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SAN LUIS OBISPO

Fire Protection Engineering Analysis of the Child Development Center

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FPE 596
June 2017

Statement of Disclaimer

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Keywords:
- Life Safety Code
- Fire Dynamics Simulator
- Prescriptive-Based Design
- Performance-Based Design
- Egress Analysis

Executive Summary

This report contains two separate forms of analysis, Prescriptive-Based Analysis and Performance-Base Analysis. The Prescriptive Analysis discusses an overview of the building and it's features whereas the Performance-Based Analysis discusses the building meeting applicable codes and standards as discussed in NFPA 101 Life Safety Code 2012 Edition, Unified Facilities Code (UFC), International Building Code (IBC) 2012 Edition, and the SFPE Handbook of Fire Protection Engineering. The Child Development Center (CDC) was analyzed as a new construction building. There are also noted assumptions within the report where necessary information about the building could not be obtained due to information restrictions from the Government.

The building discussed in this report is the Child Development Center (CDC) located in an area titled Murphy Canyon on Naval Base San Diego. Due to the nature of the building and the citizens that utilize it, Common Access Cards (CAC) are required when visiting the building. The CDC is initially considered a Group I-4 Occupancy, but can be labeled as a Group E occupancy due to the building having egress exits in each classroom to the immediate outside. This building has no immediate adjacent building surrounding it.

The prescriptive-based analysis within this document confirms that the building meets requirements of NFPA 101 Life Safety Code, NFPA 13, NFPA 17, NFPA 72, NFPA 92, Unified Facilities Code, and IBC. The report is also based on a CDC building expansion, which can be conducted at a later date.

The performance-based analysis looks into the possibilities of fires arising in a staff break room. The software that aided this report for modeling each fire scenario is Fire Dynamics Simulator (FDS). The break room fire model involved a runaway coffee pot scenario that spreads to a polyurethane couch. In the event of a failure of the heat detection device located in the break room, the time from detection and notification by the quick response sprinkler would not allow enough time to instruct the occupants to leave the building before untenable conditions occurred. Also, the desired fire suppression system flow demand does not meet the requirement set at 2,000 gpm. The flow test to the building shows a flow rate that is approximately 40 gpm less than the 50% reduction flow rate of the desired 2,000 gpm system demand. One recommendation to the project building would be the installation of a fire pump.

Due to the nature of the building owner and operator, limited pictures and as-built drawings could be taken due to security measures.

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Project Scope

The Fire and Life Safety report contained within this document will discuss in detail the required Fire & Life Safety features of the Child Development Center as well as a Performance-Based approach to the analysis of the constructed building. The report will address Fire Suppression, Fire Detection & Alarm System, Egress Analysis, and Structural Fire Protection.

This report shall be presented to the Authority Having Jurisdiction (AHJ). The list of applicable codes this building is analyzed with consists of:

- UFC 3-600-01, “Fire Protection Engineering”
- UFC 3-600-10N, “Fire Protection Engineering”
- NFPA 13, “Standard for the Installation of Sprinklers” (2011 Edition)
- NFPA 101, “Life Safety Code” (2012 Edition)
- NFPA 72, “National Fire Alarm Code” (2013 Edition)
- IBC, “International Building Code”

Building Overview

The Child Development Center (CDC) is located in San Diego and is owned and operated by the Department of Defense, Naval Division. The building is a type VB construction with a Gross Square Footage of 12,727 ft^2 and was designed for an allowable area increase of 45,125 ft^2. The CDC is a single story building and rated as an Occupancy E classification. This project was under construction from January 2014 through May 2015. The two open areas on each side of the CDC which contain the color green in Figure 1 are designated areas for the teachers to take the children out of the classroom each day for recess.

Figure 1: Aerial View of Child Development Center

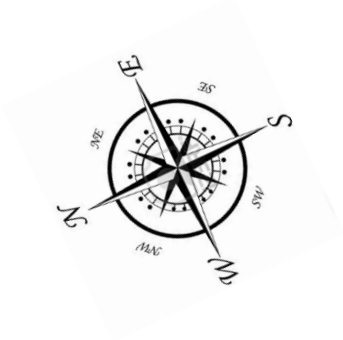


Figure 2: Top View of Child Development Center

Figure 2 shows a top view of the Child Development Center. This image shows no surrounding buildings to the newly constructed center. Figure 3 shows the frontal view of the entrance and Figure 4 displays the lobby and reception area.

Figure 3: Front Entrance

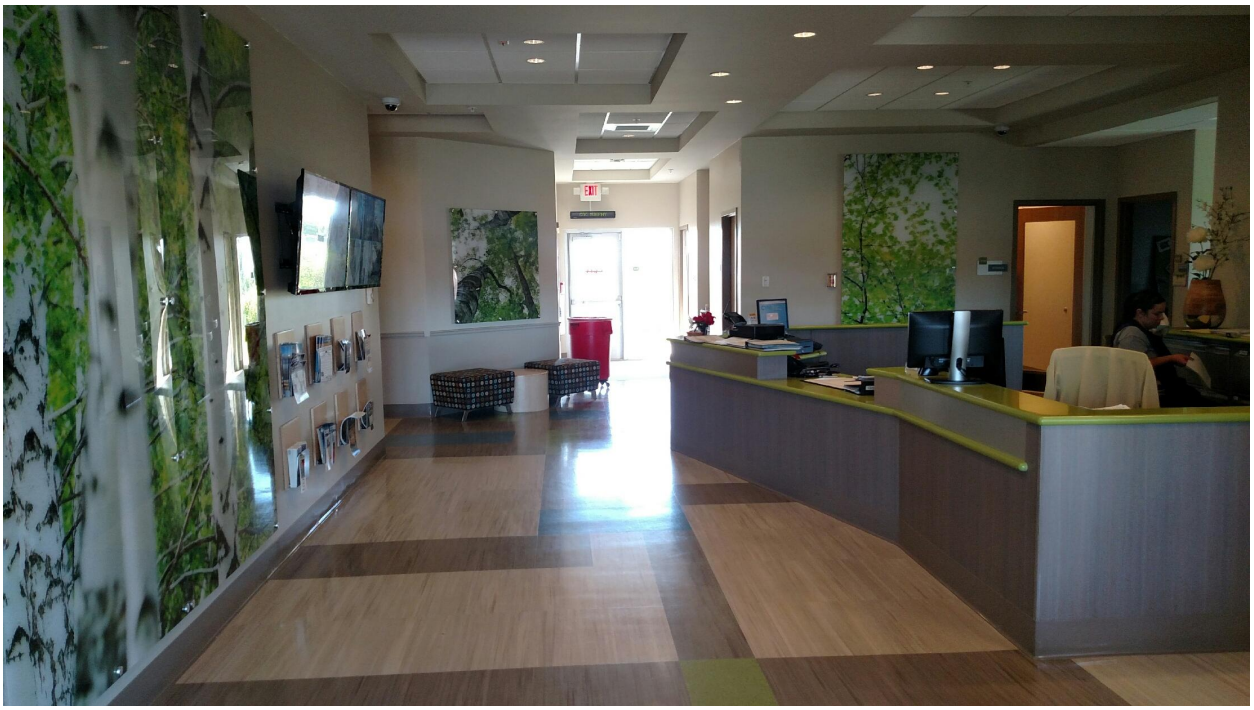
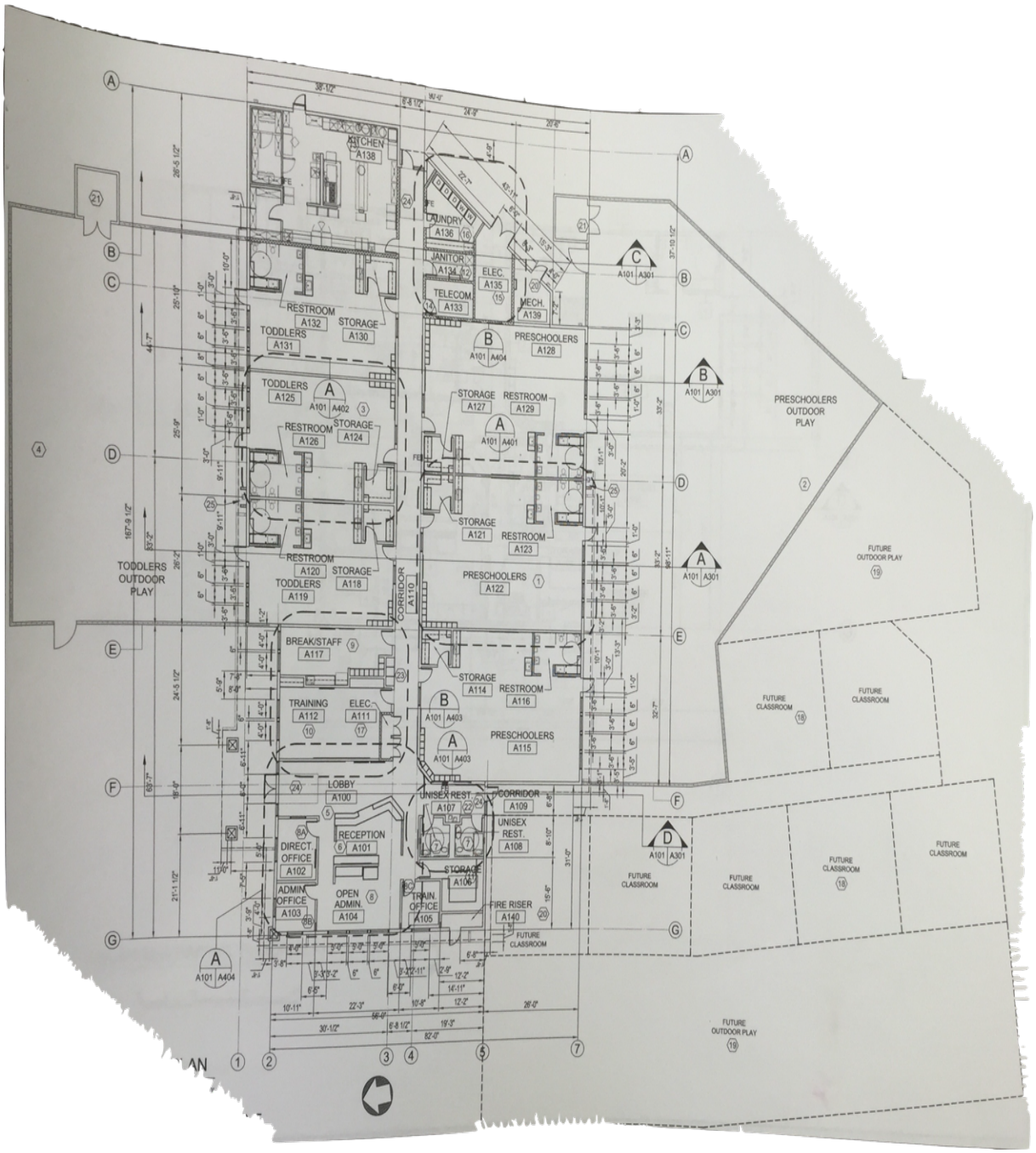


Figure 4: Lobby/Reception Area

The reception area shown in Figure 4 is directly inside the main entrance of the building and is always staffed during normal business hours. This space consists of 5 separate work areas which include a reception desk, open administration desk, administration office, training office, and director's office.

The ceiling consists of a drop down false ceiling that rests 9 feet above ground level. The building was constructed with only 3 areas containing fire rated walls. These areas consist of electrical rooms, laundry rooms, and commercial kitchens. Throughout the building are designated emergency exits with horn and strobe alarms as well as scrolling text panels located above the doors. Figure 4 shows an example of the scrolling text panels installed above the exit doors. These alarm devices are all controlled by a "EST3X" fire notification and alarm panel located in the reception area. This building is a fully sprinklered building, consisting of enough flow demand to meet a possible building expansion in later years. The next part to this report discusses the occupancy classification and means of egress.


KITCHEN A138
LAUNDRY A136
JANITOR A134
ELEC. A135
TELECOM A133
MECH. A139
RESTROOM A132
STORAGE A130
TODDLERS A131
PRESCHOOLERS A128
TODDLERS A125
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PRESCHOOLERS OUTDOOR PLAY
STORAGE A121
RESTROOM A123
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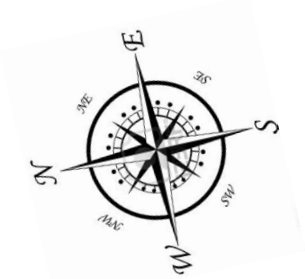
TODDLERS A119
PRESCHOOLERS A122
TODDLERS OUTDOOR PLAY
CORRIDOR A110
FUTURE OUTDOOR PLAY
BREAK/STAFF A117
STORAGE A114
RESTROOM A116
TRAINING A112
ELEC. A111
PRESCHOOLERS A115
FUTURE CLASSROOM
LOBBY A100
UNISEX REST. A107
CORRIDOR A109
UNISEX REST. A108
RECEPTION A101
DIRECT OFFICE A102
STORAGE A106
ADMIN. OFFICE A103
OPEN ADMIN. A104
TRAIN. OFFICE A105
FIRE RISER A140
FUTURE CLASSROOM
FUTURE OUTDOOR PLAY

Figure 5


E
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Prescriptive-Based Analysis

Egress Analysis

Although this building consists of a kitchen, laundry room, and offices, its main purpose is for educational functions. Table 1 addresses the quantity of various room types within the CDC. The building is a one-story structure with designated exits to the immediate outside within each classroom. Figure 6 shows the 10 designated egress exits throughout the building. Since the building in this project is classified as fully sprinklered education, the maximum common path of travel is 200 feet, which is based on the assumption that each classroom is a non-fixed seating arrangement due to the rooms not having chairs inside them. In order to provide efficient means of egress in each classroom, each room is equipped with two (2) points of egress. These two points (doors) are positioned remote from each other in the case of a blockage to one means of egress passage. All of the egress exit signs are illuminated and clearly visible without any other objects obstructing the line of sight.

Table 1: Types of CDC Components

CDC Room Components	Number of Items
Classroom	6
Kitchen	1
Electrical Room	2
Laundry Room	1
Storage	7
Office	5
Staff Break Room	1

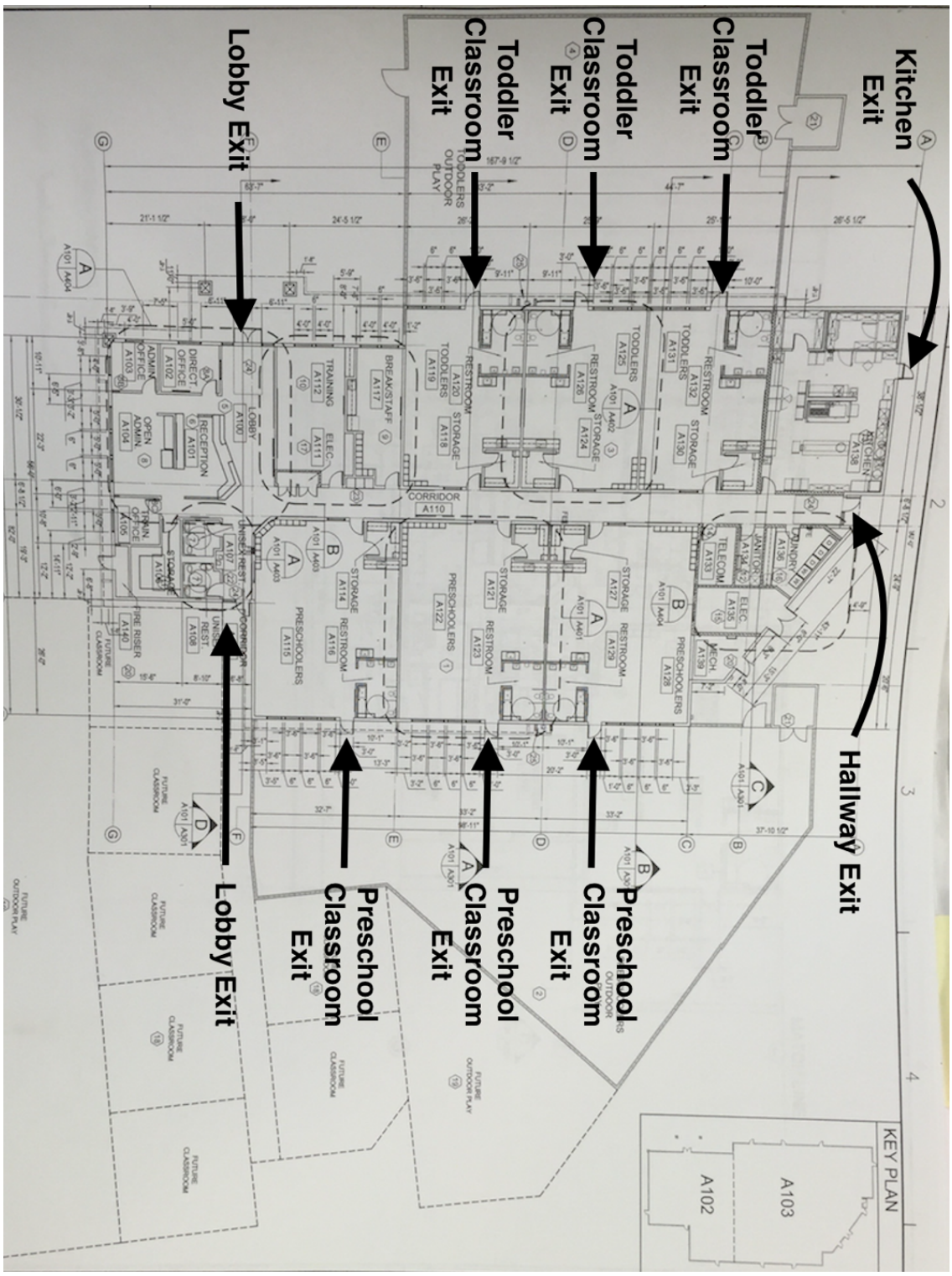


Figure 6: Egress Exits

Figure 7: CDC Classroom

Figure 7 shows the inside of one of the classrooms located at the CDC. Note the illuminated exit sign in the upper left of the picture. Although the image may suggest that the exit door is partially blocked by a low table, it is not. Table 2 below shows the square-footage of each room in the CDC.

Table 2: Areas of Individual Rooms in ft^2

CDC Rooms	Area of rooms (sq-ft)
Classroom (Preschool)	1416
Classroom (Toddler)	932
Kitchen	946
Electrical Room	177
Laundry Room	167
Storage	60
Office	110
Staff Break Room	349

Occupant Load

The Occupant Load Factor (OLF) was calculated by using the information found in Table 7.3.2.1 of Life Safety Code 2012 (Table 3 below). Knowing the area of each classroom, total number of occupants per room can be determined to allow for safe egress. These values can be viewed in Table 3 below.

Table 3: Maximum Occupancy of Rooms

CDC Rooms	Area of rooms (ft^2)	Max. Occupancy
Classroom (Preschool)	1416	40
Classroom (Toddler)	932	26
Kitchen	946	9
Storage	60	N/A
Office	110	6
Staff Break Room	349	23

The equation below was used in order to determine the Occupant Load each room is assigned.

$$Occupant\ Load = \frac{Area\ of\ Room\ (ft^2)}{Occupant\ Load\ Factor\ (ft^2\ per\ Occupant)}$$

Exit Capacity

According to the Life Safety Code, exit capacity should always be greater than the Occupant Load of any given inhabited area. Each classroom has 14 students and 2 teachers for a total of 16 individuals. Each room contains a 36" wide egress door to the outside environment. Table 7.3.3.1 of the LSC 2012 Edition discusses the capacity factor for level components. The equation below was used to determine the doorway capacity for each classroom.

Table 4: Capacity Factors

Table 7.3.3.1 Capacity Factors

Area	Stairways (width/person)		Level Components and Ramps (width/person)	
	in.	mm	in.	mm
Board and care	0.4	10	0.2	5
Health care, sprinklered	0.3	7.6	0.2	5
Health care, nonsprinklered	0.6	15	0.5	13
High hazard contents	0.7	18	0.4	10
All others	0.3	7.6	0.2	5

$$Doorway\ Capacity = \frac{Doorway\ Width}{Capacity\ Factor}$$

The Capacity Factor used is 0.2 yielding the inputs:

$$Doorway\ Capacity = \frac{36\ inches}{0.2}$$

$$Doorway\ Capacity = 180$$

This verifies that the classrooms are in compliance with the Life Safety Code in terms of exit capacity.

Means of Egress

In order for a means of egress system to be effective, the exit path of travel from the inhabited office/work area must be continuous and uninterrupted until the person is safely outside into the public way. If this route includes doors, then the route cannot be subject to locking from the side that people will be exiting from. A sub-category of an egress system is an exit passageway. According to the IBC section 1021, an exit passageway is any route of exit that is a separated fire resistance rated passageway (either corridors, stairs, connected rooms) that connects to the exit discharge. Figure 5 illustrates the locations of the 10 emergency exits located throughout the building. These 10 exits are spaced evenly throughout the building so that the furthest travel distance a person could encounter is 84 feet via a hallway leading to the outside. This building is not equipped with an assembly area for school gatherings. Therefore, each room is only required to have one exit in order to comply with the Life Safety Code since the occupant load is less than 50 people.

The hallway, as seen in Figure 8, is 6 feet 8.5 inches wide and does not contain any obstructions inhibiting the travel paths which could become problematic in the case of an emergency. For this building, all rooms meet the Life Safety Code 2012.

Figure 8: CDC Hallway

Path of Travel

Table 5 addresses the travel distances for new Educational and Day Care Centers. The longest travel distance a person could experience in this building is 84 feet, meaning an individual is located in between the hallway exit and the main lobby exits and is forced to leave via either the Hallway or Lobby Exits (both shown in Figure 9). This distance is significantly less that the Travel Distance Limit of 200 feet as specified in Table 5.

Table 5: Travel Distances

Type of Occupancy	Common Path Limit				Dead-End Limit				Travel Distance Limit			
	Unsprinklered		Sprinklered		Unsprinklered		Sprinklered		Unsprinklered		Sprinklered	
	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
Assembly												
New	20/75	6.1/23[a]	20/75	6.1/23[a]	20	6.1[b]	20	6.1[b]	200	61[c]	250	76[c]
Existing	20/75	6.1/23[a]	20/75	6.1/23[a]	20	6.1[b]	20	6.1[b]	200	61[c]	250	76[c]
Educational												
New	75	23	100	30	20	6.1	50	15	150	46	200	61
Existing	75	23	100	30	20	6.1	50	15	150	46	200	61
Day Care												
New	75	23	100	30	20	6.1	50	15	150	46[d]	200	61[d]
Existing	75	23	100	30	20	6.1	50	15	150	46[d]	200	61[d]

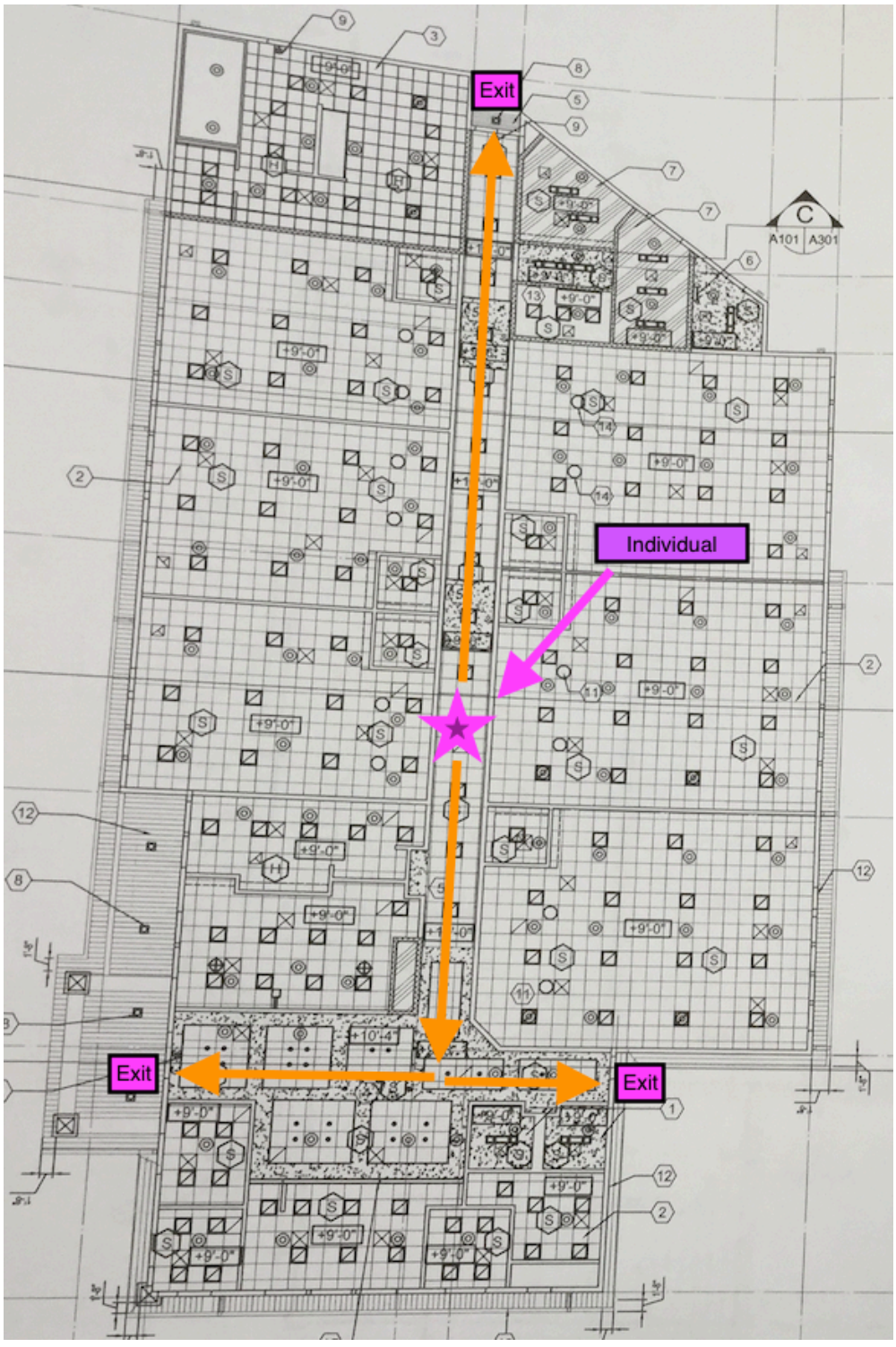


Figure 9: Longest Possible Egress Travel Route

Illumination

Section 1006.1 of the IBC states: "the *means of egress*, including the *exit discharge*, shall be illuminated at all times the building space served by the *means of egress* is occupied." Exit signs must be placed throughout the building and clearly labeled as such. Failure to comply with this code would not let the occupants know where the nearest exit is in the case of an emergency. In case of an electrical malfunction, section 1006.3 states that a backup power supply must be readily available and must supply power for a time frame no less than 90 minutes. The backup power supply serves the aisles, enclosed stairways, corridors, ect... and must provide sufficient lighting in accordance with IBC section 1006.4. Each building exit sign complies with the IBC and NFPA 101 Life Safety Code.

