FIRE PROTECTION ENGINEERING CULMINATING PROJECT

Fire Protection Systems Evaluation

Office Building

Prepared for:

FPE 596 – Culminating Experience in Fire Protection Engineering

California Polytechnic State University

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Keywords

Life Safety Code, Performance-Based Design, Fire Dynamics Simulator (FDS), Building Egress, Water-Based Fire Suppression, Smoke Control

EXECUTIVE SUMMARY

This report is a Life Safety Code (LSC) and fire protection systems evaluation of an office building located in Colorado. This report covers the prescriptive analysis of the building, as well as the performance-based aspect of the evaluation.

The prescriptive analysis of this report includes assessment of the building code for structural design, means of egress, detection and notification systems, smoke control system, and the water-based fire suppression system for this building. The 2012 International Building Code (IBC) and the National Fire Protection Agency (NFPA) 101 LSC were used for the prescriptive based evaluation and the building was determined to be compliant with the relevant code and referenced standards.

The performance-based assessment was conducted in accordance with strategies and processes from widely accepted literature in the Fire Protection industry. Two different fire scenarios were evaluated using FDS and SmokeView to show that the building is tenable during evacuation and that the occupants are not exposed to any undue risks. The fire scenarios consist of a fire in cubicle space that is prominent in the building, and the other is a fire that begins in a convenience store on the main floor that opens into the lobby.

For the cubicle fire occupants needed 366 seconds to evacuate the floor. The first tenable limit to be reached in this fire was the temperature limit of 60°C and it reached that at 400 seconds into the simulation. The next criterion to be reached was the visibility limit of 4 meters and that was at 475 seconds into the simulation. There were no issues with the carbon monoxide concentration limit during this simulation.

The convenience store fire was looked at from three points, the fire location in the small office/storage area, the store area, and the lobby area. Temperature and visibility criteria were quickly reached in the fire location but it is assumed that there are no personnel in that location at the time of the fire. Visibility was the first criterion to be reached within the store itself but was still 40 seconds beyond the required safe egress time for the store. It was determined that it would take a total of 158 seconds to evacuate the entire first floor. Both temperature and carbon monoxide criteria were never reached during the simulation in the lobby area. Visibility of 6 meters was reached at 250 seconds but this is well beyond the RSET of 158 seconds.

Based on the prescriptive and performance-based analysis of this building, there are no recommendations that need to be made. It could be worth considering an HVAC purge system to assist in the removal of smoke and toxic gases in the event of a fire but this is definitely not necessary. Another item to consider for this building is to install smoke or heat detectors in spaces that currently do not have them. By having detectors present in the areas where they are not existing and not required by code, it is possible to reduce the Required Safe Egress Time (RSET) by early detection and therefore, early notification. Again, this is not something that is necessary based on the analysis of this building but could add another level of safety for the occupants.

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1 – INTRODUCTION

1.1 – Purpose

The purpose of this report is to evaluate the life safety and fire protection systems for an office building. This report covers the prescriptive analysis of the building, as well as the performance-based aspect of the evaluation.

1.2 – Scope

This report provides details about various life safety and fire protection systems for an office building. The prescriptive based analysis covers the following areas of the building: the occupancy of the space; the structural elements present within the building and required by code; the means of egress to include exit paths, exit components and capacities, lighting, and signage; the detection and notification systems; and the suppression systems. Other systems within the building, mechanical, electrical, plumbing, etc…, are not within the scope of this document. The performance-based assessment covers two different fire scenarios that were evaluated and used to show that the building is tenable during evacuation and that the occupants are not exposed to any undue risks. The fire scenarios consist of a fire in cubicle space that is prominent in the building, and the other is a fire that begins in a convenience store on the main floor that opens into the lobby.

1.3 – Applicable Codes and Standards

The primary codes and standards used in the evaluation of this building are the following:

- International Building Code (IBC) – 2012, Second printing
- National Fire Protection Association (NFPA) 13 – Standard for the Installation of Sprinkler Systems
- NFPA 14 – Standard for the Installation of Standpipe and Hose Systems
- NFPA 25 – Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems, 2014
- NFPA 72 – National Fire Alarm and Signaling Code Handbook, 2013
- NFPA 101 – Life Safety Code (LSC), 2015
- Unified Facility Criteria (UFC), various standards and years

Additional codes and standards that may be applicable include:

- International Fire Code (IFC) – 2012 Edition
- Various NFPA Standards
- National Electrical Code (NEC)
- Various Unified Facilities Codes

1.4 – Building Overview

This building, shown in Figure 1, was originally constructed in 1991 with renovations in various areas done throughout the years. When built, it was added on to an existing building that was constructed in the mid-1980's. There is access to the adjacent building in both the basement and lobby on the main floor but these are not considered egress paths for either building. Only this building will be considered for the purposes of this report.

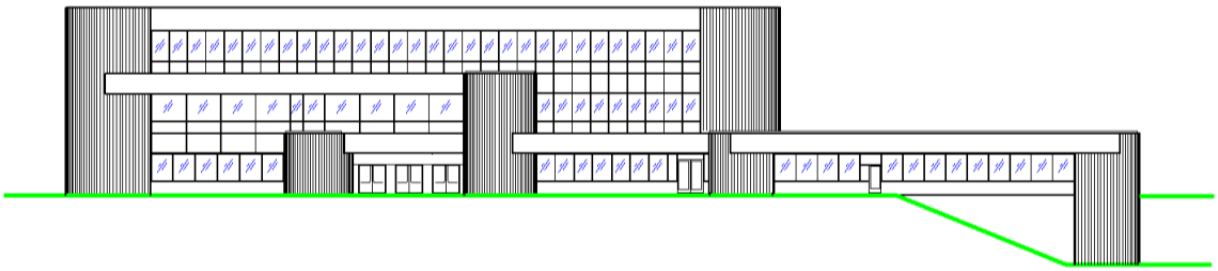


Figure 1: Office Building

The building is mainly office space but does house a kitchen and cafeteria, storage space, a small gym, and mechanical, electrical, and communications/network rooms. There are three above ground floors and a below ground basement for a total of 107,438 square feet. Table 1 identifies the area and occupancies present on each floor. There is a small enclosed atrium at the west entrance to the building. This atrium covers approximately 580 square feet and extends to the second floor but is not open to the second floor. There are windows separating the atrium and the second floor office space.

The majority of personnel in the building are employees working on the second and third floors. Permanent employees also work in the kitchen and convenience store on a daily basis. In addition to personnel that are assigned to the building, transient personnel from various areas outside of this building are allowed to use the kitchen, cafeteria, and gym areas. The building is typically occupied during normal business hours, Monday through Friday. Access is restricted via badge readers during "off-duty" hours and holidays.

Table 1: Area per Floor in Square Feet

LEVEL	GROSS FLOOR AREA (SF)	USE OF SPACE
Basement	22,234	Conference Rooms, Storage, Gym, Elevator Control Room, Mechanical/Electrical/Comm Rooms
First Floor	37,760	Kitchen, Cafeteria, Storage, Lobby, Convenience Store, Mechanical/Electrical/Comm Rooms
Second Floor	23,422	Offices, Conference Rooms, Mechanical/Electrical/Comm Rooms
Third Floor	24,022	Offices, Conference Rooms, Mechanical/Electrical/Comm Rooms
Total	*107,438*	

This office building was constructed using Type IIB construction and details of the structure and construction of the building to include construction classification, allowable area, required element fire resistance ratings are provided in subsequent sections. There is an automatic wet-pipe sprinkler system throughout the building with two dry standpipes running vertically on the north and south sides of the building that are used for fire department connections at each floor. There is a Honeywell alarm, detection, and notification system that is used to alert building occupants of emergencies and contact the appropriate authorities when necessary. By determining the occupancy classification and loads of the building, other elements and systems can be analyzed against both the prescriptive and performance-based requirements of that occupancy.

2 – OCCUPANCY

2.1 – Occupancy Classification

Within this building there are various different occupancy classifications based on Chapter 3 – Use and Occupancy Classification in the 2012 IBC as shown in Table 2. The overall occupancy of the building is Business, Group B as defined by section 304 of the 2012 IBC:

> ***SECTION 304 BUSINESS GROUP B***
> ***304.1 Business Group B.***
> *Business Group B occupancy includes, among others, the use of a building or structure, or a portion thereof, for office, professional or service-type transactions, including storage of records and accounts. Business occupancies shall include, but not be limited to, the following:*
> *…*
> *Professional services (architects, attorneys, dentists, physicians, engineers, etc.)*
> *…*

Table 2: Occupancy Classifications within the Building

USE OF AREA	OCCUPANCY CLASSIFICATION
Offices/Conference Rooms/Training Rooms	Business – Group B
Convenience Store	Mercantile – Group M
Kitchen & Cafeteria	Assembly – Group A-2
Gym/Fitness Room	Accessory to Building, Business – Group B
Storage/Loading Docks	Accessory to Building, Business – Group B
Mechanical/Electrical/Equipment Rooms	Accessory to Building, Business – Group B
Lobby	Business – Group B

The first floor lobby, the storage areas, the loading dock, and the gym/fitness room in the basement are considered accessory occupancies to the rest of the building and are therefore classified as Business, Group B occupancy. These areas are considered accessory occupancies per section 508.2 of the 2012 IBC:

> ***508.2 Accessory occupancies.***
> *Accessory occupancies are those occupancies that are ancillary to the main occupancy of the building or portion thereof. Accessory occupancies shall comply with the provisions of Sections 508.2.1 through 508.2.4.*
> *508.2.1 Area limitations.*
> *Aggregate accessory occupancies shall not occupy more than 10 percent of the building area of the story in which they are located and shall not exceed the tabular values in Table 503, without building area increases in accordance with Section 506 for such accessory occupancies.*
> *508.2.2 Occupancy classification.*
> *Accessory occupancies shall be individually classified in accordance with Section 302.1. The requirements of this code shall apply to each portion of the building based on the occupancy classification of that space.*
> *508.2.3 Allowable building area and height.*
> *The allowable building area and height of the building shall be based on the allowable building area and height for the main occupancy in accordance with Section 503.1. The height of each accessory occupancy shall not exceed the tabular values in Table 503, without increases in accordance with Section 504 for such accessory occupancies. The building area of the accessory occupancies shall be in accordance with Section 508.2.1.*

508.2.4 Separation of occupancies.
No separation is required between accessory occupancies and the main occupancy.
Exceptions:
1. Group H-2, H-3, H-4 and H-5 occupancies shall be separated from all other occupancies in accordance with Section 508.4.
2. Group I-1, R-1, R-2 and R-3 dwelling units and sleeping units shall be separated from other dwelling or sleeping units and from accessory occupancies contiguous to them in accordance with the requirements of Section 420.

Figures 2-5 are layouts of each of the building floors that identify the various areas and their use throughout the building.

Figure 2: Building Layout - Basement

Figure 3: Building Layout - First Floor

Figure 4: Building Layout - Second Floor

Figure 5: Building Layout - Third Floor

2.2 – Occupancy Loads

The basement and first floors of the building contain various occupancy classifications from storage space, to a kitchen and cafeteria, to office space. The second and third floors are considered business occupancy except for the mechanical, electrical, and equipment rooms. No occupant load was determined for the mechanical, electrical, and equipment rooms for this building since these rooms are unoccupied the majority of the time and therefore pose no additional load to building. The total allowable occupant loads per floor and for the entire building are identified in Table 4 and were calculated in accordance with Section 1004 of the 2012 IBC that states:

> ***SECTION 1004 OCCUPANT LOAD***
> ***1004.1 Design occupant load.***
> *In determining means of egress requirements, the number of occupants for whom means of egress facilities shall be provided shall be determined in accordance with this section.*

Within Section 1004, there is a table that indicates a maximum floor area allowance per occupant, otherwise known as the Occupant Load Factor. This factor is used to determine the number of persons allowed within a given square footage of a building by dividing the square foot by the Occupant Load Factor. Table 3 shows a subset of the information from the 2012 IBC occupant load factor table.

Table 3: 2012 IBC Table 1004.1.2 Max Floor Area Allowances per Occupant

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR[a]
Accessory storage areas, mechanical equipment room	300 gross
Assembly Gaming floors (keno, slots, etc.) Exhibit Gallery and Museum	 11 gross 30 net
Assembly with fixed seats	See Section 1004.4
Assembly without fixed seats Concentrated (chairs only-not fixed) Standing space Unconcentrated (tables and chairs)	 7 net 5 net 15 net
Business areas	100 gross
Exercise rooms	50 gross
Kitchens, commercial	200 gross
Mercantile Areas on other floors Basement and grade floor areas Storage, stock, shipping areas	 60 gross 30 gross 300 gross

Table 4: Occupant Loads

SPACE	OCCUPANCY	AREA (Sq Ft)	OCCUPANT LOAD FACTOR (Sq Ft per Person)	OCCUPANT LOAD (# of people)
BASEMENT				
Office Space	Business	1900	100	19
Gym	Exercise Room w/Equipment	2103	50	42
Kitchen Storage	Kitchen	1904	100	19
Accessory	Mech/Elec/Comm Rms, Elevators, Bathrooms, Locker Rms	9513	N/A	N/A
Storage	Storage	1934	N/A	N/A
FIRST FLOOR				
Conference Rooms/Offices	Business	4256	100	42
Convenience Store	Mercantile	1050	30	35
Kitchen	Kitchen	9470	100	94
Cafeteria		9293	Fixed Seating	450
Lobby	Accessory to Business	7730	100	77
Accessory	Mech/Elec/Comm Rms, Elevators, Bathrooms	2158	N/A	N/A
SECOND FLOOR				
Office Space	Business	21867	100	218
Accessory	Mech/Elec/Comm Rms, Elevators, Bathrooms	1555	N/A	N/A
THIRD FLOOR				
Office Space	Business	22467	100	224
Accessory	Mech/Elec/Comm Rms, Elevators, Bathrooms	1555	N/A	N/A
BUILDING TOTAL				
Total				*1250*

The overall occupancy of the building is Business Group B and the total calculated occupant load is 1250 people. By determining both the occupancy classification and the occupant load of the building, we are able to further analyze other aspects of the building such as the structure of the building to include construction type, various building elements, and fire protection requirements.

3 – STRUCTURE

3.1 – Building Description

This building has a total of four floors, three above ground floors and a below ground basement, and has a total of 107,438 square feet. The exterior of the building is covered with pre-cast concrete panels, windows, and metal trim. There is a concrete foundation with steel footings and primary structure of the building is comprised of steel columns and beams. There is an automatic wet sprinkler system throughout the building along with a fire alarm notification system. On the main level of the building, there is a lobby that connects this building to a larger building next door.

The building is 66'3" tall with 46'3" being above grade. The highest occupied floor is at 30' above grade. There is fire department access to the main floor on the West, North, and East sides of the building and access to the basement level on the South end. There are no special detailed requirements in the 2012 International Building Code for this building.

The basement of the building is where the core services such as mechanical, electrical, fire suppression piping, communications/network rooms, and elevator control rooms are located. There is a small classroom in the basement where training is conducted. There is also a fitness room and associated locker rooms for employees to use. The basement does have a loading dock and a storage area with freezers for the kitchen on the main level. There are two passenger elevators that service all four floors of the building and one freight elevator for use to move items between the kitchen on the main floor and the kitchen storage space in the basement.

The first floor, or main level, of this building houses a kitchen and cafeteria, several conference rooms, a small convenience store and various electrical, mechanical, and communications/network rooms. The main entrance on the west side of the building is an atrium that extends to the top of the second story. The entrance on the north of the building opens into lobby space with access to a courtyard and smoking area directly across the lobby.

The second and third floors of the building are very similar in layout and function. Both floors are mostly offices, conference rooms, and open cubicle workspaces. There are several mechanical, electrical, and communications/network rooms on each floor. Access to the buildings mechanical penthouses is via one of the stairwells within the building.

3.2 – Construction Type

For this building, the overall occupancy is Business – Group B. Also, based on the square footage of the building and number of stories, construction types IA and IB can be used as shown in Table 5. The allowable construction type is based on the occupancy, number of stories, and area alone. The number of stories can be increased by one and the area per floor can be doubled per IBC sections 504.2 and 506.3, respectively, due to the building being equipped with an approved automatic sprinkler system.

> ***504.2 Automatic sprinkler system increase.***
> *Where a building is equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1, the value specified in Table 503 for maximum building height is increased by 20 feet (6096 mm) and the*

maximum number of stories is increased by one. These increases are permitted in addition to the building area increase in accordance with Sections 506.2 and 506.3. For Group R buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.2, the value specified in Table 503 for maximum building height is increased by 20 feet (6096 mm) and the maximum number of stories is increased by one, but shall not exceed 60 feet (18 288 mm) or four stories, respectively.

***Exception:** The use of an automatic sprinkler system to increase building heights shall not be permitted for the following conditions:*

1. Buildings, or portions of buildings, classified as a Group I-2 occupancy of Type IIB, III, IV or V construction.

2. Buildings, or portions of buildings, classified as a Group H-1, H-2, H-3 or H-5 occupancy.

3. Buildings where an automatic sprinkler system is substituted for fire-resistance rated construction in accordance with Table 601, Note d.

506.3 Automatic sprinkler system increase.

Where a building is equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1, the building area limitation in Table 503 is permitted to be increased by an additional 200 percent ($I_s = 2$) for buildings with more than one story above grade plane and an additional 300 percent ($I_s = 3$) for buildings with no more than one story above grade plane. These increases are permitted in addition to the height and story increases in accordance with Section 504.2.

***Exception:** The use of an automatic sprinkler system to increase the building area limitation shall not be permitted for the following conditions:*

1. Buildings classified as a Group H-1 occupancy.

2. Buildings, or portions of buildings, classified as either a Group H-2 or H-3 occupancy. For buildings containing such occupancies, the allowable area shall be determined in accordance with Section 508.4.2, with the sprinkler system increase applicable only to the portions of the building not classified as Group H-2 or H-3.

3. Buildings where an automatic sprinkler system is substituted for fire-resistance rated construction in accordance with Table 601, Note d.

These increases mean that construction types IIA, IIB, IIIA, IIIB, and IV can also be used for this building, also shown in Table 5. Types VA and VB are not allowed due to the limit in area and/or stories.

Table 5: Subset of 2012 IBC Table 503 - Allowable Building Heights and Areas

GROUP		TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
	HEIGHT (feet)	UL	160	65	55	65	55	65	50	40
A-2	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
B	S	UL	11	5	3	5	3	5	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
M	S	UL	11	4	2	4	2	4	3	1
	A	UL	UL	21,500	12,500	18,500	12,500	20,500	14,000	9,000
S-2	S	UL	11	5	3	4	3	5	4	2
	A	UL	79,000	39,000	26,000	39,000	26,000	38,500	21,000	13,500
U	S	UL	5	4	2	3	2	4	2	1
	A	UL	35,500	19,000	8,500	14,000	8,500	18,000	9,000	5,500

	Allowable Construction Types
	Construction Type Used

This building was constructed using Type IIB construction and is 107,438 square feet. The building is four floors with the basement being 22,234 square feet, the first floor is 37,760 square feet, the second is 23,422, and the third is 24,022 square feet which are all well within the permitted increase in building stories and area allowances due to the building having an automatic sprinkler system.

3.3 – Structural Elements

The IBC identifies the required fire-resistance ratings for structural elements in section 601. Because this building was constructed using Type IIB construction, the required fire resistance rating in hours for all building elements is zero hours based on Tables 5 and 6.

Table 6: 2012 IBC Table 601 - Fire-Resistance Rating Requirements for Building Elements (Hours)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A[d]	B	A[d]	B	HT	A[d]	B
Primary structural frame[g] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls									
Exterior[f,g]	3	2	1	0	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[e]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary member (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1 ½ [b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

For SI: 1 foot = 304.8 mm.

a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

c. In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.

d. An approved automatic sprinkler system in accordance with Section 903.3.1.1 shall be allowed to be substituted for 1-hour fire-resistance-rated construction, provided such system is not otherwise required by other provisions of the code or used for an allowable area increase in accordance with Section 506.3 or an allowable height increase in accordance with Section 504.2. The 1-hour substitution for the fire resistance of exterior walls shall not be permitted.

e. Not less than the fire-resistance rating required by other sections of this code.

f. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

g. Not less than the fire-resistance rating as referenced in Section 704.10

Foundation

The foundation of the building is reinforced concrete with footings at the column locations. The basement foundation is a 6" concrete slab. The cafeteria on the main floor of the building spreads out beyond the area of the basement directly below so there is additional foundation and footings for this. The concrete slab for the cafeteria is 5" with footings at the column locations also. A partial foundation elevation is shown in Figure 6.

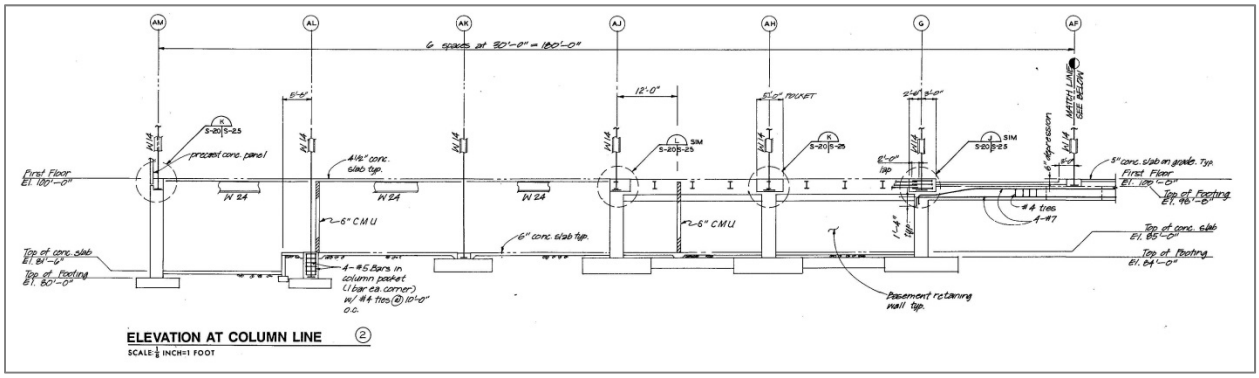


Figure 6: Partial Foundation Elevation

Primary

The primary structure of the building is made up of steel wide-flange columns, beams, girders, and joists. The majority of the interior steel columns are framed in using steel studs and gypsum wallboard. Primary structural members have a zero hour fire resistance rating because the building was constructed using Type IIB construction methods and materials.

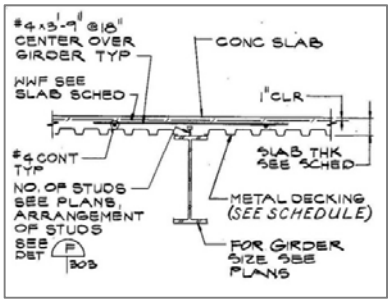


Figure 7: Typical Deck and Slab Detail at Girder

Floor/roof assemblies

The floor and roof assemblies are made up of either 16 or 18 gauge metal decking with 2.5 inches, 4 inches or 5 inches of welded-wire fabric reinforced concrete, as indicated in Table 7. The deck is supported by wide-flange beams, girders, and joists with a variety of connections. These members also have a zero hour fire resistance rating due to construction type. Figure 7 shows a typical floor assembly for this building.

Table 7: Building Slab and Decking Schedule for Floors and Roof

SLAB AND METAL DECKING SCHEDULE

LEVEL AND AREA	ELEVATION	SLAB THICKNESS TOTAL	CONCRETE SLAB			METAL DECKING									REF SHEET NO	REMARKS
			CONCRETE SLAB THICKNESS	REINFORCING STEEL: WELDED WIRE FABRIC	REINFORCING STEEL: REINFORCING BARS	DEPTH	GAGE	SECTION MODULUS MIN	MOMENT OF INERTIA MIN	COMPOSITE DECK	WELDING: END WELD & INTERMEDIATE WELDS AT SUPPORTS	WELDING: SEAM WELD	WELDING: EDGE WELD AT SUPPORTS	ICBO APPROVED MIN SHEAR CAPACITY		
HIGH ROOF	144'-0" TO 145'-9"	4"	2½"	6X6-W2.0XW2.0	#4 x 5'-9" LONG @ 18" OC OVER BEAMS & GIRDERS	1½"	18	0.39 IN³	0.33 IN⁴	YES	4 PUDDLE WELD PER EA 36" UNIT	1½" LONG SEAM WELD @ 12" OC	PUDDLE WELD @ 12" OC	2100# / LN FT @ 7'-6" SPAN	S-1.9 S-1.6	SECTION 1 & 2 & 3
FIRST, SECOND & THIRD FLOOR	99'-9½" 100'-0" 114'-5½" 115'-0" 129'-9½" 130'-0"	4½"	3"	6X6-W2.9XW2.9		1½"	18	0.39 IN³	0.33 IN⁴						S-1.4 to S-1.6 S-1.6 to S-1.8 S-12.5-13	SECTION 1 & 2
		4½" TO 7"	2½" TO 5"	6X6-W4.0XW4.0		2"	16	0.63 IN³	0.69 IN⁴						S-3, S-8 S-8, S-10 S-13	SECTION 1 & 2 AREA AT 4" TO 6" AND AT 8" TO 9"
LOW ROOF	113'-0" TO 114'-6"	4"	2½"	6X6-W2.0XW2.0	#4 x 5'-9" LONG @ 18" OC OVER BEAMS & GIRDERS	1½"	18	0.39 IN³	0.33 IN⁴	YES	4 PUDDLE WELD PER EA 36" UNIT	1½" LONG SEAM WELD @ 12" OC	PUDDLE WELD @ 12" OC	2100# / LN FT @ 7'-6" SPAN	S-6 S-9 S-10	SEE NOTE 6 & 7 SECTION 1 & 2

Exterior walls

The exterior of the building is mainly pre-cast concrete panels that are supported by a structure made up of more wide-flange steel beams. The required fire-resistance rating for the exterior walls of the building is zero hours since the fire separation distance is well over 30 feet, as shown in Table 8. There are many windows covering the exterior of this building. Using Table 9 and the fire-resistance rating requirement in Table 8, there is no limit to the number of windows and no requirement for opening protection.

Table 8: 2012 IBC Table 602 - Fire-Resistance Rating Requirements for Exterior Walls Based on Fire Separation Distance

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

For SI: 1 foot = 304.8 mm.

a. Load-bearing exterior walls shall also comply with the fire-resistance rating requirements of Table 601.

b. For special requirements for Group U occupancies, see Section 406.3.

c. See Section 706.1.1 for party walls.

d. Open parking garages complying with Section 406 shall not be required to have a fire-resistance rating.

e. The fire-resistance rating of an exterior wall is determined based upon the fire separation distance of the exterior wall and the story in which the wall is located.

f. For special requirements for Group H occupancies, see Section 415.5.

g. For special requirements for Group S aircraft hangars, see Section 412.4.1.

h. Where Table 705.8 permits nonbearing exterior walls with unlimited area of unprotected openings, the required fire-resistance rating for the exterior walls is 0 hours.

Table 9: 2012 IBC Table 705.8 - Maximum Area of Exterior Wall Openings Based on Fire Separationg Distance and Degree of Opening Protection

FIRE SEPARATION DISTANCE (feet)	DEGREE OF OPENING PROTECTION	ALLOWABLE AREA[a]
0 to less than 3[b, c]	Unprotected, Nonsprinklered (UP, NS)	Not Permitted
	Unprotected, Sprinklered (UP, S)[i]	Not Permitted
	Protected (P)	Not Permitted
3 to less than 5[d, e]	Unprotected, Nonsprinklered (UP, NS)	Not Permitted
	Unprotected, Sprinklered (UP, S)[i]	15%
	Protected (P)	15%
5 to less than 10[e, f, j]	Unprotected, Nonsprinklered (UP, NS)	10%h
	Unprotected, Sprinklered (UP, S)[i]	25%
	Protected (P)	25%
10 to less than 15[e, f, g]	Unprotected, Nonsprinklered (UP, NS)	15%h
	Unprotected, Sprinklered (UP, S)[i]	45%
	Protected (P)	45%
15 to less than 20[f, g]	Unprotected, Nonsprinklered (UP, NS)	25%
	Unprotected, Sprinklered (UP, S)[i]	75%
	Protected (P)	75%
20 to less than 25[f, g]	Unprotected, Nonsprinklered (UP, NS)	45%
	Unprotected, Sprinklered (UP, S)[i]	No Limit
	Protected (P)	No Limit
25 to less than 30[f, g]	Unprotected, Nonsprinklered (UP, NS)	70%
	Unprotected, Sprinklered (UP, S)[i]	No Limit
	Protected (P)	No Limit
30 or greater	Unprotected, Nonsprinklered (UP, NS)	No Limit
	Unprotected, Sprinklered (UP, S)[i]	Not Required
	Protected (P)	Not Required

Interior walls

Interior walls in this building are built using 3-5/8 inch steel studs placed 16 inches on-center with a layer of gypsum wallboard on each side. Certain areas where there is a requirement for increased fire rating, either 1 or 2 hour, type x gypsum wallboard is used and two layers are used on each side of the steel. Stairways, mechanical rooms, electrical rooms, and elevator shafts and control rooms throughout the building all have two hour fire rated walls and the kitchen areas on the first floor have a one hour fire-rate walls. Figures 8-11 show the various fire rated walls throughout the building. Penetrations through these rated walls are kept to a minimum and consist of sprinkler piping and electrical conduit for lighting and alarm/communication devices. These penetrations are sealed with a fire rated caulking.

The building was constructed using Type IIB construction methods and materials and meets all of the code-based requirements associated with this particular construction type to include fire resistance ratings (zero hour ratings) of various building elements. Interior walls for stairways, mechanical rooms, electrical rooms, and elevators shafts all have the appropriate fire-rated construction. This fire-rated construction for stairways in particular are all part of the egress systems so that occupants are afforded safe passage as they leave the building.

