basement elevator room. The heat detectors are EST SIGA-HRS, which are combination fixed temperature and rate of rise devices.

The UL listing space is 70 ft (Ref. 14). The cut sheet is provided in Appendix A, and a figure of the device is provided below.

Figure 4-4. EST SIGA-HRS combination heat (Ref.)

4.2.4 Duct Smoke Detectors

RMSEL uses four air-handling units (AHUs) to provide comfort air. Each AHU has a detector installed on the supply side and exhaust side. The reason for two detectors is due to the difference in requirements specified by the International Code Council (ICC) and NFPA. EST SD duct detectors are installed in the facility and when activated, result in a supervisory signal. See Appendix A and the figure below for more information.

Figure 4-5. EST SD duct detector (Ref.15)

Table 4-1. Fire detection alarm and prescriptive code analysis

No	Code Requirement	Disposition
	2012 IBC (Ref. 3)	
1	**Section 304.1 –** Business group B. Business Group B occupancy includes, among others, the use of a building or structure, or a portion thereof, for office, professional or service-type transactions, including storage of records and accounts.	RMSEL meets the definition for business occupancy.
2	**Section 404.3 –** Automatic sprinkler protection. An approved automatic sprinkler system shall be installed throughout the entire building.	**Meets requirement** RMSEL has an approved automatic sprinkler system.
3	**Section 404.4 –** Fire alarm system. A fire alarm system shall be provided in accordance with Section 907.2.14.	See disposition for 3A
3a	**Section 907.2.14 –** A fire alarm system shall be installed in occupancies with an atrium that connects more than two stories, with smoke detection installed through the atrium.	**Meets requirement** RMSEL has a fire alarm system with smoke detection installed in throughout the atrium and in all common areas, such as corridors and conference rooms.
4	**Section 404.5 – Smoke Control.** Smoke control system shall be installed in accordance with Section 909.	**Meets requirement** A full analysis of Section 909 is beyond the scope of this project. However, RMSEL is equipped with an active smoke control system.
5	**Section 907.2.2 Group B –** A manual fire alarm system shall be installed in Group B occupancies where one of the following conditions exist: (1) Occupant load of 500 or more, (2) Occupant load of is more than 100 persons above or below the lowest level of exit discharge, (3) the fire area contains an ambulatory care facility.	**Meets requirement** None of these conditions are applicable to RMSEL. However manual pull stations are located throughout the facility.
6	**Section 907.2.18.1 Smoke Detectors –** A minimum of one smoke detector listed for the intended purpose shall be installed in the following areas: 1. Mechanical equipment, electrical, transformer, telephone equipment, elevator machine or similar. 2. Elevator lobbies 3. The main return and exhaust air plenum of each air-condition system serving more than one story and located in a serviceable area downstream of the last duct inlet. 4. Each connection to a vertical duct or riser serving two more floors from return air ducts or plenums of heating, ventilating and air-conditioning systems, except in Group R occupancies…	**Meets requirement** Basis – Fire alarm upgrade drawings 1. Smoke detectors are installed in basement mechanical room, electrical rooms, telephone equipment room, and elevator shaft. 2. Smoke detection is provided in elevator lobbies. 3. Main return and supply are equipped with duct detection 4. Unable to confirm if requirement is met.

No.	Code Requirement	Disposition
	2012 IBC (continued)	
7	**Section 917.18.2 Alarm required –** Activation of the smoke control system shall activate an audible alarm at a constantly attended location.	**Meets requirement** RMSEL has a fire alarm system that is transmits an alarm to three constantly attended locations.
8	**907.4.1 Protection of Fire Alarm Control Unit.** In areas not continuously occupied, a single smoke detector shall be provided at the location of each fire alarm control unit, notification appliance circuit power extenders, and supervising station transmitting equipment.	**Does not meet** Smoke detectors are not installed in the immediate vicinity of the FACP nor the notification appliance circuit (NAC) power extenders.
9	**907.4.2.1 Location –** Manual fire alarm boxes shall be located not more than 5 feet from the entrance to each exit.	**Meets requirement** RMSEL is equipped with 35 manual pull stations. A review of the fire alarm drawings shows the pull stations have been installed at the proper locations.
	NFPA 101-2012, Life Safety Code	
10	**6.1.11.1 Definition – Business Occupancy.** An occupancy used for the transaction of business other than mercantile.	RMSEL is classified as a business occupancy.
11	**9.6.2.3** – A manual fire alarm box shall be provided by as follows, unless modified by another section of this Code. 1) For new alarm installations… 2) For existing alarm system installations, the manual fire alarm box either shall be provided in the natural exit access path near each required exit or within 60 in. of exit doorways.	**Meets requirement** RMSEL is equipped with 35 manual pull stations. A review of the fire alarm drawings shows the pull stations have been installed at the proper locations
12	**9.6.2.5** - Additional manual fire alarm boxes shall be located so that, on any given floor in any part of the building, no horizontal distance on that floor exceeding 200 ft shall need to be traversed to reach a manual fire alarm box	**Meets requirement** A review of the fire alarm upgrade project drawings supports the position that the pull stations are located according to code.
13	**9.6.2.7 -** Each manual fire alarm box on a system shall be accessible, unobstructed, and visible.	**Design meets requirement** This requirement is difficult to confirm. The locations of boxes on drawings provides evidence of meeting this requirement. However, a complete field verification ensuring that the boxes are unobstructed from furniture and other transient items has not been performed.
14	**9.6.2.8 –** Where a sprinkler system provides automatic detection and alarm system initiation, it	**Meets requirement**

No.	Code Requirement	Disposition
	shall be provided with an approved alarm initiation device that operates when the flow of water is equal to or greater than that from a single automatic sprinkler.	Each riser has multiple flow switches and pressure switches.
15	**39.3.4.1 General –** A fire alarm system in accordance with section 9.6 shall be provided in all business occupancies where any one of the following conditions exists: 1. The building is three or more stories in height	**Meets requirement** RMSEL is three stories in height and is provided with an automatic
	NFPA 72-2013	
16	**17.4.5** Initiating devices shall be installed in all areas, compartments, or locations where required by other governing laws, codes, or standards.	**Meets the requirement** The IBC states the fire detection system is required only for the portion of the building adjacent to the atrium, implying the system can be a partial coverage system since the facility has an approved fire suppression system installed throughout the facility.
17	**17.5.3.2 Partial or Selective Coverage.** Where other governing laws, codes, or standards require the protection of selected areas only, the specified areas shall be protected in accordance with this code.	RMSEL has partial coverage smoke detection.
18.	**17.6.3.1.1 Spacing –** Spacing shall not exceed their listed spacing and there shall be detectors within a distance of one-half the listed spacing, measured at right angles for all walls or partitions extending upward to within the top 15 percent of the ceiling height.	**Does not meet the requirement** This requirement is difficult to confirm since RMSEL only requires partial coverage. Smoke detectors in the corridor are spaced further than their listed spacing.
19	**17.6.3.1.3.1** Unless otherwise modified by 17.6.3.2.2, 17.6.3.3.2, or 17.6.3.7, spot-type heat-sensing fire detectors shall be located on the ceiling not less than 4 in. from the sidewall or on the sidewalls between 4 and 12 in. from the ceiling.	**Meets the requirement** Smoke detectors are mounted to the drop down ceiling and are typically located in the center of the corridor.
20	**17.6.3.5.1 (High ceilings) –** On ceilings 10 ft to 30 ft high, heat detector spacing shall be reduced in accordance with Table 17.6.3.5.1 prior to any additional reductions for beams, joists, or slope, where applicable.	**Does not meet the requirement** This requirement is difficult to confirm. The drop down ceiling height is approximately 10 ft. However, detector spacing based on scaling of the drawings is approximately 45 ft. The listed spacing is 30 ft for the smoke detectors. No reduction for ceiling height has been made.
21	**17.5.4.2.1 Supply Air System –** Where the detection of smoke in the supply air system is required by other NFPA standards, a detector(s) listed for the air velocity present and that is	**Meets the requirement** This requirement is difficult to verify. The

No.	Code Requirement	Disposition
	located in the supply air duct downstream of both the fan and the filters shall be installed.	mechanical ducting for a good portion of the facility is hidden. However, the FACP schedule indicates there are eight duct detectors for four AHUs. The device names indicate a detector is provided on for both the supply and exhaust.
22	**17.5.4.2.2 Return Air System –** Unless otherwise modified by 17.5.4.2.2(A) or 17.7.5.4.2.2(B), if the detection of smoke in the return air system is required by other NFPA standards, a detector(s) listed for the air velocity present shall be located where the air leaves each smoke compartment, or I the duct system before the air enters the return air system common to more than one smoke compartment.	**Meets the requirement** See disposition to 21.
23	**17.7.5.6.1** – (Door releasing) Smoke detectors shall be of the photoelectric, ionization, or other approved type.	**Meets the requirement** RMSEL uses approved photoelectric detectors.
24	**17.7.5.6.5.1** If doors are to be closed in response to smoke flowing in either direction, the requirements of …(A) through...(D)	**Meets the requirement** Smoke detectors are not provided on each side of the doorway.

The prescriptive code analysis results in several deficiencies. However, most of these requirements are for complete coverage, which is not applicable when the facility is fully sprinklered. It is clear the designers are relying on the automatic sprinkler system to protect the occupants and assets.

4.3 Fire Alarm System and Disposition of Signals

The fire alarm system for RMSEL is a proprietary supervising station. RMSEL is equipped with an EST Quickstart QS4-12 FACP that communicates alarm, supervisory, and trouble signals to a central station. Alarm signals are immediately relayed to the Sandia Emergency Operations Center, Sandia Protective Force, and Kirtland Air Force Fire Department. Kirtland provides all manual fire fighting capability for SNL. Each of these three entities will respond to a fire alarm. Signals are also transmitted to the manager's office of Fire Protection Maintenance. Maintenance will respond to all signals and assist the emergency forces as needed.

Consistent with NFPA 72-2010, alarm signals are immediately transmitted to all the emergency forces. Sandia Protective force is usually first on scene and will provide access to the facility. KAFD and Sandia Emergency Response will arrive and be prepared for fire fighting, technical rescue or advanced life support. If the alarm is during the occurs from 6:00 am to 12:00 am, facilities will immediately respond. Outside of those hours, facilities personnel will be notified and will be present within 2 hours to assist. The facility owner (i.e., RMSEL facility staff) will also be notified and may be expected to respond depending on the condition. Section 26.6.1 of NFPA-72-2008 states, with a couple of exceptions, all fire alarm signals received by a supervising station shall be immediately retransmitted to the to the communications center. Sandia meets this requirement because alarm signals are automatically transmitted to KAFD.

Supervisory signals will prompt the EOC to notify facilities personnel to investigate. If the supervisory signal is during off hours, the EOC will dispatch a member to investigate. This will require coordination with Security to gain access into the building. If the supervisory is promptly restored, no further action is required.

Trouble signals will be relayed to facilities personnel from the EOC. The nature of the trouble and the restoration of the signal will dictate the response. There are known troubles that occur due to testing of the telephone lines. There are also known bugs that are in the process of being resolved. If a new trouble comes in during normal hours, maintenance will respond. Outside of business hours, EOC may send a member out or wait for maintenance.

4.4 Types and Locations of Alarm Notification Devices

RMSEL is equipped with 112 notification appliance devices to ensure that personnel are notified to an alarm. The notification devices consist of horns, strobes, and combination bell and strobes. The devices used in the facility are discussed below.

4.5 Strobes

Forty-nine Wheelock RSS-24MCW-FR multi-candela strobes are installed throughout the facility. Specific locations include stairwells, restrooms, break rooms, and large conference room. Cut sheet is provided in Appendix A.

4.6 Horns

Seven horns are provided in RMSEL. Horns have been installed in the machine shops, basement equipment room and outside of some laboratories. The horns are Wheelock MT-12/24. A cut sheet is provided in Appendix A.

4.7 Horn and Strobe Combinations

Fifty-six Wheellock MT-24MCW-FR multi horn/strobe combination devices are installed. These devices are located in all common areas, such as corridors, break rooms, and conference rooms.

4.8 Notification Appliance – Location, Spacing, and Placement

An evaluation of the location, spacing, and placement of the notification appliance against the requirements of NFPA 72-2013 is provided in Table 4-2. The justification for using the 2013 edition of the code is learn about new requirements, understand changes in the requirements, and determine if the system should be modified to help ensure Sandia is achieving the status of highly protected risk.

4.9 Mass Notification Systems

RMSEL is not equipped with a mass notification system.

4.10 Secondary Power Supply Requirements

Section 10.6.7.2 of NFPA 72-2013 provides the power requirements for secondary power capacity. Specifically, "The secondary power supply shall have sufficient capacity to operate the system under quiescent load (system operating in a nonalarm 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 other permitted or required by the following…"

RMSEL does not have an ECS and, with one exception, the additional requirements do not apply. The one exception is the batter calculations shall include a 20 percent safety margin to the calculated amp-hour rating.

A battery capacity calculation is provided below. This analysis has been limited to the devices powered by the FACP. Four notification appliance circuits (NACs) are utilized to power the appliances. Notification appliances are provided power using Copper Wheelock PowerPath PS-8 power limited 8-ampere power supply/charger with batteries that serve as secondary power. The Building 895 FACP Panel Schedule (Ref. 10) is the primary source for determining which devices rely on the FACP for power. The analysis is provided on the next page.

The calculated battery capacity is 8.04 amp-hours. The EST Quickstart QS4 FACP has a 40 amp-hour capacity per the cut sheet, implying it is sufficient.

Table 4-2. Evaluation of RMSEL against the requirements of NFPA 72-2013

No.	Code Requirement	Disposition
1	**18.4.1.1** – An average ambient sound level greater than 105 dBA shall require the sue of a visible notification appliance(s) in accordance with section 18.5 where the application is public mode.	**Meets the requirement** Strobes are provided near machine shops and labs, in addition to the combo horn/strobes that are located throughout the facility.
2	**18.4.1.2** - The total sound pressure level produced by combing the ambient sound pressure level with all audible notification appliances operating shall not exceed 110 dBA at the minimum hearing distance.	**Meets the requirement.** Sound pressure levels (SPLs) were measured throughout the facility during the acceptance testing. SPLs did not exceed the requirement.
3	**18.4.1.3 –** Sound from normal or permanent sources, having duration greater than 60 seconds, shall be included when measuring maximum ambient sound level. Sound from temporary or abnormal sources shall not be required to be included when measuring maximum ambient sound level.	**Meets the requirement.** Several equipment rooms and laboratories required measuring 60 seconds worth of data.
4	**18.4.3.1 –** To ensure that audible public mode signals are clearly heard, unless otherwise permitted by 18.4.3.2 through 18.4.3.5, they shall have sound level at least 15 dB above the average ambient sound level or 5 DB above the maximum sound level having a duration of at least 60 seconds, whichever is greater, measured 5 ft above the floor in the area required to be served by the system using the A-weighted scale (dBA).	**Meets the requirement** Acceptance test shows that SPLs to be 15 dBA higher than commonly accepted values of ambient noise for office space, restrooms, etc.
5	**18.4.8.1 –** If ceiling heights allow, and unless otherwise permitted by 18.4.8.2 through 18.4.8.5, wall-mounted appliances shall have their tops above the finished floors at heights of not less than 6 in.	**Unable to verify** The majority of devices are horn/strobe combos that have separate requirements.
6	**18.5.5.1 –** Wall mounted appliances shall be mounted such that the entire lens is not less than 80 in. and not greater than 96 in. above the finished floor or at the mounting height specified using he performance-based alternative of 18.5.5.	**Meets the requirement** A fire protection assessment performed in 2006 did not identify any findings with respect to this requirement.
7	**18.5.5.2 –** Where low ceiling heights do not permit wall mounting at a minimum of 80 in., wall mounted visible appliances shall be mounted within 6 in. of the ceiling. The room size covered by a strobe of a given value shall be reduced by twice the difference between the minimum mounting height of 80 in. and the actual lower mounting height.	**Meets the requirement.** See disposition to number 6.

4-2. Evaluation of RMSEL against the requirement of NFPA 72-2013 (continued)

No.	Code Requirement	Disposition
8	**18.5.5.4 –** Spacing shall be in accordance with either Table 18.5.5.4.1(a) and Figure 18.5.5.4.1 or Table 18.5.5.4.1(b).	**Meets the requirement** The large conference has two devices with adjustable candela settings, which exceeds the requirement for the type of room it is. The large super lab has 8 horn/strobe devices and also exceeds the requirements.
9	**18.5.5.5.1 –** The installation of visible notification appliances in corridors 20 ft or less in width shall be in accordance with requirements of 18.5.5.4 or 18.5.5.5.	Noted.
10	**18.5.5.5.3 –** In a corridor application, visible appliances shall be rated not less than 15 cd.	**Meets the requirement** Sandia does purchase equipment with less than 15 cd.
11	**18.5.5.5.5 –** Visible notification appliances shall be located not more than 15 ft from the end of the corridor with a separation not great than 100 ft between appliances.	**Meets the requirement** A review of the fire alarm system upgrade project drawings show that the strobes are approximately 75 ft with more in areas where the corridor are curved. Devices are located near the end of the corridors.
12	**18.5.5.5.6 –** If there is an interruption of the concentrated viewing path, such as a fire door, an elevation change or any other obstruction, the area shall be treated as a separate corridor.	**Meets the requirement.** See disposition to number 11.
13	**18.5.5.7 -** In corridors where more than two visible notification appliances are in any field of view, they shall flash in synchronization.	**Not verified** The power supplies have the ability to support this feature.
Conclusions – The fire alarm and detection system in RMSEL generally meets the requirements of the 2013 version of the code.		

4.11 Inspection, Testing, and Maintenance

Sandia has implemented an Inspection, Testing, and Maintenance (ITM) program for fire alarm systems. The types of devices associated with 895 undergo an annual ITM. This frequency is based on Chapter 14 of NFPA 72.

A fire alarm database is maintained by the fire protection staff that identifies all the devices associated with each building FACP. The Panel Schedule provides a complete listing of this data, along with the logic and output functions. A "maintenance" query of the report will produce a checklist and instructions for testing all the devices. Some of the fields are automatically populated, such as battery age. The checklist is filled out by the maintenance staff, and then is scanned and placed into a document management system.

Table 4-3. Required battery capacity

Item	Description	Standby Current Per Unit (AMPS)		QTY		Total Standby Current (AMPS)	Alarm Current Per Unity (AMPS)		Qty		System Alarm Current (AMPS)
A	Duct Detector	0.000045	x	8	=	0.00036	0.018	x	8	=	0.144
B	Heat Detector	0.000045	x	4	=	0.00018	0.018	x	4	=	0.072
C	Pull Station	0.00025	x	35	=	0.00875	0.0004	x	35	=	0.014
D	Smoke Detector	0.000045	x	54	=	0.00243	0.018	x	54	=	0.972
E	Control Modules	0.001	x	28	=	0.028	0.001	x	28	=	0.028
F	Isolator Modules	0.000045	x	4	=	0.00018	0.000045	x	4	=	0.00018
G	Sprinkler Modules	0.000396	x	22	=	0.008712	0.00068	x	22	=	0.01496
H	Horn/strobe	0.033	x	1	=	0.033	0.96	x	1	=	0.96
I	FACP Power Card	0.072		1		0.072	0.096	x	1	=	0.096
J	FACP CPU/LCD	0.117		1	=	0.117	0.135	x	1	=	0.135
		Total System Standy Current (AMPS)				0.270612	Total Sytem Alarm Current (AMPS)				2.43614

Required Operating Time of Secondary Power Source From NFPA 72, Section 10.6.7.2.1

Standby 24 Hourse Alarm 5 Minutes/60 0.083333333

Required Standby Time (Hours)		Total System Standby Current (AMPS)		Required Standby Capacity (Amp-Hours)	Required Alarm Time (Hours)		Total System Alarm Current (AMPS)		Required Alarm Current (Amp-Hours)
24	x	0.270612	=	6.494688	0.083333333	x	2.43614	=	0.203011667

Required Standby Capacity (Amp-Hours)		Required Alarm Capacity (Amp-Hours)		Total Required Capacity (Amp-Hours)		Factory of Safety		**Required Battery Capacity (Amp-Hours)**
6.494688	+	0.20301167	=	6.697699667	x	1.2	=	**8.0372396**

Before work begins, the FACP is put into No Action Mode, implying the system will not activate the alarm. The devices are then inspected and tested per the manufacturer's instructions or the requirements of NFPA 72. For example, smoke detectors are typically tested with an aerosol that results in an alarm and signal to activate the NACs. These signals are verified at the central station as objective evidence of performing the work. Commissioning the system is similar to the annual tests.

If maintenance observes any issues with the system, they notify the fire protection staff. Fire protection will investigate and will resolve issues, typically with maintenance help.

5 Means of Egress

This section addresses prescriptive requirements for the means of egress. The requirements evaluated below are primarily from Chapter 10 of the IBC and Chapter 7 of the LSC.

5.1 Occupant Load

The first and second floors of RMSEL are the occupied spaces of the building. The basement is a large mechanical equipment room that is typically unoccupied, except for maintenance of equipment. During maintenance activities, the likely number of occupants would be two. For the purpose of the occupant load calculation, the basement is assumed to have zero occupants. The same is true for the third floor, which houses the smoke removal systems and air handler units (AHUs) for the building. Figure 5-1 is a photo of the basement.

Figure 5-1. RMSEL basement

The bases for determining the occupant load are the IBC and LSC. Each provide an occupant load factor or maximum floor area allowance per occupant that is premised on the use of the space. For example, the IBC specifies 100 ft^2 per person in a business occupancy, which is the same as the LSC occupant load factor (OLF) for business. A 1,000 ft^2 business occupancy would then have 10 occupants.

The occupant load factors and floor area allowances applicable to the RMSEL are summarized Table 5-1. Occupant load calculation evaluated each space individually since the facility has multiple occupancies.

Table 5-1. Occupant load factors and floor area allowances

2012 LSC		2012 IBC	
Occupancy Classification	**OLF [ft^2/person]**	**Function of Space**	**Floor Area Allowance [ft^2/person]**
Assembly Use – Less concentrated use, without fixed seating	15 net	Assembly without fixed seats, unconcentrated (tables and chairs)	15 net
Business (other than Air Traffic control tower observation levels)	100 gross	Business Areas[1]	100 gross
Industrial Use – General and high-hazard industrial	100 gross		

Note: 1 – IBC business areas include research and development laboratories

Appendix B provides the spreadsheet summaries for the occupant load calculation. The following table provides a summary of the occupants and floor space. The floor areas are per the Sandia space charge back maps (i.e., maps depicting the organization assigned to the specific space). The load calculation took a conservative approach by assuming all spaces were occupied, including equipment rooms. It is unlikely that all spaces would be occupied to their maximums because the occupants of cannot be in their office, laboratory, and break rooms at the same time. Conference rooms are an exception because people external to RSMEL can be attending a meeting or training.

Table 5-2. Occupant load and associated floor space

	1st Floor	2nd Floor	Total
Occupants			
Occupants	362	204	566
Assembly			202.8666667
Office Space			146.21
Industrial			228.16
		Total	**578**
Floor Area			
Assembly [ft2]	1805	1238	3043
Office Space [ft2]	7282	7339	14621
Industrial [ft2]	16915	5901	22816
		Total	40480

5.2 Exit Capacity

The LSC and IBC use similar factors for determining the exit capacity of a means of egress component. Table 7.3.3.1 of the LSC specifies 0.3 in. of width/person for stairways and 0.2 in. of

width/person for level components and ramps. Section 1005.3.1 and 1005.3.2 provide the same values for the same components.

Twenty-two doors provide an exit from the RMSEL facility to the outside. Eleven of the doors serve the large laboratory spaces on the east side. The two assembly areas each have an exit to the outside. Table 5-3 provides the exit capacity for the first floor assuming all door leafs are 32 in. wide. Corridors serving the exits are larger than the doors, implying the doors are the pinch point. The exit capacity of the first floor is much larger than the occupant load.

Table 5-3. First floor exit capacity

Type of Door	Quantity	Width [in.]	Capacity Factor [in./occupant]	Capacity [occupants]
Double Leaf	4	64	0.2	1,280
Single Leaf	18	32		2,880
				4,160

The second floor has much less exit capacity than the first floor. Five doors are provided to allow occupants to exit. Table 5-4 provides the exit capacity based the assumptions shown for the width of stairs and doors. A walk-down of the facility on 12/10/2013 confirmed that the doors are typically larger than 32 in. Nonetheless, the exit capacity is greater than the occupant load for the second floor.

Table 5-4. Second floor exit capacity

Door Location	Type of Component	Width [in.]	Capacity Factor [in./occupant]	Capacity [occupants]
NW break room	Single Leaf Door	32	0.2	**160**
	Stairs	44	0.3	246
Monumental Stairs	Double Leaf Door	64	0.2	220
	Stairs	44	0.3	**160**
East Stairwell	Single Leaf Door	32	0.2	160
	Stairs	44	0.3	**146**
West Stairwell	Single Leaf Door	32	0.2	160
	Stairs	44	0.3	**146**
South Vestibule	Double Leaf Door	64	0.2	220
	Stairs	44	0.3	**160**
Total (summation of minimum capacity from all locations)				**772**

5.3 Number of Exits

Section 7.4.1.2 of the LSC states:

The number of means of egress from any story or portion thereof, other than for existing buildings as permitted in Chapters 11 through 43, shall be as follows:

(1) Occupant load more than 500 but not more than 1000 – not less than 3

(2) Occupant load more than 1000 – not less than 4.

Section 1015.1.1 of the IBC states:

Three or more exits or exit access doorways shall be provided from any space with an occupant load of 501 to 1,000. Four exits or exit access doorways shall be provided from any space with an occupant load greater than 1,000.

The first floor of has an occupant load of 362 persons and requires a minimum of two exits. An occupant load for the second floor of 204 persons requires two exits as well. RMSEL has a minimum of four exits for each floor that does not require special access. Therefore, RMSEL meets the number of exits requirement.

5.4 Arrangement of the Means of Egress

Section 7.5.1.1 states that exits shall be located, and exit access shall be arranged, so that exits are readily accessible at all times. RMSEL is equipped with multiple exits that are spread out. The layout and number of exits allow RMSEL to meet the requirement. Exit enclosure stairwells ensure that occupants on the second floor have continuous passageways to the exits.

5.4.1 Remoteness of exits

The remoteness of the exits is critical for ensuring the occupants have opportunities to exit the building in the event that a single exit is lost. RMSEL has an approved automatic sprinkler system installed throughout the facility. Section 7.5.1.3.3 states:

buildings protected throughout by a supervised, automatic sprinkler system in accordance with Section9.7, the minimum separation distance between two exits, exit accesses, or exit discharges, measured in accordance with 7.5.1.3.2, shall be not less than one-third the length of the maximum overall diagonal dimension of the building or area to be served.

RMSEL has exits located on each end of the building, implying the distance between the exits is greater than one-third the building diagonal. Therefore, RMSEL meets this requirement. It should be noted that the Assembly occupancy with greater than 50 occupants also meets this requirement as exit doors are located near each corner of the space.

Exit remoteness and capacity ensures that a loss of a single exit does not exceed 50% of the exit capacity of the building.

5.4.2 Dead-Ends

Table A.7.6 of the LSC states dead-ends cannot exceed 50 ft of travel for sprinkled general hazard industrial occupancies. All dead ends are less than 50 ft based on a review of the floor plan, the latest Fire Protection Analysis (FPA – comprehensive evaluation of the building's fire protection system and means of egress, and the FHA (Ref. 5).

5.4.3 Common Path of Travel

Table A.7.6 of the LSC specifies a common path limit of 100 ft for general industrial facilities equipped with a supervised, approved automatic fire suppression system. Due to the number of exits in the facility, the common path of travel is approximately 10 to 40 ft based on the size room the occupant is in. RMSEL meets this requirement.

5.4.4 Travel Distance

Table A.7.6 of the LSC mandate a maximum travel distance of 250 ft for buildings with a supervised automatic fire suppression system. Two hundred and fifty feet is associated with both Assembly and General Hazard Industrial.

Section 404.9 of the states

In other than the lowest level of the atrium, where the required means of egress is through the atrium space, the portion of exit access travel distance within the atrium space shall be not greater than 200 feet. The travel distance requirements for area of buildings open to the atrium and where access to the exits is not through the atrium, shall comply with the requirements of Section 1016.

The maximum travel distance, which was office 2245, is a 130 as measured with Pathfinder.

5.4.5 Horizontal Exits

RMSEL does not have horizontal fire exits.

5.5 Fire Rated Barriers and Enclosures

RMSEL is has an atrium that incorporates the first, second, and third floor. The third floor is an unoccupied mechanical equipment room (MER) that houses the three smoke removal systems and air handler units (AHUs). Atriums drive additional requirements and the RMSEL has been constructed to meet the requirements.

Section 404 of the IBC provide the special detailed requirements based on use and occupancy. The IBC requires an approved automatic sprinkler system be installed throughout the facility. A supervised automatic sprinkler system has been provided throughout the facility.

Section 404.6 mandates that atrium spaces shall be separated from adjacent spaces by a 1-hour fire barrier constructed in accordance with Section 707 or a horizontal assembly constructed section 711 or both. The atrium space of RMSEL runs the span of the RMSEL along its main north-south corridor. One-hour fire rated construction, including doors on magnetic releases tied to the fire alarm, protects the office spaces from the atrium.

The laboratories have been fire rated with two-hour fire-rated barriers and 1.5-hour fire rated doors. Designers planned fire rated barriers to facilitate control areas for handling and storing flammable liquids and other hazardous materials. At this time, the laboratories are primarily robotics and hazardous material quantities are low when compared to most other laboratories at SNL.

Figure 5-2. First floor fire rated barriers

5.6 Exit Signs

Section 1011.1 of the IBC states

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 the exits shall be marked by exit signs.

Section 7.10 of the LSC contains more descriptive requirements than the IBC. The requirements essentially means an occupant should be able to see an exit sign everywhere within the exit, at all changes of direction, and before any door in the exit. Exit signs within the RMSEL meets the intent of the requirement as evidenced by Figure 5-3.

Figure 5-3. RMSEL exit signs

See the following Figure for proposed locations of exit signs along the first floor of RMSEL.

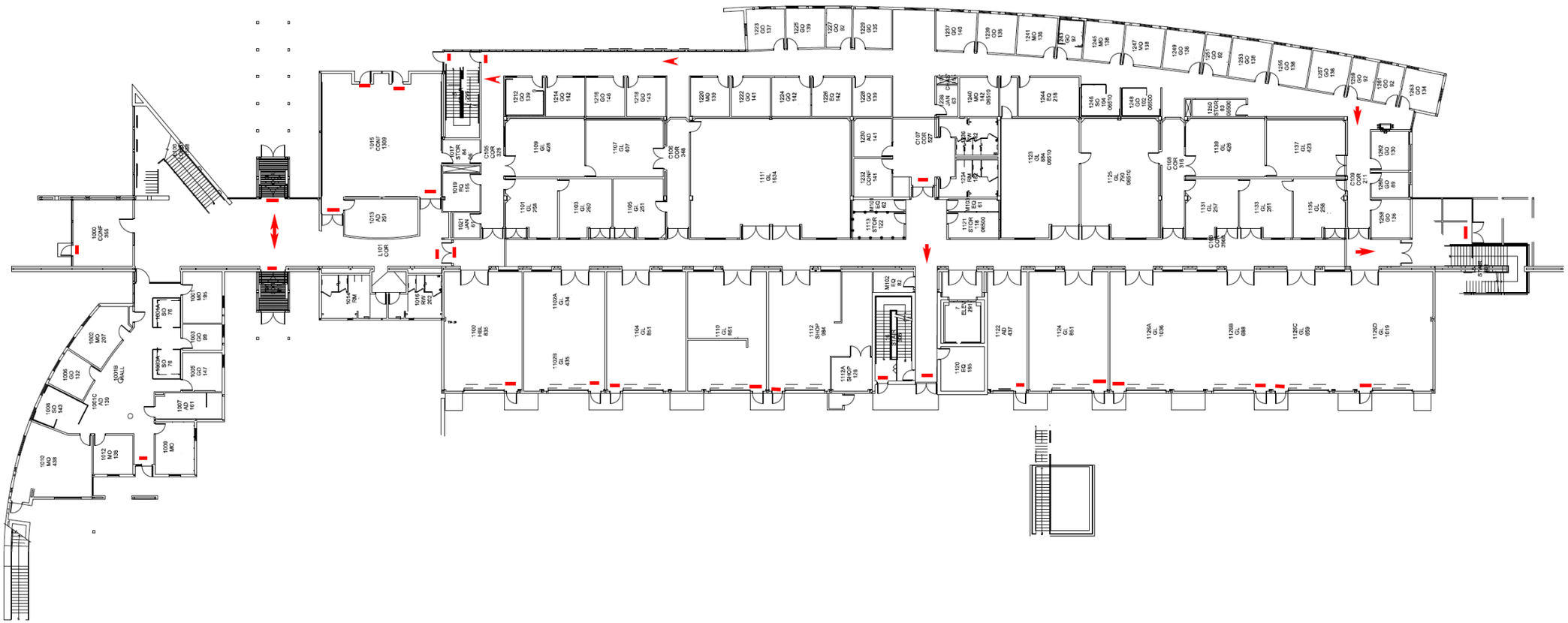

Figure 5-4. Exit sign location for the 1st floor

5.7 Interior Finishes

Section 404.8 of the IBC, which prescribes the special detail requirements based on use and occupancy, states:

The interior finish of walls and ceiling of the atrium shall be not [sic] less than Class B with no reduction in class for sprinkler protection.

In general, RMSEL meets the intent of the code for the atrium. However, a senior management area of the building has posters, pictures, acoustic panels, flags, etc.. Sandia fire protection has worked extensively with the user in the past to meet the intent of the code.

Table 803.9 of the IBC specifies Class B interior wall and ceiling finish for sprinklered Business occupancies. Corridors and enclosure for exit access stairways and exit access ramps, along with rooms and enclosed spaces can have Class C interior finishes. Assembly Group A-3 occupancies are required to have Class B or better for interior exits and corridors, and Class C or better for rooms and enclosed spaces.

The LSC requires assembly occupancies with less than 300 occupants to have Class A interior finishes for exits, A or B for Exit Access Corridors, or better than Class C for other spaces. Industrial occupancies have slightly relaxed requirements for the same areas.

6 Performance Based Evaluation

This section evaluates the performance of the fire protection and life safety systems as they pertain to three scenarios. The first scenario establishes the baseline for the time it takes to evacuate RMSEL when all exits are available. A second scenario evaluates the activation time of sprinklers in the high bay. Lastly, the third scenario evaluates a fire in the atrium, the effects of the fire on egress, and the benefits of the existing smoke removal.

6.1 Baseline for Evacuation Time

This section derives the evacuation time of the facility when all exists are available. Evacuation time is evaluated using the Society of Fire Protection Engineering (SFPE) hydraulic model and a computer package called PathFinder®.

6.1.1 Occupant Characteristics

RMSEL serves as the office space and laboratory space for engineers and scientists whose primary mission is research and development of advanced robotics and manufacturing. The majority of occupants in RMSEL on any given day are full time employees who work in the building and are familiar with its layout and exits. In addition to full time staff, RMSEL will likely have high school and college interns who may or may not be free to roam the building on there own. RMSEL resides in an area of SNL that requires special access or an escort.

RMSEL supports customers outside of SNL and tends to hosts large meetings and trainings. External occupants are likely to be unfamiliar with its layout. Such occupants are likely to be escorted by people familiar with the building.

One day a year Sandia hosts a "take your children to work day." This is the only time children are allowed inside the facility. While visiting, the children are with adults who may not be familiar with the building but can take action to see the children to safety in the event of a scenario requiring egress.

The majority of occupants are able-body people capable of using the primary means of egress. However, 6 to 10% of the occupants may need some level of assistance to evacuate. It is expected that two to three people would not be able to use the primary means of egress and would require emergency aide to evacuate.

6.1.2 Pre-Movement Time

Occupants are awake and alert implying they can respond to fire alarm in the event of a fire. Occupants may take some time to validate the need to evacuate upon notification. Before occupants are able to evacuate, they may need to secure some of their work materials and they may try to grab their personal items. It is expected that these activities may delay movement time by two minutes.

6.1.3 SFPE Hydraulic Model

The Society of Fire Protection Engineers (SFPE) has published a methodology to determine the evacuation time of a building (Ref. 18). This data evaluates the flow of persons though egress components. It neglects any pre-movement times and assumes people are able-bodied and interactions with other people are negligible. Other assumptions specific to the problem are listed below.

6.1.3.1 Assumptions:

1. RMSEL is equipped with numerous exit doors from the first floor and five exits from the second. It is assumed people exiting the laboratories on the west side of the building will use the exit door, rather than proceeding from the laboratory into the corridor and through an exit. This assumption is reasonable as the occupants perform yearly evacuation drills and this is part of the evacuation plan.
2. The limiting egress component will be the east exit stairwell or the large conference room exit doors. The stairwell exit serves the first and second floor, which will result in queuing. For this reason, the stairwell door is expected to flow at its maximum specific rate. The large conference room has two doors that lead to the exterior of the building. However, the occupant load is 87 people and will require some time to evacuate.
3. The conference room doors are each 36 inches nominal (Ref. 17).

6.1.3.2 Analysis – Large Conference Room

Evacuation time for large conference room, Room 1015.

Table 3-13.1 of the handbook) specifies a 6 in boundary layer for doors and archways, implying the effective width of each conference room door is 24 in. The maximum specific flow for a corridor, aisle, ramp, or doorway is 24.0 persons/min/ft of effective width. Therefore, the maximum flow out of the large conference room with two 36 in. nominal doors is

$$Flow_{\max} = 2\left(24in\right)\left(\frac{1ft}{12in}\right)\left(24persons/\min/ft\right) = 96person/\min$$

The occupant load of the assembly area is 87 people, which results in a movement time of approximately 55 seconds. It is expected that pre-movement time would add a minute for a total required safe egress time (RSET) of approximately 2 minutes.

6.1.3.3 Analysis – East Stairwell

The east stairwell is will have occupants coming down the stairs from the second floor merging with occupants exiting the first floor through the stairwell. The merger of two flows is accounted for using the transition equation below.

$$F_{S(out)} = \frac{F_{S(in-1)}W_{e(in-1)} + F_{S(in-2)}W_{e(in-2)}}{W_{e(out)}}$$

The maximum specific flow for a stairway, assuming 7.5 in. treads and 11 in risers is 17.1 persons/min/ft of effective width. Stairs have 6 in. boundary layer widths for an effective width of 32 in. The first floor door into the stairwell and the exit door out of the stairwell are each 3 ft doors. Maximum effective width of the doors are 24 in, given a 6 in boundary layer. Therefore, the maximum specific flow exiting the building is

$$F_{S(out)} = \frac{\left(\frac{1\,ft}{12\,in}\right)\left[(17.1\,persons/\min/\ ft)(32\,in)+(24\,persons/\min/\ ft)(24\,in)\right]}{2\,ft}$$

$$F_{S(out)} = 46\,persons/\min$$

To simplify the analysis it is conservatively assumed that $1/4^{th}$ of the building's occupants leave through this exit. Since RMSEL is equipped with multiple exits, it is not clear what exits the occupants would chose to exit through, especially if queuing occurred. This assumption is conservative the multiple exits would limit the people occupying too less than ¼ of the building. The total occupants exiting through the east stairwell is 142 (total occupant load is 566).

The time total time to evacuate would be

$$time = \frac{142\ persons}{46\ person/\min} \approx 3\min$$

The east stairwell takes approximately 1 min longer to evacuate then the conference.

6.1.4 Pathfinder

A simple egress model was performed using Pathfinder. The parameters were left at default, but were quickly reviewed to verify and understand the assumptions used in the code. Pathfinder validated the east stairwell was the most used exit. However, it predicted 88 occupants used the door as compared to the 142 used in analysis above. Total evacuation time predicted by Pathfinder was 85 seconds. The model was the Steering model, although results were also obtained with the SFPE hydraulic module. See the following Figures for a couple of screen shots of the analysis. The output file and more complete image capture are presented in Appendix C.

6.2 Analysis of Fire Detector Response

RMSEL is used for research and development of robotics and manufacturing. As part of this mission, RMSEL is constantly shipping and receiving data acquisition equipment, which typically consists of computers, monitors, and other items similar in composition. For this fire scenario, it is assumed one of the electronics laboratories has received a shipment of new computer monitors. These monitors have been placed into service and the staff has piled the empty boxes near an electrical power strip. It is assumed the power strip fails and ignites the boxes.

6.2.1 Assumptions

1. The lab is assumed to be 1126D, which is the south portion of the super lab on the west side of the building. It is a large lab with a garage door capable of receiving shipments.
2. This lab is high bay, with the upper ceiling assumed to be 28 ft (8.534 m). The lab approximately 90 ft (27.43 m) long by 35 ft (10.67 m).
3. For conservatism, it is assumed that the stack of boxes is located in the middle of four sprinklers, which form a rectangle. The Fire Protection Assessment (FPA) states the density/area is 0.17 gpm/ft^2 (Ref. 19), meaning the sprinkler system is designed to ordinary-hazard group 2 (Ref. 7). The maximum distance between sprinklers is 15 ft (4.57 m) per NFPA 13. The sprinklers are assumed to form a square with 15 ft sides. The stack of boxes is located in the center of the square.
4. There is no smoke detection in this laboratory. The only form of automatic detection is activation of a sprinkler system.
5. The boxes are assumed to be on the ground, implying the distance *H*, from the fuel package to the ceiling is 28 ft.
6. The activation temperature of the sprinkler is 165 °F (73.89°C), which correspond to ordinary temperature heads. This value has been obtained for the FPA (Ref. 19).
7. The response time index (RTI) of the sprinkler is assumed to be 115 (ms)$^{1/2}$. The basis for this value is a Job cut sheet for standard response bulbs plus a 10% safety factor.
8. Two heat release rates (HRRs) are evaluated. Each HRR is based on a data obtained by Hasegawa et al as reported in the SFPE Fire Protection Handbook (Ref. 18). The first HRR is a single pallet of 12 monitor boxes and the second is polystyrene foam in boxes.
    a. Table 3-1.11 from the SFPE handbook states monitor boxes has a maximum HRR of 4,600 kW, while boxes with polystyrene foam has a maximum heat release of 6,730 kW.
    b. HRRs are shown in Figure 6-1. The plots were created using Plotdigitizer, and a photocopy of Figure 3-1.52 from the SPFE handbook. The growth rate of each fire is considered fast when compared to the t^2 fire growth rates.