Timed Evacuation and Response

When an emergency happens in a building, there is a delay that happens from the time of the initial hazard presents itself, until the occupant leaves the hazardous area. For example, when a fire begins to smolder, an occupant that is in the general area may not notice the hazard immediately. The faster a response time is (whether it be visual, physical, or audible) to a fire, the faster people exits the hazardous areas and ensure properly trained professionals are notified to handle the situation. Visual factors would include seeing smoke, flames, smoldering items (debris, wood, ect...).

An audible alert would include a fire alarm, mass notification system, or other occupants informing each other about the fire. Due to this building being newly constructed, the fire alarm system has a mass notification system that includes a prompted audio instruction on where to proceed to safety, which is a NFPA 72 system and requires fire drills to ensure occupants are aware of how to proceed to the nearest egress exits. The fire panel is tied back to a dispatch center who then can contact the proper authorities of the given area to respond in a timely manner.

Hand Calculation

The time of safe egress was determined by incorporating various assumptions. First, a time for the faculty to react properly to an alarm notification system was needed, which was set at 10 seconds. This time is reasonable due to the alarm system being a mass notification system with audible commands. The speakers throughout the school will project the type of danger and help faculty and children react more quickly. Secondly, a time delay assumption of 14 seconds from when the faculty was notified of a fire was chosen because there are 14 students per classroom and performing a "head count" of each student prior to movement time is protocol during evacuations. Figure 11 shows the travel path used when calculating the egress time. The distance of travel is measured out to be roughly 14 meters (46.2 feet). Lastly, the walking speed of each occupant is was set at 0.55 m/s (1.82 ft/s). This value was determined by a study performed by the Technical University of Denmark on Evacuation Dynamics of Children (Figure 10). The calculated Required Safe Egress Time (RSET) was determined to be 76 seconds, which can be seen on the following page.

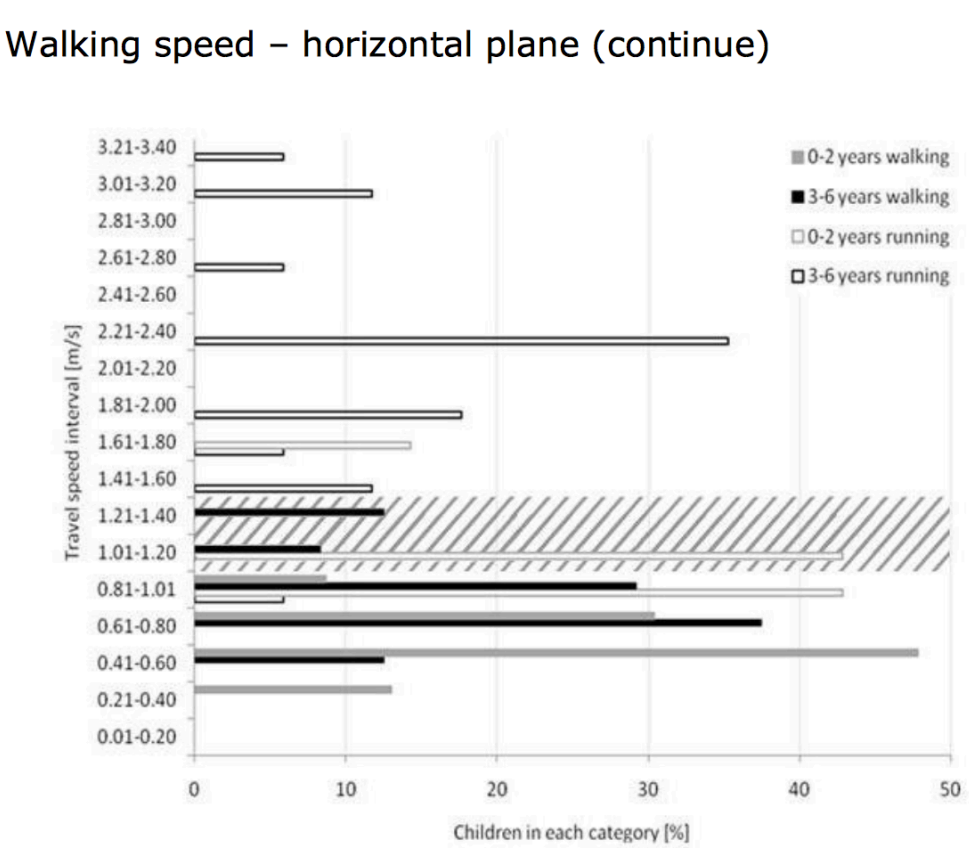


Figure 10: Walking Speeds of Children

Average time for faculty/toddlers to walk 14 meters (48.2 feet):

$$Time\ to\ walk\ path = 48.2\ feet * \frac{1\ second}{1.82\ feet}$$

$$Time\ to\ walk\ path = 26.5\ seconds$$

Total time to evacuate room:

$$Total\ Time = 14\ seconds\ premovement + 10\ seconds\ reaction\ time + \ 26.5\ seconds)$$

$$Total\ Time = 50.5\ seconds$$

Safety factor: 1.5

$$Total\ Time = 50.5 * 1.5$$

$$\boldsymbol{Total\ Time = 75.8\ seconds}$$

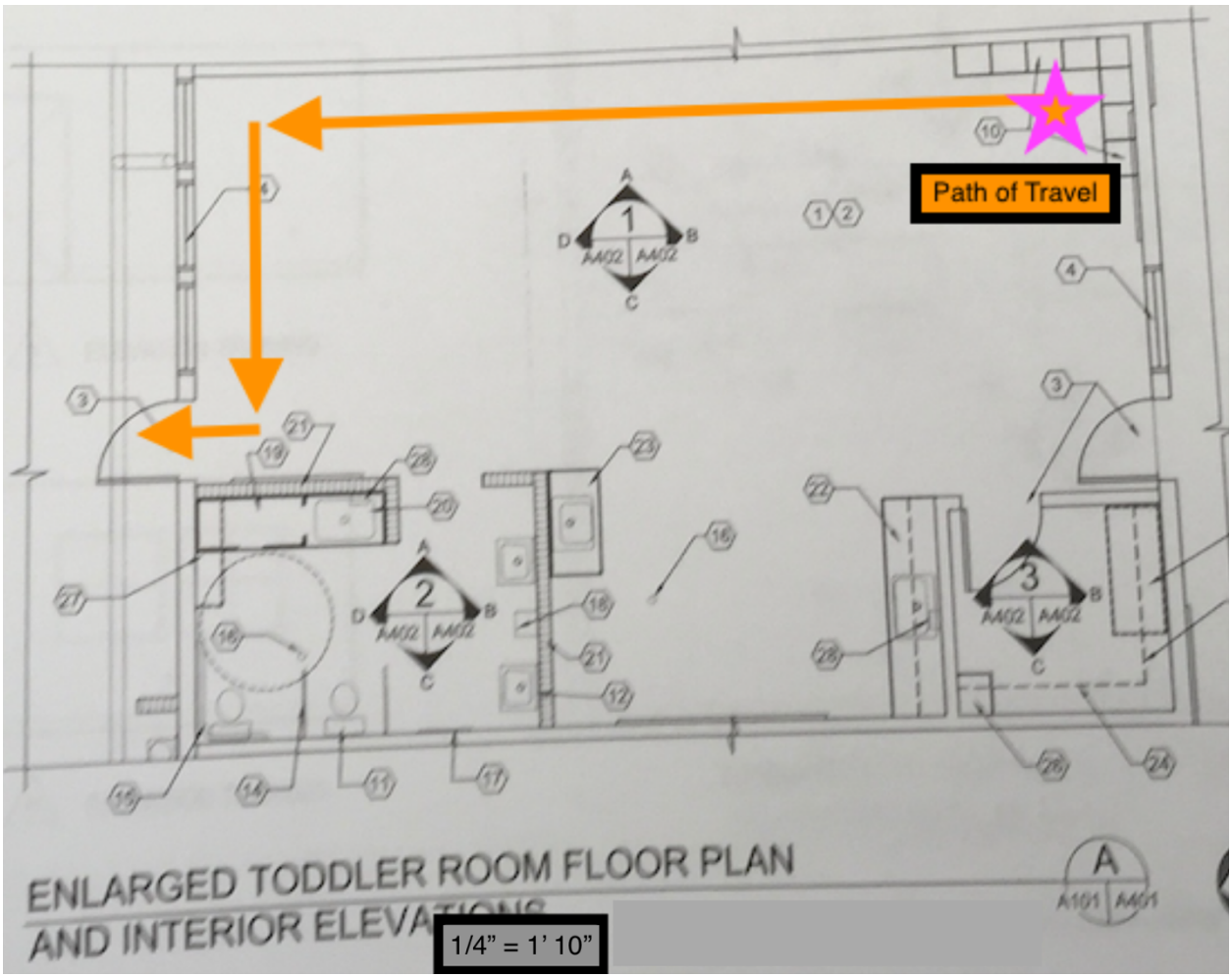


Figure 11: Path of Travel

Pathfinder

Using computer modeling to help aid the analysis of safe egress in a building is a vital commodity. Pathfinder is the software used in this report to determine the egress time of a classroom. In order to properly model the scenario, there is an initial 24 pre-movement delay time. A downside of Pathfinder is the "Requires Assistance" option only has inputs for a hospital bed or a wheelchair. There is no option for "Assisted Walk" in the event that an occupant simply needs to be lead on a travel path by another occupant. Figures 13-16 are showing the time intervals of the toddlers and teachers during the egress time steps. Figure 16 shows the final egress time output for the model run, 77.4 seconds.

Door Flow Rates:

Door	First_In (s)	Last_Out (s)	Total_Use (pers)	Flow_Avg (pers/s)
Door06	47.5	77.4	16	0.54

Room Usage:

Room	First_In (s)	Last_Out (s)	Total_Use (pers)
Room00	0.0	77.4	16

Figure 12: Pathfinder Egress Time

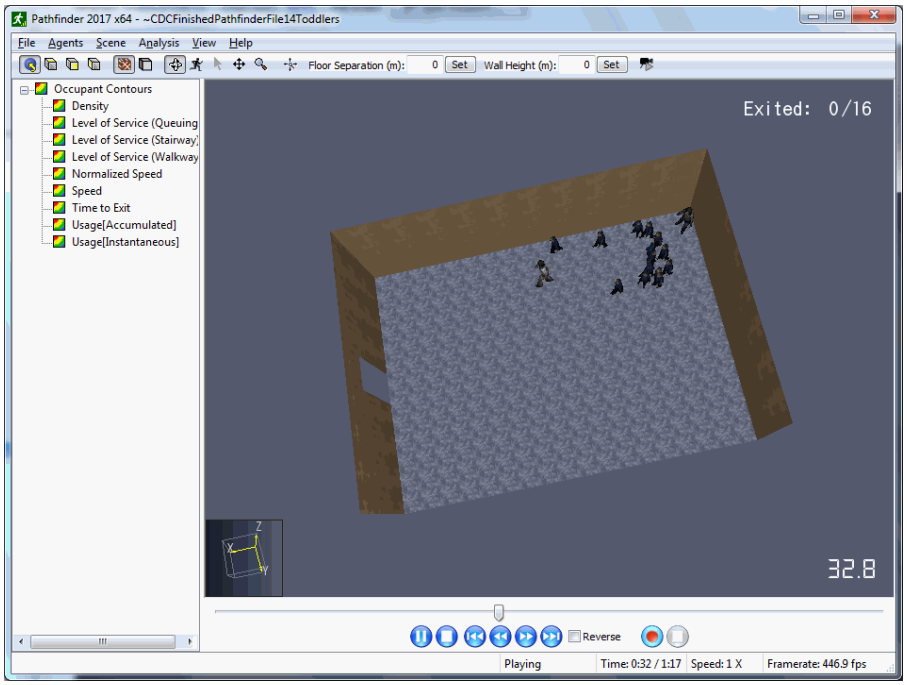


Figure 13: Pathfinder Egress @ t = 32.8 seconds

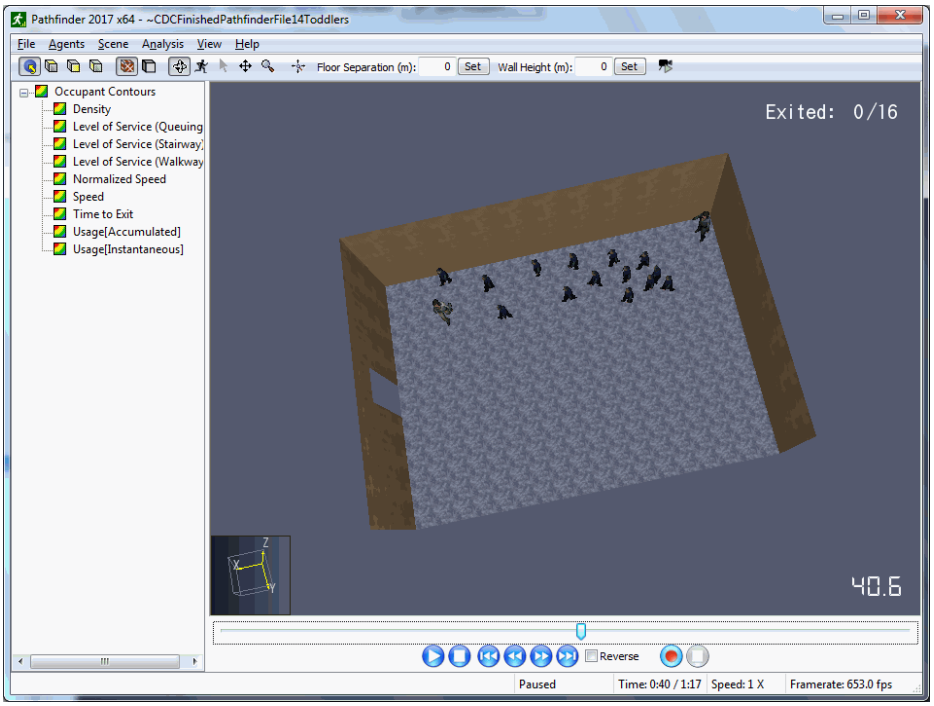


Figure 14: Pathfinder Egress @ t = 40.6 seconds

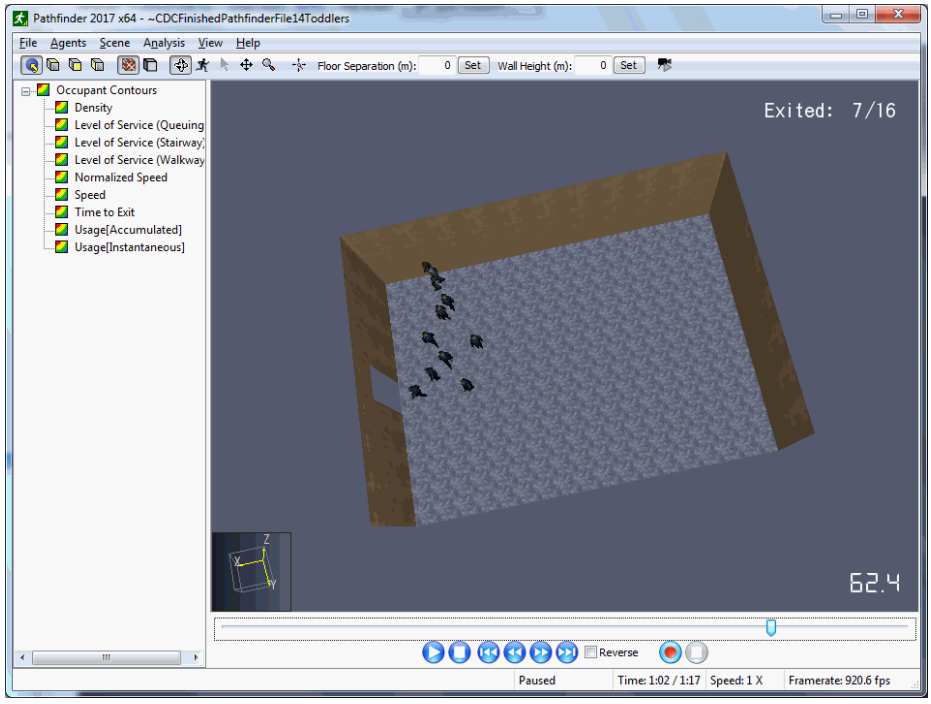


Figure 15: Pathfinder Egress @ t = 62.4 seconds

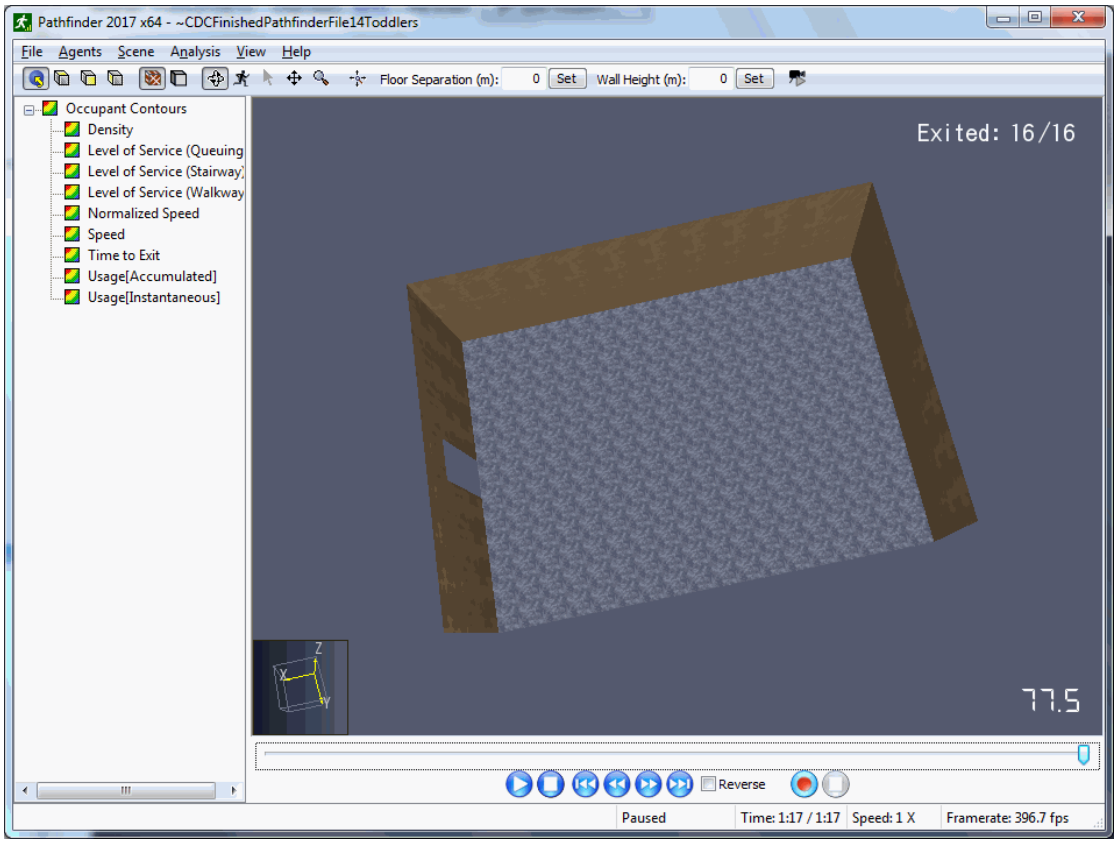


Figure 16: Pathfinder Egress @ t = 77.5 seconds

The calculated egress time for the occupants to exit the building is 75.8 seconds (~76 seconds), whereas Pathfinder determined the egress time to be 77.5 seconds. The reason for a longer Pathfinder time is due to the occupants moving in a weaving travel path at certain points. The occupants following a weaving path is due to two occupants trying to occupy an exact point along the common travel path at the same time. The obstructions each occupant inflicts on each other causes a slower movement speed for fractions of a second periodically throughout the simulation.

Egress Summary

In conclusion, the egress analysis confirmed that the current building conditions are in compliance with the Life Safety Code 2012. During any given egress simulation, Available Safe Egress Time (ASET) should always be greater than Required Safe Egress Time (RSET). This comparison of times helps determine if occupants of a building or affected area have the necessary time to evacuate a hazard zone before conditions become inhabitable. In order to better assist the occupants with a safe egress, water-based fire suppression systems, structural fire protection, and fire alarm and detection systems are incorporated into the construction of the building and will be discussed within the next parts of this report.

Water-Based Fire Suppression System

The Child Development Center is a facility which teaches, monitors, and supervises young children between the ages of 18 months old to 5 years old. According to the International Building Code (IBC) and NFPA 13, an Automatic Sprinkler System shall be installed for Group E Occupancies where the fire area exceeds 12,000 ft^2 and can be classified as "Light Hazard." The Sprinkler System is a Wet-Pipe system throughout the building. The system is designed for a Gross Area Coverage of 12,727 ft^2 and has a Fire Flow Demand of 4,000 GPM per section IFC Table B105.1. The required fire flow demand for this building is set with a 50% reduction, yielding 2,000 GPM. The design area for the sprinkler coverage is 923 ft^2 in each classroom and kitchen. There is also another form of Fire Suppression located in the kitchen. This suppression system is a Ansul R-102 3 Gallon system over the stove and oven.

Water Supplies

The Automatic Fire Sprinkler System is connected to an 8-inch PVC water main pipe directly fed from the city street water supply. This pipe system includes Thrust Blocks at each elbow leading to the Riser, conforming to NFPA 24. The point of connection from the main water supply to the Riser is 6-inches, the Riser itself is 3-inches in diameter (as seen in Figure 17). The Static Pressure, Residual Pressure, and Flow Rates are stated below in Table 6:

Table 6: Hydraulics

Hydraulic-System	
Location	**CDC**
Static Pressure	85 psi
Residual Pressure at Point of Connection	65.6 psi
Flow	1022 gpm
Flow @ 20 psi	1963 gpm

Figure 17: Riser

According to NFPA 101 Life Safety Code, Educational buildings fall under Group-E Occupancy which includes "part-day pre-schools, Kindergardens, and other schools whose purpose is primarily educational, even though the children who attend such schools are of preschool age" (NFPA 101 2012 Edition Section 14.1.2.2). Inside the building located in the storage room (Figure 18), Class I & II Commodities can be found. There are materials such as Toilet Tissue and Cartoned Wax Coated Paper Cups. The Sprinkler system design for this room is one sprinkler. The system area for the Kitchen as a whole is 923 ft^2 for 12 sprinklers. Each sprinkler has an area design coverage of 77 ft^2. The storage room has an area of 76.66 ft^2, deeming one sprinkler in this room as sufficient.