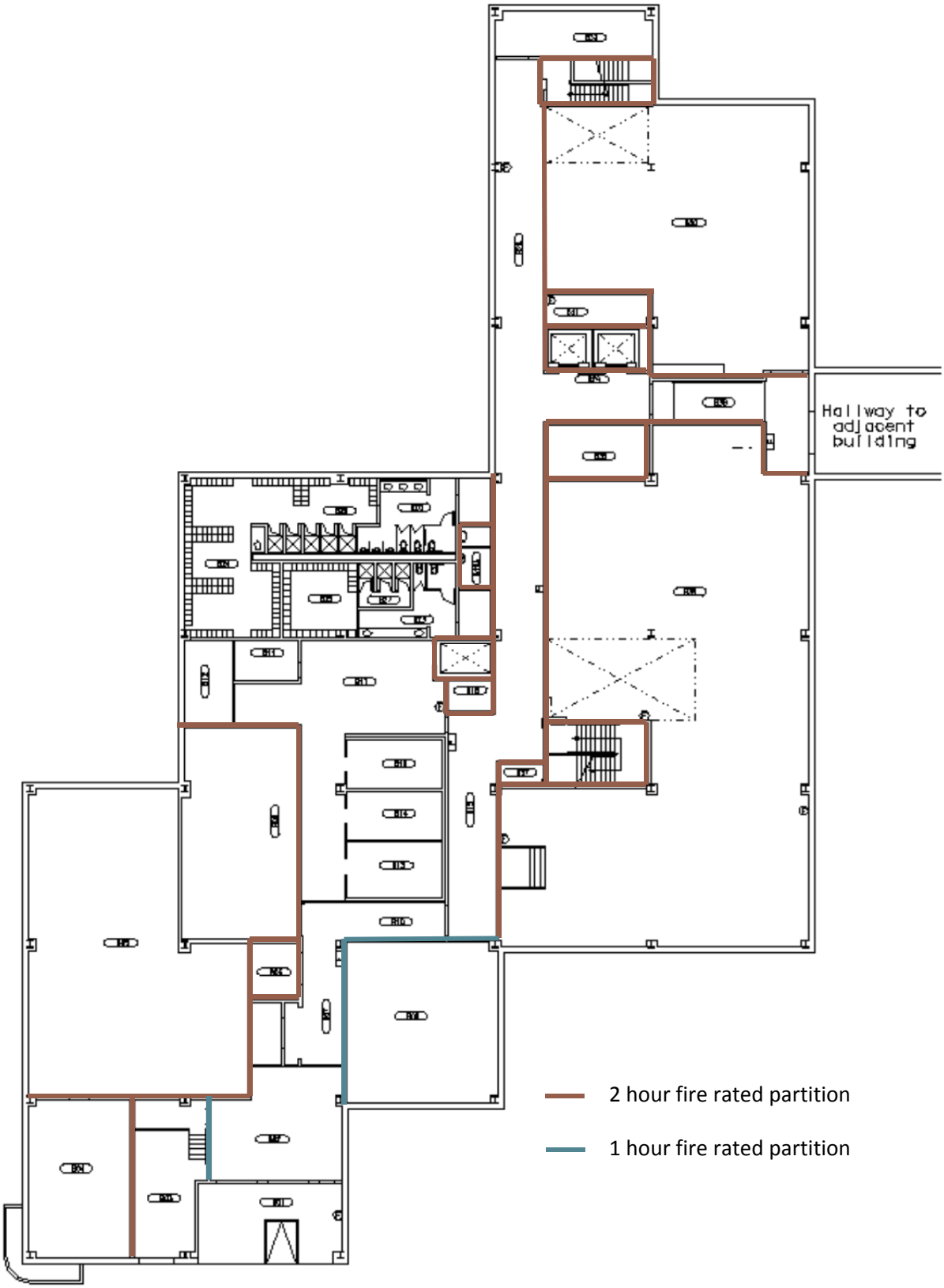


Figure 8: Fire Rated Wall Layout – Basement

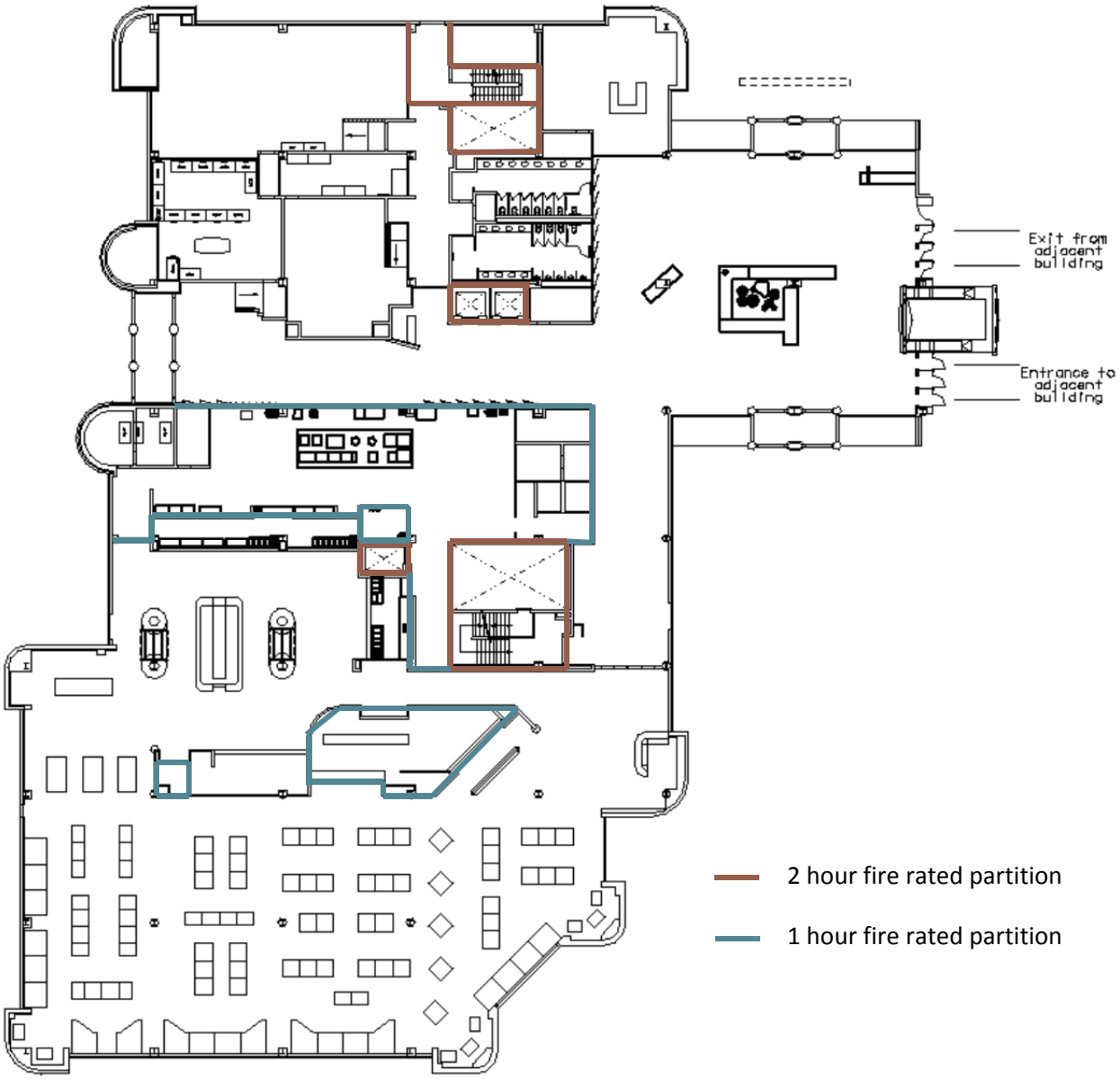


Figure 9: Fire Rated Wall Layout - First Floor

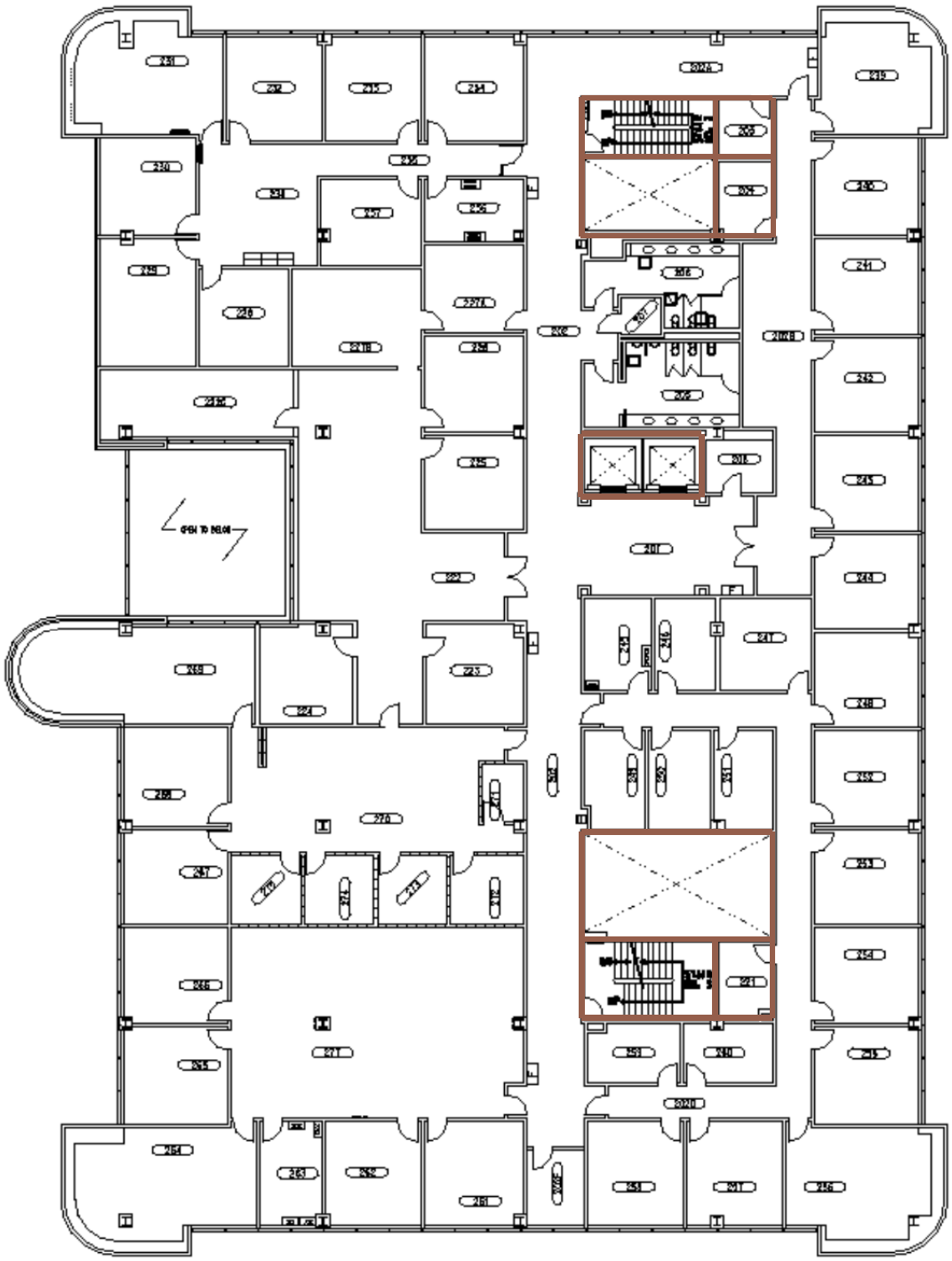


Figure 10: Fire Rated Wall Layout - Second Floor

2 hour fire rated partition

1 hour fire rated partition

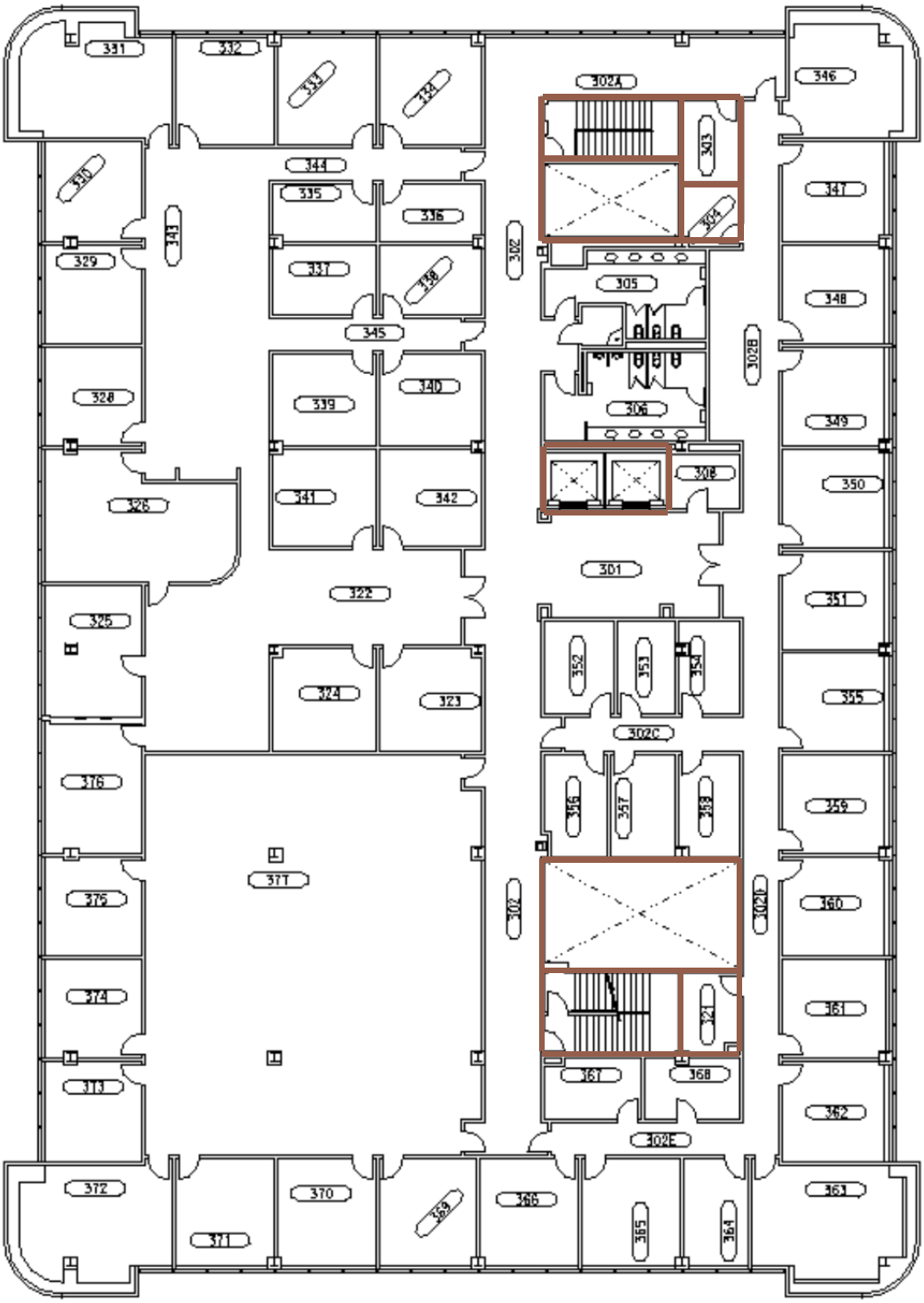


Figure 11: Fire Rated Wall Layout - Third Floor

2 hour fire rated partition

1 hour fire rated partition

4 – EGRESS SYSTEMS

4.1 – General Requirements

The LSC defines the "means of egress" in section 3.3.161 as a continuous and unobstructed way of travel from any point in a building or structure to a public way consisting of three separate and distinct parts, as shown in Figure 12. The means of egress can comprise of both vertical and horizontal travel paths and can include hallways, corridors, ramps, stairs, enclosures, lobbies, intervening room spaces, doorways, escalators and many more. The three separate and distinct parts of the means of egress are as follows:

Exit Access

The portion of a means of egress that leads to an exit

Exit

The portion of a means of egress that is separated from all other spaces of a building or structure by construction or equipment as required to provide a protected way of travel to the exit discharge and include, but are not limited to exterior exit doors, exit passageways, horizontal exits, exit stairs, exit ramps, etc…

Exit Discharge

This is the portion of the means of egress between the termination of an exit and a public way where the public way is defined as a street, alley, or other similar parcel of land essentially open to the outside air deeded, dedicated or otherwise permanently appropriated to the public for public use and having a clear width and height of not less than 10 feet.

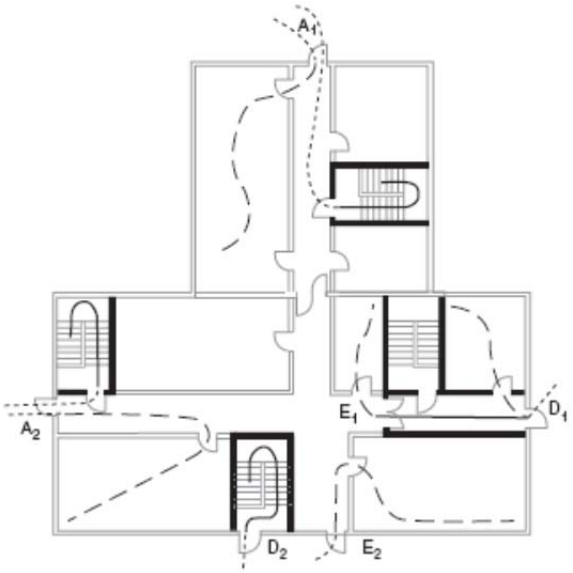


Figure 12: Examples of Means of Egress from NFPA Handbook

4.2 – Building Egress System Components

Chapter 7 of the LSC is dedicated to the Means of Egress of a building and covers everything from handrails, to exit signage, to egress component requirements. Additional pertinent information and sections from the LSC can be found in Appendix A.

Exits

Section 7.1.3.2 identifies specific requirements for exits and this building was constructed in compliance with this section of the code that was available at the time of construction. As the building has undergone renovations and upgrades over the many years since its inception, the areas being affected have been constructed in a manner that they comply with current code. Figures 9 through 11 indicate fire resistance ratings where required and Figures 14 through 17 identify building exits.

> ***7.1.3.2.1*** *Where this Code requires an exit to be separated from other parts of the building, the separating construction shall meet the requirements of Section **8.2** and the following:*
>
> *(3)* The separation shall have a minimum 2-hour fire resistance rating where the exit connects four or more stories, unless one of the following conditions exists:*
>
> *(a) In existing non-high-rise buildings, existing exit stair enclosures shall have a minimum 1-hour fire resistance rating.*
>
> *(b) In existing buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section **9.7**, existing exit stair enclosures shall have a minimum 1-hour fire resistance rating.*
>
> *(c) The minimum 1-hour enclosures in accordance with **28.2.2.1.2**, **29.2.2.1.2**, **30.2.2.1.2**, and **31.2.2.1.2** shall be permitted as an alternative to the requirement of **7.1.3.2.1**(3).*
>
> *(5) The minimum 2-hour fire resistance–rated separation required by **7.1.3.2.1**(3) shall be constructed of an assembly of noncombustible or limited-combustible materials and shall be supported by construction having a minimum 2-hour fire resistance rating, unless otherwise permitted by **7.1.3.2.1**(7).*
>
> *(8) Openings in the separation shall be protected by fire door assemblies equipped with door closers complying with **7.2.1.8**.*
>
> *(9)* Openings in exit enclosures shall be limited to door assemblies from normally occupied spaces and corridors and door assemblies for egress from the enclosure, unless one of the following conditions exists:*
>
> *(d) In buildings of Type I or Type II construction, as defined in **NFPA 220**, Standard on Types of Building Construction, (see **8.2.1.2**) existing fire protection–rated door assemblies to interstitial spaces shall be permitted, provided that such spaces meet all of the following criteria:*
>
> *i. The space is used solely for distribution of pipes, ducts, and conduits.*
>
> *ii. The space contains no storage.*
>
> *iii. The space is separated from the exit enclosure in accordance with Section **8.3**.*
>
> *(e) Existing openings to mechanical equipment spaces protected by approved existing fire protection–rated door assemblies shall be permitted, provided that the following criteria are met:*
>
> *i. The space is used solely for non-fuel-fired mechanical equipment.*
>
> *ii. The space contains no storage of combustible materials.*
>
> *iii. The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section **9.7**.*
>
> *(10) Penetrations into, and openings through, an exit enclosure assembly shall be limited to the following:*
>
> *(a) Door assemblies permitted by **7.1.3.2.1**(9)*
>
> *(b)* Electrical conduit serving the exit enclosure*
>
> *(c) Required exit door openings*
>
> *(d) Ductwork and equipment necessary for independent stair pressurization*
>
> *(e) Water or steam piping necessary for the heating or cooling of the exit enclosure*
>
> *(f) Sprinkler piping*
>
> *(g) Standpipes*
>
> *(h) Existing penetrations protected in accordance with **8.3.5***
>
> *(i) Penetrations for fire alarm circuits, where the circuits are installed in metal conduit and the penetrations are protected in accordance with **8.3.5***

Exit Remoteness:

The building contains two stairways that are considered exit enclosures. One is on the north side of the building, the other on the south. These two exits are 130 feet apart and therefore are well over the one-third diagonal distance requirement outlined in section 7.5.1.3 of the LSC as the shortest building diagonal distance is found on the second and third floors is 220 feet. Figure 13 demonstrates this remoteness.

> ***7.5.1.3*** *Remoteness shall be provided in accordance with* ***7.5.1.3.1*** *through* ***7.5.1.3.7****.*
>
> ***7.5.1.3.1*** *Where more than one exit, exit access, or exit discharge is required from a building or portion thereof, such exits, exit accesses, or exit discharges shall be remotely located from each other and be arranged to minimize the possibility that more than one has the potential to be blocked by any one fire or other emergency condition.*
>
> ***7.5.1.3.3*** *In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section* ***9.7****, the minimum separation distance between two exits, exit accesses, or exit discharges, measured in accordance with* ***7.5.1.3.2****, shall be not less than one-third the length of the maximum overall diagonal dimension of the building or area to be served.*

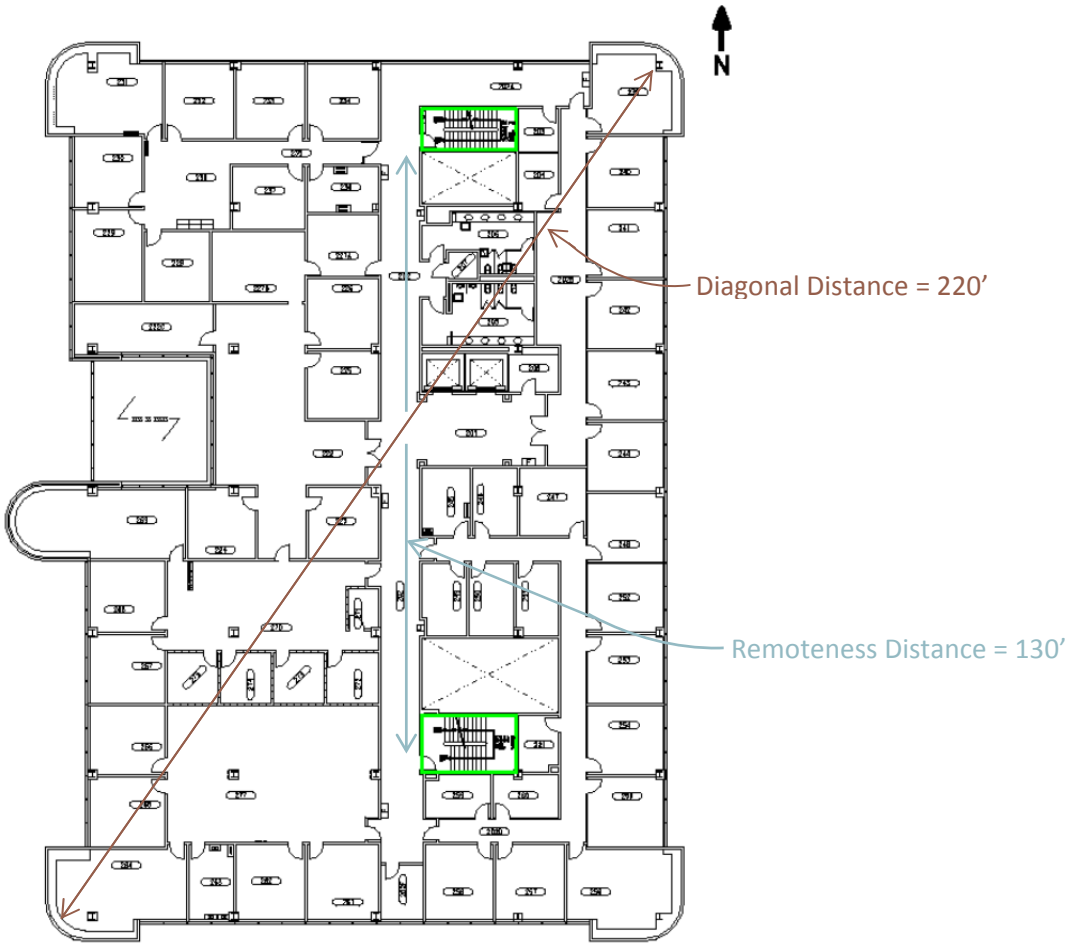


Figure 13: Exit Stairway Remoteness Layout (Second Floor)

Basement Exits:

There are three emergency exits available to occupants of the basement, as shown in Figure 14. Two of these exits are stairways that connect all floors of this building and the other is an exit door that leads occupants to the exterior of the building. The stairway is considered an exit enclosure and meets the requirements outlined above.

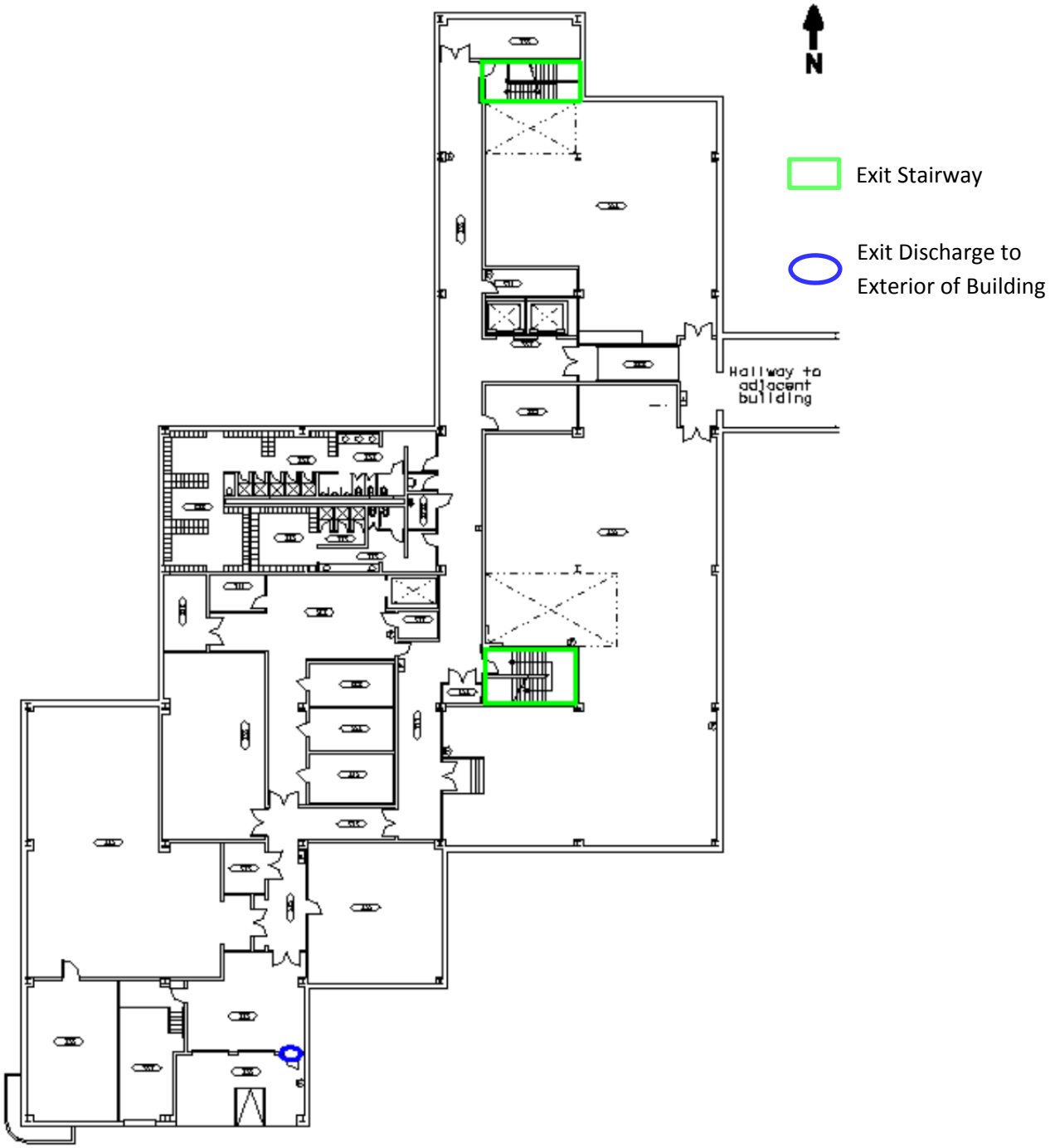


Figure 14: Exit Layout - Basement

First floor exits:

There are a total of eight exits from the main floor of the building. Three of these exits are within the kitchen and cafeteria area, three from the main lobby, and two that service the each stairway that accesses the basement, second, and third floors.

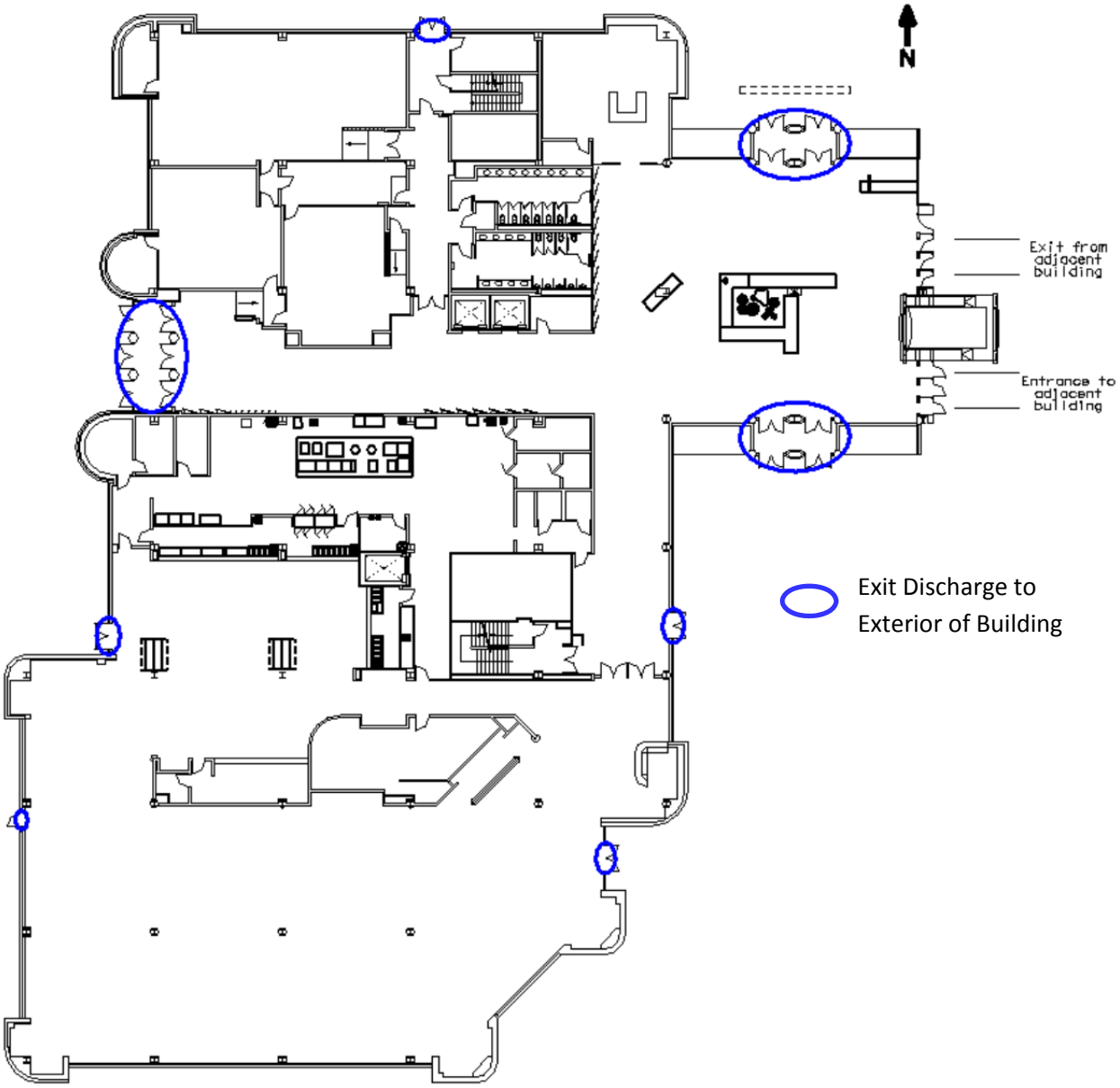


Figure 15: Exit Layout - First Floor

Second floor exits:

There are two stairways for emergency egress from the second floor. These exit enclosures are the stairways that connect the second floor to the basement, first floor, and third floor. They are sufficiently spaced apart and meet the minimum fire rating requirements outlined above. Stairs and doorways are considered in more detail in below sections.

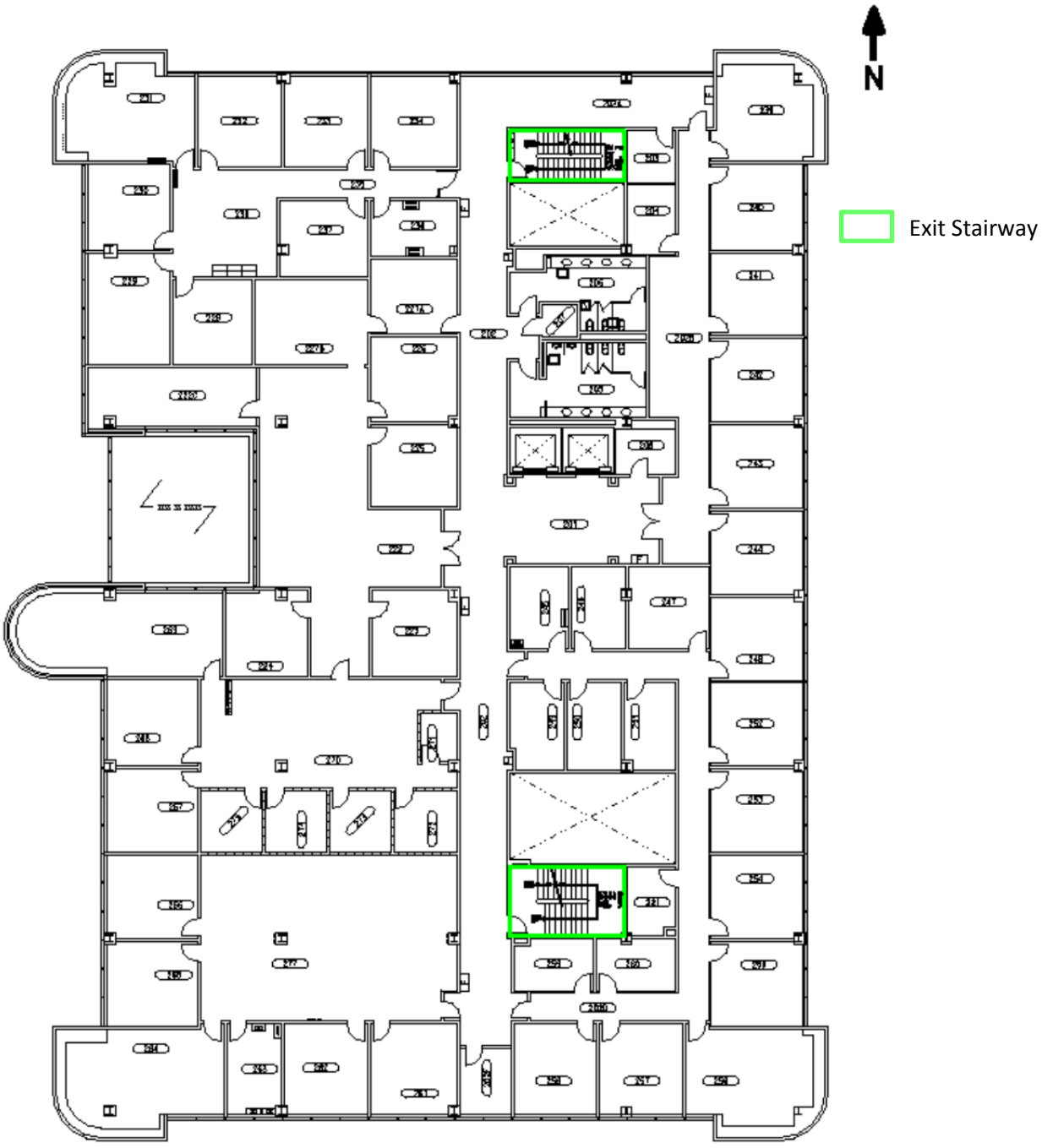


Figure 16: Exit Layout - Second Floor

Third floor exits:

The two exit stairways for the third floor are the same stairways that service the second floor of the building and meet all the same requirements.