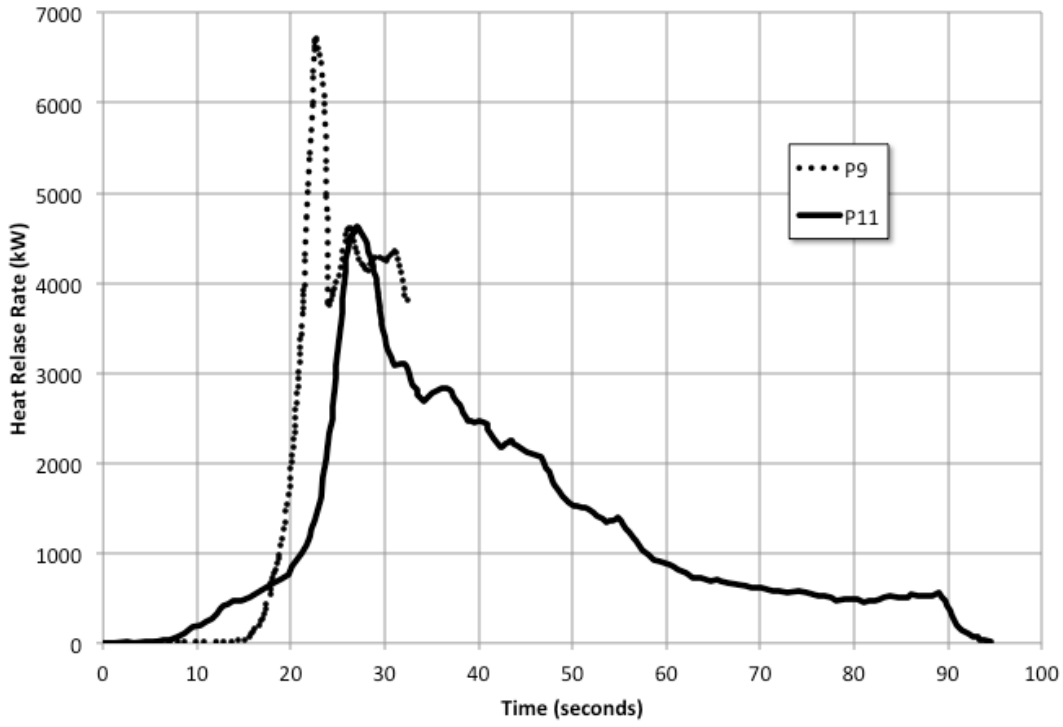

Figure 6-1. HRRs used in detector analysis

6.2.2 Methodology

Alpert's equations, which predict the ceiling jet velocities and temperatures as a function of ceiling height and radial distance, will be combined with a lumped parameter equation appropriate for predicting the temperature rise of a detector element. The equations are shown below (Ref 18)

$$U = 0.947\left(\frac{Q}{H}\right)^{1/3} \quad \text{for r/H} < 0.15 \tag{6-1}$$

$$U = 0.197\frac{\left(Q/H\right)^{1/3}}{\left(r/H\right)^{5/6}} \quad \text{for r/H} \geq 0.15 \tag{6-2}$$

$$T - T_{\infty} = 16.9\frac{\dot{Q}^{2/3}}{H^{5/3}} \quad \text{for r/H} \leq 0.18 \tag{6-3}$$

$$T - T_{\infty} = 5.38 \frac{\left(Q^{2/3} / H^{5/3}\right)}{\left(r/H\right)^{2/3}} \text{ for r/H>0.18} \quad (6\text{-}4)$$

$$T_d^{(t+\Delta t)} = T_d^{(t0} + \frac{\sqrt{u_g^{(t)}}}{RTI}\left(T_g^{(t)} - T_d^{(t)}\right)\Delta t \quad (6\text{-}5)$$

Distance between the ceiling and fuel package, H is 8.534 m and the radial distance from the fire to the sprinkler is 0.707 time the sprinkler spacing or 3.233 m.

$$r / h = \frac{3.233}{8.534} = 0.3784 \quad (6\text{-}6)$$

These equations have been programmed into a Microsoft Spreadsheet that first determines the ceiling jet velocity at time t. This value is then used to determine the ceiling jet temperature at the radial distance solved for in Equation 5-6. Both of these values are needed to solve for the detector temperature at the next time step, or $t+\Delta t$.

6.2.3 Results

Despite the large size of each fire, neither scenario activates the sprinkler. The large fire burns itself out quickly. If this scenario were real, the fire would likely spread to nearby combustibles that may activate a sprinkler. Temperature profiles for the detector are provided in Figure 5-2. For the sprinklers to have activated, the detector temperature needed to reach 74°C.

To illustrate the benefits of providing a smoke detector, the same methodology is applied using an RTI and temperature rise criteria appropriate for photoelectric detectors. NFPA 72-2013 uses an RTI of 25 $(ms)^{1/2}$ in an example problem in Annex B. Table B.4.7.5.3 states a temperature rise of 21.1°C can be used as the temperature rise criteria for activating a photoelectric smoke detector. Results for this scenario is provided alongside the sprinkler temperature profiles. A temperature rise of 21.1°C occurs at 24 seconds for P9 – boxes and polystyrene foam – and 26 seconds for P11 – empty computer monitor boxes. The fire was roughly 6,500 kW when the smoke activated for P9 and 4,400 kW for P11.

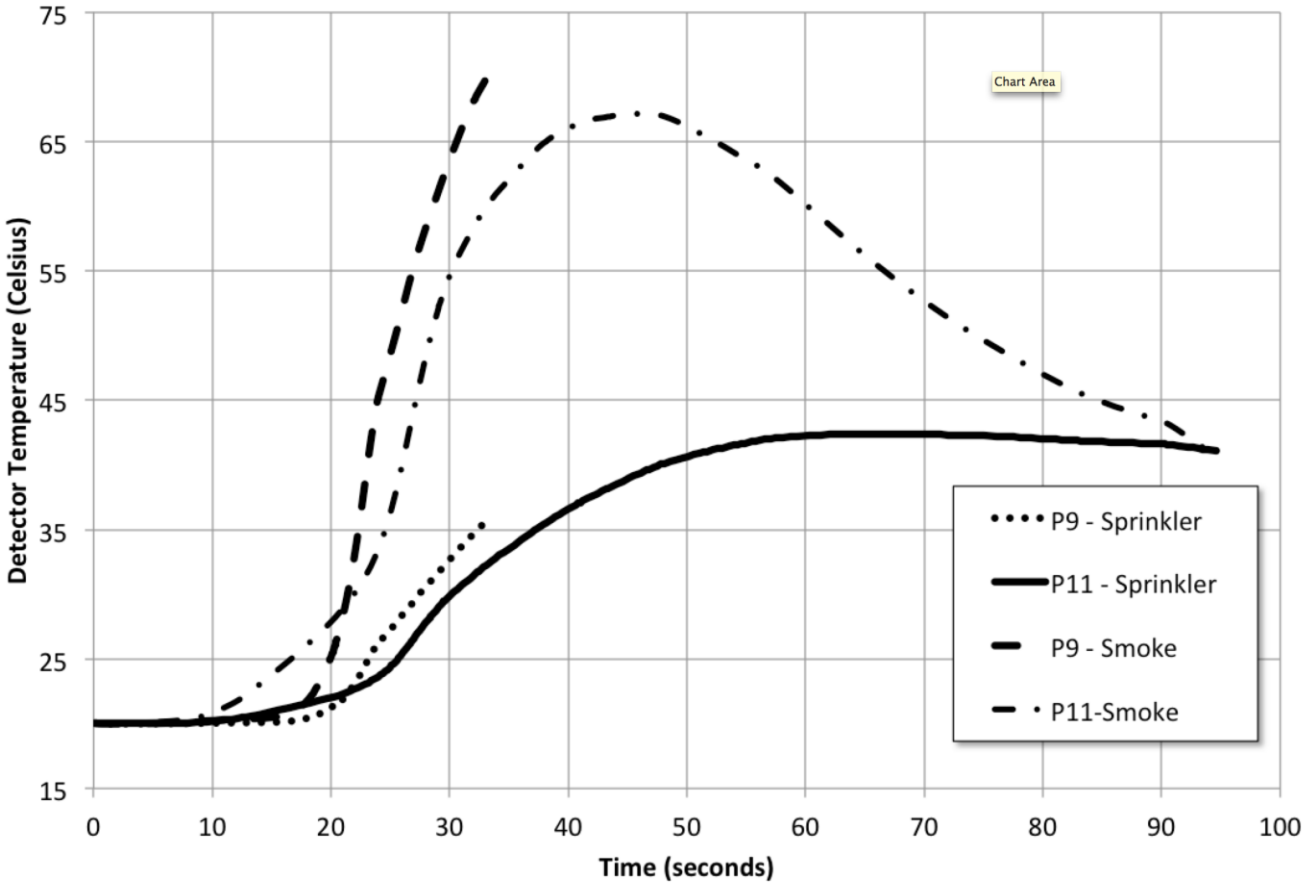

Figure 6-2. Detector temperature profiles

6.3 Fire in the Atrium

This section evaluates a fire in the atrium, the impact to egress, and the effectiveness of the smoke control system. The fire scenario is assumed to be a couch fire that is initiated by an overheated personal electric device, such as a cell phone or laptop. A small meeting area consisting of a table, chairs, and upholstered couch located below the northeast stairs. Figure 6-1 illustrates the upholstered furniture beneath the stair well and Figure 6-4 is an image of the north end of the atrium and the stairs that have the meeting area beneath them.

Development of the fire scenario is based on Design Fire Scenario 1 of the 2012 LSC (Ref. 4). The scenario takes into account occupant activities, number and location of occupants, room size, contents and furnishings, fuel properties and ignition sources, ventilation conditions and the first ignited item. The scenario can also be considered an arson scenario as the fire location immediately impacts the main entrances to the facility.

Figure 6-3. Meeting area beneath northeast stairs

Figure 6-4. Looking at the north portion of the atrium

6.3.1 Assumptions and Input Parameters

The heat release rate for the scenario is based on full scale testing that was performed by the National Institute of Standards and Technology as documented in the Figure 3-1.102 of the SFPE handbook. For conservatism, the steady state HRR was modified to 4,000 kW to account for additional fuel packages that would likely ignite and contribute to the severity of the fire.

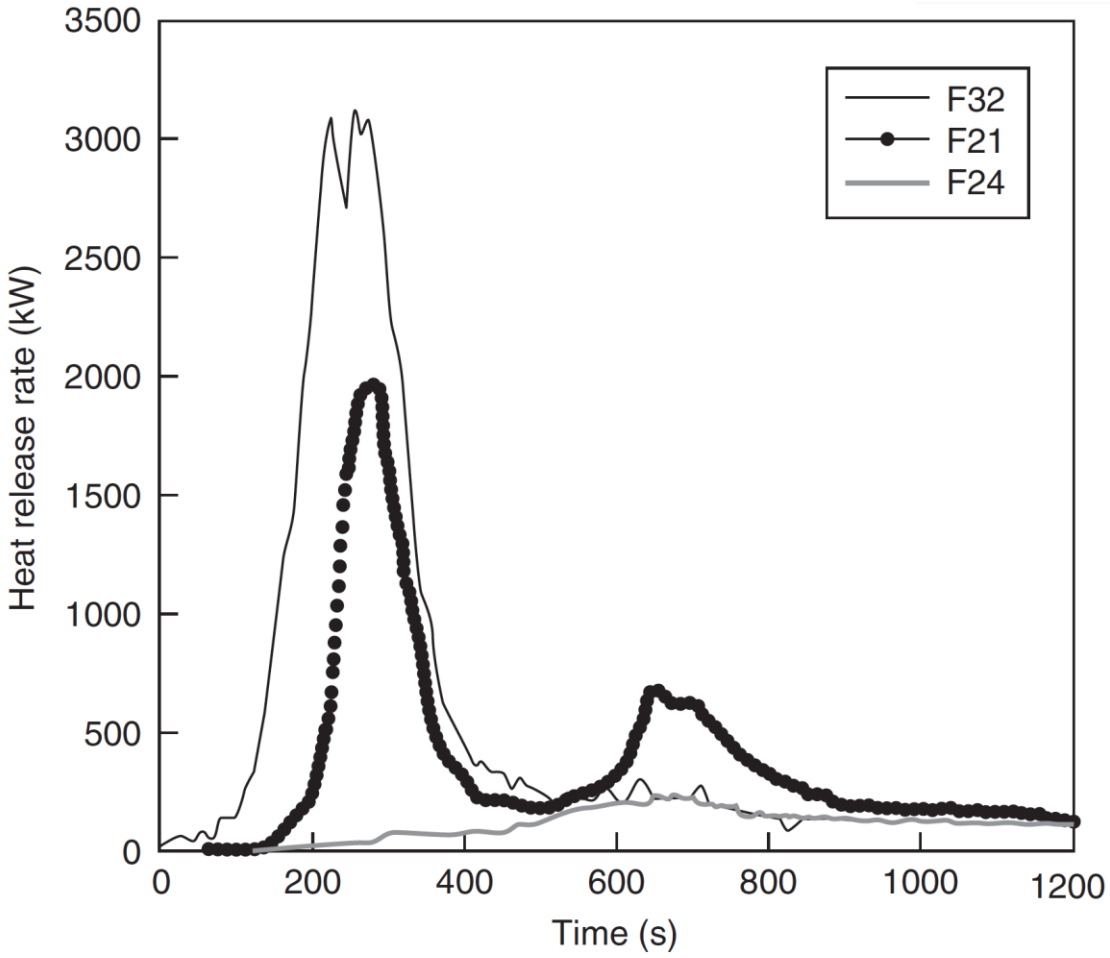

Figure 6-5. Heat release rate of couch (F32) (Ref. 18)

The carbon monoxide yield and soot yield used in this analysis is based on the average soot yields of polyurethane flexible foams as reported in Table 3-4.16 of the SFPE Handbook. Data is summarized below in

Table 6-1. Reported and average values of CO and soot yield (Ref. 18)

Material	Y_{CO} [g/g]	Y_{Soot} [g/g]
GM21	0.010	0.131
GM23	0.031	0.227
GM25	0.028	0.194
GM27	0.042	0.198
Average	0.028	0.188

Table 3-4.16 of SFPE

Heat of combustion and the chemical formulation of polyurethane foam used in Fire Dynamic Simulator (FDS) input file have been obtained from Table C.3 of the SFPE handbook. Polyurethane foam has a heat of combustion of 22.7MJ/kG and a chemical composition of C = 6.3, H=7.1, N=1, and O=2.1.

6.4 Tenability Criteria

Tenability criteria need to be appropriate for the occupants and their level of alertness while in the building. RMSEL personnel are awake and the facility is equipped with an automatic sprinkler system and partial coverage smoke detection. For these reasons, occupants are not expected to succumb to effects of toxics, irritants, or asphyxiate.

The presence of smoke detection, smoke control system and an automatic sprinkler system may not be able to control the spread of smoke. Smoke can threaten occupants because it develops early in the fire and impairs the occupant's visibility. The loss of vision clarity in smoke is detrimental to egress as occupants become unwilling to travel through it, especially when they are not fully aware of where they are going.

RMSEL's atrium has the potential to spread smoke between the first and second floors. Given the concerns about smoke, an applicable performance criterion is to limit the smoke layer to a height of 6 ft on the second floor. This criterion is specified in section 909.8.1 of the 2012 IBC when using the exhaust method for smoke control. However, the 1994 UBC required a smoke layer height of 10 ft. Layer heights are not used for this analysis because, despite being required, the system was not designed in that manner. To maintain a layer height, exhaust is generally designed from the top of the compartment with inlets down near the bottom. The RMSEL smoke control system uses the ducting and supply fan for the building HVAC. Supply ducts are located at all elevations of the building meaning they inject fresh air into the smoke layer, which causes the smoke layer to expand. This also disrupts the smoke layer making it uneven and causes it to descend below 6 ft.

A more appropriate performance criterion for RMSEL is visibility. The most conservative value for visibility discussed in the SFPE handbook is 13 m. Thirteen meters is good for buildings where the occupants are not familiar with the layout of the building. Since RMSEL host visitors, this seems appropriate. Another reason for using visibility is the fact that FDS has been shown to predict visibility well has a model bias factor of 1.01, meaning FDS tends to over predicts visibility by 1%. FDS does a poor job of predicting smoke concentration as it over predicts by approximately 260%. See the following figures for more information.

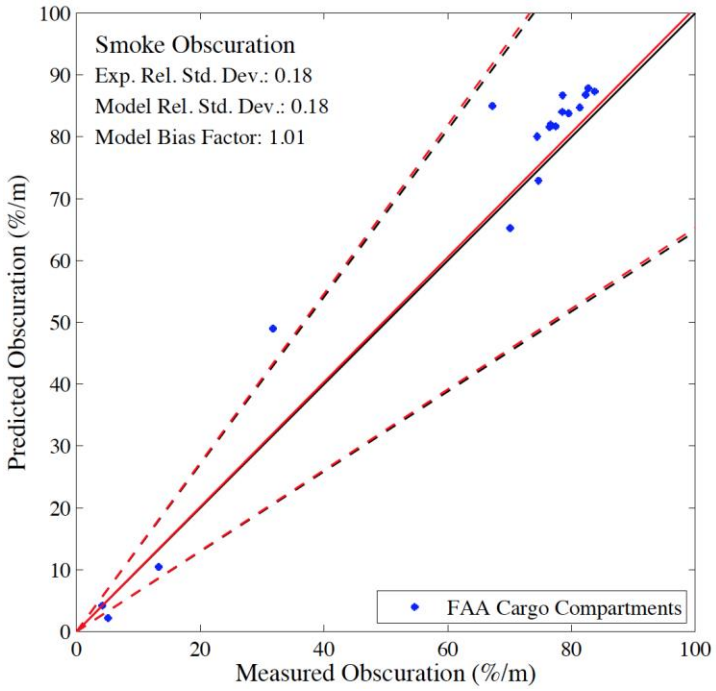

Figure 6-6. FDS model bias for visibility (Ref. 20)

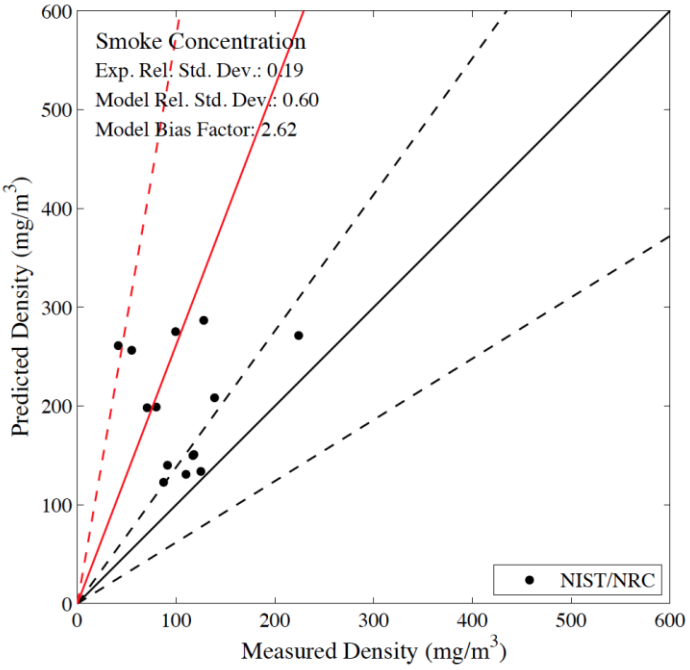

Figure 6-7. FDS model bias for smoke concentration (Ref. 20)

6.4.1 Results

An important aspect of this fire scenario is to characterize the benefit of the smoke control system. To do this, four scenarios were evaluated: 1) unmitigated (i.e, no sprinklers or smoke control), 2) sprinklers only, 3) smoke control only, 4) sprinklers and smoke control. Sprinklers were simulated by determining the activation time using the heat detectors in the unmitigated model and capping the HRR in the runs with sprinklers.

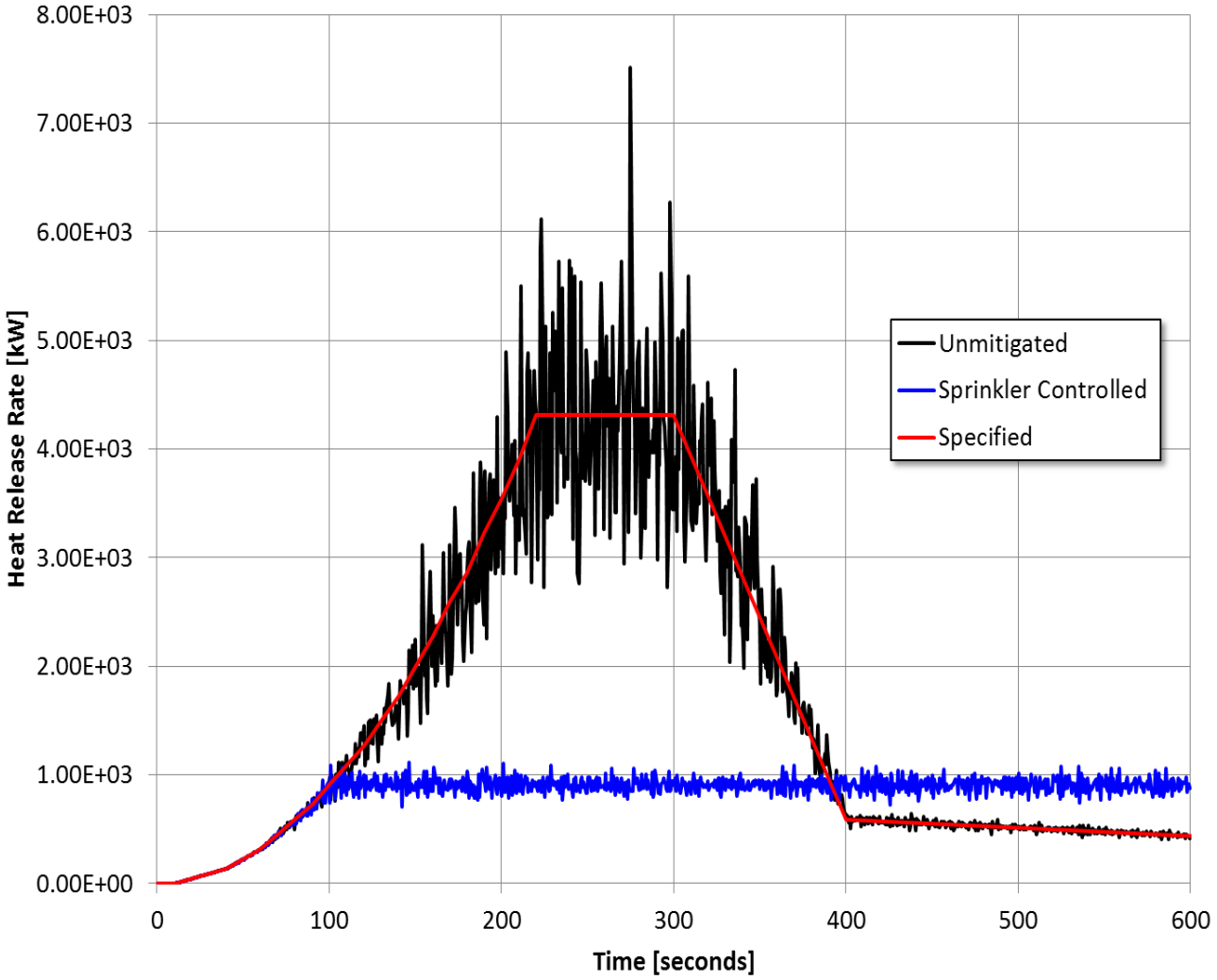

Figure 6-8. HRR used in the fire models

FDS slice files showing the visibility at locations sensitive to evacuation are shown in Figures 6-9 through 11 for the unmitigated scenario and Figures 6-12 through 15 for the sprinkler and smoke control case.

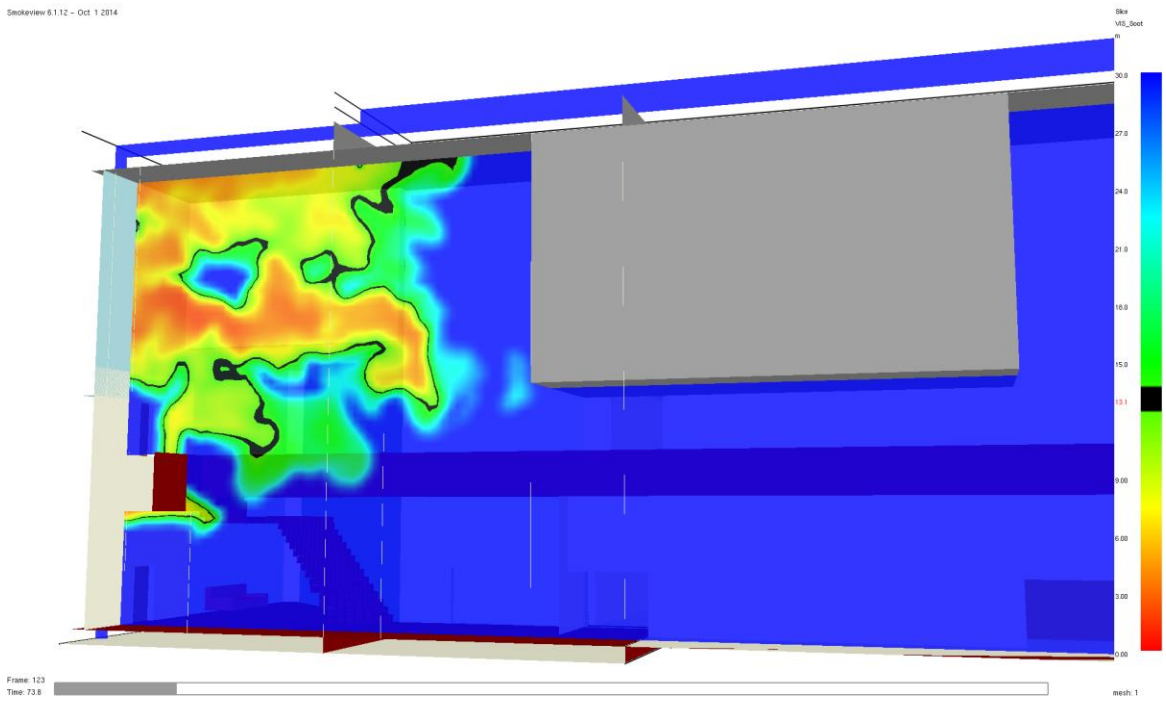

Figure 6-9. Unmitigated - loss of visibility at conference room

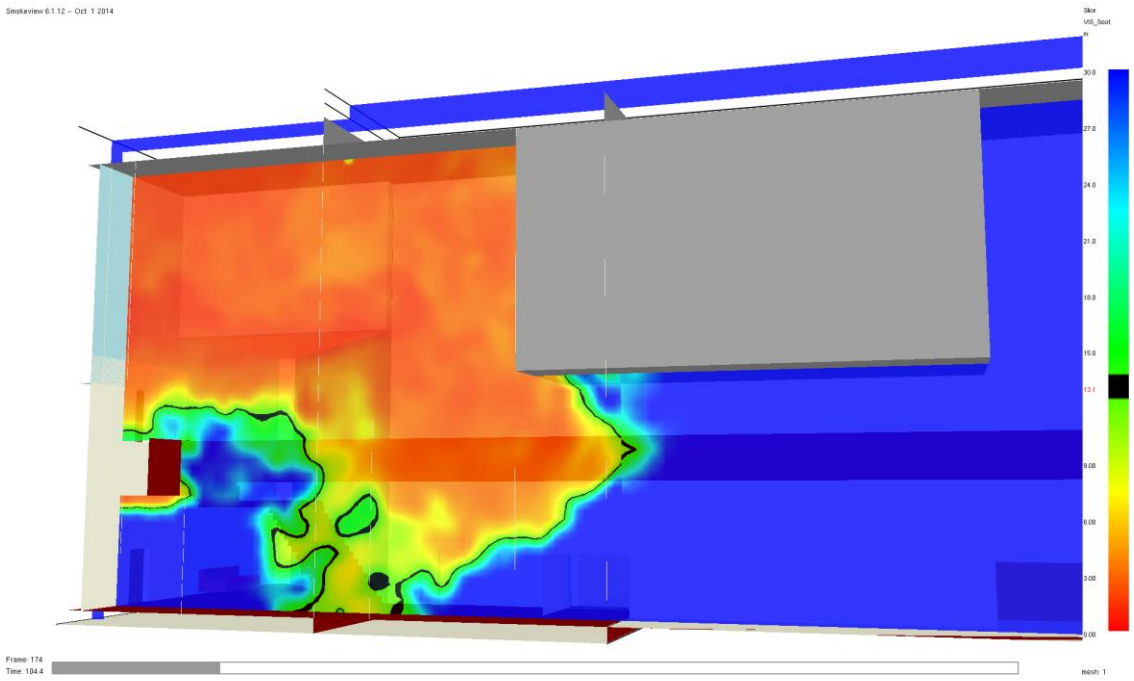

Figure 6-10. Unmitigated - loss of main entrance egress

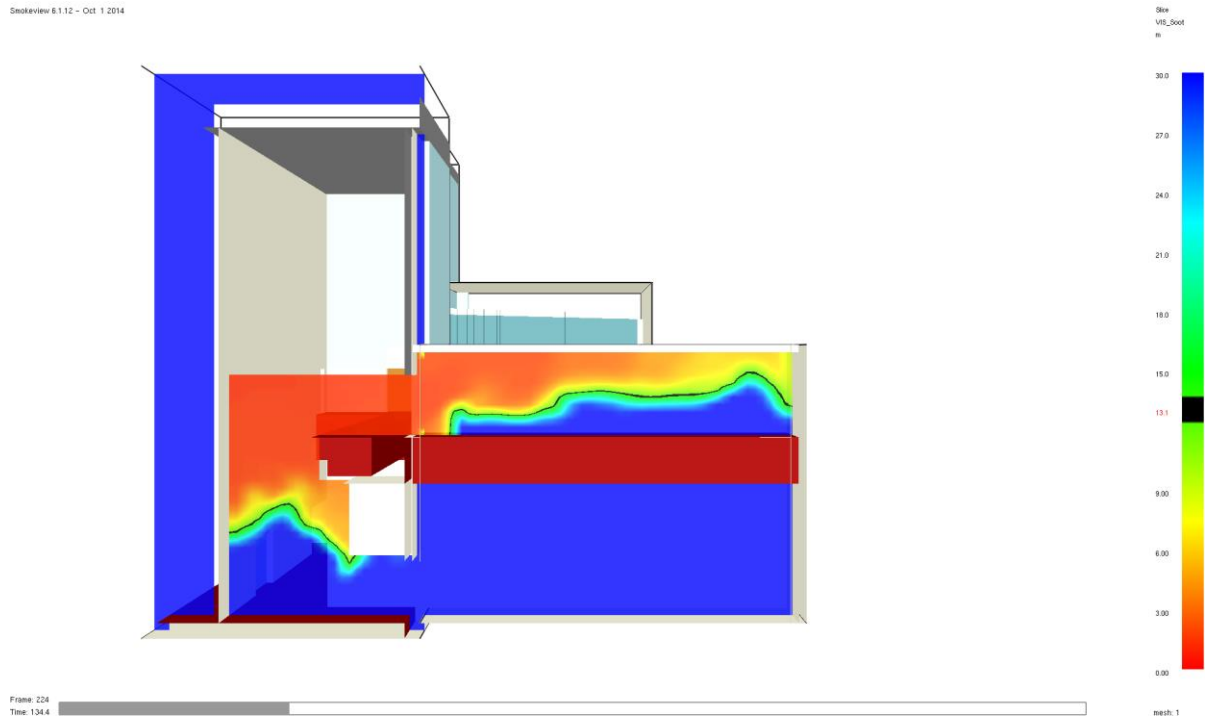

Figure 6-11. Unmitigated - loss of tenability at NE stairwell

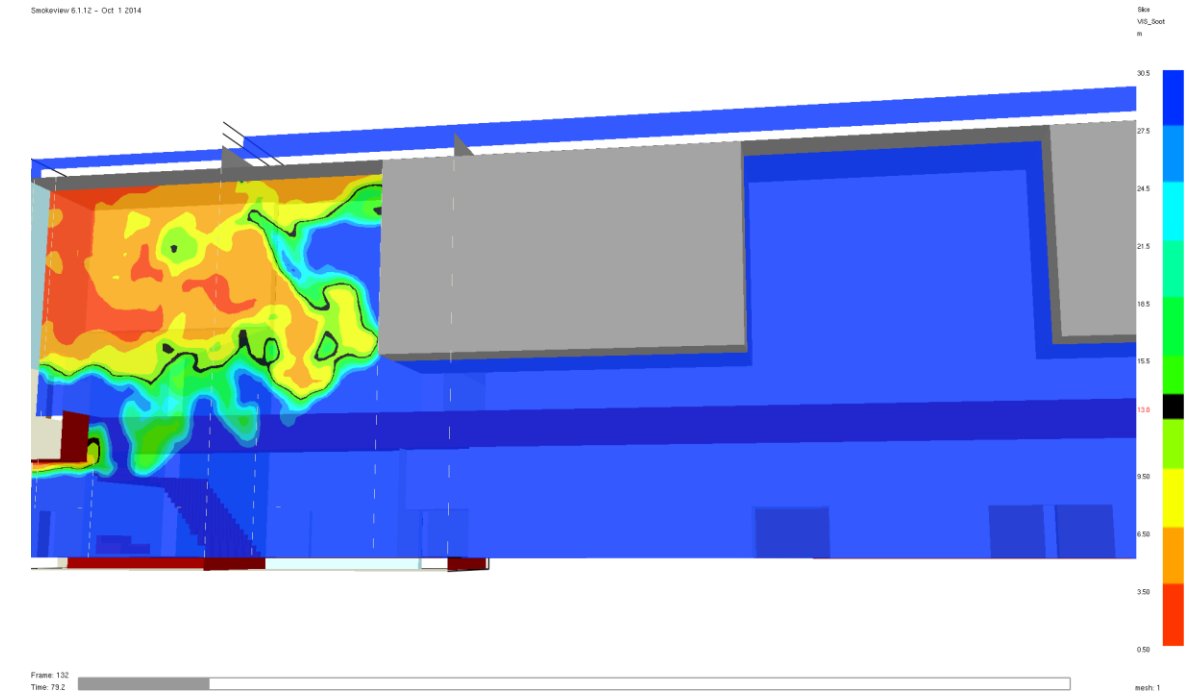

Figure 6-12. Sprinkler controlled –loss of tenability at 2nd floor conference room

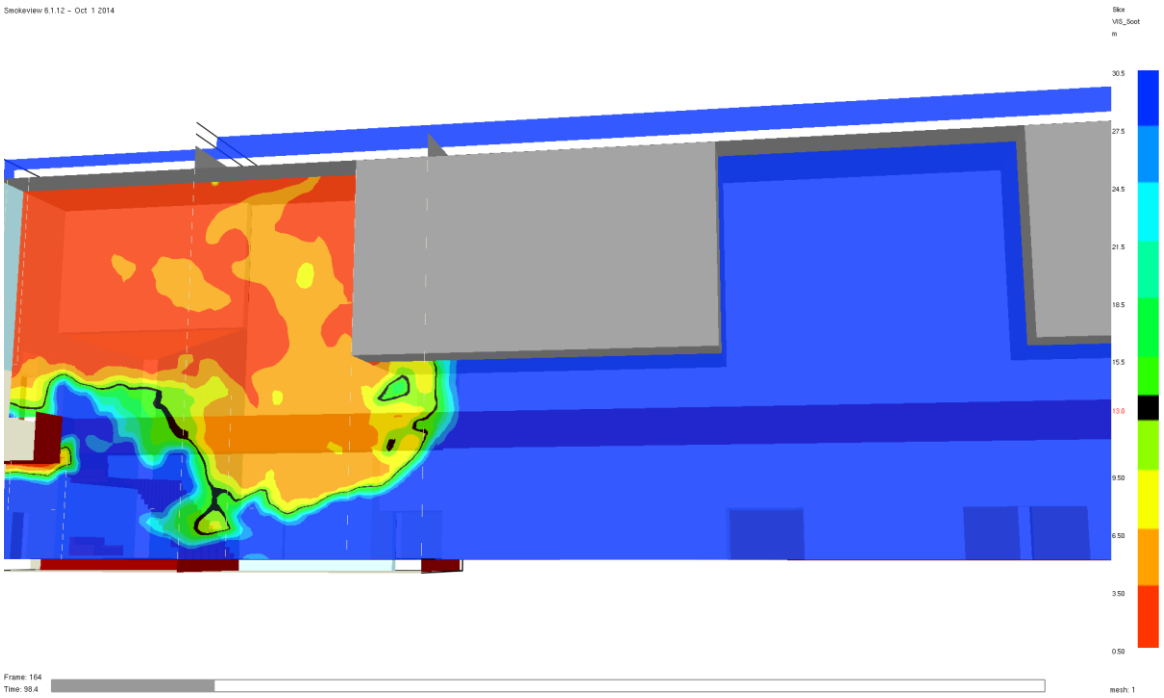

Figure 6-13- Sprinkler controlled - loss of tenability at main entrance

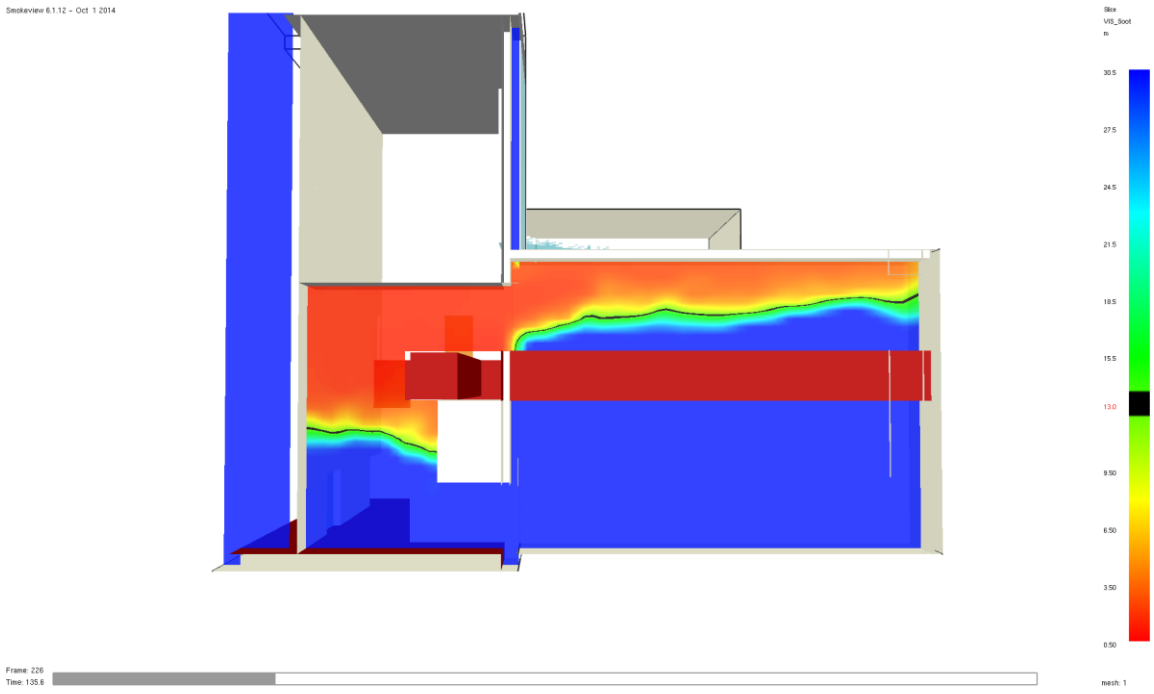

Figure 6-14. Sprinkler controlled - loss of tenability at NE exit

Despite the presence of the smoke control system and sprinklers, tenability is lost throughout the atrium. However, the smoke control does help extend the time it takes to loose tenability. Times associated with the loss of tenability need to be put into context with respect to the evacuation times. This analysis is generally referred to as a comparison of the required safe egress time (RSET) and the available safe egress time (ASET). The RSET has to been less than the ASET

SFPE handbook defines RSET as

$$RSET = t_d + t_n + t_{p-e} + t_e$$

where t_d = time from ignition to detection

t_n = time from detection to notification

t_{p-e} = time from notification to evacuation commences

t_e = time to evacuate once evacuation commences.

The unmitigated scenario showed sprinklers or a heat detector would take approximately 100 seconds from the time the fire started to the time of detection. For the analysis, the detector is assumed to have a 74°C (165°F) activation temperature and a response time index of 105 $(ms)^{1/2}$. Therefore, t_d = 100 seconds.

For this analysis, two times are considered for the time from ignition to detection. The first assumes the detection is smoke detectors, which has a rapid notification time. For this case, t_d is assumed to be zero. In the case of sprinkler flow, a 60 sec delay is assumed because this is the maximum allowable delay time allowed by the code.

The occupants are awake and alert. These are important aspects to consider when estimating the time it takes for the occupants to actively start removing themselves from the building. However, the Sandia performs numerous evacuation drills and exercises and because Sandia has a fair number of nuisance alarms, it is assumed that it will take the occupants roughly 60 seconds to start moving once they are aware of the alarm. Therefore, t_{p-e} is 60 seconds

This analysis will evaluate loss of tenability at four distinct locations. The first is the second floor conference room located on the north end of the atrium. The second is the main entrances near the north of the corridor. The third location is the northeast stair well and the final location is the central west exit. The RSET values for each of these locations is compared to the ASET values in Table 6-2.

Table 6-2. RSET vs ASET results*

Location	RSET** (heat detectors/sprinklers) [seconds]	ASET [seconds]			
		Unmitigated	Mitigated – sprinklers only	Mitigated – smoke control only	Mitigated – Sprinklers and Smoke Control
2nd floor conference rm	190/250	73	93	106	127
Main entrance	210/270	104	106	125	127
2nd floor east stairwell	220/280	134	137	180	**247**
Middle corridor	220/280	220	**286**	**292**	**338**
South exit	225/285	**352**	**424**	**398**	**560**

*Numbers in bold lettering indicate

**The difference between heat detectors and sprinklers is the assumption that heat detectors notify immediately and sprinklers notify after a 60 second delay.

7 Summary and Conclusions

A comprehensive fire protection and life safety evaluation has been performed for the Robotic Manufacturing Science and Engineering Laboratory (RMSEL) at Sandia National Laboratories (SNL). The evaluation considered both prescriptive and performance based aspects.

Current codes, such as the 2012 International Building Code and the 2013 version of NFPA 13 – Standard for the Installation of Sprinkler Systems, are generally the basis for the prescriptive evaluation even though they are not the code of record for the building. Use of current codes for this evaluation is mostly for academic reasons. Nevertheless, the facility is generally compliant with the provisions of the current codes.

Fire modeling has been used to evaluate the performance of the smoke control system in the atrium. RMSEL is a three-story building with an atrium that communicates with all three floors. As such, the atrium is required to have a smoke control system designed in accordance with "generally accepted and well-established principles of engineering relevant to the design." The smoke control system for RMSEL essentially transitions the heating, venting, and air conditioning (HVAC) system to supply 100% outside air and exhaust 100%. As designed, it is not certain that the smoke control will maintain a tenable environment. For this reason, fire modeling has been used to characterize the conditions resulting from a fire in the atrium.

To characterize the benefit of the smoke control system, four runs scenarios have been evaluated. The first scenario assumed the fire burned unmitigated. The second scenario assumed that the sprinklers controlled the heat release rate of the fire. A third scenario considered only the smoke control system activated (i.e., no sprinklers) and the last scenario considered both sprinklers and smoke control.

Results of the fire modeling, combined with results from simulated egress times, shows that in general, it takes more time than available to safely egress certain area prior to the loss of tenability. Nevertheless, the smoke control system combined with sprinkler control of the fire extended the available safe egress time longer than the required safe egress time for all but the areas in the immediate vicinity of the fire. The smoke control system provides benefit.

This analysis assumed tenability is lost when visibility is less than 13 m, a conservative value. Fire modeling was conservative as it assumed a higher than expected heat release rate, and the soot yield was an average of yields for different foams.

It is recommended that the facility stakeholders address the backup power deficiency for the smoke control. Consideration should also be given to running the fire models with less conservatism to better characterize the egress times.

8 References

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Appendix A –Fire Alarm Submittals

EST™
Life Safety & Communications

Intelligent Photoelectric Smoke Detector

SIGA-PS

Overview

The Signature Series Model SIGA-PS Intelligent Photoelectric Smoke Detector gathers analog information from its smoke sensing element and converts it into digital signals. The detector's on-board microprocessor measures and analyzes these signals. It compares the information to historical readings and time patterns to make an alarm decision. Digital filters remove signal patterns that are not typical of fires. Unwanted alarms are virtually eliminated.

The microprocessor in each detector provides four additional benefits - Self-diagnostics and History Log, Automatic Device Mapping, Stand-alone Operation and Fast, Stable Communication.

Self-diagnostics and History Log - Each Signature Series detector constantly runs self-checks to provide important maintenance information. The results of the self-check are automatically updated and permanently stored in the detector's non-volatile memory

Automatic Device Mapping - The loop controller learns where each device's serial number address is installed relative to other devices on the circuit. The mapping feature provides supervision of each device's installed location to prevent a detector from being reinstalled (after cleaning etc.) in a different location from where it was originally.

Stand-alone Operation - A decentralized alarm decision by the detector is guaranteed. On-board intelligence permits the detector to operate in stand-alone mode. If loop controller CPU communications fail for more than four seconds, all devices on that circuit go into stand-alone mode. The circuit acts like a conventional alarm receiving circuit.