Figure 18: Kitchen Storage Room

Location/Sizes of Riser, Cross-Mains, Branch Lines, and Sprinklers

The location of the Riser is the Southwest corner of the building (see Figure 22). The Riser is fed by an 8-inch PVC city water supply pipe where it meets a 6-inch connector pipe just before the Riser. The Riser itself is a 3-inch pipe that connects to the 3-inch Feed Main line. Figure 19 (below) shows the Feed Main connecting to the 3-inch Cross Main leading to the Branch Lines servicing each sprinkler. Each branch line can be seen in Figure 22 on the following page.

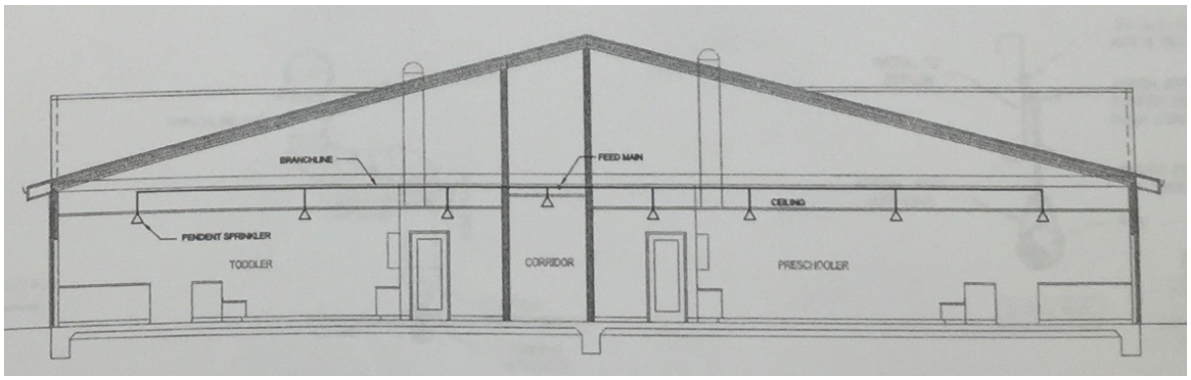


Figure 19: Side View Branch Line

The sprinkler heads (as seen in Figure 21) are 1/2 – inch thread with a K-factor of 5.6. There are 117 sprinklers total, having a temperature rating of 135 ^{o}F for the Sprinkler heads located in the classrooms, break room, offices, and the hallway. The sprinklers located in the kitchen, laundry room, and electrical rooms are rated at 155 ^{o}F. 12 sprinklers have been installed in the kitchen and 8 in each classroom. Each branch line is 1-inch at the very ends and increases to 1.5-inches before connecting to the Cross Main. The manufacturer of the building's sprinklers is Viking.

Figure 21: Sprinkler Head

Hydraulic Calculations

When looking at the CDC, it is apparent that the most remote area to perform hydraulic calculations is located in the kitchen. Figure 22 (below) has two enclosed areas, one showing a classroom and the other showing the kitchen. For this report, calculations were performed on the kitchen. The calculations used a 1,200 ft^2 room with a nominal 100 ft^2 coverage per sprinkler. With these parameters I calculated out a value of 12 sprinklers.

To determine the number of sprinklers per branch line I used the equation:

$$Number\ of\ Sprinkler\ Heads = 1.2 * \frac{Area^{1/2}}{8}$$

$$Number\ of\ Sprinkler\ Heads = 1.2 * \frac{1200^{1/2}}{8}$$

This yields a value of 5.19 which rounds up to 6 sprinklers per branch line.

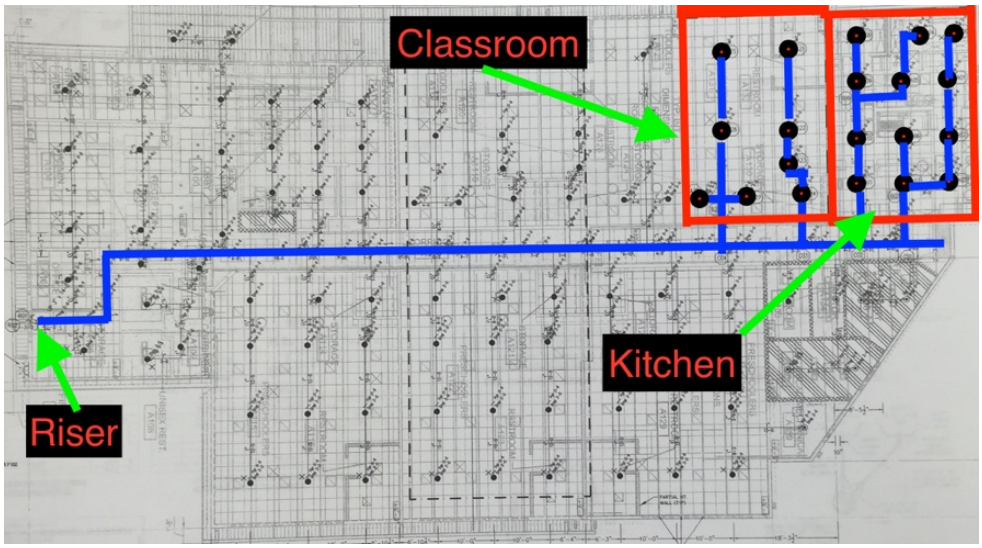


Figure 22: Most Remote Area

Figure 23 shows a water flow demand of 257 gpm at a pressure of 75.4 psi for the most remote area of the building. Completing the building hydraulic calculations back to the base of the riser, a flow demand of 568 gpm at a pressure of 104 psi was determined. A completed hydraulic calculation for the project building can be seen on the next page in Figure 23.

FPE 523 Hydraulic Calc			Tyler Ball																			
Step No.	Nozzle Identity and Location		Flow in gpm		Pipe size	Pipe Fittings and Devices	Equivalent Pipe Length			Friction loss (psi/ft)			Pressure Summary			Normal Pressure			Summarized Values			Notes
1	1	BL-1	q		1.049	1 Elbow	L	8	C	120	Pt	10.5	Pt	0.305514	k	5.6		Q=A*D
							F	2			Pe		Pv	0.305514	Q	18.15		D = 0.15 gpm/ft2
			Q	18.15			T	10	pf	0.1087	Pf	0.9	Pn	0	Pt	10.5		10.50454401
2	2	BL-1	q	18.9	1.049		L	8	C	120	Pt	11	Pt	12.64664	k	5.6		
							F				Pe		Pv	1.272155	Q	37.0		
			Q	37.0			T	8	pf	0.4069	Pf	3.25	Pn	11.37448	Pt	11.4		
3	3	BL-1	q	21.4	1.049		L	8	C	120	Pt	14.6	Pt	17.79842	k	5.6		
							F				Pe		Pv	3.169065	Q	58.5		
			Q	58.5			T	8	pf	0.9465	Pf	7.57	Pn	14.62936	Pt	14.6		
4	4	BL-1	q	26.4	1.049	1 Elbow 1T-5	L	8	C	120	Pt	22.2	Pt	28.87681	Pt	22.2		
							F	7			Pe		Pv	6.675708	Q	84.8		
			Q	84.8			T	15	pf	1.8854	Pf	28.28	Pn	22.2011	K(BL)	18.0		
5	5	BL-1	q	39.8	1.61		L	8	C	120	Pt	50.5	Pt	53.07827	k	5.6		
							F				Pe		Pv	2.59611	Q	124.6		
			Q	124.6			T	8	pf	0.4768	Pf	3.814	Pn	50.48216	K(BL)	17.5		
6	6 To CM	BL-1	q		1.61	1T-5	L	8	C	120	Pt	54.3	Pt	2.59611	k	5.6		
							F	5			Pe	0.4	Pv	2.59611	Q	124.6		Pe = 1 x 0.433 psi
			Q	124.6			T	13	pf	0.4768	Pf	6.198	Pn	0	K(BL)	16.9		
7	7 BL-2 To CM	BL-2	q	132.0	1.61		L	8	C	120	Pt	60.9	Pt		k	5.6		
							F				Pe		Pv	11.00942	Q	256.7		
			Q	256.7			T	8	pf	1.814	Pf	14.5	Pn		K(BL)	16.9		
8	BL-2 CM To Feed Main		q	146.9	3.07	2-90 Deg Elbows	L	94.83	C	120.000	Pt	75.4	Pt		k	5.6		
							F	10			Pe		Pv	2.058923	Q	403.6		
			Q	403.6			T	104.83	pf	0.181	Pf	19.0	Pn	75.44148	K(BL)	16.9		
9	Feed Main To Base of Riser		q	164.3	3.07	1-90 deg Elbow	L	8	C=	120.000	Pt	94.4	Pt		k	5.6		
							F	5			Pe	5.2	Pv	4.077098	Q	567.9		Pe= 12*.433 = 5.2
			Q	567.9			T	13	pf	0.340	Pf	4.4	Pn		K(BL)	16.9		
			q				L		C=	120.000	Pt	104.0	Pt		k	5.6		

Figure 23: Hydraulic Calculation

Water Supply vs. Demand

Figure 24 below shows the on-site water supply from the city as well as the system demand. A performed flow test resulted in the recordings of a Static Pressure of 85 psi and a Residual Pressure of 65.5 psi with 1022 gpm flow rate. The city water supply also showed a flow rate of 1963 gpm at a pressure of 20 psi. With the determined values for the water demand, the city water supply is inadequate to meet the demand of the system. The CDC is planning on expanding the square-footage of the building in years to come. At that time, a fire pump would need to be installed in order to meet system demands. At this time, unknown as to why a fire pump has not been installed in the building. At full buildout, designs call for a fire flow rate of 4,000 gpm per IFC Table B105.1. For the fire flow demand with the fire sprinkler system, the flow rate is 2,000 gpm due to having a 50% reduction in the system. With these numbers, the flow test performed still did not meet the required 2,000 gpm that was attempted to be achieved even at a low city pressure of 20 psi.

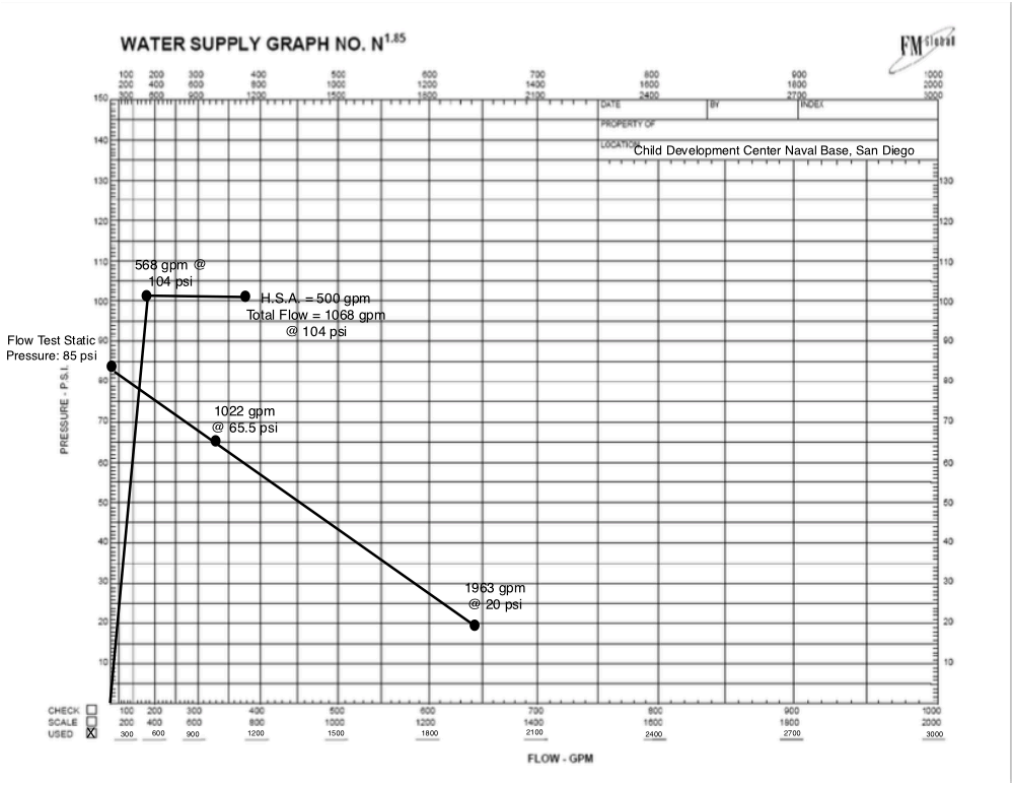


Figure 24: Water Demand vs. Supply

Inspection, Testing, and Maintenance of Building

This project building is equipped with a wet-pipe automatic sprinkler system. Inspection of the sprinkler system in order to determine if the piping system can still perform under required situations is vital. NFPA 25 directly relates to the Inspection, Testing, and Maintenance standards. The inspection of each hose connection must be done annually. The hangers, braces, and supports for the piping system must also be inspected annually along with the pipes and fittings. The entire sprinkler piping system for this building shall be visually inspected annually.

Valve supervisory signal devices and Waterflow alarms must be inspected quarterly. The pressure gages for the sprinkler system must be inspected and recorded annually. Each recorded pressure must me kept at the riser for at least one year until a new inspection is performed and recorded. According to NFPA 25 Table 5.1.1.2, the sprinklers in the building shall be tested at 50 years and then every ten years thereafter. All maintenance to keep the suppression system functioning properly must be performed annually. Control valves for this system must be inspected annually. A flow test of the system must be performed every 5 years and documented. For the Fire Hydrants servicing the building, visual inspections must be done annually and hydrant flow tests must also be performed annually as well as after each operation.

Throughout the building there are 3 heat detectors and 37 smoke detectors. Per NFPA 25, each of these detectors shall be visually inspected and tested monthly in order to determine proper functionality. A monthly inspection is required due to the possibility of debris build-up in each detector, causing possible malfunctions in case of a fire. The Ansul R-102 suppression system in the commercial kitchen must meet inspections requirements set in place by NFPA 25 as well. According to section 5.4.1.7, automatic spray nozzles that are being used to protect commercial-type cooking equipment and/or ventilation systems must be replaced annually. If a commercial kitchen is upgraded and a new stove system is being used, then a suppression system needs to be retrofitted/installed that meets the new requirements for the commercial use.

Water-Based Fire Suppression Summary

In conclusion, the building's water supply does not meet the system demand. With a building water supply lower tower than the demand, it is crucial to maintain the other aspects of the fire detection and notification system. If other parts of the fire detection and notification system are not maintained, serious injury and even death can occur from hazardous conditions. Inspection, testing, and maintenance is an important role in ensuring the system functions properly. The next topic to be covered in this report relates to the structural fire protection the building is equipped with.

Structural Fire Protection Requirements

Structural Fire Protection is a crucial role in any building construction. For the construction of the CDC, the International Building Code (IBC) was used. When referring to Section 508 of the IBC, each portion of a building must be individually classified according to Section 302.1 and comply with such provisions found in Sections 508.2, 508.3, and 508.4. Section 508.2 can be implemented for the kitchen and laundry room in this CDC building because both of these rooms are classified as accessory occupancies. Section 508.2 states that no separation is required between accessory occupancies.

The kitchen is a F-1 occupancy (commercial kitchen) and the laundry room is a "B" occupancy. Both the kitchen and the laundry room are accessory occupancies for this building. In section 509, it states that if a laundry room is found to be over 100 square-feet, then a one-hour fire separation or automatic fire sprinkler system is needed. The laundry room in this building is measured to be 167 square-feet. The door to the kitchen is a self-closing, 1-hour fire rated magnetized door. If a fire is detected, the door will automatically close in attempt to seal the fire off.

When referring to section 508.3 (Non-Separated Occupancies), the portions of the building should be individually classified with stated requirements. The IBC can be interpreted that the separation between both kitchens and laundry rooms with surrounding occupancies involving educational rooms, hallways, offices, ect… must be protected by a 1-hour fire rated wall or automatic suppression systems. For this building, both the kitchen and laundry room consist of a 1-hour fire rated wall surrounding them as well as an automatic fire suppression system.

Construction Type

In order to determine the required construction type of the building, Table 503 must be referred to. Table 503 defines this building as being able to fall under a V-B due to certain parameters: total area of building, height, and material that load- bearing beams are allowed to consist of. Section 506.3 allows increase in building area for approved automatic sprinkler systems that are being installed throughout the building. For a single story such as this building, the allowable increase is calculated out to be 300% of the original design area. Table 7 shows the allowable building area for the Child Development Center.

Table 7: Area of Allowable CDC Expansion

CDC	Area (sq-ft)
Original Area of Building	12,727
Maximum Building Increase Limit	38,181
Future Building Expansion Increase	8,300
Building Area at Full Build-out	21,027

Due to the surrounding distances to adjacent structures (>30 feet), no fire hour rating is required for the exterior walls. The outer construction walls are allowed to have many openings according to Table 705.8. Since this building is also an E occupancy, the corridors are equipped with full sprinklers so that the fire rating of the walls being one-hour is not required, but a 5/8' Gypsum wallboard is still utilized. The corridors were found to be 6' 6" wide. Due to this building having more than 100 occupants, then a redundancy of not requiring fire rated walls is met. If the walls were less than 5 feet wide, then 1-hour fire rated walls would be required.

Building Structure Details

The architects, engineers, and fire protection engineers determined that the CDC could be built under the Type V-B requirements. A reason as to why a Type V-B classification could be because of financial reasons. It is more expensive to have to build a structure with steel beams and apply a fire proofing material like SFRM. This building still contains a full sprinkler system though due to it having other classifications inside the building.

The foundation of the building consists of graded soil with a 4" slab pour consisting of reinforced concrete. The reinforced concrete consists of rebar with a 1" cover pour on top to conceal the rebar. The floors of the hallways and rooms are made up of a cove base with an epoxy smooth finish and vinyl bumpers along the edges of each wall.

The outside structure of the building consists of dual glazed window systems, steel tracks, and 5/8" Gypsum wallboard on the inside walls. The outside of the building consists of non-load bearing walls and has Sure board wall sheathing with a coat cement plaster finish for protection. The outside walls required 6" nominal steel studs spaced apart at 16" on center. The exterior doors and walls are not fire rated.

The outside roof is made from factory finished aluminum zinc alloy coated steel 24 Galvanized. The next layers of the roof are: ice and water shield membrane, metal decking, and 6" rigid insulation board. The trusses of the building are pre manufactured steel roof trusses. In some areas of the building, a drop down ceiling made from 1-hour fire rated Gypsum board is required. The inside walls consist of wood frames with 5/8" Gypsum wallboard on each side. One of the classrooms' walls is shared with the laundry room wall and has a 1-hour fire rating for that wall.

Code Compliance

After careful review of the elements and products that have gone into making the Child Daycare Center, both the structural and non-structural aspects have fallen into compliance with the IBC requirements for this type of building. The Gypsum wallboards, fire insulations, and sprinklers throughout the building provide for a safe environment for a daycare and school center. The building dealt with multiple types of code compliances and not only fell under Type V-B construction, but also consisted of occupancy E & I-4, making certain areas of the building interesting to think about if the fire ratings were adequate. All sprinklers (117 total) were found to be within code and there was proper distance and coverage among all.

Structural Summary

For this building, the construction cost objective was to be kept at a minimum. Even though cost played a crucial factor in the design, construction, and completion of this building, the lives of the children and employees were a higher priority. Due to this reason and others, only the suitable materials and applications were used to provide the highest level of safety. This document will now discuss the Fire Alarm Detection and Notification System used in the building. The next part of this report will cover a performance-based design, analyzing the components of the building and how the building performs in the event of a fire.

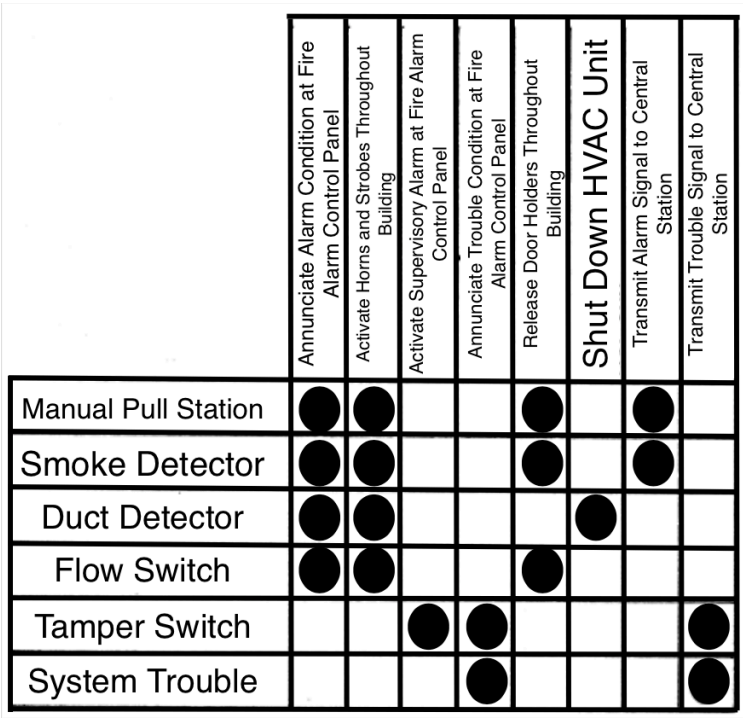
Fire Alarm Detection and Notification System

The Child Development Center (CDC) is a newly constructed building that conforms with the NFPA 101 Life Safety Code (2012 Edition) as well as NFPA 72 (2010 Edition). The Fire Alarm Control Panel (FACP) is linked to an on-base dispatch center, which dispatches necessary emergency services depending on the transmitted signal. The requirement of a remote-monitored dispatch center is a specification that can be found in NFPA 72 section 3.3.285.1, Central Station Service. This section states:

> The use of a system or a group of systems including the protected premises fire alarm system(s) in which the operations of circuits and de- vices are signaled to, recorded in, and supervised from a listed central station that has competent and experienced operators who, upon receipt of a signal, take such action as required by this Code. (NFPA 72-31 2013 Edition)

Types of Signals

The FACP installed in this building is the EST3X and provides the dispatch center 3 different types of signals which are alarm, supervisory, and trouble signals. The alarm signal transmits a warning of fire danger that require immediate action. Supervisory signal is related to an action that needs to be performed in connection with the operation of other fire protection systems that are being monitored by the fire alarm system. Trouble signals are a fault in a monitored circuit/component of the fire alarm system or an interference of the primary/secondary power supply. The operational matrix below (Figure 25) shows events that can occur and the outputs the FACP undergoes.



	Annunciate Alarm Condition at Fire Alarm Control Panel	Activate Horns and Strobes Throughout Building	Activate Supervisory Alarm at Fire Alarm Control Panel	Annunciate Trouble Condition at Fire Alarm Control Panel	Release Door Holders Throughout Building	Shut Down HVAC Unit	Transmit Alarm Signal to Central Station	Transmit Trouble Signal to Central Station
Manual Pull Station	●	●			●		●	
Smoke Detector	●	●			●		●	
Duct Detector	●	●				●		
Flow Switch	●	●			●			
Tamper Switch			●	●				●
System Trouble				●				●

Figure 25: Operational Matrix

Alarm Signaling and Notification Devices

There are various alarm signaling/notification devices located throughout the building. The devices installed in the building are listed below and can be found on the following pages including the location of the FACP (Figures 27 & 28). The devices are color coded on the drawings as follows:

- Red: Manual Pull Stations
- Pink: In-Ceiling Speakers
- Purple: Horns & Strobes
- Yellow: Emergency Light
- Blue: Photoelectric Smoke Detectors
- Orange: Heat Detector
- Green: Scrolling Text Bars

The EST3X FACP (Figure 26) has various programmable operating characteristics. The FACP can be programmed to hold up to 2 minutes of prerecorded messages. These messages can advise the building occupants of various dangers and help spread appropriate actions more efficiently.