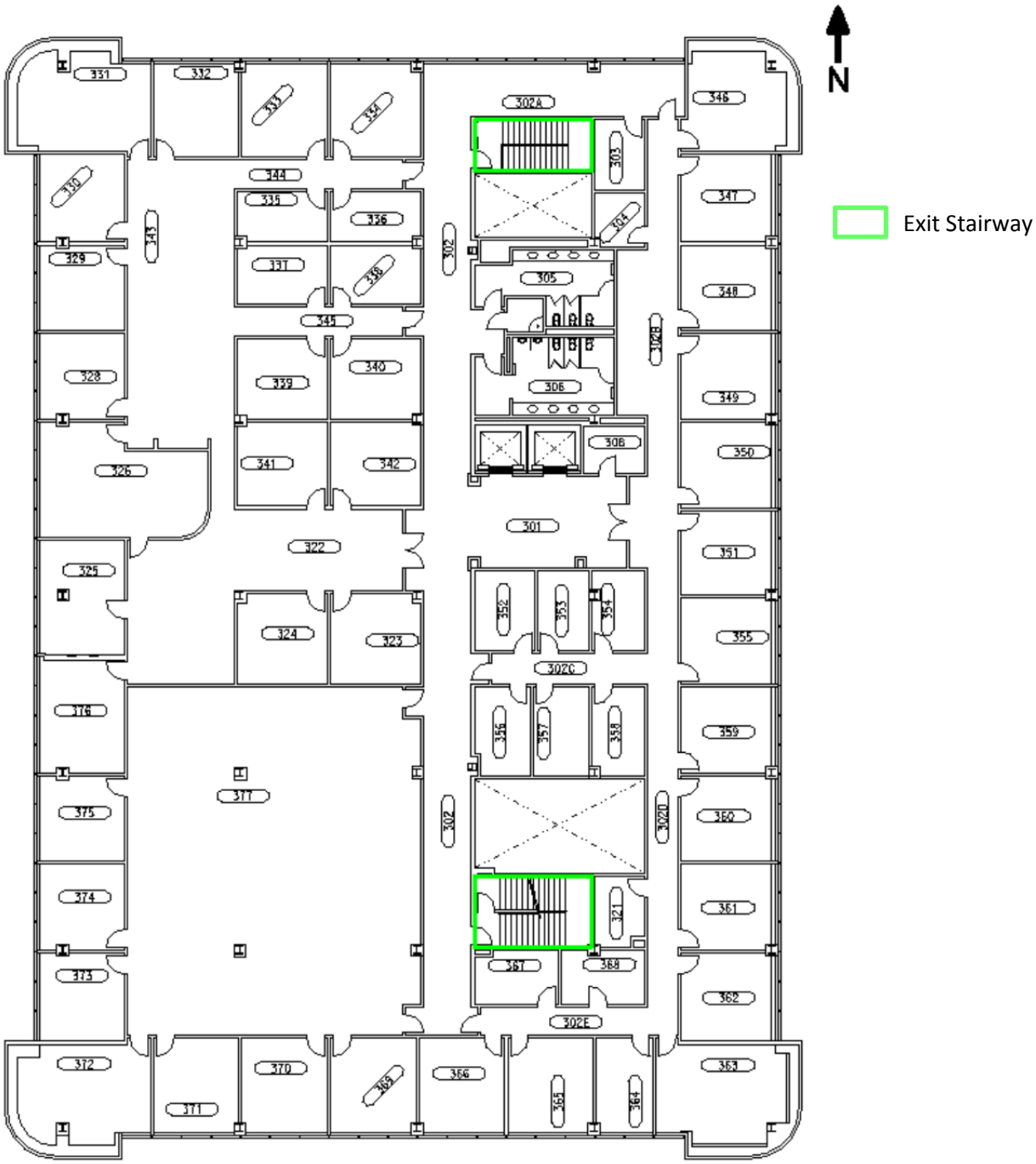


Figure 17: Exit Layout - Third Floor

Stairways

The stairways in this building are used as a means of egress from the building and meet the requirements of the LSC. Stairs that exist in this building are simple switchback stairways that have handrails on both sides and unlocked doors at each floor level. Figure 18 is a basic diagram showing how stairs in this building are constructed. Because this is an existing building that had stairs built with it in 1991, the dimensional criteria of table 7.2.2.2.1.1(b) from the LSC apply, as shown in Table 10. The North stairs connecting the basement to the third floor are 48 inches wide, have a riser height of 7 inches, and a tread depth of 11 inches. The South stairs from the basement to the third floor are 68 inches wide, have a riser height of 7 inches, and a tread depth of 11 inches.

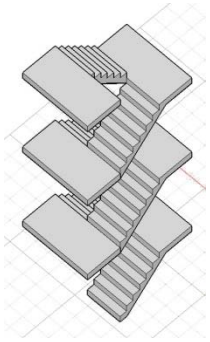


Figure 18: Example of Building Stairs

Table 10: LSC Table 7.2.2.2.1.1 (b) - Dimensional Criteria for Existing Stairs

Table 7.2.2.2.1.1(b) Existing Stairs

Feature	Dimensional Criteria	
	ft/in.	mm
Minimum width clear of all obstructions, except projections not more than 4½ in. (114 mm) at or below handrail height on each side	36 in.	915
Maximum height of risers	8 in.	205
Minimum tread depth	9 in.	230
Minimum headroom	6 ft 8 in.	2030
Maximum height between landings	12 ft	3660
Landing	See 7.2.1.3 and 7.2.1.4.3.1.	

Doorways

All exit discharge doors for each of the floors of this building are identified on the drawings in Figures 14 and 15 and meet requirements listed in section 7.2.1 of the LSC. One of the basement exits and all of the first floor exits are doorways leading to the exterior of the building and are therefore considered exit discharges. The other doors described here are doors into the stairways that connect all floors.

7.2.1 Door Openings.

7.2.1.1 General.

7.2.1.1.1 *A door assembly in a means of egress shall conform to the general requirements of Section* ***7.1*** *and to the special requirements of* ***7.2.1****.*

7.2.1.1.2 *Every door opening and every principal entrance that is required to serve as an exit shall be designed and constructed so that the path of egress travel is obvious and direct. Windows that, because of their physical configuration or design and the materials used in their construction, have the potential to be mistaken for door openings shall be made inaccessible to the occupants by barriers or railings.*

7.2.1.1.3 Occupied Building.

7.2.1.1.3.1 *For the purposes of Section* ***7.2****, a building shall be considered to be occupied at any time it meets any of the following criteria:*

(1) It is open for general occupancy.
(2) It is open to the public.
(3) It is occupied by more than 10 persons.

7.2.1.1.3.2 *Where means of egress doors are locked in a building that is not considered occupied, occupants shall not be locked beyond their control in buildings or building spaces, except for lockups in accordance with **22.4.5** and **23.4.5**, detention and correctional occupancies, and health care occupancies.*

7.2.1.2 Door Leaf Width.

7.2.1.2.1* Measurement of Clear Width.

7.2.1.2.1.1 Swinging Door Assemblies. *For swinging door assemblies, clear width shall be measured as follows:*

(1) The measurement shall be taken at the narrowest point in the door opening.
(2) The measurement shall be taken between the face of the door leaf and the stop of the frame.
(3) For new swinging door assemblies, the measurement shall be taken with the door leaf open 90 degrees.
(4) For any existing door assembly, the measurement shall be taken with the door leaf in the fully open position.
(5) Projections of not more than 4 in. (100 mm) into the door opening width on the hinge side shall not be considered reductions in clear width, provided that such projections are for purposes of accommodating panic hardware or fire exit hardware and are located not less than 34 in. (865 mm), and not more than 48 in. (1220 mm), above the floor.
(6) Projections exceeding 6 ft 8 in. (2030 mm) above the floor shall not be considered reductions in clear width.

Every door is a swinging door; there are no other types of doors in this building. Doors into the stairway from the basement, first, second, and third floors are all 36 inches wide with a clear width of 34 inches. Two of the doors in the kitchen and cafeteria area are double doors that are 72 inches wide with a clear width of 68 inches and the third in this area is a single door with a width of 36 inches and a clear width of 34 inches. There are three doorways consisting of sets of multiple doors, two with 2 double doors and one with 3 double doors, in the lobby. Each double door is 72 inches wide with a clear width of 68 inches. All doors along the exit paths open in the direction of egress. All measurements of clear width are in accordance with section 7.2.1.2.2 of the LSC.

7.2.1.2.2* Measurement of Egress Capacity Width.

7.2.1.2.2.1 Swinging Door Assemblies. *For swinging door assemblies, egress capacity width shall be measured as follows:*

(1) The measurement shall be taken at the narrowest point in the door opening.
(2) The measurement shall be taken between the face of the door leaf and the stop of the frame.
(3) For new swinging doors assemblies, the measurement shall be taken with the door leaf open 90 degrees.
(4) For any existing door assembly, the measurement shall be taken with the door leaf in the fully open position.
(5) Projections not more than 3 1/2 in. (90 mm) at each side of the door openings at a height of not more than 38 in. (965 mm) shall not be considered reductions in egress capacity width.
(6) Projections exceeding 6 ft 8 in. (2030 mm) above the floor shall not be considered reductions in egress capacity width.

Lighting and Signage

This building is equipped with emergency lighting, illuminated exit signs, and evacuation plans on each floor. The emergency lighting system for the building is powered by Uninterruptible Power Systems (UPS) so even in the event of a power outage, the emergency lighting and exits signs will remain operational. Figures 20 through 23 show where emergency lights and exit signs are located throughout the building.

Figure 19: Typical Exit Sign

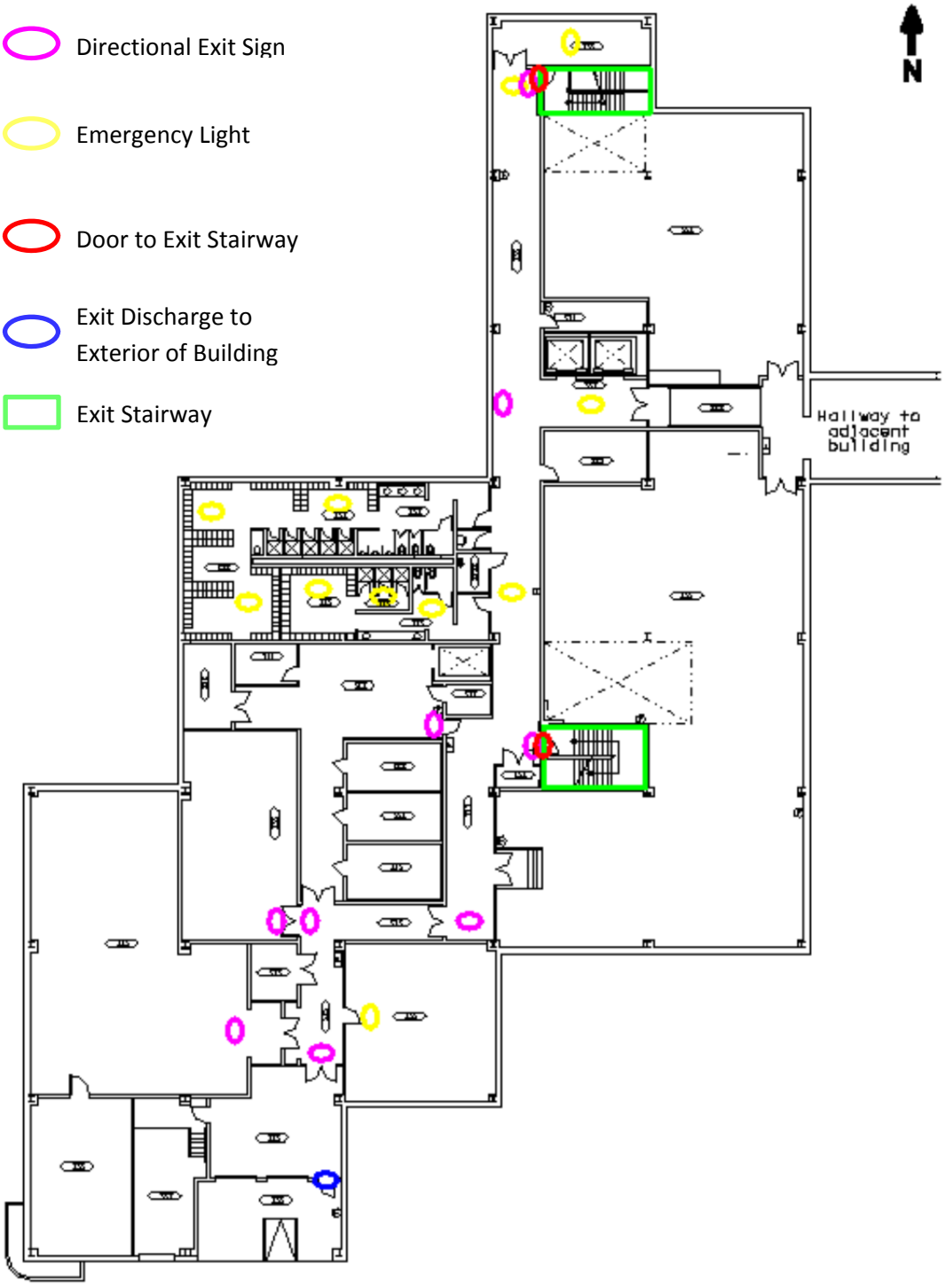


Figure 20: Emergency Light and Exit Sign Layout - Basement

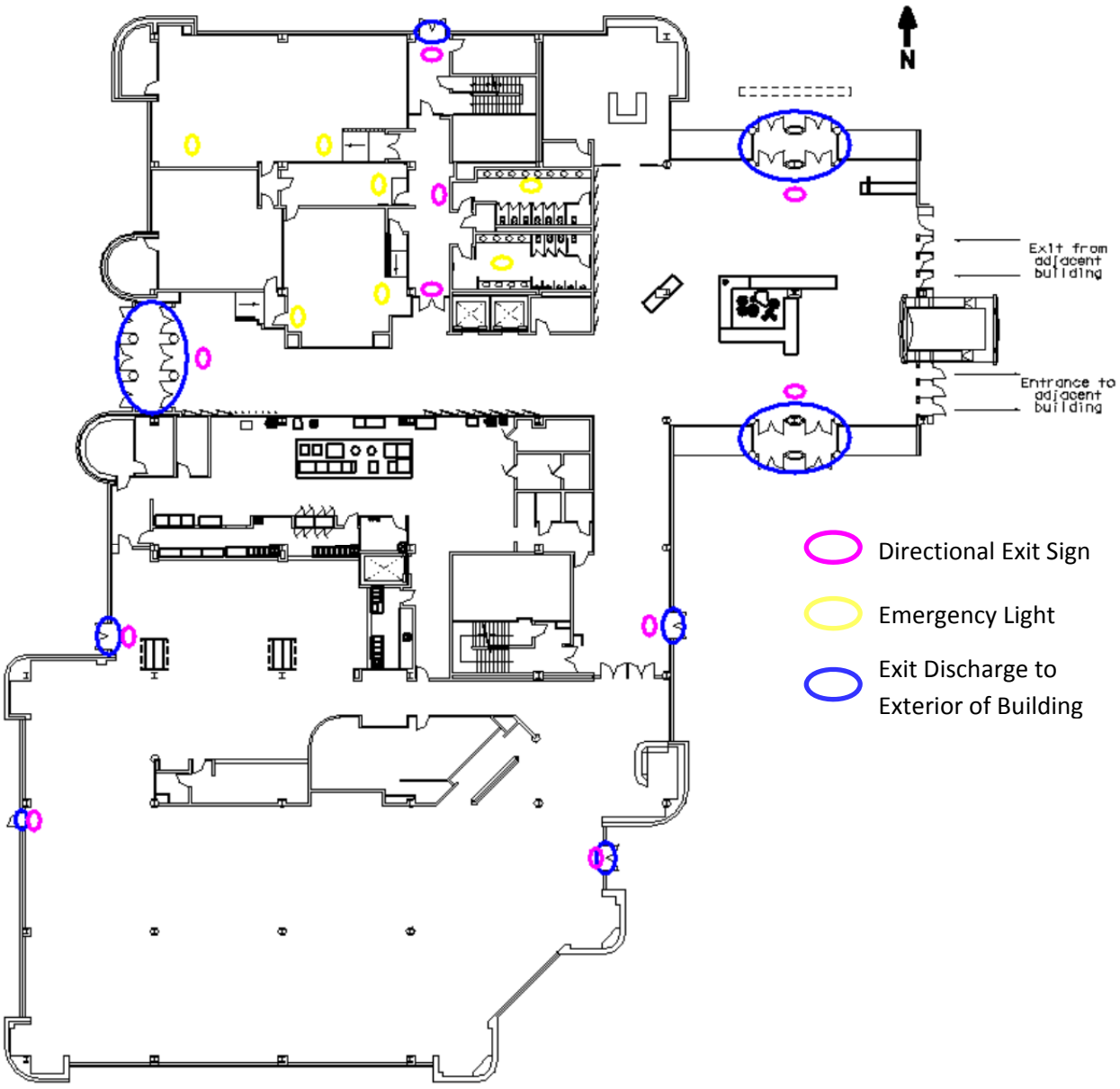


Figure 21: Emergency Light and Exit Sign Layout - First Floor

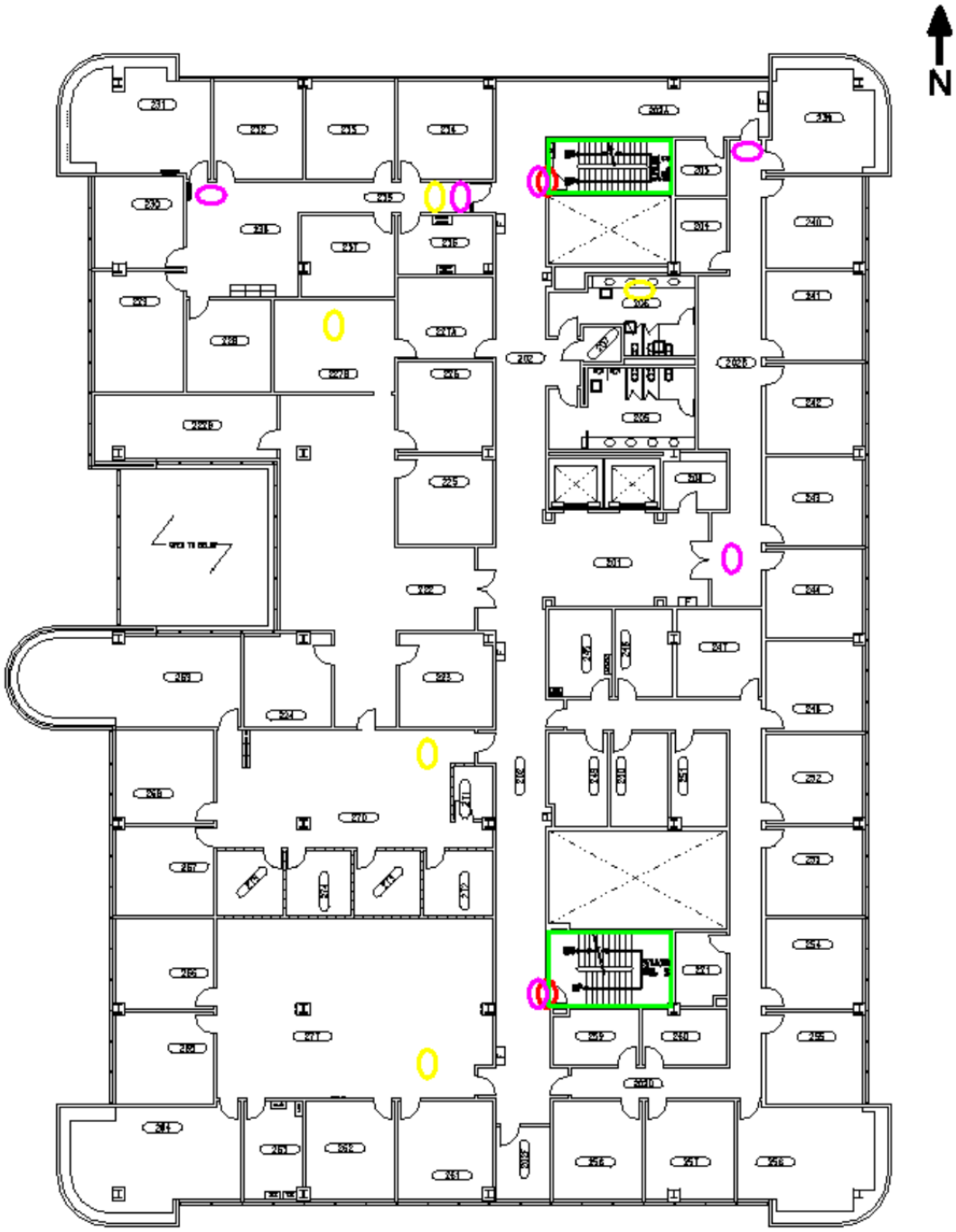


Figure 22: Emergency Light and Exit Sign Layout - Second Floor

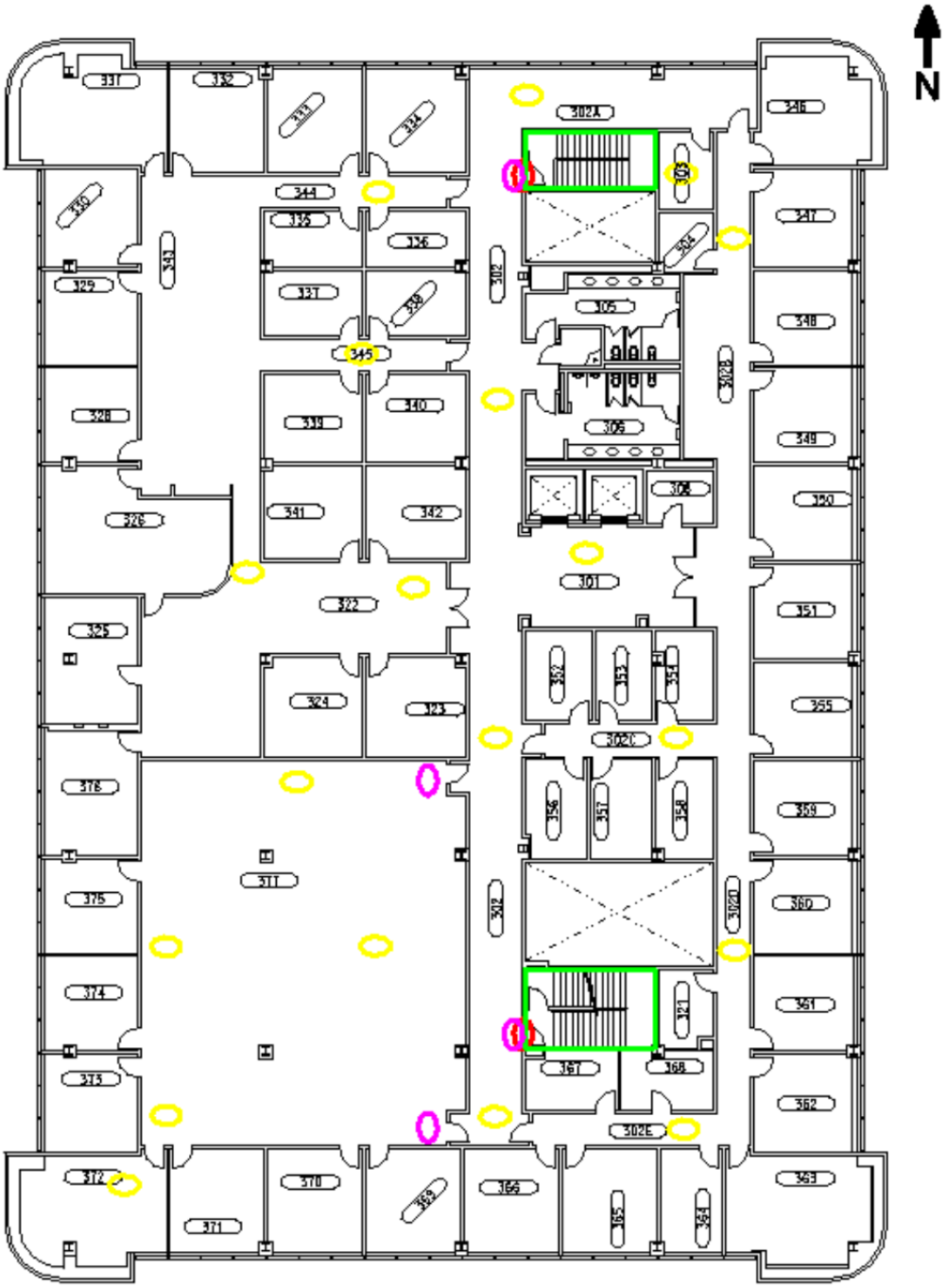


Figure 23: Emergency Light and Exit Sign Layout - Third Floor

Directional Exit Sign

Emergency Light

Door to Exit Stairway

Exit Stairway

4.3 – EMERGENCY MOVEMENT CALCULATIONS

Exit Capacities

The 2012 IBC describes how to size components of the means of egress system in section 1005. It states the following:

> ***1005.1 General.***
> *All portions of the means of egress system shall be sized in accordance with this section.*
> ***1005.2 Minimum width based on component.***
> *The minimum width, in inches (mm), of any means of egress components shall not be less than that specified for such component, elsewhere in this code.*

The IBC further provides the following *capacity factors* for certain components in Sections 1005.3.1 and 1005.3.2

> ***1005.3.1 Stairways.***
> *The capacity, in inches (mm), of means of egress stairways shall be calculated by multiplying the occupant load served by such stairway by a means of egress capacity factor of 0.3 inch (7.6 mm) per occupant. Where stairways serve more than one story, only the occupant load of each story considered individually shall be used in calculating the required capacity of the stairways serving that story.*
> ***1005.3.2 Other egress components.***
> *The capacity, in inches (mm), of means of egress components other than stairways shall be calculated by multiplying the occupant load served by such component by a means of egress capacity factor of 0.2 inch (5.1 mm) per occupant.*

The following tables identify the exit capacities for doors and stairways on each floor calculated per the 2012 IBC as discussed above.

Table 11: Exit Capacity - Basement

Basement			
Exit Component	**Clear Width (inches)**	**Capacity Factor for Exit Component (in/person)**	**Exit Capacity (# of People)**
North Stair	44	0.2	220
Center Stair	64	0.2	320
North Door	34	0.3	113
Center Door	34	0.3	113
South Door	34	0.3	113
Total Stair Capacity			*540*
Total Door Capacity			*339*

Table 12: Exit Capacity - First Floor

First Floor			
Exit Component	**Clear Width (inches)**	**Capacity Factor for Exit Component (in/person)**	**Exit Capacity (# of People)**
North Doorways	128	0.2	640
West Doorways	192	0.2	960
South Lobby Doorways	128	0.2	640
East Lobby Door	68	0.2	340
West Kitchen Door	68	0.2	340
East Cafeteria Door	34	0.2	170
West Cafeteria Door	68	0.2	340
Total Door Capacity			*3430*

Table 13: Exit Capacity - Second Floor

Second Floor			
Exit Component	**Clear Width (inches)**	**Capacity Factor for Exit Component (in/person)**	**Exit Capacity (# of People)**
North Stair	44	0.2	220
South Stair	64	0.2	320
North Door	34	0.3	113
South Door	34	0.3	113
Total Stair Capacity			*540*
Total Door Capacity			*226*

Table 14: Exit Capacity - Third Floor

Third Floor			
Exit Component	**Clear Width (inches)**	**Capacity Factor for Exit Component (in/person)**	**Exit Capacity (# of People)**
North Stair	44	0.2	220
South Stair	64	0.2	320
North Door	34	0.3	113
South Door	34	0.3	113
Total Stair Capacity			*540*
Total Door Capacity			*226*

Evacuation Times

The NFPA Handbook, Section 4, Chapter 2 outlines the calculations for evacuation times. This process uses two tables from the NFPA Handbook that provide exit element boundary layer information and the maximum specific flow through exit elements, shown in Tables 15 and 16, respectively.

Table 16: NFPA HB Table 4.2.4

TABLE 4.2.4 Boundary Layer Widths

Exit Route Element	Boundary Layer in.	Boundary Layer cm
Stairways—walls or side of tread	6.0	15
Railings, handrails*	3.5	9
Theater chairs, stadium benches	0.0	0
Corridor, ramp walls	8.0	20
Obstacles	4.0	10
Wide concourses, passageways	Up to 18	46
Door, archways	6.0	15

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

Table 15: NFPA HB Table 4.2.8

TABLE 4.2.8 Maximum Specific Flow, F_{sm}

Exit Route Element	Riser (in.)	Riser (mm)	Tread (in.)	Tread (mm)	Maximum Specific Flow: Persons/min/ft of Effective Width	Maximum Specific Flow: Persons/sec/m of Effective Width
Corridor, Aisle, Ramp, Doorway					24.0	1.30
Stairs						
	7.5	(190)	10	(254)	17.1	0.94
	7.0	(178)	11	(279)	18.5	1.01
	6.5	(165)	12	(305)	20.0	1.09
	6.5	(165)	13	(330)	21.2	1.16

Source: Table 3-14.5, *SFPE Handbook of Fire Protection Engineering*, 3rd edition, 2002. Courtesy Society of Fire Protection Engineers.

The time it takes to evacuate through the exit element is determined by multiplying the effective width in feet of that exit element by the maximum specific flow. Tables 17 through 20 show the calculated the time for that floor to evacuate out of the doorways available to that floor.

Table 17: Evacuation Time through Doorways - Basement

Basement						
Exit Component	**Clear Width (inches)**	**Boundary Layer NFPA HB Tbl 4.2.4**	**Effective Width (inches)**	**Effective Width Conversion (feet)**	**Maximum Specified Flow Rate NFPA HB Tbl 4.2.8**	**Maximum Flow (persons/min)**
North Stair	44	12	32	2.67	18.5	49
Center Stair	64	12	52	4.33	18.5	80
North Door	34	12	22	1.83	24	43
Center Door	34	12	22	1.83	24	43
South Door	34	12	22	1.83	24	43

Total # People per floor	80	People
Discharge rate through doors	129	People/Min
Time to exit through door	0.62	Minutes

Table 18: Evacuation Time through Doorways - First Floor

First Floor						
Exit Component	**Clear Width (inches)**	**Boundary Layer NFPA HB Tbl 4.2.4**	**Effective Width (inches)**	**Effective Width Conversion (feet)**	**Maximum Specified Flow Rate NFPA HB Tbl 4.2.8**	**Maximum Flow (persons/min)**
North Doorways	128	12	116	9.67	18.5	178
West Doorways	192	12	180	15	18.5	277
South Lobby Doorways	128	12	116	9.67	24	232
East Lobby Door	68	12	52	4.33	24	112
West Kitchen Door	68	12	52	4.33	24	112
East Cafeteria Door	34	12	22	1.83	24	43
West Cafeteria Door	68	12	52	4.33	24	112

Total # People per floor	1305	People
Discharge rate through doors	1066	People/Min
Time to exit through door	1.22	Minutes

Table 19: Evacuation Time through Doorways - Second Floor

Second Floor						
Exit Component	**Clear Width (inches)**	**Boundary Layer NFPA HB Tbl 4.2.4**	**Effective Width (inches)**	**Effective Width Conversion (feet)**	**Maximum Specified Flow Rate NFPA HB Tbl 4.2.8**	**Maximum Flow (persons/min)**
North Stair	44	12	32	2.67	18.5	49
South Stair	64	12	52	4.33	18.5	80
North Door	34	12	22	1.83	24	43
South Door	34	12	22	1.83	24	43

Total # People per floor	218	People
Discharge rate through doors	86	People/Min
Time to exit through door	2.53	Minutes

Table 20: Evacuation Time through Doorways - Third Floor

Third Floor						
Exit Component	**Clear Width (inches)**	**Boundary Layer NFPA HB Tbl 4.2.4**	**Effective Width (inches)**	**Effective Width Conversion (feet)**	**Maximum Specified Flow Rate NFPA HB Tbl 4.2.8**	**Maximum Flow (persons/min)**
North Stair	44	12	32	2.67	18.5	49
South Stair	64	12	52	4.33	18.5	80
North Door	34	12	22	1.83	24	43
South Door	34	12	22	1.83	24	43

Total # People per floor	224	People
Discharge rate through doors	86	People/Min
Time to exit through door	2.6	Minutes

The buildings egress components such as stairs, doors, lighting, and signage all meet the NFPA 101 requirements. Exit capacities through doorways and stairways in the building are all adequately sized for the occupancy loads of the floors. The next building system to be evaluated is the fire detection, alarm, and communication system.

5 – BUILDING FIRE DETECTION, ALARM, AND COMMUNICATIONS SYSTEMS

This building contains an automatic, wet sprinkler system that utilizes a fire detection system (heat and/or smoke detectors), an alarm system, a mass notification system, and a fire suppression system (sprinklers). The building also is equipped with an emergency lighting system and exit signage throughout, both with battery backup systems should there be a loss of power. The building is equipped with a Honeywell fire alarm and mass notification system that appears to meet all applicable code requirements. This system includes detection, initiation, and notification devices consisting of smoke detectors in elevator lobbies and kitchen storage and elevator, thermal/heat detectors in the kitchen area and roof penthouses for HVAC, duct smoke detectors, manual pull stations throughout, water flow devices, and tamper switches. Signals from these devices are transmitted using a Digital Alarm Communicator Trasmitter (DACT) to the Honeywell XLS1000 Fire Alarm Control Panel (FACP). These signals also activate notification appliances and transmit alarm signals to a 24 hour manned monitoring station. Power failure, low battery, and other system issues annunciate trouble conditions at the FACP and transmit trouble signals to the monitoring station. Duct smoke detectors shut down the air handling units in the basement of the building.

5.1 – Detection, Alarm, and Notification Systems

The smoke detection system, automatic sprinkler system, and alarm and annunciation system all work in conjunction with each other along with a 24 hour manned operations center and fire department. If there is an alarm within the building, several units including the fire department, the security operations center, and the facilities maintenance groups are all notified that there has been an alarm and what type of alarm is being transmitted. The building contains speaker/strobe alarms throughout all areas that allow instructions to be annunciated to all occupants.

Detection and Initiating Devices

Water flow devices are installed on the sprinkler system and will send an alarm signal when water flows in the system in accordance with NFPA 72 Section 17.12.

> ***17.12*** *Sprinkler Waterflow Alarm-Initiating Devices.*
> ***17.12.1**** The provisions of Section **17.12** shall apply to devices that initiate an alarm indicating a flow of water in a sprinkler system.*
> ***17.12.2**** Activation of the initiating device shall occur within 90 seconds of waterflow at the alarm-initiating device when flow occurs that is equal to or greater than that from a single sprinkler of the smallest orifice size installed in the system.*
> ***17.12.3*** *Movement of water due to waste, surges, or variable pressure shall not initiate an alarm signal.*

Figure 24: Typical Water Flow Device

Each of the four floors is equipped with a water flow device. Flow devices are shown in the drawings in Appendix B. A typical water flow device found in the building is shown in Figure 24.

Photoelectric smoke detectors are used in several locations in the building. Smoke detectors are used in the elevator lobbies on each of the floors. In the basement, additional smoke detectors are

installed within the elevator equipment room, kitchen storage area, and the kitchen freight elevator. Locations of smoke detectors can be found in the drawings in Appendix B and pertinent NFPA 72 Sections in Appendix E.