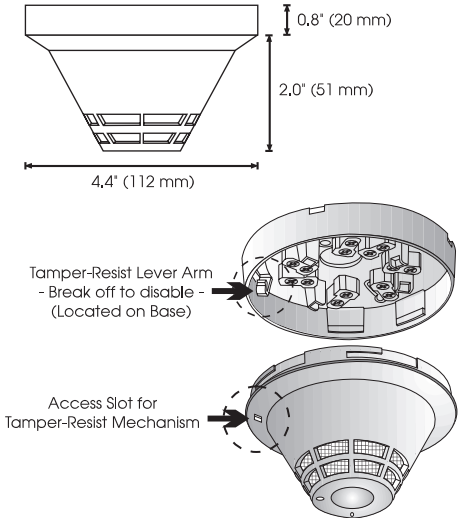
Fast Stable Communication - On-board intelligence means less information needs to be sent between the detector and the loop controller. Other than regular supervisory polling response, the detector only needs to communicate with the loop controller when it has something new to report.

Standard Features

- Integral microprocessor
- Non-volatile memory
- Automatic mapping device
- Electronic addressing
- Environmental compensation
- Intelligent detector
- Wide 0.67% to 3.77%/ft. sensitivity range
- Twenty pre-alarm sensitivity values, set in 5% increments
- Identification of dirty or defective detectors
- Automatic day/night sensitivity adjustment
- Twin RED/GREEN status LEDs
- Standard, relay, fault isolator, and audible mounting bases
- Designed and manufactured to ISO 9001 standards

Installation

Signature Series detectors mount to North American 1-gang boxes, 3-1/2 inch or 4 inch octagon boxes, and to 4 inch square electrical boxes 1-1/2 inches (38 mm) deep. They mount to European BESA and 1-gang boxes with 60.3 mm fixing centers.



Testing & Maintenance

Each detector automatically identifies when it is dirty or defective and causes a “dirty detector” message. The detector’s sensitivity measurement can also be transmitted to the loop controller. A sensitivity report can be printed to satisfy NFPA sensitivity measurements which must be conducted at the end of the first year and every two years thereafter.

The user-friendly maintenance program shows the current state of each detector and other pertinent messages. Single detectors may be turned off temporarily from the control panel. Availability of maintenance features is dependent on the fire alarm system used. Scheduled maintenance (Regular or Selected) for proper detector operation should be planned to meet the requirements of the Authority Having Jurisdiction (AHJ). Refer to current NFPA 72 and ULC CAN/ULC 536 standards.

Compatibility

The SIGA-PS detectors are compatible only with the Signature Loop Controller.

Warnings & Cautions

This detector will not operate without electrical power. As fires frequently cause power interruption, we suggest you discuss further safeguards with your fire protection specialist.

This detector will NOT sense fires that start in areas where smoke cannot reach the detector. Smoke from fires in walls, roofs, or on the opposite side of closed doors may not reach the detector to alarm it.

Accessories

All detector mounting bases have wiring terminals that are accessible from the “room-side” after mounting the base to the electrical box. The bases mount to North American 1-gang boxes and to 3½ inch or 4 inch octagon boxes, 1½ inches (38 mm) deep. They also mount to European BESA and 1-gang boxes with 60.3 mm fixing centers. The SIGA-SB4, SIGA-RB4, and SIGA-IB4 mount to North American 4 inch sq. electrical boxes in addition to the above boxes. They include the SIGA-TS4 Trim Skirt which is used to cover the “mounting ears” on the base. The SIGA-AB4G mounts to a 4” sqare box only.

SIGA-AB4G
Audible Base

SIGA-SB
Standard Base

SIGA-IB
Isolator Base

SIGA-RB
Relay Base

SIGA-LED
Remote LED

Standard Base SIGA-SB, SIGA-SB4 - This is the basic mounting base for Edwards Signature Series detectors. The SIGA-LED Remote LED is supported by the Standard Base.

Relay Base SIGA-RB, SIGA-RB4 - This base includes a relay. Normally open or closed operation is selected during installation. The dry contact is rated for 1 amp (pilot duty) @ 30 Vdc. The relay’s position is supervised to avoid accidentally jarring it out of position. The SIGA-RB can be operated as a control relay if programmed to do so at the control panel (EST3 V.2 only). The relay base does not support the SIGA-LED Remote LED.

Audible Base SIGA-AB4G - This base is designed for use where localized or group alarm signaling is required. When the detector senses an alarm condition, the audible base emits a local alarm signal. The optional SIGA-CRR Polarity Reversal Relay can be used for sounding to other audible bases on the same 24 Vdc circuit.

Relay and Audible Bases operate as follows:

- at system power-up or reset, the relay is de-energized
- when a detector is installed in the base with the power on, the relay energizes for four seconds, then de-energizes
- when a detector is removed from a base with the power on, the relay is de-energized
- when the detector enters the alarm state, the relay is energized.

Isolator Base SIGA-IB, SIGA-IB4 - This base includes a built-in line fault isolator for use on Class A circuits. A detector must be installed for it to operate. The isolator base does not support the SIGA-LED Remote LED.

The isolator operates as follows:

- a short on the line causes all isolators to open within 23 msec
- at 10 msec intervals, beginning on one side of the Class A circuit nearest the loop controller, the isolators close to provide the next isolator down the line with power
- when the isolator next to the short closes, reopens within 10 msec.

The process repeats beginning on the other side of the loop controller.

Remote LED SIGA-LED - The remote LED connects to the SIGA-SB or SIGA-SB4 Standard Base only. It features a North American size 1-gang plastic faceplate with a white finish and red alarm LED.

SIGA-TS4 Trim Skirt - Supplied with 4 inch bases, it can also be ordered separately to use with the other bases to help hide surface imperfections not covered by the smaller bases.

Application

Although photoelectric detectors have a wide range of fire sensing capabilities they are best suited for detecting slow, smoldering fires. The table below shows six standard test fires used to rate the sensitivity of smoke and heat detectors. The table indicates that no single sensing element is suited for all test fires.

Edwards recommends that this detector be installed according to latest recognized edition of national and local fire alarm codes.

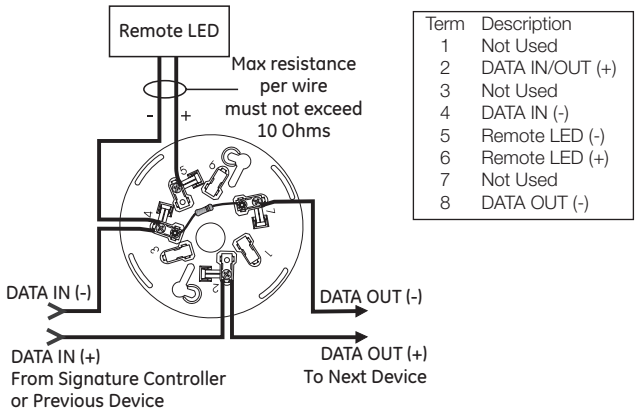
Test Fire	SIGA-IS Ion	SIGA-PS Photo	SIGA-HRS and SIGA-HFS Rate-of-Rise/ Fixed Temp.	SIGA-PHS Photo Heat 3D	SIGA-IPHS Ion/Photo/Heat 4D
Open Wood	**optimum**	unsuitable	**optimum**	very suitable	**optimum**
Wood Pyrolysis	suitable	**optimum**	unsuitable	**optimum**	**optimum**
Smouldering Cotton	very suitable	**optimum**	unsuitable	**optimum**	**optimum**
Poly Urethane Foam	very suitable	very suitable	suitable	very suitable	**optimum**
n-Heptane	**optimum**	very suitable	very suitable	**optimum**	**optimum**
Liquid Fire without Smoke	unsuitable	unsuitable	**optimum**	very suitable	very suitable

Typical Wiring

The detector mounting bases accept #18 AWG (0.75mm^2), #16 (1.0mm^2), #14 AWG (1.5mm^2), and #12 AWG (2.5mm^2) wire sizes.

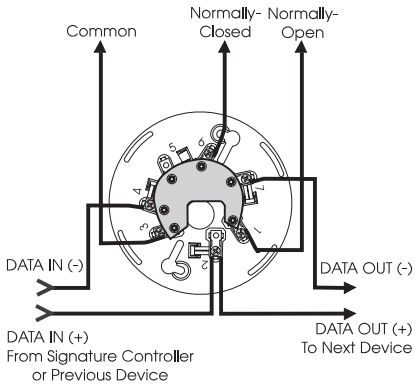
Note: Sizes #16 AWG (1.0mm^2) and #18 AWG (0.75mm^2) are preferred for ease of installation. See Signature Loop Controller catalog sheet for detailed wiring requirement specifications.

Standard Detector Base, SIGA-SB, SIGA-SB4



Term	Description
1	Not Used
2	DATA IN/OUT (+)
3	Not Used
4	DATA IN (-)
5	Remote LED (-)
6	Remote LED (+)
7	Not Used
8	DATA OUT (-)

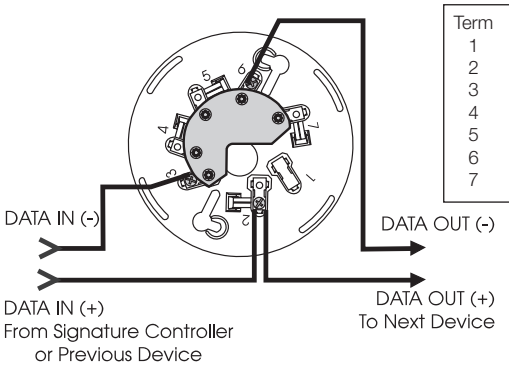
Relay Detector Base, SIGA-RB, SIGA-RB4



Term	Description
1	Normally Open
2	DATA IN/OUT (+)
3	Common
4	DATA IN (-)
5	Not Used
6	Normally-Closed
7	DATA OUT (-)

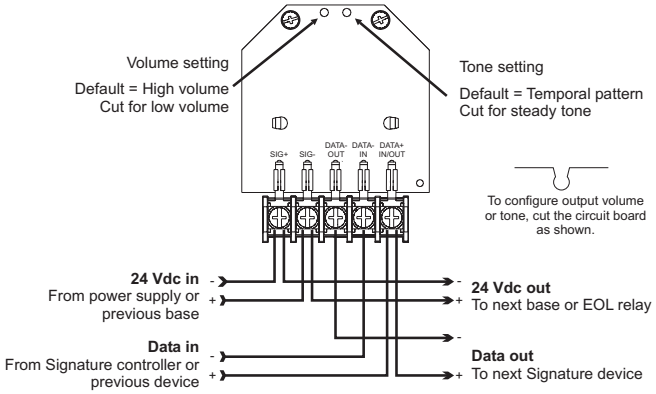
CONTACT RATING
1.0 Amp @ 30 VDC
(Pilot Duty)

Isolator Detector Base, SIGA-IB, SIGA-IB4



Term	Description
1	Not Used
2	DATA IN/OUT (+)
3	DATA IN (-)
4	Not Used
5	Not Used
6	DATA OUT (-)
7	Not Used

Audible Detector Base, SIGA-AB4G



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Specifications

Sensing Element	Photoelectric - Light Scattering Principle
Storage & Operating Environment	Air Velocity Range: 0 to 5,000 ft/min (0 to 25.39 m/s); Humidity: 0 to 93% RH, Non-Condensing Operating Temp: 32ºF to 120ºF (0ºC to 49ºC); Storage Temp: -4ºF to 140ºF (-20ºCto 60ºC)
Sensitivity Range	ULI/ULC - 0.67% to 3.77% obscuration/foot
User Selected Alarm Sensitivity Settings	Most Sensitive: 1.0%/ft.; More Sensitive: 2.0%/ft.; Normal: 2.5%/ft.; Less Sensitive: 3.0%/ft.; Least Sensitive: 3.5%/ft.
Pre-alarm Sensitivity	5% increments, allowing up to 20 pre-alarm settings
Operating Voltage	15.2 to 19.95 Vdc (19 Vdc nominal)
Operating Current	Quiescent: 45µA @ 19 V; Alarm: 45µA @ 19 V Emergency Stand-alone Alarm Mode: 18mA Pulse Current: 100 µA (100 msec); During Communication: 9 mA max.
Construction & Finish	High Impact Engineering Polymer - White
Compatible Mounting Bases	SIGA-SB Standard Base, SIGA-RB Relay Base, SIGA-IB Isolator Base, SIGA-AB4, SIGA-AB4G Audible Bases
LED Operation	On-board Green LED - Flashes when polled; On-board Red LED - Flashes when in alarm Both LEDs - Glow steady when in alarm (stand-alone) Compatible Remote Red LED (model SIGA-LED) Flashes when in alarm
Compatibility	Use With: SIGNATURE Loop Controller
Address Requirements	Uses one Device Address
Agency Listings	UL, ULC, MEA, CSFM
UL Listed Spacing	30 ft

Ordering Information

Catalog Number	Description	Ship Wt. lbs (kg)
SIGA-PS	Intelligent Photoelectric Detector - UL/ULC Listed	0.5 (.23)
Accessories		
SIGA-SB	Detector Mounting Base - Standard	0.2 (.09)
SIGA-SB4	4-inch Detector Mounting Base c/w SIGA-TS4 Trim Skirt	
SIGA-RB	Detector Mounting Base w/Relay	
SIGA-RB4	4-inch Detector Mounting Base w/Relay, c/w SIGA-TS4 Trim Skirt	
SIGA-IB	Detector Mounting Base w/Fault Isolator	
SIGA-IB4	4-inch Detector Mounting Base w/ Fault Isolator, c/w SIGA-TS4 Trim Skirt	
SIGA-LED	Remote Alarm LED	
SIGA-AB4G	Audible (Sounder) Base	.3 (0.15)
SIGA-TS4	Trim Skirt (supplied with 4-inch bases)	.1 (.04)

Overview

The SIGA-270 and SIGA-278 series Manual Pull Stations are part of GE Security's Signature Series system. The SIGA-270 Fire Alarm Manual Pull Stations feature our very familiar teardrop shape. They are made from die-cast zinc and finished with red epoxy powder-coat paint complemented by aluminum colored stripes and markings. With positive pull-lever operation, one pull on the station handle breaks the glass rod and turns in a positive alarm, ensuring protection plus fool-proof operation. Presignal models (SIGA-270P) are equipped with a general alarm (GA) keyswitch for applications where two stage operation is required. The up-front highly visible glass rod discourages tampering, but is not required for proper operation.

GE Security's double action single stage SIGA-278 station is a contemporary style manual station made from durable red colored lexan. To initiate an alarm, first lift the upper door marked "LIFT THEN PULL HANDLE", then pull the alarm handle.

Standard Features

Note: *Some features described here may not be supported by all control systems. Check your control panel's Installation and Operation Guide for details.*

- **Traditional familiar appearance**
  SIGA-270 models feature our familiar teardrop design with simple positive pull action and sturdy die-cast metal body.
- **One stage (GA), two stage (pre-signal), and double action models**
  SIGA-270 models are available for one or two stage alarm systems. The single stage double action SIGA-278 features a rugged Lexan housing with keyed reset mechanism.
- **Break glass operation**
  An up-front visible glass rod on the SIGA-270 discourages tampering.
- **Intelligent device c/w 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.
- **Non-volatile memory**
  Permanently stores serial number, type of device, and job number. Automatically updates historic information including hours of operation, last maintenance date, number of alarms and troubles, and time and date of last alarm.
- **Automatic device mapping**
  Each station transmits wiring information to the loop controller regarding its location with respect to other devices on the circuit.
- **Electronic addressing**
  Permanently stores programmable address; there are no switches or dials to set. Addresses are downloaded from a PC, or the SIGA-PRO Signature Program/Service Tool.
- **Stand-alone operation**
  The station inputs an alarm even if the loop controller's polling interrogation stops.
- **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).

Manual Pull Stations

SIGA-270, SIGA-270P, SIGA-278

SIGA-278

SIGA-270 SERIES

MEA

Patented

Application

The operating characteristics of the fire alarm stations are determined by their sub-type code or "Personality Code". NORMALLY-OPEN ALARM - LATCHING (Pesonality Code 1**)** is assigned by the factory; no user configuration is required. The device is configured for Class B IDC operation. An ALARM signal is sent to the loop controller when the station's pull lever is operated. The alarm condition is latched at the station.

Compatibility

Signature Series manual stations are compatible only with GE Security's Signature Loop Controller.

Warnings & Cautions

This device will not operate without electrical power. As fires frequently cause power interruption, we suggest you discuss further safeguards with your local fire protection specialist.

Testing & Maintenance

To test (or reset) the station simply open the station and operate the exposed switch. The SIGA-270 series are opened with a tool; the SIGA-278 requires the key which is supplied with that station.

The station's automatic self-diagnosis identifies when it is defective and causes a trouble message. The user-friendly maintenance program shows the current state of each Signature series device and other pertinent messages. Single devices may be deactivated temporarily, from the control panel. Availability of maintenance features is dependent on the fire alarm system used.

Scheduled maintenance (Regular or Selected) for proper system operation should be planned to meet the requirements of the Authority Having Jurisdiction (AHJ). Refer to current NFPA 72 and ULC CAN/ULC 536 standards.

Typical Wiring

The fire alarm station's terminal block accepts #18 AWG (0.75mm^2) to #12 AWG (2.5mm^2) wire sizes. See Signature Loop Controller catalog sheet for detailed wiring requirement specifications.

Wiring Notes

1. Refer to Signature Loop Controller manual for maximum wire distance.
2. All wiring is power limited and supervised.

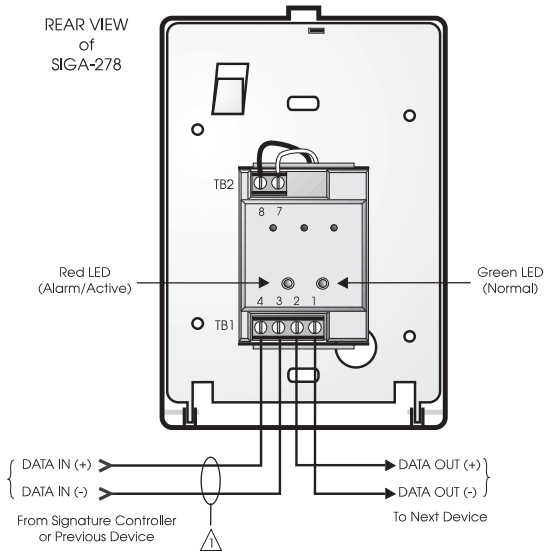

Figure 4. Single Stage Systems

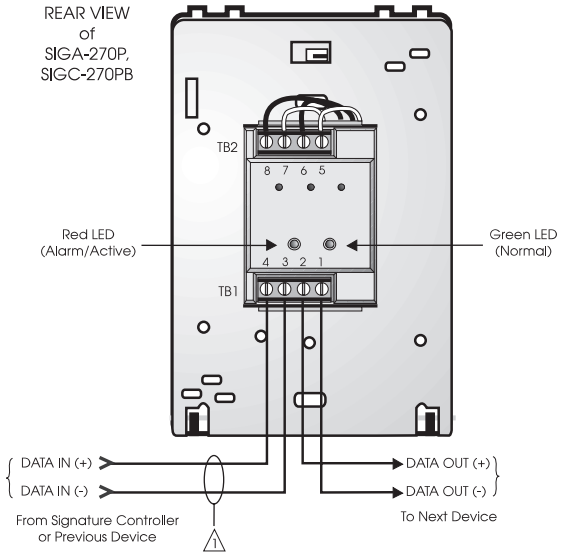

Figure 5. Two Stage Systems

Installation

Single-stage Signature Series fire alarm manual pull stations mount to North American 2½ inch (64 mm) deep 1-gang boxes.

Two stage presignal (270P) models require 1½ inch (38 mm) deep 4-inch square boxes with 1-gang, ½-inch raised covers. Openings must be angular. *Rounded openings are not acceptable.* Recommended box: Steel City Model 52-C-13; in Canada, use Iberville Model CI-52-C-49-1/2.

All models include terminals are suited for #12 to #18 AWG (2.5 mm^2 to 0.75 mm^2) wire size. GE Security recommends that these fire alarm stations be installed according to latest recognized edition of national and local fire alarm codes.

Electronic Addressing: The loop controller electronically addresses each manual station, saving valuable time during system commissioning. Setting complicated switches or dials is not required. Each station has its own unique serial number stored in its on-board memory. The loop controller identifies each device on the loop and assigns a "soft" address to each serial number. If desired, the stations can be addressed using the SIGA-PRO Signature Program/Service Tool.

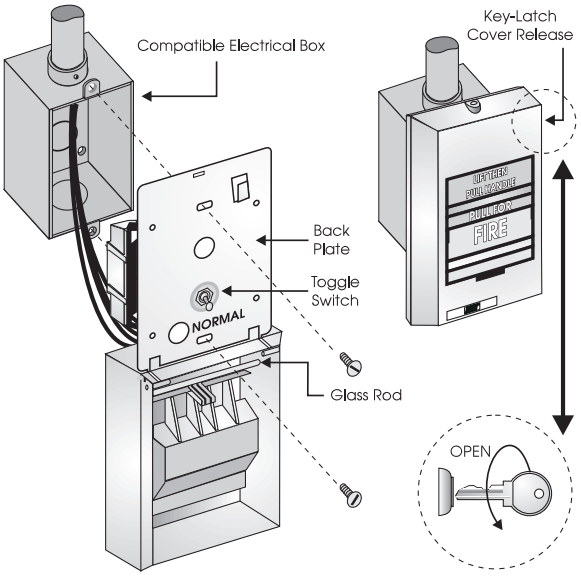

Figure 1. SIGA-278 installation

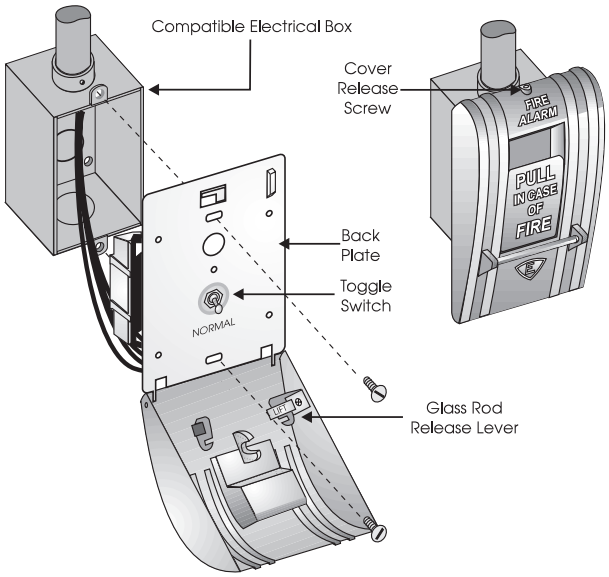

Figure 2. SIGA-270, SIGC-270F, SIGC-270B installation

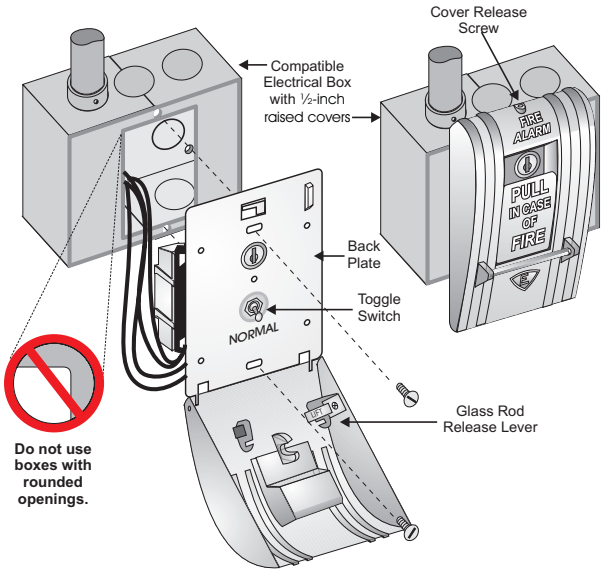

Figure 3. SIGA-270P, SIGC-270PB installation

U.S.
T 888-378-2329
F 866-503-3996

Canada
T 519 376 2430
F 519 376 7258

Asia
T 852 2907 8108
F 852 2142 5063

Australia
T 61 3 9259 4700
F 61 3 9259 4799

Europe
T 32 2 725 11 20
F 32 2 721 86 13

Latin America
T 305 593 4301
F 305 593 4300

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Specifications

Catalog Number	SIGA-270, SIGC-270F, SIGC-270B	SIGA-270P, SIGC-270PB	SIGA-278
Description	Single Action - One Stage	Single Action -Two Stage (Presignal)	Double Action - One Stage
Addressing Requirements	Uses 1 Module Address	Uses 2 Module Addresses	Uses 1 Module Address
Operating Current	Standby = 250µA Activated = 400µA	Standby = 396µA Activated = 680µA	Standby = 250µA Activated = 400µA
Construction & Finish	Diecast Zinc - Red Epoxy with aluminum markings		Lexan - Red with white markings
Type Code	Factory Set		
Operating Voltage	15.2 to 19.95 Vdc (19 Vdc nominal)		
Storage and Operating Environment	Operating Temperature: 32°F to 120°F (0°C to 49°C) Storage Temperature: -4°F to 140°F (-20°C to 60°C) Humidity: 0 to 93% RH		
LED Operation	On-board Green LED - Flashes when polled On-board Red LED - Flashes w hen in alarm Both LEDs - Glow steady when in alarm (stand-alone)		
Compatibility	Use With: Signature Loop Controller		
Agency Listings	UL, ULC (note 1), MEA, CSFM		

Note: *SIGC-270F, SIGC-270B and SIGC-270PB are ULC listed only. Suffix "F" indicates French markings. Suffix "B" indicates English/French biling ual markings.*

Ordering Information

Catalog Number	Description	Ship Wt. lbs (kg)
SIGA-270	One Stage Fire Alarm Station, English Markings - UL/ULC Listed	1 (0.5)
SIGC-270F	One Stage Fire Alarm Station, French Markings - ULC Listed	
SIGC-270B	One Stage Fire Alarm Station, French/English Markings - ULC Listed	
SIGA-270P	Two Stage (Presignal) Fire Alarm Station, English Markings - UL/ULC Listed	
SIGC-270PB	Two Stage (Presignal) Fire Alarm Station, French/English Markings - ULC Listed	
SIGA-278	Double Action (One Stage) Fire Alarm Station, English Markings - UL/ULC Listed	

Accessories		
32997	GA Key w/Tag - for pre-signal station (CANADA ONLY)	0.1 (.05)
276-K2	GA Key - for pre-signal station (USA ONLY)	
27165	12 Glass Rods - for SIGA-270 series (CANADA ONLY)	
270-GLR	20 Glass Rods - for SIGA-270 series (USA ONLY)	
276-GLR	20 Glass Rods - for SIGA-278 series	
276B-RSB	Surface Mount Box, Red - for SIGA pull stations	1 (0.6)

imagination at work

Overview

Signature Series Model SIGA-HFS and SIGA-HRS Intelligent Heat Detectors gather analog information from their fixed temperature and/or rate-of-rise heat sensing elements and converts it into digital signals. The detector's on-board microprocessor measures and analyzes these signals. It compares the information to historical readings and time patterns to make an alarm decision. Digital filters remove signal patterns that are not typical of fires. Unwanted alarms are virtually eliminated.

The microprocessor in each detector provides four additional benefits - Self-diagnostics and History Log, Automatic Device Mapping, Stand-alone Operation and Fast, Stable Communication.

Standard Features

Note: *Some features described here may not be supported by all control systems. Check your control panel's Installation and Operation Guide for details.*

- 70 foot (21.3 meter) spacing
- 15° F (9° C)/min rate-of-rise/135° F (57° C) ft. and 135° F (57 ° C) fixed temperature type
- Intelligent detector c/w integral microprocessor
- Non-volatile memory
- Automatic device mapping
- Electronic addressing
- Identification of defective detectors
- Twin RED/GREEN status LEDs
- Standard, relay, fault isolator, and audible mounting bases
- Designed and manufactured to ISO 9001 standards

Intelligent Heat Detectors

SIGA-HFS & SIGA-HRS

Application Notes Available

Signature Series Overview

Self-diagnostics and History Log - Each Signature Series detector constantly runs self-checks to provide important maintenance information. The results of the self-check are automatically updated and permanently stored in the detector's non-volatile memory. This information is accessible for review any time at the control panel, PC, or by using the SIGA-PRO Signature Program/Service Tool.

In the unlikely event that an unwanted alarm does take place, the control panel's history file can be called up to help isolate the problem and prevent it from happening again.

Automatic Device Mapping - The loop controller learns where each device's serial number address is installed relative to other devices on the circuit. This mapping feature provides supervision of each device's installed location to prevent a detector from being reinstalled (after cleaning etc.) in a different location from where it was originally. The history log for the detector remains relevant and intact regardless of its new location.

The Signature Series Data Entry Program also uses the mapping feature. With interactive menus and graphic support, the wired circuits between each device can be examined. Layout or "as-built" drawing information showing wire branches (T-taps), device types and their address are stored on disk for printing hard copy. This takes the mystery out of the installation. The preparation of as-built drawings is fast and efficient.

Stand-alone Operation - A decentralized alarm decision by the detector is guaranteed. On-board intelligence permits the detector to operate in stand-alone mode. If loop controller CPU communications fail for more than four seconds, all devices on that circuit go into stand-alone mode. The circuit acts like a conventional alarm receiving circuit. Each detector on the circuit continues to collect and analyze information from its surroundings. Both the SIGA-HRS and SIGA-HFS detectors alarm if the ambient temperature increases to 135°F (57°C) or for the SIGA-HRS only, the temperature increases at a rate exceeding 15°F (9°C)/minute. If the detector is mounted to a relay base, the relay operates. Similarly, if it is mounted to an audible base, the on-board horn sounds.

Fast Stable Communication - On-board intelligence means less information needs to be sent between the detector and the loop controller. Other than regular supervisory polling response, the detector only needs to communicate with the control panel when it has something new to report. This provides very fast control panel response time and allows a lower baud rate (speed) to be used for communication on the circuit. The lower baud rate offers several advantages including:

- less sensitivity to circuit wire characteristics
- less sensitivity to noise glitches on the cable
- less emitted noise from the data wiring
- twisted or shielded wiring is not required

Electronic Addressing - The loop controller electronically addresses each detector, saving valuable time during system commissioning. Setting complicated switches or dials is not required. Each detector has its own unique serial number stored in its on-board memory. The loop controller identifies each device on the circuit and assigns a "soft" address to that device's serial number. If desired, detectors can be addressed using the SIGA-PRO Signature Program/Service Tool.

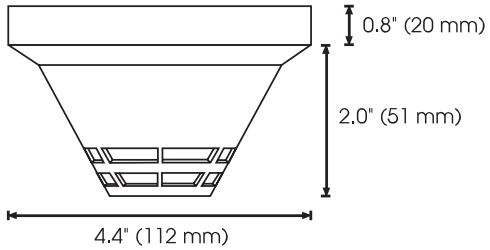
Installation Spacing - The SIGA-HFS (fixed temperature) and the SIGA-HRS (fixed temperature/rate-of-rise combination) intelligent heat detectors are rated for installation at up to 70 foot (21.3 meter) spacing. These detectors may be installed in rooms with ambient temperatures up to 100°F (38°C).

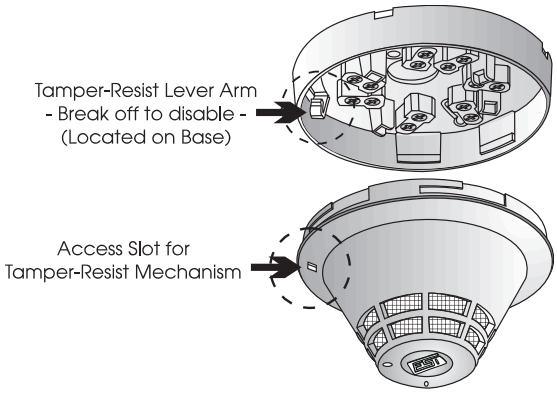
Status LEDs - Twin LEDs are visible from any direction. A flashing GREEN LED shows normal system polling from the loop controller. A flashing RED LED means the detector is in alarm state. Both LEDs on steady shows alarm state - stand-alone mode. Normal GREEN LED activity is not distracting to building occupants, but can be quickly spotted by a maintenance technician.

Quality and Reliability - GE Security detectors are manufactured in North America to strict international ISO 9001 standards. All electronics utilize surface mount technology (SMT) for smaller size and greater immunity to RF noise. A conformal coating is used for humidity and corrosion resistance. All critical contacts are gold plated.

Installation

Signature Series detectors mount to North American 1-gang boxes, 3-1/2 inch or 4 inch octagon boxes, and to 4 inch square electrical boxes 1-1/2 inches (38 mm) deep. They mount to European BESA and 1-gang boxes with 60.3 mm fixing centers.





Application

The table below shows six standard test fires used to rate the sensitivity of smoke and heat detectors. The table indicates that no single sensing element is suited for all test fires.

GE Security recommends that this detector be installed according to latest recognized edition of national and local fire alarm codes.

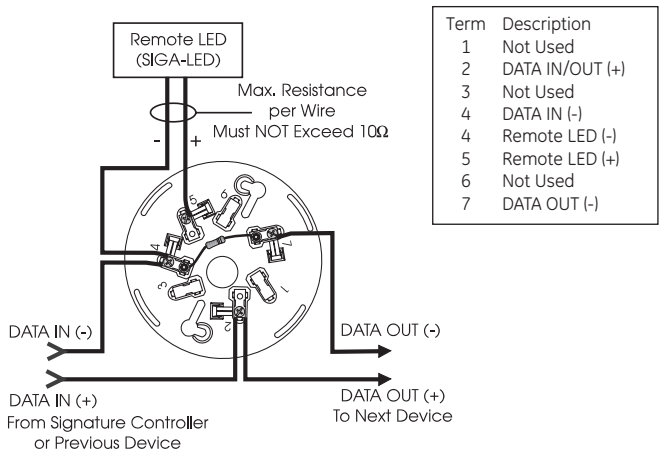
Test Fire	SIGA-IS Ion	SIGA-PS Photo	SIGA-HRS and SIGA-HFS Rate-of-Rise/ Fixed Temp.	SIGA-PHS Photo Heat 3D	SIGA-IPHS Ion/Photo/Heat 4D
Open Wood	**optimum**	unsuitable	**optimum**	very suitable	**optimum**
Wood Pyrolysis	suitable	**optimum**	unsuitable	**optimum**	**optimum**
Smouldering Cotton	very suitable	**optimum**	unsuitable	**optimum**	**optimum**
Poly Urethane Foam	very suitable	very suitable	suitable	very suitable	**optimum**
n-Heptane	**optimum**	very suitable	very suitable	**optimum**	**optimum**
Liquid Fire without Smoke	unsuitable	unsuitable	**optimum**	very suitable	very suitable

Typical Wiring

The detector mounting bases will accept #18 AWG (0.75mm^2), #16 (1.0mm^2), #14 AWG (1.5mm^2), and #12 AWG (2.5mm^2) wire sizes.

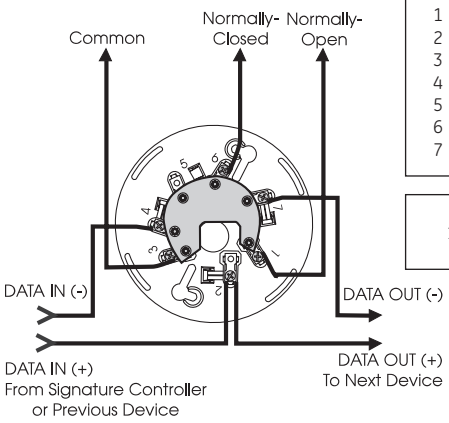
Note: Sizes #16 AWG (1.0mm^2) and #18 AWG (0.75mm^2) are preferred for ease of installation. See Signature Loop Controller catalog sheet for detailed wiring requirement specifications.

Standard Detector Base, SIGA-SB, SIGA-SB4



Term	Description
1	Not Used
2	DATA IN/OUT (+)
3	Not Used
4	DATA IN (-)
4	Remote LED (-)
5	Remote LED (+)
6	Not Used
7	DATA OUT (-)

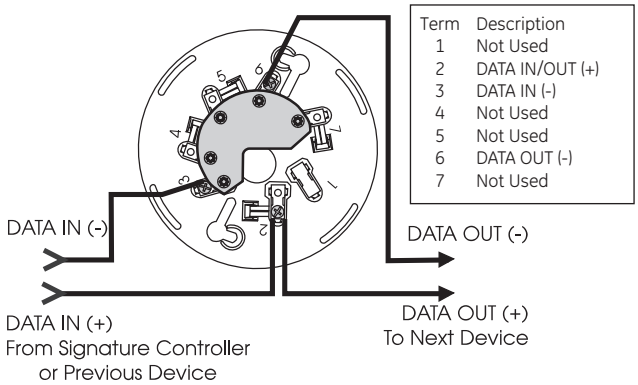
Relay Detector Base, SIGA-RB, SIGA-RB4



Term	Description
1	Normally-Open
2	DATA IN/OUT (+)
3	Common
4	DATA IN (-)
5	Not Used
6	Normally-Closed
7	DATA OUT (-)

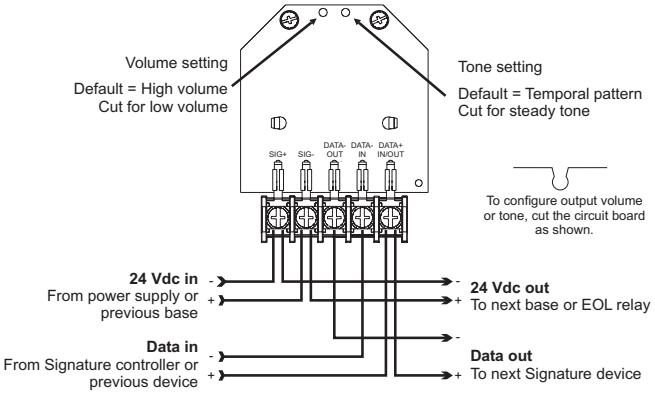
CONTACT RATING
1.0 Amp @ 30 VDC
(Pilot Duty)

Isolator Detector Base, SIGA-IB, SIGA-IB4



Term	Description
1	Not Used
2	DATA IN/OUT (+)
3	DATA IN (-)
4	Not Used
5	Not Used
6	DATA OUT (-)
7	Not Used

Audible Detector Base, SIGA-AB4G



Accessories

All detector mounting bases have wiring terminals that are accessible from the "room-side" after mounting the base to the electrical box. The bases mount to North American 1-gang boxes and to 3½ inch or 4 inch octagon boxes, 1½ inches (38 mm) deep. They also mount to European BESA and 1-gang boxes with 60.3 mm fixing centers. The SIGA-SB4, SIGA-RB4, and SIGA-IB4 mount to North American four inch square electrical boxes in addition to the above boxes. They include the SIGA-TS4 Trim Skirt which is used to cover the "mounting ears" on the base. The SIGA-AB4G mounts to a 4" sqare box only.


SIGA-AB4G
Audible Base


SIGA-SB
Standard Base


SIGA-IB
Isolator Base


SIGA-RB
Relay Base


SIGA-LED
Remote LED

Standard Base SIGA-SB, SIGA-SB4 - This is the basic mounting base for GE Security Signature Series detectors. The SIGA-LED Remote LED is supported by the Standard Base.

Relay Base SIGA-RB, SIGA-RB4 - This base includes a relay. Normally open or closed operation is selected during installation. The dry contact is rated for 1 amp (pilot duty) @ 30 Vdc. The relay's position is supervised to avoid accidentally jarring it out of position. The SIGA-RB can be operated as a control relay if programmed to do so at the control panel (EST3 V. 2 only). The relay base does not support the SIGA-LED Remote LED.

Audible Base SIGA-AB4G - This base is designed for use where localized or group alarm signaling is required. When the detector senses an alarm condition, the audible base emits a local alarm signal. The optional SIGA-CRR Polarity Reversal Relay can be used for sounding to other audible bases on the same 24 Vdc circuit.

Relay and Audible Bases operate as follows:

- at system power-up or reset, the relay is de-energized
- when a detector is installed in the base with the power on, the relay energizes for four seconds, then de-energizes
- when a detector is removed from a base with the power on, the relay is de-energized
- when the detector enters the alarm state, the relay is energized.

Isolator Base SIGA-IB, SIGA-IB4 - This base includes a built-in line fault isolator for use on Class A circuits. A detector must be installed for it to operate. The isolator base does not support the SIGA-LED Remote LED.

The isolator operates as follows:

- a short on the line causes all isolators to open within 23 msec
- at 10 msec intervals, beginning on one side of the Class A circuit nearest the loop controller, the isolators close to provide the next isolator down the line with power
- if the isolator next to the short closes, it reopens within 10 msec.

The process repeats beginning on the other side of the loop controller.

Remote LED SIGA-LED - The remote LED connects to the SIGA-SB or SIGA-SB4 Standard Base only. It features a North American size 1-gang plastic faceplate with a white finish and red alarm LED.

SIGA-TS4 Trim Skirt - Supplied with 4 inch bases, it can also be ordered separately to use with the other bases to help hide surface imperfections not covered by the smaller bases.

Warnings & Cautions

This detector will not operate without electrical power. As fires frequently cause power interruption, we suggest you discuss further safeguards with your fire protection specialist.

This detector will NOT sense fires that start in areas where heat cannot reach the detector. Heat from fires in walls, roofs, or on the opposite side of closed doors may not reach the detector to alarm it.

The heat sensor in this device only provides a source of information to supplement the information provided by photoelectric or ionization smoke detectors which may be located nearby. The heat detector by itself does NOT provide life safety protection. Under no circumstances should heat detectors be relied on as the sole means of fire protection.

Compatibility

The SIGA-HFS and SIGA-HRS detectors are compatible only with GE Security's Signature Loop Controller.

Specifications

Catalog Number	SIGA-HFS	SIGA-HRS
Heat Sensing Element	Fixed Temperature	Fixed & Temperature/ Rate-of-Rise
Alarm Point	Alarms at 135°F (57°C) Ambient	Alarms at 135°F (57°C) Ambient or Temp. increase above 15°F (9°C) per min.
UL Listed Detector Spacing	70 feet (21.3 meters) center to center spacing	
Operating and Storage Environment	Operating Temp: 32°F to 100°F (0°C to 38°C) Storage Temp: -4°F to 140°F (-20°C to 60°C) Humidity: 0 to 93% RH, Non-Condensing	
Operating Voltage	15.2 to 19.95 Vdc (19 Vdc nominal)	
Operating Current	Quiescent: 45µA @ 19 V Alarm: 45µA @ 19V Emergency Stand-alone Alarm Mode: 18mA Pulse Current: 100 µA (100 msec)	
Construction & Finish	High Impact Engineering Polymer - White	
Compatible Mounting Bases	SIGA-SB Standard Base, SIGA-RB Relay Base, SIGA-IB Isolator Base, SIGA-AB4, SIGA-AB4G Audible Bases	
LED Operation	On-board Green LED - Flashes when polled On-board Red LED - Flashes when in alarm; Both LEDs - Glow steady when in alarm (stand-alone) Compatible Remote Red LED (model SIGA-LED) Flashes when in alarm	
Compatibility	Use With: SIGNATURE Loop Controller	
Address Requirements	Uses one device address	
Agency Listings	UL, ULC, MEA, CSFM	

Ordering Information

Catalog Number	Description	Ship Wt. lbs (kg)
SIGA-HFS	Intelligent Fixed Temperature Heat Detector - UL/ULC Listed	0.5 (0.23)
SIGA-HRS	Intelligent Fixed Temperature/Rate-of-Rise Heat Detector - UL/ULC Listed	
Accessories		
SIGA-SB	Detector Mounting Base	0.2 (.09)
SIGA-SB4	4-inch Detector Mounting Base c/w SIGA-TS Trim Skirt	
SIGA-RB	Detector Mounting Base w/Relay	
SIGA-RB4	4-inch Detector Mounting Base /w Relay c/w SIGA-TS Trim Skirt	
SIGA-IB	Detector Mounting Base w/Fault Isolator	
SIGA-IB4	4-inch Detector Mounting Base w/ Fault Isolator c/w SIGA-TS Trim Skirt	
SIGA-LED	Remote Alarm LED	
SIGA-AB4G	Audible (Sounder) Base	0.3 (0.15)
SIGA-TS4	Trim Skirt (supplied with 4-inch bases)	0.1 (.04)

U.S.
T 888-378-2329
F 866-503-3996

Canada
T 519 376 2430
F 519 376 7258

Asia
T 852 2907 8108
F 852 2142 5063

Australia
T 61 3 9259 4700
F 61 3 9259 4799

Europe
T 32 2 725 11 20
F 32 2 721 86 13

Latin America
T 305 593 4301
F 305 593 4300

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imagination at work

Overview

The GE Security *SuperDuct* Signature Series smoke detector is the most advanced and most reliable device in its class. Designed for easy installation and superb reliability, *SuperDuct* represents the perfect balance of practical design and advanced technology.