Figure 26: FACP

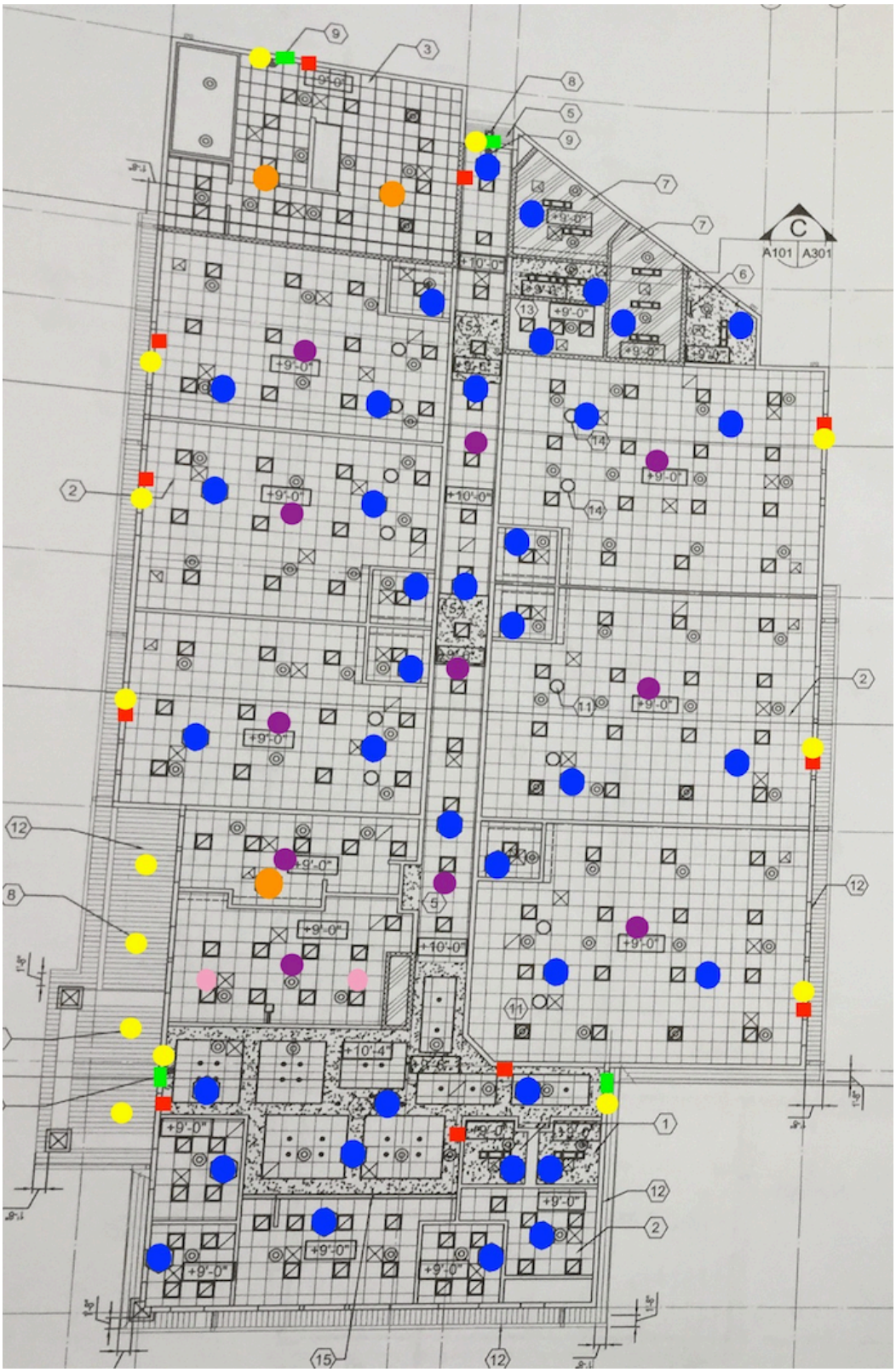


Figure 27: Location of Devices

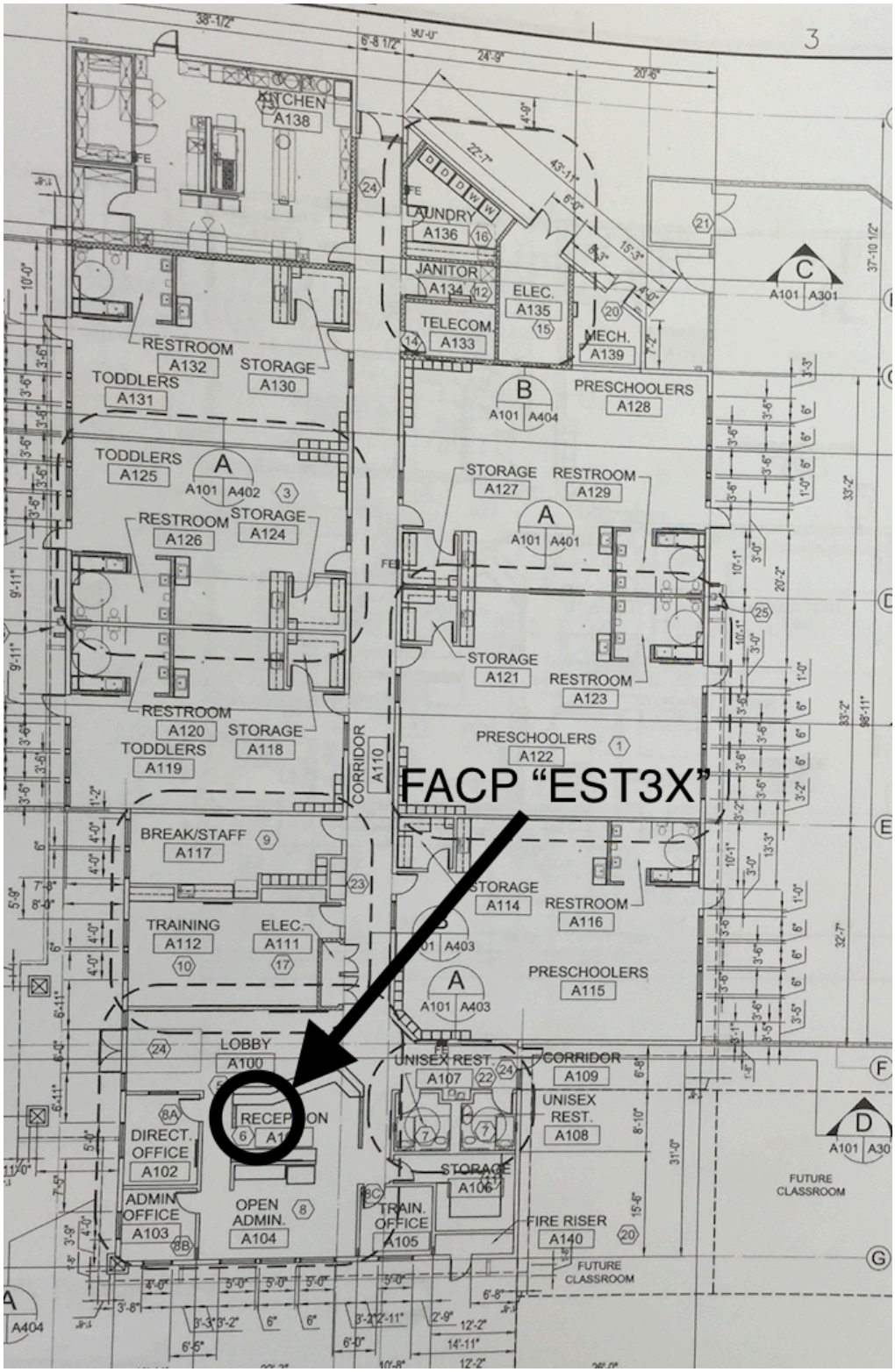


Figure 28: FACP

Mass Notification System

The building complies with NFPA 72 section 24.4.3.1.2, which discusses the requirements of a Mass Notification System. According to this section, an in-building mass notification system shall include one or more of the following components:

1.) Autonomous control unit (ACU)
2.) Local operating console (LOC)
3.) Fire alarm control interface
4.) Notification appliance network
5.) Initiating devices
6.) *Interface to other systems and alerting sources

Manual Pull Stations

The CDC contains 11 manual pull stations dispersed around the building next to exit doors. These pull stations are Edwards Signaling Double-Action fire alarm stations. According to NFPA 72 section 17.14.5, the manual pull stations shall not be less than 42 inches (1.07 meters) and not more than 48 inches (1.22 meters) from the finished floor. The manual pull stations (Figure 29) must also comply with NFPA 72 section 17.14.8.4 stating the the distance between an egress exit and a manual pull station must not exceed 5 feet (1.5 meters). The 11 manual pull stations in this building fall within NFPA 72 section 17.14.8.5 requirements stating manual fire alarm boxes shall be provided so that the travel distance to the nearest manual fire alarm box will not exceed 200 feet.

Figure 29: Manual Pull Station

Smoke Control

NFPA 101 section 9.3.4 addresses smoke control system operations. This section of the Life Safety Code discusses how floor dependent smoke control systems shall be automatically activated by sprinkler waterflow or smoke detection systems such as Photoelectric and Duct detectors both discussed more in detail next.

Photoelectric Smoke Detectors

NFPA 72 section 17.7.3.2.1 addresses the requirements for Photoelectric smoke detectors placed in buildings. This section states the smoke detectors shall be located on the ceiling or, if on a sidewall, between the ceiling and 12 inches down from the ceiling to the top of the detector. A total of 38 photoelectric smoke detectors are installed in the CDC, 3 in each classroom. Edwards Signaling SC30U series smoke detectors (Figure 30) are used in this building and are compliant with the EST3X FACP system.

Figure 30: Photoelectric Smoke Detector

Duct Detectors

Duct detectors (Figure 31) are installed in the Child Development Center. Per NFPA 72:

> **17.7.5.3.1** To prevent the recirculation of dangerous quantities of smoke, a detector approved for air duct use shall be installed on the supply side of air-handling systems as required by NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, and 17.7.5.4.2.1

These detectors are meant to monitor the air passing through the heating, ventilation, and air-conditioning (HVAC) systems in buildings and send signals to the FACP in the event of a possible hazard. A function of a duct detector is, once activated, a signal is sent to the FACP where the panel can determine the type of signal being transmitted. For smoke control, the HVAC system would be shut off to prevent smoke from being transported to unaffected areas of the building and subjecting occupants in remote areas to hazardous conditions.

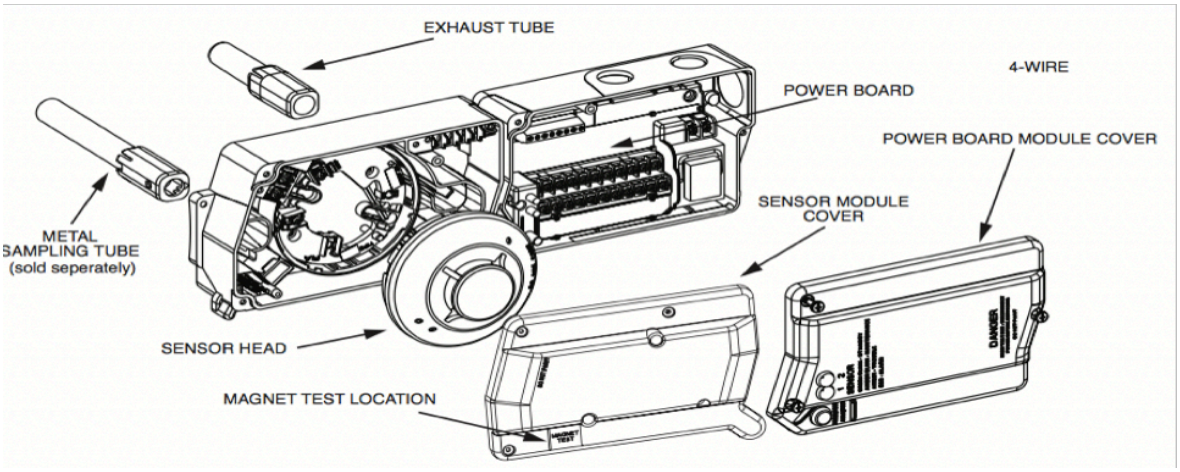


Figure 31: Standard Duct Detector

Ceiling/Wall Horns and Strobes

GE Genesis ceiling/wall horn and strobe devices (Figure 32) were used in the CDC, having a horn output volume of 99 dB peak. The pattern for the horn follows NFPA 72 and can be seen in Figure 18.4.2.1 below. The placement of these devices is one in each classroom and 3 along the hallway corridor spaced evenly apart and comply with the NFPA 72 section 18.4.8.1. This section states that the mounted devices shall have their tops above the finished floors at heights of not less than 90 inches, if height permits. The Horn and Strobe devices are installed within 15 feet from the end of the hallway and are spaced at a distanced less than 100 feet apart, therefore adhering to NFPA 72 requirements on visible notification appliances spacing.

The horn aspect of the GE Genesis device meets NFPA 72 requirements for sound levels. Hearing loss with occupants can occur at levels of 110 dB, the horn reaches a peak output of 110 dB. NFPA 72 lists the ambient sound level of an educational building at 45 dB (Table 8). With the horn notification system reaching sounds significantly higher than the ambient sound, the occupants should be able to successfully hear the alarms.

Table 8: NFPA 72 A.18.4.3 Average Ambient Sound Levels

Table A.18.4.3 Average Ambient Sound Level According to Location

Location	Average Ambient Sound Level (dBA)
Business occupancies	55
Educational occupancies	45

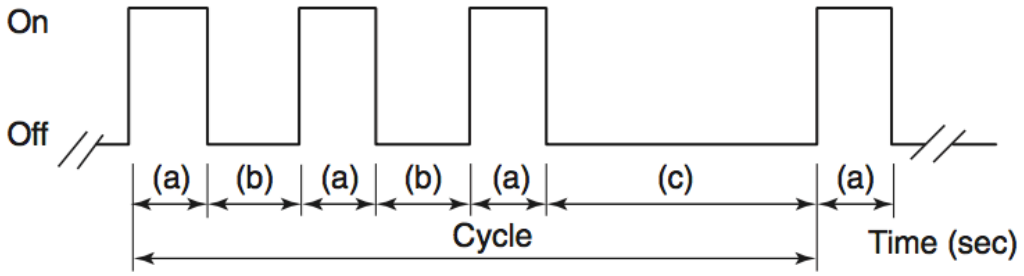
The visual strobe candela rating for the notification devices in each room contain 95-177 candela output. Table 9 below shows the requirements for visible light output for room sizes according to NFPA 72. For the two different classroom sizes, room dimensions of 40 feet x 40 feet and 50 x 50 feet were used. Since the candela rating of the installed strobes is 95-177 candela output, then the visual devices meet NFPA requirements.

Table 9: Room Spacing for Ceiling-Mounted Visible Appliances

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

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

Figure 32: Horn and Strobe



Key:
Phase (a) signal is on for 0.5 sec ±10%
Phase (b) signal is off for 0.5 sec ±10%
Phase (c) signal is off for 1.5 sec ±10% [(c) = (a) + 2(b)]
Total cycle lasts for 4 sec ±10%

FIGURE 18.4.2.1 Temporal Pattern Parameters.

Backup Power Supply

In the event of a power failure, the FACP must have a secondary form of power. NFPA 72 section 105.6.3.1 addresses the requirement as follows:

> 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.

Figure 33 on the following page shows the battery calculation performed on the CDC. The calculations incorporate the 24 hour stand-by time along with the alarm system operating for 5 minutes in active mode. A safety factor of 20% is included in the backup battery supply per NFPA section 10.5.6.3.1 (1). The FACP has a secondary power supply of 55 Amp-Hours. After performing all calculations, roughly 38 spare Amp-Hours are available. According to NFPA 72 section 10.14.1:

> Equipment shall be designed so that it is capable of performing its intended functions under the following conditions:
>
> - At 85 percent and at 110 percent of the nameplate primary (main) and secondary input voltage(s).

NFPA 72 section 10.14.1 means that the installed FACP and detection system should not exceed a manufactures maximum voltage drop in order to keep the system fully operational. Due to the inability to gain access to the type of AWG size used in the CDC and the total length of the wires used, voltage drop calculations were unable to be performed.

Child Development Center San Diego

	Qty	Description	Standby Current	Total Standby	Alarm Current	Total Alarm
Panel Equipment						
FACP	**1**	EST3X FACP	0.115000	0.115000	0.115000	0.115000
2	**38**	Photoelectric Smoke Detectors	0.000062	0.002356	0.100000	3.800000
3	**10**	Horn and Strobe Device	0.002000	0.020000	0.006000	0.060000
4	**4**	Scrolling Text Bar	0.050000	0.200000	0.100000	0.400000
5	**11**	Manual Pull Station	0.000300	0.003300	0.000300	0.003300
6	**3**	Heat Detector	0.000450	0.001350	0.000450	0.001350
7	**6**	Duct Detector	0.000300	0.001800	0.000000	0.000000
8	**1**	Water Flow Switch	0.000300	0.000300	0.000300	0.000300
9	**1**	Tamper Switch	0.000800	0.000800	0.005700	0.005700
10	**1**	Device Activation Current	0.200000	0.200000	0.200000	0.200000
11	**1**	Notification Circuit	0.000000	0.000000	1.210000	1.210000
		Control Panel Card Power	0.545		5.796	
		Power For External Peripheral Devices	0.00000		0.00000	
			0.545	<-- Sub Totals -->	5.796	
			0.000		0.000	
					0.000	
			0.545	**<--Grand Totals -->**	**5.796**	
			0.000		0.000	
		Standby Time = **24** Hrs	13.078	Standby Ah		
		Alarm Time = **5** Mins.	0.483	Alarm Ah		
		Standby + Alarm =	13.561			
		Minimum Battery Required per NFPA 72 2010	**16.273**	**20% Safety Margin**		
		Battery Provided	55			
		Spare Amp-Hours	**38.727**			

Figure 33: Battery Calculations

Inspection, Testing, and Maintenance

Throughout the building there are 3 heat detectors and 38 smoke detectors. Inspection, testing, and maintenance (ITM) of fire alarm systems and their devices are an important role in ensuring proper functionality of the alarm system year-round. Visual inspections of fire alarm notification and detection systems shall be performed in accordance with NFPA 72 Table 14.3.1. Waterflow Supervisory signal devices require a visual inspection most frequently; every 3 months. Smoke, Heat, Duct, and Manual Pull Stations shall be inspected every 6 months. These inspections are critical to ensure properly functioning devices in the event of a fire. A summarized list for ITM requirements of a Fire Detection and Notification system can found on Table 10 on the following page.

Table 10: ITM of Fire Alarm System

Component	Testing	Visual Inspection	Maintenance
All Equipment	Test Components in Accordance with NFPA 72 Table 14.4.3.1	Annually	Ensure no changes have been implemented that can inhibit alarm detection and notification system from functionally properly.
Control Equipment	Annually	Annually	Confirm normal system operation
Digital Alarm Communicator Transmitter	Annually	Annually	Confirm correct location and normal system condition
Batteries	Annually	Semi-annually	Inspect for corrosion and connectivity
Notification Appliance Circuit Power Extenders	Annually	Annually	Confirm normal operating status
Duct Smoke Detectors	Annually	Semi-annually	Confirm proper mounting, no openings near duct detector
Manual Pull Stations	Annually	Semi-annually	Confirm proper installation
Smoke Detectors	Annually	Semi-annually	Confirm proper installation and test the sensitivity. Activate alarm condition and check
Supervisory Signal Devices	Annually	Quarterly	Confirm proper installation.
Fire Alarm Control Panel (FACP)	Semi-annually	Semi-annually	Confirm location and good working condition
Audible Appliances	Annually	Semi-annually	Confirm proper working condition
Visible Appliances	Annually	Semi-annually	Confirm proper working condition and proper light output.

Fire Alarm Detection and Notification Summary

The FACP and detection devices located in the CDC comply with NFPA 72. The battery calculations were performed with a 20% safety margin to account for the secondary power supply losing charge over a period of time. Table 10 reiterates the importance of the ITM for this building to ensure adequate operational function. Overall, there is sufficient coverage (i.e. sound candela light, ect…) of the alarm notification and devices. The next part of this report will address a performance-based design scenario regarding a fire outbreak.

Performance-Based Analysis

The performance-based analysis for this report consists of determining if the fire protection systems would perform in a successful manner in the event of fire. The installed detection, notification, and suppression systems must operate properly to ensure adequate protection for life safety, as well as minimize damages caused by fires to the building. For this scenario, the Life Safety Code design fire scenario 3 will be used. This scenario can be found in LSC 2012 Edition Section 5.5.3.3 and states: "It is a fire that starts in a normally unoccupied room, potentially endangering a large number of occupants in a large room or other area" (101-42). This scenario is chosen due to the design fire propagating in the staff break room. At the time of ignition and the fire growing in size, it is assumed that there are no occupants present in the room. The absences of staff in the break room will allow for the fire detection and alarm system located in the break room to be the first level of response for notifying the occupants of danger. The desired end result of the simulation is to allow for safe egress of all building occupants before non-tenable conditions arise and inhibit the occupants from safe egress. Another design fire scenario that was considered but not implemented in this report was a fire outbreak in the kitchen. The kitchen walls are 1-hour fire rated barriers between the adjacent rooms. The reason for this scenario to not be incorporated is because the kitchen doors are required to be closed at all times due to the nature of the kitchen and keeping non-faculty occupants out of a more hazardous space in terms of slippery doors, hot grease, and sharp objects.

Tenability

Specified criteria is established to ensure safe egress of occupants in the event of a fire. These limits are set in order to minimize the exposure of heat and toxic gases to any occupant who is not directly impacted by the immediate hazardous environment. For this report, all tenability criteria (Table 11) must pass and untenable conditions must not descend to lower than a height of 6 feet above ground level.

Heat Exposure

Exposure to heat can be fatal. Referencing Table 2-6.20 of the SFPE Handbook, the tolerance time for the average person subjected to a heat of 100 degrees C is roughly 12 minutes. After this threshold, the person's body can lose all function. Radiation from fire can cause all stages of degree burns depending on the intensity the person is subjected to. For a fire less than 2.5 kW/m^2, the person can experience first degree burns and have a tolerance time of over 5 minutes. When the fire is 2.5 kW/ m^2, the tolerance time is 30 seconds. For a 10 kW/ m^2 intensity, the person has about a 4 second tolerance time and experiences severe incapacitation along with 2^{nd} degree burns. Fatal exposure and 3^{rd} degree burns start at 16.7 kW/ m^2 fires.

Visibility

Smoke control is of high concern trying to maintain tenable conditions. In the event of a fire, the Fire Alarm system would take over and shut down the HVAC system to prevent the smoke from being transferred to non-affected rooms. This helps keep the visibility level in the surrounding building from being impaired. Looking at Table 2-6.11 in the SFPE Handbook, behavior of people in smoke filled environments can be seen. In an unaffected visibility route, the average walking speed is 1.2 m/s whereas a reduced visibility (~2-3 meters) has a walking speed of 0.3 m/s. If a hallway/room that people attempt to escape through has a high smoke density, 30% of people turn back to where they came from rather than enter said area. According to the SFPE Handbook, people who are unfamiliar with the building layout and evacuation routes need a visibility of about 10-13 meters in order to properly evacuate the building. For the people who are familiar with the layout, they only need a visibility level of between 3-5 meters.

Toxic Gases

Exposure to toxic gases is of high concern when looking into building requirements. Carbon Monoxide is a dangerous, odorless chemical that attaches to the hemoglobin of the blood, preventing oxygen from being transported throughout the body. In the CDC, Carbon Monoxide is a dangerous chemical to have children exposed to. Early detection of CO before the symptoms of dizziness, nausea, vomiting is vital in allowing the children to be safely escorted out by the responsible teachers/adults. According to Carbon Monoxide Toxicity by Penney, the resting parts per million of CO in the bloodstream for adults is 2.6. Once levels start increasing about this number, adults will start to experience the effects of CO poisoning. Table 12 shows the tenability limits this report uses.