Fixed temperature/rate of rise heat detectors are used in the kitchen area and in the HVAC penthouses on the roof. These heat detectors activate at 135 degrees Fahrenheit or if the temperature rise is 15 degrees Fahrenheit every minute. Heat detectors are shown on the drawings in Appendix B.

Figure 25: Typical Detectors –Smoke, Heat, and Duct (L-R)

HVAC duct smoke detectors are installed in the air handler units located in the basement mechanical rooms. Should these devices activate, the air handling units will shut down to prevent the spread of smoke throughout the building. Locations of these devices can be found in the drawings in Appendix B.

Figure 26: Typical Manual Pull Station

The building is equipped with manual pull stations throughout the building. These manual pull stations are installed in accordance with NFPA 72, section 17.14 and the layout of these devices can be found in the drawings in Appendix B.

17.14 Manually Actuated Alarm-Initiating Devices.

17.14.1 *Manually actuated alarm-initiating devices for initiating signals other than for fire alarm shall be permitted if the devices are differentiated from manual for fire alarm boxes by a color other than red and labeling.*

17.14.2 *Combination manual fire alarm boxes and guard's signaling stations shall be permitted.*

17.14.3 *Manually actuated alarm-initiating devices shall be securely mounted.*

17.14.4 *Manually actuated alarm-initiating devices shall be mounted on a background of contrasting color.*

17.14.5 *The operable part of a manually actuated alarm-initiating device shall be not less than 42 in. (1.07 m) and not more than 48 in. (1.22 m) from the finished floor.*

17.14.6 *Manually actuated alarm-initiating devices shall be permitted to be single action or double action.*

17.14.7* *Listed protective covers shall be permitted to be installed over single- or double-action manually actuated alarm-initiating devices.*

17.14.8 *Manual fire alarm boxes shall comply with **17.14.8.1** through **17.14.8.6**.*

17.14.8.1 *Manual fire alarm boxes shall be used only for fire alarm initiating purposes.*

17.14.8.2 *Manual fire alarm boxes shall be installed so that they are conspicuous, unobstructed, and accessible.*

17.14.8.3* *Unless installed in an environment that precludes the use of red paint or red plastic, manual fire alarm boxes shall be red in color.*

17.14.8.4 *Manual fire alarm boxes shall be located within 5 ft (1.5 m) of each exit doorway on each floor.*

17.14.8.5* *Additional manual fire alarm boxes shall be provided so that the travel distance to*

the nearest manual fire alarm box will not exceed 200 ft (61 m), measured horizontally on the same floor.

17.14.8.6 *Manual fire alarm boxes shall be mounted on both sides of grouped openings over 40 ft (12.2 m) in width, and within 5 ft (1.5 m) of each side of the grouped opening*

Notification Appliances

The building is equipped with wall mounted speaker-strobes throughout and they are installed in accordance with the applicable sections of NFPA 72, found below and in Appendix E. These combine audible and visual signals meet the requirements of both the audible and visible sections in NFPA 72 in a single device. These units were installed in accordance with the following table and diagram from section 18.5 of NFPA 72. Data sheets for the speaker strobes can be found in Appendix D.

Figure 27: Typical Notification Device

Table 21: NFPA 72 Table 18.5.5.4.1 (a) - Room Spacing for Wall-Mounted Visible Appliances

Table 18.5.5.4.1(a) Room Spacing for Wall-Mounted Visible Appliances

Maximum Room Size		Minimum Required Light Output [Effective Intensity (cd)]	
ft	m	One Light per Room	Four Lights per Room (One Light per Wall)
20 × 20	6.10 × 6.10	15	NA
28 × 28	8.53 × 8.53	30	NA
30 × 30	9.14 × 9.14	34	NA
40 × 40	12.2 × 12.2	60	15
45 × 45	13.7 × 13.7	75	19
50 × 50	15.2 × 15.2	94	30
54 × 54	16.5 × 16.5	110	30
55 × 55	16.8 × 16.8	115	30
60 × 60	18.3 × 18.3	135	30
63 × 63	19.2 × 19.2	150	37
68 × 68	20.7 × 20.7	177	43
70 × 70	21.3 × 21.3	184	60
80 × 80	24.4 × 24.4	240	60
90 × 90	27.4 × 27.4	304	95
100 × 100	30.5 × 30.5	375	95
110 × 110	33.5 × 33.5	455	135
120 × 120	36.6 × 36.6	540	135
130 × 130	39.6 × 39.6	635	185

NA: Not allowable.

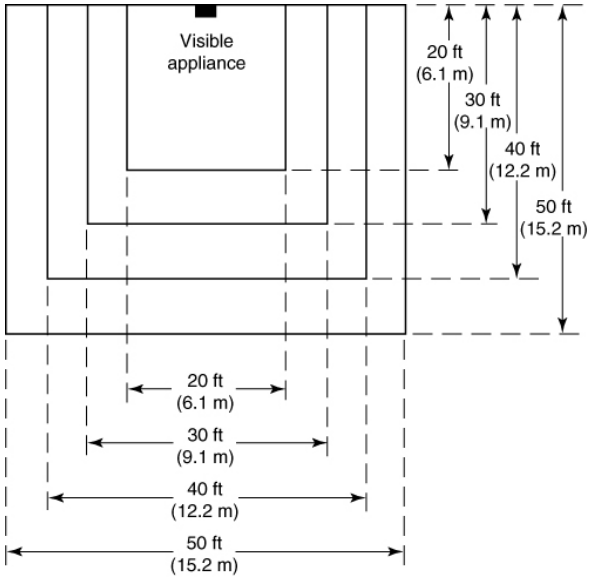


Figure 28: NFPA 72 Figure 18.5.5.4.1 - Room Spacing for Wall-Mounted Visible Appliances

General audible requirements for notification appliances are outlined in Section 18.4.1 of NFPA 72 and are shown here. Additional pertinent sections of NFPA 72 can be found in Appendix E.

18.4.1 General Requirements.

18.4.1.1* *An average ambient sound level greater than 105 dBA shall require the use of a visible notification appliance(s) in accordance with Section* ***18.5*** *where the application is public mode or Section* ***18.6*** *where the application is private mode.*

18.4.1.2* *The total sound pressure level produced by combining the ambient sound pressure level with all audible notification appliances operating shall not exceed 110 dBA at the minimum hearing distance.*

18.4.1.3* *Sound from normal or permanent sources, having a duration greater than 60 seconds, shall be included when measuring maximum ambient sound level. Sound from temporary or abnormal sources shall not be required to be included when measuring maximum ambient sound level.*

18.4.1.4 *Audible notification appliances for alert and evacuation signal tones shall meet the requirements of*

18.4.3 *(Public Mode Audible Requirements),* ***18.4.4*** *(Private Mode Audible Requirements),* ***18.4.5*** *(Sleeping Area Requirements), or* ***18.4.6*** *(Narrow Band Tone Signaling for Exceeding Masked Thresholds), as applicable.*

18.4.1.4.1* *The designer of the audible notification system shall identify the rooms and spaces that will have audible notification and those where audible notification will not be provided.*

18.4.1.4.2* *Unless otherwise required by other sections of this Code, the coverage area for audible occupant notification shall be as required by other governing laws, codes, or standards. Where the other governing laws, codes, or standards require audible occupant notification for all or part of an area or space, coverage shall only be required in occupiable areas as defined in* ***3.3.178****.*

18.4.1.4.3 *The sound pressure levels that must be produced by the audible appliances in the coverage areas to meet the requirements of this Code shall be documented by the system designer during the planning and design of the notification system. The greater of the expected average ambient sound pressure level or expected maximum sound pressure level having a duration of at least 60 seconds shall also be documented for the coverage area by the system designer to ensure compliance with* ***18.4.3****,* ***18.4.4****,* ***18.4.5****, or* ***18.4.6*** *for the coverage area.*

18.4.1.4.4 *The design sound pressure levels to be produced by the notification appliances for the various coverage areas shall be documented for use during acceptance testing of the system.*

18.4.1.4.5 *Where required by the authority having jurisdiction, documentation of the design sound pressure levels for the various coverage areas shall be submitted for review and approval.*

18.4.1.5* *Voice messages shall not be required to meet the audibility requirements of* ***18.4.3*** *(Public Mode Audible Requirements),* ***18.4.4*** *(Private Mode Audible Requirements),* ***18.4.5*** *(Sleeping Area Requirements), or* ***18.4.6*** *(Narrow Band Tone Signaling for Exceeding Masked Thresholds), but shall meet the intelligibility requirements of* ***18.4.10*** *where voice intelligibility is required.*

General visible requirements for notification appliances are outlined in Section 18.5.1 of NFPA 72 and are shown here.

18.5* Visible Characteristics — Public Mode.

18.5.1* Visible Signaling.

18.5.1.1 *Public mode visible signaling shall meet the requirements of Section* ***18.5*** *using visible notification appliances.*

18.5.1.2* *The coverage area for visible occupant notification shall be as required by other governing laws, codes, or standards. Where the other governing laws, codes, or standards require visible occupant notification for all or part of an area or space, coverage shall only be required in occupiable areas as defined in* ***3.3.178****.*

5.2 – Power Supply for Detection, Alarm, and Notification Systems

The building is equipped with commercial power supply. Power is split into two forms within the building. One form of power is tech power and there is an Uninterruptible Power Supply System (UPSS) that will activate should commercial power be lost. Critical systems, such as the fire alarm, detection, and communications systems along with other operational critical equipment, are maintained on the tech power side so that systems are not affected due to a loss of commercial power. Section 10.6.4 of NFPA outlines the requirements of this type of power supply system for the alarm, detection, and notification systems and the building system is compliant. Additional information for voltage calculations and power supply code can be found in Appendices C and E.

10.6.4 Uninterruptible Power Supplies (UPS).

10.6.4.1 *The UPS device shall be configured in compliance with* ***NFPA 111****, Standard on Stored Electrical Energy Emergency and Standby Power Systems, for a Type 0, Class 24, Level 1 system.*

10.6.4.2 *The UPS device shall comply with the requirements of* ***10.6.5****.*

10.6.4.3 *Failure of the UPS shall result in the initiation of a trouble signal in accordance with Section* ***10.15****.*

The detection, alarm, and communications systems meet the requirements set forth in NFPA 72. These systems play a major role in the fire protection systems as a whole and provide valuable information to the wet-pipe fire suppression system.

6 – FIRE SUPPRESSION SYSTEMS

This building contains an automatic wet pipe sprinkler system that utilizes an alarm system, a mass notification system, and a fire suppression system (sprinklers). The sprinkler piping enters the building on the South end and there are two dry standpipes, one entering the South end and the other of the North end of the building, for fire department connections on each floor.

6.1 – Building Water Supply

Water Supply Information

There is a single water supply pipe that enters the building on the South side in the basement Mechanical room. The riser associated with the sprinkler system runs vertically up the South side of the building. The most recent test was conducted in 2013 and the following flow data was produced.

Static Pressure: 95 psi

Residual Pressure: 87 psi

Flow: 1119 gpm

Fire Department Connections

There are two dry stand pipes for fire department connections. One enters the building in the same location as the sprinkler supply line on the South side of the building and the other on the North end of the building, as shown in Figure 29. Each riser for the fire department connection runs vertically up in the stairways of the building with connection points on each floor.

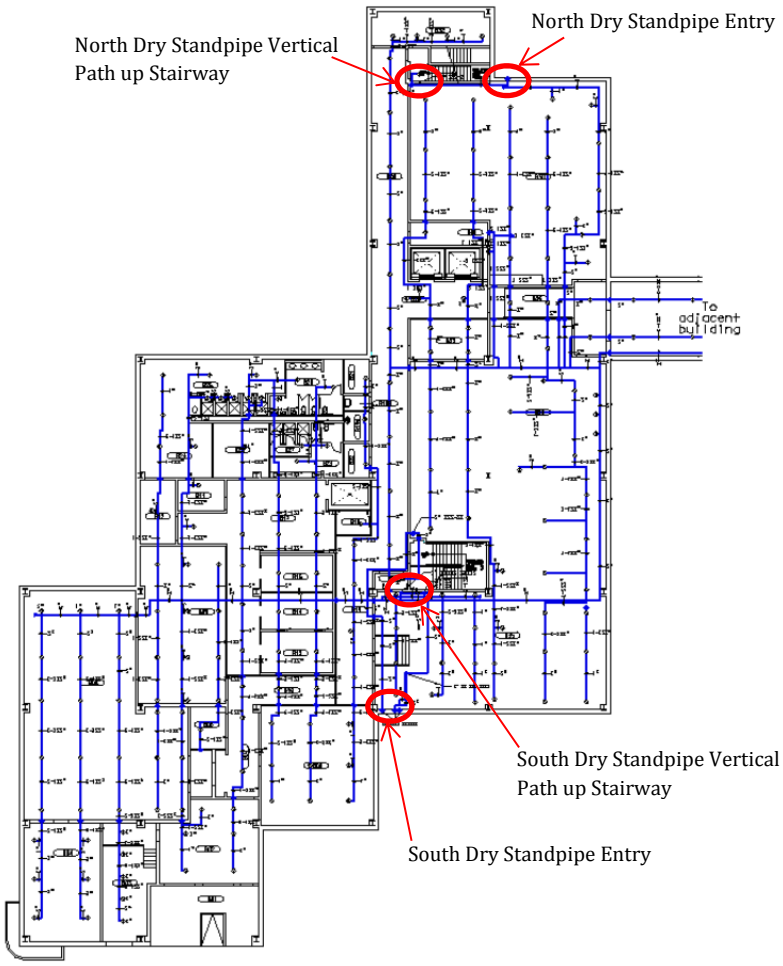


Figure 29: Dry Standpipe Locations

6.2 – Automatic Sprinkler Systems

This building is protected throughout with an automatic wet sprinkler system. Viking standard response pendent and upright heads with glass bulbs are used throughout, although there are various temperature ratings based on the hazard classification.

Victaulic fittings are used throughout the system and there is an Ames Double Check Assembly on the sprinkler supply piping once it enters the building. Additional information on some of the components can be found in Appendix H.

6.3 – Hazard Classification and Associated Design Criteria

The building is mainly classified as light hazard but there are a few areas within the building that are considered Ordinary Hazard 1 or 3. Tables 22 through 25 outline hazard classifications and associated design criteria for this building.

Table 22: Hazard Classifications and Associated Design Criteria - Basement

Basement								
Room/Area	Hazard Classification	Wet or Dry Pipe Sprinkler System	Density (GPM/sqft) (Minimum)	Sprinkler System Hydraulic Design Area (sqft)	Sprinkler Heads			
					Spacing (sqft) (Maximum)	Temp (Degree F)	Position	Kind
Storage	Ordinary Hazard Group 1	Wet	0.15	3000	130	212	Pendent	Chrome
Trash Room	Ordinary Hazard Group 3	Wet	0.25	3000	100	165	Upright	Brass
Mech & Elec Rooms	Ordinary Hazard Group 1	Wet	0.15	3000	130	212	Upright	Brass
All other areas, corridors	Light Hazard	Wet	0.10	3000	150	165	Pendent	Chrome

Table 23: Hazard Classifications and Associated Design Criteria - First Floor

First Floor								
Room/Area	Hazard Classification	Wet or Dry Pipe Sprinkler System	Density (GPM/sqft) (Minimum)	Sprinkler System Hydraulic Design Area (sqft)	Sprinkler Heads			
					Spacing (sqft) (Maximum)	Temp (Degree F)	Position	Kind
Kitchen & ancillary room	Ordinary Hazard Group 1	Wet	0.15	3000	130	212	Pendent	Chrome
Back Projection Room	Ordinary Hazard Group 1	Wet	0.15	3000	130	165	Pendent	Chrome
All other areas	Light Hazard	Wet	0.10	3000	150	165	Pendent, Upright	Chrome Brass

Table 24: Hazard Classifications and Associated Design Criteria - Second Floor

Second Floor								
Room/Area	Hazard Classification	Wet or Dry Pipe Sprinkler System	Density (GPM/sqft) (Minimum)	Sprinkler System Hydraulic Design Area (sqft)	Sprinkler Heads			
					Spacing (sqft) (Maximum)	Temp (Degree F)	Position	Kind
All Areas	Light Hazard	Wet	0.10	3000	150	165	Pendent	Chrome

Table 25: Hazard Classifications and Associated Design Criteria - Third Floor

Third Floor								
Room/Area	Hazard Classification	Wet or Dry Pipe Sprinkler System	Density (GPM/sqft) (Minimum)	Sprinkler System Hydraulic Design Area (sqft)	Sprinkler Heads			
					Spacing (sqft) (Maximum)	Temp (Degree F)	Position	Kind
All Areas	Light Hazard	Wet	0.10	3000	150	165	Pendent	Chrome

6.4 – Calculations

The following hydraulic calculations were performed for an office area on the third floor, as shown in the figure below. Refer to Appendix G for manual calculation sheets.

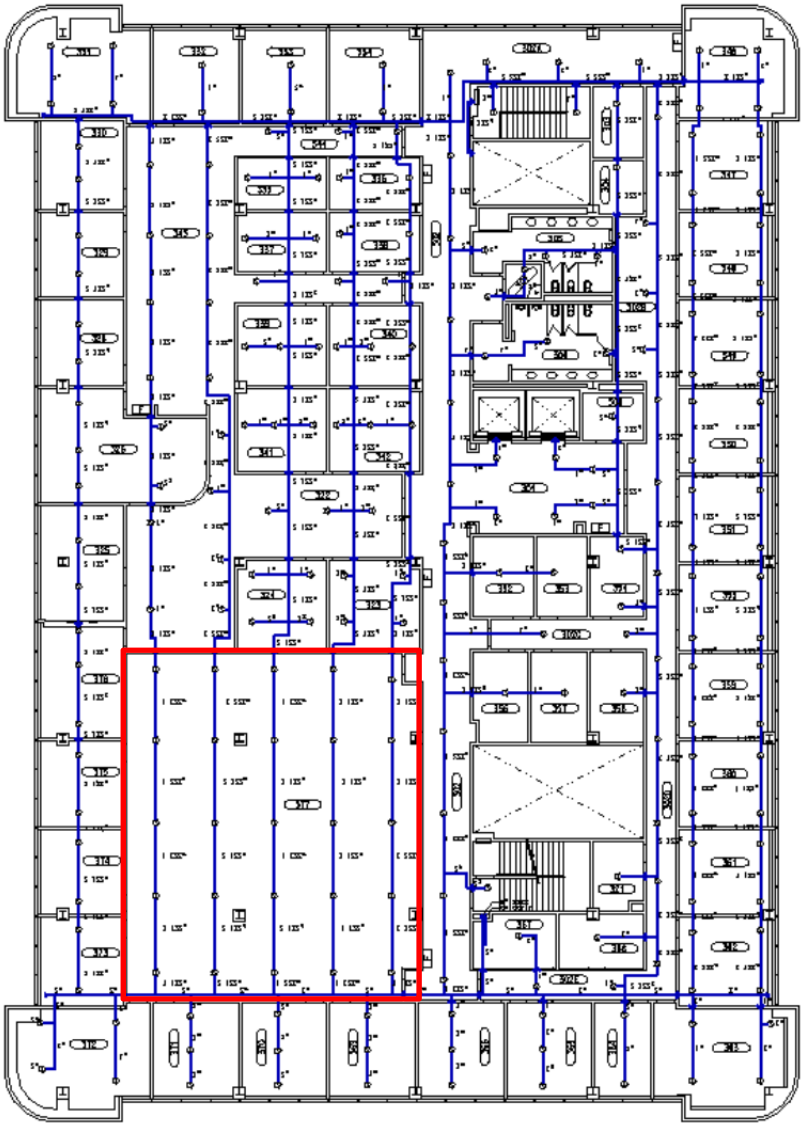


Figure 30: Hydraulic Calculation Location

Remote area is determined to be 2900 square feet with 25 of sprinklers operating. The maximum area of coverage for each sprinkler is 150 square feet. Sprinklers are pendent style, standard response with a K-factor of 5.6. Branch lines are schedule 40 black steel pipe with 1 ½" diameter. Main lines are schedule 40 black steel pipe with 3" diameter.

Manual Hydraulic Calculations

- Refer to Appendix G for manual calculation sheets.
- Office 377
- Hazard Classification – Light Hazard
- Design Criteria
- Density = 0.10 gpm/ft^2
- Area of Operation = 3000 ft^2
- Max area per sprinkler = 150 ft^2
- Area of Room = 2900 ft^2
- Demand at riser location = 251.2 gpm, 15.4 psi

For this area of the building the demand on the system falls well within the hydrant test performance. Figure 31 illustrates the demand of the remote area versus the available water supply curve.

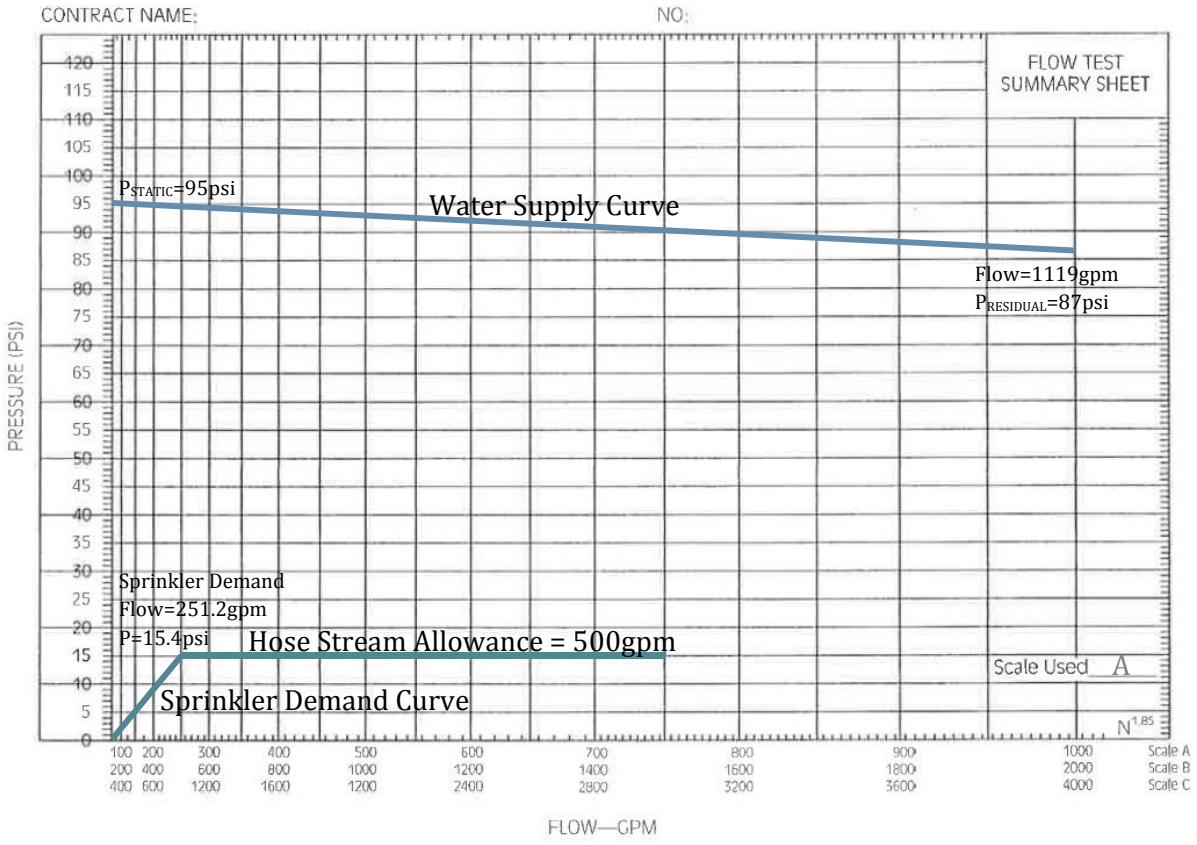


Figure 31: Water Supply-Demand Curve

The building is equipped with a wet-pipe fire sprinkler system, along with two dry standpipes for fire department connections on each floor. This fire suppression system was installed according to NFPA 13 and there is more than adequate water supply for this building. It is also maintained, tested, and inspected as required by NFPA 25.

7 - INSPECTION, TESTING, AND MAINTENANCE

7.1 – Fire Detection, Alarm, and Communications Systems

Requirements for the inspection, testing, and maintenance of fire alarm, detection, and communications systems can be found in NFPA 72, Chapter 14. Visual inspection should occur on a regular basis and Table 14.3.1 in NFPA 72 outlines the component, frequency, and method for visual inspection. Fire alarm, detection, and communications systems should also be tested at certain intervals during its serviceable life. Table 14.4.3.2 in NFPA 72 outlines specific components that need to be tested, the frequency they should be tested and the method of testing that component. The building is maintained and tested per the manufacturer's guidelines and in accordance with NFPA 72, Chapter 14. Additional NFPA 72 sections regarding inspection, testing, and maintenance of the detection, alarm, and communications systems can be found in Appendix I.

7.2 – Automatic Sprinkler Systems

Routine system maintenance and testing is performed through an off-site contractor and approved/observed by the Authority Having Jurisdiction (AHJ). General observations of the system are completed during routine building maintenance by the Facilities Operations and Maintenance team. All inspection, maintenance, and testing of the sprinkler system is done in accordance with NFPA 25. Any time that a space within the building is modified, hydraulic calculations and drawings are completed and stamped by a NICET Level 3 person through the off-site contractor and approved by the AHJ prior to any system modifications. Additional inspection and testing is done as needed based on the number of sprinkler heads affected during the modification.

Table 26 indicates applicable components and the standard care and maintenance with respect to the building. Additional NFPA 25 information can be found in Appendix J.

Table 26: System Components and Standard Care and Maintenance

Component	Standard Care and Maintenance
Base Water Main	Maintained by Air Force Installation personnel Visual inspection to be completed quarterly
Pipes and Fittings	Inspections completed by sprinkler contractor Inspection of piping and supports to be completed annually or when occupancy changes or modifications are done to the building.
Valves and Gauges	Visual inspections completed by Facility Operations & Maintenance personnel. Routine inspections completed by Base Fire Marshal. Visual inspections should be conducted quarterly.

Waterflow Alarm Devices and Supervisory Signal Devices	Visual inspections completed by Base Fire Marshal. Routine testing completed by sprinkler contractor. Visual inspections should be conducted quarterly. Routine testing should be completed quarterly or semiannually based on type of device.
Signs	Inspections completed by sprinkler contractor. Inspection of signs to be conducted annually.
Sprinklers	Visual observation completed by Facility Operations & Maintenance personnel. Routine inspections completed by the sprinkler contractor. Inspections should be conducted annually. Routine testing should be completed after 20 years and every 10 years thereafter.

Both the detection, alarm, and communications systems and the automatic sprinkler system are inspected, tested, and maintained in accordance with the respective NFPA codes, 72 and 25. All pertinent prescriptive based requirements have been evaluated so the performance based evaluation will now be looked at to include tenability conditions and required versus available safe egress times for two fire scenarios selected for this building.

8 – Performance-Based Analysis

The performance-based design of a building shall meet the goals and objectives of the LSC per section 5.1.2. The goals and objectives of the code are outlined in sections 4.1 and 4.2 and state the following:

> ***4.1* Goals.***
>
> ***4.1.1* Fire.*** *A goal of this Code is to provide an environment for the occupants that is reasonably safe from fire by the following means:*
>
> *(1)* Protection of occupants not intimate with the initial fire development*
>
> *(2) Improvement of the survivability of occupants intimate with the initial fire development*
>
> ***4.1.2* Comparable Emergencies.*** *An additional goal is to provide life safety during emergencies that can be mitigated using methods comparable to those used in case of fire.*
>
> ***4.1.3* Crowd Movement.*** *An additional goal is to provide for reasonably safe emergency crowd movement and, where required, reasonably safe nonemergency crowd movement.*
>
> ***4.2 Objectives.***
>
> ***4.2.1 Occupant Protection.*** *A structure shall be designed, constructed, and maintained to protect occupants who are not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place.*
>
> ***4.2.2 Structural Integrity.*** *Structural integrity shall be maintained for the time needed to evacuate, relocate, or defend in place occupants who are not intimate with the initial fire development.*
>
> ***4.2.3 Systems Effectiveness.*** *Systems utilized to achieve the goals of Section **4.1** shall be effective in mitigating the hazard or condition for which they are being used, shall be reliable, shall be maintained to the level at which they were designed to operate, and shall remain operational.*

These goals and objectives were kept in mind while analyzing the building from a performance-based perspective.

8.1 – Tenability Criteria

The effects of smoke obscuration, toxicity of combustion products, and temperature can have a severe adverse effect on occupants if they are exposed to any or all of these conditions. Therefore, certain criteria must be selected to ensure that occupants are provided a safe egress path before the fire creates untenable conditions.

Carbon Monoxide – 1100 ppm

Carbon monoxide is one of many combustion products that are toxic to occupants but it tends to have the most significant effect on occupants and therefore will be the focus of the toxic combustion products. The effects and times to incapacitation for CO expose can widely vary from person to person and the amount of CO produced by the fire will be dependent on type, size, and ventilation of the fire. For this building, the CO concentration was selected to be 1100 ppm. Figure 32 shows a graphical representation of time to incapacitation versus CO concentration and at the selected concentration, it will take approximately 22 minutes for an occupant to become incapacitated.

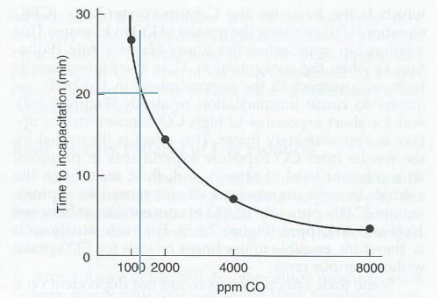


Figure 2-6.5. *Relationship between time to incapacitation and carbon monoxide concentration in active monkeys. 1000 ppm Ct = 26,600 ppm·min; 2000 ppm Ct = 28,097 ppm·min; 4000 ppm Ct = 26,868 ppm·min; 8000 ppm Ct = 26,086 ppm·min.*

Figure 32: SFPE Handbook, 4th Ed Fig 2-6.5

Visibility – 4 meters/6 meters

Occupants will likely assess the visibility of the path ahead of them to determine if it is safe to traverse or not. For the third floor office fire, a visibility criterion of 4 meters was selected based on the fact that occupants in this area will be very familiar with the space and where the exits are located and that the area is restricted to only the occupants who work there. This means that there should not be occupants in the area that are unfamiliar with the layout. The convenience store fire is a different situation and it is entirely possible that there will be occupants unfamiliar with the building in the vicinity of the fire so a visibility criterion of 6 meters was chosen for that scenario.

Temperature – 60°C

The temperature that an occupant perceives will determine if that occupant egresses or not. Temperature can cause incapacitation and even death in three ways; heat stroke (increase in core body temperature, physically burning the occupant, and burning the respiratory airways of the occupant. The temperature that an occupant can withstand for a given period of time is dependent on the occupant and the surrounding environment. As this building is located in Colorado where the environmental conditions are most commonly cool, dry air, humid air temperature exposure will not be considered. At a temperature of 60°C, an occupant should be able to move through an area at that temperature without suffering long-term damage from the thermal exposure so this will be the temperature criteria used.

8.2 – Fire Scenario 1: Office Workstation

The first fire scenario is an office workstation fire and was selected as it presents a typical situation within the building. The source of the fire is electrical in nature. The building facility specification does not allow occupants to plug in or use space heaters but Facility Operations and Maintenance technicians frequently find these being used in the building so this is the source of the fire. Data shown in Figure 33 from the 4th Edition SFPE Handbook was used to determine the heat release rate curve and fire growth.

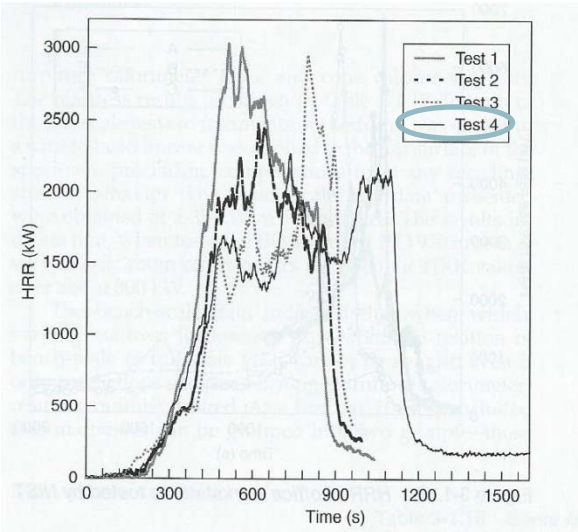


Figure 3-1.61. *HRR of four unit workstations tested at NRIFD.*

Figure 33: HRR Data from SFPE Handbook, 4th Ed.

The area is an open area with cubicles throughout the space as shown in Figure 34 on the next page. There are two doors from the cubicle area that will lead occupants to a hallway and exit stairway. The two doors are always closed and restrict access into the space but are not locked in the direction of egress at any time.

Several assumptions were made for this scenario and are as follows;

- There is no one in the particular cubicle where the fire starts when it starts so it is allowed to grow to a point where personnel evacuate the area instead of trying to put the fire out.
- There are no heat or smoke detectors in the area so personnel in the area pull the manual pull station once they are aware of the fire and see smoke.
- Personnel do not attempt to fight the fire so it is allowed to grow as indicated in Figure 34 until the sprinkler located above the workstation activates. Once this occurs, the fire is maintained at a constant HRR for the duration of the scenario.
- Entry/exit doors into the area are closed except during occupant egress.