***SuperDuct* detectors** feature a unique design that speeds installation and simplifies maintenance. Removable dust filters, conformally coated circuit boards, and optional water-resistant gaskets keep contaminants away from components, ensuring years of trouble-free service. When cleaning is required, the assemblies come apart easily and snap back together in seconds.

A Signature Series photoelectric sensor is incorporated into the design of each SIGA-SD duct smoke detector. This sensor inherits the power and benefits of this exceptional line of intelligent devices.

Signature Series sensors gather analog information from their smoke sensing elements and convert it into digital signals. The sensor measures and analyses these signals and compares the information to historical readings and time patterns to make an alarm decision. Digital filters remove signal patterns that are not typical of fires, which virtually eliminates unwanted alarms.

WARNING: Duct detectors have specific limitations. Duct detectors are not a substitute for an open area smoke detector. Duct detectors are not a substitute for early warning detection or a replacement for a building's regular fire detection system. Smoke detectors are not designed to detect toxic gases which can build up to hazardous levels in some fires. These devices will not operate without electrical power. As fires frequently cause power interruptions, GE Security suggests you discuss further safeguards with your local fire protection specialist.

Standard Features

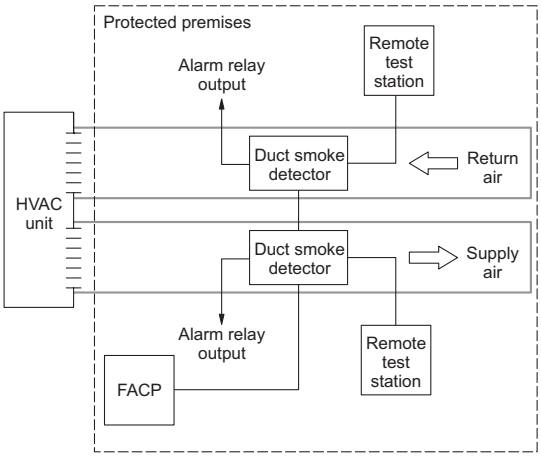
- Less than 2" deep for easy installation and applications where space is tight
- -20 to 158 °F (-29 to 70 °C) operating range with 100 ft/min. to 4,000 ft/min air velocity rating assures reliability under harsh environmental conditions
- Status LEDs remain visible through clear assembly cover
- Cover monitor switch for added security
- Standard sampling tube spacing for easy drop-in migration from other detectors
- Sampling tube can be installed with or without the cover in place and can be rotated in 45-degree increments to ensure proper alignment with duct airflow
- 15.2 to 19.95 Vdc operation
- Magnet-activated test switch
- One Form C auxiliary alarm relay for controlling ancillary equipment (e.g., HVAC controls)
- No special tools required for easy access to field connections
- Signature Series intelligence
- Environmental compensation with differential sensing for reliable, stable, and drift-free sensitivity
- Wide 0.79% to 2.46% obscuration/ft. smoke sensitivity
- Identification of dirty or defective detectors

Intelligent Duct Smoke Detector

SIGA-SD

Application

SuperDuct detectors are ideally suited to duct smoke detection applications where early indication of combustion is required within the confined space of ventilation ductwork. Its primary purpose is to provide early warning of an impending fire and to prevent smoke from circulating throughout the building. It is typically used to detect smoke in the supply side of the HVAC system but can provide supervision of the return side as well.



SuperDuct detectors continually sample air flow in the HVAC duct and initiate an alarm condition whenever smoke is detected. An alarm is activated when the quantity (percent obscuration) of combustion products in that air sample exceeds the detector's sensitivity setting.

Signature Series Intelligence

Like all Signature detectors, the SIGA-SD features electronic addressing and issues a dirty sensor warning when it reaches its preset limit. The dirty sensor warning indicates the sensor is operating within its specified limits but is in need of servicing. When the detector's ability to compensate for environmental changes has reached its limit, the duct smoke detector signals a trouble condition.

The SIGA-SD also uses differential sensing to prevent gradual environmental changes from triggering unwanted alarms. A rapid change in environmental conditions, such as smoke from a fire, causes the detector to signal an alarm state, but dust and debris accumulated over time does not change alarm sensitivity.

Each Signature Series SuperDuct detector contains a microprocessor that performs comprehensive self-diagnostics and stores the results in nonvolatile memory. Stored results include details such as hours of operation, last maintenance date, and number of alarms and troubles. This information can be retrieved and reviewed when desired.

Detector Configuration

The detector assembly cover provides easy access to the smoke sensor, its wiring connections, sample and exhaust tubes, and the smoke chamber itself.

Air enters the detector's sensing chamber through a sampling tube (ordered separately) that extends into the duct and is directed back into the ventilation system through an exhaust tube (included). The difference in air pressure between the two tubes pulls the sampled air through the sensing chamber. When a sufficient amount of smoke is detected in the sensing chamber, the detector initiates an alarm.

The sampling tube may be installed from either the duct side of the assembly or from inside the sensor compartment, as preferred by the installer. (The exhaust tube must be installed from the duct side.) Sampling tubes may be rotated in 45-degree increments so that air-holes can be aligned to allow the unit to be mounted at virtually any angle relative to the air flow.

In installations where the duct smoke detector's controls and indicators are hidden from view, a remote test station or an LED indicator can be connected to the detector to provide these functions.

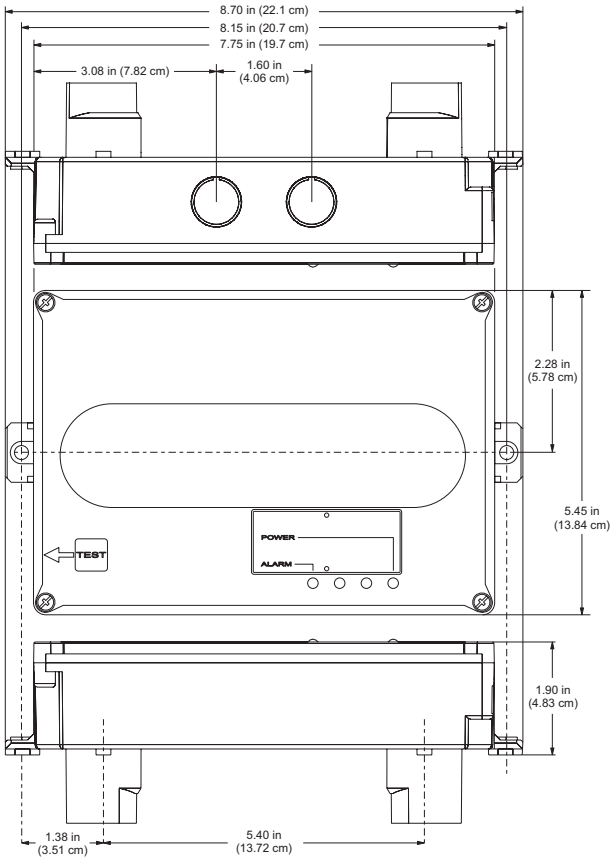
Remote Test Stations

Labor-saving Remote Test/Reset stations provide alarm testing from the convenience of a remote location. Tests can be performed quickly and safely – without having to climb to the roof. Magnetically-operated and key-operated one-gang models are available. Signature SuperDuct detectors are also compatible with SIGA-LED remote alarm LED.

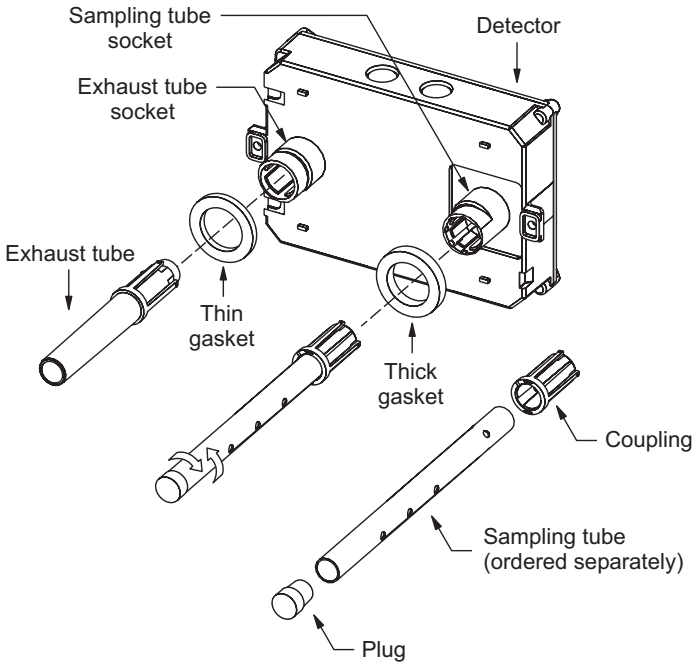
Air velocity in the duct as low as 100 ft/min. maintains adequate air flow into the sensor smoke chamber through air holes in the air sampling tube and discharges through the exhaust tube. *SuperDuct* air sampling tubes must be installed with the inlet holes facing the airstream. Sampling tubes may be rotated in 45-degree increments so that air-holes can be aligned to allow the unit to be mounted in virtually any angle relative to the airflow.

SuperDuct sensors are engineered to operate optimally under the harsh environmental conditions frequently found in HVAC ductwork. Nonetheless, before installing the detector, test the duct air velocity, temperature, and humidity to verify that it is within the operating range of the *SuperDuct* detector. Consult the *SuperDuct* installation sheet for details.

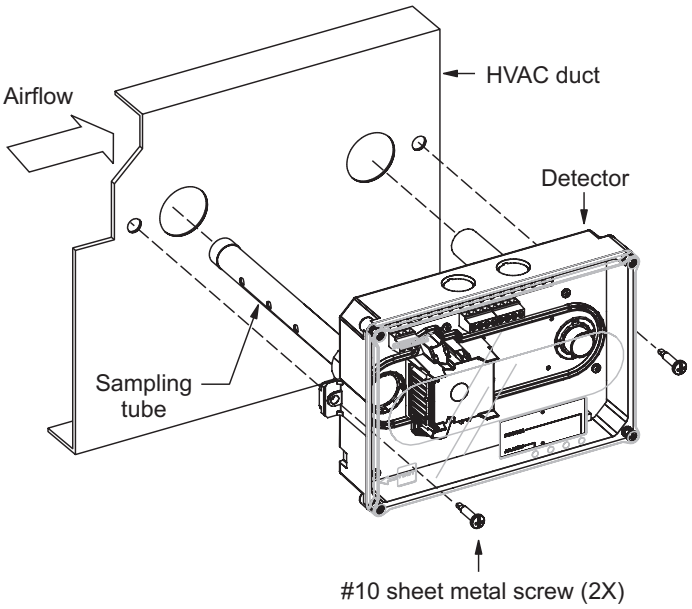
Dimensions



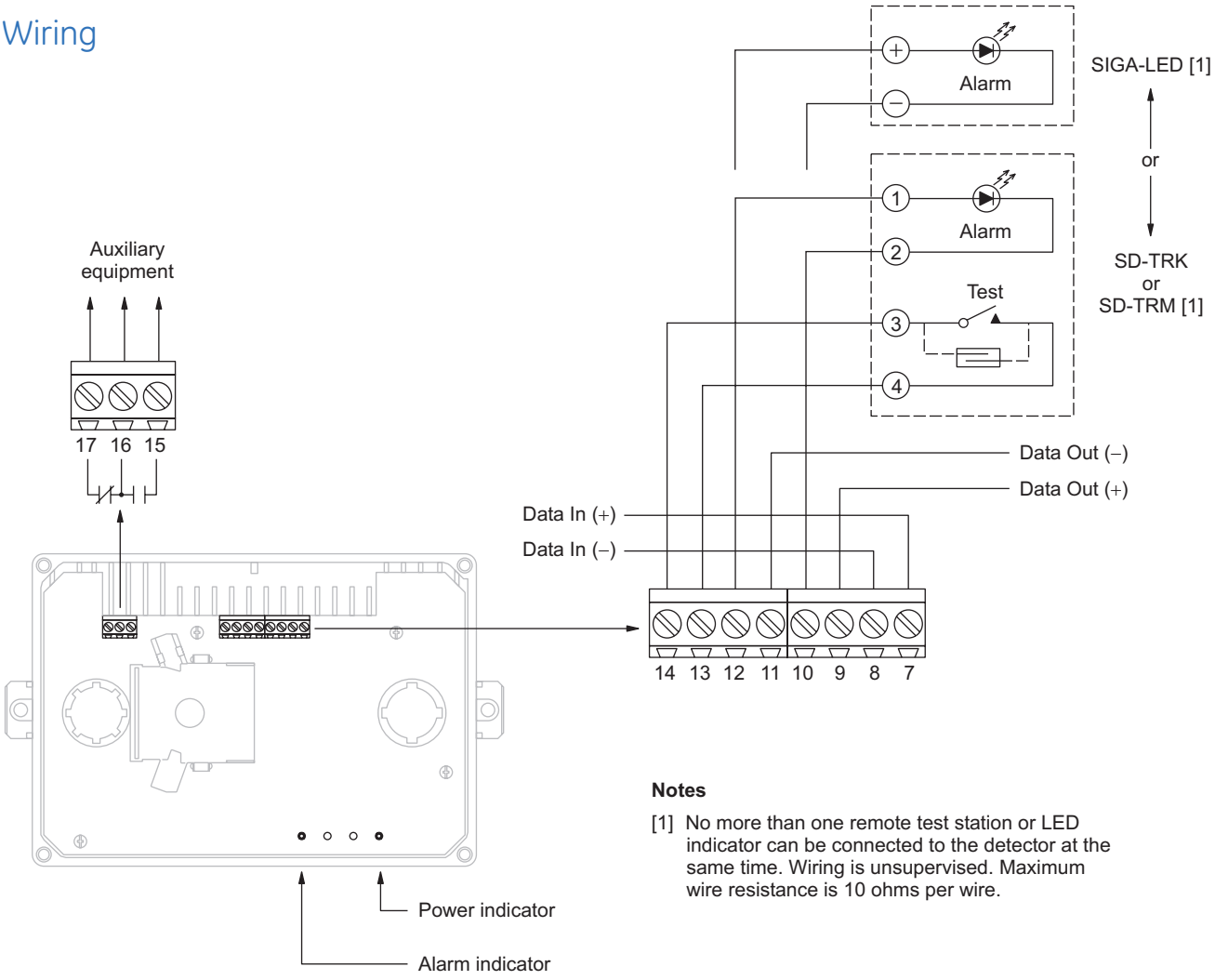
Assembly



Mounting



Wiring



Notes

[1] No more than one remote test station or LED indicator can be connected to the detector at the same time. Wiring is unsupervised. Maximum wire resistance is 10 ohms per wire.

GE
Security

U.S.
T 888-378-2329
F 866-503-3996

Canada
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F 519 376 7258

Asia
T 852 2907 8108
F 852 2142 5063

Australia
T 61 3 9259 4700
F 61 3 9259 4799

Europe
T 32 2 725 11 20
F 32 2 721 86 13

Latin America
T 305 593 4301
F 305 593 4300

www.gesecurity.com

Signature Series is a Trademark of GE Security.

Specifications, detector

Dimensions	8.70 x 5.45 x 1.90 inches (221 x 138 x 48 mm)
Wire size	14 to 22 AWG
Smoke detection method	Photoelectric (light scattering principle)
Air velocity rating	100 to 4,000 ft/min
Air pressure differential	0.005 to 1.00 inches of water
Sensitivity	0.79 to 2.46 %/ft obscuration
Alarm test response time	5 seconds
LED indicators	Alarm (red), Power (green)
Common alarm relay	Unsupervised and power-limited Quantity: 1 Type: Form C Ratings: 2.0 A at 30 Vdc (resistive)
Operating voltage	15.2 to 19.95 Vdc
Operating current	Standby: 45 µA Alarm: 45 µA Inrush: 1 mA Standalone alarm: 18 mA
Operating environment	Temperature: -20 to 158 °F (-29 to 70 °C) Humidity 93% RH, noncondensing
Agency listings	UL, ULC, CSFM, FM, MEA

Specifications, test stations

Remote Test/Reset Stations provide alarm test, trouble indication, and reset capability from a remote location. They include a one-gang plate, momentary SPST switch, red alarm LED, and terminal block. Magnetically-operated models (TRM) or key-operated models (TRK) are available.

Compatible electrical boxes	North American 1-gang box Standard 4-in square box, 1-1/2 inches deep, with 1-gang cover
LED indicators	Alarm (red)
LED type	Clear lens
Wire size	14 to 22 AWG
Resistance per wire	10 Ohms, max.
Current requirements	See controller specifications
LED circuit ratings	Voltage: 3 Vdc, max. Current: 30 mA, max.
Switch ratings (SD-TRK)	Voltage: 125 Vdc, max. Current: 4 A, max.
Switch ratings (SD-TRM)	Voltage: 200 Vdc, max. Current: 0.5 A, max.
Compatible detectors	SuperDuct conventional two-wire and Signature duct smoke detectors
Operating environment	Temperature: 32 to 131 °F (0 to 55 °C) Humidity: 93% RH, noncondensing
Storage temperature	-4 to 140 °F (-20 to 60 °C)
Agency listings	UL, ULC, CSFM

Ordering Information

Catalog Number	Description	Ship Wt., lb. (kg)
SIGA-SD	Intelligent SuperDuct Detector	2.4 (1.1)
Accessories		
SD-T8	8-inch sampling tube	0.5 (0.2)
SD-T18	18-inch sampling tube	1.5 (0.7)
SD-T24	24-inch sampling tube	2.7 (1.2)
SD-T36	36-inch sampling tube	3.0 (1.4)
SD-T42	42-inch sampling tube	3.5 (1.6)
SD-T60	60-inch sampling tube	5.8 (2.6)
SD-T78	78-inch sampling tube	7.5 (3.4)
SD-T120	120-inch sampling tube	11.5 (5.2)
SIGA-LED	Remote alarm LED	1.0 (0.5)
SD-TRM	Remote test station, magnetic	1.0 (0.5)
SD-TRK	Remote test station, keyed	1.0 (0.5)
SD-VTK	Air velocity test kit (stoppers only, etc)	1.0 (0.5)
SD-GSK	Cover gasket kit	0.5 (0.2)
SD-MAG	Test magnet kit	0.5 (0.2)
SIGA-SDPCB	Replacement PCB/Signature sensor kit	1.0 (0.5)

imagination at work

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.

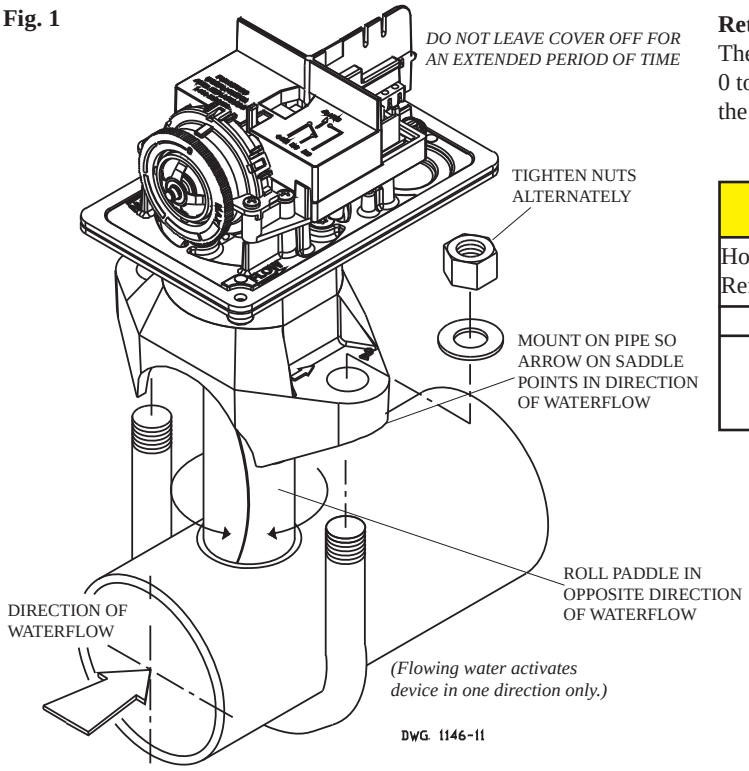
NOTE: Do not leave cover off for an extended period of time.

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

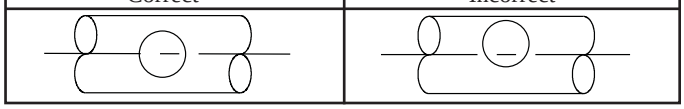


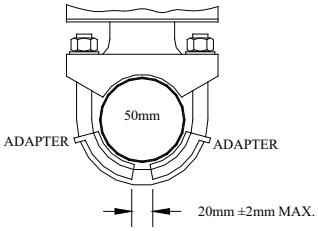
Retard Adjustment

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

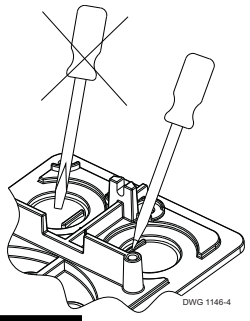
DWG# 1146-1F

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.

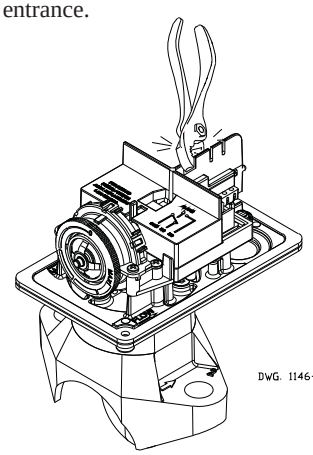
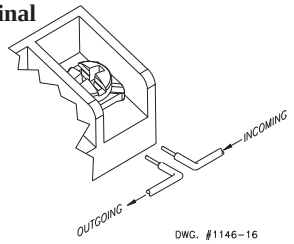


Fig. 4 Switch Terminal Connections Clamping Plate Terminal

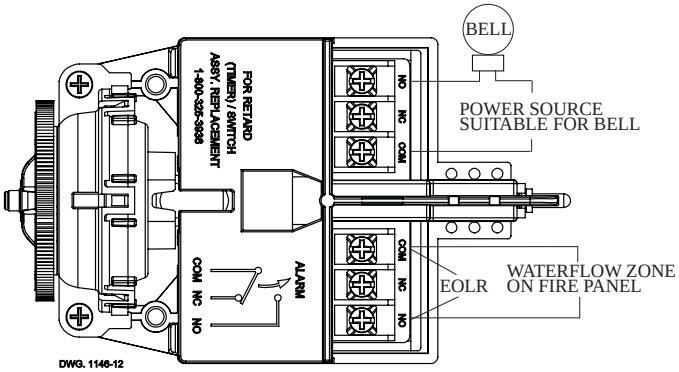


WARNING
An uninsulated section of a single conductor should not be looped around the terminal and serve as two separate connections. The wire must be severed, thereby providing supervision of the connection in the event that the wire become dislodged from under the terminal. Failure to sever the wire 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).

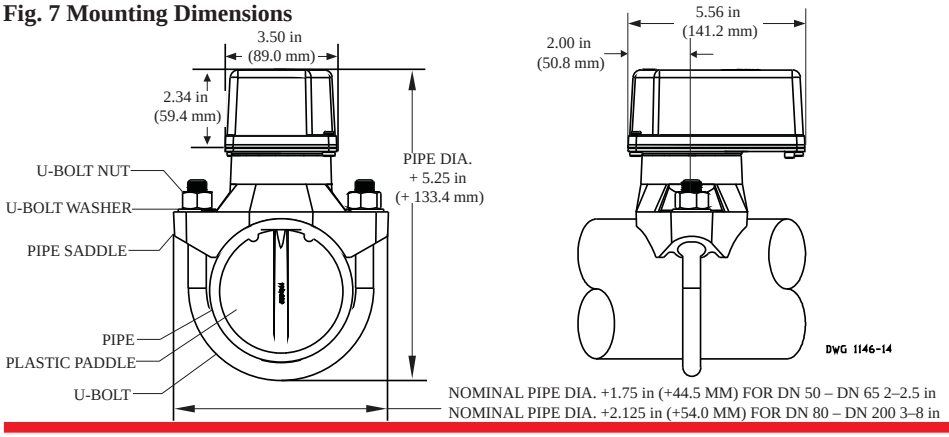


Testing
The frequency of inspection and testing for the Model VSR and its associated protective monitoring system shall be in accordance with applicable NFPA Codes and Standards and/or the authority having jurisdiction (manufacturer recommends quarterly or more frequently).

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.

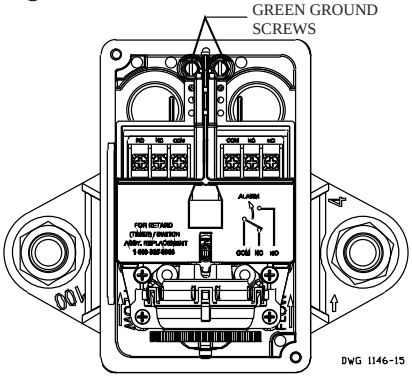
NOTICE Advise the person responsible for testing of the fire protection system that this system must be tested in accordance with the testing instructions.

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

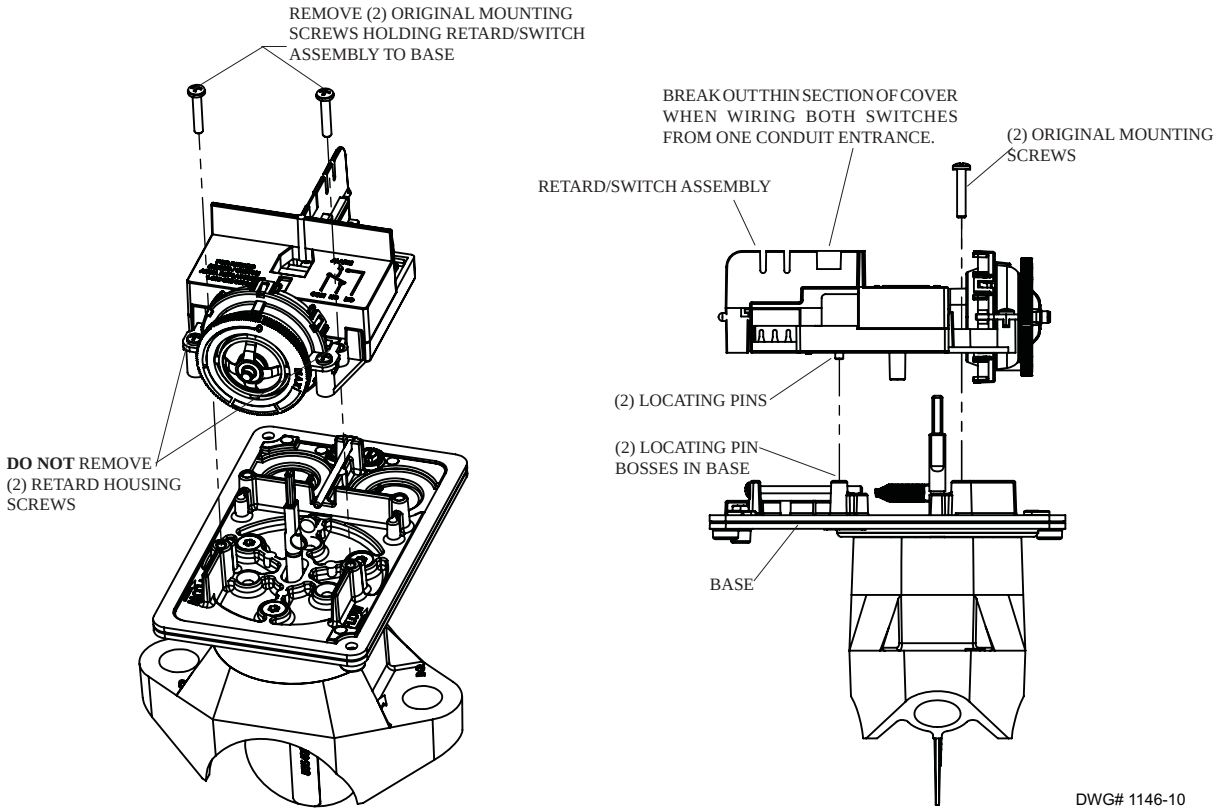
Inspect detectors monthly. If leaks are found, replace the detector. The VSR waterflow switch should provide years of trouble-free service. The retard and switch assembly are easily field replaceable. In the unlikely event that either component does not perform properly, please order replacement retard 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.

MODEL PS10A
PRESSURE SWITCH

PS10-1A Single Switch - Stock No. 1340101
PS10-2A Double Switch - Stock No. 1340102

UL, cUL and CSFM Listed, FM and LPC Approved, NYMEA Accepted, CE Marked

Dimensions: 4 3/4" (12,1cm)W x 2 1/4" (5,7cm)D x 4 3/8" (11,1cm)H

Enclosure: Cover - Die-cast with textured red powdercoat finish
Base - Plated Steel

Pressure Connection: 1/2" NPT Male

Factory Adjustment:
Operates on Pressure increase at 6 ±1 PSI (0,41±0,07 BAR)
Operates on Pressure decrease at 5 ±1 PSI (0,35±0,07 BAR)

Maximum Differential: 1 PSI (0,06 BAR)

Maximum System Pressure: 250 PSI (17,2 BAR)

Switch Contacts: SPDT (Form C)
15.0 Amps at 125/250VAC, 2.5 Amps at 30VDC
One set in PS10-1A, Two sets in PS10-2A

Environmental Specifications: Indoor or outdoor use
NEMA 4/IP55 Rated Enclosure - when used with proper conduit fittings
Temperature range: -40°F to 140°F (-40°C to 60°C)
(Not for use in hazardous locations)

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

Tamper: Cover incorporates tamper resistant fasteners that require a special key for removal. One key is supplied with each device. For optional cover tamper switch kit, order Stock No. 0090134.

INSTALLATION AND TEST PROCEDURES

The Potter PS10A Series Pressure Actuated Switches are designed for the detection of a waterflow condition in automatic fire sprinkler systems of particular designs such as wet systems with alarm check valves or dry pipe systems. They may also be used to provide a low pressure supervisory signal. They may be adjusted to operate on pressure between 4 and 20 PSI (0,27 and 0,4 BAR).

MOUNTING: Device should be mounted in upright position (threaded connection down). Requires NEMA type 4 conduit hub for outdoor installations.

TESTING: The operation of the pressure alarm switch should be tested upon completion of installation and periodically thereafter in accordance with the applicable NFPA codes and standards and/or the authority having jurisdiction (manufacturer recommends quarterly or more frequently).

WET SYSTEM:

METHOD 1: When using PS10A and control unit with retard - connect PS10A into alarm port piping on the input side of retard chamber and electrically connect PS10A to control unit that provides a retard to compensate for surges. Insure that no unsupervised shut-off valves are present between the alarm check valve and PS10A.

METHOD 2: When using the PS10A for local bell application or with a control that does not provide a retard feature - the PS10A must be installed on the alarm outlet side of the retard chamber of the sprinkler system.

TESTING: Accomplished by opening the inspector's end-of-line test valve. Allow time to compensate for system or control retard.

CAUTION: Method 2 is not applicable for remote station service use, if there is an unsupervised shut-off valve between the alarm check valve and the PS10A.

WET SYSTEM WITH EXCESS PRESSURE:

Connect PS10A into alarm port piping extending from alarm check valve. Retard provisions are not required. Insure that no unsupervised shut-off valves are present between the alarm check valve and the PS10A.

TESTING: Accomplished by opening the water by-pass test valve or the inspector's end-of-line test valve. When using end-of-line test, allow time for excess pressure to bleed off.

DRY SYSTEM:

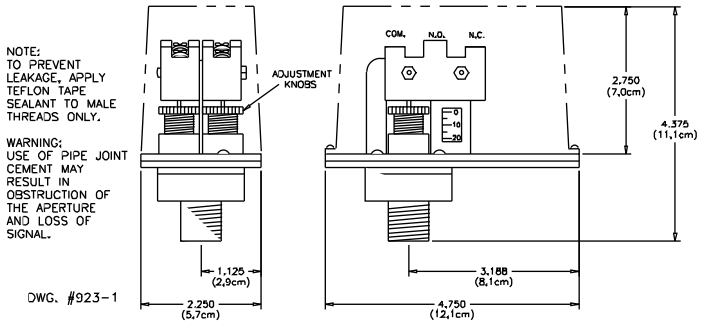
Connect PS10A into alarm port piping that extends from the intermediate chamber of the alarm check valve. Install on the outlet side of the in-line check valve of the alarm port piping. Insure that no unsupervised shut-off valves are present between the alarm check valve and the PS10A.

TESTING: Accomplished by opening the water by-pass test valve.

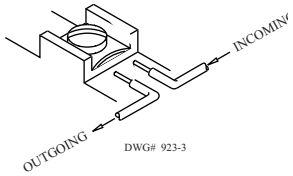
CAUTION: The above tests may also activate any other circuit closer or water motor gongs that are present on the system.

MODEL PS10A
PRESSURE SWITCH

DIMENSIONS

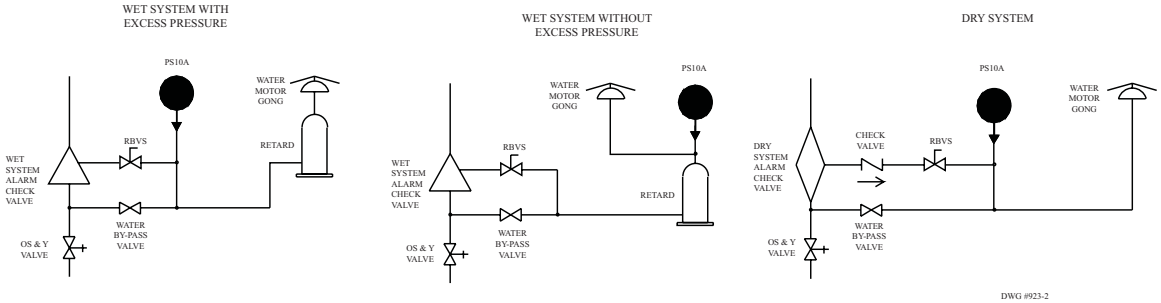


SWITCH TERMINAL CONNECTIONS
CLAMPING PLATE TERMINAL



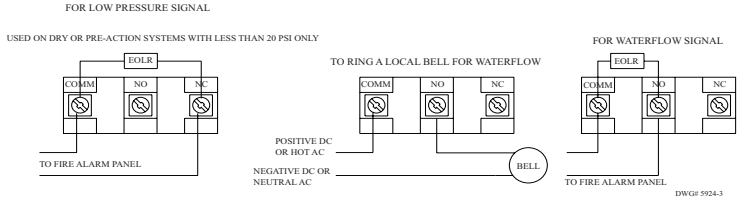
CAUTION:
An uninsulated section of a single conductor should not be looped around the terminal and serve as two separate connections. The wire must be severed, thereby providing supervision of the connection in the event that the wire becomes dislodged from under the terminal.

TYPICAL SPRINKLER APPLICATIONS

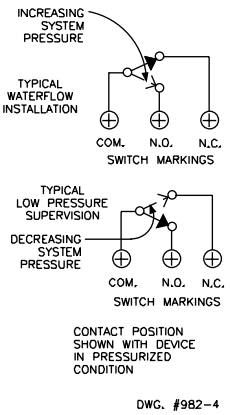


CAUTION: Closing of any shutoff valves between the alarm check valve and the PS10A will render the PS10A inoperative. To comply with NFPA-72 any such valve shall be electrically supervised with a supervisory switch such as Potter Model BVS.

TYPICAL ELECTRICAL CONNECTIONS



PRESSURE SWITCH TERMINATION



ORDERING INFORMATION

Model	Description	Stock No.
PS10-1A	Pressure switch with one set SPDT contacts	1340101
PS10-2A	Pressure switch with two sets SPDT contacts	1340102
	Hex Key	5250062
	Cover Tamper Switch Kit	0090134
RBVS	Ball Valve tamper switch	1000040

APPLICATION WARNING!

Due to the possibility of unintended discharges caused by pressure surges, trapped air, or short retard times, waterflow switches that are monitoring wet pipe sprinkler systems should not be used as the sole initiating device to discharge AFFF, deluge, or chemical suppression systems.

ENGINEER/ARCHITECT SPECIFICATIONS

Pressure type waterflow switches shall be a Model PS10A as manufactured by Potter Electric Signal Co. of St. Louis, Mo. and shall be installed on the sprinkler systems as shown on the drawings and/or specified herein.

Switches shall be provided with a 1/2" NPT male pressure connection to be connected into the alarm check valve of a “wet” sprinkler system or into the intermediate chamber of a “dry” pipe system and shall be actuated by any flow of water to or in excess of the discharge from one sprinkler head.

Switches shall have a maximum service pressure rating of 250 PSI (17,2 BAR) and shall be factory adjusted to operate on pressure increase at 6 ±1 PSI (0,4 ±0,06 BAR). There shall be one (1) or two (2) SPDT contacts rated at 15.0 Amps at 125/250VAC and 2.5 Amps at 30VDC.

The switch housing shall be weather proof and oil resistant. The cover shall incorporate tamper resistant screws.

The unit shall be UL and CSFM Listed, FM and LPC Approved, and NYMEA Accepted.

EST™
Life Safety & Communications

Input Modules

SIGA-CT1, SIGA-CT1HT, SIGA-CT2, SIGA-MCT2


SIGA-MCT2


SIGA-CT1/2

MEA

Application Notes Available

Overview

The SIGA-CT1 Single Input Module, SIGA-CT1HT High Temperature Single Input Module and SIGA-CT2/SIGA-MCT2 Dual Input Modules are intelligent analog addressable devices used to connect one or two Class B normally-open Alarm, Supervisory, or Monitor type dry contact Initiating Device Circuits (IDC).

The actual function of these modules is determined by the "personality code" selected by the installer. This code is downloaded to the module from the Signature loop controller during system configuration.

The input modules gather analog information from the initiating devices connected to them and convert it into digital signals. The module's on-board microprocessor analyzes the signal and decides whether or not to input an alarm.

The SIGA-CT1, SIGA-CT1HT and SIGA-CT2 mount to standard North American 1-gang electrical boxes, making them ideal for locations where only one module is required. Separate I/O and data loop connections are made to each module.

The SIGA-CT1HT module operates at an expanded temperature range of 32 ºF to 158 ºF (0 ºC to 70 ºC) for those applications requiring more extreme environmental temperature variation.

The SIGA-MCT2 is part of the UIO family of plug-in Signature Series modules. It functions identically to the SIGA-CT2, but takes advantage of the modular flexibility and easy installation that characterizes all UIO modules. Two- and six-module UIO motherboards are available. All wiring connections are made to terminal blocks on the motherboard. UIO assemblies may be mounted in Edwards enclosures.

Standard Features

- **Multiple applications**
  Including Alarm, Alarm with delayed latching (retard) for waterflow applications, Supervisory, and Monitor. The installer selects one of four "personality codes" to be downloaded to the module through the loop controller.
- **SIGA-CT1HT rated for high temperature environments**
  Suitable for attic installation and monitoring high temperature heat detectors.
- **Plug-in (UIO) or standard 1-gang mount**
  UIO versions allow quick installation where multiple modules are required. The 1-gang mount version is ideal for remote locations that require a single module.
- **Automatic device mapping**
  Signature modules transmit information to the loop controller regarding their circuit locations with respect to other Signature devices on the wire loop.
- **Electronic addressing**
  Programmable addresses are downloaded from the loop controller, a PC, or the SIGA-PRO Signature Program/Service Tool. There are no switches or dials to set.
- **Stand-alone operation**
  The module makes decisions and inputs an alarm from initiating devices connected to it even if the loop controller's polling interrogation stops. (Function availability dependent upon control panel.)
- **Ground fault detection by address**
  Detects ground faults right down to the device level.

Signature Series Overview

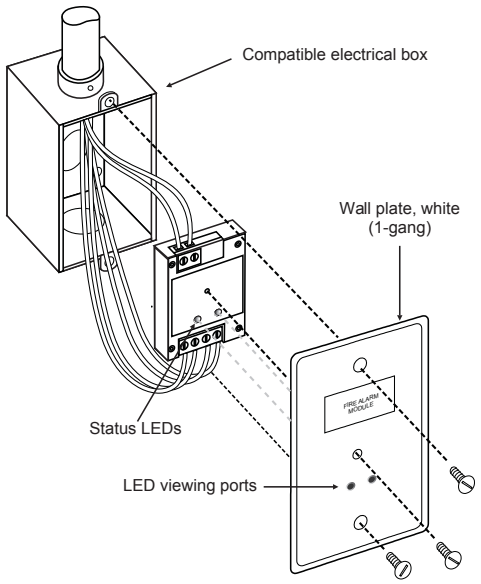
The Signature Series intelligent analog-addressable system from Edwards Security is an entire family of multi-sensor detectors and mounting bases, multiple-function input and output modules, network and non-network control panels, and user-friendly maintenance and service tools. Analog information from equipment connected to Signature devices is gathered and converted into digital signals. An onboard microprocessor in each Signature device measures and analyzes the signal and decides whether or not to input an alarm. The microprocessor in each Signature device provides four additional benefits – Self-diagnostics and History Log, Automatic Device Mapping, Stand-alone Operation and Fast, Stable Communication.

Self-diagnostics and History Log – Each Signature Series device constantly runs self-checks to provide important maintenance information. The results of the self-check are automatically updated and permanently stored in its non-volatile memory. This information is accessible for review any time at the control panel, PC, or using the SIGA-PRO Signature Program/Service Tool.

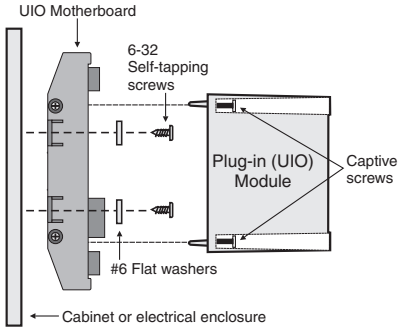
Automatic Device Mapping –The Signature Data Controller (SDC) learns where each device's serial number address is installed relative to other devices on the circuit. The SDC keeps a map of all Signature Series devices connected to it. The Signature Series Data Entry Program also uses the mapping feature. With interactive menus and graphic support, the wired circuits between each device can be examined. Layout or "as-built" drawing information showing branch wiring (T-taps), device types and their address are stored on disk for printing hard copy.

Installation

SIGA-CT1, SIGA-CT1HT and SIGA-CT2: modules mount to North American 2½ inch(64 mm) deep 1-gang boxes and 1½ inch (38 mm) deep 4 inch square boxes with 1-gang covers and SIGA-MP mounting plates. The terminals are suited for #12 to #18 AWG (2.5 mm^2 to 0.75 mm^2) wire size.



SIGA-MCT2: mount the UIO motherboard inside a suitable Edwards enclosure with screws and washers provided. Plug the SIGA-MCT2 into any available position on the motherboard and secure the module to the motherboard with the captive screws. Wiring connections are made to the terminals on the motherboard (see wiring diagram). UIO motherboard terminals are suited for #12 to #18 AWG (2.5 mm^2 to 0.75 mm^2) wire size.



Electronic Addressing - The loop controller electronically addresses each module, saving valuable time during system commissioning. Setting complicated switches or dials is not required. Each module has its own unique serial number stored in its on-board memory. The loop controller identifies each device on the loop and assigns a "soft" address to each serial number. If desired, the modules can be addressed using the SIGA-PRO Signature Program/Service Tool.

Edwards recommends that this module be installed according to latest recognized edition of national and local fire alarm codes.

Application

The duty performed by the SIGA-CT1 and SIGA-CT2/MCT2 is determined by their sub-type code or "Personality Code". The code is selected by the installer depending upon the desired application and is downloaded from the loop controller.