Table 11: SFPE Toxicity Limits

Fire	Rate of growth	CO_2/CO	Toxic hazard	Time to incapacitation	Escape time available
1. Smoldering/non-flaming: victim in room of origin or remote	Slow	~1	CO 0–1500 ppm low O_2 15–21 % irritants, smoke	Hours	Ample if alerted
2. Well ventilated Flaming: victim in room of origin	Rapid	1000 decreasing toward 50	CO 0–0.2 % CO_2 0–10 % low O_2 10–21 % irritants, heat, smoke	A few minutes	A few minutes
3. Small vitiated flaming: victim in room of origin or remote	Rapid, then slow	<10	CO 0.2–4 % CO_2 1–10 % O2 < 12 % HCN to 1000 ppm irritants, heat, smoke	A few minutes	A few minutes
4. Fully developed: (postflashover) victim remote	Rapid	<10	O2 0–3 % in upper layer flowing from fire CO 0–3 %[a] HCN 0–1000 ppm some irritants, smoke, and possibly heat	<1 min near fire, elsewhere depends on degree of smoke dilution	Escape may be impossible or time very restricted. More time at remote locations

The tenability limits found in Table 12 were chosen based on values found in the SFPE 5th Edition Handbook. A temperature of 80 ^{o}C was used because of two different pieces of data found in the SFPE Handbook. First, Dr. Purser stated that if a temperature rises above 120 ^{o}C, then 1st and 2nd degree burns are imminent. Secondly, C.J. Wieczork and N.A. Dembsey discovered that skin subjected to a heat of 74 ^{o}C can lose sensation and develop 2nd degree burns in a matter of seconds. Taking both pieces of data into consideration, a value of 80 ^{o}C was implemented into the performance-based design. For the visibility criteria, the visibility criteria for a person who is unfamiliar with a building is approximately 10 meters. The visibility criteria for people familiar with the building is between 3-5 meters. For this project, the worst case scenario is addressed and uses the criteria of 10-meter visibility for an unfamiliar person needing to have a safe egress time. A CO value of 1,500 ppm was used because of Table 10 above. A toxic hazard of CO ranges between 0-1,500 ppm for a smoldering fire with a victim being remote to the source. For the purpose of this design fire, the doors positioned on each side of the hallway to all classrooms are assumed to be closed. Another assumption is no staff members are present in the break room or the immediate surrounding area outside the break room.

Table 12: Tenability Limits

CDC Tenability	Limits
Temperature	80 ^{o}C
Visibility	10 m
Carbon Monoxide	1,500 ppm

Design Fire

The design fire for this report will assume worst case scenario. This means the heat detector located inside the break room fails, causing a delay in the detection system. All other notification and suppression systems will be assumed to function properly. The fire scenario involves a closed and unoccupied room and assumes worst case scenario. All heat and toxic gases are assumed to spread down the main hallway towards the classrooms.

Room Components & Characteristics

The staff break room (as seen in Figure 36) contains a polyurethane couch, several chairs, two wood tables, and one plastic table. The Heat Release Rate used in this scenario is 3000 kW and grows as an ultra-fast t^2 fire. Figures 34 & 35 are HRR for a Coffee Pot and Upholstered furniture (respectively). A Carbon Monoxide yield was found in the SFPE Handbook 5th edition Table A.40 as 0.04 g/g and a soot yield for polyurethane was found in Table A.39 in the SFPE Handbook giving a value of 0.01 g/g. The characteristics of the inputs will be discussed next in the Fire Dynamics Simulation Model.

Fig. 26.25 HRR of coffee makers

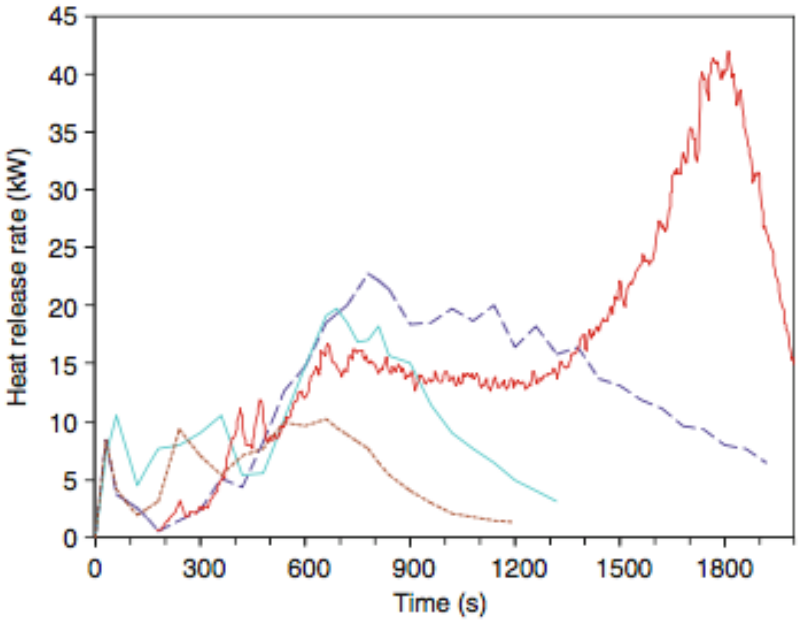


Figure 34: HRR of Coffee Pots

Fig. 26.114 HRR of several upholstered furniture items tested at NIST

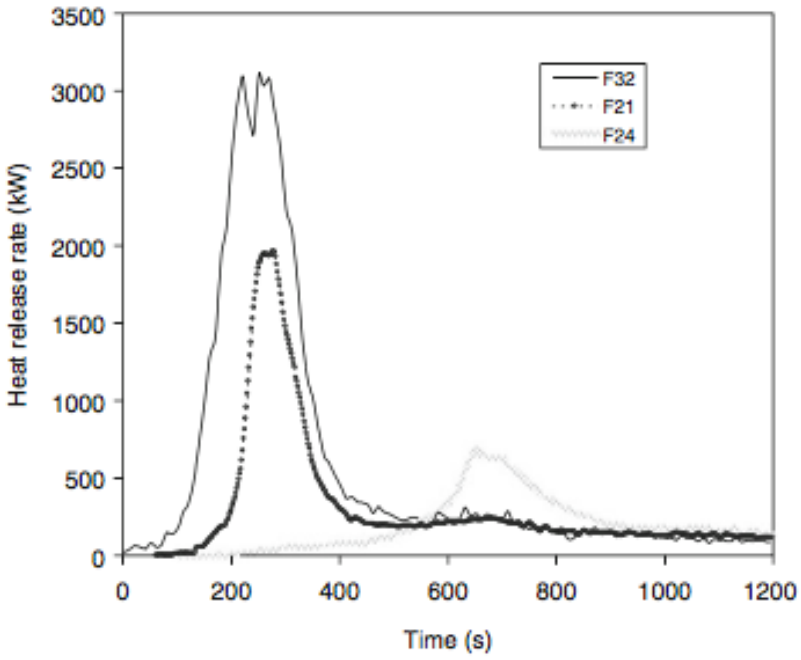


Figure 35: HRR of Furniture

Figure 36: Staff Break Room

Fire Dynamics Simulator (FDS)

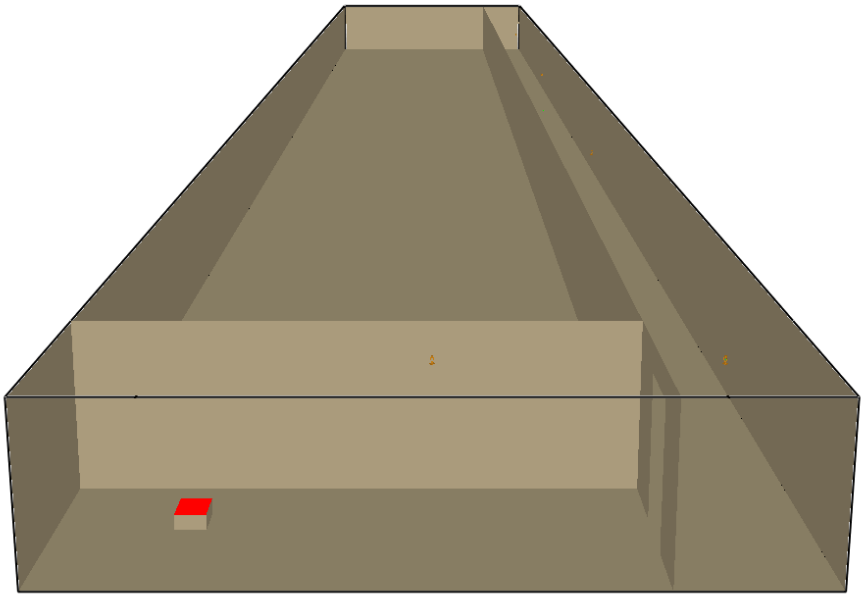


Figure 37: Layout of Fire Model

The FDS model of the staff break room (area with red square located inside) and the main hallway (long narrow stretch on the right side) can be seen in Figure 37. Each of the walls were specified as Marinite Wall Board with a thickness of 0.025 meters. In order to visualize when the fire detection system and notification system activates, sprinklers were placed throughout the model. The activation temperature of the sprinklers in the model was set to 57 ^{o}C and consisted of an RTI of 40 $(m\text{-}s)^{1/2}$ for Quick-Response. There are 5 of these sprinklers total and they are placed as follows: 1 in the center ceiling of the break room and 4 spaced at a distance of 3.64 meters (12 feet) apart from each other. The sprinkler in the staff break room activates at a time of $t \approx 139$ seconds.

Tenability

The temperature and CO levels passed but the smoke layer descended to a height lower than 1.2 meters (6 feet) at 177 seconds. The upper gas layer did not reach the critical value of 80 ^{o}C at a height less that 6 feet from the ground level throughout the hallway of the CDC. Figure 39 shows final upper layer gas temperature after egress time has passed. Figure 40 shows the visibility violation for the hallway and Figure 41 shows that CO toxicity levels throughout the hallway remain less than 1,500 ppm.

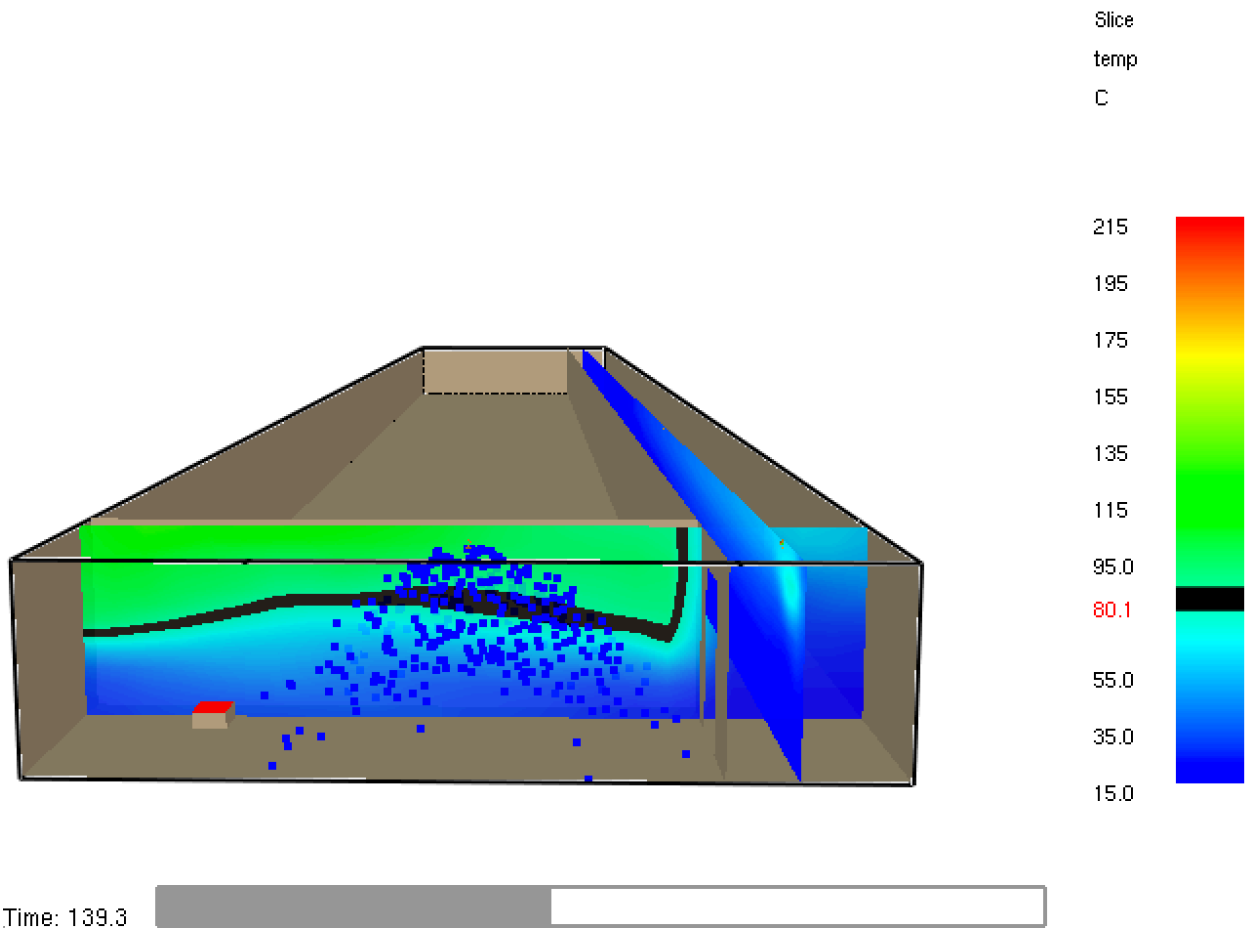


Figure 38: Initial Alarm Activation & Temperature of Upper Gas Layer

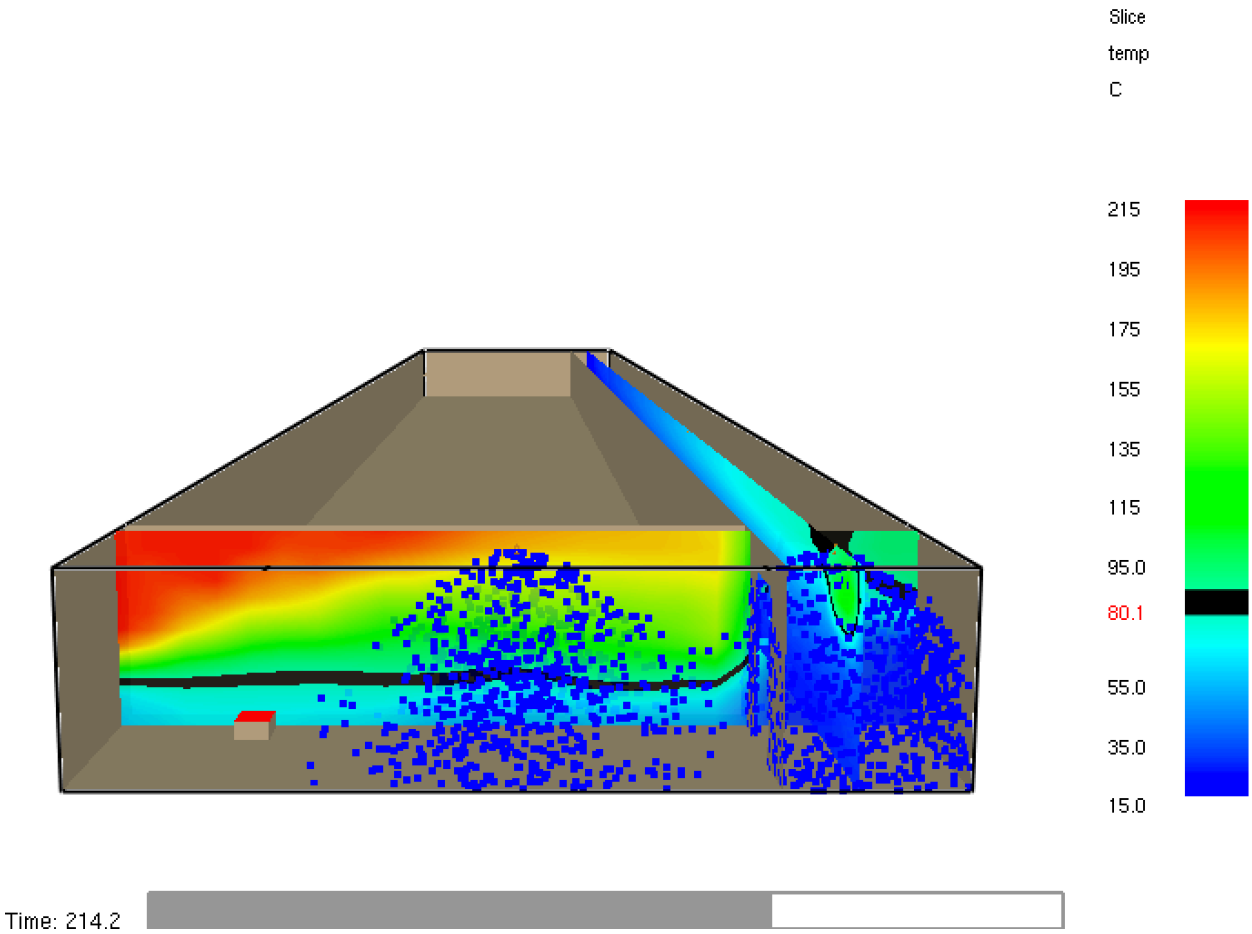


Figure 39: Temperature of Upper Gas Layer After Elapsed Egress Time

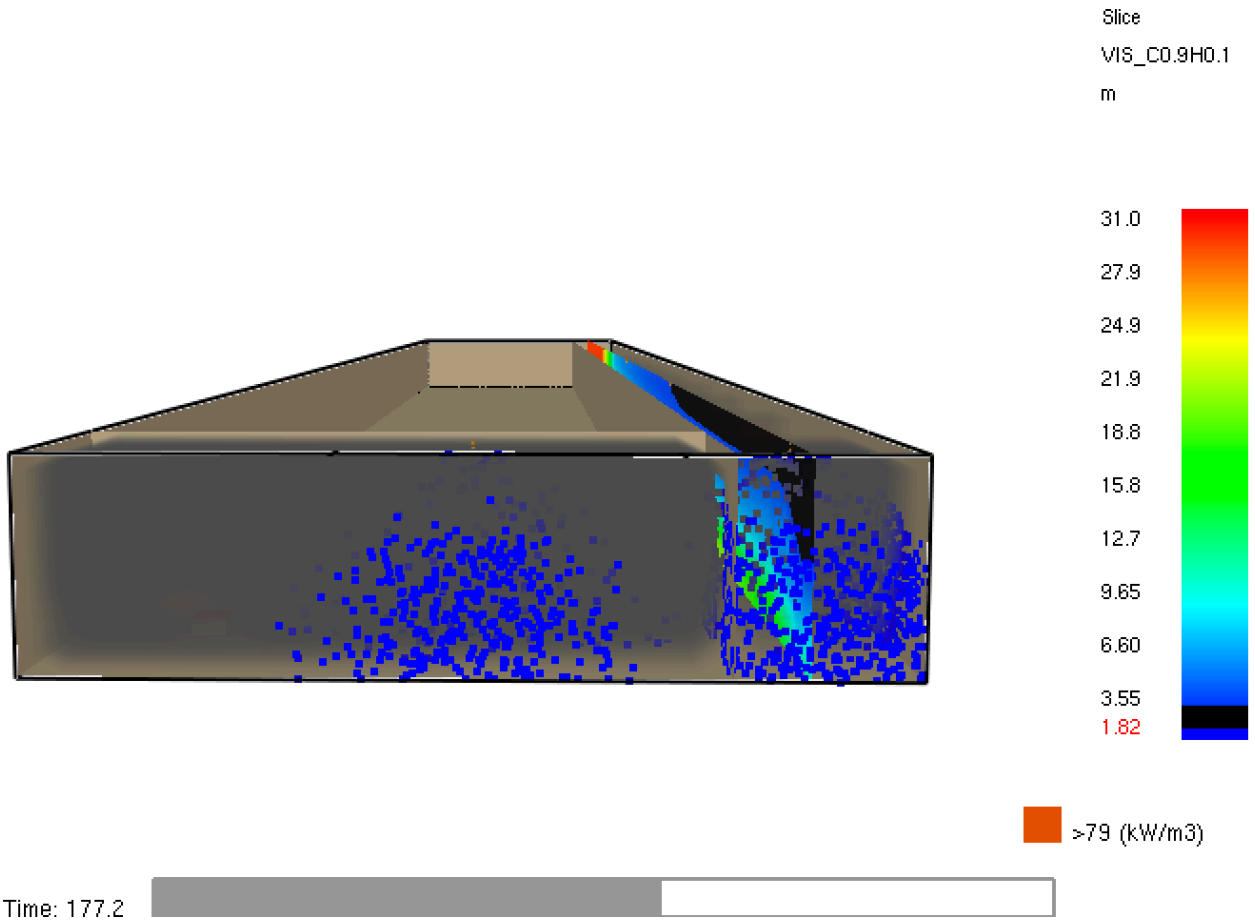


Figure 40: Visibility Violation at 177 seconds

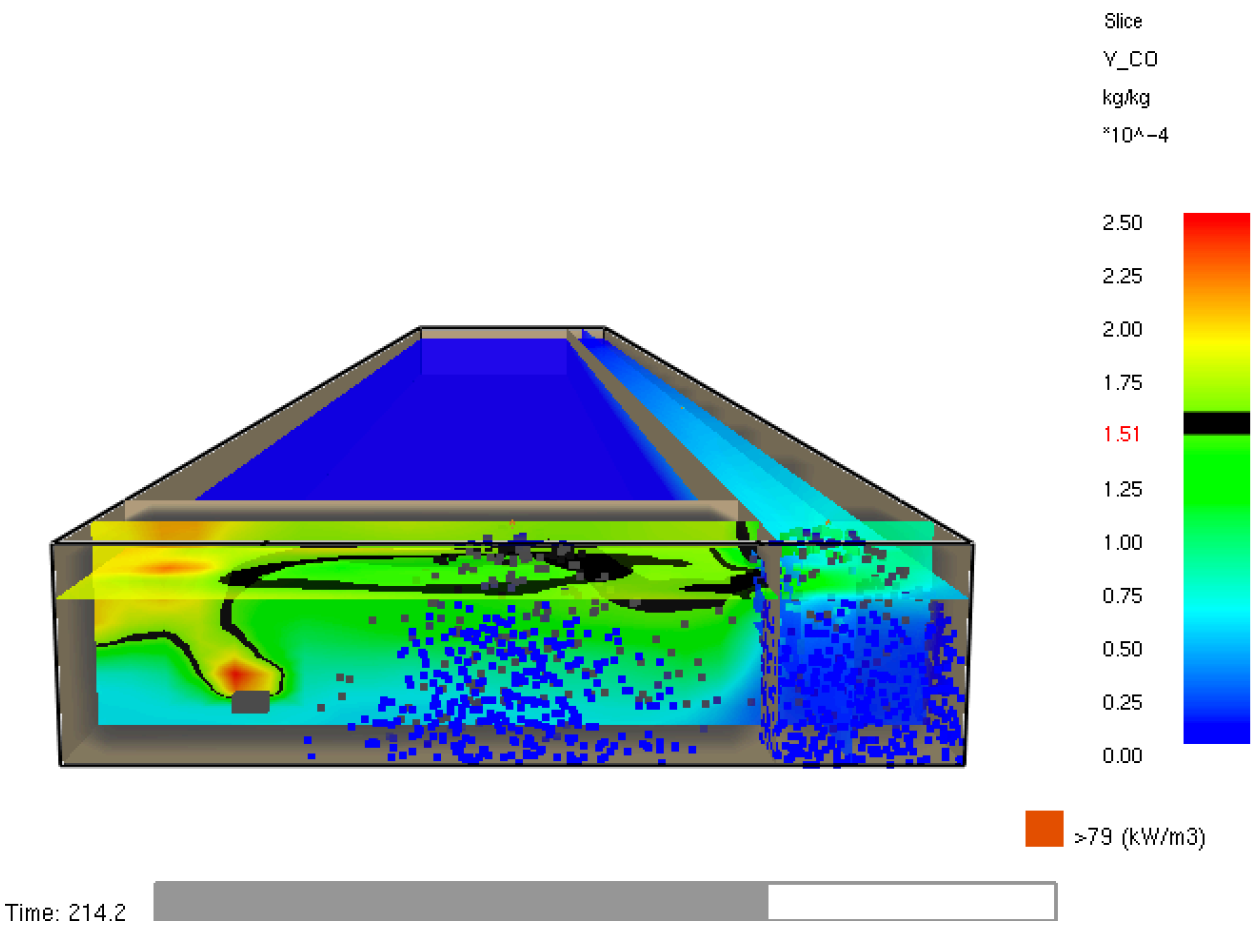


Figure 41: CO Toxicity Levels

RSET & ASET Comparison

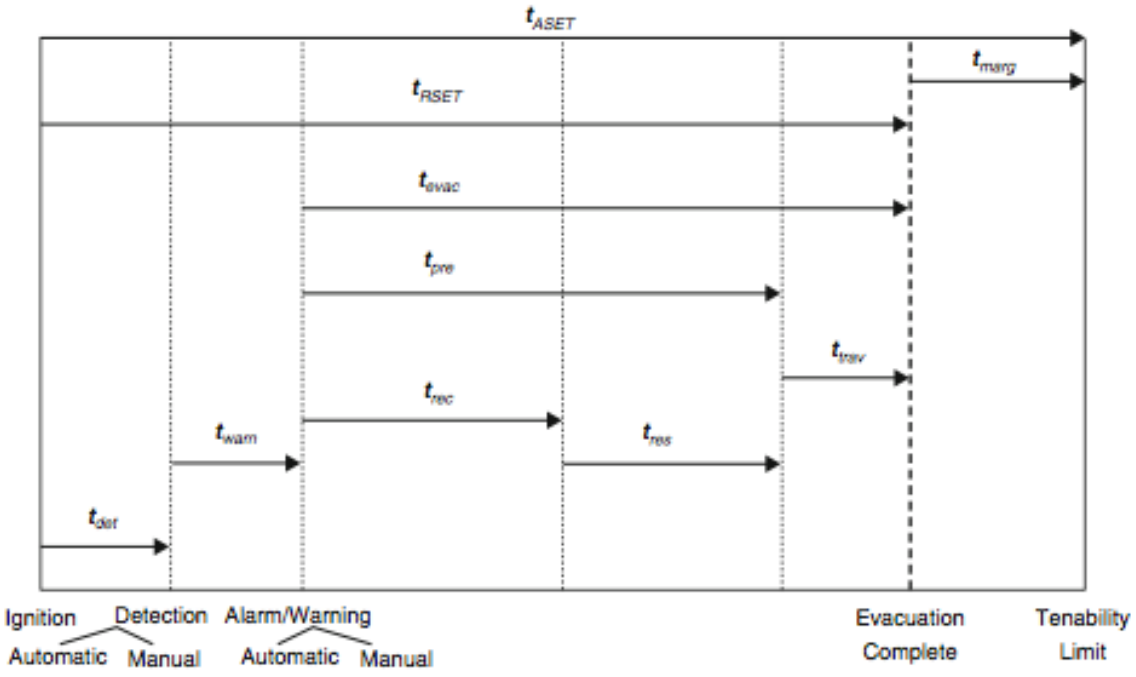


Fig. 64.2 Engineering timeline

Figure 42: SFPE 5th Edition RSET Table

ASET must be greater than RSET in order to ensure safe egress time for building occupants. Assuming initial detection of the fire is by the fire detection system and not a staff member, the time to detection is 139 seconds. There is a 10 second warning time to allow for the fire detection and notification system to relay the message to the occupants and then for the occupants to interpret the broadcasted signal. The pre-movement time is 14 seconds ("head count") and movement time is about 78 seconds. The summation of these values yields an RSET of 241 seconds.

$$RSET = t_{detection} + t_{warning} + t_{premovement} + t_{evacuation}$$

$$RSET = 139 \text{ seconds} + 10 \text{ seconds} + 14 \text{ seconds} + 78 \text{ seconds}$$

$$RSET \approx 241 \text{ seconds}$$

The RSET value was calculated to be: 241 seconds. The first tenability criteria failed directly outside the staff break room door at 177 seconds when the smoke layer in the hallway dropped below 1.2 meters (6 feet). This means RSET > ASET, meaning the scenario fails.