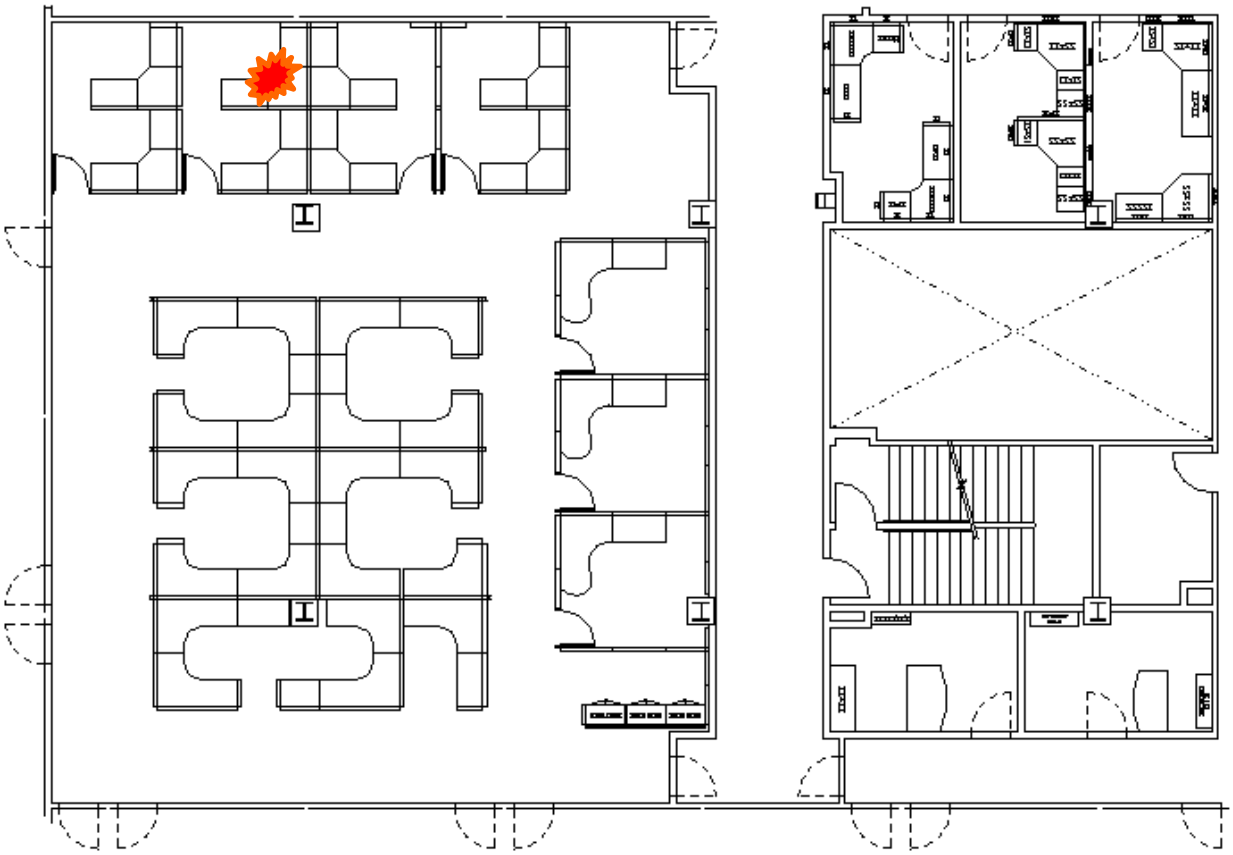


Figure 34: Office Layout & Fire Location for Workstation Fire

Required Safe Egress Time – Office Workstation Fire

As there are no detectors in this area, it is left up to the occupants to detect and determine a response for the fire. Based on FDS simulations, smoke starts to become evident at approximately 60 seconds after ignition, as shown in Figure 35.

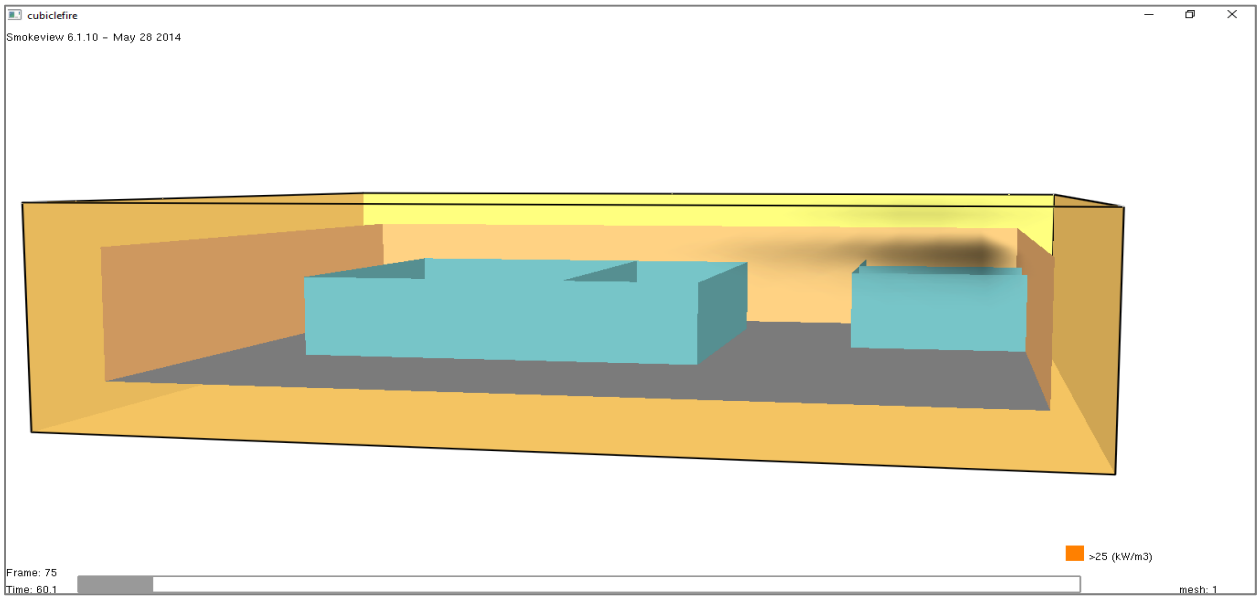


Figure 35: Visible Smoke at t=60 Seconds for Office Workstation Fire

At this time of 60 seconds, occupants will begin to assess the situation and decide to use one of the manual pull stations in the area. It will take another 60 seconds for personnel to assess what is going on and then activate the pull station assuming they will be trying to alert other occupants as they make their way to the pull station. Once the pull station is activated the alarms will sound and personnel will begin the evacuation process which includes the decision to evacuate. Personnel will first try to determine if evacuation is necessary. This evacuation decision should reasonably take up to 30 seconds. It will take another 60 seconds for personnel to secure materials around their work areas and begin evacuating. It will take another 156 seconds for personnel on the third floor to get out the exit doors and into the stairways as shown in section 4.3 of this report. Since the fire will be secluded to one area with the doors closed, it is assumed that personnel will continue to evacuate to the exterior of the building but will be out of eminent danger so the total required safe egress time of 366 seconds, as shown in Figure 36, is calculated to the point of entry into the stairways.

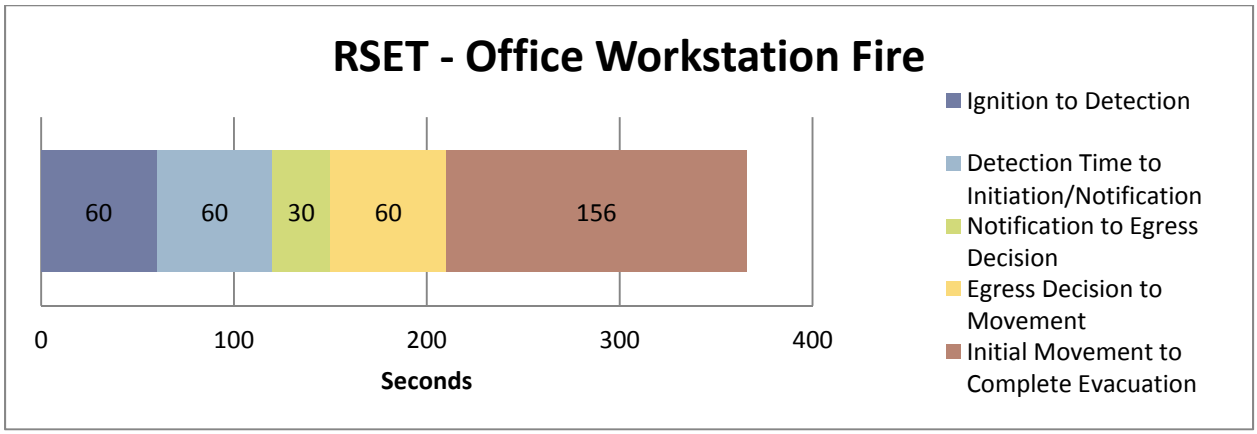


Figure 36: Required Safe Egress Time for Office Workstation Fire

Available Safe Egress Time (ASET)

ASET – Carbon Monoxide

Figure 37 indicates the CO levels within the office area do not deteriorate at any time during the simulation. The units shown in the figure are kg/kg * 10^{-5} and even at the simulation completion time of 800 seconds, the CO level does not increase over 9.50 kg/kg * 10^{-5} or the equivalent of 95ppm.

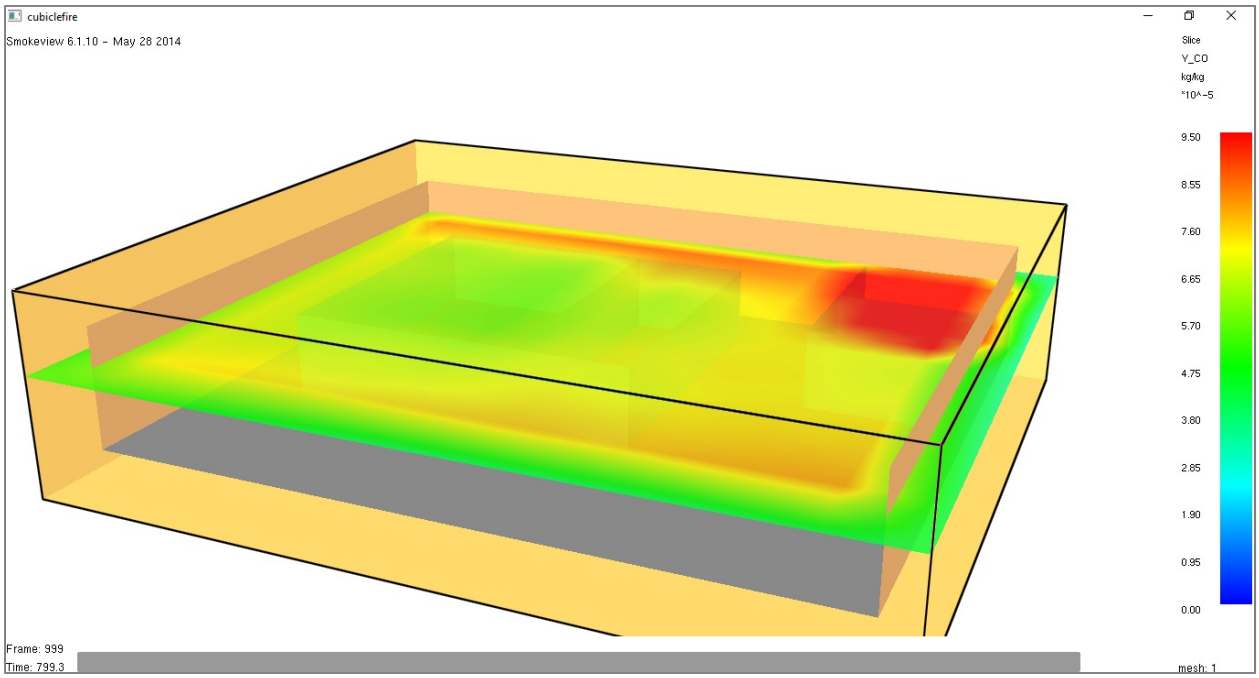


Figure 37: CO Concentration at 800 Seconds

ASET – Visibility

Visibility begins to drop below 4 meters around the perimeter of the room at a time of 475 seconds, as shown in Figure 38. This drop in visibility is well beyond the required safe egress time.

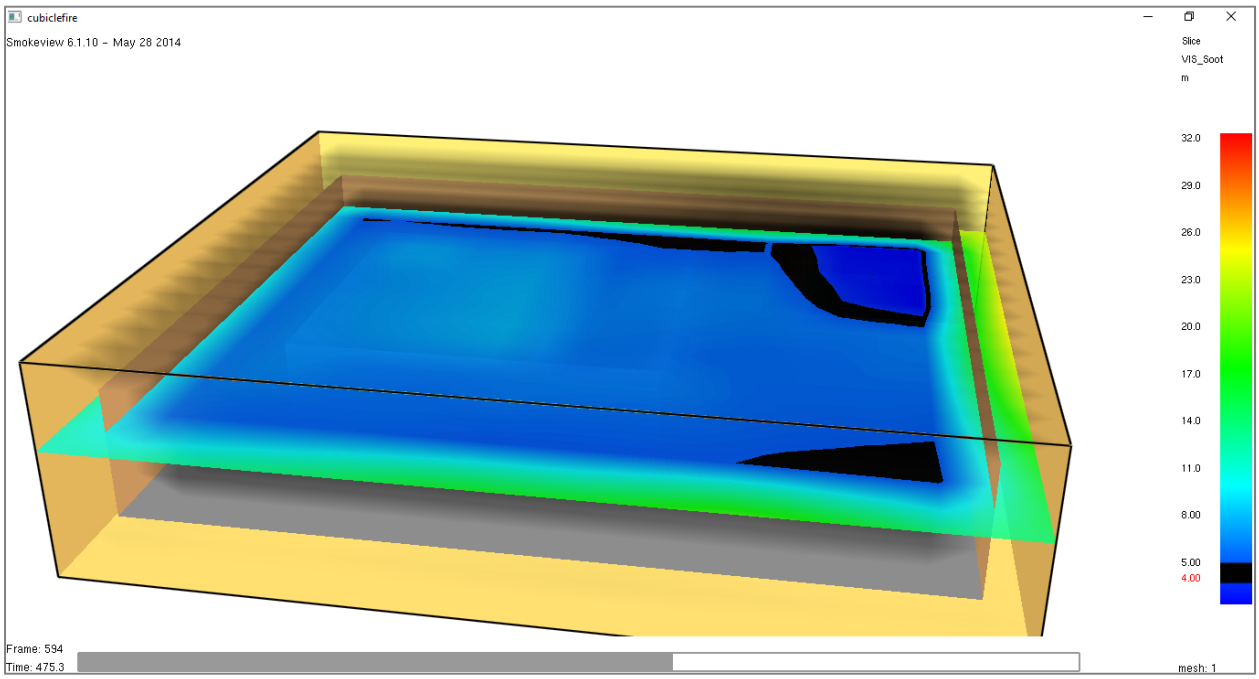


Figure 38: Visibility Dropping Below 4 Meters

ASET – Temperature

The temperature in the area of the office that is directly above the fire location reaches 60°C at 335 seconds, as shown in Figure 39. Even at the end of the RSET, 366 seconds, only the area above the fire location reached the tenable temperature criteria of 60°C. Temperature at RSET is shown in Figure 40.

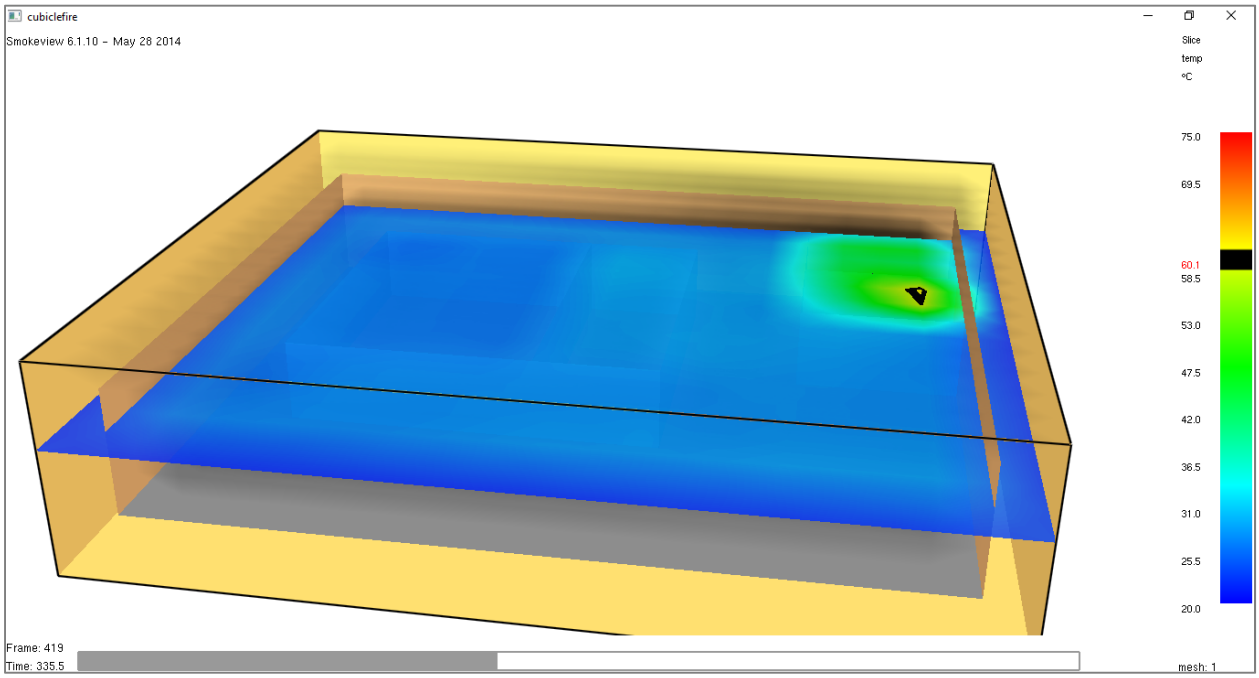


Figure 39: Temperature Reaching 60 Degrees Celsius

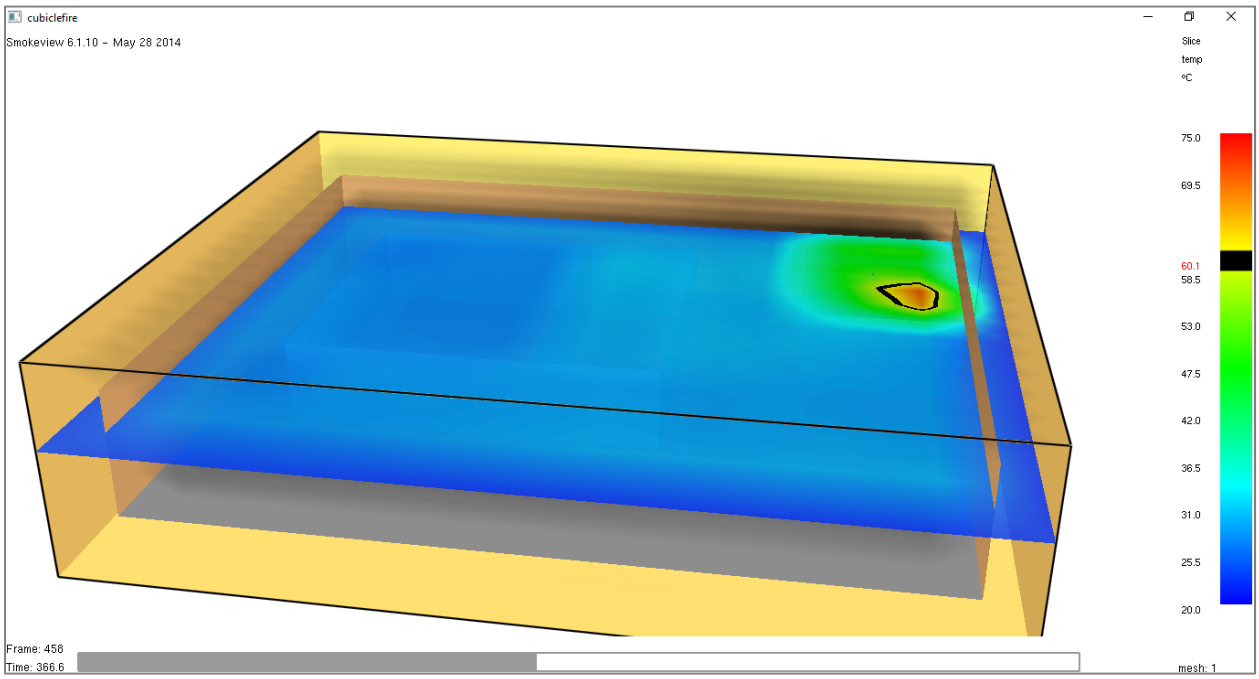


Figure 390: Temperature at RSET (366 s)

There were no tenability issues with this fire scenario. Both visibility and temperature limits were reached beyond the required safe egress time and at no point during the simulation did the carbon monoxide levels elevate to untenable conditions.

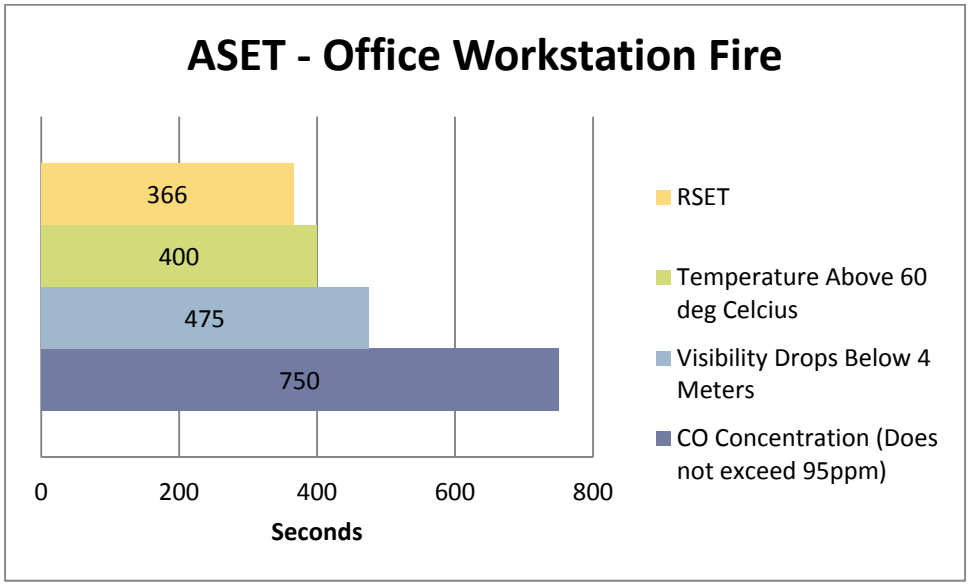


Figure 40: Available Safe Egress Time for Office Workstation Fire

8.3 – Fire Scenario 2: Convenience Store

The second fire scenario is a fire in the convenience store and was selected to analyze how smoke would move through the main lobby area. The source of the fire is electrical in nature. There is a lot of powered refrigeration equipment in the convenience store and it is possible to overload the circuit causing electrical sparks to start the fire. Data shown in Figure 42 from the 4th Edition SFPE Handbook was used to determine the heat release rate curve and fire growth.

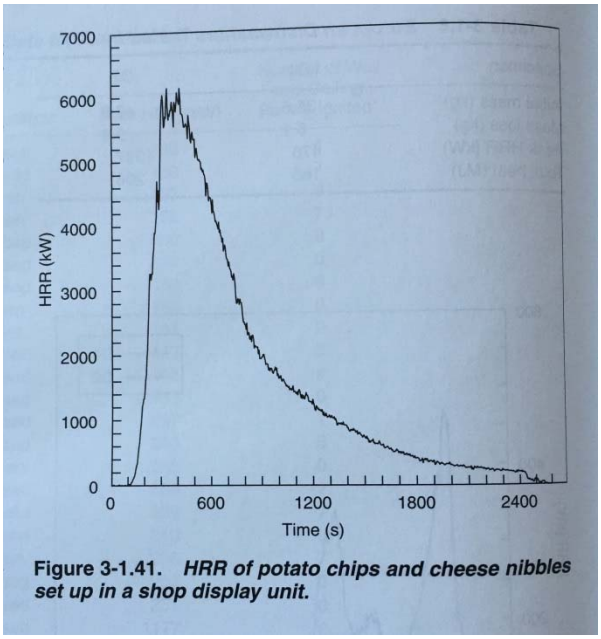


Figure 412: SFPE Handbook Fig 3-1.41

Several assumptions were made for this scenario and are as follows;

- There are no heat or smoke detectors in the area so personnel in the area pull the manual pull station once they are aware of the fire and see smoke.
- Personnel do not attempt to fight the fire so it is allowed to grow until the sprinkler located above the fire activates. Once this occurs, the fire is maintained at a constant HRR for the duration of the scenario.
- The information provided in the 4th edition of the SFPE handbook shows a rapidly growing, very large fire. Due to the size of the convenience store and the ceiling height, the fire HRR was reduced to a maximum of 2000 kW. Fire growth time was maintained.

- Fire occurs during normal business hours so the fire is detected by occupants and a pull station is activated to being the evacuation process.
- The store entrance door is a sliding door and is always open during business hours.
- No one is in the small office/storage room when the fire starts.
- The small office/storage room door is open within the convenience store.
- Smoke fills the small office/storage room and begins moving into the store area before personnel notice.

Figure 43 identifies the location of the fire within the small office/storage area in the convenience store.

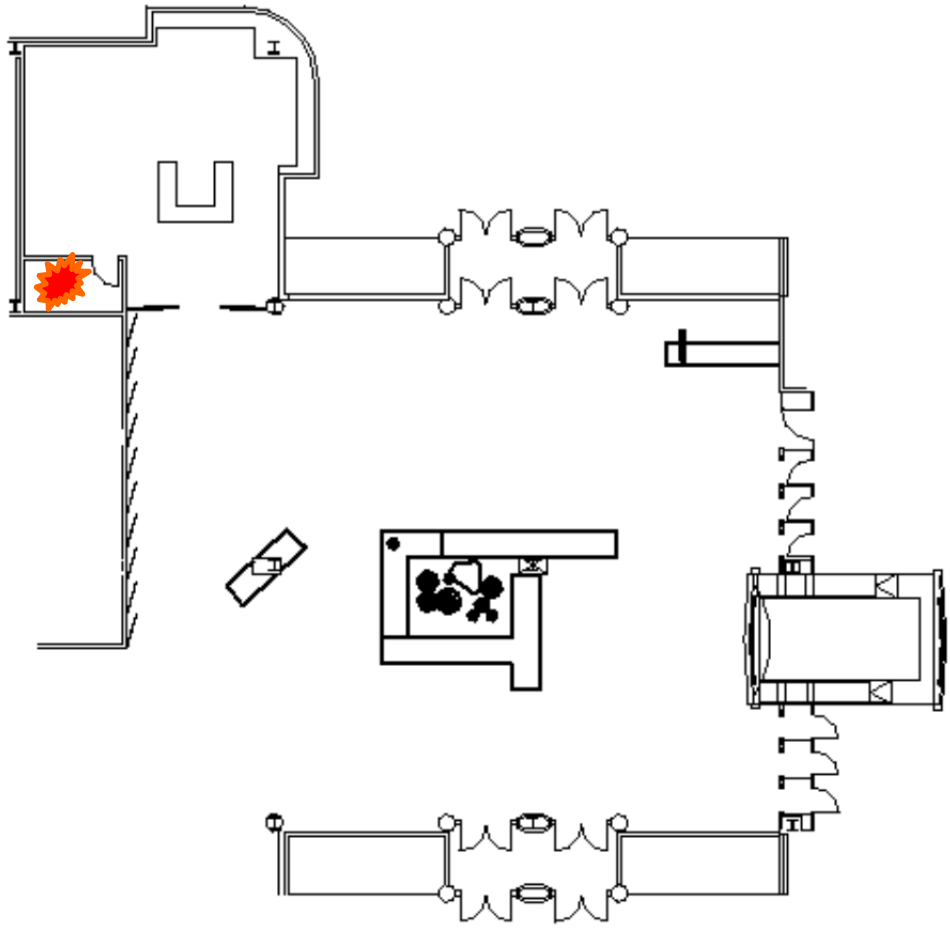


Figure 42: Convenience Store Fire Location

Required Safe Egress Time – Convenience Store Fire

As there are no detectors in the convenience store, it is left up to the occupants to detect and determine a response for the fire. Detection should occur rather quickly as the area is rather small and is always occupied during normal business hours. Based on FDS simulations, smoke starts entering the store area at approximately 25 seconds after ignition, as shown in Figure 44.

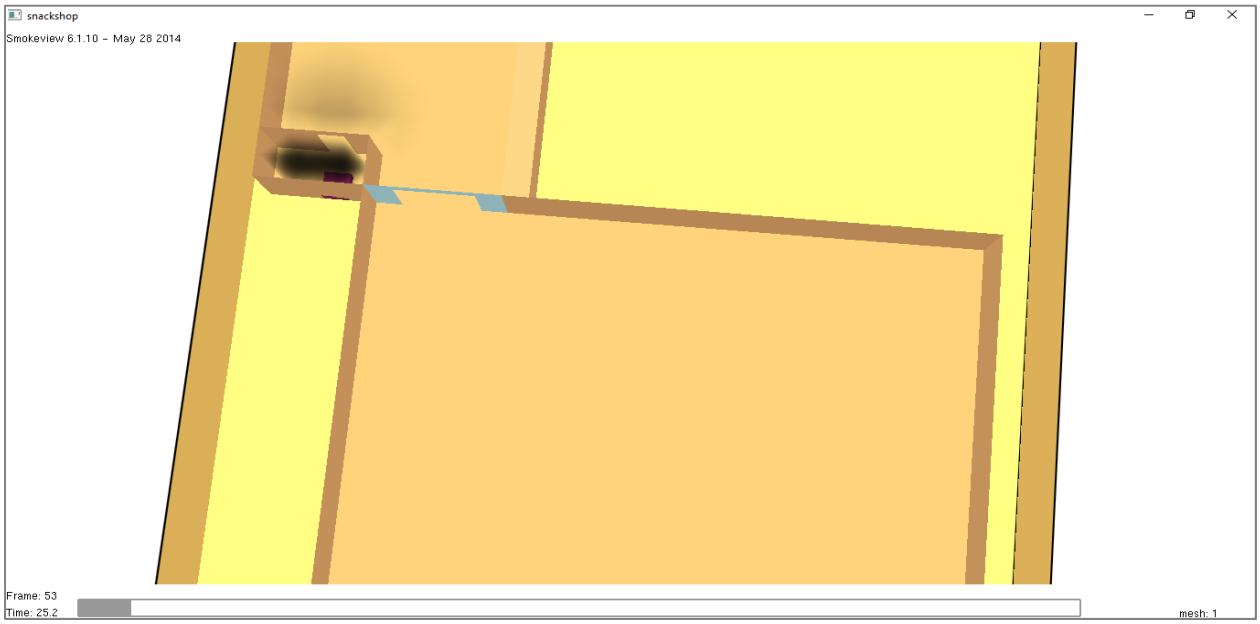


Figure 43: Smoke Beginning to Enter the Store Area at 25 Seconds

Once the smoke begins to enter the store will be when occupants begin to assess the situation and decide to use one of the manual pull stations in the area. It will take only another 15 seconds for personnel to activate the pull station. Once the pull station is activated the alarms will sound and personnel will begin the evacuation process which includes the decision to evacuate. For personnel within the convenience store, this decision will be rather quick but for other occupants on the first floor the analysis of the situation and decision to evacuate could take up to 60 seconds. There aren't any permanent workstation spaces so the time for personnel to grab their belongings and begin evacuating will be a relatively short 15 seconds. It will take another 73 seconds for personnel on the first floor to get out the exit doors as shown in section 4.3 of this report. The total required safe egress time of 158 seconds is needed for occupants on the first floor to get out of the building. Figure 45 shows each of these phases of the RSET for the convenience store fire.

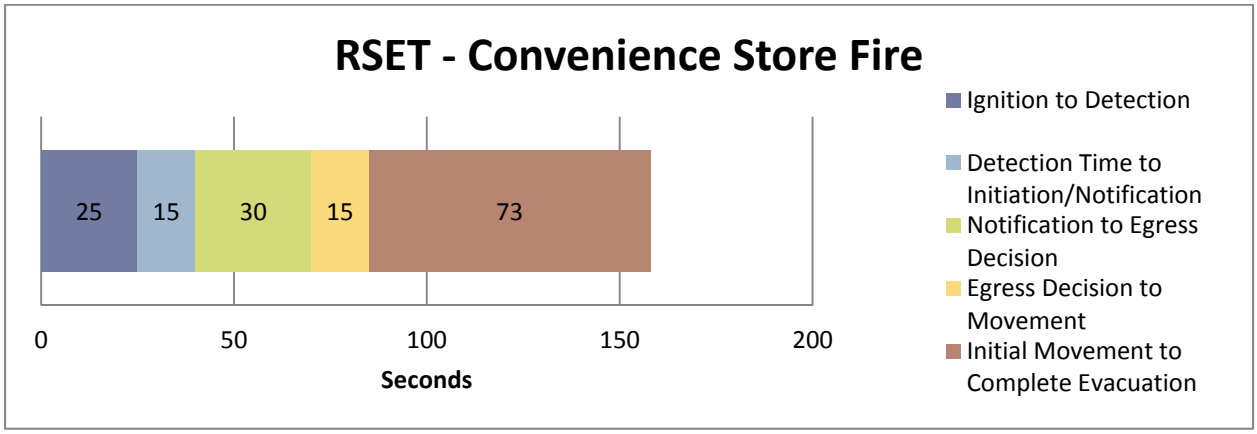


Figure 44: Required Safe Egress Time for Convenience Store Fire

Available Safe Egress Time (ASET)

ASET – Carbon Monoxide

Figure 46 indicates the CO levels for this simulation do not deteriorate at any time. The units shown in the figure are kg/kg * 10^{-5} and even at the simulation completion time of 450 seconds, the CO level does not increase over 1.0 kg/kg * 10^{-5} or the equivalent of 10ppm.