One personality code can be assigned to the SIGA-CT1. Two personality codes can be assigned to the SIGA-CT2/MCT2. Codes 1, 2, 3 and 4 can be mixed on SIGA-CT2/MCT2 modules only. For example, personality code 1 can be assigned to the first address (circuit A) and code 4 can be assigned to the second address (circuit B).

NORMALLY-OPEN ALARM - LATCHING (Personality Code 1) - Assign to one or both circuits. Configures either circuit A or B or both for Class B normally open dry contact initiating devices such as Pull Stations, Heat Detectors, etc. An ALARM signal is sent to the loop controller when the input contact is closed. The alarm condition is latched at the module.

NORMALLY-OPEN ALARM - DELAYED LATCHING (Personality Code 2) - Assign to one or both circuits. Configures either circuit A or B or both for Class B normally-open dry contact initiating devices such as Waterflow Alarm Switches. An ALARM signal is sent to the loop controller when the input contact is closed for approximately 16 seconds. The alarm condition is latched at the module.

NORMALLY-OPEN ACTIVE - NON-LATCHING (Personality Code 3) - Assign to one or both circuits. Configures either circuit A or B or both for Class B normally-open dry contact monitoring input such as from Fans, Dampers, Doors, etc. An ACTIVE signal is sent to the loop controller when the input contact is closed. The active condition is not latched at the module.

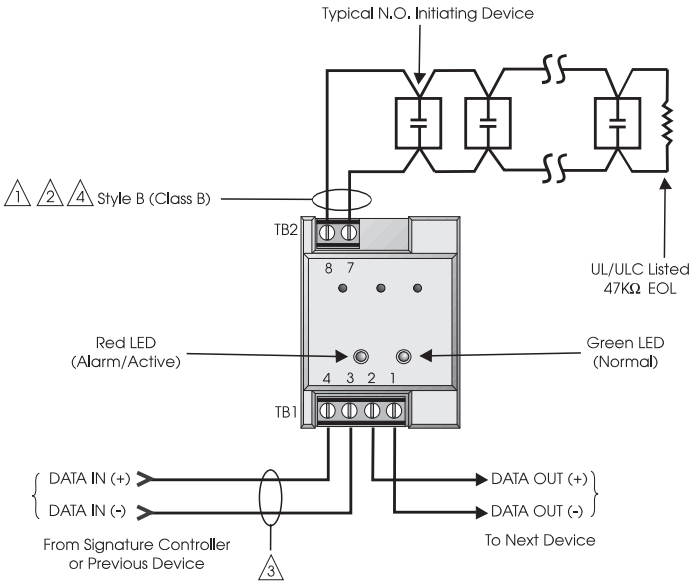
NORMALLY-OPEN ACTIVE - LATCHING (Personality Code 4) - Assign to one or both circuits. Configures either circuit A or B or both for Class B normally open dry contact monitoring input such as from Supervisory and Tamper Switches. An ACTIVE signal is sent to the loop controller when the input contact is closed. The active condition is latched at the module.

Typical Wiring

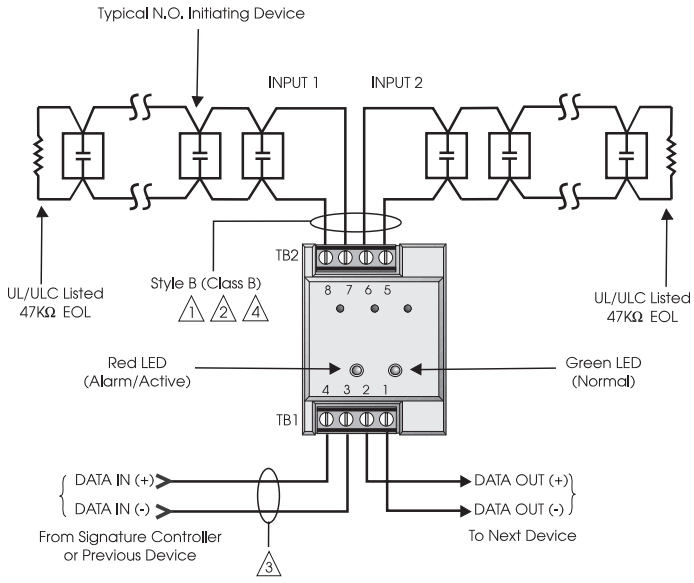
Modules will accept #18 AWG (0.75mm^2), #16 (1.0mm^2), and #14AWG (1.50mm^2), and #12 AWG (2.50mm^2) wire sizes.

Note: Sizes #16 AWG (1.0mm^2) and #18 AWG (0.75mm^2) are preferred for ease of installation. See Signature Loop Controller catalog sheet for detailed wiring requirement specifications.

Initiating (Slave) Device Circuit Wire Specifications		
Maximum Allowable Wire Resistance	50 ohms (25 ohms per wire) per Circuit	
Maximum Allowable Wire Capacitance	0.1µF per Circuit	
For Design Reference:	**Wire Size**	**Maximum Distance to EOLR**
	#18 AWG (0.75 mm^2)	4,000 ft (1,219 m)
	#16 AWG (1.00 mm^2)	
	#14 AWG (1.50 mm^2)	
	#12 AWG (1.50 mm^2)	



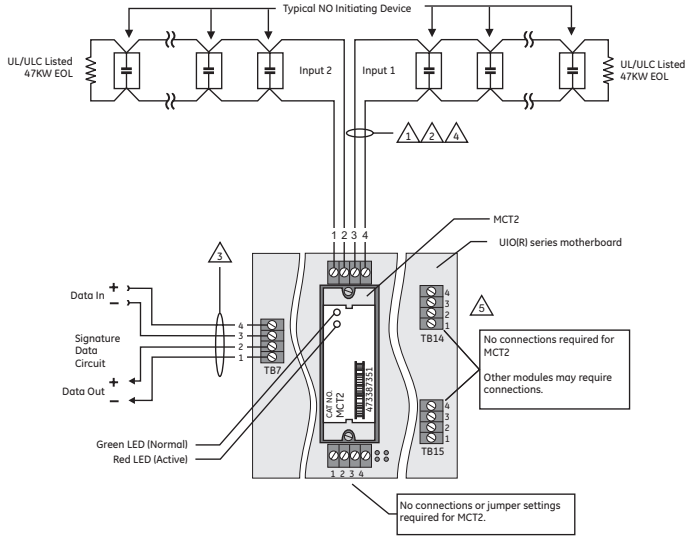
SIGA-CT1, SIGA-CT1HT



SIGA-CT2

NOTES

1. Maximum 25 Ohm resistance per wire.
2. Maximum #12 AWG (2.5 mm^2) wire; Minimum #18 AWG (0.75 mm2).
3. Refer to Signature controller installation sheet for wiring specifications.
4. Maximum 10 Vdc @ 350 µA
5. The SIGA-UIO6R and the SIGA-UIO2R do not come with TB14.
6. All wiring is supervised and power-limited.
7. These modules will not support 2-wire smoke detectors.



SIGA-MCT2

Warnings & Cautions

This module will not operate without electrical power. As fires frequently cause power interruption, we suggest you discuss further safeguards with your local fire protection specialist.

Compatibility

The Signature Series modules are compatible only with EST's Signature Loop Controller.

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Specifications

Catalog Number	SIGA-CT1HT	SIGA-CT1	SIGA-CT2	SIGA-MCT2
Description	Single Input Module		Dual Input Module	
Type Code	48 (factory set) Four sub-types (personality codes) are available		49 (factory set) Four sub-types (personality codes) are available	
Address Requirements	Uses One Module Address		Uses Two Module Addresses	
Operating Current	Standby = 250µA; Activated = 400µA		Standby = 396µA; Activated = 680µA	
Operating Voltage	15.2 to 19.95 Vdc (19 Vdc nominal)			
Construction	High Impact Engineering Polymer			
Mounting	North American 2½ inch (64 mm) deep one-gang boxes and 1½ inch (38 mm) deep 4 inch square boxes with one-gang covers and SIGA-MP mounting plates			UIO2R/6R/6 Motherboard
Operating Environment	32°F to 158°F (0°C to 70°C)	32°F to 120°F (0°C to 49°C)		
Storage Environment	-4°F to 140°F (-20°C to 60°C); Humidity: 0 to 93% RH			
LED Operation	On-board Green LED - Flashes when polled; On-board Red LED - Flashes when in alarm/active. Both LEDs - Glow steady when in alarm (stand-alone)			
Compatibility	Use with Signature Loop Controller			
Agency Listings	UL, ULC, MEA, CSFM			

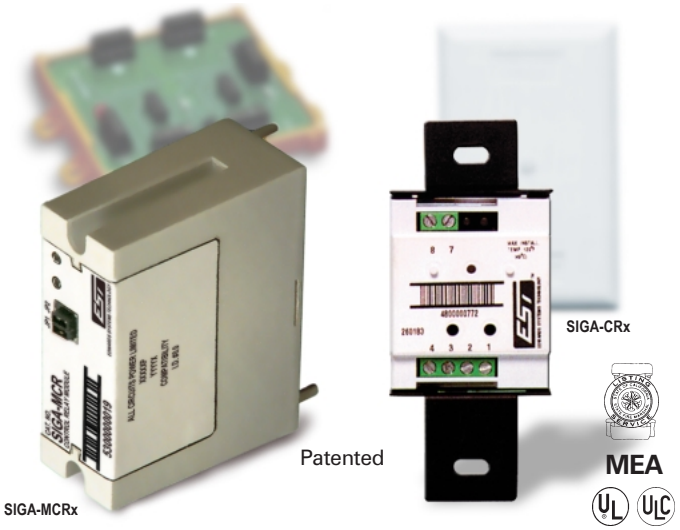
Ordering Information

Catalog Number	Description	Ship Wt. lbs (kg)
SIGA-CT1	Single Input Module — UL/ULC Listed	0.4 (0.15)
SIGA-CT1HT	Single Input Module High Temperature Operation UL/ULC Listed	0.4 (0.15)
SIGA-CT2	Dual Input Module — UL/ULC Listed	0.4 (0.15)
SIGA-MCT2	Dual Input Plug-in (UIO) Module — UL, ULC Listed	0.1 (0.05)

Related Equipment		
27193-11	Surface Mount Box - Red, 1-gang	1.0 (0.6)
27193-16	Surface Mount Box - White, 1-gang	1.0 (0.6)
SIGA-UIO2R	Universal Input-Output Module Board w/Riser Inputs — Two Module Positions	0.32 (0.15)
SIGA-UIO6R	Universal Input-Output Module Board w/Riser Inputs — Six Module Positions	0.62 (0.28)
SIGA-UIO6	Universal Input-Output Module Board — Six Module Positions	0.56 (0.25)
MFC-A	Multifunction Fire Cabinet — Red, supports Signature Module Mounting Plates	7.0 (3.1)
SIGA-MB4	Transponder Mounting Bracket (allows for mounting two 1-gang modules in a 2-gang box)	0.4 (0.15)
SIGA-MP1	Signature Module Mounting Plate, 1 footprint	1.5 (0.70)
SIGA-MP2	Signature Module Mounting Plate, 1/2 footprint	0.5 (0.23)
SIGA-MP2L	Signature Module Mounting Plate, 1/2 extended footprint	1.02 (0.46)

Control Relay Modules

Model SIGA-CR, SIGA-MCR, SIGA-CRR, SIGA-MCRR



Features

- **Provides one no/nc contact (SIGA-CR/MCR)**
  Form "C" dry relay contact can be used to control external appliances such as door closers, fans, dampers etc.
- **Allows group operation of sounder bases**
  The SIGA-CRR/MCRR reverses the polarity of its 24 Vdc output, thus activating all Sounder Bases on the data loop.
- **Plug-in (UIO) or standard 1-gang mount**
  UIO versions allow quick installation where multiple modules are required. The 1-gang mount version is ideal for remote locations that require a single module.
- **Automatic device mapping**
  Signature modules transmit information to the loop controller regarding their circuit locations with respect to other Signature devices on the wire loop.
- **Electronic Addressing**
  Programmable addresses are downloaded from the loop controller, a PC, or the SIGA-PRO Signature Program/Service Tool. There are no switches or dials to set.
- **Intelligent device with microprocessor**
  All decisions are made at the module to allow lower communication speed with substantially improved control panel response time and less sensitivity to line noise and loop wiring properties; twisted or shielded wire is not required.
- **Ground fault detection by address**
  Detects ground faults right down to the device level.
- **Non-volatile memory**
  Permanently stores serial number, type of device, and job number. Automatically updates historic information including hours of operation, last maintenance date, number of alarms and troubles, and time and date of last alarm.
- **Diagnostic LEDs**
  Flashing GREEN shows normal polling; flashing RED shows alarm/active state.
- **High ambient temperature operation**
  Install in ambient temperatures up to 120°F (49°C).
- **Designed to ISO 9001 standards**
  All Signature products are manufactured to strict international quality standards to ensure highest reliability.

Description

The Control Relay Module and the Polarity Reversal Relay Module are part of EST's Signature Series system. They are intelligent analog addressable devices available in either plug-in (UIO) versions, or standard 1-gang mount versions.

The SIGA-CR/MCR Control Relay Module provides a Form "C" dry relay contact to control external appliances such as door closers, fans, dampers etc. This device does not provide supervision of the state of the relay contact. Instead, the on-board microprocessor ensures that the relay is in the proper ON/OFF state. Upon command from the loop controller, the SIGA-CR/MCR relay activates the normally open or normally-closed contact.

The SIGA-CRR/MCRR Polarity Reversal Relay Module provides a Form "C" dry relay contact to power and activate a series of SIGA-AB4 Audible Sounder Bases. Upon command from the Signature loop controller, the SIGA-CRR reverses the polarity of its 24 Vdc output, thus activating all Sounder Bases on the data loop.

Standard-mount versions (SIGA-CR and SIGA-CRR) are installed to standard North American 1-gang electrical boxes, making them ideal for locations where only one module is required. Separate I/O and data loop connections are made to each module.

Plug-in UIO versions (SIGA-MCR and SIGA-MCRR) are part of the UIO family of plug-in Signature Series modules. They function identically to the standard mount versions, but take advantage of the modular flexibility and easy installation that characterizes all UIO modules. Two- and six-module UIO motherboards are available. All wiring connections are made to terminal blocks on the motherboard. UIO assemblies may be mounted in EST enclosures.

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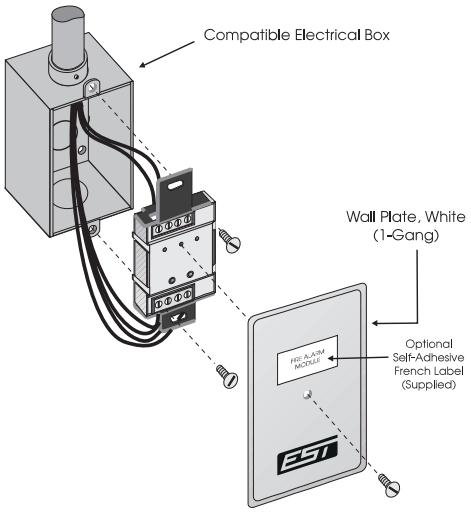
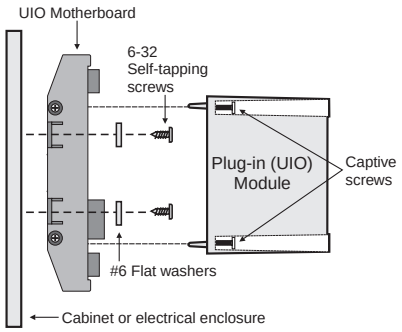
Installation

SIGA-CR and SIGA-CRR: modules mount to North American 2½ inch (64 mm) deep 1-gang boxes and 1½ inch (38 mm) deep 4 inch square boxes with 1-gang covers. The terminals are suited for #12 to #18 AWG (2.5 mm^2 to 0.75 mm^2) wire size.



SIGA-MCR and SIGA-MCRR: mount the UIO motherboard inside a suitable EST enclosure with screws and washers provided. Plug the module into any available position on the motherboard and secure the module to the motherboard with the captive screws. Wiring connections are made to the terminals on the motherboard (see wiring diagram). UIO motherboard terminals are suited for #12 to #18 AWG (2.5 mm^2 to 0.75 mm^2) wire size.



Electronic Addressing - The loop controller electronically addresses each module, saving valuable time during system commissioning. Setting complicated switches or dials is not required. Each module has its own unique serial number stored in its on-board memory. The loop controller identifies each device on the loop and assigns a "soft" address to each serial number. If desired, the modules can be addressed using the SIGA-PRO Signature Program/Service Tool.

EST recommends that this module be installed according to latest recognized edition of national and local fire alarm codes.

Application

The operation of Signature Series control relays is determined by their sub-type code or "Personality Code."

Personality Code 8: CONTROL RELAY (SIGA-CR/MCR) - Dry Contact Output. This setting configures the module to provide one Form "C" DRY RELAY CONTACT to control Door Closers, Fans, Dampers, etc. Contact rating is 2.0 amp @ 24 Vdc; 0.5 amp @ 120 Vac (or 220 Vac for non-UL applications). Personality Code 8 is assigned at the factory. No user configuration is required.

Personality Code 8: POLARITY REVERSAL RELAY MODULE (SIGA-CRR/MCRR). This setting configures the module to reverse the polarity of its 24 Vdc output. Contact rating is 2.0 amp @ 24 Vdc (pilot duty). Personality Code 8 is assigned at the factory. No user configuration is required.

Compatibility

The Signature Series modules are compatible only with EST's Signature Loop Controller.

Warnings & Cautions

This module will not operate without electrical power. As fires frequently cause power interruption, we suggest you discuss further safeguards with your local fire protection specialist.

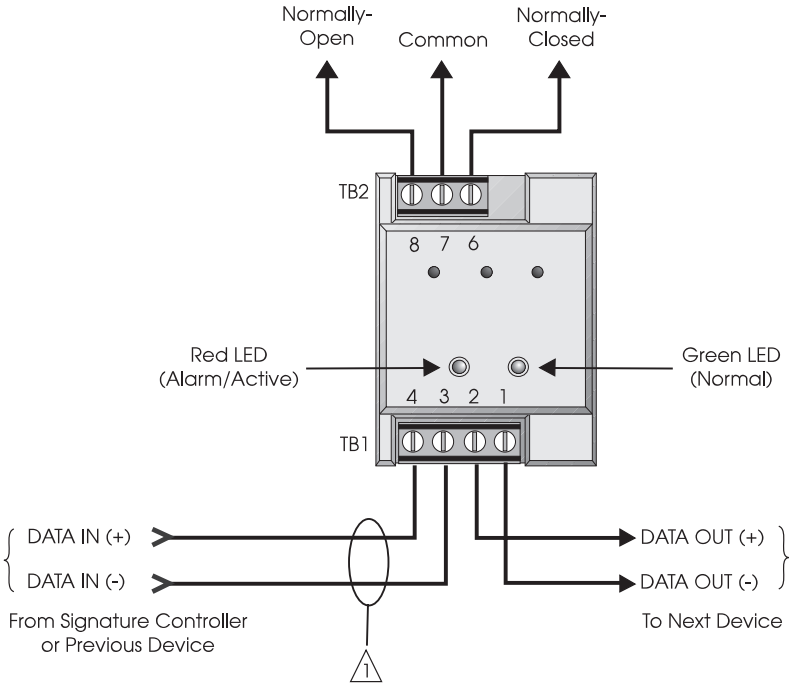
Testing & Maintenance

The module's automatic self-diagnosis identifies when it is defective and causes a trouble message. The user-friendly maintenance program shows the current state of each module and other pertinent messages. Single modules may be turned off (deactivated) temporarily, from the control panel. Availability of maintenance features is dependent on the fire alarm system used. Scheduled maintenance (Regular or Selected) for proper system operation should be planned to meet the requirements of the Authority Having Jurisdiction (AHJ). Refer to current NFPA 72 and ULC CAN/ULC 536 standards.

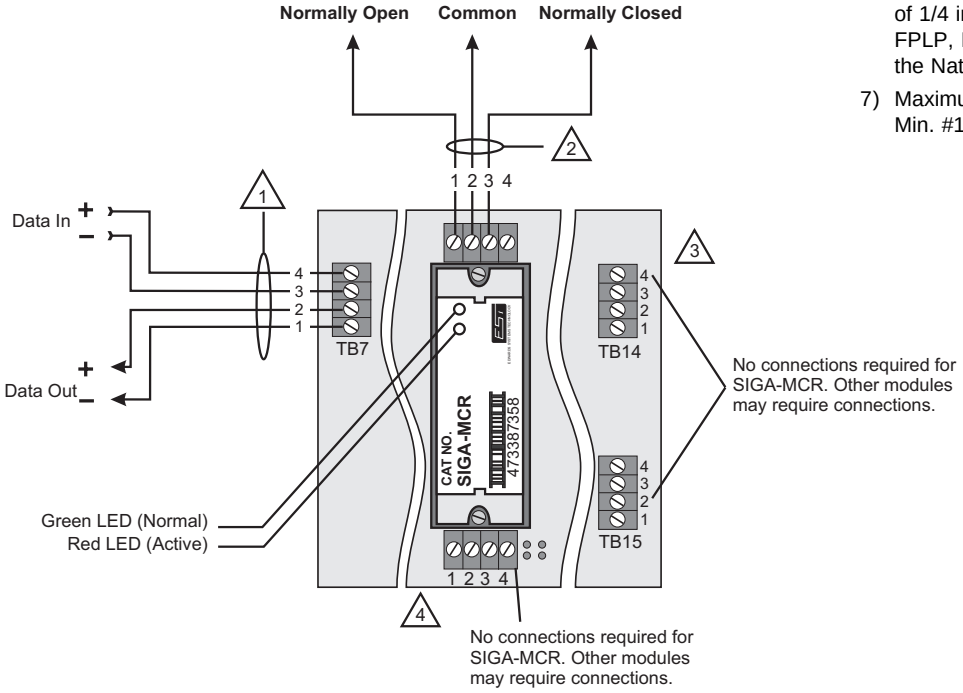
Typical Wiring

Modules will accept #18 AWG (0.75mm^2), #16 (1.0mm^2), #14 AWG (1.50mm^2) and #12 AWG (2.5mm^2) wire sizes.

Note: Sizes #16 AWG (1.0mm^2) and #18 AWG (0.75mm^2) are preferred for ease of installation. See Signature Loop Controller catalog sheet for detailed wiring requirement specifications.



SIGA-CR Control Relay



SIGA-MCR Control Relay

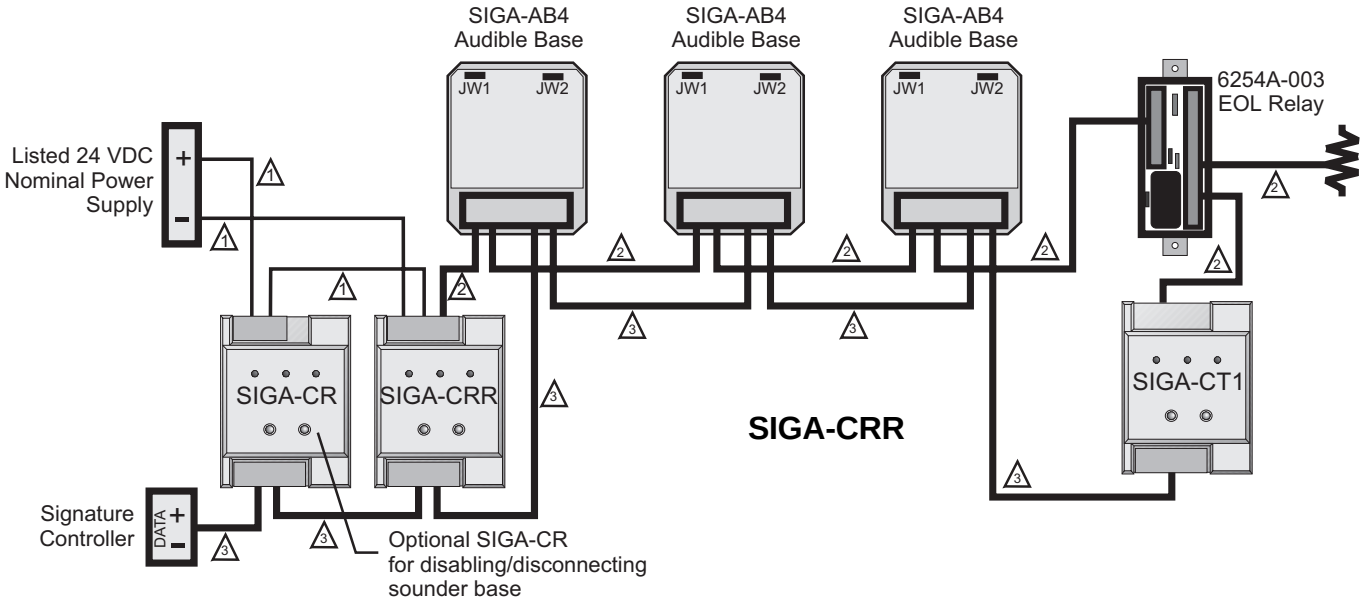
Notes

1. Refer to Signature Loop Controller Installation Sheet for wiring specifications.
2. SIGA-CR/MCR must be installed within the same room as the device it is controlling.
3. The SIGA-UIO6R and the SIGA-UIO2R do not come with TB14.
4. The SIGA-UIO6 does not come with TB8 through TB13.
5. Supervised and power-limited.
6. If the source is nonpower-limited, maintain a space of 1/4 inch from power-limited wiring or use FPL, FPLP, FPLR, or an equivalent in accordance with the National Electrical Code.
7) Maximum #12 AWG (2.5mm^2) wire. Min. #18 (0.75mm^2).

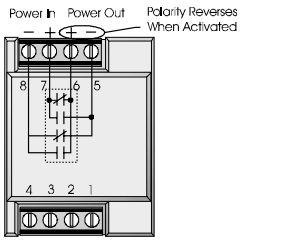
Typical Wiring

Modules will accept #18 AWG (0.75mm^2), #16 (1.0mm^2), #14 AWG (1.50mm^2) and #12 AWG (2.50mm^2) wire sizes.

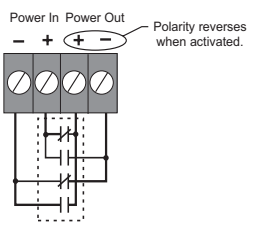
Note: Sizes #16 AWG (1.0mm^2) and #18 AWG (0.75mm^2) are preferred for ease of installation. See Signature Loop Controller catalog sheet for detailed wiring requirement specifications.



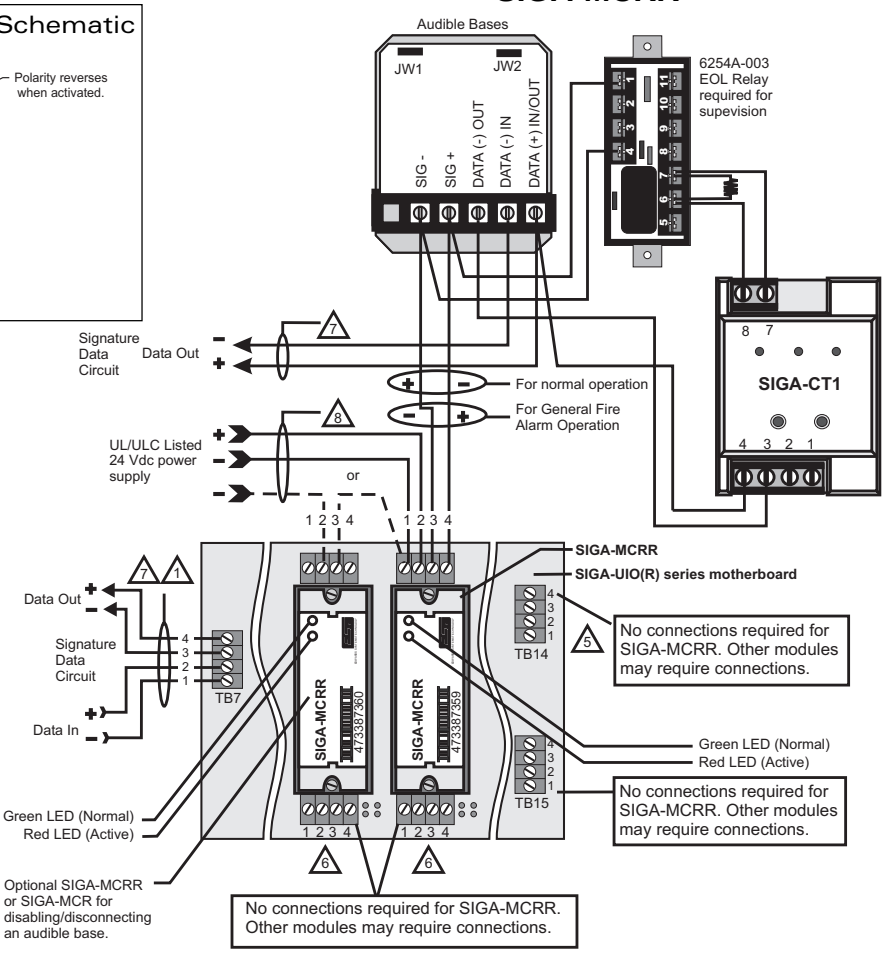
SIGA-CRR Schematic



SIGA-MCRR Schematic



SIGA-MCRR



Notes

1. Refer to the Signature controller installation sheet for wiring.
2. One Pair of Wires (24 Vdc power).
3. One Pair of Wires (Signature Data).
4. Single Wire (24 Vdc power).
5. The SIGA-UIO6R and the SIGA-UIO2R do not come with TB14.
6. The SIGA-UIO6 does not come with TB8 through TB13.
7. Supervised and power-limited.
8. If the source is nonpower-limited, maintain a space of 1/4 inch from power-limited wiring or use FPL, FPLP, FPLR, or an equivalent in accordance with the National Electrical Code.
9. Maximum #12 AWG (2.5 mm^2) wire; Minimum #18 AWG (0.75 mm^2).
10. End-of-Line Relay must monitor and report power supply trouble to control panel.
11. Class B Data wiring may be "T-tapped."

Specifications

Catalog Number	SIGA-CR	SIGA-MCR	SIGA-CRR	SIGA-MCRR
Description	Control Relay		Polarity Reversal Relay	
Type Code	Personality Code 8 (Factory Set)			
Address Requirements	Uses 1 Module Address			
Operating Current	Standby = 100µA Activated = 100µA			
Operating Voltage	15.2 to 19.95 Vdc (19 Vdc nominal)			
Relay Type and Rating	Form "C" 24 VDC = 2 amps (pilot duty) 120 Vac = 0.5 amps 220 Vac (non-UL) = 0.5 amps			
Mounting	North American 2½ inch (64 mm) deep 1-gang boxes and 1½ inch (38 mm) deep 4 inch square boxes with 1-gang covers	Plugs into UIO2R, UIO6R or UIO6 Motherboards	North American 2½ inch (64 mm) deep 1-gang boxes and 1½ inch (38 mm) deep 4 inch square boxes with 1-gang covers	Plugs into UIO2R, UIO6R or UIO6 Motherboards
Construction & Finish	High Impact Engineering Polymer			
Storage and Operating Environment	Operating Temperature: 32°F to 120°F (0°C to 49°C) Storage Temperature: -4°F to 140°F (-20°C to 60°C) Humidity: 0 to 93% RH			
LED Operation	On-board Green LED - Flashes when polled On-board Red LED - Flashes when in alarm/active			
Compatibility	Use With: Signature Loop Controller			
Agency Listings	UL, ULC (See Ordering Table), CSFM, MEA			

Ordering Information

Catalog Number	Description	Ship Weight - lbs (kg)
SIGA-CR	Control Relay Module (Standard Mount) - UL/ULC Listed	0.4 (0.15)
SIGA-MCR	Control Relay Module (UIO Mount) - UL Listed	0.18 (0.08)
SIGA-CRR	Polarity Reversal Relay Module (Standard Mount) - UL/ULC Listed	0.4 (0.15)
SIGA-MCRR	Polarity Reversal Relay Module (UIO Mount) - UL Listed	0.18 (0.08)
Related Equipment		
27193-21	Surface Mount Box - Red, 1-gang	1 (0.6)
27193-26	Surface Mount Box - White, 1-gang	1 (0.6)
SIGA-MB4	Module Mounting Bracket for installing two 1-gang modules in a single North American 4-inch square box.	.5 (.3)
SIGA-UIO2R	Universal Input-Output Module Board w/Riser Inputs - Two Module Positions	0.32 (0.15)
SIGA-UIO6R	Universal Input-Output Module Board w/Riser Inputs - Six Module Positions	0.62 (0.28)
SIGA-UIO6	Universal Input-Output Module Board - Six Module Positions	0.56 (0.25)

Description (Signature Overview)

The Signature Series intelligent analog-addressable system from Edwards Systems Technology is an entire family of multi-sensor detectors and mounting bases, multiple-function input and output modules, network and non-network control panels, and user-friendly maintenance and service tools. Analog information from equipment connected to Signature devices is gathered and converted into digital signals. An onboard microprocessor in each Signature device measures and analyzes the signal and decides whether or not to input an alarm. The microprocessor in each Signature device provides four additional benefits – **Self-diagnostics and History Log, Automatic Device Mapping, Stand-alone Operation and Fast, Stable Communication**.

Self-diagnostics and History Log – Each Signature Series device constantly runs self-checks to provide important maintenance information. The results of the self-check are automatically updated and permanently stored in its non-volatile memory. This information is accessible for review any time at the control panel, PC, or using the SIGA-PRO Signature Program/Service Tool. The information stored in device memory includes:

- Device serial number, address, and type
- Date of manufacture, hours of operation, and last maintenance date[2]
- Number of recorded alarms and troubles[2]
- Time and date of last alarm[1]
- Most recent trouble code logged by the detector — 32 possible trouble codes may be used to diagnose faults.

Automatic Device Mapping –The Signature Data Controller (SDC) learns where each device's serial number address is installed relative to other devices on the circuit. The SDC keeps a map of all Signature Series devices connected to it. The Signature Series Data Entry Program also uses the mapping feature. With interactive menus and graphic support, the wired circuits between each device can be examined. Layout or "as-built" drawing information showing branch wiring (T-taps), device types and their address are stored on disk for printing hard copy. This takes the mystery out of the installation. The preparation of as-built drawings is fast and efficient.

Device mapping allows the Signature Data Controller to discover:

- Unexpected additional device addresses
- Missing device addresses
- Changes to the wiring in the circuit.

Most Signature modules use a personality code selected by the installer to determine their actual function. Personality codes are downloaded from the SDC during system configuration and are indicated during device mapping.

Standalone Operation – A decentralized alarm decision by the device is guaranteed. Onboard intelligence permits the device to operate in standalone (degrade) mode. If Signature loop controller CPU communications fail for more than four seconds, all devices on that circuit go into standalone mode. The circuit acts like a conventional alarm receiving circuit. Each Signature device on the circuit continues to collect and analyze information from its slave devices. When connected to a panel utilizing standalone operation, modules with their "personality" set as alarm devices (IDC) will alarm should their slave alarm-initiating device activate.

Fast Stable Communication – Built-in intelligence means less information needs to be sent between the device and the Signature Data Controller (SDC). Other than regular supervisory polling response, Signature devices only need to communicate with the SDC when they have something new to report. This provides very fast control panel response and allows a lower baud rate (speed) to be used for communication on the circuit. The lower baud rate offers several advantages including:

- Less sensitivity to circuit wire characteristics
- Less sensitivity to noise glitches on the cable
- Less emitted noise from the data wiring
- Twisted or shielded wiring is not required.

Diagnostic LEDs – Twin LEDs on most Signature devices provide visual indication of normal and alarm-active conditions. A flashing green LED shows normal system polling. A flashing red LED means the module is in alarm-active state. Both LEDs on steady indicates alarm-active state – standalone mode.

Testing & Maintenance – Automatic self-diagnosis identifies when a Signature device is defective and causes a trouble message. The user-friendly maintenance program shows the current state of each device and other pertinent information. Single devices may be turned off temporarily, from the control panel. **Scheduled maintenance (Regular or Selected) for proper system operation should be planned to meet the requirements of the Authority Having Jurisdiction (AHJ). Refer to current NFPA 72 and ULC CAN/ULC 536 standards.**

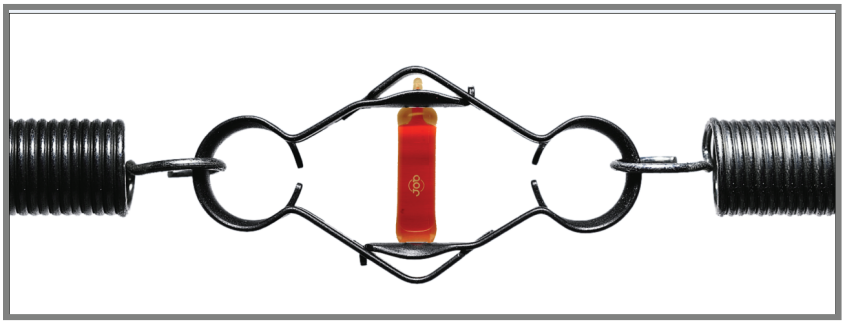
Quality and Reliability – EST Signature devices are manufactured in North America to strict international ISO 9001 standards. All electronics utilize surface mount technology (SMT) for smaller size and greater immunity to RF noise. A conformal coating is used for humidity and corrosion resistance.

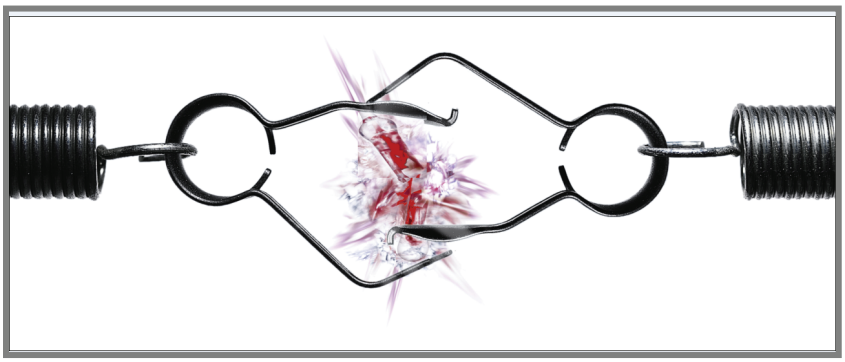
[1] EST3 V.2 only.
[2] Retrievable with SIGA-PRO programming tool.

THERMO BULBS®

Standard Response THERMO BULB® LINK

for Kitchen Hoods, Fire Dampers, Smoke Vents





°F	°C	Color
135	57	orange
155	68	red
165	74	red
175	79	yellow
200	93	green
212	100	green
286	141	blue
360	182	mauve
450	232	black
500	260	black

RTI 105 $(ms)^{1/2}$
190 $(fts)^{1/2}$

Design Load:
min: 0
max: 55 lbs.
250 N

Directly compatible to most existing fusible links

U.S. Patent No. 5,927,890

JOB® has developed the only Standard Response THERMO BULB® LINK in the world

JOB® has combined the succesfully proven G5 **JOB THERMO BULB®** used in all Standard Response Sprinklers with a strong and innovative Link design to meet the latest requirements for Standard Response link technology and their applications.

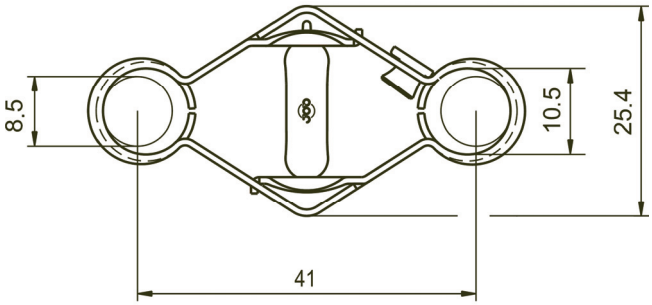
Main features:

- RTI 105 $(ms)^{½}$
- Temperature range:
  135 °F (57 °C) to 500 °F (260 °C) in 10 different temperature ratings
- Activates at **zero load**. No minimum load requirement
- Permanent load 55 lbs. max.
- Loading Safety Factor 6
- Developed and tested according with UL 33
- UL listed

JOB THERMO BULB® LINKS (U.S. Patent No. 5,927,890 and other international patents) can be used in virtually any area where a positive thermally actuated self-releasing mechanism is required to operate in the event of fire, such as:

- Kitchen Hoods, Fire Dampers, Smoke Vents, Ventilation Ducts, etc.
- The activation of water, foam, dry powder, CO_2 or other gaseous based fire extinguishing apparatus
- The activation of devices which open or close windows, doors, roof vents, hatches, machine and belt stops etc.
- The activation of special alarm or evacuation apparatus

For Life Safety and Property Protection the Standard Response JOB THERMO BULB® LINK is the best answer!



COOPER Notification

Series MT and MT Strobe Multitone Electronic Appliances

SERIES MT STROBE

MT4-115-WH

SERIES MT-12/24

Description:

The Wheelock Series MT and MT Strobe Multitone electronic appliances offer a choice of eight (8) nationally and internationally recognized alerting sounds: Horn, Bell, March Time Horn, Code-3 Tone, Code-3 Horn, Slow Whoop, Siren or Hi/Lo Tone. The Code-3 Horn and tone patterns are engineered to comply with NFPA/ANSI Temporal Pattern specifications without requiring additional equipment. With MT and MT Strobe appliances, one alarm appliance meets most of your signaling needs. The MT strobes can be synchronized using the Wheelock SM, DSM Sync Modules, Wheelock Power Supplies or other manufacturers panel incorporating the Wheelock Patented Sync Protocol.

The MT Strobes are designed for ADA applications while meeting or exceeding the latest requirements of NFPA 72, ANSI 117.1, UFC and UL Standard 1971 as well as meeting ADA requirements concerning photosensitive epilepsy.

Each MT and MT Strobe appliance has two installer selective sound output levels: STANDARD dBA and HIGH dBA. Non-strobe versions provide selectable voltage capability in one unit, 12VDC or 24VDC. Strobe versions are specific for either 12VDC or 24VDC and all models may be used with filtered or unfiltered (full-wave-rectified) input voltages. Separate input terminals are available, shunt wires are provided to enable both tone and strobe to operate simultaneously from a single input.

The Series MT Multitone Strobe appliances are UL Listed for indoor wall mount applications under Standard 1971 for Signaling Devices for the Hearing Impaired and under Standard 464 for Audible Signaling Appliances.

Features:

- Approvals include: UL Standard 1971, UL Standard 464, California State Fire Marshal (CSFM), New York City (MEA), Factory Mutual (FM) and Chicago (BFP) See approvals by model in Specifications and Ordering Information
- Designed to meet or exceed ADA/NFPA/UFC/ANSI Standards and Accessibility Guidelines
- Complies with OSHA 29, Part 1910.165
- Series MT appliances have IN and OUT wiring terminations that accept two #12 to #18 American Wire Gauge (AWG) wires at each terminal. Inputs are polarized for compatibility with standard reverse polarity type supervision
- One alarm appliance with (8) eight selective signals to provide superior sound penetration for various ambient and wall conditions with two field selectable sound output levels
- Code-3 Horn and Tone meet ANSI/NFPA temporal pattern for standard emergency evacuation signaling
- Audible and strobe can operate from a single NAC circuit or from separate NAC circuits with any of the (8) eight audible sounds
- MT Strobe models are available with Wheelock patented MCW Multi-Candela strobes with field selectable candela settings at 15/30/75/110cd or with single candela 1575cd strobes. Synchronize using the Wheelock Sync Modules or panels with built-in Wheelock Patented Sync Protocol
- Selectable input voltage on non-strobe versions. Strobe versions are factory set for either 12 or 24VDC, with wide-Listed voltage range, filtered (DC) and FWR
- No additional trimplate required for flush mounting

For Weatherproof MTWP See Data Sheet S9004

E5946

151-92-E

7135-0785:118 (MT4)
7125-0785:155 (MT)
7125-0758:156 (MTWP)

NOTE: All CAUTIONS and WARNINGS are identified by the symbol ⚠. All warnings are printed in bold capital letters .
⚠ WARNING: PLEASE READ THESE SPECIFICATIONS AND INSTALLATION INSTRUCTIONS CAREFULLY BEFORE USING, SPECIFYING OR APPLYING THIS PRODUCT. FAILURE TO COMPLY WITH ANY OF THESE INSTRUCTIONS, CAUTIONS AND WARNINGS COULD RESULT IN IMPROPER APPLICATION, INSTALLATION AND/OR OPERATION OF THESE PRODUCTS IN AN EMERGENCY SITUATION, WHICH COULD RESULT IN PROPERTY DAMAGE, AND SERIOUS INJURY OR DEATH TO YOU AND/OR OTHERS.