When comparing results to the last two documented CDC egress times for April and March, the time from alarm notification to time of safe egress completion was documented at 60 seconds. This means as soon as the fire alarm was put into active mode, the occupants immediately started the safe egress process. Using the CDC documented egress time of 60 seconds, the RSET is calculated as follows:

$$RSET = t_{detection} + t_{warning} + t_{premovement} + t_{evacuation}$$

$$RSET = 139 \text{ seconds} + 0 \text{ seconds} + 0 \text{ seconds} + 60 \text{ seconds}$$

$$RSET \approx 200 \text{ seconds}$$

When comparing this reported RSET time to the ASET time of 177 seconds, the result is:

$$RSET > ASET \text{ ; } \underline{\text{fails}}$$

DETACT

DETACT is used as another form of modeling in order to determine detector activation in a fire scenario. The software uses Alpert's equations on the flow of the ceiling jet. By using Alpert's equations and a fire growth rate specified by the user, the activation time of a fixed temperature heat detector can be determined. Table 13 on the following page shows the inputs incorporated into the DETACT excel spreadsheet. Utilizing DETACT software for the design fire discussed in this performance-based scenario, the time of heat detector activation was determined. When referencing Table 13 on the next page, using a heat detector RTI of 5 $(m\text{-}s)^{1/2}$ and an actuation temperature of 41.1 ^{o}C, the detection time for the heat detector was improved to 63 seconds. The inputs in Table 13 are to determine the room height, detector distance from fire, and fire characteristics pertaining to the design fire. The heat detector is modeled at activating when reaching a specified temperature of 41.1 ^{o}C. The new computed time until detection yields an RSET value as follows:

$$RSET = t_{detection} + t_{warning} + t_{premovement} + t_{evacuation}$$

$$RSET = 63 \text{ seconds} + 10 \text{ seconds} + 14 \text{ seconds} + 78 \text{ seconds}$$

$$RSET \approx 165 \text{ seconds}$$

$$\text{Safety Factor: } 1.5 \text{ x } RSET$$

$$RSET = (165 \text{ seconds}) \text{ x } 1.5$$

$$RSET = 247 \text{ seconds}$$

When comparing this RSET value to ASET time of 177 seconds, the result is:

$$RSET > ASET \text{ ; } \underline{\text{fails}}$$

DETACT Summary

According to DETACT calculations, the fire detection, notification, and suppression system will still not allow for ASET > RSET when incorporating a safety factor. If the reliability of the heat detectors degrades, then tenability could be compromised even more. The graph in Figure 43 shows the gas temperature in green and the heat detector temperature in red.
The red and green line graphs in Figure 43 stay close to one other because the change in detector temperature remains close to the change in gas layer temperature, meaning the closer the lines are together, the more responsive the detector is. A small gap value between the gas temperature and heat detector is because the RTI value of the heat detector is set a value close to zero. Table 13 shows at time step 63 seconds, the HRR of the fire is 186 kW with a gas layer temperature of roughly 45.4 ^{o}C.

Table 13: DETACT

INPUT PARAMETERS			CALC. PARAMETERS	
Ceiling height (H)	2.42	m	R/H	1.825
Radial distance (R)	4.4	m	dT(cj)/dT(pl)	0.201
Ambient temperature (To)	20	C	u(cj)/u(pl)	0.121
Actuation temperature (Td)	41.1	C	Rep. t2 coeff.	k
Response time index (RTI)	5	(m-s)1/2	Slow	0.003
Fire growth power (n)	2	-	Medium	0.012
Fire growth coefficient (k)	0.0469	kW/s^n	Fast	0.047
Time step (dt)	1	s	Ultrafast	0.400

Calculation time (s)	HRR	Gas temp	Gas velocity	Det temp	dT/dt
0	0.0	20.0	0.00	20.00	0.0000
1	0.0	20.1	0.03	20.00	0.0037
2	0.2	20.3	0.05	20.00	0.0114
3	0.4	20.4	0.07	20.02	0.0220
4	0.8	20.6	0.08	20.04	0.0347
5	1.2	20.9	0.10	20.07	0.0489
59	163.3	43.2	0.49	39.50	0.5263
60	168.8	43.8	0.50	40.02	0.5293
61	174.5	44.3	0.50	40.55	0.5323
62	180.3	44.8	0.51	41.08	0.5352
63	186.1	45.4	0.52	41.62	0.5381
64	192.1	45.9	0.52	42.16	0.5410

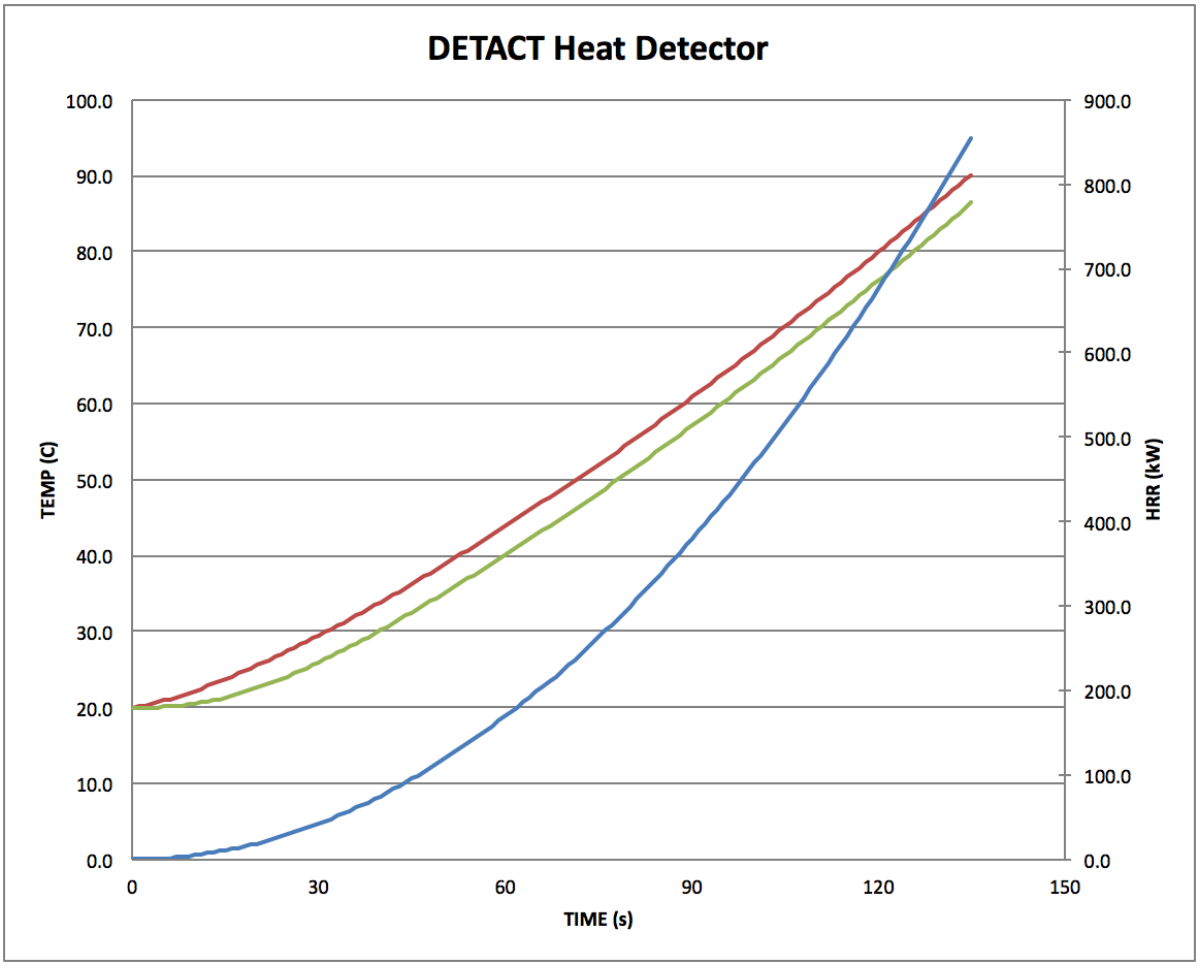


Figure 43: DETACT Graph

Conclusion

The contents of this report discuss the Life Safety features and fire protection design of the Child Development Center. The topics covered are water-based suppression, fire detection and alarm, egress characteristics, and structural fire protection. The water-based suppression system meets the requirements for the most remote area calculations but the overall flow rate for the water suppression system is below the desired 2,000 gpm. To correct this issue, a fire pump should be considered when the building undergoes a multiple classroom expansion phase (which is desired in the future). The egress system of the building meets code requirements with regards to common path of travel distances, number of exits, exit door widths, and illuminated exit signs. This building is a construction Type VB with an overall Occupancy Type E and is compliant with the IBC 2012 edition for structural fire protection requirements. A performance-based analysis was conducted in order to determine the functionality of the fire protection systems installed within the building as well as addressing key Life Safety Code requirements. The performance-based scenario was a polyurethane fire outbreak in the staff break room. A model of this fire was constructed in FDS and the egress time for the occupants was modeled in Pathfinder. The required safe egress time (RSET) was determined to be 241 seconds. The tenability criteria of the smoke layer to remain 6 feet above the ground level was violated outside the break room door (surrounding hallway) at 177 seconds. The other tenability requirements involving temperature and CO levels passed. The door to the staff break room is designed to be self closing. In the event the door is fixed in the open position, smoke containment in the break room isn't feasible and will spread to adjacent building areas. Considering the teachers do not fix the classroom doors in the open position, there is sufficient safe egress time for the classrooms. If there are students and/or teachers in the hallway during a fire outbreak in the break room, then RSET > ASET. Using documented data from the CDC on the most recent fire drill egress time, the RSET value is 200 seconds, which is greater than the ASET time of 177 seconds. Again, the performance-based design in FDS was based on a worst-case scenario and assumes failure of the heat detector located in the break room. If the heat detector functions properly in the event of the fire modeled in this report, the RSET time will yield a value of 247 seconds (including a 1.5x safety factor). Incorporating times determined in Pathfinder and DETACT, the values calculated still show RSET (247 seconds) > ASET (177 seconds).

Recommendation

In order to help ensure safe egress from the building in case of a fire, a recommendation would be to require teachers to not allow door stops that keep the classroom doors open to the hallway, or require the staff break room door to not be left in the open position. Incorporating the policy of not allowing doors to be fixed in the "open" position would help decrease the smoke and heat being transferred throughout the main hallways and towards the classrooms. Another recommendation would be to install a fire pump during the building expansion phase that is desired in the future to ensure the fire suppression water flow demand is met.

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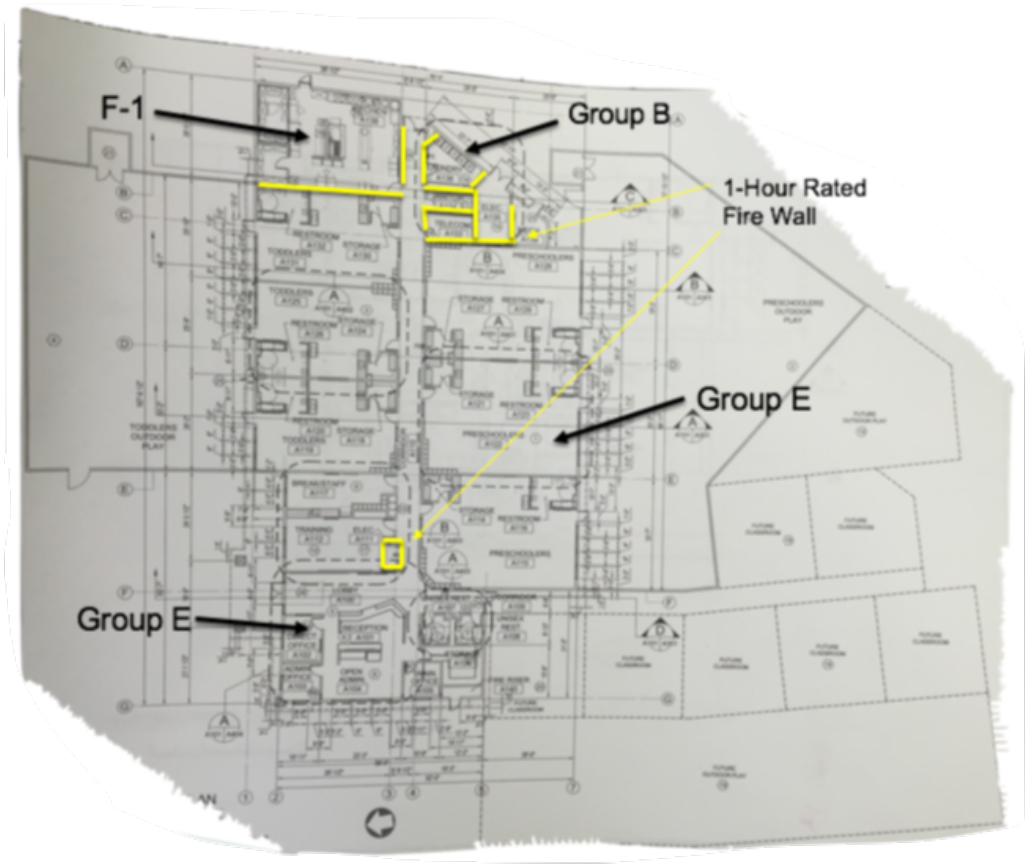
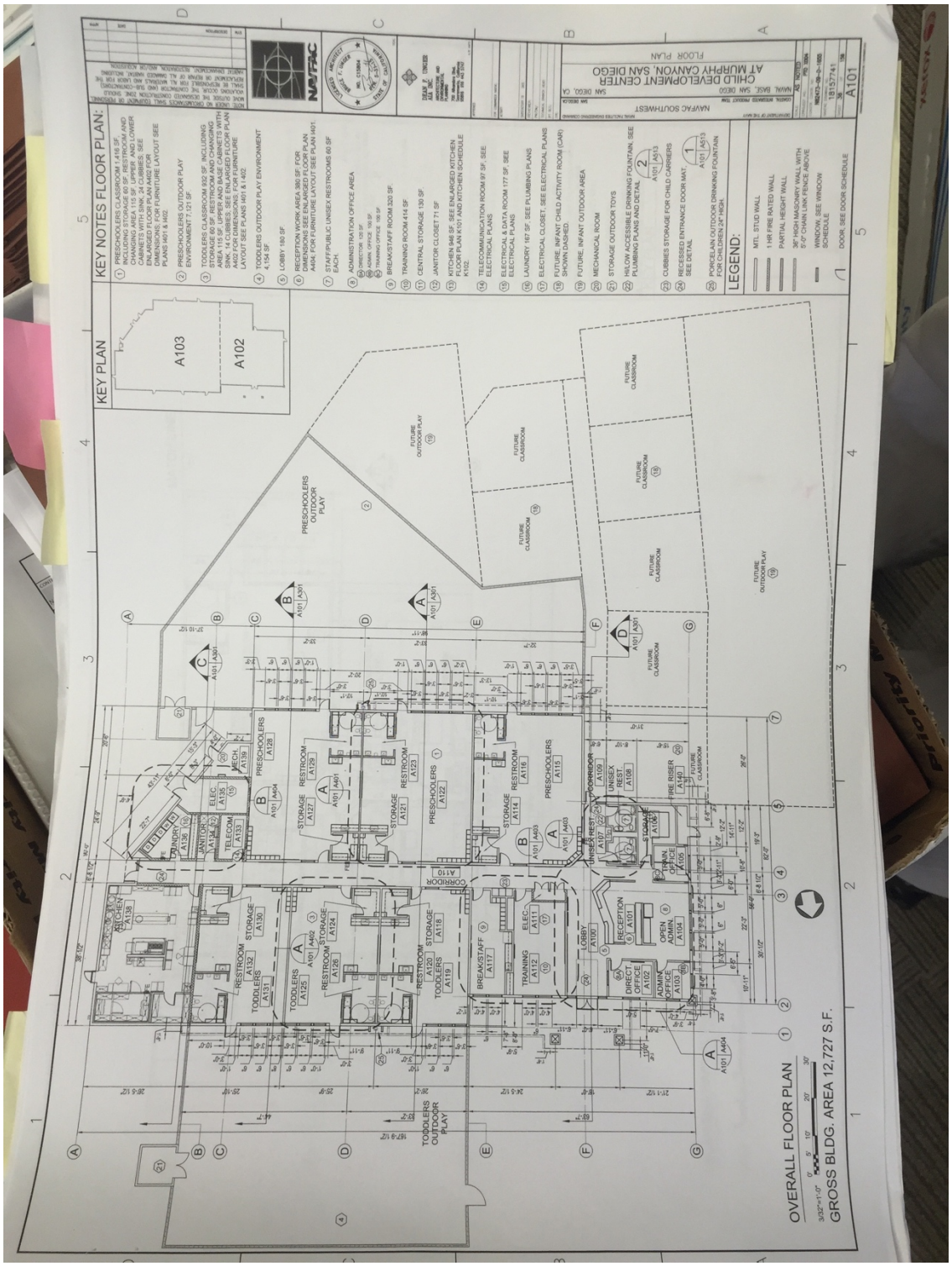
<www.koverholt.com>

Appendix

Occupancy Layout



Overall Floor Plan



EST™
Life Safety & Communications

EST3X Life Safety Control System

Description

EST3X represents the latest generation of life safety control panels for mid to large sized applications. With large multi-message displays and innovative controls, intuitive interfaces, and bold colored cabinets — these systems capture the imagination, and catch the eye. But behind the LCD display is where they really shine.

New microprocessors and chipsets take full advantage of the latest advances in computing technology, leading to smarter, faster, higher-capacity processing and more efficient designs. EST3X's patented Voltage Boost™ technology, for example, delivers consistent voltage – even at low battery power – resulting in lighter cable requirements and/or longer runs. That saves time and money.

High performance processing also leads to powerful networking features and versatile digital audio functionality. The wide range of EST3X configurations include standalone operation, networking with up to 64 nodes, or integration with an EST3 network comprising as many as 64 nodes — complete with EST3-Sixty mass notification capabilities and display of security events.

EST3X sets a new standard in front-panel life safety control interfaces. Its exclusive SpeedTouch™ rotary control offers nimble forward and back scrolling through events and options, while a mere tap of the control selects items with an unprecedented fluidity of motion. Its extra-large backlit display reveals up to eight concurrent messages, and switch/LED strips provide ample space for meaningful custom labels. And for end users, large tactile control buttons instill confidence and promote quick response when time is of the essence.

Standard Features

- Up to six intelligent analog loops hosting as many as 1,500 Signature Series devices per panel
- Optional integrated eight-channel digital audio
- 10 amp power supply with universal 94 to 264 Vac input voltage
- Patented Voltage Boost™ technology delivers consistent voltage — even at low battery power
- Four built-in 3-amp notification/auxiliary circuits
- Large 24-line by 40-character backlit LCD
- Simplified operation with the SpeedTouch™ rotary control
- 65 amp hour battery charger
- 64-node network nodes using copper and/or fiber
- Supports up to 30 R-Series remote annunciators
- Removable terminals on all low voltage wiring
- Space for up to three additional option cards such as extra SLC loops, amplifiers, or dialer/modem
- Optional Ethernet interface
- 1,100 event history log

Application

Application flexibility is where EST3X's leading edge computing power is put to best use. This generation of control panels is equally at home as the center of a simple single-building standalone system as it is when part of a sophisticated life safety network serving thousands of points across multiple buildings. Optional voice evacuation bridges the gap left by other mid-range systems, and makes these panels a cost-effective solution for most applications.

Strong Networking

Networking is among EST3X's strong suits. Highly efficient RS485 connectivity, plus fiber-optic communications deliver faster response times and more sophisticated diagnostic capabilities, while cost-effective remote annunciation solutions keep basic monitoring and control always within reach.

A simple EST3X network can comprise up to 64 nodes – enough to serve the needs of most campuses and larger buildings. Its ability to join an EST3 network with as many as 64 nodes extends EST3X's reach into mass notification applications, security reporting, as well as making it an ideal candidate for retrofits.

High Capacity Audio

An optional paging microphone provides local, as well as remote, audio functions.

EST3X features a full eight channels of integrated digital audio with up to two minutes of on-board programmable message storage. An optional high quality paging microphone gives live access to local, as well as remote, audio functions. Auxiliary inputs are available for mass notification operations, and ZA Series amplifiers may be mounted directly on the EST3X rail assembly.

Seamless System Integration

EST3X borrows much from it's larger sibling, the venerable EST3 Life Safety Platform. And for good reason: by integrating with the EST3 networking and computing environment, an EST3X control panel can serve as a cost-effective remote node for extinguishing, smoke control, or even mass notification functions — all within the same compliance framework.

Retrofits and expansions benefit enormously from this arrangement, but programming and equipment management for new installations is equally efficient as a result of these shared resources. EST3X will accommodate up to three EST3 modules on its own rail assembly, giving it access to such proven EST3 successes as zoned amplifiers, conventional device circuits, modem communicators, and RS-485 functions. Meanwhile, installers familiar with EST3 configuration will find that the two systems share many of the same programming and diagnostic conventions.

Local and Remote Annunciation

Up to 30 R-Series annunciators may be configured for each node on the EST3X network.

Up to 30 R-Series LCD, LED annunciators and driver interface cards may be configured for each node on the EST3X network. No additional nodes are required for annunciation purposes. In addition, EST3X supports EST3 network annunciators, while GCI and GCIX driver interface cards provide cost-effective graphic annunciation solutions. And all annunciator inputs and outputs are easily programmable through the rules and labels function of EST3X's Software Definition Utility.