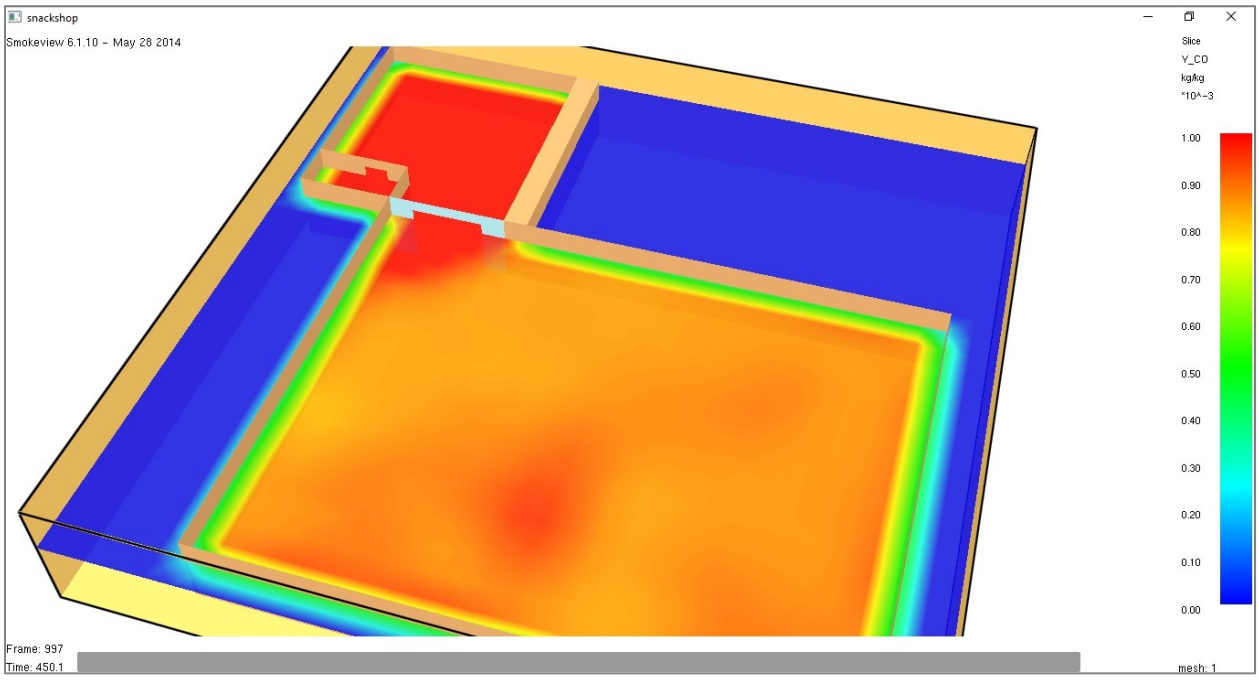


Figure 45: CO Concentration at 450 Seconds

ASET – Visibility

As expected, visibility within the small office/storage area begins to decrease quickly. As discussed in the ASET-Carbon Monoxide section, it is a safe assumption that occupants will have evacuated the store at 45 seconds. Visibility at this time is not an issue, as shown in Figure 47. Visibility really begins to deteriorate within the store at 85 seconds, shown in Figure 48.

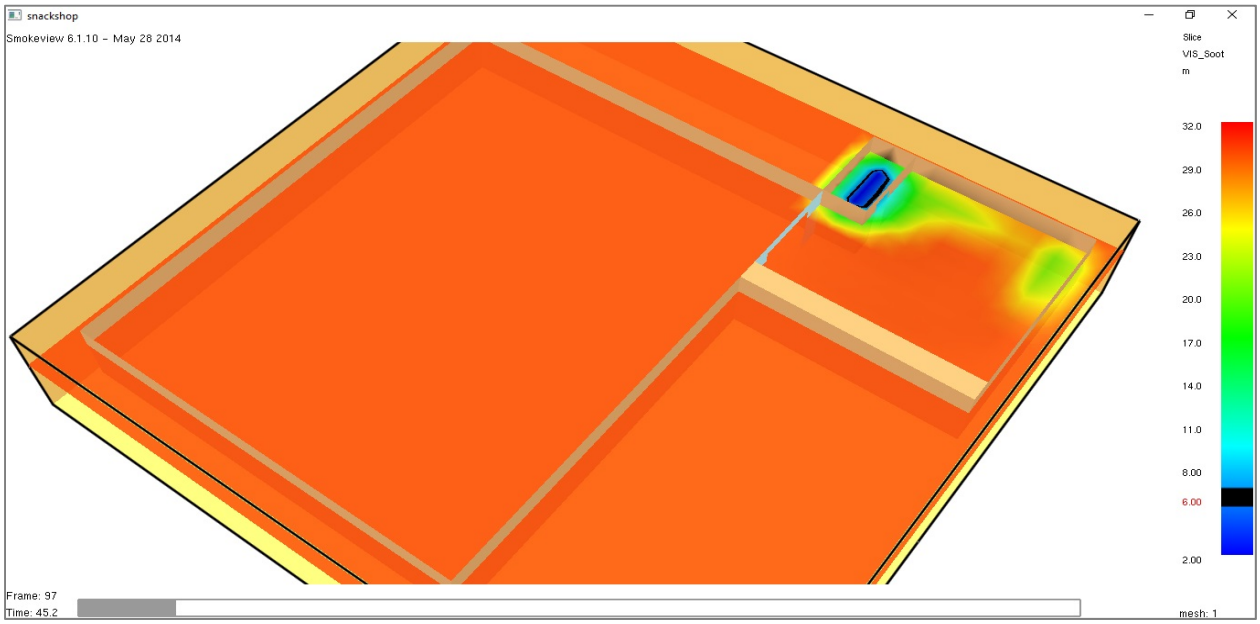


Figure 47: Visibility at 45 Seconds

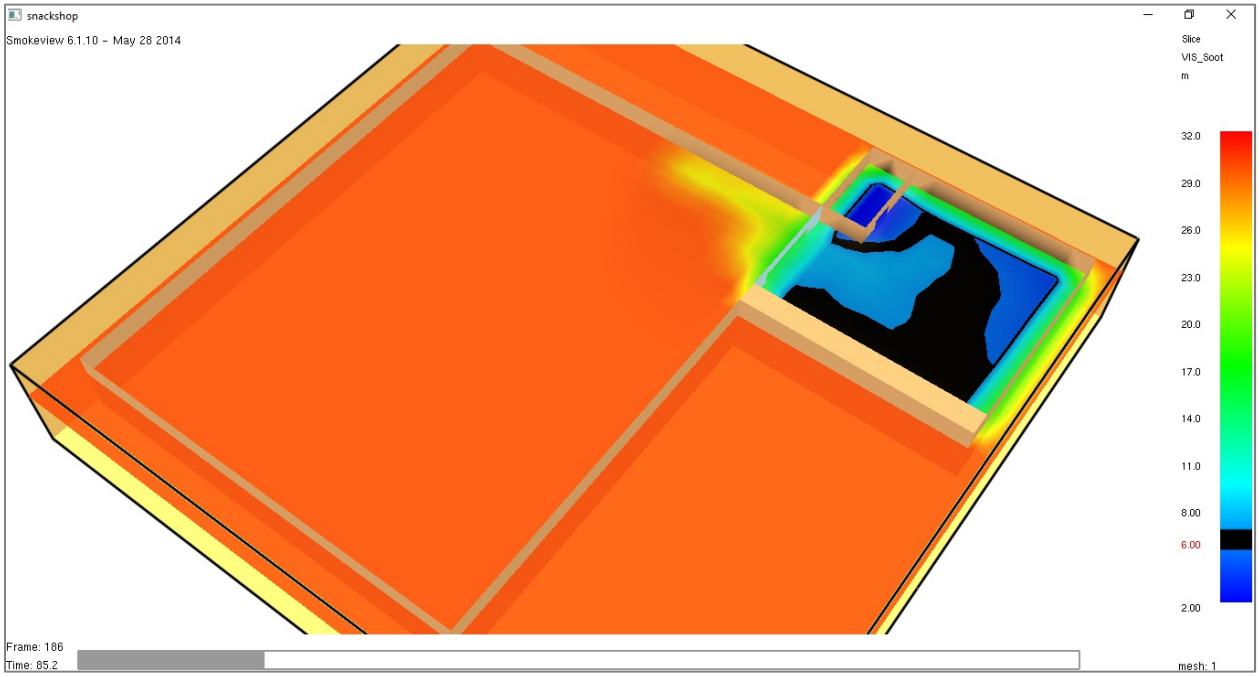


Figure 48: Visibility at 85 Seconds

Visibility near the store entrance begins to drop at the required safe egress time of 158 seconds, as shown in Figure 49, and becomes a widespread issue in the lobby between 290 and 390 seconds, shown in Figure 50.

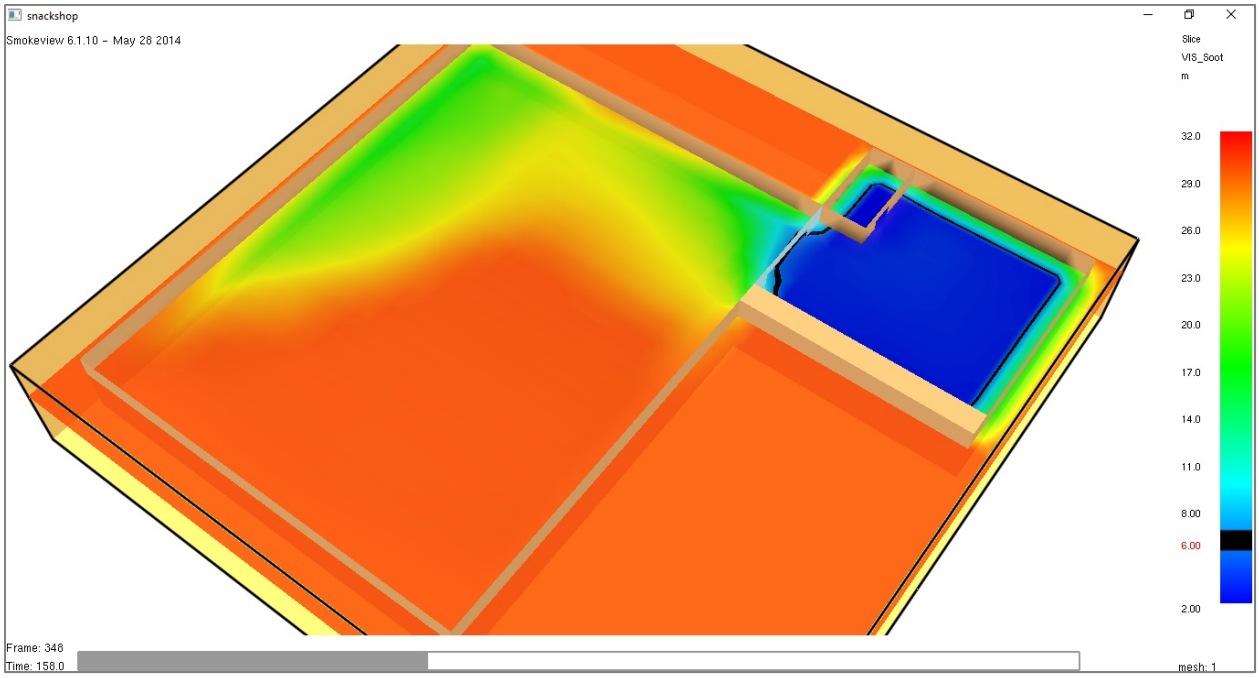


Figure 49: Visibility at RSET (158 Seconds)

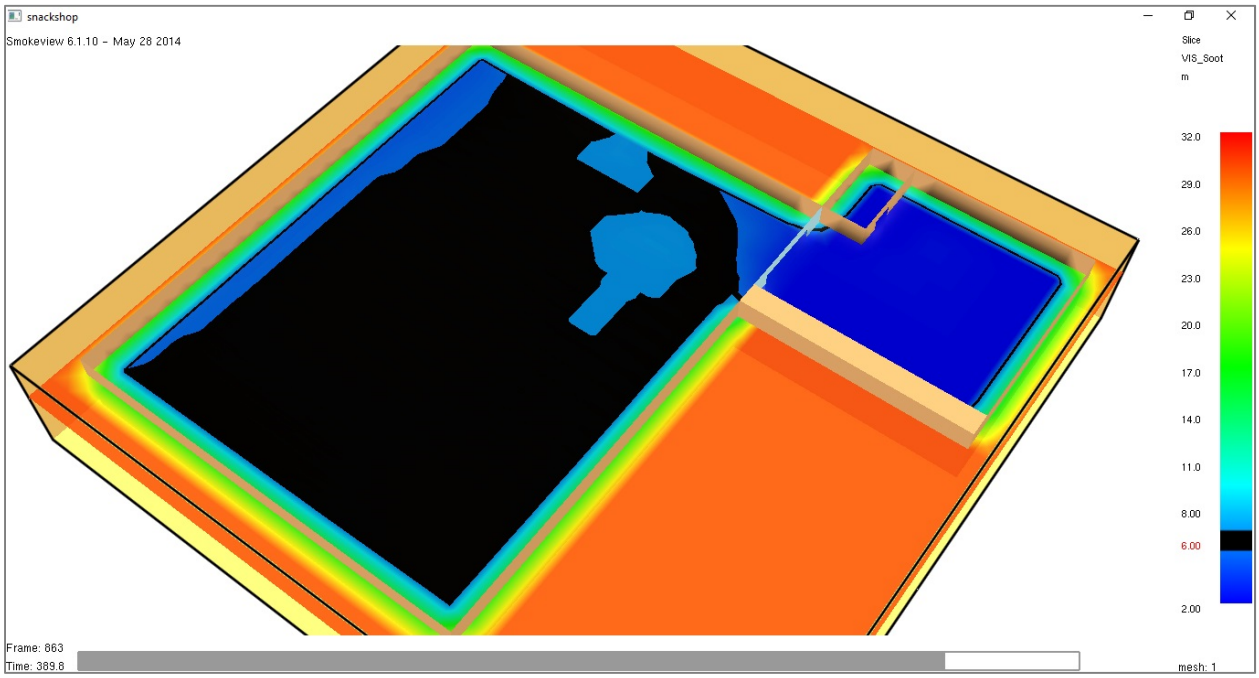


Figure 460: Visibility in the Lobby at 390 Seconds

ASET – Temperature

The temperature in the location of the fire reaches the tenable criteria limit at approximately 31 seconds, shown in Figure 51, and does not begin to increase in the store until 45 seconds into combustion, shown in Figure 52. As discussed above, it is assumed that occupants will be out of the store at this time.

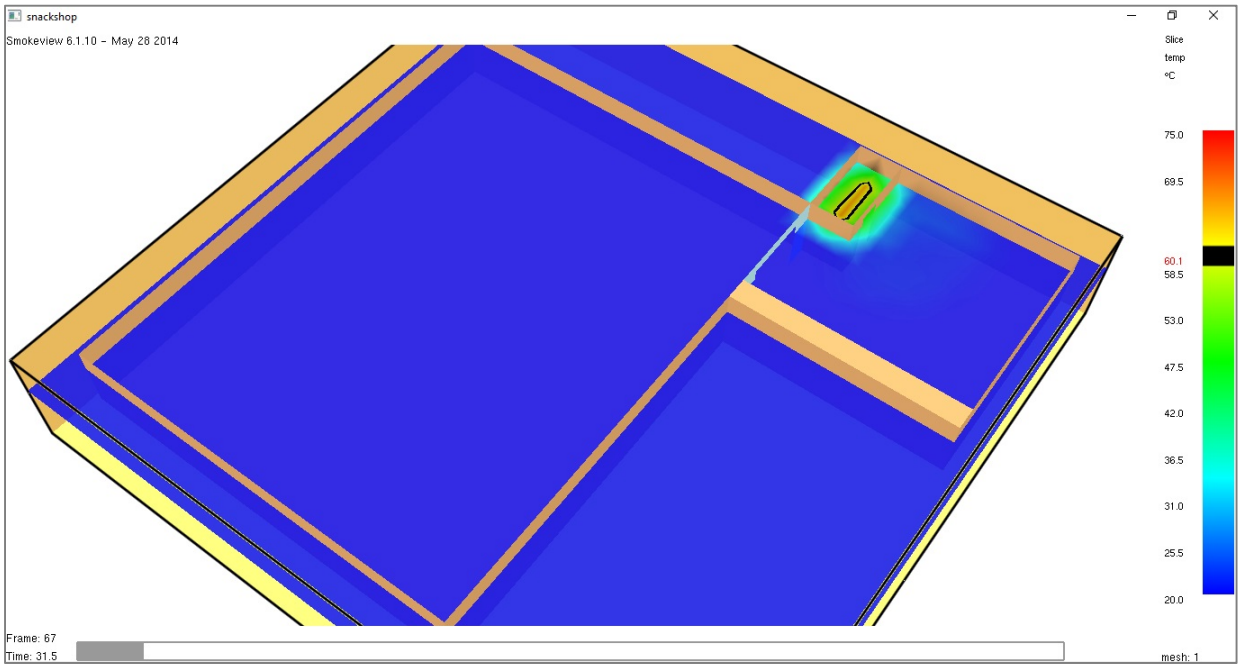


Figure 471: Temperature at 31 Seconds

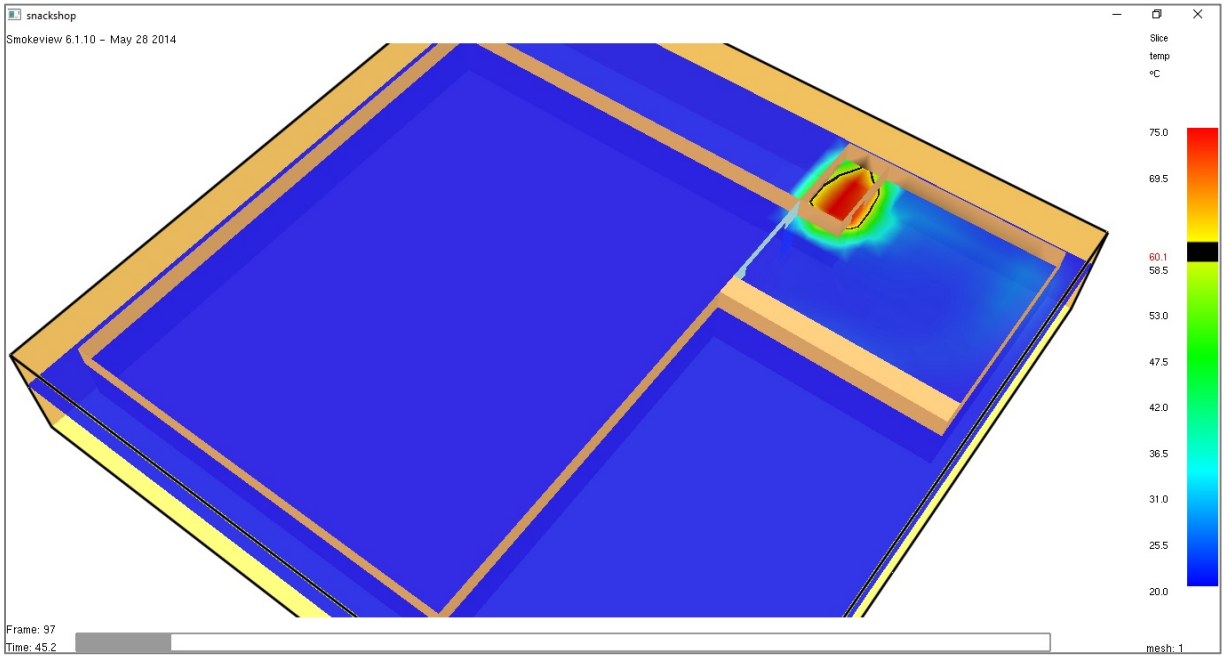


Figure 482: Temperature at 45 Seconds

Even at the end of the RSET, 158 seconds, only the area within the small office/storage reached the tenable temperature criteria of 60°C. Temperature in the store begins to escalate at 225 seconds and even at the end of the simulation time of 450 seconds, it does not approach 60°C anywhere in the lobby. These situations are shown in Figures 53 and 54.

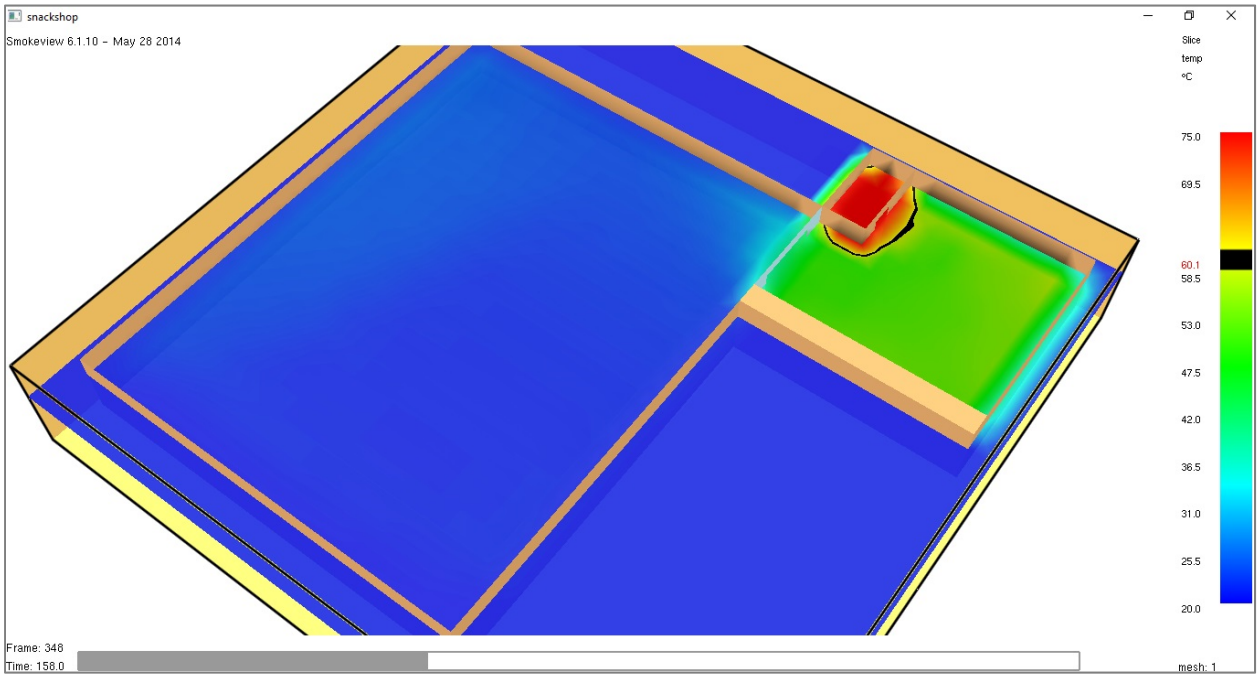


Figure 49: Temperature at RSET (158 Seconds)

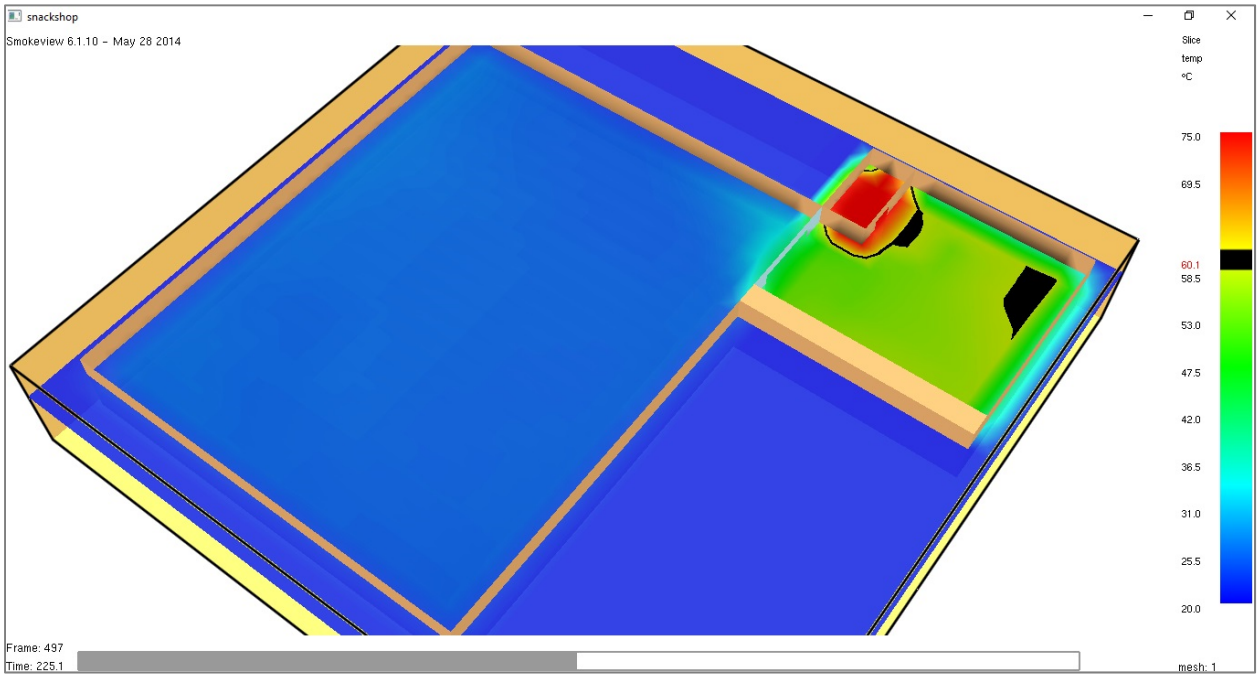


Figure 50: Temperature at 225 Seconds

Visibility and temperature criteria failed quickly in the location of the fire which was within a small office/storage area for the store. Visibility criteria failed within the store itself before the determined RSET for the entire first floor, although it should be noted that it would be a reasonable assumption that occupants within the store would evacuate the store quickly, within 45 seconds of ignition as indicated in Figure 55.

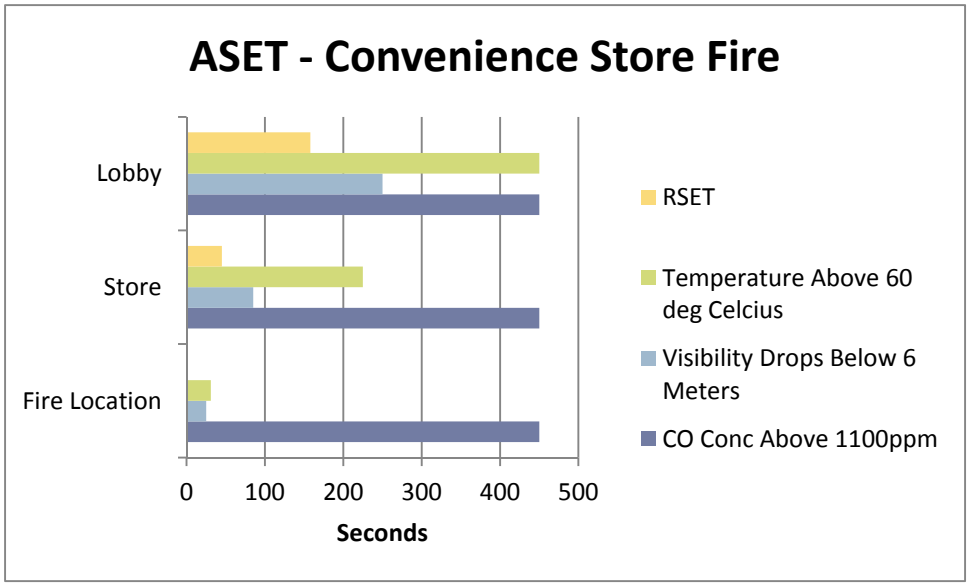


Figure 51: Available Safe Egress Time for Convenience Store Fire

Visibility within the store itself deteriorates quickly once the simulation hit 85 seconds but again, it is assumed that occupants will have evacuated the store by this point. Visibility in the lobby remains above the tenability criteria well past the RSET time of 158 seconds. At approximately 290 seconds smoke begins to fill the lobby area and visibility begins to decrease and by 390 seconds into the simulation the visibility throughout the lobby had dropped below 6 meters.

Temperature was only an issue within the room where the fire began. At no point during the simulation did the temperature raise above the tenability criteria for the store or the lobby.

9 – Summary

This office building meets or exceeds the prescriptive requirements that were assessed within the scope of this life safety and fire protection systems evaluation to include the occupancy classification and loading, fire-resistance and protection of structural elements, means of egress, egress marking, the detection and notification systems, and the suppression systems.

From a performance-based analysis perspective and the scenarios selected, the building performed well and is considered a safe place for occupants. Tenable conditions were maintained during both fire scenarios well past the required safe egress time.

For the cubicle fire occupants needed 366 seconds to evacuate the floor. The first tenable limit to be reached in this fire was the temperature limit of 60°C and it reached that at 400 seconds into the simulation. The next criterion to be reached was the visibility limit of 4 meters and that was at 475 seconds into the simulation. There were no issues with the carbon monoxide concentration limit during this simulation.

The convenience store fire was looked at from three points, the fire location in the small office/storage area, the store area, and the lobby area. Temperature and visibility criteria were quickly reached in the fire location but it is assumed that there are no personnel in that location at the time of the fire. Visibility was the first criterion to be reached within the store itself but was still 40 seconds beyond the required safe egress time for the store. It was determined that it would take a total of 158 seconds to evacuate the entire first floor. Both temperature and carbon monoxide criteria were never reached during the simulation in the lobby area. Visibility of 6 meters was reached at 250 seconds but this is well beyond the RSET of 158 seconds.

Based on the prescriptive and performance-based analysis of this building, there are no recommendations that need to be made. It could be worth considering an HVAC purge system to assist in the removal of smoke and toxic gases in the event of a fire but this is definitely not necessary. The existing HVAC equipment has the capability to purge but it would take some changes to how the system is controlled, and possibly to some of the control components, to make this a reality.

Another item to consider for this building is to install smoke or heat detectors in spaces that currently do not have them. By having detectors present in the areas where they are not existing and not required by code, it is possible to reduce the Required Safe Egress Time (RSET) by early detection and therefore, early notification. Again, this is not something that is necessary based on the analysis of this building but could add another level of safety for the occupants.

REFERENCES

[1] International Code Council, 2012 – Second Printing, International Building Code
[2] SFPE, NFPA, 2008, The SFPE Handbook of Fire Protection Engineering, 4th Edition
[3] NFPA, 2008, NFPA Fire Protection Handbook, 20th Edition
[4] NFPA, 2012, NFPA 101 – Life Safety Code
[5] NFPA, 2013, NFPA 72 – National Fire Alarm and Signaling Code
[6] Author Unknown, 2016, Form Z, from http://www.formz.com/manuals/formz7/!SSL!/WebHelp/10310_Switchback_Stairs.html
[7] NFPA, 2011, NPFA 25 – Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
[8] NIST, September 2005, Fire Tests of Single Office Workstations

APPENDICES

Contents

APPENDIX A

Additional Pertinent Life Safety Code Sections for Egress Systems

Chapter 3 Definitions

3.1 General.

The definitions contained in this chapter shall apply to the terms used in this Code. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. Merriam-Webster's Collegiate Dictionary, 11th edition, shall be the source for the ordinarily accepted meaning.