General Notes:
- Strobes are designed to flash at 1 flash per second minimum over their "Regulated Voltage Range" (16-33v for 24VDC units and 8-17.5v for 12VDC units). Regulated Voltage Range is the newest terminology used by UL to identify the listed voltage range.
- All candela ratings represent minimum effective Multitone Strobe intensity based on UL Standard 1971.
- MT Strobe models are UL Standard 1971 Listed for indoor use with a temperature range of 32°F to 120°F (0°C to 49°C) and maximum humidity of 93% ±2%. The MT-12/24, MTWP and MT4 models and listed for outdoor use at -31°F to 150°F (-35°C to 66°C) and maximum humidity of 95% (See Data Sheet S9004 or Installation Instruction Sheet P84150 for more detail on MTWP). MTWP and MT4 strobes are listed under UL 1638.
- MT Audible is UL Standard 464 Listed.

Alarm Tones

TONE	ALARM TONES PATTERN DESCRIPTION
HORN	BROADBAND HORN (Continuous)
BELL	1560 Hz MODULATED (0.07 sec. ON/Repeat)
MARCH TIME HORN	HORN (0.25 sec. ON/0.25 sec. OFF/Repeat
CODE-3 HORN	HORN (ANSI S3.41 Temporal Pattern)
CODE-3 TONE	500 Hz (ANSI S3.41 Temporal Pattern)
SLOW WHOOP	500-1200 Hz SWEEP (4.0 sec. ON/0.5 sec. OFF/Repeat)
SIREN	600-1200 Hz SWEEP (1.0 sec. ON/Repeat)
HI/LO	1000/800 Hz (0.25 sec. ON/Alternate)

Table 1: dBA and Current Ratings for Multitone Audible Portion

	RMS Current (amps)										dBA @ 10ft (UL Reverberant)					
	24 VDC				12 VDC				120 VAC		24 VDC		12 VDC		120 VAC	
	HI Output		STD Output		HI Output		STD Output		HI Output	STD Output	HI Output	STD Output	HI Output	STD Output	HI Output	STD Output
	@ 24 VDC	UL max*	@ 24 VDC	UL max*	@ 24 VDC	UL max*	@ 24 VDC	UL max*	UL max*	UL max*						
Horn	0.074	0.108	0.033	0.044	0.145	0.176	0.023	0.034	0.050	0.042	92	87	90	77	85	82
Bell	0.040	0.053	0.018	0.024	0.077	0.095	0.014	0.020	0.041	0.039	86	80	85	69	82	75
March Time Horn	0.067	0.104	0.033	0.038	0.109	0.142	0.023	0.034	0.050	0.040	89	84	89	74	85	79
Code-3 Horn	0.069	0.091	0.026	0.035	0.100	0.142	0.023	0.034	0.050	0.042	88	83	88	73	82	75
Code-3 Tone	0.061	0.075	0.026	0.035	0.088	0.105	0.015	0.021	0.042	0.040	85	80	84	70	79	75
Slow Whoop	0.069	0.098	0.028	0.037	0.100	0.142	0.025	0.035	0.050	0.042	90	89	89	75	85	82
Siren	0.080	0.104	0.027	0.036	0.122	0.152	0.021	0.030	0.045	0.041	89	84	89	75	85	82
HI/LO	0.044	0.057	0.020	0.026	0.089	0.114	0.018	0.026	0.042	0.039	86	81	86	71	82	79

Table 2: Strobe Current Ratings

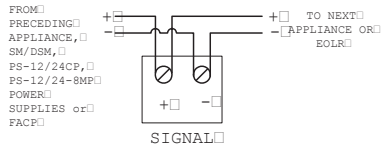
	RMS Current (amps)						
Model	MT-121575	MT-241575	MTWP-2475	MT-24MCW			
Candela	1575cd	1575cd	180cd	15cd	30cd	75cd	110cd
@ 24VDC	0.152	0.060	0.094	0.041	0.063	0.109	0.140
UL max*	0.255	0.090	0.138	0.060	0.092	0.165	0.220

Note: If the strobe and audible operate on the same circuit, add the strobe current from Table 2 to the audible current from Table 1.

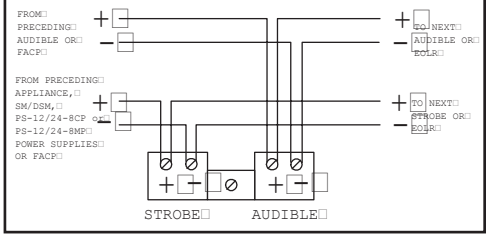
* RMS current ratings are per UL average RMS method. UL max current rating is the maximum RMS current within the listed voltage range (16-33v for 24v units). For strobes the UL max current is usually at the minimum listed voltage (16v for 24v units). For audibles the max current is usually at the maximum listed voltage (33v for 24v units). For unfiltered FWR ratings, see installation instructions.

Wiring Diagrams (for all models)

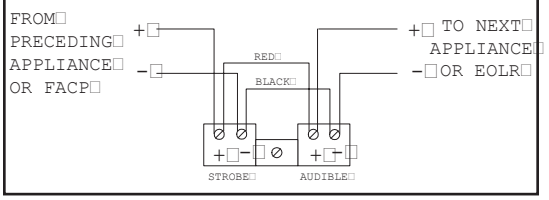
MT SIGNAL



AUDIBLE SIGNAL AND STROBE OPERATE INDEPENDENTLY



AUDIBLE SIGNAL AND STROBE OPERATE IN UNISON. RED AND BLACK SHUNT-WIRES ARE SUPPLIED.



Specifications and Ordering Information

Model Number	Order Code	Input Voltage	Rated Candela	Mounting Options***	Agency Approvals				
					UL	MEA	CSFM	FM	BFP
MT-12/24-R	5023	12/24	-	D,E,F,L,M,O,P,R	X	X	X	X	X
MT-12/24-W	5024	12/24	-	D,E,F,L,M,O,P,R	X	X	X	X	X
MT-241575W-FR#	8422	24	15 (75 on AXIS)	D,E,F,L,M,O,P,R	X	X	X	X	*
MT-24MCW-FR	3301	24	15/30/75/110	D,E,F,L,M,O,P,R	X	*	X	*	*
MT-24MCW-FW	3303	24	15/30/75/110	D,E,F,L,M,O,P,R	X	*	X	*	*
MT-24MCW-AR***	3304	24	15/30/75/110	D,E,F,L,M,O,P,R	X	*	X	*	*
MT-121575W-FR#	8421	12	15 (75 on AXIS)	D,E,F,L,M,O,P,R	X	X	X	X	*
MT-121575W-NW	9747	12	15 (75 on AXIS)	D,E,F,L,M,O,P,R	X	X	X	X	*
MTWP-2475W-FR**	8420	24	180 @ 77°F (25°C)	M	X	X	X	X	*
MTWP-2475W-NW**	9744	24	180 @ 77°F (25°C)	M	X	X	X	X	*
MT4-115-R	6223	120 VAC	-	D,E,J,K,N,O,R	X	X	X	X	X
MT4-115-S	6142	120 VAC	-	D,E,J,K,N,O,R	X	X	X	X	X
MT4-115-WH-VFR##	6224	120 VAC	15	D,E,J,K,N,O,R	X	X	X	X	X
MT4-12/24-R	5308	12/24	-	D,E,J,K,N,O,R	X	*	*	*	*
MT4-12/24-S	7997	12/24	-	D,E,J,K,N,O,R	X	*	*	*	*

NOTE: *Pending

**MTWP-2475W is Weatherproof and rated for 180 cd @ 77°F (25°C). See Data Sheet S9004 or Installation Instruction P84150.

***For additional information on mounting please refer to Data Sheet S7000.

1575 strobes are UL Listed for 15cd with 75cd on AXIS.

Series WH Strobe is listed for UL Standard 1638 only. See Instruction Sheet P83160.

*** "A" Stands for Agent Lettering.

⚠WARNING: CONTACT WHEELOCK FOR THE CURRENT "INSTALLATION INSTRUCTIONS" P82467 MT-12/24, P84155 MT w/Strobe P84150 MTWP WEATHERPROOF "GENERAL INFORMATION" SHEET (P82380) ON THESE PRODUCTS. THESE DOCUMENTS DO UNDERGO PERIODIC CHANGES. IT IS IMPORTANT THAT YOU HAVE CURRENT INFORMATION ON THESE PRODUCTS. THESE MATERIALS CONTAIN IMPORTANT INFORMATION THAT SHOULD BE READ PRIOR TO SPECIFYING OR INSTALLING THESE PRODUCTS, INCLUDING:

- **TOTAL CURRENT REQUIRED BY ALL APPLIANCES CONNECTED TO SYSTEM SECONDARY POWER SOURCES.**
- **FUSE RATINGS ON NOTIFICATION APPLIANCE CIRCUITS TO HANDLE PEAK CURRENTS FROM ALL APPLIANCES ON THOSE CIRCUITS.**
- **COMPOSITE FLASH RATE FROM MULTIPLE STROBES WITHIN A PERSON'S FIELD OF VIEW.**
- **THE VOLTAGE APPLIED TO THESE PRODUCTS MUST BE WITHIN THEIR RATED INPUT VOLTAGE RANGE.**
- **INSTALLATION IN OFFICE AREAS AND OTHER SPECIFICATION AND INSTALLATION ISSUES.**
- **USE STROBES ONLY ON CIRCUITS WITH CONTINUOUSLY APPLIED OPERATING VOLTAGE. DO NOT USE STROBE ON CODED OR INTERRUPTED CIRCUITS IN WHICH THE APPLIED VOLTAGE IS CYCLED ON AND OFF AS THE STROBE MAY NOT FLASH.**
- **FAILURE TO COMPLY WITH THE INSTALLATION INSTRUCTIONS OR GENERAL INFORMATION SHEETS COULD RESULT IN IMPROPER INSTALLATION, APPLICATION, AND/OR OPERATION OF THESE PRODUCTS IN AN EMERGENCY SITUATION,WHICH COULD RESULT IN PROPERTY DAMAGE AND SERIOUS INJURY OR DEATH TO YOU AND/OR OTHERS.**
- **CONDUCTOR SIZE (AWG), LENGTH AND AMPACITY SHOULD BE TAKEN INTO CONSIDERATION PRIOR TO DESIGN AND INSTALLATION OF THESE PRODUCTS, PARTICULARLY IN RETROFIT INSTALLATIONS.**

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

Architects and Engineers Specifications

The notification appliance shall be a Wheelock Series MT audible/visual appliance or equivalent. Notification appliance shall be electronic and use solid state components. Electromechanical alternatives are not approved. Each electronic appliance shall provide eight (8) field selectable alarm tones. The tones shall consist of: HORN, BELL, MARCH TIME HORN, CODE-3 HORN, CODE-3 TONE, SLOW WHOOP, SIREN and HI/LO. Tone selection shall be by durable dip switch assembly and not clips or jumpers. The Multitone Audible appliance shall be UL Listed under Standard 464 for Audible Signal Appliances. The audible and the strobe shall be able to operate from a single NAC circuit while producing any of these tones. The appliance shall provide two output sound levels: STANDARD and HIGH dBA. The HIGH dBA setting shall provide a minimum 5 dBA increase in sound output at nominal voltage. The HIGH anechoic dBA measurement at 10 feet at the alarm HORN SETTING shall be 99 dBA minimum. Operating voltages shall be either 12 VDC or 24 VDC using filtered power or unfiltered power supply (full-wave-rectified). All models shall have provisions for standard reverse polarity type supervision and IN/OUT field wiring using terminals that accept #12 to #18 AWG wiring.

Combination audible/visual appliances shall incorporate a Xenon flashtube enclosed in a rugged Lexan® lens or equivalent with solid state circuitry. Strobe shall produce a flash rate of one (1) flash per second minimum over the voltage range. The MT strobe intensity shall be rated per UL and Listed under Standard 1971 for Signaling Devices for the Hearing Impaired for 1575cd multi-candela with field selectable 15/30/75/110 candela settings. The 1575 candela strobe shall be specified when 15 candela or with 75 candela intensity on-axis is required. Strobe Models shall incorporate circuitry for synchronized strobe flash and shall be designed for compatibility with Wheelock SM, DSM Sync Modules, Wheelock Power Supplies or other manufacturers panels with built-in Wheelock Patented Sync Protocol. The strobes shall not drift out of synchronization at any time during operation. If the module fails to operate (i.e., contacts remain closed), the strobes shall revert to a non-synchronized default flash rate. Strobe activation shall be via independent input or from the same input circuit as the audible.

The combination audible/visual appliances shall be installed indoors and may be surface or flush mounted. They shall mount to standard electrical hardware requiring no additional trimplate or adapter. The aesthetic appearance shall not have any mounting holes or screw heads visible when the installation is completed. The appliance shall be finished in a textured red color.

The Series MT-12/24, MTWP and MT4 appliances may be installed indoor or outdoor with the proper back box.

NOTE: Due to continuous development of our products, specifications and offerings are subject to change without notice in accordance with Wheelock Inc. standard terms and conditions.

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3 YEAR WARRANTY
Made in USA

S2000 MT 06/11

NJ Location
273 Branchport Ave.
Long Branch, NJ 07740
P: 800-631-2148
F: 732-222-8707
www.coopernotification.com

FL Location
7246 16th Street E, Unit 105
Sarasota FL 34243-6817
P: 941-487-2300
F: 941-487-2389

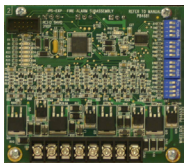
VA Location
103 West Broad Street, Suite 500
Falls Church, VA 22046
P: 877-459-7726
F: 703-294-6560

COOPER Notification

POWERPATH™ NAC POWER SUPPLIES

PS-6

PS-8



PS-EXP

Description

The Wheelock Series PS-6 and PS-8 are 24VDC, filtered and regulated, supervised remote power supply/battery chargers are used for supervision and expanded power driving capability of Fire Alarm Notification Appliance Circuits. The PS-6 provides 6 amps of power distributed across 4 outputs, while the PS-8 provides 8 Amps across 4 output. In addition the PS-8 provides additional room in the chassis for accessories like an Addressable Control Module, with mounting studs.

The Power Supplies may be connected to any 12V or 24V (FWR or DC) Fire Alarm Control Panel (FACP) by using a Notification Appliance Circuit (NAC) or a "Dry Contact". Primary applications include NAC expansion (supports ADA requirements) and auxiliary power to support system accessories. This unit provides filtered and regulated 24VDC, up to four (4) Class "B", two (2) Class "A", or two (2) Class "B" and one (1) Class "A" Notification Appliance Circuits. With the optional plug-in PS-EXP module the unit supports (8) Class "B" or (4) Class "A" Notification Appliance Circuits. Additionally, an auxiliary power output of 2.5 Amps (disconnected upon AC power loss or an alarm condition) or up to 0.240 A of constant power on the PS-8 and 0.075 A of constant power on the PS-6.

The Wheelock Power Supplies can accommodate 7 or 12 AH batteries inside its lockable chassis. Using an external battery cabinet it can charge up to 33 AH batteries (pending UL testing). Two FACP NAC circuits or two "Dry" contact initiating circuits can be connected to the inputs. These inputs can then be directed to control supervision and power delivery to any combination of the four (4) outputs. Each output is rated at 3.0 Amps (Class "B") or (Class "A") and can be programmed to generate a steady or Code 3 Temporal Horn sound and a strobe output under alarm condition. Total load for the PS-6 and PS-8 NAC circuits must not exceed the power supplies rated output.

The Power Suppliesunder non-alarm condition provides independent supervision for Class "A" and Class "B" FACP NAC circuits. In the event of circuit trouble, the FACP will be notified via the POWERPATH steered input (IN1 or IN2). In addition there are two sets of trouble reporting terminals, one used for AC power loss reporting and the other for all troubles. The AC power loss reporting, on the common trouble terminals and on IN1 or IN2, can be delayed for either 30 seconds or 170 minutes. The AC power loss terminals will always report the trouble within 1 second after loss of AC power.

The PS-6 and PS-8 Power Supplies are UL Listed under UL Standard 864, 9th Edition to be used with any 24 volt Listed Regulated notification appliances. They include the capability to synchronize Wheelock strobes and horns and to silence the horn signal when horn/strobes are operating on two wires.

Approvals
- Approvals Include: UL Standard 864, 1481, California State Fire Marshal (CSFM), Factory Mutual (FM)
- Compliant with NFPA 72

Inputs
- 120VAC, 50/60Hz, 4.25 Amps (PS-6/8) and 5.32 Amps (PS-8) Operating Power in Alarm
- 240VAC, 60Hz, 2.42 Amps (PS-6E and 3.22 Amps (PS-8E)' Operating Power in Alarm
- 24VDC Battery Backup Connection
- Two (2), 12V or 24V NAC Initiating Circuits (8-33V at 5mA) FWR or DC
- Two (2) "Dry" Contact initiating Circuits
- Accepts two (2) Class "A" or two (2) Class "B" circuit inputs
- Built in battery charger for sealed lead acid or gel type batteries

Outputs
- NAC outputs are 24VDC, 3.0 Amps each, power limited
- 8 Amps on PS-8 and 6 Amps on the PS-6 total alarm current

FM APPROVED

...Features continued on next page

- Capable of four (4), Class "B" circuits
- Capable of two (2) Class "A" circuits
- Capable of one (1) Class "A" circuit and two (2) Class "B" circuits
- Capable of (8) Class "B" or four (4) Class "A" circuits with optional PS-EXP module
- Temporal (Code 3), constant voltage output, Wheelock Sync output or True input to output follower mode
- Built-in Wheelock synchronization mode that can be fed to any or all of the output circuits
- Input and output can be synchronized with "IN>OUT SYNC" mode (DSM, 2nd POWERPATH™ or FACP with synchronization protocol is required)
- Audible silence capability
- Filtered and electronically regulated output
- 2.5 Amp auxiliary power limited output with reset capability. (Removed upon AC loss or alarm. Automatic reset 30 seconds after AC power returns or the alarm condition is over) or 0.075 Amps (PS-6) or 0.240 Amps (PS-8) of auxiliary power limited output which remains on during AC loss or an alarm condition when configured for 24 hour battery backup

Supervision
- Compatible with 12V or 24V (FWR or DC) FACP
- Signaling appliance circuits are supervised and steered to either IN1 or IN2
- 10K Ohm, 1 Watt (Wheelock Model #MPEOL) End of Line Resistor (EOLR) for supervision of all outputs
- 37 distinguishable trouble diagnostics
- AC loss trouble reported over a separate set of contacts (delay of 1 second)
- All troubles are reported over the common trouble contacts (AC loss can have a delay of 30 seconds or 170 minutes)
- Automatic switchover to standby battery when AC fails
- Thermal and short circuit protection with auto reset
- Input and output status LED indicators
- AC fail supervision
- Battery presence and low battery supervision
- Ground Fault Detection, with diagnostics to indicate which circuit fault is on
- Latching LED's for NAC trouble annunciation and Diagnostic trouble LED's (latching can be disabled)

Power
- Not Battery Dependent
- Automatic switch over to standby batteries when AC fails
- Supports sealed lead acid or gel type batteries
- Fused battery protection
- Thermal and short circuit protection with auto reset
- Supports both 7AH or 12AH batteries in the same cabinet

POWERPATH™ Operating Modes (refer to Installation Manual):

Normal Mode: Provides constant 24 VDC output upon initiation by a voltage to input IN1 or IN2 or by a contact opening on DRY1 or DRY2. The unit returns to standby mode when the input is deactivated.

Wheelock Sync Mode: Provides signals for synchronization of patented Wheelock audible and strobe notification appliances. Audibles can also be silenced in this mode while the strobes continue to flash.

In>Out Sync Mode: Accepts a synchronization signal on the input to provide a coded output or synchronized output. This signal may come from a FACP, another POWERPATH or a Wheelock DSM synchronization module. Caution: Do not use strobes on coded output circuits.

True Input Follower Mode: Accepts a coded signal on the input to provide a coded output with the same timing as the input. The signal may come from a FACP, another POWERPATH or other coded source. Caution: Do not use strobes on coded output circuits.

Temporal Mode: Codes the output voltage in a code-3 temporal pattern to drive audible appliances such as horns, bells or chimes. Caution: Do not use strobes on coded output circuits.

Specifications and Ordering Information

Model Number	Order Code	Input Voltage/Current	Approvals		
			UL	CSFM	FM
PS-6	105530	6 amp, red enclosure	X	X	X
PS-6B	100257	6 amp, black enclosure	X	X	X
PS-8	105531	8 amp, red enclosure	X	X	X
PS-8B	105830	8 amp, black enclosure	X	X	X
PS-6EXP	105083	6 amp power supply with preinstalled expansion module	X	X	X
PS-8EXP	105084	8 amp power supply with preinstalled expansion module	X	X	X
PS-EXP	105534	4 class B or 2 class A expansion module	X	X	X
PS-EXP-RETRO	105527	Field upgrade kit for models prior to January 2010#	X	X	X

Input Circuit		Input Voltage and Current	
Input voltage Range		8 to 33 VDC	
Input Current @ 12 VDC		0.005 amps	
Input Current @ 24 VDC		0.005 amps	
Output Circuit		Output Voltage and Current	
Four (4) Class B or		24 VDC @ up to 3 amps per curcuit	
Two (2) Class A or			
One (1) Class A and Two (2) Class "B" or			
8 Class B or 4 Class A (optional PS-EXP module necessary)			
Continuous duty up to 3 Amps per circuit, up to 4 Amps maximum per panel			
Standby Current		0.129 Amps	
Alarm Current		0.129 Amps	
Primary PS-6 (120 VAC models)		105 to 130 VAC, 50/60 Hz @ 4.25 Amps	
Primary PS-8 (120VAC models)		105 to 130 VAC 50/60 Hz @ 5.32 Amps	
Primary PS-6E (240 VAC models)		210 to 260 VAC, 50/60 Hz @ 2.42 Amps	
Primary PS-8E (240 VAC models)		210 to 260 VAC 50/60 Hz @ 3.22 Amps	
Secondary Power Charging Capacity		32 Amp hours @ 0.750 Amps per hour	
Enclosure can house up to two 12 AH batteries			
Aux Output			
CP Mode	PS-6 up to 75 mA	PS-8 up to 250 mA	
MP Mode	2.5A during non alarm		
Model	Dimensions	Weight	Comments
PS-6/PS-6B	17"H x 13"W x 3.5"D	11.5lbs. (Ship) 9.4lbs (Unit)	Small profile
PS-8/PS-8B	17"H x 15"W x 5.5"D	17.7lbs (Ship) 15.6lbs (Unit)	Additional room for modules
PS-EXP	4.3"H x 3.7"W x 1"D	1lb. (Ship & Unit)	Plugs into main pcb on all models

X= Approved
*= Pending
#=Contact Technical Support for additional inforamation on upgrade options

Architects and Engineers Specifications

The power supply shall be Wheelock POWERPATH™ Series PS-8, or equivalent. The unit shall be stand alone power supply intended for powering fire alarm notification appliances via its own Notification Appliance Circuit(s) (NAC). The unit shall be UL 864 Listed for power limited operation of outputs and comply with NFPA 70 (NEC), article 760.
The power supply shall support a full 8A of notification power even if the battery is in a degraded mode and only AC power is connected.
The power supply shall be activated by a standard Notification Appliance Circuit (NAC) from any Fire Alarm Control Panel (FACP) or a "Dry contact" opening. The units shall be 8 ampere, 24 VDC, regulated and filtered, supervised remote power supply/charger. It shall operate over the voltage range of 8 to 33 VDC or FWR. The primary application of the unit shall be able to expand fire alarm system capabilities for additional NAC circuits to support ADA requirements and to provide auxiliary power to support system accessories or functions. The power supply shall provide four Class "B", two Class "A", or two Class "B" and one Class "A" NAC circuit(s). Eight Class "B" or Four Class "A" circuits shall be available with an optional PS-EXP module. The PS-8 unit shall supply up to 240 mA of auxiliary power that is available during both non-alarm and alarm or auxiliary power of not less than 2.5A at 24 VDC during non-alarm. The power supply shall be capable of charging batteries of up to 33 ampere hours per NFPA 72 at maximum rate of 0.750 Amps per hour.
Input activation options shall be from not less than two NAC circuits or Dry Contact closures. These inputs shall have the capability of being directed to any combination of the four NAC circuit outputs. Each NAC circuit output shall be rated at 3 amperes for Class "B" applications or 3 amperes each for Class "A". The outputs shall be programmable to generate a steady or Temporal (Code 3) output and or a synchronized strobe or horn output. The power supply shall provide independent loop supervision for either Class "A" or Class "B" FACP NAC circuits and shall have the capability to "steer" all alarm or trouble conditions to either incoming NAC circuit. The units shall have common trouble terminals. The power supply shall be powered from a 120 VAC source with a current consumption of xx amperes max. The unit shall incorporate short circuit protection with auto reset. The power supply shall incorporate a built in battery charger for lead acid or gel type batteries with automatic switchover to battery back up in the event of AC power failure. The charger shall incorporate fused protection for the batteries and have the ability to report low battery and/or no battery condition(s). Standby current for battery back up shall be 0.129 Amps max. The power supply shall have the ability to latch trouble LED's so the circuit in trouble can be identified. The cabinet dimensions shall be 17" H x 15" W x 5.5" D.

The power supply shall be Wheelock POWERPATH™ Series PS-6, or equivalent. The unit shall be stand alone power supply intended for powering fire alarm notification appliances via its own Notification Appliance Circuit(s) (NAC). The unit shall be UL 864 Listed for power limited operation of outputs and comply with NFPA 70 (NEC), article 760.
The power supply shall support a full 6A of notification power even if the battery is in a degraded mode and only AC power is connected.
The power supply shall be activated by a standard Notification Appliance Circuit (NAC) from any Fire Alarm Control Panel (FACP) or a "Dry contact" opening. The units shall be 6 ampere, 24 VDC, regulated and filtered, supervised remote power supply/charger. It shall operate over the voltage range of 8 to 33 VDC or FWR. The primary application of the unit shall be able to expand fire alarm system capabilities for additional NAC circuits to support ADA requirements and to provide auxiliary power to support system accessories or functions. The power supply shall provide four Class "B", two Class "A", or two Class "B" and one Class "A" NAC circuit(s). Eight Class "B" or Four Class "A" circuits shall be available with an optional PS-EXP module. The PS-6 unit shall supply up to 200 mA of auxiliary power that is available during both non-alarm and alarm or auxiliary power of not less than 2.5A at 24 VDC during non-alarm. The power supply shall be capable of charging batteries of up to 33 ampere hours per NFPA 72 at a maximum rate of 0.750 Amps per hour.
Input activation options shall be from not less than two NAC circuits or Dry Contact closures. These inputs shall have the capability of being directed to any combination of the four NAC circuit outputs. Each NAC circuit output shall be rated at 3 amperes for Class "B" applications or 3 amperes each for Class "A". The outputs shall be programmable to generate a steady or Temporal (Code 3) output and or a synchronized strobe or horn output. The power supply shall provide independent loop supervision for either Class "A" or Class "B" FACP NAC circuits and shall have the capability to "steer" all alarm or trouble conditions to either incoming NAC circuit. The units shall have common trouble terminals. The power supply shall be powered from a 120 VAC source with a current consumption of xx amperes max. The unit shall incorporate short circuit protection with auto reset. The power supply shall incorporate a built in battery charger for lead acid or gel type batteries with automatic switchover to battery back up in the event of AC power failure. The charger shall incorporate fused protection for the batteries and have the ability to report low battery and/or no battery condition(s). Standby current for battery back up shall be 0.130 Amps max. The power supply shall have the ability to latch trouble LED's so the circuit in trouble can be identified. The cabinet dimensions shall be 17" H x 13" W x 3.5" D.

⚠ WARNING: PLEASE READ THESE SPECIFICATIONS AND INSTALLATION INSTRUCTIONS CAREFULLY BEFORE USING, SPECIFYING OR APPLYING THIS PRODUCT. FAILURE TO COMPLY WITH ANY OF THESE INSTRUCTIONS, CAUTIONS AND WARNINGS COULD RESULT IN IMPROPER APPLICATION, INSTALLATION AND/OR OPERATION OF THESE PRODUCTS IN AN EMERGENCY SITUATION, WHICH COULD RESULT IN PROPERTY DAMAGE, AND SERIOUS INJURY OR DEATH TO YOU AND/OR OTHERS.

NOTE: Due to continuous development of our products, specifications and offerings are subject to change without notice in accordance with Wheelock Inc. standard terms and conditions.

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1 YEAR WARRANTY

S9100 PS-6 & 8 06/11

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Long Branch, NJ 07740
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F: 732-222-8707
www.coopernotification.com

COOPER Notification

Series RSS and RSSP Strobes and Strobe Plates

Series RSS

Series RSS

Series RSSWP

Description

The Wheelock patented Series RSS Strobe Appliances and Series RSSP Strobe Plates have lower current draw while maintaining outstanding performance, reliability and cost effectiveness. These versatile appliances will satisfy virtually all requirements for indoor, wall or ceiling mount applications.

Strobe options for wall mount models include 1575 or the Wheelock Patented MCW multi-candela strobe with field selectable candela settings of 15/30/75/110cd or the high intensity MCWH strobe with field selectable 135/185cd. Ceiling mount models include the patented MCC multi-candela ceiling strobe with field selectable intensities of 15/30/75/95cd or the high intensity MCCH strobe with field selectable 115/177cd.

All models may be synchronized using the Wheelock DSM Sync Modules, Wheelock Power Supplies or other manufacturers panels incorporating the Wheelock Patented Sync Protocol. Synchronized strobes can eliminate possible restrictions on the number of strobes in the field of view. Wheelock's synchronized strobes offer an easy way to comply with ADA recommendations concerning photosensitive epilepsy as well as meeting the requirements of NFPA 72.

The Wheelock Series RSS Strobes employ a Patented Integral Strobe Mounting Plate that can be mounted to a single gang, double gang, 4" square, 100mm European backboxes or the SHBB surface backbox. If the flush backbox has side or top space between it and the finished wall, the NATP (Notification Appliance Trimplate) may be used. It provides an additional .65" of trim for the Appliance. An attractive cover plate is provided for a clean, finished appearance on all models.

The Series RSSP Multi-Candela Strobe Plates are a cost effective way to retrofit required wall strobe appliances to bells, horns, chimes, multitones or speakers and easily mounts to standard 4" backboxes or for surface mount use with the Wheelock SBL2 surface backbox.

Features

- Approvals include: UL Standard 1971, New York City (MEA), California State Fire Marshal (CSFM), Factory Mutual (FM), and Chicago (BFP) See approvals by model in Specifications and Ordering Information
- ADA/NFPA/UFC/ANSI compliant. Meets OSHA 29 Part 1910.165
- Wall mount Multi-Candela models are available with Field Selectable Candela Settings of 15/30/ 75/110cd or 135/185cd. Single Candela models are available in 1575cd
- Ceiling mount Multi-Candela models are available with field selectable candela settings of 15/30/75/95cd or 115/177cd. (Square)
- Strobes produce 1 flash per second over the regulated voltage range
- 12 and 24 VDC models with wide UL "Regulated Voltage" using filtered (DC) or unfiltered VRMS input voltage
- Synchronize using the Wheelock sync modules or panels with built-in Wheelock Patented Sync Protocol
- Fast installation with IN/OUT screw terminals using #12 to #18 AWG wire

For Weatherproof Series RSS See Datatsheet S9004

S5391 151-92-E 7125-0785:141 7300-0785:154

NOTE: All CAUTIONS and WARNINGS are identified by the symbol ⚠. All warnings are printed in bold capital letters.

⚠ **WARNING: PLEASE READ THESE SPECIFICATIONS AND ASSOCIATED INSTALLATION INSTRUCTIONS CAREFULLY BEFORE USING, SPECIFYING OR APPLYING THIS PRODUCT. VISIT WWW.COOPERNOTIFICATION.COM OR CONTACT COOPER WHEELOCK FOR THE CURRENT INSTALLATION INSTRUCTIONS. FAILURE TO COMPLY WITH ANY OF THESE INSTRUCTIONS, CAUTIONS OR WARNINGS COULD RESULT IN IMPROPER APPLICATION, INSTALLATION AND/OR OPERATION OF THESE PRODUCTS IN AN EMERGENCY SITUATION, WHICH COULD RESULT IN PROPERTY DAMAGE, AND SERIOUS INJURY OR DEATH TO YOU AND/OR OTHERS.**

General Notes:

- Strobes are designed to flash at 1 flash per second minimum over their "Regulated Voltage Range". Note that NFPA-72 specifies a flash rate of 1 to 2 flashes per second and ADA Guidelines specify a flash rate of 1 to 3 flashes per second.
- All candela ratings represent minimum effective Strobe intensity based on UL Standard 1971.
- **"Regulated Voltage Range" is the newest terminology used by UL to identify the voltage range. Prior to this change UL used the terminology "Listed Voltage Range".**

Table 1: Average RMS Current*

RSS/RSSP 24VDC Models	RSS/RSSP - Wall Mount							Ceiling Mount					
	241575W	24MCW				24MCWH		24MCC				24MCCH	
	1575cd	15cd	30cd	75cd	110cd	135cd	185cd	15cd	30cd	75cd	95cd	115cd	177cd
UL max*	0.090	0.060	0.092	0.165	0.220	0.300	0.420	0.065	0.105	0.189	0.249	0.300	0.420

RSS/RSSP 24VDC Models	RSS/RSSP Wall Mount
	121575W
12 vdc	**0.152**
UL max*	0.255

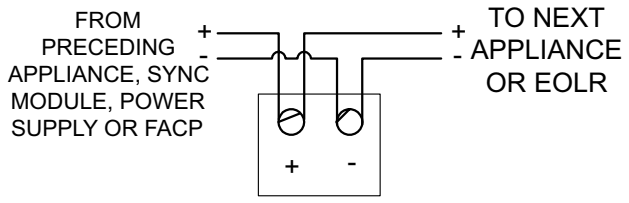
* RMS current ratings are per UL average RMS method. UL max current rating is the maximum RMS current within the listed voltage range (16-33v for 24v units). For strobes the UL max current is usually at the minimum listed voltage (16v for 24v units). For audibles the max current is usually at the maximum listed voltage (33v for 24v units). For unfiltered FWR ratings, see installation instructions.

Table 2: Audibles/Speakers for RSSP Strobe Plate

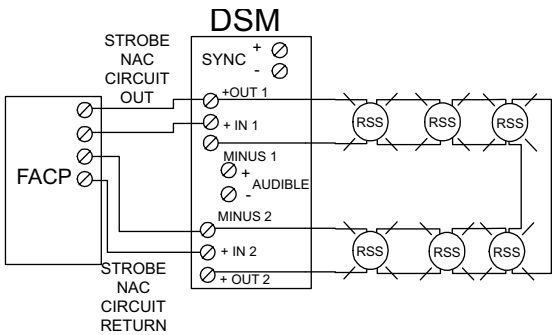
Product	Series
Multitone Appliances	AMT, MT
Horns	AH, NH, HS
Motor Bells	MB-G6/G10
Speakers	ET-1010/1080, E70, ET70
Chimes	CH70

Wiring Diagrams

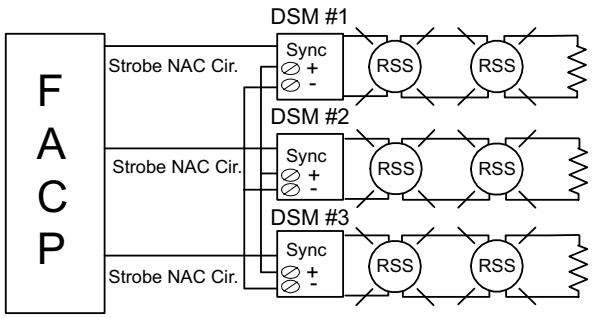
SERIES RSS/RSSP APPLIANCE



SERIES RSS/RSSP APPLIANCES SYNCHRONIZED WITH DSM MODULE SINGLE CLASS "A" NAC CIRCUIT

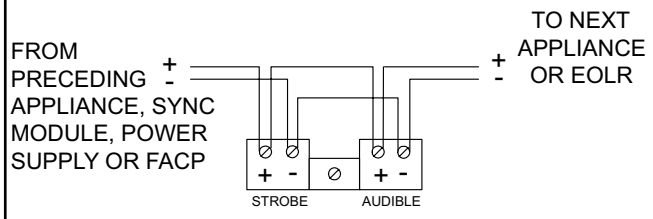


SERIES RSS/RSSP APPLIANCES SYNCHRONIZED WITH MULTIPLE DSM MODULES

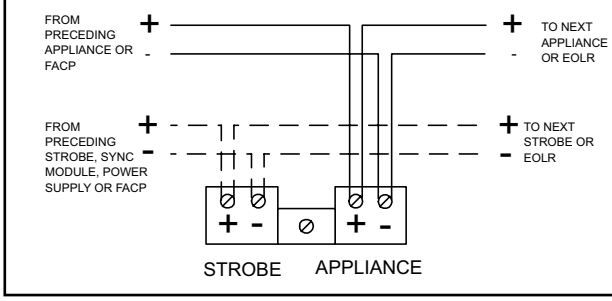


DSM Interconnecting wiring shown. Maximum of twenty (20)

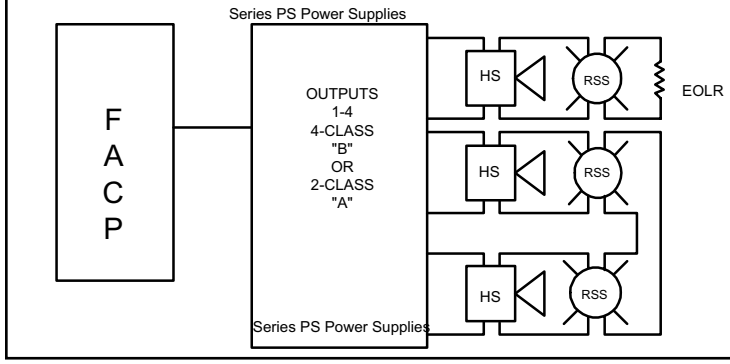
STROBE/PLATE ASSEMBLY
AUDIBLE & VISIBLE APPLIANCE OPERATE IN UNISON



STROBE/PLATE ASSEMBLY
AUDIBLE & VISIBLE APPLIANCE OPERATE INDEPENDENTLY



SERIES RSS/RSSP APPLIANCES SYNCHRONIZED WITH WHEELOCK POWER SUPPLIES



For detail using DSM Sync Module refer to Data Sheet S3000 or Installation Instructions P83177 for DSM. For wiring information on the power supplies refer to Wheelock Power Supplies.

Specifications and Ordering Information

Model	Order Code	Wall Mount	Ceiling Mount	Non-Sync	Strobe Candela	24 VDC	12 VDC	Color RED	Color WHITE	Mounting Options***	Square or Round	Agency Approvals				
												UL	MEA	CSFM	FM	BFP
RSS-24MCW-FR	940	X	-	X	15/30/75/110	X	-	X	-	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	X
RSS-24MCW-FW	9401	X	-	X	15/30/75/110	X	-	-	X	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	X
RSS-24MCW-AR****	9773	X	-	X	15/30/75/110	X	-	-	X	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	X
RSS-241575W-FR	7471	X	-	X	15 (75 on Axis)	X	-	X	-	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	X
RSS-241575W-FW	7788	X	-	X	15 (75 on Axis)	X	-	-	X	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	X
RSS-121575W-FR	7476	X	-	X	15 (75 on Axis)	-	X	X	-	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	X
RSS-121575W-FW	7468	X	-	X	15 (75 on Axis)	-	X	-	X	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	X
RSS-24MCC-FW	3158	-	X	X	15/30/75/95	X	-	-	X	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	-
RSS-24MCC-FR	3157	-	X	X	15/30/75/95	X	-	X	-	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	-
RSS-24MCCH-FW	3461	-	X	X	115/177	X	-	-	X	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	-
RSS-24MCWH-FR	3465	X		X	135/185	X		X		B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	-
RSS-24MCWH-FW	3464	X		X	135/185	X			X	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	-
RSSWP-2475W-FR**	9013	X	-	X	180@ 77°F 75@ -31°F	X	-	X	-	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	-
RSSWP-2475W-FW**	3034	X	-	X	180@ 77°F 75@ -31°F	X	-	-	X	B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	X	-
RSSP-121575W-FR	7798	X	-	X	15 (75 on Axis)	-	X	X	-	D,E,Z	Square	X	-	X	X	X
RSSP-24MCW-FR	9402	X	-	X	15/30/75/110	X	-	X	-	D,E,Z	Square	X	X	X	X	X
RSSP-241575W-FR	7793	X	-	X	15 (75 on Axis)	-	-	X	-	D,E,Z	Square	X	X	X	X	X
RSSP-24MCWH-FR	9482	X		X	135/185	X		X		B,D,E,F,G,H,J,N,O,R,X	Square	X	X	X	-	-

All models sync with Wheelock DSM or Wheelock Power Supplies.
Models are available in either Red or White. Call Customer Service for Order Code & Delivery.
**For Weatherproof Series RSS Strobe specifications see data sheet S9004.
***Refer to data sheet S7000 for mounting options.
**** "A" stands for Agent Lettering.

Architects and Engineers Specifications

The visual notification appliances shall be Wheelock Series RSS Strobe Appliances or approved equals. The Series RSS shall meet and be listed for UL Standard 1971 (Emergency Devices for the Hearing-Impaired) for Indoor Fire Protection Service. The strobe shall be listed for indoor use and shall meet the requirements of FCC Part 15 Class B. The strobe appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range and shall incorporate a Xenon flashtube enclosed in a rugged Lexan® lens. All inputs shall be compatible with standard reverse polarity supervision of circuit wiring by a Fire Alarm Control Panel (FACP). When Strobe Plates are to be installed, they shall be the Wheelock Series RSSP Strobe Plate and shall have the same electronic circuitry as the Wheelock Series RSS.

The Series RSS Strobe shall be of low current design. Where Multi-Candela appliances are specified, the strobe intensity shall have field selectable settings and shall be rated per UL Standard 1971 at 15/30/75/110cd or 135/185cd for wall mount and 15/30/75/95cd or 115/177cd for ceiling mount. The selector switch for selecting the candela shall be tamper resistant. The 1575 candela strobe shall be specified when 15 candela UL Standard 1971 Listing with 75 candela on axis is required (e.g. ADA compliance).

When synchronization is required, the appliance shall be compatible with Wheelock's DSM Sync Modules, Wheelock Power Supplies or other manufacturers panels with built-in Wheelock Patented Sync Protocol. The strobes shall not drift out of synchronization at any time during operation. If the sync module or Power Supply fails to operate, (i.e., contacts remain closed), the strobe shall revert to a non-synchronized flash rate. The strobes shall be designed for indoor surface of flush mounting.

The Series RSS Strobe Appliances shall incorporate a Patented, Integral Strobe Mounting Plate that shall allow mounting to single-gang, double-gang, 4-inch square, 100mm European type backboxes, or the SHBB Surface Backbox. If required, an NATP (Notification Appliance Trimplate) shall be provided. An attaching cover plate shall be provided to give the Appliance and attractive appearance. The Appliance shall not have any mounting holes or screw heads visible when the installation is completed.

The Series RSSP Multi-Candela or single candela Strobe Plate shall mount to either a standard 4 inch square backbox for flush mounting, or the Wheelock SBL2 backbox for surface mounting.

All notification appliances shall be backward compatible.