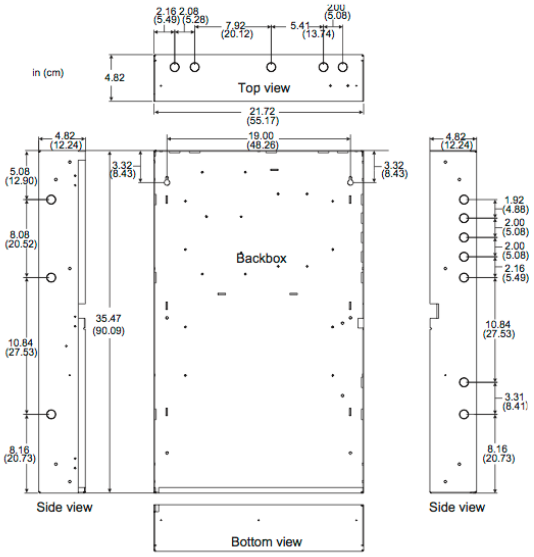
Power to Count On

Edwards' patented Voltage Boost™ technology delivers a consistent 22.5 Vdc – even at low battery power. This means lighter gauge cable can be used for equivalent distances compared with conventional power supplies, or longer wire runs on the same gauge cable. Either way, this breakthrough technology saves time and equipment costs, making EST3X not only a high-performance solution — but a cost-effective one as well.

EST3X's four on-board Notification Appliance Circuits are fully synchronized to UL 1971 standards — without the need for external modules or other electronics. It's ample 10-amp power supply is finely tuned to get the most out of Edwards' widely-acclaimed low profile Genesis notification appliances.

Dimensions

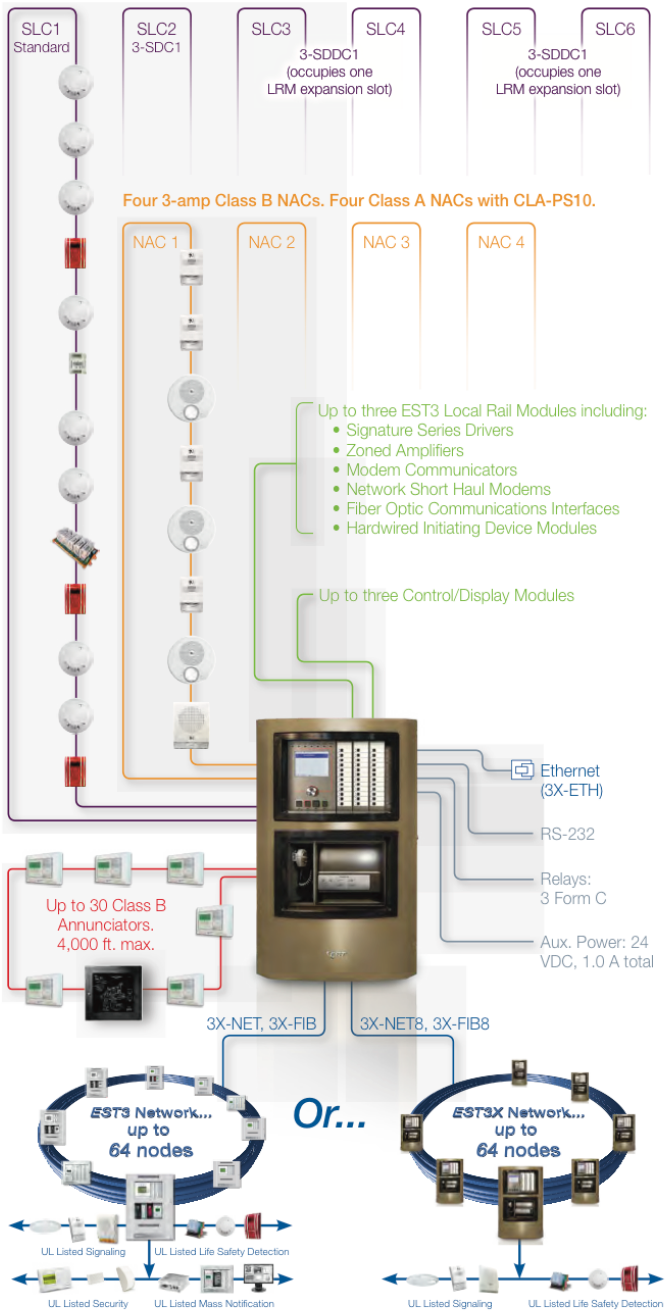
The backbox is designed for semiflush or surface mounting. Conduit and nail knockouts, keyhole style mounting holes, and wide wiring troughs facilitate efficiency during installation.



Note: Add 0.25 in (0.64 cm). to height and width dimensions to allow for knockouts when framing in the backbox for semiflush mounting.

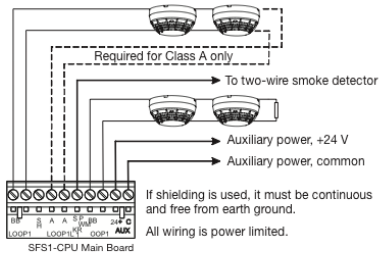
System Layout

Up to six intelligent analog loops hosting as many as 250 devices each.

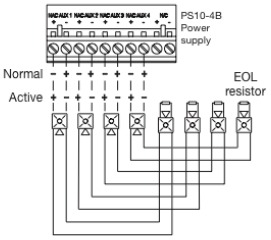


Wiring

Signature (initiating) Data Circuit



Notification Appliance Circuits



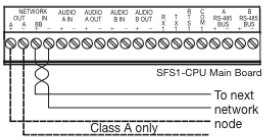
Wiring is supervised and power limited.

TB2 terminal marking indicates signal polarity when the circuit is not active. Polarity reverses when the circuit is active.

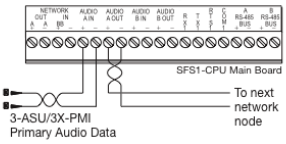
For proper circuit supervision, break the wire run at each notification appliance and install the EOL resistor at the end of the circuit.

Do not loop wires around notification appliance terminals.

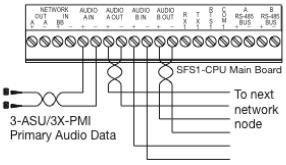
Network data circuit



Network data circuit, Class B audio

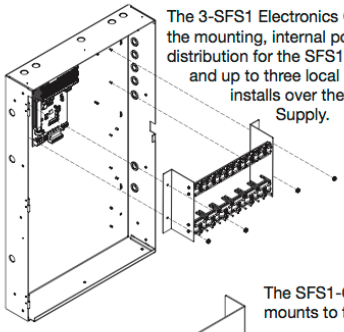


Network data circuit, Class A audio

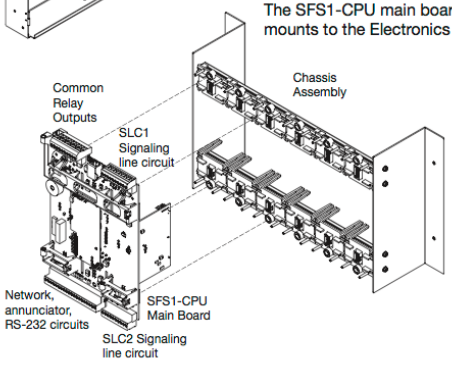


Main Component Assembly

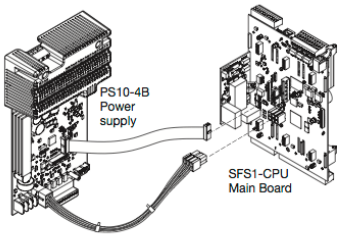
EST3X systems are designed for quick assembly and easy access in the field. Components are modular and require no special tools to service or replace.



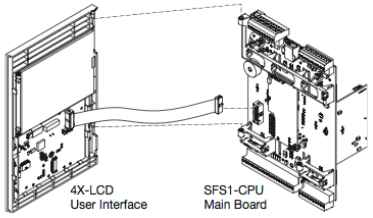
The 3-SFS1 Electronics Chassis provides the mounting, internal power, and data distribution for the SFS1-CPU main board and up to three local rail modules. It installs over the PS10-4B Power Supply.



The SFS1-CPU main board mounts to the Electronics Chassis.

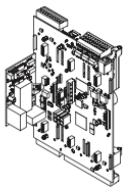


Two cables connect the PS10-4B Power Supply to the back of the SFS1-CPU main board.



The 4X-LCD assembly mounts to hinge pins on the CPU and connects with a single ribbon cable.

SFS1-CPU Main Board



The SFS1-CPU main board processes all information from modules installed within the cabinet as well as data received from other panels over the network data riser. When a network card is installed, the CPU employs a command set to determine its type.

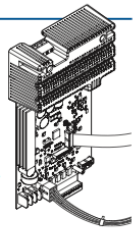
SFS1-CPU Specifications

Voltage	24 VDC
Current	
Standby	115 mA at 24 VDC
Alarm	115 mA at 24 VDC
Relay outputs	
Quantity	3 (alarm, supervisory, and trouble)
UL type	Common
Contact arrangement	Form C
Rating	30 VDC at 1 A
AUX power outputs	
Quantity	2
Voltage	24 VDC, resettable or continuous
Current	1.0 A each circuit, 1.0 A total
Data network (RS-485)	
Nodes	2 to 64 (requires optional network card)
Performance class	Class A or Class B
Wire type	Twisted pair, 6 twists per foot, min.
Circuit length	5,000 ft. (1,524 m) between any three panels
Circuit resistance	90 Ω, max.
Circuit capacitance	0.3 µF, max.
Serial Port (RS-232)	
Circuit length	20 ft. (6 m) max.
Circuit resistance	13 Ω, max.
Circuit capacitance	0.7 µF, max.
Annunciator port (RS-485)	
Performance class	Class B and Redundant Class B
Baud rate	9600 and 38400
Wire type	Twisted pair, 6 twists per foot, min.
Circuit length	4,000 ft. (1,219 m)
Circuit resistance	90 Ω, max.
Circuit capacitance	0.3 µF, max.
Signaling line circuit	
Quantity	2 (second SLC requires optional 3-SDC1 card)
Performance class	Class A or Class B
Circuit capacity	125 detectors, 125 single address modules
Circuit resistance	100 Ω, max.
Circuit capacitance	0.5 µF, max.
Wire size	18 to 12 AWG (0.75 mm² to 2.50 mm²)
Ground fault impedance	10 kΩ
Operating environment	
Temperature	32 to 120°F (0 to 49°C)
Relative humidity	0 to 93% noncondensing

Notes

- For battery calculations, standby and alarm currents include all listed primary power supplies.
- The common trouble relay operation does not include AC trouble delay functionality and cannot be used for reporting troubles off premises per UL 864 9th edition.

PS10-4B Power Supply Card



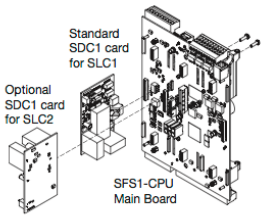
The PS10-4B Power Supply Card provides the required power and related supervision functions for the control panel, as well as filtered, regulated power to the rail chassis modules. It also provides 24 VDC for operating ancillary equipment.

PS10-4B Specifications

Mains voltage	94 to 264 VAC, 50/60 Hz
AC Input Current	
Standby	1.5 amps
Alarm	3.0 amps
Brownout level	93 VRMS
Battery charging capacity	65 Ah max.
Total Power Supply Ratings	Voltage 24vdc Current 10 amps (UL), 9.0amps (ULC)
Notification appliance/Auxiliary power circuits	
UL rating	
Quantity	4
Circuit configuration	Class B[1]
Output voltage	Special: 24 Vdc Regulated: 24 Vdc
Output current	Special: 3 amps Regulated: 1.5 amps
EOLR	15 kΩ (UL P/N EOL-15, ULC P/N EOL-P1)
Wiring	
Mains input[2]	Supervised, non power-limited
Battery input	Supervised, non power-limited
NAC outputs	Supervised, power-limited
Wire size	18 to 12 AWG (0.75 mm² to 2.50 mm²)
Ground fault impedance	10 kΩ
Operating environment	
Temperature	32 to 120 °F (0 to 49 °C)
Relative humidity	0 to 93% noncondensing

[1]Class A when a CLA-PS10 Class A adapter card is installed.
[2]Connect the mains supply using a dedicated branch.

3-SDC1 Signature Data Circuit Card



Each 3-SDC1 Signature Data Circuit Card provides one Class A or Class B signaling line circuit (SLC1) that supports up to 125 Signature Series detectors and 125 Signature Series module addresses. These modules also provide connection for powering conventional two-wire smoke detector circuits on Signature Series modules.

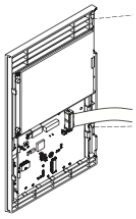
EST3X comes standard with one 3-SDC1 card installed as SLC1. An optional second 3-SDC1 card may be installed to provide SLC2, thus doubling system signaling line capacity.

3-SDC1 Specifications

Voltage	24 VDC
Operating Current	
Standby	3-SSDC1 144 mA; 3-SDDC1 264 mA
Alarm	3-SSDC1 204 mA; 3-SDDC1 336 mA
Smoke power	19.95 VDC max.[1]
Circuit	
Configuration	Class B, Style 4, DCLB; Class A, Style 6, DCLA
Capacity	125 Signature Series detectors and 125 Signature Series modules per SLC
Resistance	100 Ω with 250 devices
Capacitance	0.5 µF max.
Wire size	12 AWG (1.5 mm²) max.
Termination	Removable plug-in terminal strips on the SFS1-CPU main board and Signature module
Operating environment	
Temperature	32 to 120 °F (0 to 49 °C)
Relative humidity	0 to 93% noncondensing

[1]For special applications, refer to EST3 ULI/ULC Compatibility Lists (P/N 3100427)

4X-LCD User Interface

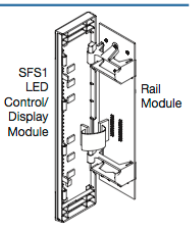


Included in the EST3X basic package, the 4X-LCD provides the user interface for the EST3X system. It connects to the SFS1-CPU main board with a ribbon cable, and attaches to the CPU via hinges. Only one display module is required to provide a point of control for the entire network. Additional displays can be added to any EST3X panel in the network to provide additional points of control.

4X-LCD Specifications

Operating current	
Standby	38 mA
Alarm	50 mA
LCD display	Backlit liquid crystal display 240 x 320 pixels 24 lines of 40 characters
Operating environment	
Temperature	32 to 120 °F (0 to 49 °C)
Relative humidity	0 to 93% noncondensing

SFS1 LED Control/ Display Module

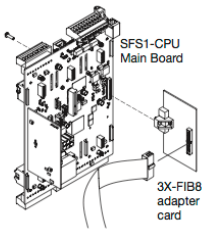


The SFS1 LED Control/Display Module provides additional operator interface capability for the SFS1 system. It can be mounted on any of the three right-most local rail modules on the 3-SFS1 electronics chassis. Inserts are provided for labeling switches and LEDs.

SFS1 Specifications

Voltage	24 VDC
Operating current	
Standby	2.0 mA plus 1.5 mA for each active LED
Alarm	2.0 mA plus 1.5 mA for each active LED
Operating environment	
Temperature	32 to 120 °F (0 to 49 °C)
Relative humidity	0 to 93% noncondensing

3X-FIB fiber optic network module



The 3X-FIB fiber optic network module gives an EST3X panel the ability to network 64 or more EST3X panels, or interface with an EST3 network. Both Class A and Class B connections are supported. The module consists of the adapter card and electronics card.

The 3X-FIB supports the following fiber optic transceivers:

Model	Description
SMXLO2	Standard output single mode fiber optic transceiver
SMXHI2	High output single mode fiber optic transceiver
MMXVR	Standard output multimode fiber optic transceiver

The 3X-FIB provides terminals for connecting a 24 VDC backup power source to maintain data transmissions in the event the panel is powered down.

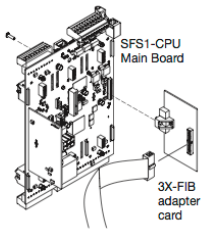
Note: All networked panels must have the 3X-FIB network card installed.

3X-FIB Specifications

Voltage		19.2 to 27.6 VDC (24 VDC nominal)
Fiber optics network and audio		
Budget		
	SMXLO2	15 dBm between two interfaces
	SMXHI2	25 dBm max. and 8 dBm min. 10 dBm between two interfaces
	MMXVR	50/125, 62.5/125, or 100/140 for MMXVR
Cable type		
Connectors		50/125, 62.5/125, or 100/140 for
	SMXLO2, SMXHI2	Type Duplex SC
	MMXVR	Type ST
Network data circuit		
Circuit configuration		Class B (style 4) or Class A (style 7)
Data rate		19.2 K, 38.4 kbps
Isolation		Isolated from previous panel CPU when using copper. Total isolation when using fiber optics.
Digitized audio data circuit		
Circuit configuration		Class B (style 4) or Class A (style 7)
Data rate		327 kbps
Isolation		Isolated from previous panel CPU when using copper. Total isolation when using fiber optics.
Copper wired network data circuit segment		
Circuit		
Length		5,000 ft. (1,524 m) max. between any three panels
Resistance		90 Ω max.
Capacitance		0.3 µF max.[1]
Wire type		Twisted Pair, 18 AWG (0.75 mm²) min.
Operating environment		
Temperature		32 to 120 °F (0 to 49 °C)
Relative humidity		0 to 93% noncondensing

[1]Include shield capacitance, if shielding is used.

3X-FIB8 fiber optic network module



The 3X-FIB8 fiber optic network module gives an EST3X panel the ability to network up to eight other EST3X nodes. Both Class A and Class B connections are supported. The module consists of the adapter card and electronics card.

The 3-FIB8 supports the following fiber optic transceivers:

Model	Description
SMXLO2	Standard output single mode fiber optic transceiver
SMXHI2	High output single mode fiber optic transceiver
MMXVR	Standard output multimode fiber optic transceiver

The 3X-FIB8 provides terminals for connecting a 24 VDC backup power source to maintain data transmissions in the event the panel is powered down.

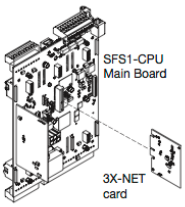
Note: All networked panels must have the 3X-FIB8 network card installed.

3X-FIB8 Specifications

Voltage		19.2 to 27.6 VDC (24 VDC nominal)
Fiber optics network and audio		
Budget		
	SMXLO2	15 dBm between two interfaces
	SMXHI2	25 dBm max. and 8 dBm min. 10 dBm between two interfaces
	MMXVR	50/125, 62.5/125, or 100/140 for MMXVR
Cable type		
Connectors		50/125, 62.5/125, or 100/140 for
	SMXLO2, SMXHI2	Type Duplex SC
	MMXVR	Type ST
Network data circuit		
Circuit configuration		Class B (style 4) or Class A (style 7)
Data rate		19.2 K, 38.4 kbps
Isolation		Isolated from previous panel CPU when using copper. Total isolation when using fiber optics.
Digitized audio data circuit		
Circuit configuration		Class B (style 4) or Class A (style 7)
Data rate		327 kbps
Isolation		Isolated from previous panel CPU when using copper. Total isolation when using fiber optics.
Copper wired network data circuit segment		
Circuit		
Length		5,000 ft. (1,524 m) max. between any three panels
Resistance		90 Ω max.
Capacitance		0.3 µF max.[1]
Wire type		Twisted Pair, 18 AWG (0.75 mm²) min.
Operating environment		
Temperature		32 to 120 °F (0 to 49 °C)
Relative humidity		0 to 93% noncondensing

[1]Include shield capacitance, if shielding is used.

3X-NET Network Adapter Card



The 3X-NET network adapter card gives an SFS1-CPU main board the ability to network up to 64 nodes on an EST3 network. The card supports Class B and Class A wiring.

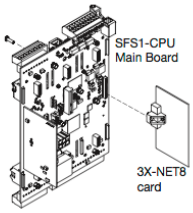
The 3X-NET adapter card provides two independent RS 485 circuits: one for network data communications and one for digital audio communications.

3X-NET Specifications

Voltage	24 VDC
Operating Current	
Standby	98 mA at 24 VDC
Alarm	98 mA at 24 VDC
Circuit configuration	
Network data	Class A, Style 6 & Class B, Style 4
Network audio	Class A, Style 6 & Class B, Style 4
Isolation	
Network data	Network A port not isolated; Network B port isolated
Network audio	Audio A IN and Audio B IN isolated Audio A OUT and Audio B OUT not isolated
Wire size	Twisted pair[1] 18 AWG (0.75 mm) min.
Circuit length	5,000 ft. (1,524 m) between any three panels
Circuit resistance	90 Ω max.
Circuit capacitance	Data: 0.3 µF max.; Audio 0.09 µF max.
Operating environment	
Temperature	32 to 120 °F (0 to 49 °C)
Relative humidity	0 to 93% noncondensing

[1]Six twists per foot minimum

3X-NET8 network card



The 3X-NET8 RS-485 network card gives an SFS1-CPU main board the ability to network through dedicated copper wire up to eight EST3X control panels. The card supports Class B and Class A wiring.

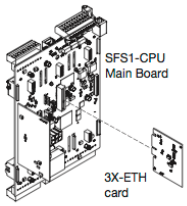
Note: All networked panels must have a 3X-NET8 network card installed.

3X-NET8 Specifications

Voltage	24 VDC
Operating Current	
Standby	98 mA at 24 VDC
Alarm	98 mA at 24 VDC
Circuit configuration	
Network data	Class A, Style 6 & Class B, Style 4
Isolation	
Network data	Network A port not isolated, Network B port isolated
Wire size	Twisted pair[1] 18 AWG (0.75 mm) min.
Circuit length	5,000 ft. (1,524 m) between any three panels
Circuit resistance	90 Ω max.
Circuit capacitance	0.3 µF max.
Operating environment	
Temperature	32 to 120 °F (0 to 49 °C)
Relative humidity	0 to 93% noncondensing

[1] Six twists per foot min.

3X-ETH1 Ethernet Adapter Card



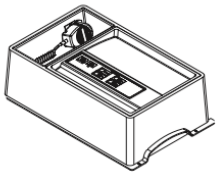
The 3X-ETH1 adapter card provides a standard 10/100 Base-T Ethernet network connection for panel programming, diagnostics, and status monitoring. Four LEDs on the adapter card indicate card and network status.

3X-ETH1 Specifications

Ethernet	10/100 Base-T
Voltage	24 VDC
Operating current	
Standby	44 mA at 24 VDC (54 mA when connected to an active Ethernet connection)
Alarm	44 mA at 24 VDC
Connection mode	Auto negotiation
Copper wired network data circuit segment	
Circuit	
Length	5,000 ft. (1,524 m) max. between any three panels
Resistance	90 Ω max.
Capacitance	0.3 µF max.[1]
Wire type	Twisted Pair, 18 AWG (0.75 mm²) min.
Copper wired audio data circuit	
Circuit	
Length	5,000 ft. (1,524 m) max. between any 3 panels
Resistance	90 Ω max.
Capacitance	0.09 µF, max[1]
Wire type	Twisted pair, 18 AWG (0.75 sq²) min.
Wire runs	
Distance	200 ft. (60 m) max.[1]
Type	Cat 5
Connector	RJ-45
Operating environment	
Temperature	32 to 120 °F (0 to 49 °C)
Relative humidity	0 to 93% noncondensing

[1]Panel to communication equipment

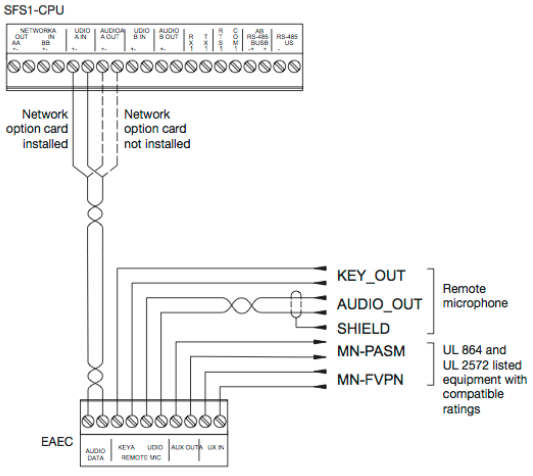
3X-PMI Paging Microphone Interface



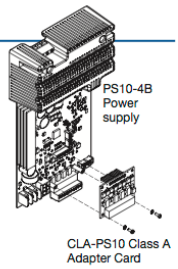
The 3X-PMI Paging Microphone Interface provides controls for emergency voice/alarm communications. It consists of an **audio mounting bracket, EAEC Emergency Audio Evacuation Controller card, audio enclosure, and paging microphone.**

3X-PMI Paging Microphone Interface Specifications

Voltage	
Current	24 VDC
Standby	15.5 mA
Alarm	16.6 mA
Ground fault impedance	10 kΩ
Wire size	18 to 12 AWG (0.75 to 2.50 mm²)
Audio channels	8 simultaneous
Audio inputs	
Local microphone	Isolated and supervised
Remote microphone	Isolated and supervised
Remote audio	Isolated and supervised
EAEC communication	See the EAEC Emergency Audio Evacuation Control Installation Sheet (P/N 3101789)
Messages	
Storage	2 min. total
Length	39 sec. max.
Controls and indicators	
Common	
Paging Volume	Indicates relative signal strength during active page
Ready To Page	Flashes during preannouncement tone, steady when ready to page
Paging Microphone	
All Call	Activates/deactivates page to all areas
All Call Minus	Activates/deactivates page to areas not receiving EVAC or Alert message
Page To Evac	Activates/deactivates page to areas currently receiving the EVAC message
Page To Alert	Activates/deactivates page to areas currently receiving the Alert message
Operating environment	
Temperature	32 to 120°F (0 to 49°C)
Relative humidity	0 to 93% noncondensing



CLA-PS10 Class A Adapter Card



The CLA-PS10 Class A Adapter Card is an optional card used to convert the four Class B notification appliance/auxiliary power circuits on the power supply card to Class A.