3.3 General Definitions.

3.3.21 Area.

3.3.21.2.1* Gross Floor Area. *The floor area within the inside perimeter of the outside walls of the building under consideration with no deductions for hallways, stairs, closets, thickness of interior walls, columns, elevator and building services shafts, or other features, but excluding floor openings associated with atriums and communicating spaces. (SAF-MEA)*

3.3.21.2.2 Net Floor Area. *The floor area within the inside perimeter of the outside walls, or the outside walls and fire walls of a building, or outside and/or inside walls that bound an occupancy or incidental use area requiring the occupant load to be calculated using net floor area under consideration with deductions for hallways, stairs, closets, thickness of interior walls, columns, or other features. (SAF-MEA)*

3.3.21.3 Gross Leasable Area. *Fifty percent of major tenant areas, and 100 percent of all other floor areas designated for tenant occupancy and exclusive use, including storage areas. The area of tenant occupancy is measured from the centerlines of joint partitions to the outside of the tenant walls. (SAF-MER)*

3.3.21.4* Hazardous Area. *An area of a structure or building that poses a degree of hazard greater than that normal to the general occupancy of the building or structure. (SAF-FIR)*

3.3.21.5 Living Area. *Any normally occupiable space in a residential occupancy, other than sleeping rooms or rooms that are intended for combination sleeping/living, bathrooms, toilet compartments, kitchens, closets, halls, storage or utility spaces, and similar areas. (SAF-RES)*

3.3.21.6* Normally Unoccupied Building Service Equipment Support Area. *A building service equipment support area in which people are not expected to be present on a regular basis. (SAF-MEA)*

3.3.21.7 Occupiable Area. *An area of a facility occupied by people on a regular basis. (SAF-FUN)*

3.3.22* Area of Refuge. *An area that is either (1) a story in a building where the building is protected throughout by an approved, supervised automatic sprinkler system and has not less than two accessible rooms or spaces separated from each other by smoke-resisting partitions; or (2) a space located in a path of travel leading to a public way that is protected from the effects of fire, either by means of separation from other spaces in the same building or by virtue of location, thereby permitting a delay in egress travel from any level. (SAF-MEA)*

3.3.22.1 Accessible Area of Refuge. *An area of refuge that complies with the accessible route requirements of ICC/ANSI A117.1, American National Standard for Accessible and Usable Buildings and Facilities (SAF-MEA).*

3.3.23 Assembly.

3.3.23.1 Door Assembly. *Any combination of a door, frame, hardware, and other accessories that is placed in an opening in a wall that is intended primarily for access or for human entrance or exit. [**252**, 2012] (SAF-MEA)*

3.3.23.1.1 Fire Door Assembly. *Any combination of a fire door, a frame, hardware, and other accessories that together provide a specific degree of fire protection to the opening. [**80,** 2013] (SAF-FIR)*

3.3.23.1.1.1 Horizontal Fire Door Assembly. *A combination of a fire door, a frame, hardware, and other accessories installed in a horizontal plane, which together provide a specific degree of fire protection to a through-opening in a fire resistance–rated floor or roof. [**288,** 2012] (SAF-FIR)*

3.3.23.2 Fire Window Assembly. *A window or glass block assembly having a fire protection rating. [**80,** 2013] (SAF-FIR)*

3.3.27* Atrium. *A large-volume space created by a floor opening or series of floor openings connecting two or more stories that is covered at the top of the series of openings and is used for purposes other than an enclosed stairway; an elevator hoistway; an escalator opening; or as a utility shaft used for plumbing, electrical, air-conditioning, or communications facilities. (SAF-FIR)*

3.3.31 Barrier.

3.3.31.1* Fire Barrier. *A continuous membrane or a membrane with discontinuities created by protected openings with a specified fire protection rating, where such membrane is designed and constructed with a specified fire resistance rating to limit the spread of fire. (SAF-FIR)*

3.3.31.2* Smoke Barrier. *A continuous membrane, or a membrane with discontinuities created by protected openings, where such membrane is designed and constructed to restrict the movement of smoke. (SAF-FIR)*

3.3.31.3* Thermal Barrier. *A material that limits the average temperature rise of an unexposed surface to not more than 250°F (139°C) for a specified fire exposure complying with the standard time-temperature curve of ASTM E 119, Standard Test Methods for Fire Tests of Building Construction and Materials, or ANSI/UL 263, Standard for Fire Tests of Building Construction and Materials. (SAF-BCF)*

3.3.36* Building. *Any structure used or intended for supporting or sheltering any use or occupancy. (SAF-FUN)*

3.3.62 Door.

3.3.62.1 Elevator Lobby Door. *A door between an elevator lobby and another building space other than the elevator shaft. (SAF-MEA)*

3.3.62.2 Fire Door. *The door component of a fire door assembly. (SAF-FIR)*

3.3.70 Elevator Lobby. *A landing from which occupants directly enter an elevator car(s) and into which occupants directly enter upon leaving an elevator car(s). (SAF-MEA)*

3.3.71 Elevator Lobby Door. *See **3.3.62.1**.*

3.3.83* Exit. *That portion of a means of egress that is separated from all other spaces of the building or structure by construction, location, or equipment as required to provide a protected way of travel to the exit discharge. (SAF-MEA)*

3.3.83.1* Horizontal Exit. *A way of passage from one building to an area of refuge in another building on approximately the same level, or a way of passage through or around a fire barrier to an area of refuge on approximately the same level in the same building that affords safety from fire and smoke originating from the area of incidence and areas communicating therewith. (SAF-MEA)*

3.3.84 Exit Access. *That portion of a means of egress that leads to an exit. (SAF-MEA)*

3.3.85 Exit Discharge. *That portion of a means of egress between the termination of an exit and a public way. (SAF-MEA)*

3.3.85.1* Level of Exit Discharge. *The story that is either (1) the lowest story from which not less than 50 percent of the required number of exits and not less than 50 percent of the required egress capacity from such a story discharge directly outside at the finished ground level; or (2) where no story meets the conditions of item (1), the story that is provided with one or more exits that discharge directly to the outside to the finished ground level via the smallest elevation change. (SAF-MEA)*

3.3.92 Finish.

3.3.92.1 Interior Ceiling Finish. *The interior finish of ceilings. (SAF-INT)*

3.3.92.2* Interior Finish. *The exposed surfaces of walls, ceilings, and floors within buildings. (SAF-INT)*

3.3.92.3* Interior Floor Finish. *The interior finish of floors, ramps, stair treads and risers, and other walking surfaces. (SAF-INT)*

3.3.92.4 Interior Wall Finish. *The interior finish of columns, fixed or movable walls, and fixed or movable partitions. (SAF-INT)*

3.3.94 Fire Barrier. *See **3.3.31.1**.*

3.3.95 Fire Barrier Wall. *See **3.3.288.1**.*

3.3.96* Fire Code. *The fire code enforced by the jurisdiction or agency enforcing this Code (SAF-FUN).*

3.3.97 Fire Compartment. *See **3.3.48.1**.*

3.3.98 Fire Door. *See **3.3.62.2**.*

3.3.99 Fire Door Assembly. *See **3.3.23.1.1**.*

3.3.100 Fire Exit Hardware. *See **3.3.135.1**.*

3.3.101* Fire Model. *A structured approach to predicting one or more effects of a fire. (SAF-FUN)*

3.3.102 Fire Protection Rating. *See **3.3.223.1**.*

3.3.103 Fire Resistance Rating. *See **3.3.223.2**.*

3.3.105* Fire Scenario. *A set of conditions that defines the development of fire, the spread of combustion products throughout a building or portion of a building, the reactions of people to fire, and the effects of combustion products. (SAF-FUN)*

3.3.105.1 Design Fire Scenario. *A fire scenario selected for evaluation of a proposed design. (SAF-FUN)*

3.3.135 Hardware.

3.3.135.1 Fire Exit Hardware. *A type of panic hardware that additionally provides fire protection where used as part of a fire door assembly. (SAF-MEA)*

3.3.135.2 Panic Hardware. *A door-latching assembly incorporating an actuating member or bar that releases the latch bolt upon the application of a force in the direction of egress travel. (SAF-MEA)*

3.3.138* Heat Release Rate (HRR). *The rate at which heat energy is generated by burning. **[921,** 2014] (SAF-INT)*

3.3.146 Illuminated.

3.3.146.1* Externally Illuminated. *Refers to an illumination source that is contained outside of the device or sign legend area that is to be illuminated. (SAF-MEA)*

3.3.146.2* Internally Illuminated. *Refers to an illumination source that is contained inside the device or legend that is illuminated. (SAF-MEA)*

3.3.148 Incapacitation. *A condition under which humans do not function adequately and become unable to escape untenable conditions. (SAF-FUN)*

3.3.160 Life Safety Evaluation. *A written review dealing with the adequacy of life safety features relative to fire, storm, collapse, crowd behavior, and other related safety considerations. (SAF-AXM)*

3.3.164 Load.

3.3.164.1* Fuel Load. *The total quantity of combustible contents of a building, space, or fire area. (SAF-FUN)*

3.3.164.2 Occupant Load. *The total number of persons that might occupy a building or portion thereof at any one time. (SAF-MEA)*

3.3.172* Means of Egress. *A continuous and unobstructed way of travel from any point in a building or structure to a public way consisting of three separate and distinct parts: (1) the exit access, (2) the exit, and (3) the exit discharge. (SAF-MEA)*

3.3.172.1 Accessible Means of Egress. *A means of egress that provides an accessible route to an area of refuge, a horizontal exit, or a public way. (SAF-MEA)*

3.3.190 Occupancy. *The purpose for which a building or other structure, or part thereof, is used or intended to be used. [**ASCE/SEI 7:**1.2] (SAF-FUN)*

3.3.190.3* Business Occupancy. *An occupancy used for the transaction of business other than mercantile. (SAF-MER)*

3.3.190.10 Mixed Occupancy. *A multiple occupancy where the occupancies are intermingled. (SAF-FUN)*

3.3.206* Performance Criteria. *Threshold values on measurement scales that are based on quantified performance objectives. (SAF-FUN)*

3.3.220 Public Way. *A street, alley, or other similar parcel of land essentially open to the outside air deeded, dedicated, or otherwise permanently appropriated to the public for public use and having a clear width and height of not less than 10 ft (3050 mm). (SAF-MEA)*

3.3.223 Rating.

3.3.223.1* Fire Protection Rating. *The designation indicating the duration of the fire test exposure to which an opening protective assembly was exposed. [**221,** 2015] (SAF-FIR)*

3.3.223.2 Fire Resistance Rating. *The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as determined by the tests, or methods based on tests, prescribed by this Code. (SAF-FIR)*

Chapter 7 Means of Egress

7.1 General.

7.1.1* Application. *Means of egress for both new and existing buildings shall comply with this chapter. (See also **4.5.3**.)*

7.1.3 Separation of Means of Egress. *See also Section **8.2**.*

7.1.3.1 Exit Access Corridors. *Corridors used as exit access and serving an area having an occupant load exceeding 30 shall be separated from other parts of the building by walls having not less than a 1-hour fire resistance rating in accordance with Section **8.3**, unless otherwise permitted by one of the following:*

(1)This requirement shall not apply to existing buildings, provided that the occupancy classification does not change.

*(2)This requirement shall not apply where otherwise provided in Chapters **11** through **43**.*

7.1.3.2 Exits.

7.1.3.2.1 *Where this Code requires an exit to be separated from other parts of the building, the separating construction shall meet the requirements of Section **8.2** and the following:*

(1) The separation shall have a minimum 1-hour fire resistance rating where the exit connects three or fewer stories.*

*(2) The separation specified in **7.1.3.2.1**(1), other than an existing separation, shall be supported by construction having not less than a 1-hour fire resistance rating.*

(3) The separation shall have a minimum 2-hour fire resistance rating where the exit connects four or more stories, unless one of the following conditions exists:*

(a) In existing non-high-rise buildings, existing exit stair enclosures shall have a minimum 1-hour fire resistance rating.

*(b) In existing buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section **9.7**, existing exit stair enclosures shall have a minimum 1-hour fire resistance rating.*

*(c) The minimum 1-hour enclosures in accordance with **28.2.2.1.2**, **29.2.2.1.2**, **30.2.2.1.2**, and **31.2.2.1.2** shall be permitted as an alternative to the requirement of **7.1.3.2.1**(3).*

(4) Reserved.

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

(6) Structural elements, or portions thereof, that support exit components and either penetrate into a fire resistance–rated assembly or are installed within a fire resistance–rated wall assembly shall be protected, as a minimum, to the fire resistance rating required by **7.1.3.2.1**(1) or (3).*

*(7) In Type III, Type IV, and Type V construction, as defined in **NFPA 220**, Standard on Types of Building Construction (see **8.2.1.2**), fire retardant–treated wood enclosed in noncombustible or limited-combustible materials shall be permitted.*

*(8) Openings in the separation shall be protected by fire door assemblies equipped with door closers complying with **7.2.1.8**.*

(9) Openings in exit enclosures shall be limited to door assemblies from normally occupied spaces and corridors and door assemblies for egress from the enclosure, unless one of the following conditions exists:*

*(a) Vestibules that separate normally unoccupied spaces from an exit enclosure shall be permitted, provided the vestibule is separated from adjacent spaces by corridor walls and related opening protectives as required for the occupancy involved but not less than a smoke partition in accordance with Section **8.4**.*

*(b) In buildings of Type I or Type II construction, as defined in **NFPA 220**, Standard on Types of Building Construction, (see **8.2.1.2**) fire protection–rated door assemblies to normally unoccupied building service equipment support areas as addressed in Section **7.13** shall be permitted, provided the space is separated from the exit enclosure by fire barriers as required by **7.1.3.2.1**(3).*

*(c) Openings in exit passageways in mall buildings as provided in Chapters **36** and **37** shall be permitted.*

*(d) In buildings of Type I or Type II construction, as defined in **NFPA 220**, Standard on Types of Building Construction, (see **8.2.1.2**) existing fire protection–rated door assemblies to interstitial spaces shall be permitted, provided that such spaces meet all of the following criteria:*

i. The space is used solely for distribution of pipes, ducts, and conduits.

ii. The space contains no storage.

*iii. The space is separated from the exit enclosure in accordance with Section **8.3**.*

(e) Existing openings to mechanical equipment spaces protected by approved existing fire protection–rated door assemblies shall be permitted, provided that the following criteria are met:

i. The space is used solely for non-fuel-fired mechanical equipment.

ii. The space contains no storage of combustible materials.

*iii. The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section **9.7**.*

(10) Penetrations into, and openings through, an exit enclosure assembly shall be limited to the following:

*(a) Door assemblies permitted by **7.1.3.2.1**(9)*

(b) Electrical conduit serving the exit enclosure*

(c) Required exit door openings

(d) Ductwork and equipment necessary for independent stair pressurization

(e) Water or steam piping necessary for the heating or cooling of the exit enclosure

(f) Sprinkler piping

(g) Standpipes

*(h) Existing penetrations protected in accordance with **8.3.5***

*(i) Penetrations for fire alarm circuits, where the circuits are installed in metal conduit and the penetrations are protected in accordance with **8.3.5***

(11) Penetrations or communicating openings shall be prohibited between adjacent exit enclosures.

*(12) Membrane penetrations shall be permitted on the exit access side of the exit enclosure and shall be protected in accordance with **8.3.5.6**.*

7.1.3.2.2 *An exit enclosure shall provide a continuous protected path of travel to an exit discharge.*

7.1.3.2.3* *An exit enclosure shall not be used for any purpose that has the potential to interfere with its use as an exit and, if so designated, as an area of refuge. (See also **7.2.2.5.3**.)*

7.1.4 Interior Finish in Exit Enclosures.

7.1.4.1* ***Interior Wall and Ceiling Finish in Exit Enclosures.*** *Interior wall and ceiling finish shall be in accordance with Section **10.2**. In exit enclosures, interior wall and ceiling finish materials complying with Section **10.2** shall be Class A or Class B.*

7.1.4.2* ***Interior Floor Finish in Exit Enclosures.*** *New interior floor finish in exit enclosures, including stair treads and risers, shall be not less than Class II in accordance with Section **10.2**.*

7.1.5* Headroom.

7.1.5.1 *Means of egress shall be designed and maintained to provide headroom in accordance with other sections of this Code, and such headroom shall be not less than 7 ft 6 in. (2285 mm), with projections from the ceiling not less than 6 ft 8 in. (2030 mm) with a tolerance of − 3/4 in. (−19 mm), above the finished floor, unless otherwise specified by any of the following:*

(1) In existing buildings, the ceiling height shall be not less than 7 ft (2135 mm) from the floor, with projections from the ceiling not less than 6 ft 8 in. (2030 mm) nominal above the floor.

*(2) Headroom in industrial equipment access areas as provided in **40.2.5.3** shall be permitted.*

7.1.5.2 *The minimum ceiling height shall be maintained for not less than two-thirds of the ceiling area of any room or space, provided that the ceiling height of the remaining ceiling area is not less than 6 ft 8 in. (2030 mm).*

7.1.5.3 *Headroom on stairs shall be not less than 6 ft 8 in. (2030 mm) and shall be measured vertically above a plane parallel to, and tangent with, the most forward projection of the stair tread.*

7.1.6 Walking Surfaces in the Means of Egress.

7.1.6.1 General.

7.1.6.1.1 *Walking surfaces in the means of egress shall comply with **7.1.6.2** through **7.1.6.4**.*

7.1.6.1.2 *Approved existing walking surfaces shall be permitted.*

7.1.6.2 Changes in Elevation. *Abrupt changes in elevation of walking surfaces shall not exceed 1/4 in. (6.3 mm). Changes in elevation exceeding 1/4 in. (6.3 mm), but not exceeding 1/2 in. (13 mm), shall be beveled with a slope of 1 in 2. Changes in elevation exceeding 1/2 in. (13 mm) shall be considered a change in level and shall be subject to the requirements of **7.1.7**.*

7.1.6.3 Level.

7.1.6.3.1 *Walking surfaces shall comply with all of the following:*

(1) Walking surfaces shall be nominally level.

*(2) The slope of a walking surface in the direction of travel shall not exceed 1 in 20, unless the ramp requirements of **7.2.5** are met.*

(3) The slope perpendicular to the direction of travel shall not exceed 1 in 48.

7.1.6.3.2 *Vehicle ramps in parking structures, as permitted in **42.8.2.2.6**, and not on an accessible means of egress or other accessible element shall be exempt from the provisions of **7.1.6.3.1**.*

7.1.6.4* Slip Resistance. *Walking surfaces in the means of egress shall be slip resistant under foreseeable conditions.*

7.1.7 Changes in Level in Means of Egress.

7.1.7.1 *Changes in level in means of egress shall be achieved by an approved means of egress where the elevation difference exceeds 21 in. (535 mm).*

7.1.7.2* *Changes in level in means of egress not in excess of 21 in. (535 mm) shall be achieved either by a ramp complying with the requirements of **7.2.5** or by a stair complying with the requirements of **7.2.2**.*

7.1.7.2.1 *Where a ramp is used to meet the requirements of **7.1.7.2**, the presence and location of ramped portions of walkways shall be readily apparent.*

7.1.7.2.2 *Where a stair is used to meet the requirements of **7.1.7.2**, the tread depth of such stair shall be not less than 13 in. (330 mm).*

7.1.7.2.3 *Tread depth in industrial equipment access areas as provided in **40.2.5.3** shall be permitted.*

7.1.7.2.4 *The presence and location of each step shall be readily apparent.*

7.1.8* Guards. *Guards in accordance with **7.2.2.4** shall be provided at the open sides of means of egress that exceed 30 in. (760 mm) above the floor or the finished ground level below except where guards are specifically exempted by provisions of Chapters **11** through **43**.*

7.1.9 Impediments to Egress. *Any device or alarm installed to restrict the improper use of a means of egress shall be designed and installed so that it cannot, even in case of failure, impede or prevent emergency use of such means of egress, unless otherwise provided in **7.2.1.6** and Chapters **18**, **19**, **22**, and **23**.*

7.1.10 Means of Egress Reliability.

7.1.10.1* Maintenance. *Means of egress shall be continuously maintained free of all obstructions or impediments to full instant use in the case of fire or other emergency.*

7.1.10.2 Furnishings and Decorations in Means of Egress.

7.1.10.2.1 *No furnishings, decorations, or other objects shall obstruct exits or their access thereto, egress therefrom, or visibility thereof.*

7.1.10.2.2 *No obstruction by railings, barriers, or gates shall divide the means of egress into sections appurtenant to individual rooms, apartments, or other occupied spaces. Where the authority having jurisdiction finds the required path of travel to be obstructed by furniture or other movable objects, the authority shall be permitted to require that such objects be secured out of the way or shall be permitted to require that railings or other permanent barriers be installed to protect the path of travel against encroachment.*

7.1.10.2.3 *Mirrors shall not be placed on exit door leaves. Mirrors shall not be placed in or adjacent to any exit in such a manner as to confuse the direction of egress.*

7.1.11 Sprinkler System Installation. *Where another provision of this chapter requires an automatic sprinkler system, the sprinkler system shall be installed in accordance with the subparts of **9.7.1.1** permitted by the applicable occupancy chapters.*

7.2 Means of Egress Components.

7.2.1 Door Openings.

7.2.1.1 General.

7.2.1.1.1 *A door assembly in a means of egress shall conform to the general requirements of Section **7.1** and to the special requirements of **7.2.1**.*

7.2.1.1.2 *Every door opening and every principal entrance that is required to serve as an exit shall be designed and constructed so that the path of egress travel is obvious and direct. Windows that, because of their physical configuration or design and the materials used in their construction, have the potential to be mistaken for door openings shall be made inaccessible to the occupants by barriers or railings.*

7.2.1.1.3 Occupied Building.

7.2.1.1.3.1 *For the purposes of Section **7.2**, a building shall be considered to be occupied at any time it meets any of the following criteria:*

(1) It is open for general occupancy.

(2) It is open to the public.

(3) It is occupied by more than 10 persons.

7.2.1.1.3.2 *Where means of egress doors are locked in a building that is not considered occupied, occupants shall not be locked beyond their control in buildings or building spaces, except for lockups in accordance with **22.4.5** and **23.4.5**, detention and correctional occupancies, and health care occupancies.*

7.2.1.2 Door Leaf Width.

7.2.1.2.1* Measurement of Clear Width.

7.2.1.2.1.1 Swinging Door Assemblies. *For swinging door assemblies, clear width shall be measured as follows:*

(1) The measurement shall be taken at the narrowest point in the door opening.

(2) The measurement shall be taken between the face of the door leaf and the stop of the frame.

(3) For new swinging door assemblies, the measurement shall be taken with the door leaf open 90 degrees.

(4) For any existing door assembly, the measurement shall be taken with the door leaf in the fully open position.

(5) Projections of not more than 4 in. (100 mm) into the door opening width on the hinge side shall not be considered reductions in clear width, provided that such projections are for purposes of accommodating panic hardware or fire exit hardware and are located not less than 34 in. (865 mm), and not more than 48 in. (1220 mm), above the floor.

(6) Projections exceeding 6 ft 8 in. (2030 mm) above the floor shall not be considered reductions in clear width.

7.2.1.2.2* Measurement of Egress Capacity Width.

7.2.1.2.2.1 Swinging Door Assemblies. *For swinging door assemblies, egress capacity width shall be measured as follows:*

(1) The measurement shall be taken at the narrowest point in the door opening.

(2) The measurement shall be taken between the face of the door leaf and the stop of the frame.

(3) For new swinging doors assemblies, the measurement shall be taken with the door leaf open 90 degrees.

(4) For any existing door assembly, the measurement shall be taken with the door leaf in the fully open position.

(5) Projections not more than 3 1/2 in. (90 mm) at each side of the door openings at a height of not more than 38 in. (965 mm) shall not be considered reductions in egress capacity width.

(6) Projections exceeding 6 ft 8 in. (2030 mm) above the floor shall not be considered reductions in egress capacity width.

7.2.1.2.3 Minimum Door Leaf Width.

7.2.1.2.3.1 *For purposes of determining minimum door opening width, the clear width in accordance with **7.2.1.2.1** shall be used, unless door leaf width is specified.*

7.2.1.2.3.2 *Door openings in means of egress shall be not less than 32 in. (810 mm) in clear width, except under any of the following conditions:*

(1) Where a pair of door leaves is provided, one door leaf shall provide not less than a 32 in. (810 mm) clear width opening.

(2) Exit access door assemblies serving a room not exceeding 70 ft² (6.5 m²) and not required to be accessible to persons with severe mobility impairments shall be not less than 24 in. (610 mm) in door leaf width.*

(3) Door openings serving a building or portion thereof not required to be accessible to persons with severe mobility impairments shall be permitted to be 28 in. (710 mm) in door leaf width.*

(4) In existing buildings, the existing door leaf width shall be not less than 28 in. (710 mm).

*(5) Door openings in detention and correctional occupancies, as otherwise provided in Chapters **22** and **23**, shall not be required to comply with **7.2.1.2.3**.*

*(6) Interior door openings in dwelling units as otherwise provided in Chapter **24** shall not be required to comply with **7.2.1.2.3**.*

*(7) A power-operated door leaf located within a two-leaf opening shall be exempt from the minimum 32 in. (810 mm) single-leaf requirement in accordance with **7.2.1.9.1.5**.*

*(8) Revolving door assemblies, as provided in **7.2.1.10**, shall be exempt from the minimum 32 in. (810 mm) width requirement.*

(9) Where a single door opening is provided for discharge from a stairway required to be a minimum of 56 in. (1420 mm) wide in accordance with **7.2.2.2.1.2**(B), and such door assembly serves*

*as the sole means of exit discharge from such stairway, the clear width of the door opening, measured in accordance with **7.2.1.2.2**, shall be not less than two-thirds the required width of the stairway.*

7.2.1.3 Floor Level.

7.2.1.3.1 *The elevation of the floor surfaces on both sides of a door opening shall not vary by more than 1/2 in. (13 mm), unless otherwise permitted by **7.2.1.3.5**, **7.2.1.3.6**, or **7.2.1.3.7**.*

7.2.1.3.2 *The elevation of the floor surfaces required by **7.2.1.3.1** shall be maintained on both sides of the door openings for a distance not less than the width of the widest leaf.*

7.2.1.3.3 *Thresholds at door openings shall not exceed 1/2 in. (13 mm) in height.*

7.2.1.3.4 *Raised thresholds and floor level changes in excess of 1/4 in. (6.3 mm) at door openings shall be beveled with a slope not steeper than 1 in 2.*

7.2.1.3.5 *In existing buildings, where the door opening discharges to the outside or to an exterior balcony or exterior exit access, the floor level outside the door opening shall be permitted to be one step lower than that of the inside, but shall be not more than 8 in. (205 mm) lower.*

7.2.1.3.6 *In existing buildings, a door assembly at the top of a stair shall be permitted to open directly at a stair, provided that the door leaf does not swing over the stair and that the door opening serves an area with an occupant load of fewer than 50 persons.*

7.2.1.3.7 *Where doors serve spaces that are not normally occupied, the floor level shall be permitted to be lower than that of the door opening but shall be not more than 8 in. (205 mm) lower.*

7.2.1.4 Swing and Force to Open.

7.2.1.4.1* Swinging-Type Door Assembly Requirement. *Any door assembly in a means of egress shall be of the side-hinged or pivoted-swinging type, and shall be installed to be capable of swinging from any position to the full required width of the opening in which it is installed, unless otherwise specified as follows:*

*(1) Door assemblies in dwelling units, as provided in Chapter **24**, shall be permitted.*

*(2) Door assemblies in residential board and care occupancies, as provided in Chapters **32** and **33**, shall be permitted.*

*(3) Where permitted in Chapters **11** through **43**, horizontal-sliding or vertical-rolling security grilles or door assemblies that are part of the required means of egress shall be permitted, provided that all of the following criteria are met:*

(a) Such grilles or door assemblies shall remain secured in the fully open position during the period of occupancy by the general public.

(b) On or adjacent to the grille or door opening, there shall be a readily visible, durable sign in letters not less than 1 in. (25 mm) high on a contrasting background that reads as follows: THIS DOOR TO REMAIN OPEN WHEN THE SPACE IS OCCUPIED.

(c) Door leaves or grilles shall not be brought to the closed position when the space is occupied.

(d) Door leaves or grilles shall be operable from within the space without the use of any special knowledge or effort.

(e) Where two or more means of egress are required, not more than half of the means of egress shall be equipped with horizontal-sliding or vertical-rolling grilles or door assemblies.

(4) Horizontal-sliding door assemblies shall be permitted under any of the following conditions:

*(a) Horizontal-sliding door assemblies in detention and correctional occupancies, as provided in Chapters **22** and **23**, shall be permitted.*

*(b) Special-purpose horizontally sliding accordion or folding door assemblies complying with **7.2.1.14** shall be permitted.*

*(c) Unless prohibited by Chapters **11** through **43**, horizontal-sliding door assemblies serving a room or area with an occupant load of fewer than 10 shall be permitted, provided that all of the following criteria are met:*

i. The area served by the door assembly has no high hazard contents.

ii. The door assembly is readily operable from either side without special knowledge or effort.

iii. The force required to operate the door assembly in the direction of door leaf travel is not more than 30 lbf (133 N) to set the door leaf in motion and is not more than 15 lbf (67 N) to close the door assembly or open it to the minimum required width.

*iv. The door assembly complies with any required fire protection rating, and, where rated, is self-closing or automatic-closing by means of smoke detection in accordance with **7.2.1.8** and is installed in accordance with **NFPA 80**, Standard for Fire Doors and Other Opening Protectives.*

v. Corridor door assemblies required to be self-latching have a latch or other mechanism that ensures that the door leaf will not rebound into a partially open position if forcefully closed.

(d) Where private garages, business areas, industrial areas, and storage areas with an occupant load not exceeding 10 contain only low or ordinary hazard contents, door openings to such areas and private garages shall be permitted to be horizontal-sliding door assemblies.

(5) Where private garages, business areas, industrial areas, and storage areas with an occupant load not exceeding 10 contain only low or ordinary hazard contents, door openings to such areas and private garages shall be permitted to be vertical-rolling door assemblies.

*(6) Revolving door assemblies complying with **7.2.1.10** shall be permitted.*

*(7) Existing fusible link–operated horizontal-sliding or vertical-rolling fire door assemblies shall be permitted to be used as provided in Chapters **39**, **40**, and **42**.*

7.2.1.4.2 Door Leaf Swing Direction. *Door leaves required to be of the side-hinged or pivoted-swinging type shall swing in the direction of egress travel under any of the following conditions:*

(1) Where serving a room or area with an occupant load of 50 or more, except under any of the following conditions:

*(a) Door leaves in horizontal exits shall not be required to swing in the direction of egress travel where permitted by **7.2.4.3.8.1** or **7.2.4.3.8.2**.*

*(b) Door leaves in smoke barriers shall not be required to swing in the direction of egress travel in existing health care occupancies, as provided in Chapter **19**.*

(2) Where the door assembly is used in an exit enclosure, unless the door opening serves an individual living unit that opens directly into an exit enclosure

(3) Where the door opening serves a high hazard contents area

7.2.1.4.3* Door Leaf Encroachment.

7.2.1.4.3.1 *During its swing, any door leaf in a means of egress shall leave not less than one-half of the required width of an aisle, a corridor, a passageway, or a landing unobstructed, unless both of the following conditions are met:*

(1) The door opening provides access to a stair in an existing building.

*(2) The door opening meets the requirement of **7.2.1.4.3.2**.*

7.2.1.4.3.2 *When fully open, any door leaf in a means of egress shall not project more than 7 in. (180 mm) into the required width of an aisle, a corridor, a passageway, or a landing, unless the door leaf is equipped with an approved self-closing device and is not required by the provisions of **7.2.1.4.2** to swing in the direction of egress travel.*

7.2.1.4.3.3 *Surface-mounted latch release hardware on the door leaf shall be exempt from being included in the maximum 7 in. (180 mm) projection requirement of **7.2.1.4.3.1**, provided that both of the following criteria are met:*

(1) The hardware is mounted to the side of the door leaf that faces the aisle, corridor, passageway, or landing when the door leaf is in the open position.

(2) The hardware is mounted not less than 34 in. (865 mm), and not more than 48 in. (1220 mm), above the floor.

7.2.1.4.5 Door Leaf Operating Forces.

7.2.1.4.5.1 *The forces required to fully open any door leaf manually in a means of egress shall not exceed 15 lbf (67 N) to release the latch, 30 lbf (133 N) to set the leaf in motion, and 15 lbf (67 N) to open the leaf to the minimum required width, unless otherwise specified as follows:*

(1) The opening forces for interior side-hinged or pivoted-swinging door leaves without closers shall not exceed 5 lbf (22 N).

(2) The opening forces for existing door leaves in existing buildings shall not exceed 50 lbf (222 N) applied to the latch stile.

*(3) The opening forces for horizontal-sliding door leaves in detention and correctional occupancies shall be as provided in Chapters **22** and **23**.*

*(4) The opening forces for power-operated door leaves shall be as provided in **7.2.1.9**.*

7.2.1.4.5.2 *The forces specified in **7.2.1.4.5** shall be applied to the latch stile.*

7.2.1.5 Locks, Latches, and Alarm Devices.

7.2.1.5.1 *Door leaves shall be arranged to be opened readily from the egress side whenever the building is occupied.*

7.2.1.5.2* *The requirement of **7.2.1.5.1** shall not apply to door leaves of listed fire door assemblies after exposure to elevated temperature in accordance with the listing, based on laboratory fire test procedures.*

7.2.1.5.3 *Locks, if provided, shall not require the use of a key, a tool, or special knowledge or effort for operation from the egress side.*

7.2.1.5.4 *The requirements of **7.2.1.5.1** and **7.2.1.5.3** shall not apply where otherwise provided in Chapters **18** through **23**.*

7.2.1.5.6 Electrically Controlled Egress Door Assemblies. *Door assemblies in the means of egress shall be permitted to be electrically locked if equipped with approved, listed hardware, provided that all of the following conditions are met:*

(1)The hardware for occupant release of the lock is affixed to the door leaf.

(2)The hardware has an obvious method of operation that is readily operated in the direction of egress.

(3)The hardware is capable of being operated with one hand in the direction of egress.

(4)Operation of the hardware interrupts the power supply directly to the electric lock and unlocks the door assembly in the direction of egress.
*(5)*Loss of power to the listed releasing hardware automatically unlocks the door assembly in the direction of egress.*
(6)Hardware for new installations is listed in accordance with ANSI/UL 294, Standard for Access Control System Units.

7.2.1.5.8* *Every door assembly in a stair enclosure serving more than four stories, unless permitted by **7.2.1.5.8.2**, shall meet one of the following conditions:*
(1)Re-entry from the stair enclosure to the interior of the building shall be provided.
(2)An automatic release that is actuated with the initiation of the building fire alarm system shall be provided to unlock all stair enclosure door assemblies to allow re-entry.
*(3)Selected re-entry shall be provided in accordance with **7.2.1.5.8.1**.*

7.2.1.5.8.1 *Door assemblies on stair enclosures shall be permitted to be equipped with hardware that prevents re-entry into the interior of the building, provided that all of the following criteria are met:*
(1)There shall be not less than two levels where it is possible to leave the stair enclosure to access another exit.
(2)There shall be not more than four stories intervening between stories where it is possible to leave the stair enclosure to access another exit.
(3)Re-entry shall be possible on the top story or next-to-top story served by the stair enclosure, and such story shall allow access to another exit.
(4)Door assemblies allowing re-entry shall be identified as such on the stair side of the door leaf.
(5)Door assemblies not allowing re-entry shall be provided with a sign on the stair side indicating the location of the nearest door opening, in each direction of travel, that allows re-entry or exit.

7.2.1.5.8.2 *The requirements of **7.2.1.5.8**, except as provided in **7.2.1.5.8.3**, shall not apply to the following:*
*(1)Existing installations in buildings that are not high-rise buildings as permitted in Chapters **11** through **43***
*(2)Existing installations in high-rise buildings as permitted in Chapters **11** through **43** where the occupancy is within a building protected throughout by an approved, supervised automatic sprinkler system in accordance with Section **9.7***
*(3)Existing approved stairwell re-entry installations as permitted by Chapters **11** through **43***
*(4)Stair enclosures serving a building permitted to have a single exit in accordance with Chapters **11** through **43***
*(5)Stair enclosures in health care occupancies where otherwise provided in Chapter **18***
*(6)Stair enclosures in detention and correctional occupancies where otherwise provided in Chapter **22***

7.2.1.5.8.3 *When the provisions of **7.2.1.5.8.2** are used, signage on the stair door leaves shall be required as follows;*
(1)Door assemblies allowing re-entry shall be identified as such on the stair side of the door leaf.
(2)Door assemblies not allowing re-entry shall be provided with a sign on the stair side indicating the location of the nearest door opening, in each direction of travel, that allows re-entry or exit.

7.2.1.5.9 *If a stair enclosure allows access to the roof of the building, the door assembly to the roof either shall be kept locked or shall allow re-entry from the roof.*

7.2.1.5.10* *A latch or other fastening device on a door leaf shall be provided with a releasing device that has an obvious method of operation and that is readily operated under all lighting conditions.*

7.2.1.5.10.1 *The releasing mechanism for any latch shall be located as follows:*
(1)Not less than 34 in. (865 mm) above the finished floor for other than existing installations
(2)Not more than 48 in. (1220 mm) above the finished floor

7.2.1.5.10.2 *The releasing mechanism shall open the door leaf with not more than one releasing operation, unless otherwise specified in **7.2.1.5.10.3**, **7.2.1.5.10.4**, or **7.2.1.5.10.6**.*

7.2.1.5.10.3* *Egress door assemblies from individual living units and guest rooms of residential occupancies shall be permitted to be provided with devices, including automatic latching devices, that require not more than one additional releasing operation, provided that such device is operable from the inside without the use of a key or tool and is mounted at a height not exceeding 48 in. (1220 mm) above the finished floor.*

7.2.1.5.10.4 *Existing security devices permitted by **7.2.1.5.10.3** shall be permitted to have two additional releasing operations.*

7.2.1.5.10.5 *Existing security devices permitted by **7.2.1.5.10.3**, other than automatic latching devices, shall be located not more than 60 in. (1525 mm) above the finished floor.*

7.2.1.5.10.6 *Two releasing operations shall be permitted for existing hardware on a door leaf serving an*

area having an occupant load not exceeding three, provided that releasing does not require simultaneous operations.