NEMA Member

WE ENCOURAGE AND SUPPORT NICET CERTIFICATION
3 YEAR WARRANTY

S0410 RSS/RSSP 07/11

NJ Location
273 Branchport Ave.
Long Branch, NJ 07740
P: 800-631-2148
F: 732-222-8707
www.coopernotification.com

Item	Description	Standby Current Per Unit (AMPS)		QTY		Total Standby Current (AMPS)	Alarm Current Per Unity (AMPS)		Qty		System Alarm Current (AMPS)
A	Duct Detector	0.000045	x	8	=	0.00036	0.018	x	8	=	0.144
B	Heat Detector	0.000045	x	4	=	0.00018	0.018	x	4	=	0.072
C	Pull Station	0.00025	x	35	=	0.00875	0.0004	x	35	=	0.014
D	Smoke Detector	0.000045	x	54	=	0.00243	0.018	x	54	=	0.972
E	Control Modules	0.001	x	28	=	0.028	0.001	x	28	=	0.028
F	Isolator Modules	0.000045	x	4	=	0.00018	0.000045	x	4	=	0.00018
G	Sprinkler Modules	0.000396	x	22	=	0.008712	0.00068	x	22	=	0.01496
H	Horn/strobe	0.033	x	1	=	0.033	0.96	x	1	=	0.96
I	FACP - Power Card	0.072		1		0.072	0.096	x	1	=	0.096
J	FACP - CPU/LCD	0.117		1	=	0.117	0.135	x	1	=	0.135
		Total System Standy Current (AMPS)				0.270612	Total Sytem Alarm Current (AMPS)				2.43614

Required Operating Time of Secondary Power Source From NFPA 72, Section 10.6.7.2.1

Standby 24 Hourse Alarm 5 Minutes/60 0.083333333

Required Standby Time (Hours)		Total System Standby Current (AMPS)		Required Standby Capacity (Amp-Hours)	Required Alarm Time (Hours)		Total System Alarm Current (AMPS)		Required Alarm Current (Amp-Hours)
24	x	0.270612	=	6.494688	0.083333333	x	2.43614	=	0.203011667

Required Standby Capacity (Amp-Hours)		Required Alarm Capacity (Amp-Hours)		Total Required Capacity (Amp-Hours)		Factory of Safety		**Required Battery Capacity (Amp-Hours)**
6.494688	+	0.20301167	=	6.697699667	x	1.2	=	**8.0372396**

Appendix B – Occupant Load

	1st Floor	2nd Floor	Total
Occupants	362	204	566
Assembly			202.8666667
Office Space			146.21
Industrial			228.16
			577.2366667

Assembly [ft2]	1805	1238	3043
Office Space [ft2]	7282	7339	14621
Industrial [ft2]	16915	5901	22816
		Total	40480

Room No.	Area [ft2]	Sandia Use	Occupancy	OLF[ft2/per]	Occupants	PathFinder
1000	355	Conference Rm	Assembly - Less concentr	15	23.66666667	24
1015	1309	Conference Rm	Assembly - Less concentr	15	87.26666667	87
1232	141	Conference Rm	Assembly - Less concentr	15	9.4	9
1001	195	Manager Office	Business Use	100	1.95	2
1001A	76	Secretary Office	Business Use	100	0.76	1
1002	207	Manager Office	Business Use	100	2.07	2
1003	99	General office	Business Use	100	0.99	1
1003A	76	Secretary Office	Business Use	100	0.76	1
1005	147	General office	Business Use	100	1.47	1
1006	132	General office	Business Use	100	1.32	1
1007	132	Records Storage	Business Use	100	1.32	1
1008	143	Secretary Office	Business Use	100	1.43	1
1009	184	Manager Office	Business Use	100	1.84	2
1010	438	Director Office	Business Use	100	4.38	4
1012	138	Manager Office	Business Use	100	1.38	1
1013	251	Media Room	Business Use	100	2.51	3
1014	251	Restroom	Business Use	100	2.51	3
1016	202	Restroom	Business Use	100	2.02	2
1021	61	Janitoral Room	Business Use	100	0.61	1
1212	139	General office	Business Use	100	1.39	1
1214	142	General office	Business Use	100	1.42	1
1216	146	General office	Business Use	100	1.46	1
1218	143	General office	Business Use	100	1.43	1
1220	139	General office	Business Use	100	1.39	1
1222	143	General office	Business Use	100	1.43	1
1223	137	General office	Business Use	100	1.37	1
1224	142	General office	Business Use	100	1.42	1
1225	139	General office	Business Use	100	1.39	1
1227	92	General office	Business Use	100	0.92	1
1228	139	General office	Business Use	100	1.39	1

1229	135	General office	Business Use	100	1.35	1
1230	141	Copy Room	Business Use	100	1.41	1
1234	162	Restroom	Business Use	100	1.62	2
1236	162	Restroom	Business Use	100	1.62	2
1237	140	General office	Business Use	100	1.4	1
1239	138	General office	Business Use	100	1.38	1
1240	142	Manager Office	Business Use	100	1.42	1
1241	138	Manager Office	Business Use	100	1.38	1
1243	92	General office	Business Use	100	0.92	1
1245	138	Manager Office	Business Use	100	1.38	1
1246	104	Secretary Office	Business Use	100	1.04	1
1247	138	Manager Office	Business Use	100	1.38	1
1248	102	General office	Business Use	100	1.02	1
1249	138	General office	Business Use	100	1.38	1
1251	92	General office	Business Use	100	0.92	1
1253	138	General office	Business Use	100	1.38	1
1255	138	General office	Business Use	100	1.38	1
1257	138	General office	Business Use	100	1.38	1
1258	136	General office	Business Use	100	1.36	1
1259	92	General office	Business Use	100	0.92	1
1260	89	General office	Business Use	100	0.89	1
1261	92	General office	Business Use	100	0.92	1
1262	130	General office	Business Use	100	1.3	1
1263	134	General office	Business Use	100	1.34	1
1017	84	Office Storage	Industrial - General	100	0.84	1
1019	155	Equipment Room	Industrial - General	100	1.55	2
1100	835	High-Bay Laboratory	Industrial - General	100	8.35	8
1101	258	General Laboratory	Industrial - General	100	2.58	3
1102A	434	General Laboratory	Industrial - General	100	4.34	4
1102B	435	General Laboratory	Industrial - General	100	4.35	4
1103	260	General Laboratory	Industrial - General	100	2.6	3

1104	851	General Laboratory	Industrial - General	100	8.51	9
1105	251	General Laboratory	Industrial - General	100	2.51	3
1107	407	General Laboratory	Industrial - General	100	4.07	4
1109	428	General Laboratory	Industrial - General	100	4.28	4
1110	851	General Laboratory	Industrial - General	100	8.51	9
1111	1634	General Laboratory	Industrial - General	100	16.34	16
1112	984	Machine Shop	Industrial - General	100	9.84	10
1112A	128	Machine Shop	Industrial - General	100	1.28	1
1113	122	Laboratory Storage	Industrial - General	100	1.22	1
1120	185	Equipment Room	Industrial - General	100	1.85	2
1121	118	Laboratory Storage	Industrial - General	100	1.18	1
1122	437	Shipping and Receiving	Industrial - General	100	4.37	4
1123	884	General Laboratory	Industrial - General	100	8.84	9
1124	851	High-Bay Laboratory	Industrial - General	100	8.51	9
1125	790	General Laboratory	Industrial - General	100	7.9	8
1126A	1036	High-Bay Laboratory	Industrial - General	100	10.36	10
1126B	688	High-Bay Laboratory	Industrial - General	100	6.88	7
1126C	659	High-Bay Laboratory	Industrial - General	100	6.59	7
1126D	1019	High-Bay Laboratory	Industrial - General	100	10.19	10
1131	257	General Laboratory	Industrial - General	100	2.57	3
1133	261	General Laboratory	Industrial - General	100	2.61	3
1135	258	General Laboratory	Industrial - General	100	2.58	3
1137	423	General Laboratory	Industrial - General	100	4.23	4
1139	426	General Laboratory	Industrial - General	100	4.26	4
1226	142	Equipement Rm	Industrial - General	100	1.42	1
1238	63	Janitoral Room	Industrial - General	100	0.63	1
1244	218	Equipement Rm	Industrial - General	100	2.18	2
1250	83	Office Storage	Storage (other than Merc	100	0.83	1
Totals	26002				362	362

Room No.	Area [ft2]	Sandia Use	Occupancy	OLF[ft2/per]	Occupants
2001	740	Breakroom	Assembly - Less concentrated use	15	49.3333333
2000	355	Conference Rm	Assembly - Less concentrated use	15	23.6666667
2232	143	Conference Rm	Assembly - Less concentrated use	100	1.43
2003	566	Mens Locker Room	Business Use	100	5.66
2003A	419	Womens Locker Room	Business Use	100	4.19
2014	206	Restroom	Business Use	100	2.06
2016	188	Restroom	Business Use	100	1.88
2201	131	General Office	Business Use	100	1.31
2202	75	Janitorial Closet	Business Use	100	0.75
2203	135	General Office	Business Use	100	1.35
2204	139	General Office	Business Use	100	1.39
2205	90	General Office	Business Use	100	0.9
2207	150	General Office	Business Use	100	1.5
2209	114	General Office	Business Use	100	1.14
2210	142	General Office	Business Use	100	1.42
2211	90	General Office	Business Use	100	0.9
2212	138	General Office	Business Use	100	1.38
2213	90	General Office	Business Use	100	0.9
2214	40	Office Storage	Business Use	100	0.4
2215	90	General Office	Business Use	100	0.9
2216	105	Secretary Office	Business Use	100	1.05
2217	135	Manager Office	Business Use	100	1.35
2218	102	Secretary Office	Business Use	100	1.02
2219	135	Manager Office	Business Use	100	1.35
2220	139	General Office	Business Use	100	1.39
2221	135	General Office	Business Use	100	1.35
2222	141	Manager Office	Business Use	100	1.41
2223	134	General Office	Business Use	100	1.34

2224	142	General Office	Business Use	100	1.42
2225	137	General Office	Business Use	100	1.37
2227	137	General Office	Business Use	100	1.37
2228	72	Office Storage	Business Use	100	0.72
2229	136	General Office	Business Use	100	1.36
2230	139	Copier Room	Business Use	100	1.39
2237	137	General Office	Business Use	100	1.37
2238	78	Janitorial Closet	Business Use	500	0.156
2239	138	General Office	Business Use	100	1.38
2240	140	General Office	Business Use	100	1.4
2241	138	General Office	Business Use	100	1.38
2243	138	General Office	Business Use	100	1.38
2245	138	Manager Office	Business Use	100	1.38
2246	99	Office Storage	Business Use	100	0.99
2247	138	General Office	Business Use	100	1.38
2248	97	Secretary Office	Business Use	100	0.97
2249	138	General Office	Business Use	100	1.38
2250	56	Storage	Business Use	100	0.56
2251	138	General Office	Business Use	100	1.38
2253	138	General Office	Business Use	100	1.38
2255	92	General Office	Business Use	100	0.92
2257	92	General Office	Business Use	100	0.92
2259	92	General Office	Business Use	100	0.92
2260	131	General Office	Business Use	100	1.31
2261	92	General Office	Business Use	100	0.92
2262	142	General Office	Business Use	100	1.42
2263	134	General Office	Business Use	100	1.34
2264	131	General Office	Business Use	100	1.31
2266	130	General Office	Business Use	100	1.3

2002	57	Equipment Room	Industrial - General	100	0.57
2101	427	General Laboratory	Industrial - General	100	4.27
2103	402	General Laboratory	Industrial - General	100	4.02
2111	283	General Laboratory	Industrial - General	100	2.83
2113	322	Equipment Room	Industrial - General	100	3.22
2115A	226	Computer Laboratory	Industrial - General	100	2.26
2115B	237	Computer Laboratory	Industrial - General	100	2.37
2116	59	Laboratory Storage	Industrial - General	100	0.59
2117	83	Equipment Room	Industrial - General	100	0.83
2118	289	General Laboratory	Industrial - General	100	2.89
2120	185	Equipment Room	Industrial - General	100	1.85
2121	316	General Laboratory	Industrial - General	100	3.16
2122	293	Machine Shop	Industrial - General	100	2.93
2123	285	General Laboratory	Industrial - General	100	2.85
2125	267	General Laboratory	Industrial - General	100	2.67
2127	254	General Laboratory	Industrial - General	100	2.54
2131	424	General Laboratory	Industrial - General	100	4.24
2133	418	General Laboratory	Industrial - General	100	4.18
2208	123	Equipment Room	Industrial - General	100	1.23
2226	111	Equipment Room	Industrial - General	100	1.11
2244	217	Equipment Room	Industrial - General	100	2.17
2234	180	Restroom	Restroom	100	1.8
2236	182	Restroom	Restroom	100	1.82
Total	14217				204

Appendix C

Pathfinder Images and Output File

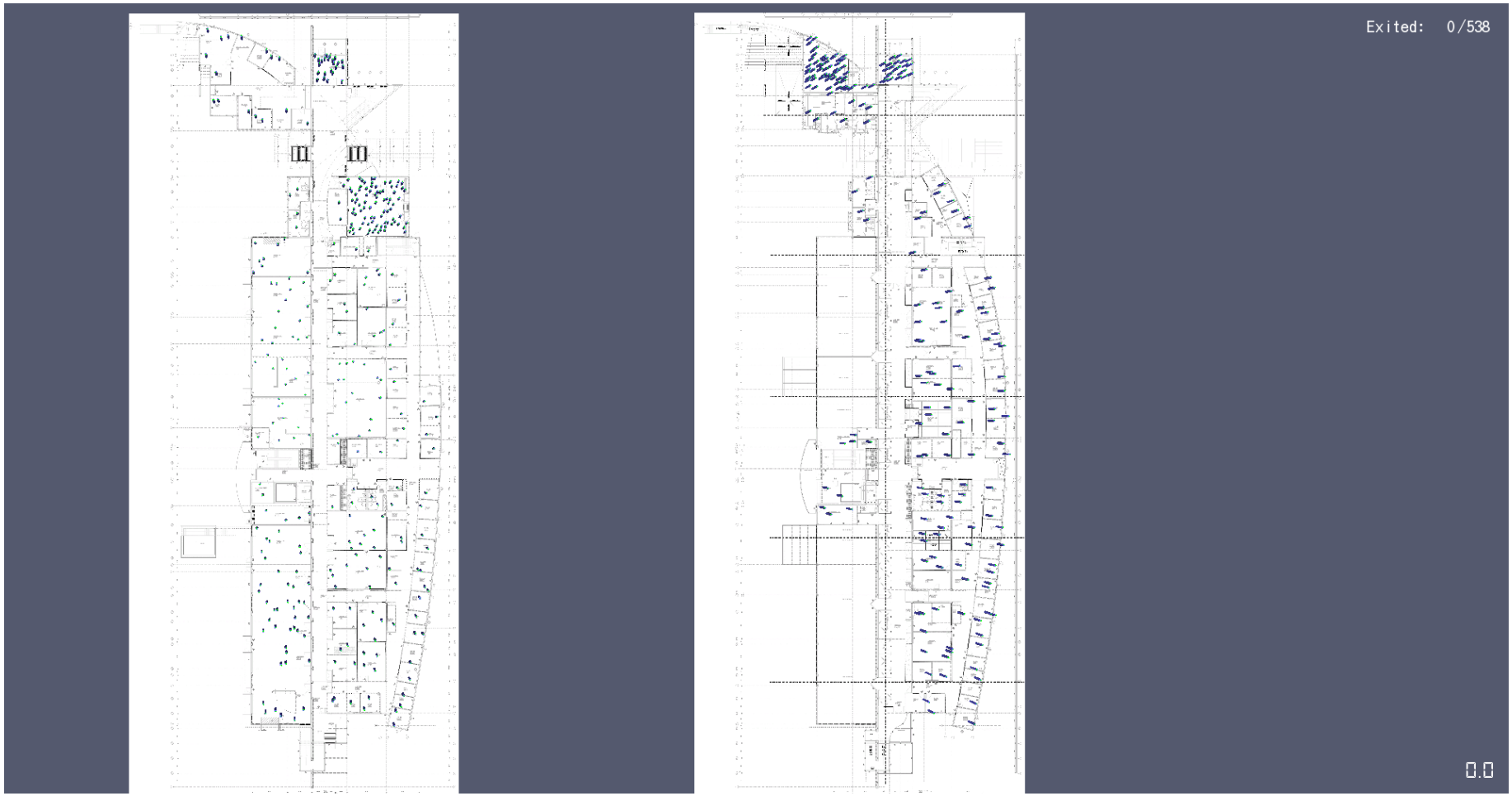


Figure C-1. Pathfinder t=0

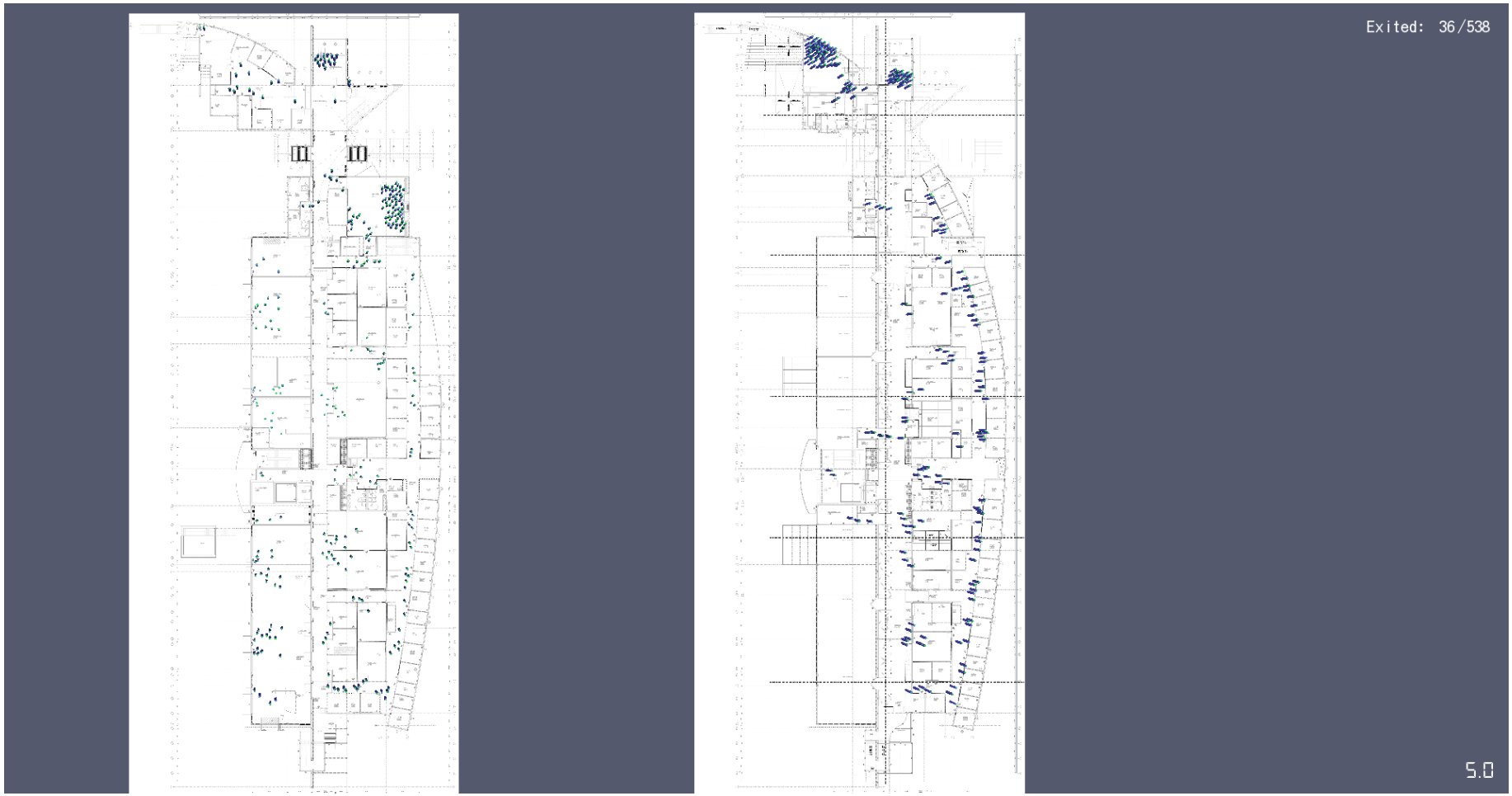


Figure C-2. Pathfinder t=5 s

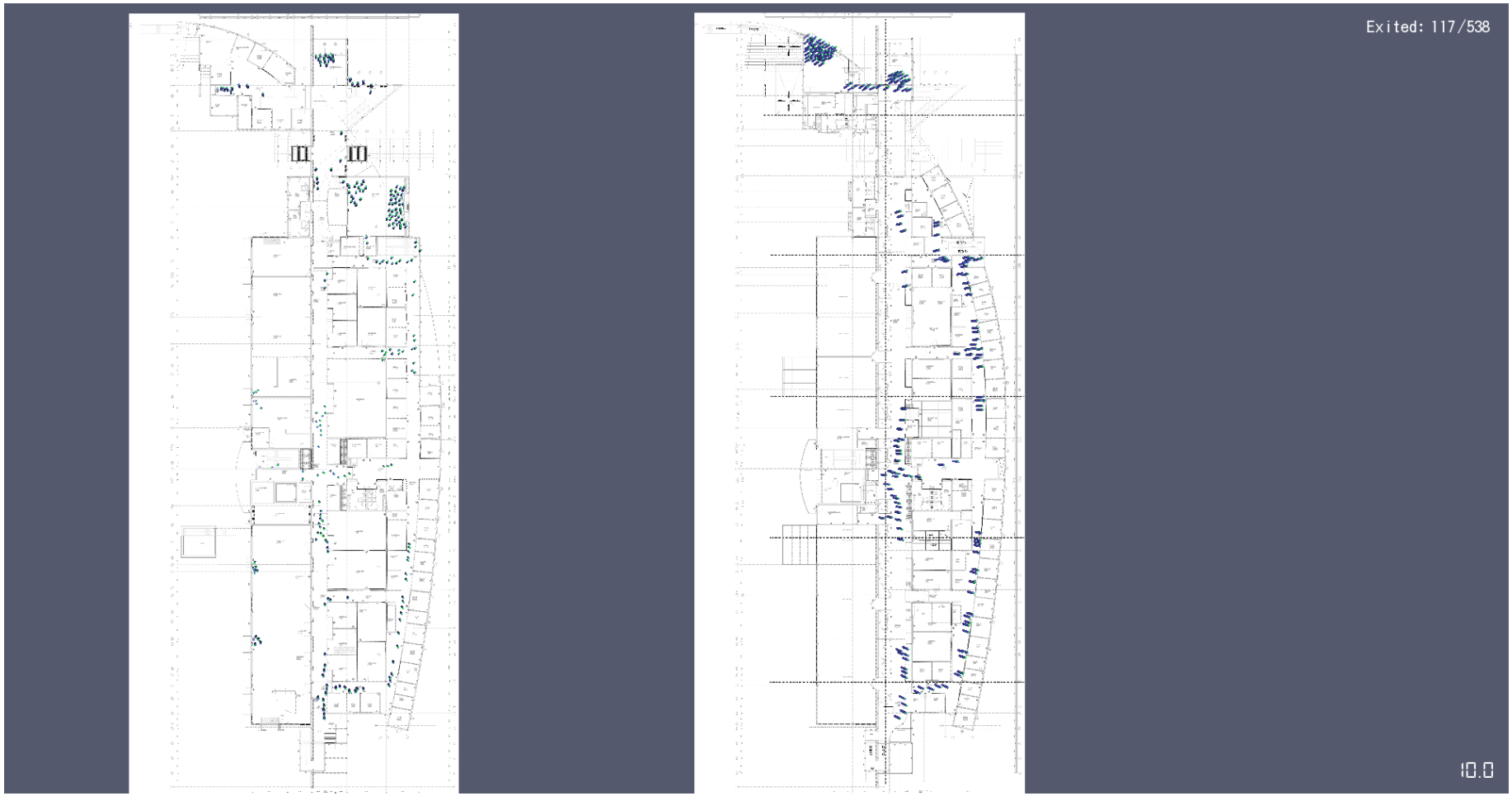


Figure C-3. Pathfinder t=10 s

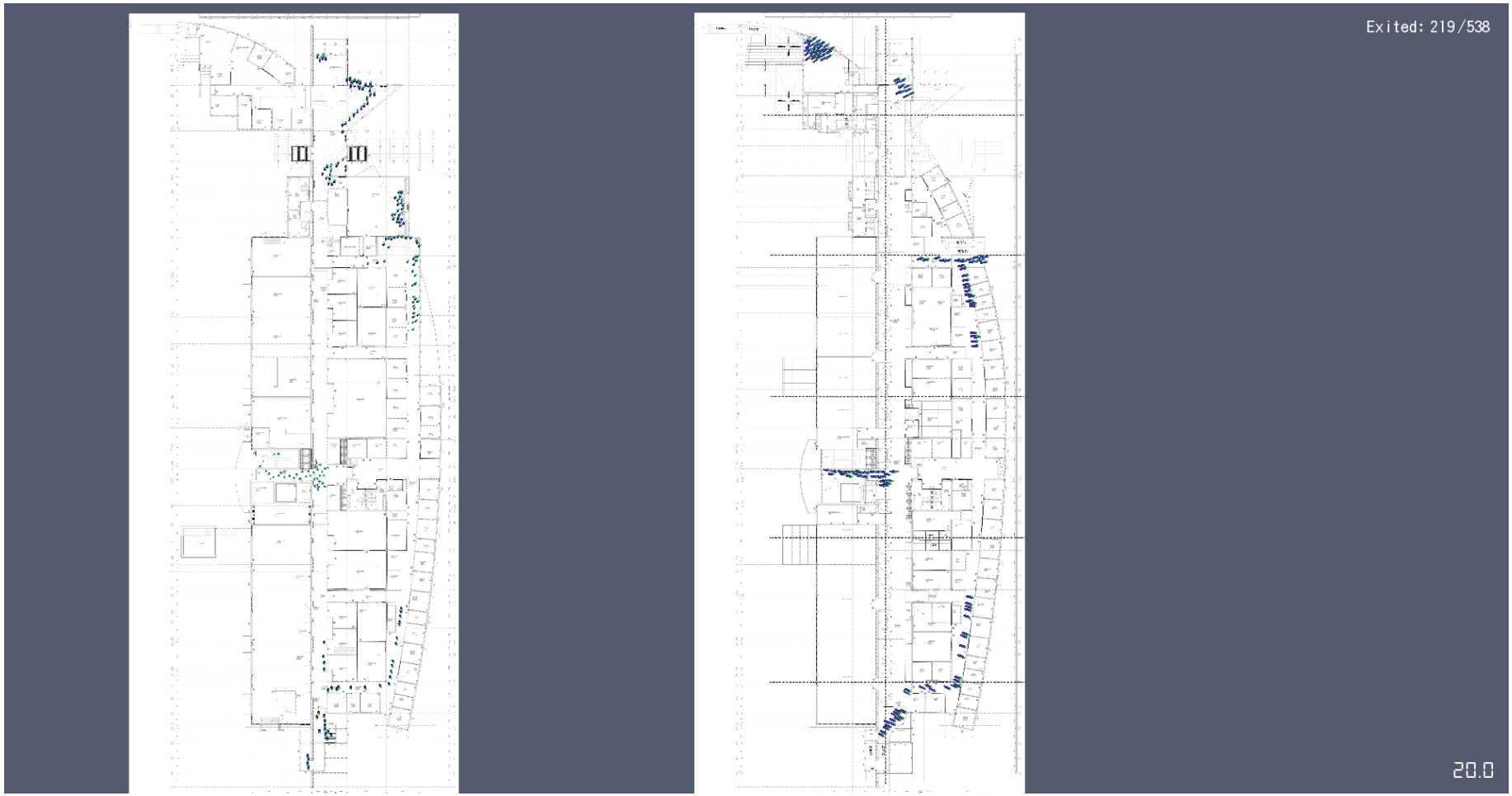


Figure C-4. Pathfinder t=15 s

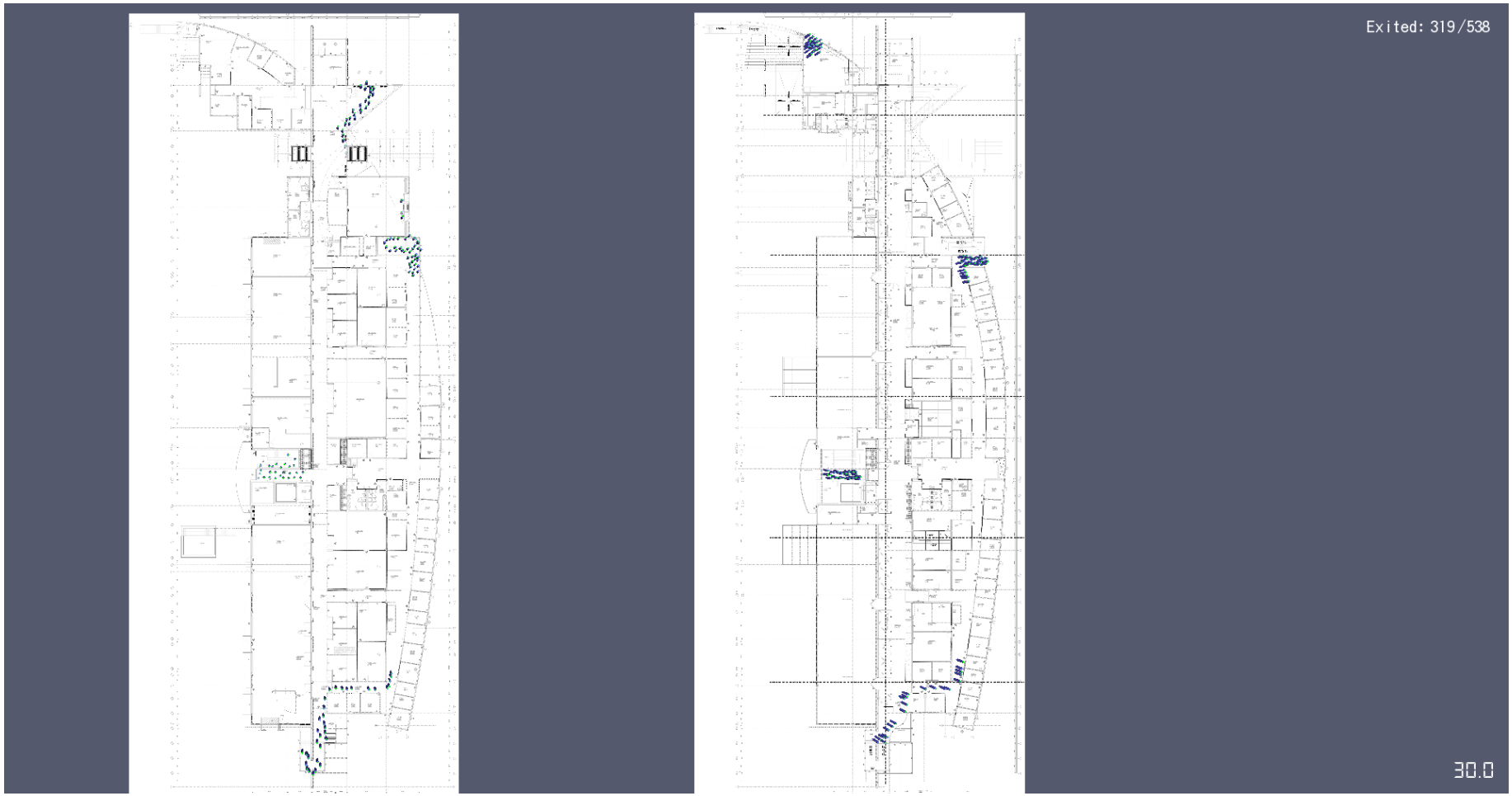


Figure C-5. Pathfinder t=30 s

Figure C-6. t=60 s

Figure C-7. Pathfinder t=75 s

Figure C-8. Pathfinder t=85 s

*****SUMMARY***SUMMARY***SUMMARY***SUMMARY***SUMMARY*****

Simulation: 131211C RMSEL Redeux

Mode: Steering

Total Occupants: 538

Exit Times (s):

Min: 0.9

Max: 85.9

Average: 28.4

StdDev: 19.9

[Components] All: 447

[Components] Doors: 245

Triangles: 2900

Startup Time: 0.1s

CPU Time: 7.2s

ROOM/DOOR	FIRST IN (s)	LAST OUT (s)	TOTAL USE (pers)	FLOW AVG. (pers/s)
Floor 0.0 ft->1000	0.0	24.6	23	
Floor 0.0 ft->1001	0.0	3.1	1	
Floor 0.0 ft->1002	0.0	4.7	2	

Floor 0.0 ft->1003	**0.0**	**1.6**	**1**
Floor 0.0 ft->1005	**0.0**	**2.8**	**2**
Floor 0.0 ft->1006	**0.0**	**3.1**	**1**
Floor 0.0 ft->1007	**0.0**	**3.4**	**1**
Floor 0.0 ft->1008	**0.0**	**3.7**	**1**
Floor 0.0 ft->1009	**0.0**	**4.4**	**2**
Floor 0.0 ft->1010	**0.0**	**6.0**	**4**
Floor 0.0 ft->1012	**0.0**	**2.9**	**1**
Floor 0.0 ft->1013	**0.0**	**5.4**	**2**
Floor 0.0 ft->1014	**0.0**	**4.5**	**2**
Floor 0.0 ft->1015	**0.0**	**31.5**	**88**
Floor 0.0 ft->1016	**0.0**	**3.1**	**2**
Floor 0.0 ft->1017	**0.0**	**12.8**	**5**
Floor 0.0 ft->1019	**0.0**	**1.4**	**1**
Floor 0.0 ft->1021	**0.0**	**2.3**	**1**
Floor 0.0 ft->1100	**0.0**	**9.1**	**8**
Floor 0.0 ft->1101	**0.0**	**5.0**	**2**
Floor 0.0 ft->1102	**0.0**	**10.0**	**8**
Floor 0.0 ft->1103	**0.0**	**4.0**	**2**
Floor 0.0 ft->1104	**0.0**	**9.3**	**8**
Floor 0.0 ft->1105	**0.0**	**3.0**	**2**
Floor 0.0 ft->1107	**0.0**	**6.2**	**4**
Floor 0.0 ft->1109	**0.0**	**4.6**	**4**
Floor 0.0 ft->1110	**0.0**	**13.2**	**8**

Floor 0.0 ft->1111	**0.0**	**10.5**	**16**
Floor 0.0 ft->1112	**0.0**	**12.0**	**10**
Floor 0.0 ft->1112A	**0.0**	**2.2**	**1**
Floor 0.0 ft->1113	**0.0**	**3.8**	**1**
Floor 0.0 ft->1120	**0.0**	**2.9**	**2**
Floor 0.0 ft->1121	**0.0**	**3.8**	**1**
Floor 0.0 ft->1122	**0.0**	**9.5**	**4**
Floor 0.0 ft->1123	**0.0**	**8.9**	**8**
Floor 0.0 ft->1124	**0.0**	**10.9**	**8**
Floor 0.0 ft->1126	**0.0**	**14.5**	**34**
Floor 0.0 ft->1131	**0.0**	**4.2**	**2**
Floor 0.0 ft->1135	**0.0**	**4.3**	**2**
Floor 0.0 ft->1137	**0.0**	**5.6**	**4**
Floor 0.0 ft->1139	**0.0**	**6.3**	**4**
Floor 0.0 ft->1212	**0.0**	**3.1**	**1**
Floor 0.0 ft->1214	**0.0**	**2.6**	**1**
Floor 0.0 ft->1216	**0.0**	**2.7**	**1**
Floor 0.0 ft->1218	**0.0**	**4.2**	**1**
Floor 0.0 ft->1220	**0.0**	**3.2**	**1**
Floor 0.0 ft->1222	**0.0**	**2.5**	**1**
Floor 0.0 ft->1223	**0.0**	**1.1**	**1**
Floor 0.0 ft->1224	**0.0**	**1.4**	**1**
Floor 0.0 ft->1226	**0.0**	**1.9**	**1**
Floor 0.0 ft->1227	**0.0**	**1.3**	**1**

Floor 0.0 ft->1228	**0.0**	**2.0**	**1**
Floor 0.0 ft->1229	**0.0**	**2.7**	**1**
Floor 0.0 ft->1230	**0.0**	**2.9**	**1**
Floor 0.0 ft->1232	**0.0**	**2.0**	**1**
Floor 0.0 ft->1234	**0.0**	**3.6**	**2**
Floor 0.0 ft->1236	**0.0**	**4.9**	**2**
Floor 0.0 ft->1237	**0.0**	**1.6**	**1**
Floor 0.0 ft->1238	**0.0**	**2.4**	**1**
Floor 0.0 ft->1239	**0.0**	**1.2**	**1**
Floor 0.0 ft->1240	**0.0**	**2.9**	**1**
Floor 0.0 ft->1241	**0.0**	**1.4**	**1**
Floor 0.0 ft->1243	**0.0**	**2.5**	**1**
Floor 0.0 ft->1244	**0.0**	**3.7**	**2**
Floor 0.0 ft->1245	**0.0**	**2.1**	**2**
Floor 0.0 ft->1246	**0.0**	**2.7**	**1**
Floor 0.0 ft->1247	**0.0**	**4.1**	**2**
Floor 0.0 ft->1249	**0.0**	**2.9**	**1**
Floor 0.0 ft->1250	**0.0**	**2.0**	**1**
Floor 0.0 ft->1251	**0.0**	**1.7**	**1**
Floor 0.0 ft->1253	**0.0**	**3.7**	**2**
Floor 0.0 ft->1255	**0.0**	**3.6**	**1**
Floor 0.0 ft->1257	**0.0**	**2.3**	**1**
Floor 0.0 ft->1258	**0.0**	**2.9**	**2**
Floor 0.0 ft->1259	**0.0**	**2.5**	**1**

Floor 0.0 ft->1260	**0.0**	**2.0**	**1**	
Floor 0.0 ft->1261	**0.0**	**1.6**	**1**	
Floor 0.0 ft->1262	**0.0**	**2.7**	**2**	
Floor 0.0 ft->1263	**0.0**	**2.7**	**2**	
Floor 0.0 ft->C102	**1.6**	**17.3**	**12**	
Floor 0.0 ft->C103	**1.6**	**45.2**	**85**	
Floor 0.0 ft->C104	**1.1**	**62.8**	**39**	
Floor 0.0 ft->C104	**1.1**	**33.8**	**24**	
Floor 0.0 ft->C105	**1.4**	**29.4**	**16**	
Floor 0.0 ft->C106	**2.1**	**15.4**	**10**	
Floor 0.0 ft->C107	**2.3**	**37.2**	**41**	
Floor 0.0 ft->C108	**2.2**	**12.4**	**4**	
Floor 0.0 ft->C109	**1.5**	**41.1**	**33**	
Floor 0.0 ft->Door00	**1.4**	**24.6**	**22**	**0.95**
Floor 0.0 ft->Door02	**3.1**	**3.1**	**1**	
Floor 0.0 ft->Door05	**1.6**	**1.6**	**1**	
Floor 0.0 ft->Door06	**1.9**	**2.8**	**2**	
Floor 0.0 ft->Door07	**3.4**	**3.4**	**1**	
Floor 0.0 ft->Door08	**3.2**	**4.4**	**2**	**1.78**
Floor 0.0 ft->Door09	**7.1**	**17.3**	**12**	**1.18**
Floor 0.0 ft->Door10	**3.7**	**4.7**	**2**	
Floor 0.0 ft->Door100	**3.1**	**3.1**	**1**	
Floor 0.0 ft->Door102	**2.7**	**2.7**	**1**	
Floor 0.0 ft->Door103	**2.6**	**2.6**	**1**	

Floor 0.0 ft->Door104	**4.2**	**4.2**	**1**	
Floor 0.0 ft->Door105	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door106	**2.5**	**2.5**	**1**	
Floor 0.0 ft->Door107	**3.2**	**3.2**	**1**	
Floor 0.0 ft->Door108	**1.1**	**1.1**	**1**	
Floor 0.0 ft->Door109	**1.4**	**1.4**	**1**	
Floor 0.0 ft->Door11	**2.9**	**2.9**	**1**	
Floor 0.0 ft->Door110	**3.2**	**3.2**	**1**	
Floor 0.0 ft->Door111	**1.9**	**1.9**	**1**	
Floor 0.0 ft->Door112	**1.3**	**1.3**	**1**	
Floor 0.0 ft->Door113	**2.0**	**2.0**	**1**	
Floor 0.0 ft->Door114	**2.7**	**2.7**	**1**	
Floor 0.0 ft->Door115	**2.0**	**2.0**	**1**	
Floor 0.0 ft->Door116	**2.9**	**2.9**	**1**	
Floor 0.0 ft->Door117	**4.6**	**16.0**	**10**	**0.88**
Floor 0.0 ft->Door118	**6.3**	**7.5**	**3**	**2.40**
Floor 0.0 ft->Door119	**1.6**	**3.6**	**2**	**1.01**
Floor 0.0 ft->Door12	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door120	**3.9**	**4.9**	**2**	
Floor 0.0 ft->Door121	**2.4**	**2.4**	**1**	
Floor 0.0 ft->Door122	**1.6**	**1.6**	**1**	
Floor 0.0 ft->Door123	**1.2**	**1.2**	**1**	
Floor 0.0 ft->Door124	**2.9**	**2.9**	**1**	
Floor 0.0 ft->Door125	**1.4**	**1.4**	**1**	

Floor 0.0 ft->Door126	**2.5**	**2.5**	**1**	
Floor 0.0 ft->Door127	**2.9**	**3.7**	**2**	
Floor 0.0 ft->Door128	**1.2**	**2.1**	**2**	
Floor 0.0 ft->Door129	**2.7**	**2.7**	**1**	
Floor 0.0 ft->Door13	**2.1**	**6.0**	**4**	**1.03**
Floor 0.0 ft->Door130	**3.4**	**4.1**	**2**	
Floor 0.0 ft->Door131	**1.4**	**1.4**	**1**	
Floor 0.0 ft->Door132	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door133	**2.9**	**2.9**	**1**	
Floor 0.0 ft->Door134	**2.0**	**2.0**	**1**	
Floor 0.0 ft->Door135	**1.7**	**1.7**	**1**	
Floor 0.0 ft->Door136	**2.9**	**3.7**	**2**	
Floor 0.0 ft->Door137	**3.6**	**3.6**	**1**	
Floor 0.0 ft->Door138	**2.3**	**2.3**	**1**	
Floor 0.0 ft->Door139	**5.3**	**41.1**	**33**	**0.92**
Floor 0.0 ft->Door14	**3.7**	**3.7**	**1**	
Floor 0.0 ft->Door140	**4.4**	**33.8**	**24**	**0.82**
Floor 0.0 ft->Door141	**2.5**	**2.5**	**1**	
Floor 0.0 ft->Door142	**1.6**	**1.6**	**1**	
Floor 0.0 ft->Door143	**2.3**	**2.9**	**2**	
Floor 0.0 ft->Door144	**2.0**	**2.0**	**1**	
Floor 0.0 ft->Door145	**1.5**	**2.7**	**2**	**1.74**
Floor 0.0 ft->Door146	**1.1**	**2.7**	**2**	**1.23**
Floor 0.0 ft->Door15	**3.1**	**3.1**	**1**	

Floor 0.0 ft->Door154	**5.5**	**53.8**	**34**	**0.70**
Floor 0.0 ft->Door165	**10.0**	**52.9**	**46**	**1.07**
Floor 0.0 ft->Door20	**2.3**	**2.3**	**1**	
Floor 0.0 ft->Door21	**12.8**	**26.1**	**7**	**0.53**
Floor 0.0 ft->Door22	**8.1**	**46.8**	**57**	**1.47**
Floor 0.0 ft->Door23	**10.8**	**85.9**	**82**	**1.09**
Floor 0.0 ft->Door24	**14.1**	**70.2**	**79**	**1.41**
Floor 0.0 ft->Door25	**1.3**	**30.7**	**29**	**0.99**
Floor 0.0 ft->Door26	**1.1**	**31.5**	**30**	**0.99**
Floor 0.0 ft->Door27	**1.2**	**19.2**	**25**	**1.39**
Floor 0.0 ft->Door28	**2.9**	**5.4**	**2**	**0.81**
Floor 0.0 ft->Door29	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door30	**3.0**	**4.5**	**2**	**1.36**
Floor 0.0 ft->Door34	**3.2**	**6.5**	**4**	**1.21**
Floor 0.0 ft->Door35	**1.0**	**3.1**	**2**	**0.99**
Floor 0.0 ft->Door36	**8.8**	**45.2**	**43**	**1.18**
Floor 0.0 ft->Door37	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door38	**11.9**	**14.5**	**3**	**1.15**
Floor 0.0 ft->Door39	**8.1**	**62.8**	**36**	**0.66**
Floor 0.0 ft->Door40	**9.3**	**29.4**	**16**	**0.80**
Floor 0.0 ft->Door41	**5.6**	**12.8**	**5**	**0.69**
Floor 0.0 ft->Door42	**2.5**	**9.6**	**4**	**0.56**
Floor 0.0 ft->Door43	**1.4**	**1.4**	**1**	
Floor 0.0 ft->Door44	**2.3**	**2.3**	**1**	