CLA-PS10 Specifications

Voltage	24 VDC
Notification appliance/Auxiliary power circuits	
UL rating	Special application or Regulated
Quantity	4
Performance class	Class A
Output current	Special 3.0 A; Regulated: 1.5 A each circuit
EOLR	15 kΩ (UL P/N EOL-15, ULC P/N EOL-P1)
Wiring	Supervised, power-limited
Wire size	18 to 12 AWG (0.75 mm² to 2.50 mm²)
Operating environment	
Temperature	32 to 120 °F (0 to 49 °C)
Relative humidity	0 to 93% noncondensing

Ordering Information

Intelligent Analog Control Panels			
Model	**Door Color**	**Language**	**Description**
3X-SFS1B	Bronze	English	FACP, complete system with user interface, CPU, one loop with second loop expansion, three option card slots, four Class B NAC, universal 110/220v 10 amp power supply. Order 3-SDC1 for second loop.
3X-SFS1R	Red		
3X-SFS1Bi	Bronze	Selectable	
3X-SFS1Ri	Red		
TRIM6			Flush trim ring

Network communication option cards	
3X-NET8	RS485, eight node max. Class A/B network. Use on 3-SFS systems only.
3X-NET	RS485, Class A/B network. For connection to EST3 systems.
3X-FIB8	Fiber, 8 node max. Uses MMXVR, SMXHI2, SMXLO2. Use on 3-SFS systems only.
3X-FIB	Fiber motherboard for connection to EST3 systems. Used with MMXVR, SMXHI2 and SMXLO2.
SMXLO2	Standard output single mode fiber optic transceiver
SMXHI2	High output single mode fiber optic transceiver
MMXVR	Standard output multimode fiber optic transceiver

Communication Options	
3X-ETH1	Ethernet Adapter, 10/100. Provides Ethernet connection from system to 3-SDU for remote programming and diagnostics. Uses standard Ethernet cable (not supplied).

Front Panel LED/Switch display modules	
4X-12/S1GY	LED Display/Control Module - 12 Switches, 1 Green, 1 YELLOW LED per switch.
4X-12/S1RY	LED Display/Control Module - 12 Switches, 1 RED, 1 YELLOW LED per switch.
4X-12SR	LED Display/Control Module - 12 Switches with 12 RED LEDs.
4X-12RY	LED Display Module - 12 pairs of LEDs (1 Red; 1 Yellow)
4X-24Y	LED Display Module - 24 YELLOW
4X-24R	LED Display Module - 24 RED
4X-6/3S1G2Y	LED/Switch Module - six groups of three Switches with one LED each.
4X-6/3S1GYR	LED/Switch Module - six groups of three Switches with one LED each.
4X-4/3SGYWR	LED/Switch Module, four groups of three switches and four LEDs. LED colors: Green, Red, Yellow and White.
4X-LKF	Label Kit, French

Option Cards and Interfaces	
3X-PMI	Paging Microphone Interface
3-SSDC1	Single Signature Driver Controller, c/w one 3-SDC1
3-SDDC1	Dual Signature Driver Controller, c/w two 3-SDC1s
3-SDC1	Signature Device Card - expands the 3X base panel to two loops
3-ZA20A	20 Watt Zoned Amplifier w/Class A/B Audio & Class A/B 24 VDC outputs
3-ZA20B	20 Watt Zoned Amplifier w/Class B Audio & Class B 24 VDC outputs
3-ZA40A	40 Watt Zoned Amplifier w/Class A/B Audio & Class A/B 24 VDC outputs
3-ZA40B	40 Watt Zoned Amplifier w/Class B Audio & Class B 24 VDC outputs
3-MODCOM	Modem/Dialer (DACT)
3-MODCOMP	Modem/Dialer (DACT) w/TAP Pager Protocol
3-AADC1	Addressable Analog Module
3-IDC8/4	Initiating Device Circuit Module
3-OPS	Off Premises Signaling module
CLA-PS10	Class A Adapter, PS10 NACs
CDR-3	PSNI Coder Module
GCI	Graphic Annunciator Driver Master, provides outputs for 32 LEDs and connection to common control switches and LEDs for R-Series annunciators.
GCIX	Graphic Annunciator Driver Expander, provides outputs for 48 LEDs and inputs for 24 switches.

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Accessories	
PS10-4B	Power Supply, Replacement
SFS1-ELEC	Base Electronics, replacement
4X-LCD	Main user interface assembly, monochrome. Eight line 1/4 VGA LCD, four controls plus rotary knob. English language.
4X-LCD-LC	Main user interface assembly, monochrome. Eight Line 1/4 VGA LCD, four controls plus Rotary knob. Insertable language, shipped with English inserts. Order alternate languages separately.
4X-CAB6D	Replacement door, bronze
4X-CAB6DR	Replacement door, red
4X-CAB6B	Backbox, black

Related Data Sheets

85010-0129 -- Signature Driver Controller Modules
85010-0057 -- EST3 Zoned Audio Amplifiers
85010-0107 -- EST3 Modem Communicator
85010-0131 -- Fiber Optic Communications Interface
85010-0113 -- Network Short Haul Modem
85005-0128 -- R-Series Remote Annunciators

Technology that saves lives

Ceiling Speakers, Speaker-Strobes

Genesis GC Series

MEA 7320-1657: 0211/0285 S2813

See Specifications Section for listings details.

Overview

The Genesis line of ceiling life safety and emergency communications speakers and speaker-strobes combine high performance output with a low profile design to deliver a life safety signal solution that's as versatile as it is effective. While they are designed to mount inconspicuously overhead, these devices are also rated for wall-mounted applications.

Clear-lens speaker-strobes are available in high and low candela models, which feature 15 to 95, or 95 to 177 cd output (see ordering information). Ceiling speakers feature ¼ W to 2 W operation, which allows devices to be easily fine-tuned to achieve maximum benefit in exchange for the lowest possible system overhead.

Light output and wattage tap settings are selectable with conveniently-located switches. Settings remain clearly visible even after final installation, yet they are locked in place to prevent unauthorized movement after installation.

High fidelity models meet the NPFA 520 Hz requirements for newly construced commercial sleeping areas. They also produce crisp, clear voice audio output that is highly intelligible over large areas.

These low-profile appliances feature textured housings in architecturally neutral white or eye-catching life safety red. Optional *ALERT* or *FIRE* markings make them ideal for applications that require differentiation between life safety and mass notification alerts.

Standard Features

- **High Fidelity 520 Hz speaker models available**
  Low frequency output meets NFPA standards for newly constructed commercial sleeping areas; increases sound fidelity and audio intelligibility.
- **Field configurable – no need to remove the device**
  - Select ¼, ½, 1, or 2 watt operation
  - 15/30/75/95 cd and 95/115/150/177 cd models available
  - Switch settings remain visible *even after the unit is installed*
- **Ideal for Mass Notification applications**
  - amber lens models available with optional *ALERT* markings
- **Unique low-profile design**
  - 30 per cent slimmer profile than comparable signals
  - Available with white or red housings
- **Unparalleled performance**
  - loud 90 dBA output ensures clear, crisp audio
  - Precision strobe timing meets UL synchronization standards
  - 25 V_{RMS} and 70 V_{RMS} models available
- **Easy to install**
  - Fits all standard 4-inch square electrical boxes with plenty of room for extra wire – *no extension ring or trim plate needed*
  - #18 - #12 AWG terminals – ideal for long runs, existing wiring
- **Approved for public and private mode applications**
  - UL 1971-listed as signaling devices for the hearing impaired
  - UL 1638-listed as protective visual signaling appliances
  - UL 1480-listed as life safety speaker
  - UL/ULC listed for ceiling or wall use

Strobe Application

Genesis strobes are UL 1971 or 1638 listed for indoor use. Prevailing codes require strobes to be used where ambient noise conditions exceed specified levels, where occupants use hearing protection, and in areas of public accommodation. Consult with your Authority Having Jurisdiction for details.

All Genesis strobes exceed UL synchronization requirements (within 10 milliseconds over a two-hour period) when used with a synchronization source. Synchronization for multiple strobe lights in a single field of view is required. See the Specifications table for compatible synchronization sources.

Speaker Application

The suggested sound pressure level for each signaling zone used with alert or alarm signals is a minimum of 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. This is measured 5 feet (1.5 m) above the floor.

Doubling the distance from the signal to the ear will theoretically cause a 6 dB reduction in the received sound pressure level. The actual effect depends on the acoustic properties of materials in the space. Doubling the power output of a device (e.g.: a speaker from 1 W to 2 W) will increase the sound pressure level by 3 dBA. A 3 dBA difference represents a barely noticeable change in volume.

Combination audible/visual signals must be installed in accordance with guidelines established for strobes.

High Fidelity Models

Genesis G4HF Series High Fidelity appliances provide highly intelligible voice audio output. They are also effective in areas subject to high levels of ambient noise. These appliances are approved for use in sleeping areas under conditions described below.

Sleeping Room Applications

Genesis GCHF Series High Fidelity appliances are ideal for hotels, dormitories, and other residential occupancies where audible output must meet the 520 Hz signaling characteristics required by NFPA 72.

In sleeping areas, always ensure that the wattage tap of the speaker is set sufficiently high so that the sound pressure reaches at least 75 dBA-fast at the pillow.

These appliances are part of an end-to-end audio system approved for use in sleeping areas when used in conjunction with approved audio hardware and a factory-supplied 520 Hz tone. Check the System Compatibility List for other 520 Hz signaling requirements.

NOTE: Speakers driven by third-party audio systems are not UL approved for use in sleeping rooms.

Mass Notification Applications

Genesis Mass Notification appliances bring the same high-performance life safety features and unobtrusive design to mass notification applications. Models are available with optional ALERT housing labels, which make them ideal for applications that require differentiation between life safety and mass notification alerts.

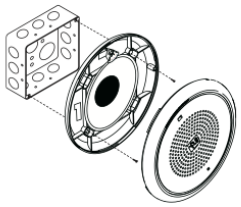
Application Notes - Canada

(Based in part on 1995 Canada National Building Code)

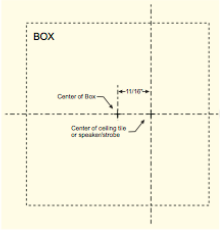
The signal sound pressure level shall not exceed 110 dBA in any normally occupied area. The sound pressure level from an audible signal in a floor area used for occupancies other than residential occupancies shall not be less than 10 dBA above ambient levels, and never less than 65 dBA. In sleeping rooms the sound pressure level from an audible signal shall not be less than 75 dBA when any intervening doors between the device and the sleeping room are closed.

Installation and Mounting

All models are intended for in-door ceiling or wall applications only. Speaker-strobes are mounted to a flush North-American 4" square electrical box, $2^{1}/_{8}$" (54 mm) deep.



Genesis ceiling speaker-strobes simply unlatch and hinge down to open. This gains access to mounting screws and the selectable candela wattage tap switches. The shallow depth of Genesis devices leaves ample room behind the signal for extra wiring. Once installed with the cover in place, no mounting screws are visible.

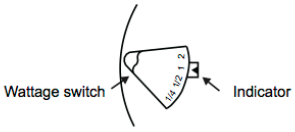


Installation Note:

When installed, these devices are not centered on the electrical box. Make sure boxes are mounted to compensate for this difference. Use the mounting template provided with installation sheet 3100614.

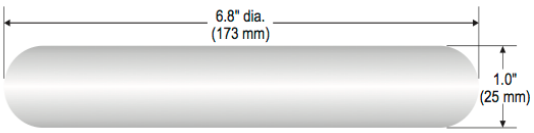
Field Configuration

Genesis ceiling speaker-strobes may be set for ¼, ½, 1, or 2 watt operation. Depending on the model, Genesis ceiling speaker-strobes have multi-candela output (see ordering information).

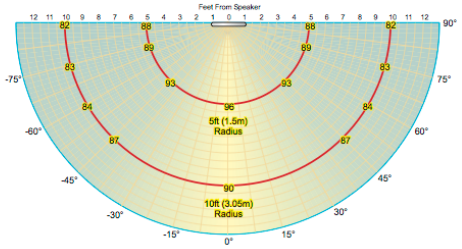


Output settings are changed by simply opening the device and sliding the switches to the desired settings. The speaker-strobe does not have to be removed to change the output settings. The settings remain visible through small windows on the front of the device after the cover is closed.

Dimensions

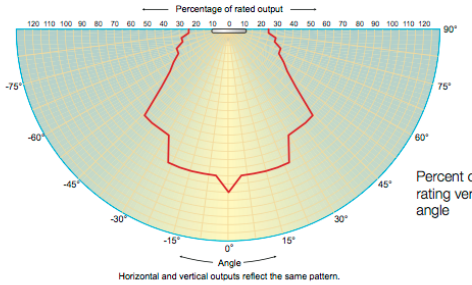


Typical Sound Output (dBA)



Measured at 2 watts setting in anechoic chamber

Light output - (effective cd)



Percent of UL rating versus angle

Horizontal and vertical outputs reflect the same pattern.

Sound Output	Setting (nominal)	Wattage (actual)	UL 1480 Rating	ULC-S541 Rating	Anechoic (nominal)
520 Hz High Fidelity models (dBA) output at 3.05 m (10 ft.)					
25 VRMS	¼ W	0.25 W	81.4	81.5	81
	½ W	0.50 W	84.5	84.3	84
	1 W	1.00 W	88.2	87.2	87
	2 W	2.00 W	90.0	90.1	91
70 VRMS	¼ W	0.25 W	81.5	81.9	81
	½ W	0.50 W	84.1	84.9	84
	1 W	1.10 W	87.9	87.9	87
	2 W	2.30 W	90.8	90.8	91
Standard Hz models (dBA) at 3.05 m (10 ft.)					
25 VRMS	¼ W	0.25 W	81		
	½ W	0.50 W	84		
	1 W	1.00 W	87		
	2 W	2.00 W	90		
70 VRMS	¼ W	0.25 W	81		
	½ W	0.50 W	84		
	1 W	1.00 W	87		
	2 W	2.00 W	91		

Strobe Output and Current Draw		Candela switch setting D	C	B	A
Standard cd output models					
Operating current, RMS (A)	VDC	0.109	0.151	0.281	0.318
	VFWR	0.131	0.194	0.379	0.437
Light output (cd)	Clear Lens	15	30	75	95
	Amber Lens	13	26	65	82
High cd output models					
Operating current, RMS (A)	VDC	0.330	0.392	0.502	0.565
	VFWR	0.432	0.518	0.643	0.693
Light output (cd)	Clear Lens	95	115	150	177
	Amber Lens	82	100	130	155

VDC = Volts direct current, regulated and filtered
VFWR = Volts full wave rectified
Operating currents shown above were measured at 16 VDC and 16 VFWR.

***Sound level output notes:** dBA = Decibels, A-weighted. **UL1480:** Sound level output at 10 ft (3.05 m) measured in a reverberant room using 400 to 4,000 Hz band limited pink noise. **ULC-S541:** Meets or exceeds 85dBA in an anechoic chamber at 10 ft (3.05 m) on at least one setting per code.
Directional characteristics: Within 6 dB of on-axis sound level when measured 90° off-axis (horizontal).

Current Draw

UL Nameplate Rating

See note 1	"15" or "D"	"30" or "C"	"75" or "B"	"95" or "A"
	RMS	RMS	RMS	RMS
16 Vdc	109	151	281	318
16 Vfwr	131	194	379	437

UL Nameplate Rating (high cd output models)

"95" or "D"	"115" or "C"	"150" or "B"	"177" or "A"
RMS	RMS	RMS	RMS
330	392	502	565
432	518	643	693

Typical Current

See note 1	"15" or "D"	"30" or "C"	"75" or "B"	"95" or "A"
	RMS	RMS	RMS	RMS
16 Vdc	94	140	273	325
20 Vdc	74	108	205	244
24 Vdc	63	90	168	194
33 Vdc	48	70	124	139
16 Vfwr	126	187	368	403
20 Vfwr	108	156	281	333
24 Vfwr	97	139	240	270
33 Vfwr	89	119	197	214

Typical Current (high cd output models)

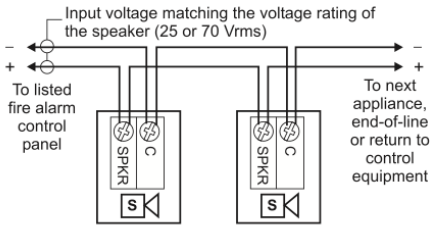
95 cd	115 cd	150 cd	177 cd
RMS	RMS	RMS	RMS
333	392	499	551
259	303	378	429
212	245	306	342
155	180	211	236
484	570	673	724
380	438	537	604
318	361	434	484
245	269	308	338

Current Draw Notes

1. Light output switch settings for UL 1971 listed models are selectable by numeric candela value. ECS/MNS appliances are selectable by A, B, C, or D designations.
2. Current values are shown in mA.

Wiring

Field wiring terminals accommodate #18 to #12 AWG (0.75 mm² to 2.5 mm²) wiring.



Specifications

Housing	Textured UV stabilized, color impregnated engineered plastic. Exceeds 94V-0 UL flammability rating. Red and white models available.
Mounting	Flush mount to North American 4-inch square electrical box, 2-1/8 (54 mm) inches deep, or 960A-4RF round flush box. No extension ring required. Suitable for indoor wall or ceiling applications.
Wire connections	Screw terminals: polarized inputs for speaker, #18 to #12 AWG (0.75 mm² to 2.5 mm²) wire size.
Operating environment	Indoor only: 32-120° F (0-49° C) ambient temperature; 0-93% relative humidity.
Agency listings and approvals, GC Models	Meets ULC-S541, year 2004 UL requirements for standards UL1638 and UL1971. Complies with UL1480 Fifth Edition. UL/ULC File Number: S2813. FM, MEA, CSFM approved. CSFM File Number: 7320-1657: 0211/0285. Speaker-strobes comply with ADA Code of Federal Regulation Chapter 28 Part 36 Final Rule.
Agency listings and approvals, Low Frequency GCHF Models	UL 464 Listed for low frequency signaling applications. Meets ULC-S541, year 2004 UL requirements for standards UL1638 and UL1971. Complies with UL1480 Fifth Edition. FM, MEA, CSFM pending. Speaker-strobes comply with ADA Code of Federal Regulation Chapter 28 Part 36 Final Rule.
Supervisory voltage	30 V max.
Speaker	
Operating Voltage	25 Vrms or 70 Vrms
Speaker response	400 to 4,000 Hz
Output	See table on previous page.
Strobe	
Light output	Field selectable. See table on previous page.
Operating current	See table on previous page.
Strobe output rating	UL 1971, UL 1638, ULC S526: selectable 15/30/75/95 cd (VM models) and 95/115/150/177 cd (VMH models)
Strobe operating voltage	16 to 33 VDC (24 VDC nominal) or 16 to 33 VFWR (24 VFWR nominal)
Strobe flash rate	One flash per second, default. Temporal setting (private mode only): synchronized to temporal output of Genesis audible signals on same circuit.
Synchronization	Meets or exceeds UL 1971 requirements. Maximum allowed resistance between any two devices is 20 Ohms. Refer to specifications for the synchronization control module, this strobe, and the control panel to determine allowed wire resistance.
Synchronization Sources	FACPs: VM and VS Series life safety systems, FX Series fire alarm control panels. Moduels: GSA-CC1S, GSA-MCC1S, SIGA-CC2A, GSA-MCC2A, EG1M-RM. Power supplies: MIRBPS6A, MIRBPS10A, APS6A, APS10A.
Lens	Optical grade polycarbonate.

Ordering Information

Model	High Fidelity (520 Hz capable)	Housing Color	Text Marking	Strobe Output	Speaker Voltage	Shipping Weight
Life safety Appliances						
GCHFRF-S2VMC	✓	Red	FIRE	Selectable 15, 30, 75, or 95 cd	25 Volt (Selectable ¼, ½, 1, or 2 watt)	1.62 lb. (0.73 kg.)
GCHFWF-S2VMC	✓	White				
GCF-S2VM						
GC-S2VM			None			
GCHFRN-S2VMC	✓	Red				
GCHFWN-S2VMC	✓	White				
GCHFRF-S2VMCH	✓	Red	FIRE	Selectable 95, 115, 150, 177		
GCHFWF-S2VMCH	✓	White				
GCF-S2VMH						
GCHFRN-S2VMCH	✓	Red	None			
GCHFWN-S2VMCH	✓	White				
GC-S2VMH						
GCHFRF-S2	✓	Red	FIRE	Speaker only models		
GCFR-S2						
GCHFWF-S2	✓	White				
GCHFRN-S2	✓	Red	None			
GCHFWN-S2	✓	White				
GC-S2						
GCWN-S2						
GCHFRF-S7VMC	✓	Red	FIRE	15, 30, 75, or 95 cd	70 V (Selectable ¼, ½, 1, or 2 watt)	
GCHFWF-S7VMC	✓	White				
GCF-S7VM						
GCHFRN-S7VMC	✓	Red	None			
GCHFWN-S7VMC	✓	White				
GCHFRF-S7VMCH	✓	Red	FIRE	95, 115, 150, 177		
GCHFWF-S7VMCH	✓	White				
GCF-S7VMH						
GCHFRN-S7VMCH	✓	Red	None			
GCHFWN-S7VMCH	✓	White				
GCHFRF-S7	✓	Red	FIRE	Speaker only models		
GCFR-S7		Red				
GCHFWF-S7	✓	White				
GCF-S7						
GCHFRN-S7	✓	Red	None			
GCHFWN-S7	✓	White				
GC-S7						

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Email: kidde.fire@fs.utc.com
Web: *Kidde.com/EngineeredSystems*

Kidde is a UTC brand.
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Mebane, NC 27302

Ordering Information

Model	High Fidelity	Text Marking	Lens Color	Strobe Output	Speaker Voltage	Shipping Weight
Mass Notification Appliances, white housings						
GCHFWA-S2VMA	✓	ALERT	Amber	13, 26, 65, or 82 cd	25 Volt (Selectable ¼, ½, 1, or 2 watt)	1.62 lb. (0.73 kg.)
GCWA-S2VMA						
GCHFWN-S2VMA	✓	None				
GCWN-S2VMA						
GCWN-S2VMC			Clear	15, 30, 75, or 95 cd		
GCHFWA-S2VMC	✓	ALERT				
GCWA-S2VMC						
GCHFWA-S2VMHA	✓		Amber	82, 100, 130, or 155 cd		
GCWA-S2VMHA						
GCHFWN-S2VMHA	✓	None				
GCWN-S2VMHA						
GCWN-S2VMHC			Clear	95, 115, 150, or 177 cd		
GCHFWA-S2VMCH	✓	ALERT				
GCWA-S2VMHC						
GCHFWA-S2	✓		Speaker only models			
GCWA-S2						
GCHFWA-S7VMA	✓	ALERT	Amber	13, 26, 65, or 82 cd	70 V (Selectable ¼, ½, 1, or 2 watt)	
GCWA-S7VMA						
GCHFWN-S7VMA	✓	None				
GCWN-S7VMA						
GCWN-S7VMC			Clear	15, 30, 75, or 95 cd		
GCHFWA-S7VMC	✓	ALERT				
GCWA-S7VMC						
GCHFWA-S7VMAH	✓		Amber	82, 100, 130, or 155 cd		
GCWA-S7VMHA						
GCHFWN-S7VMAH	✓	None				
GCWN-S7VMHA						
GCWN-S7VMHC			Clear	95, 115, 150, or 177 cd		
GCHFWA-S7VMCH	✓	ALERT				
GCWA-S7VMHC						
GCHFWA-S7	✓		Speaker only models			
GCWA-S7						

Accessories

EG1M-RM	Synchronization Output Module (1-gang)	0.2 (0.1)
GSA-CC1S	Intelligent Synchronization Output Module (2-gang)	0.5 (0.23)
GSA-MCC1S	Synchronization Output Module (Plug-in UIO)	0.18 (0.08)