Floor 0.0 ft->Door45	**0.9**	**9.1**	**8**	**0.98**
Floor 0.0 ft->Door46	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door47	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door48	**3.9**	**5.0**	**2**	**1.86**
Floor 0.0 ft->Door49	**4.6**	**10.0**	**8**	**1.48**
Floor 0.0 ft->Door50	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door51	**2.8**	**4.0**	**2**	**1.67**
Floor 0.0 ft->Door52	**4.0**	**9.3**	**8**	**1.53**
Floor 0.0 ft->Door53	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door54	**1.6**	**1.6**	**1**	
Floor 0.0 ft->Door55	**8.6**	**15.4**	**10**	**1.45**
Floor 0.0 ft->Door56	**3.0**	**3.0**	**1**	
Floor 0.0 ft->Door57	**2.1**	**6.2**	**4**	**0.97**
Floor 0.0 ft->Door58	**2.1**	**4.6**	**4**	**1.62**
Floor 0.0 ft->Door59	**5.5**	**13.2**	**8**	**1.04**
Floor 0.0 ft->Door61	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door62	**2.0**	**6.0**	**5**	**1.24**
Floor 0.0 ft->Door63	**2.4**	**8.3**	**6**	**1.02**
Floor 0.0 ft->Door64	**6.0**	**10.5**	**5**	**1.11**
Floor 0.0 ft->Door65	**4.7**	**12.0**	**10**	**1.36**
Floor 0.0 ft->Door66	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door67	**2.2**	**2.2**	**1**	
Floor 0.0 ft->Door68	**8.5**	**28.5**	**39**	**1.95**
Floor 0.0 ft->Door69	**5.7**	**37.2**	**41**	**1.30**

Floor 0.0 ft->Door71	**23.3**	**71.6**	**34**	**0.70**
Floor 0.0 ft->Door73	**3.8**	**3.8**	**1**	
Floor 0.0 ft->Door74	**2.3**	**2.9**	**2**	
Floor 0.0 ft->Door75	**3.8**	**3.8**	**1**	
Floor 0.0 ft->Door76	**3.3**	**9.5**	**4**	**0.65**
Floor 0.0 ft->Door77	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door79	**2.9**	**8.9**	**8**	**1.34**
Floor 0.0 ft->Door80	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door81	**3.9**	**10.9**	**8**	**1.15**
Floor 0.0 ft->Door82	**2.6**	**7.7**	**8**	**1.55**
Floor 0.0 ft->Door83	**3.3**	**14.5**	**11**	**0.98**
Floor 0.0 ft->Door84	**2.8**	**13.5**	**11**	**1.02**
Floor 0.0 ft->Door85	**6.2**	**11.7**	**6**	**1.08**
Floor 0.0 ft->Door86	**2.9**	**8.9**	**6**	**1.01**
Floor 0.0 ft->Door87	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door88	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door89	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door90	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door91	**8.2**	**12.4**	**4**	**0.96**
Floor 0.0 ft->Door92	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door93	**3.2**	**4.2**	**2**	
Floor 0.0 ft->Door94	**3.0**	**3.7**	**2**	
Floor 0.0 ft->Door95	**0.0**	**0.0**	**0**	
Floor 0.0 ft->Door96	**3.3**	**4.3**	**2**	

Floor 0.0 ft->Door97 0.0 0.0 0

Floor 0.0 ft->Door98 2.9 5.6 4 1.51

Floor 0.0 ft->Door99 2.2 6.3 4 0.98

Floor 0.0 ft->L100_1 1.2 46.8 64

Floor 0.0 ft->Room108 0.0 7.7 8

Floor 0.0 ft->Room121 0.0 3.7 2

Floor 0.0 ft->Room140 0.0 3.2 1

Floor 0.0 ft->Room167 0.0 1.4 1

Floor 0.0 ft->Room20 13.0 63.9 34

Floor 0.0 ft->Room23 8.3 34.7 34

Floor 0.0 ft->Rstrm Vstbl 1 1.0 6.5 4

Floor 0.0 ft->Stair 3 Bottom 8.1 85.9 82

Floor 0.0 ft->Stair 3 Lower 20.1 80.1 46

Stair 3 Lower door 1 20.1 67.1 46 0.98

Stair 3 Lower door 2 25.8 80.1 46 0.85

Floor 0.0 ft->Stair 3 Mid 17.6 67.1 46

Floor 0.0 ft->Stair 3 Upper 12.4 60.3 46

Stair 3 Upper door 1 17.6 60.3 46 1.08

Stair 3 Upper door 2 12.4 55.2 46 1.08

Floor 0.0 ft->Stair 4B 21.4 71.6 34

Floor 0.0 ft->Stair 5 Lower 20.6 66.1 37

Stair 5 Lower door 1 22.9 59.8 36 0.98

Stair 5 Lower door 2 20.6 66.1 37 0.81

Floor 0.0 ft->Stair 5 Mid 19.7 59.8 36

Floor 0.0 ft->Stair 5 Upper 15.3 56.6 36

Stair 5 Upper door 1 19.7 56.6 36 0.98

Stair 5 Upper door 2 15.3 52.2 36 0.97

Floor 0.0 ft->Stair08 15.6 69.7 34

Stair08 door 1 21.4 69.7 34 0.70

Stair08 door 2 15.6 63.9 34 0.70

Floor 0.0 ft->Stair09 7.9 61.3 34

Stair09 door 1 7.9 56.2 34 0.70

Stair09 door 2 13.0 61.3 34 0.70

Floor 0.0 ft->Stair15 4.5 30.2 34

Stair15 door 1 4.5 26.4 34 1.56

Stair15 door 2 8.3 30.2 34 1.55

Floor 0.0 ft->Stair17 11.2 41.8 34

Stair17 door 1 11.2 34.7 34 1.45

Stair17 door 2 18.3 41.8 34 1.45

Floor 0.0 ft->Vestibule 3 8.8 70.2 79

Floor 0.0 ft->c107 1.6 16.0 10

Floor 18.3333 ft->2000 0.0 22.3 23

Floor 18.3333 ft->2001 0.0 47.5 64

Floor 18.3333 ft->2002 0.0 0.0 0

Floor 18.3333 ft->2003 0.0 8.0 5

Floor 18.3333 ft->2003A 0.0 8.3 4

Floor 18.3333 ft->2014 0.0 5.0 2

Floor 18.3333 ft->2016 0.0 2.5 2

Floor 18.3333 ft->2101	**0.0**	**6.5**	**4**
Floor 18.3333 ft->2103	**0.0**	**4.3**	**4**
Floor 18.3333 ft->2111	**0.0**	**7.9**	**3**
Floor 18.3333 ft->2113	**0.0**	**5.9**	**3**
Floor 18.3333 ft->2115	**0.0**	**4.7**	**4**
Floor 18.3333 ft->2116	**0.0**	**2.3**	**1**
Floor 18.3333 ft->2117	**0.0**	**2.2**	**1**
Floor 18.3333 ft->2118	**0.0**	**3.7**	**3**
Floor 18.3333 ft->2120	**0.0**	**3.6**	**2**
Floor 18.3333 ft->2121	**0.0**	**5.9**	**3**
Floor 18.3333 ft->2122	**0.0**	**6.6**	**3**
Floor 18.3333 ft->2123	**0.0**	**3.9**	**3**
Floor 18.3333 ft->2125	**0.0**	**4.4**	**3**
Floor 18.3333 ft->2127	**0.0**	**0.0**	**0**
Floor 18.3333 ft->2131	**0.0**	**4.5**	**4**
Floor 18.3333 ft->2133	**0.0**	**6.6**	**4**
Floor 18.3333 ft->2201	**0.0**	**2.1**	**1**
Floor 18.3333 ft->2202	**0.0**	**2.3**	**1**
Floor 18.3333 ft->2203	**0.0**	**3.4**	**2**
Floor 18.3333 ft->2204	**0.0**	**3.2**	**1**
Floor 18.3333 ft->2205	**0.0**	**2.1**	**1**
Floor 18.3333 ft->2207	**0.0**	**3.7**	**2**
Floor 18.3333 ft->2208	**0.0**	**2.6**	**1**
Floor 18.3333 ft->2209	**0.0**	**3.2**	**1**

Floor 18.3333 ft->2210	**0.0**	**1.9**	**1**
Floor 18.3333 ft->2211	**0.0**	**3.3**	**1**
Floor 18.3333 ft->2212	**0.0**	**0.0**	**0**
Floor 18.3333 ft->2213	**0.0**	**2.0**	**1**
Floor 18.3333 ft->2215	**0.0**	**1.9**	**1**
Floor 18.3333 ft->2216	**0.0**	**1.9**	**1**
Floor 18.3333 ft->2217	**0.0**	**4.3**	**2**
Floor 18.3333 ft->2218	**0.0**	**1.0**	**1**
Floor 18.3333 ft->2219	**0.0**	**4.4**	**2**
Floor 18.3333 ft->2220	**0.0**	**3.6**	**1**
Floor 18.3333 ft->2221	**0.0**	**4.1**	**1**
Floor 18.3333 ft->2222	**0.0**	**0.0**	**0**
Floor 18.3333 ft->2224	**0.0**	**1.1**	**1**
Floor 18.3333 ft->2225	**0.0**	**4.2**	**2**
Floor 18.3333 ft->2226	**0.0**	**3.4**	**1**
Floor 18.3333 ft->2227	**0.0**	**4.0**	**1**
Floor 18.3333 ft->2228	**0.0**	**2.7**	**1**
Floor 18.3333 ft->2228	**0.0**	**3.9**	**2**
Floor 18.3333 ft->2230	**0.0**	**2.2**	**1**
Floor 18.3333 ft->2232	**0.0**	**2.8**	**2**
Floor 18.3333 ft->2234	**0.0**	**2.7**	**2**
Floor 18.3333 ft->2236	**0.0**	**5.4**	**2**
Floor 18.3333 ft->C201	**2.7**	**53.8**	**34**
Floor 18.3333 ft->C202	**0.9**	**15.1**	**8**

Floor 18.3333 ft->C203	**1.4**	**26.4**	**34**	
Floor 18.3333 ft->C203	**1.0**	**45.0**	**74**	
Floor 18.3333 ft->C204	**1.0**	**31.3**	**30**	
Floor 18.3333 ft->C2041	**0.0**	**0.0**	**0**	
Floor 18.3333 ft->C205	**1.9**	**52.9**	**46**	
Floor 18.3333 ft->C206	**3.1**	**11.8**	**5**	
Floor 18.3333 ft->C206	**0.9**	**35.3**	**24**	
Floor 18.3333 ft->C207	**1.4**	**15.7**	**10**	
Floor 18.3333 ft->Door147	**1.0**	**47.5**	**53**	**1.14**
Floor 18.3333 ft->Door148	**0.0**	**0.0**	**0**	
Floor 18.3333 ft->Door149	**7.4**	**16.8**	**11**	**1.17**
Floor 18.3333 ft->Door150	**3.3**	**8.0**	**5**	**1.06**
Floor 18.3333 ft->Door151	**2.3**	**8.3**	**4**	**0.67**
Floor 18.3333 ft->Door152	**8.2**	**45.0**	**36**	**0.98**
Floor 18.3333 ft->Door153	**12.1**	**27.4**	**32**	**2.09**
Floor 18.3333 ft->Door155	**3.4**	**5.0**	**2**	**1.23**
Floor 18.3333 ft->Door156	**2.1**	**2.1**	**1**	
Floor 18.3333 ft->Door157	**0.0**	**0.0**	**0**	
Floor 18.3333 ft->Door158	**1.6**	**2.5**	**2**	
Floor 18.3333 ft->Door159	**2.3**	**2.3**	**1**	
Floor 18.3333 ft->Door160	**1.7**	**3.7**	**3**	**1.45**
Floor 18.3333 ft->Door161	**2.7**	**3.6**	**2**	
Floor 18.3333 ft->Door162	**3.4**	**6.6**	**3**	**0.94**
Floor 18.3333 ft->Door163	**0.0**	**0.0**	**0**	

Floor 18.3333 ft->Door164	**4.6**	**31.3**	**30**	**1.12**
Floor 18.3333 ft->Door166	**12.6**	**19.2**	**6**	**0.91**
Floor 18.3333 ft->Door167	**8.5**	**15.1**	**8**	**1.21**
Floor 18.3333 ft->Door168	**1.0**	**3.0**	**2**	**1.03**
Floor 18.3333 ft->Door169	**0.0**	**0.0**	**0**	
Floor 18.3333 ft->Door170	**3.1**	**4.3**	**2**	**1.67**
Floor 18.3333 ft->Door171	**7.8**	**11.8**	**5**	**1.24**
Floor 18.3333 ft->Door172	**1.3**	**6.5**	**4**	**0.77**
Floor 18.3333 ft->Door173	**0.0**	**0.0**	**0**	
Floor 18.3333 ft->Door174	**4.4**	**7.9**	**3**	**0.88**
Floor 18.3333 ft->Door175	**2.8**	**5.9**	**3**	**0.95**
Floor 18.3333 ft->Door176	**2.2**	**2.2**	**1**	
Floor 18.3333 ft->Door177	**1.7**	**2.1**	**2**	
Floor 18.3333 ft->Door178	**1.9**	**4.7**	**2**	**0.71**
Floor 18.3333 ft->Door179	**4.4**	**15.7**	**10**	**0.88**
Floor 18.3333 ft->Door18	**1.4**	**22.3**	**23**	**1.10**
Floor 18.3333 ft->Door180	**2.0**	**5.9**	**3**	**0.76**
Floor 18.3333 ft->Door181	**1.6**	**3.9**	**3**	**1.35**
Floor 18.3333 ft->Door182	**2.0**	**4.4**	**3**	**1.28**
Floor 18.3333 ft->Door183	**0.0**	**0.0**	**0**	
Floor 18.3333 ft->Door184	**1.9**	**4.5**	**4**	**1.55**
Floor 18.3333 ft->Door185	**2.8**	**6.6**	**4**	**1.05**
Floor 18.3333 ft->Door186	**2.3**	**2.3**	**1**	
Floor 18.3333 ft->Door187	**0.9**	**3.4**	**2**	**0.79**

Floor 18.3333 ft->Door188	**3.2**	**3.2**	**1**	
Floor 18.3333 ft->Door189	**2.1**	**2.1**	**1**	
Floor 18.3333 ft->Door190	**3.2**	**3.7**	**2**	
Floor 18.3333 ft->Door191	**2.6**	**2.6**	**1**	
Floor 18.3333 ft->Door192	**3.2**	**3.2**	**1**	
Floor 18.3333 ft->Door193	**1.9**	**1.9**	**1**	
Floor 18.3333 ft->Door194	**0.0**	**0.0**	**0**	
Floor 18.3333 ft->Door195	**3.3**	**3.3**	**1**	
Floor 18.3333 ft->Door196	**2.0**	**2.0**	**1**	
Floor 18.3333 ft->Door198	**1.9**	**1.9**	**1**	
Floor 18.3333 ft->Door199	**1.9**	**1.9**	**1**	
Floor 18.3333 ft->Door200	**3.1**	**4.3**	**2**	**1.63**
Floor 18.3333 ft->Door201	**1.0**	**1.0**	**1**	
Floor 18.3333 ft->Door202	**3.5**	**4.4**	**2**	
Floor 18.3333 ft->Door203	**3.6**	**3.6**	**1**	
Floor 18.3333 ft->Door204	**4.1**	**4.1**	**1**	
Floor 18.3333 ft->Door205	**0.0**	**0.0**	**0**	
Floor 18.3333 ft->Door206	**2.6**	**2.6**	**1**	
Floor 18.3333 ft->Door207	**1.1**	**1.1**	**1**	
Floor 18.3333 ft->Door208	**2.2**	**4.2**	**2**	**0.96**
Floor 18.3333 ft->Door209	**3.4**	**3.4**	**1**	
Floor 18.3333 ft->Door210	**4.0**	**4.0**	**1**	
Floor 18.3333 ft->Door211	**2.7**	**2.7**	**1**	
Floor 18.3333 ft->Door212	**2.4**	**3.9**	**2**	**1.33**

Floor 18.3333 ft->Door213 1.9 2.8 2

Floor 18.3333 ft->Door214 2.2 2.2 1

Floor 18.3333 ft->Door216 1.4 2.7 2 1.54

Floor 18.3333 ft->Door217 3.8 5.4 2 1.25

Floor 18.3333 ft->Door218 0.0 0.0 0

Floor 18.3333 ft->2223 0.0 2.6 1

Floor 18.3333 ft->Room37 8.2 52.2 36

Floor 18.3333 ft->Stair 3 Top 10.0 55.2 46

Floor 18.3333 ft->Stair 4 Top 5.5 56.2 34

Floor 18.3333 ft->2238 0.0 1.6 1

Floor 18.3333 ft->Door219 1.6 1.6 1

Floor 18.3333 ft->2237 0.0 3.5 1

Floor 18.3333 ft->Door220 3.5 3.5 1

Floor 18.3333 ft->2240 0.0 3.8 2

Floor 18.3333 ft->Door221 3.2 3.8 2

Floor 18.3333 ft->2239 0.0 2.6 1

Floor 18.3333 ft->Door222 2.6 2.6 1

Floor 18.3333 ft->2244 0.0 4.1 2

Floor 18.3333 ft->Door223 1.4 4.1 2 0.75

Floor 18.3333 ft->Room297 0.0 3.2 1

Floor 18.3333 ft->Door224 3.2 3.2 1

Floor 18.3333 ft->2243 0.0 3.1 1

Floor 18.3333 ft->Door225 3.1 3.1 1

Floor 18.3333 ft->2246 0.0 3.2 1

Floor 18.3333 ft->Door226 3.2 3.2 1

Floor 18.3333 ft->2245 0.0 3.3 2

Floor 18.3333 ft->Door227 2.1 3.3 2 1.67

Floor 18.3333 ft->2248 0.0 1.1 1

Floor 18.3333 ft->Door228 1.1 1.1 1

Floor 18.3333 ft->2247 0.0 2.7 2

Floor 18.3333 ft->Door229 2.0 2.7 2

Floor 18.3333 ft->2249 0.0 3.2 2

Floor 18.3333 ft->Door230 2.4 3.2 2

Floor 18.3333 ft->2251 0.0 2.3 1

Floor 18.3333 ft->Door231 2.3 2.3 1

Floor 18.3333 ft->2251 0.0 2.9 2

Floor 18.3333 ft->Door232 0.9 2.9 2 1.00

Floor 18.3333 ft->2253 0.0 2.6 1

Floor 18.3333 ft->Door234 2.6 2.6 1

Floor 18.3333 ft->2255 0.0 2.2 1

Floor 18.3333 ft->2255 2.2 2.2 1

Floor 18.3333 ft->Room308 0.0 2.3 1

Floor 18.3333 ft->2257 2.3 2.3 1

Floor 18.3333 ft->2259 0.0 0.0 0

Floor 18.3333 ft->Door237 0.0 0.0 0

Floor 18.3333 ft->2261 0.0 2.5 1

Floor 18.3333 ft->Door238 2.5 2.5 1

Floor 18.3333 ft->2262 0.0 1.9 1

Floor 18.3333 ft->C209 1.5 40.4 28

Floor 18.3333 ft->Door242 5.2 35.3 24 0.80

Floor 18.3333 ft->Door243 4.0 40.4 28 0.77

Floor 18.3333 ft->2260 0.0 1.9 1

Floor 18.3333 ft->Door244 1.9 1.9 1

Floor 18.3333 ft->Door245 1.9 1.9 1

Floor 18.3333 ft->2263 0.0 3.1 1

Floor 18.3333 ft->Door246 3.1 3.1 1

Floor 18.3333 ft->2264 0.0 1.5 1

Floor 18.3333 ft->Door247 1.5 1.5 1

Floor 18.3333 ft->2266 0.0 3.8 1

Floor 18.3333 ft->Door248 3.8 3.8 1

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Appendix D – FDS Input File

```
&HEAD CHID='ATRIUMS',TITLE='ATRIUM BASE CASE' /


&MESH ID='Mesh 1', IJK=68, 80, 96, XB=17.500, 26.000, 117.0, 127.0, -0.5, 11.5
/
&MESH ID='MESH 2', IJK=34, 40, 72, XB=9.0, 17.5, 117.0, 127.0, -0.5, 17.50 /

&MESH ID='MESH 3', IJK=36, 40, 74, XB=9.0, 18.0, 107.0, 117.0, -0.5, 18.00 /

&MESH ID='MESH 4', IJK=18, 70, 36, XB=9.0, 18.0, 72.0, 107.0, 0.0, 18.00 /
&MESH ID='MESH 5', IJK=9, 60, 18, XB=9.0, 18.0, 12.0, 72.0, 0.0, 18.00/
&MESH ID='MESH 6', IJK=50, 12, 36, XB=18.0, 30.50, 107.0, 110.0, 0.0, 9.000/

&TIME TWFIN=600. /


&MISC TMPA=20.0
      P_INF=83288.
      SURF_DEFAULT='WALL BOARD' /

12.08 psi - Based on elevation of ABQ

&DUMP DT_RESTART=25.

&REAC ID  ='POLYURETHANE'
      FYI = 'SFPE Handbook, 4th - Table C.3'
      C   =  6.3
      H   =  7.1
      N   =  1.0
      O   =  2.1
      HEAT_OF_COMBUSTION = 23200.0
      CO_YIELD = 0.023
      SOOT_YIELD = 0.1875

&MATL ID ='FOAM'
       FYI='Polyurethane - Table 2.1, Dyrsdale'
       SPECIFIC_HEAT  = 0.84
       CONDUCTIVITY   = 0.78

       DENSITY        = 2700.

&SURF ID             ='FURNITURE'
      FYI='Drysdale, Intro to Fire, Table 2.1'

      MATL_ID        ='FOAM'
      COLOR          ='BROWN'
      THICKNESS      =0.1524

&MATL ID='GLASS'

       FYI='SFPE Handbook, Table B.7'

       SPECIFIC_HEAT  = 0.84
       CONDUCTIVITY   = 0.78
```

```
        DENSITY        = 2700. /


&SURF ID         = 'WINDOW'

        MATL_ID    = 'GLASS'

        COLOR      = 'POWDER BLUE'

        THICKNESS  = 0.0015 / 5/8 in.

&MATL ID='CONCRETE'

        FYI='Drysdale, Intro to Fire, Table 2.1'

        SPECIFIC_HEAT  = 880.
        CONDUCTIVITY   = 1.1
        DENSITY        = 2100. /


&SURF ID         = 'FLOOR'

        MATL_ID    = 'CONCRETE'

        COLOR      = 'MAROON'

        THICKNESS  = 0.127 /

&MATL ID='GYPSUM'

        FYI='Drysdale, Intro to Fire, Table 2.1'

        SPECIFIC_HEAT  = 840.
        CONDUCTIVITY   = 0.48
        DENSITY        = 1440. /


&SURF ID         = 'WALL BOARD'

        MATL_ID    = 'GYPSUM'
        COLOR      = 'BEIGE'

        THICKNESS  = 0.0015 / 5/8 in.

&MATL ID='OAK'

        FYI='Drysdale, Intro to Fire, Table 2.1'

        SPECIFIC_HEAT  = 2380.
        CONDUCTIVITY   = 0.17
        DENSITY        = 800. /


&SURF ID         = 'WOOD DOOR'
```

```
        MATL_ID    = 'OAK'
        COLOR      = 'BRICK'

        THICKNESS  = 0.051 / (2 in. door)

&PROP ID='HEAT_DET'
      QUANTITY='LINK TEMPERATURE'
      RTI=115.5
      ACTIVATION_TEMPERATURE=74./ Source - Jobs Thermo Bulb

&SURF ID='FIRE', RAMP_Q='tsquared', HRRPUA=2017.5, COLOR='RED' /
&RAMP ID='tsquared', T= 0.0, F=0.00 /
&RAMP ID='tsquared', T= 10.0, F=0.00 /
&RAMP ID='tsquared', T= 20.0, F=0.01 /
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 RAMP ID='tsquared', T= 700.0, F=0.08 /



Simple Smoke Control (Exhaust)
&SURF ID='EXH_1', VOLUME_FLOW=1.416, COLOR='BLUE'/ 3,000 CFM
&SURF ID='EXH_2', VOLUME_FLOW=0.283, COLOR='BLUE'/  600 CFM
&SURF ID='EXH_3', VOLUME_FLOW=0.142, COLOR='BLUE'/  300 CFM
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&VENT XB = 24.500, 25.000, 125.00, 125.500, 10.25, 10.25, SURF_ID='EXH_1'/
&VENT XB = 22.000, 22.500, 125.00, 125.500, 10.25, 10.25, SURF_ID='EXH_1'/
&VENT XB = 20.000, 20.500, 122.00, 122.500, 10.25, 10.25, SURF_ID='EXH_1'/
&VENT XB = 13.500, 14.500, 117.00, 118.000, 16.00, 16.00, SURF_ID='EXH_1'/
&VENT XB = 13.500, 14.500, 123.00, 124.000, 16.00, 16.00, SURF_ID='EXH_1'/
&VENT XB = 27.000, 28.000, 108.00, 109.000, 8.75, 8.75, SURF_ID='EXH_3'/
&VENT XB = 27.000, 28.000, 108.00, 109.000, 4.500, 4.500, SURF_ID='EXH_3'/
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```
Simple Smoke Control (Supply)
&SURF ID='SUP_1', VOLUME_FLOW=-0.047, COLOR='GREEN'/ 100 cfm
&SURF ID='SUP_2', VOLUME_FLOW=-0.189, COLOR='GREEN'/ 400 CFM
&SURF ID='SUP_3', VOLUME_FLOW=-0.005, COLOR='GREEN'/ 100/9 CFM
&SURF ID='SUP_4', VOLUME_FLOW=-0.070, COLOR='GREEN'/ 150 CFM
&VENT XB = 14.500, 14.500, 36.000, 37.000, 4.0, 5.0, SURF_ID='SUP_1'/
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&VENT XB = 14.500, 14.500, 62.000, 63.000, 4.0, 5.0, SURF_ID='SUP_1'/
&VENT XB = 14.500, 14.500, 75.000, 76.000, 4.0, 5.0, SURF_ID='SUP_1'/
&VENT XB = 14.500, 14.500, 90.000, 91.000, 4.0, 5.0, SURF_ID='SUP_1'/
&VENT XB = 14.500, 14.500, 98.000, 99.000, 4.0, 5.0, SURF_ID='SUP_1'/
&VENT XB = 15.500, 15.500, 108.000, 109.000, 3.0, 4.000, SURF_ID='SUP_1'/
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&VENT XB = 15.250, 15.750, 117.000, 117.500, 4.5, 4.5, SURF_ID='SUP_1'/
&VENT XB = 22.000, 23.000, 108.00, 109.000, 8.750, 8.750, SURF_ID='SUP_1'/
&VENT XB = 22.000, 23.000, 108.00, 109.000, 4.500, 4.500, SURF_ID='SUP_1'/


Computational Boundaries
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&VENT MESH_ID='MESH 1', MB=XMAX, SURF_ID='OPEN', COLOR='INVISIBLE'/
&VENT MESH_ID='MESH 1', MB=YMAX, SURF_ID='OPEN', COLOR='INVISIBLE'/
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 VENT MESH_ID='MESH 2', MB=XMAX, SURF_ID='OPEN', COLOR='INVISIBLE'/
 VENT MESH_ID='MESH 2', MB=YMAX, SURF_ID='OPEN', COLOR='INVISIBLE'/
 VENT MESH_ID='MESH 2', MB=YMIN, SURF_ID='OPEN', COLOR='INVISIBLE'/
 VENT MESH_ID='MESH 2', MB=ZMAX, SURF_ID='OPEN', COLOR='INVISIBLE'/
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&VENT MESH_ID='MESH 6', MB=YMIN, SURF_ID='OPEN', COLOR='INVISIBLE'/

Room 1000 (Mesh 1)
 OBST XB =
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 OBST XB = 11.0, 11.4, 126.5, 132.1, 0.0, 9.0, SURF_ID='WALL BOARD'/ West wall
 OBST XB = 11.5, 17.3, 132.1, 132.2, 0.0, 4.3, SURF_ID='WINDOW'/ North Glass
Wall
 OBST XB = 17.3, 17.8, 126.5, 132.2, 0.0, 9.0, SURF_ID='WALL BOARD'/ East wall

&OBST XB = 9.0, 17.75, 126.0, 126.5, 0.0, 9.0, SURF_ID='WALL BOARD'/ South Wall
&HOLE XB = 14.3, 15.5, 126.0, 127.5, 0.0, 2.0, /Door
&OBST XB = 14.3, 15.5, 126.3, 126.5, 0.0, 2.0, SURF_ID='WOOD DOOR',
PERMIT_HOLE=.FALSE./


Room 2000 (Mesh 1)
 OBST XB =
 11.5, 17.3, 126.5, 132.1, 4.0, 6.0, SURF_ID='FLOOR'/ Floor
 OBST XB = 11.5, 17.3, 130.1, 130.2, 6.0, 10.3, SURF_ID='WINDOW'/ North Glass
Wall
 OBST XB = 11.0, 17.8, 126.5, 132.1, 9.00, 9.5, SURF_ID='WALL BOARD'/ Ceiling
&HOLE XB = 14.3, 15.5, 126.0, 127.5, 6.0, 8.0, /Door
&OBST XB = 14.3, 15.5, 126.6, 126.7, 6.0, 8.0, SURF_ID='WOOD DOOR',
PERMIT_HOLE=.FALSE./

East Corridor
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&OBST XB = 30.250, 30.500, 107.000, 110.000, 0.000, 9.000/
&OBST XB = 17.750, 30.250, 107.250, 109.750, 8.750, 9.000/
&OBST XB = 17.750, 30.250, 107.250, 109.750, 4.500, 6.000, SURF_ID='FLOOR'/
&HOLE XB = 29.000, 30.000, 106.000, 107.500, 6.000, 8.250/
&HOLE XB = 29.000, 30.000, 106.000, 107.500, 0.000, 2.250/


Triangle (Mesh 2)
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Tri-wall (Start Obst 141/ Mesh 2)
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&OBST XB = 16.875, 17.625, 117.625, 117.750, 0.000, 0.250, SURF_ID='FLOOR'/
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&OBST XB = 17.125, 17.875, 117.375, 117.500, 0.000, 0.250, SURF_ID='FLOOR'/
&OBST XB = 17.250, 18.000, 117.250, 117.375, 0.000, 0.250, SURF_ID='FLOOR'/

First Floor - Main Corridor Floor
&OBST XB = 9.500, 17.500, 117.000, 126.5, -0.5, 0.0, SURF_ID='FLOOR'/
&OBST XB = 17.500, 25.700, 125.400, 126.5, -0.5, 0.0, SURF_ID='FLOOR'/
&OBST XB = 9.500, 17.500, 71.5, 117.000, -0.5, 0.0, SURF_ID='FLOOR'/

First Floor - Walls and doors
&OBST XB = 11.000, 18.000, 126.0, 126.5, 8.0, 16.0, SURF_ID='WINDOW'/ North
Corridor wall above Rm 2000
&OBST XB = 17.000, 17.500, 117.000, 126.500, 10.25, 16.50, SURF_ID='WINDOW'/
East wall above triangle
&OBST XB = 9.750, 11.500, 122.000, 126.500, 3.75, 4.00/
&OBST XB = 9.750, 10.000, 122.000, 126.500, 0.0, 4.000, SURF_ID='WALL BOARD'/
&OBST XB = 9.750, 11.500, 122.000, 122.500, 0.0, 4.000, SURF_ID='WALL BOARD'/
&OBST XB = 11.000, 11.500, 115.000, 122.000, 0.0, 6.500, SURF_ID='WALL BOARD'/
&OBST XB = 11.000, 11.500, 110.000, 126.500, 2.000, 16.000/
&OBST XB = 11.000, 11.250, 112.250, 115.000, 0.000, 2.000, SURF_ID='WINDOW'/
&OBST XB = 11.000, 11.500, 110.000, 112.250, 0.000, 6.000/
&OBST XB = 11.000, 11.500, 13.500, 110.000, 0.000, 16.000/
&HOLE XB = 9.750, 10.000, 124.500, 125.500, 0.000, 2.000/
&OBST XB = 9.500, 10.250, 124.500, 125.500, 0.000, 2.000, SURF_ID='WOOD DOOR',
PERMIT_HOLE=.FALSE./
&HOLE XB = 9.500, 12.250, 124.500, 125.500, 6.000, 8.000/
&OBST XB = 11.000, 11.250, 124.500, 125.500, 6.000, 8.000, SURF_ID='WOOD DOOR',
PERMIT_HOLE=.FALSE./
&OBST XB = 17.500, 18.000, 110.000, 117.000, -0.5, 16.000, SURF_ID='WINDOW'/
East Corridor Wall
&OBST XB = 17.500, 17.750, 13.500, 110.000, 0.0, 16.000,/ East Corridor Wall
&HOLE XB = 17.500, 18.100, 112.250, 115.000, 0.000, 2.000/
&OBST XB = 17.750, 18.000, 112.250, 115.000, 0.000, 2.000, SURF_ID='WINDOW',
PERMIT_HOLE=.FALSE./
&OBST XB = 14.500, 17.500, 110.000, 110.010, 0.000, 4.500/ Partial wall north
of Media Room
&HOLE XB = 17.500, 18.100, 107.000, 110.000, 0.000, 2.000/
 OBST XB = 15.500, 15.550, 107.000, 110.000, 0.000, 2.000, SURF_ID='WOOD DOOR'/
Auditorium Door
&OBST XB = 15.500, 17.500, 107.000, 110.000, 2.000, 4.500/
&OBST XB = 14.500, 17.500, 13.500, 107.000, 0.000, 4.500/ First floor east wall
&HOLE XB = 14.000, 17.750, 92.500, 95.500, 0.000, 2.000/
&OBST XB = 17.500, 17.510, 92.500, 95.500, 0.000, 2.000, SURF_ID='WOOD DOOR',
PERMIT_HOLE=.FALSE./
&HOLE XB = 13.000, 15.000, 82.000, 86.500, 0.000, 2.000/
&OBST XB = 14.500, 14.750, 84.500, 86.500, 0.000, 2.000, SURF_ID='WOOD DOOR',
PERMIT_HOLE=.FALSE./ Corridor 105
&OBST XB = 14.500, 14.750, 82.000, 84.000, 0.000, 2.000, SURF_ID='WOOD DOOR',
PERMIT_HOLE=.FALSE./ Lab 1101
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&HOLE XB = 13.000, 15.000, 70.000, 74.500, 0.000, 2.000/
&OBST XB = 14.500, 14.750, 72.500, 74.500, 0.000, 2.000, SURF_ID='WOOD DOOR',
PERMIT_HOLE=.FALSE./
&OBST XB = 14.500, 14.750, 70.000, 72.500, 0.000, 2.000, SURF_ID='WOOD DOOR',
PERMIT_HOLE=.FALSE./
&OBST XB = 11.000, 18.000, 13.500, 13.9, 0.0, 16.0/
&HOLE XB = 15.000, 16.000, 13.400, 14.000, 0.0, 1.0/ Simple vent to outside

Second Floor - Main Corridor Floor
&OBST XB = 10.000, 17.500, 123.50, 126.500, 4.000, 6.000, SURF_ID='FLOOR'/
&OBST XB = 14.500, 16.000, 110.00, 123.500, 4.500, 6.000, SURF_ID='FLOOR'/
&OBST XB = 14.500, 17.500, 13.500, 110.000, 4.500, 6.000, SURF_ID='FLOOR'/
&OBST XB = 11.500, 14.500, 49.000, 52.000, 4.500, 6.000, SURF_ID='FLOOR'/
&OBST XB = 17.500, 17.875, 124.25, 126.125, 5.125, 5.500, SURF_ID='FLOOR'/
&OBST XB = 17.875, 18.250, 124.25, 126.125, 4.750, 5.125, SURF_ID='FLOOR'/
&OBST XB = 18.250, 18.650, 124.25, 126.125, 4.375, 4.750, SURF_ID='FLOOR'/
&OBST XB = 18.650, 19.000, 124.25, 126.125, 3.750, 4.375, SURF_ID='FLOOR'/
&OBST XB = 19.000, 24.500, 124.25, 126.125, 3.500, 3.750, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 24.625, 124.250, 124.375, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 24.750, 124.375, 124.500, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 24.875, 124.500, 124.625, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 25.000, 124.625, 124.750, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 25.125, 124.750, 124.875, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 25.250, 124.875, 125.000, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 25.375, 125.000, 125.125, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 25.500, 125.125, 125.250, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 25.625, 125.250, 125.375, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 25.750, 125.375, 125.500, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 25.875, 125.500, 125.625, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 26.000, 125.625, 125.750, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 26.125, 125.750, 125.875, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 26.250, 125.875, 126.000, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 24.500, 26.375, 126.000, 126.125, 3.50, 3.75, SURF_ID='FLOOR'/ Mid-
landing
&OBST XB = 20.500, 24.500, 124.125, 124.250, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 20.625, 24.375, 124.000, 124.125, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 20.750, 24.250, 123.875, 124.000, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 20.875, 24.125, 123.750, 123.875, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 21.000, 24.000, 123.625, 123.750, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 21.125, 23.875, 123.500, 123.625, 3.50, 3.75, SURF_ID='FLOOR'/
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&OBST XB = 21.250, 23.750, 123.375, 123.500, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 21.375, 23.625, 123.250, 123.375, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 21.500, 23.500, 123.125, 123.250, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 21.625, 23.375, 123.000, 123.125, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 21.750, 23.250, 122.875, 123.000, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 21.875, 23.125, 122.750, 122.875, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 22.000, 23.000, 122.625, 122.750, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 22.125, 22.825, 122.500, 122.625, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 22.250, 22.750, 122.375, 122.500, 3.50, 3.75, SURF_ID='FLOOR'/
&OBST XB = 22.375, 22.625, 122.250, 122.375, 3.50, 3.75, SURF_ID='FLOOR'/

&HOLE XB = 11.400, 18.600, 50.000, 52.000, 6.0, 8.0/
&OBST XB = 11.500, 12.000, 50.000, 52.000, 6.0, 8.0, SURF_ID='WOOD DOOR',
PERMIT_HOLE=.FALSE./
&OBST XB = 17.500, 18.000, 50.000, 52.000, 6.0, 8.0, SURF_ID='WOOD DOOR',
PERMIT_HOLE=.FALSE./
&HOLE XB = 17.400, 18.000, 107.000, 109.000, 6.0, 8.0/ East North Cororidor
 OBST XB = 17.500, 18.000, 107.000, 109.000, 6.0, 8.0, SURF_ID='WOOD DOOR',
PERMIT_HOLE=.FALSE./

Third Floor Mechanical Rooms and Walkway
&OBST XB = 11.500, 17.500, 95.500, 110.000, 8.000, 16.000, COLOR='GRAY'/ Rm
P004
&OBST XB = 11.500, 17.500, 69.500, 84.000, 8.000, 16.000, COLOR='GRAY'/ Rm P003
&OBST XB = 11.500, 17.500, 44.500, 58.500, 8.000, 16.000, COLOR='GRAY'/ Rm P002
&OBST XB = 11.500, 17.500, 20.500, 34.500, 8.000, 16.000, COLOR='GRAY'/ Rm P002
&OBST XB = 11.000, 18.000, 71.500, 126.500, 16.000, 17.000, COLOR='GRAY'/ Third
floor ceiling
&OBST XB = 11.000, 18.000, 13.500, 71.500, 16.000, 17.5000, COLOR='GRAY'/ South
floor ceiling

Two-seat couch
&OBST XB = 19.000, 19.250, 124.750, 126.000, 0.125, 0.625, SURF_ID='FURNITURE'/
&OBST XB = 19.000, 21.750, 125.750, 126.000, 0.125, 1.000, SURF_ID='FURNITURE'/
&OBST XB = 21.500, 21.750, 124.750, 125.750, 0.125, 0.625, SURF_ID='FURNITURE'/
&OBST XB = 19.250, 21.500, 124.750, 125.750, 0.125, 0.500, SURF_IDS='FIRE',
'FURNITURE', 'FURNITURE'/


Sprinklers
&DEVC XYZ = 25.000, 125.5, 3.4, PROP_ID='HEAT_DET', ID=1/
&DEVC XYZ = 22.000, 125.5, 3.4, PROP_ID='HEAT_DET', ID=2/
&DEVC XYZ = 18.500, 125.5, 3.4, PROP_ID='HEAT_DET', ID=3/
&DEVC XYZ = 24.125, 123.375, 3.4, PROP_ID='HEAT_DET', ID=4/
&DEVC XYZ = 20.000, 121.625, 2.0, PROP_ID='HEAT_DET', ID=5/
&DEVC XYZ = 20.000, 125.5, 4.5, PROP_ID='HEAT_DET', ID=6/
&DEVC XYZ = 15.750, 120.5, 4.5, PROP_ID='HEAT_DET', ID=7/
&DEVC XYZ = 25.000, 125.5, 10.1, PROP_ID='HEAT_DET', ID=8/
&DEVC XYZ = 22.000, 125.5, 10.1, PROP_ID='HEAT_DET', ID=10/
&DEVC XYZ = 18.500, 125.5, 10.1, PROP_ID='HEAT_DET', ID=11/
&DEVC XYZ = 22.000, 123.5, 10.1, PROP_ID='HEAT_DET', ID=12/
&DEVC XYZ = 18.500, 108.5, 8.750, PROP_ID='HEAT_DET', ID=13/
&DEVC XYZ = 18.500, 108.5, 4.500, PROP_ID='HEAT_DET', ID=14/

Heat Flux on Window
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&DEVC ID ='FLUX', QUANTITY='NET HEAT FLUX', XYZ=20.75,126.25,1.25, IOR=-2/

&SLCF PBY=125.0, QUANTITY='TEMPERATURE', VECTOR=.TRUE. /

&SLCF PBY=108.5, QUANTITY='TEMPERATURE', VECTOR=.TRUE. /

&SLCF PBX=13.5, QUANTITY='TEMPERATURE',VECTOR=.TRUE./

&SLCF PBX=9.1, QUANTITY='TEMPERATURE', VECTOR=.TRUE./

&SLCF PBZ=2.0,QUANTITY='TEMPERATURE', VECTOR=.TRUE./

&SLCF PBY=125.0,QUANTITY='VISIBILITY'/

&SLCF PBY=108.5,QUANTITY='VISIBILITY'/

&SLCF PBX=13.5, QUANTITY='VISIBILITY'/

&SLCF PBX=9.1, QUANTITY='VISIBILITY'/

&SLCF PBZ=2.0,QUANTITY='VISIBILITY'/

&SLCF PBZ=8.0,QUANTITY='VISIBILITY'/

&SLCF PBZ=13.0,QUANTITY='VISIBILITY'/

&SLCF PBY=125.0,QUANTITY='PRESSURE', VECTOR=.TRUE./

&SLCF PBX=13.5, QUANTITY='PRESSURE', VECTOR=.TRUE./

&SLCF PBX=9.1, QUANTITY='PRESSURE', VECTOR=.TRUE./

&SLCF PBZ=2.0,QUANTITY='PRESSURE', VECTOR=.TRUE./

&SLCF PBZ=4.25, QUANTITY='V-VELOCITY', VECTOR=.TRUE./
&SLCF PBY=108.5, QUANTITY='W-VELOCITY', VECTOR=.TRUE./

&SLCF PBX=13.5, QUANTITY='VOLUME FRACTION', SPEC_ID='CARBON MONOXIDE'/
&SLCF PBY=108.5, QUANTITY='VOLUME FRACTION', SPEC_ID='CARBON MONOXIDE'/
&TAIL/
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