7.2.1.5.11 *Where pairs of door leaves are required in a means of egress, one of the following criteria shall be met:*

(1)Each leaf of the pair shall be provided with a releasing device that does not depend on the release of one leaf before the other.

(2)Approved automatic flush bolts shall be used and arranged such that both of the following criteria are met:

(a)The door leaf equipped with the automatic flush bolts shall have no doorknob or surface-mounted hardware.

(b)Unlatching of any leaf shall not require more than one operation.

7.2.1.5.12* *Devices shall not be installed in connection with any door assembly on which panic hardware or fire exit hardware is required where such devices prevent or are intended to prevent the free use of the leaf for purposes of egress, unless otherwise provided in **7.2.1.6**.*

7.2.1.7 Panic Hardware and Fire Exit Hardware.

7.2.1.7.1 *Where a door assembly is required to be equipped with panic or fire exit hardware, such hardware shall meet all of the following criteria:*

(1)It shall consist of a cross bar or a push pad, the actuating portion of which extends across not less than one-half of the width of the door leaf.

(2)It shall be mounted as follows:

(a)New installations shall be not less than 34 in. (865 mm), and not more than 48 in. (1220 mm), above the floor.

(b)Existing installations shall be not less than 30 in. (760 mm), and not more than 48 in. (1220 mm), above the floor.

(3)It shall be constructed so that a horizontal force not to exceed 15 lbf (66 N) actuates the cross bar or push pad and latches.

7.2.1.7.2* *Only approved fire exit hardware shall be used on fire protection-rated door assemblies. New panic hardware and new fire exit hardware shall comply with ANSI/UL 305, Standard for Safety Panic Hardware, and ANSI/BHMA A156.3, Exit Devices.*

7.2.1.7.3 *Required panic hardware and fire exit hardware, in other than detention and correctional occupancies as otherwise provided in Chapters **22** and **23**, shall not be equipped with any locking device, set screw, or other arrangement that prevents the release of the latch when pressure is applied to the releasing device.*

7.2.1.7.4 *Devices that hold the latch in the retracted position shall be prohibited on fire exit hardware, unless such devices are listed and approved for such a purpose.*

7.2.1.8 Self-Closing Devices.

7.2.1.8.1* *A door leaf normally required to be kept closed shall not be secured in the open position at any time and shall be self-closing or automatic-closing in accordance with **7.2.1.8.2**, unless otherwise permitted by **7.2.1.8.3**.*

7.2.1.8.2 *In any building of low or ordinary hazard contents, as defined in **6.2.2.2** and **6.2.2.3**, or where approved by the authority having jurisdiction, door leaves shall be permitted to be automatic-closing, provided that all of the following criteria are met:*

(1)Upon release of the hold-open mechanism, the leaf becomes self-closing.

(2)The release device is designed so that the leaf instantly releases manually and, upon release, becomes self-closing, or the leaf can be readily closed.

*(3)The automatic releasing mechanism or medium is activated by the operation of approved smoke detectors installed in accordance with the requirements for smoke detectors for door leaf release service in **NFPA 72**, National Fire Alarm and Signaling Code.*

(4)Upon loss of power to the hold-open device, the hold-open mechanism is released and the door leaf becomes self-closing.

(5)The release by means of smoke detection of one door leaf in a stair enclosure results in closing all door leaves serving that stair.

7.2.1.8.3 *The elevator car doors, and the associated hoistway enclosure doors, at the floor level designated for recall in accordance with the requirements of **9.4.3** shall be permitted to remain open during Phase I Emergency Recall Operation.*

7.2.1.9* Powered Door Leaf Operation.

7.2.1.9.1* General. *Where means of egress door leaves are operated by power upon the approach of a person or are provided with power-assisted manual operation, the design shall be such that, in the event of power failure, the leaves open manually to allow egress travel or close when necessary to safeguard the means of egress.*

7.2.1.9.1.1 *The forces required to manually open the door leaves specified in **7.2.1.9.1** shall not exceed those required in **7.2.1.4.5**, except that the force required to set the leaf in motion shall not exceed 50 lbf (222 N).*

7.2.1.9.1.2 *The door assembly shall be designed and installed so that, when a force is applied to the door leaf on the side from which egress is made, it shall be capable of swinging from any position to provide full use of the required width of the opening in which it is installed. (See **7.2.1.4**.)*

7.2.1.9.1.3 *A readily visible, durable sign in letters not less than 1 in. (25 mm) high on a contrasting background that reads as follows shall be located on the egress side of each door opening:*
IN EMERGENCY, PUSH TO OPEN

7.2.1.9.2 Self-Closing or Self-Latching Door Leaf Operation. *Where door leaves are required to be self-closing or self-latching and are operated by power upon the approach of a person, or are provided with power-assisted manual operation, they shall be permitted in the means of egress where they meet the following criteria:*

*(1)The door leaves can be opened manually in accordance with **7.2.1.9.1** to allow egress travel in the event of power failure.*
(2)New door leaves remain in the closed position, unless actuated or opened manually.
(3)When actuated, new door leaves remain open for not more than 30 seconds.
*(4)Door leaves held open for any period of time close — and the power-assist mechanism ceases to function — upon operation of approved smoke detectors installed in such a way as to detect smoke on either side of the door opening in accordance with the provisions of **NFPA 72**, National Fire Alarm and Signaling Code.*
*(5)Door leaves required to be self-latching are either self-latching or become self-latching upon operation of approved smoke detectors per **7.2.1.9.2**(4).*
(6)New power-assisted swinging door assemblies comply with BHMA/ANSI A156.19, American National Standard for Power Assist and Low Energy Power Operated Doors.

7.2.1.15 Inspection of Door Openings.

7.2.1.15.1* *Where required by Chapters **11** through **43**, the following door assemblies shall be inspected and tested not less than annually in accordance with **7.2.1.15.2** through **7.2.1.15.7**:*

*(1)Door leaves equipped with panic hardware or fire exit hardware in accordance with **7.2.1.7***
(2)Door assemblies in exit enclosures
(3)Electrically controlled egress doors
*(4)Door assemblies with special locking arrangements subject to **7.2.1.6***

7.2.1.15.2* *The inspection and testing interval for fire-rated and nonrated door assemblies shall be permitted to exceed 12 months under a written performance-based program.*

7.2.1.15.2.1 *Goals established under a performance-based program shall provide assurance that the door assembly will perform its intended function.*

7.2.1.15.2.2 *Technical justification for inspection, testing, and maintenance intervals shall be documented.*

7.2.1.15.2.3 *The performance-based option shall include historical data.*

7.2.1.15.3 *A written record of the inspections and testing shall be signed and kept for inspection by the authority having jurisdiction.*

7.2.1.15.4 *Functional testing of door assemblies shall be performed by individuals who can demonstrate knowledge and understanding of the operating components of the type of door being subjected to testing.*

7.2.1.15.5 *Door assemblies shall be visually inspected from both sides of the opening to assess the overall condition of the assembly.*

7.2.1.15.6 *As a minimum, the following items shall be verified:*

(1)Floor space on both sides of the openings is clear of obstructions, and door leaves open fully and close freely.
*(2)Forces required to set door leaves in motion and move to the fully open position do not exceed the requirements in **7.2.1.4.5**.*
*(3)Latching and locking devices comply with **7.2.1.5**.*
*(4)Releasing hardware devices are installed in accordance with **7.2.1.5.10.1**.*
*(5)Door leaves of paired openings are installed in accordance with **7.2.1.5.11**.*
(6)Door closers are adjusted properly to control the closing speed of door leaves in accordance with accessibility requirements.
*(7)Projection of door leaves into the path of egress does not exceed the encroachment permitted by **7.2.1.4.3**.*
*(8)Powered door openings operate in accordance with **7.2.1.9**.*
*(9)Signage required by **7.2.1.4.1**(3), **7.2.1.5.5**, **7.2.1.6**, and **7.2.1.9** is intact and legible.*
*(10)Door openings with special locking arrangements function in accordance with **7.2.1.6**.*
*(11)Security devices that impede egress are not installed on openings, as required by **7.2.1.5.12**.*

*(12)Where required by **7.2.2.5.5.7**, door hardware marking is present and intact.*
*(13)Emergency lighting on access-controlled egress doors and doors equipped with delayed-egress locking systems is present and functioning in accordance with Section **7.9**.*

7.2.1.15.7 *Door openings not in proper operating condition shall be repaired or replaced without delay.*

7.2.2 Stairs.

7.2.2.1 General.

7.2.2.1.1 *Stairs used as a component in the means of egress shall conform to the general requirements of Section **7.1** and to the special requirements of **7.2.2**, unless otherwise specified in **7.2.2.1.2**.*

7.2.2.1.2 *The requirement of **7.2.2.1.1** shall not apply to the following:*
*(1)Aisle stairs in assembly occupancies, as provided in Chapters **12** and **13***
(2)Approved existing noncomplying stairs

7.2.2.2 Dimensional Criteria.

7.2.2.2.1 Standard Stairs.

7.2.2.2.1.1 *Stairs shall meet the following criteria:*
*(1)New stairs shall be in accordance with **Table 7.2.2.2.1.1(a)** and **7.2.2.2.1.2**.*
*(2)Existing stairs shall be permitted to remain in use, provided that they meet the requirements for existing stairs shown in **Table 7.2.2.2.1.1(b)**.*
(3)Approved existing stairs shall be permitted to be rebuilt in accordance with the following:
*(a)Dimensional criteria of **Table 7.2.2.2.1.1(b)***
*(b)Other stair requirements of **7.2.2***
*(4)The requirements for new and existing stairs shall not apply to stairs located in industrial equipment access areas where otherwise provided in **40.2.5.3**.*

Table 7.2.2.2.1.1(a) New Stairs

Feature	Dimensional Criteria ft/in.	Dimensional Criteria mm
Minimum width	See 7.2.2.2.1.2.	
Maximum height of risers	7 in.	180
Minimum height of risers	4 in.	100
Minimum tread depth	11 in.	280
Minimum headroom	6 ft 8 in.	2030
Maximum height between landings	12 ft	3660
Landing	See 7.2.1.3, 7.2.1.4.3.1, and 7.2.2.3.2.	

7.2.2.3 Stair Details.

7.2.2.3.1 Construction.

7.2.2.3.1.1 *All stairs serving as required means of egress shall be of permanent fixed construction, unless they are stairs serving seating that is designed to be repositioned in accordance with Chapters **12** and **13**.*

7.2.2.3.1.2 *Each stair, platform, and landing, not including handrails and existing stairs, in buildings required in this Code to be of Type I or Type II construction shall be of noncombustible material throughout.*

7.2.2.3.2 Landings.

7.2.2.3.2.1 *Stairs shall have landings at door openings, except as permitted in **7.2.2.3.2.5**.*

7.2.2.3.2.2 *Stairs and intermediate landings shall continue with no decrease in width along the direction of egress travel.*

7.2.2.3.2.3 *In new buildings, every landing shall have a dimension, measured in the direction of travel, that is not less than the width of the stair.*

7.2.2.3.2.4 *Landings shall not be required to exceed 48 in. (1220 mm) in the direction of travel, provided that the stair has a straight run.*

7.2.2.3.2.5 *In existing buildings, a door assembly at the top of a stair shall be permitted to open directly to the stair, provided that the door leaf does not swing over the stair and the door opening serves an area with an occupant load of fewer than 50 persons.*

7.2.2.3.3 Tread and Landing Surfaces.

7.2.2.3.3.1 *Stair treads and landings shall be solid, without perforations, unless otherwise permitted in **7.2.2.3.5**.*

7.2.2.3.3.2* *Stair treads and landings shall be free of projections or lips that could trip stair users.*

7.2.2.3.3.3* *Stair treads and landings within the same stairway shall have consistent surface traction.*

7.2.2.3.3.4 *If not vertical, risers on other than existing stairs shall be permitted to slope under the tread at an angle not to exceed 30 degrees from vertical, provided that the projection of the nosing does not exceed 1 1/2 in. (38 mm).*

7.2.2.3.3.5 *The requirement of **7.2.2.3.3.1** shall not apply to noncombustible grated stair treads and landings in the following occupancies:*

*(1)Assembly occupancies as otherwise provided in Chapters **12** and **13***

*(2)Detention and correctional occupancies as otherwise provided in Chapters **22** and **23***

*(3)Industrial occupancies as otherwise provided in Chapter **40***

*(4)Storage occupancies as otherwise provided in Chapter **42***

7.2.2.3.4* Tread and Landing Slope. *The tread and landing slope shall not exceed 1/4 in./ft (21 mm/m) (a slope of 1 in 48).*

7.2.2.3.5* Riser Height and Tread Depth. *Riser height shall be measured as the vertical distance between tread nosings. Tread depth shall be measured horizontally, between the vertical planes of the foremost projection of adjacent treads and at a right angle to the tread's leading edge, but shall not include beveled or rounded tread surfaces that slope more than 20 degrees (a slope of 1 in 2.75). At tread nosings, such beveling or rounding shall not exceed 1/2 in. (13 mm) in horizontal dimension.*

7.2.2.3.6* Dimensional Uniformity.

7.2.2.3.6.1 *Variation in excess of 3/16 in. (4.8 mm) in the sizes of adjacent tread depths or in the height of adjacent risers shall be prohibited, unless otherwise permitted in **7.2.2.3.6.3**.*

7.2.2.3.6.2 *The variation between the sizes of the largest and smallest riser or between the largest and smallest tread depths shall not exceed 3/8 in. (9.5 mm) in any flight.*

7.2.2.3.6.3 *Where the bottom or top riser adjoins a sloping public way, walk, or driveway having an established finished ground level and serves as a landing, the bottom or top riser shall be permitted to have a variation in height of not more than 1 in. in every 12 in. (25 mm in every 305 mm) of stairway width.*

7.2.2.3.6.4 *The size of the variations addressed by **7.2.2.3.6.1**, **7.2.2.3.6.2**, and **7.2.2.3.6.3** shall be based on the nosing-to-nosing dimensions of the tread depths and riser heights, consistent with the measurement details set out in **7.2.2.3.5**.*

7.2.2.3.6.5* *All tread nosings of stairs utilizing the provision of **7.2.2.3.6.3** shall be marked in accordance with **7.2.2.5.4.3**. Those portions of the marking stripe at locations where the riser height below the nosing is inconsistent by more than 3/16 in. (4.8 mm), relative to other risers in the stair flight, shall be distinctively colored or patterned, incorporating safety yellow, to warn descending users of the inconsistent geometry relative to other steps in the flight.*

7.2.2.3.6.6 *The variation in the horizontal projection of all nosings, including the projection of the landing nosing, shall not exceed 3/8 in. (9.5 mm) within each stair flight and, for other than existing nosings, shall not exceed 3/16 in. (4.8 mm) between adjacent nosings.*

7.2.2.4 Guards and Handrails.

7.2.2.4.1 Handrails.

7.2.2.4.1.1 *Stairs and ramps shall have handrails on both sides, unless otherwise permitted in **7.2.2.4.1.5** or **7.2.2.4.1.6**.*

7.2.2.4.1.2 *In addition to the handrails required at the sides of stairs by **7.2.2.4.1.1**, both of the following provisions shall apply:*

(1)For new stairs, handrails shall be provided within 30 in. (760 mm) of all portions of the required egress width.

(2)For existing stairs, handrails shall meet the following criteria:

(a)They shall be provided within 44 in. (1120 mm) of all portions of the required egress width.

*(b)Such stairs shall not have their egress capacity adjusted to a higher occupant load than permitted by the capacity factor in **Table 7.3.3.1** if the stair's clear width between handrails exceeds 60 in. (1525 mm).*

7.2.2.4.1.3 *Where new intermediate handrails are provided in accordance with **7.2.2.4.1.2**, the minimum clear width between handrails shall be 20 in. (510 mm).*

7.2.2.4.1.4* *The required egress width shall be provided along the natural path of travel.*

7.2.2.4.1.5 *If a single step or a ramp is part of a curb that separates a sidewalk from a vehicular way, it shall not be required to have a handrail.*

7.2.2.4.1.6 *Existing stairs, existing ramps, stairs within dwelling units and within guest rooms, and ramps within dwelling units and guest rooms shall be permitted to have a handrail on one side only.*

7.2.2.4.2 Continuity. *Required guards and handrails shall continue for the full length of each flight of stairs. At turns of new stairs, inside handrails shall be continuous between flights at landings.*

7.2.2.4.3 Projections. *The design of guards and handrails and the hardware for attaching handrails to guards, balusters, or walls shall be such that there are no projections that might engage loose clothing. Openings in guards shall be designed to prevent loose clothing from becoming wedged in such openings.*

7.2.2.4.4 Direction. *For standard stairs, at least one handrail shall be installed at a right angle to the leading edge of the stair treads.*

7.2.2.4.5* Handrail Details.

7.2.2.4.5.1 *New handrails on stairs shall be not less than 34 in. (865 mm), and not more than 38 in. (965 mm), above the surface of the tread, measured vertically to the top of the rail from the leading edge of the tread.*

7.2.2.4.5.2 *Existing required handrails shall be not less than 30 in. (760 mm), and not more than 38 in. (965 mm), above the surface of the tread, measured vertically to the top of the rail from the leading edge of the tread.*

7.2.2.4.5.3 *The height of required handrails that form part of a guard shall be permitted to exceed 38 in. (965 mm), but shall not exceed 42 in. (1065 mm), measured vertically to the top of the rail from the leading edge of the tread.*

7.2.2.4.5.4 *Additional handrails that are lower or higher than the main handrail shall be permitted.*

7.2.2.4.5.5 *New handrails shall be installed to provide a clearance of not less than 2 1/4 in. (57 mm) between the handrail and the wall to which it is fastened.*

7.2.2.4.5.6 *Handrails shall include one of the following features:*

(1)Circular cross section with an outside diameter of not less than 1 1/4 in. (32 mm) and not more than 2 in. (51 mm)

*(2)*Shape that is other than circular with a perimeter dimension of not less than 4 in. (100 mm), but not more than 6 1/4 in. (160 mm), and with the largest cross-sectional dimension not more than 2 1/4 in. (57 mm), provided that graspable edges are rounded so as to provide a radius of not less than 1/8 in. (3.2 mm)*

7.2.2.4.5.7 *New handrails shall be continuously graspable along their entire length.*

7.2.2.4.5.8 *Handrail brackets or balusters attached to the bottom surface of the handrail shall not be considered to be obstructions to graspability, provided that both of the following criteria are met:*

(1)They do not project horizontally beyond the sides of the handrail within 1 1/2 in. (38 mm) of the bottom of the handrail and provided that, for each additional 1/2 in. (13 mm) of handrail perimeter dimension greater than 4 in. (100 mm), the vertical clearance dimension of 1 1/2 in. (38 mm) is reduced by 1/8 in. (3.2 mm).

(2)They have edges with a radius of not less than 0.01 in. (0.25 mm).

7.2.2.4.5.9 *New handrail ends shall be returned to the wall or floor or shall terminate at newel posts.*

7.2.2.4.5.10 *In other than dwelling units, new handrails that are not continuous between flights shall extend horizontally, at the required height, not less than 12 in. (305 mm) beyond the top riser and continue to slope for a depth of one tread beyond the bottom riser.*

7.2.2.4.5.11 *Within dwelling units, handrails shall extend, at the required height, to at least those points that are directly above the top and bottom risers.*

7.2.2.4.6 Guard Details. *See **7.1.8** for guard requirements.*

7.2.2.4.6.1 *The height of guards required in **7.1.8** shall be measured vertically to the top of the guard from the surface adjacent thereto.*

7.2.2.4.6.2 *Guards shall be not less than 42 in. (1065 mm) high, except as permitted by one of the following:*

(1)Existing guards within dwelling units shall be permitted to be not less than 36 in. (915 mm) high.

*(2)The requirement of **7.2.2.4.6.2** shall not apply in assembly occupancies where otherwise provided in Chapters **12** and **13**.*

*(3)*Existing guards on existing stairs shall be permitted to be not less than 30 in. (760 mm) high.*

7.2.2.4.6.3 *Open guards, other than approved existing open guards, shall have intermediate rails or an ornamental pattern such that a sphere 4 in. (100 mm) in diameter is not able to pass through any opening up to a height of 34 in. (865 mm), and the following also shall apply:*

(1)The triangular openings formed by the riser, tread, and bottom element of a guardrail at the open side of a stair shall be of such size that a sphere 6 in. (150 mm) in diameter is not able to pass through the triangular opening.

(2)In detention and correctional occupancies, in industrial occupancies, and in storage occupancies, the clear distance between intermediate rails, measured at right angles to the rails, shall not exceed 21 in. (535 mm).

7.2.2.5 Enclosure and Protection of Stairs.

7.2.2.5.1 Enclosures.

7.2.2.5.1.1 *All inside stairs serving as an exit or exit component shall be enclosed in accordance with **7.1.3.2**.*

7.2.2.5.1.2 *Inside stairs, other than those serving as an exit or exit component, shall be protected in accordance with Section* ***8.6****.*

7.2.2.5.1.3 *In existing buildings, where a two-story exit enclosure connects the story of exit discharge with an adjacent story, the exit shall be permitted to be enclosed only on the story of exit discharge, provided that not less than 50 percent of the number and capacity of exits on the story of exit discharge are independent of such enclosures.*

7.2.2.5.3* Usable Space. *Enclosed, usable spaces within exit enclosures shall be prohibited, including under stairs, unless otherwise permitted by* ***7.2.2.5.3.2****.*

7.2.2.5.3.1 *Open space within the exit enclosure shall not be used for any purpose that has the potential to interfere with egress.*

7.2.2.5.3.2 *Enclosed, usable space shall be permitted under stairs, provided that both of the following criteria are met:*

(1)The space shall be separated from the stair enclosure by the same fire resistance as the exit enclosure.

(2)Entrance to the enclosed, usable space shall not be from within the stair enclosure. (See also ***7.1.3.2.3****.)*

7.2.2.5.4* Stairway Identification.

7.2.2.5.4.1 *New enclosed stairs serving three or more stories and existing enclosed stairs, other than those addressed in* ***7.2.2.5.4.1****(P), serving five or more stories shall comply with* ***7.2.2.5.4.1****(A) through* ***7.2.2.5.4.1****(O).*

(A) The stairs shall be provided with special signage within the enclosure at each floor landing.

(B) The signage shall indicate the floor level.

(C) The signage shall indicate the terminus of the top and bottom of the stair enclosure.

(D) The signage shall indicate the identification of the stair enclosure.

(E) The signage shall indicate the floor level of, and the direction to, exit discharge.

(F) The signage shall be located inside the stair enclosure.

(G) The bottom of the signage shall be located a minimum of 48 in. (1220 mm) above the floor landing, and the top of the signage shall be located a maximum of 84 in. (2135 mm) above the floor landing

(H) The signage shall be in a position that is visible when the door is in the open or closed position.

(I) The signage shall comply with 7.10.8.1 and 7.10.8.2 of this Code.

(J) The floor level designation shall also be tactile in accordance with ICC/ANSI A117.1, American National Standard for Accessible and Usable Buildings and Facilities.

(K) The signage shall be painted or stenciled on the wall or on a separate sign securely attached to the wall.

(L) The stairway identification shall be located at the top of the sign in minimum 1 in. (25 mm) high lettering and shall be in accordance with 7.10.8.2.

(M) Signage that reads NO ROOF ACCESS shall designate stairways that do not provide roof access. Lettering shall be a minimum of 1 in. (25 mm) high and shall be in accordance with 7.10.8.2.*

(N) The floor level number shall be located below the stairway identifier in minimum 5 in. (125 mm) high numbers and shall be in accordance with 7.10.8.2. Mezzanine levels shall have the letter "M" or other appropriate identification letter preceding the floor number, while basement levels shall have the letter "B" or other appropriate identification letter preceding the floor level number.

(O) Identification of the lower and upper terminus of the stairway shall be on the sign in minimum 1 in. (25 mm) high letters or numbers and shall be in accordance with 7.10.8.2.

(P) Previously approved, existing signage shall not be required to comply with 7.2.2.5.4.1(L) through (O).

7.2.2.5.4.2 *Wherever an enclosed stair requires travel in an upward direction to reach the level of exit discharge, special signs with directional indicators showing the direction to the level of exit discharge shall be provided at each floor level landing from which upward direction of travel is required, unless otherwise provided in* ***7.2.2.5.4.2****(A) and* ***7.2.2.5.4.2****(B), and both of the following also shall apply:*

(1)Such signage shall comply with ***7.10.8.1*** *and* ***7.10.8.2****.*

(2)Such signage shall be visible when the door leaf is in the open or closed position.

(A) The requirement of 7.2.2.5.4.2 shall not apply where signs required by 7.2.2.5.4.1 are provided.

(B) The requirement of 7.2.2.5.4.2 shall not apply to stairs extending not more than one story below the level of exit discharge where the exit discharge is clearly obvious.

7.3 Capacity of Means of Egress.

7.3.1 Occupant Load.

7.3.1.1 Sufficient Capacity.

7.3.1.1.1 *The total capacity of the means of egress for any story, balcony, tier, or other occupied space shall be sufficient for the occupant load thereof.*

7.3.1.1.2 *For other than existing means of egress, where more than one means of egress is required, the means of egress shall be of such width and capacity that the loss of any one means of egress leaves available not less than 50 percent of the required capacity.*

7.3.1.2* Occupant Load Factor. *The occupant load in any building or portion thereof shall be not less than the number of persons determined by dividing the floor area assigned to that use by the occupant load factor for that use as specified in* ***Table 7.3.1.2***, ***Figure 7.3.1.2(a)***, *and* ***Figure 7.3.1.2(b)***. *Where both gross and net area figures are given for the same occupancy, calculations shall be made by applying the gross area figure to the gross area of the portion of the building devoted to the use for which the gross area figure is specified and by applying the net area figure to the net area of the portion of the building devoted to the use for which the net area figure is specified.*

Table 7.3.1.2 Occupant Load Factor

Use	(ft^2/person)[a]	(m^2/person)[a]
Assembly Use		
Concentrated use, without fixed seating	7 net	0.65 net
Less concentrated use, without fixed seating	15 net	1.4 net
Bench-type seating	1 person/ 18 linear in.	1 person/ 455 linear mm
Fixed seating	Use number of fixed seats	Use number of fixed seats
Waiting spaces	See 12.1.7.2 and 13.1.7.2.	See 12.1.7.2 and 13.1.7.2.
Kitchens	100	9.3
Library stack areas	100	9.3
Library reading rooms	50 net	4.6 net
Swimming pools	50 (water surface)	4.6 (water surface)
Swimming pool decks	30	2.8
Exercise rooms with equipment	50	4.6
Exercise rooms without equipment	15	1.4
Stages	15 net	1.4 net
Lighting and access catwalks, galleries, gridirons	100 net	9.3 net
Casinos and similar gaming areas	11	1
Skating rinks	50	4.6
Educational Use		
Classrooms	20 net	1.9 net
Shops, laboratories, vocational rooms	50 net	4.6 net
Day-Care Use	35 net	3.3 net
Health Care Use		
Inpatient treatment departments	240	22.3
Sleeping departments	120	11.1
Ambulatory health care	100	9.3
Detention and Correctional Use	120	11.1
Residential Use		
Hotels and dormitories	200	18.6
Apartment buildings	200	18.6
Board and care, large	200	18.6
Industrial Use		
General and high hazard industrial	100	9.3
Special-purpose industrial	NA	NA
Business Use (other than below)	100	9.3
Air traffic control tower observation levels	40	3.7

Table 7.3.1.2 *Continued*

Use	(ft^2/person)[a]	(m^2/person)[a]
Storage Use		
In storage occupancies	NA	NA
In mercantile occupancies	300	27.9
In other than storage and mercantile occupancies	500	46.5
Mercantile Use		
Sales area on street floor[b,c]	30	2.8
Sales area on two or more street floors[c]	40	3.7
Sales area on floor below street floor[c]	30	2.8
Sales area on floors above street floor[c]	60	5.6
Floors or portions of floors used only for offices	See business use.	See business use.
Floors or portions of floors used only for storage, receiving, and shipping, and not open to general public	300	27.9
Mall buildings[d]	Per factors applicable to use of space[e]	

NA: Not applicable. The occupant load is the maximum probable number of occupants present at any time.

[a]All factors are expressed in gross area unless marked "net."

[b]For the purpose of determining occupant load in mercantile occupancies where, due to differences in the finished ground level of streets on different sides, two or more floors directly accessible from streets (not including alleys or similar back streets) exist, each such floor is permitted to be considered a street floor. The occupant load factor is one person for each 40 ft^2 (3.7 m^2) of gross floor area of sales space.

[c]For the purpose of determining occupant load in mercantile occupancies with no street floor, as defined in 3.3.253, but with access directly from the street by stairs or escalators, the floor at the point of entrance to the mercantile occupancy is considered the street floor.

[d]For any food court or other assembly use areas located in the mall that are not included as a portion of the gross leasable area of the mall building, the occupant load is calculated based on the occupant load factor for that use as specified in Table 7.3.1.2. The remaining mall area is not required to be assigned an occupant load.

[e]The portions of the mall that are considered a pedestrian way and not used as gross leasable area are not required to be assessed an occupant load based on Table 7.3.1.2. However, means of egress from a mall pedestrian way are required to be provided for an occupant load determined by dividing the gross leasable area of the mall building (not including anchor stores) by the appropriate lowest whole number occupant load factor from Figure 7.3.1.2(a) or Figure 7.3.1.2(b).

Each individual tenant space is required to have means of egress to the outside or to the mall based on occupant loads calculated by using the appropriate occupant load factor from Table 7.3.1.2.

Each individual anchor store is required to have means of egress independent of the mall.

7.3.2 Measurement of Means of Egress.

7.3.2.1 *The width of means of egress shall be measured in the clear at the narrowest point of the egress component under consideration, unless otherwise provided in **7.3.2.2** or **7.3.2.3**.*

7.3.2.2 *Projections within the means of egress of not more than 4 1/2 in. (114 mm) on each side shall be permitted at a height of 38 in. (965 mm) and below. In the case of stair and landing handrails forming part of a guard, in accordance with **7.2.2.4.5.3**, such projections shall be permitted at a height of 42 in. (1065 mm) and below.*

7.3.2.3 *In health care and ambulatory health care occupancies, projections shall be permitted in corridors in accordance with Chapters **18** through **21**.*

7.3.3* Egress Capacity.

7.3.3.1 *Egress capacity for approved components of means of egress shall be based on the capacity factors shown in **Table 7.3.3.1**, unless otherwise provided in **7.3.3.2**.*

Table 7.3.3.1 Capacity Factors

	Stairways (width/person)		Level Components and Ramps (width/person)	
Area	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

7.3.3.2 *For stairways wider than 44 in. (1120 mm) and subject to the 0.3 in. (7.6 mm) width per person capacity factor, the capacity shall be permitted to be increased using the following equation:*

$$C = 146.7 + \left(\frac{Wn - 44}{0.218} \right)$$

[7.3.3.2]

where:
C = capacity, in persons, rounded to the nearest integer
Wn = nominal width of the stair as permitted by 7.3.2.2 (in.)

7.3.3.3 *The required capacity of a corridor shall be the occupant load that utilizes the corridor for exit access divided by the required number of exits to which the corridor connects, but the corridor capacity shall be not less than the required capacity of the exit to which the corridor leads.*

7.3.4 Minimum Width.

7.3.4.1 *The width of any means of egress, unless otherwise provided in **7.3.4.1.1** through **7.3.4.1.3**, shall be as follows:*

*(1)Not less than that required for a given egress component in this chapter or Chapters **11** through **43***
*(2)Not less than 36 in. (915 mm) where another part of this chapter and Chapters **11** through **43** do not specify a minimum width*

7.3.4.1.1 *The width of exit access serving not more than six people and having a length not exceeding 50 ft (15 m) shall meet both of the following criteria:*

(1)The width shall be not less than 18 in. (455 mm), at and below a height of 38 in. (965 mm), and not less than 28 in. (710 mm) above a height of 38 in. (965 mm).
(2)A width of not less than 36 in. (915 mm) for new exit access, and not less than 28 in. (710 mm) for existing exit access, shall be capable of being provided without moving permanent walls.

7.3.4.1.2 *In existing buildings, the width of exit access shall be permitted to be not less than 28 in. (710 mm).*

7.3.4.1.3 *The requirement of **7.3.4.1** shall not apply to the following:*

*(1)Doors as otherwise provided for in **7.2.1.2***
*(2)Aisles and aisle accessways in assembly occupancies as otherwise provided in Chapters **12** and **13***
*(3)Industrial equipment access as otherwise provided in **40.2.5.3***

7.3.4.2 *Where a single exit access leads to an exit, its capacity in terms of width shall be not less than the required capacity of the exit to which it leads.*

7.3.4.3 *Where more than one exit access leads to an exit, each shall have a width adequate for the number of persons it accommodates.*

7.4* Number of Means of Egress.

7.4.1 General.

7.4.1.1 *The number of means of egress from any balcony, mezzanine, story, or portion thereof shall be not less than two, except under one of the following conditions:*

*(1)A single means of egress shall be permitted where permitted in Chapters **11** through **43**.*

*(2)A single means of egress shall be permitted for a mezzanine or balcony where the common path of travel limitations of Chapters **11** through **43** are met.*

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

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

(2)Occupant load more than 1000 — not less than 4

7.4.1.3 *Accessible means of egress in accordance with **7.5.4** that do not utilize elevators shall be permitted to serve as any or all of the required minimum number of means of egress.*

7.4.1.4 *The occupant load of each story considered individually shall be required to be used in computing the number of means of egress at each story, provided that the required number of means of egress is not decreased in the direction of egress travel.*

7.4.1.5 *Doors other than the hoistway door; the elevator car door; and doors that are readily openable from the car side without a key, a tool, special knowledge, or special effort shall be prohibited at the point of access to an elevator car.*

7.4.1.6 Elevator Landing and Lobby Exit Access.

7.4.1.6.1 *Each elevator landing and lobby shall have access to at least one exit.*

7.4.1.6.2 *The elevator landing and lobby exit access required by **7.4.1.6.1** shall not require the use of a key, a tool, special knowledge, or special effort, unless permitted by **7.4.1.6.3**.*

7.4.1.6.3 *Doors separating the elevator lobby from the exit access required by **7.4.1.6.1** shall be permitted to be electronically locked in accordance with **7.2.1.6.3**.*

7.5 Arrangement of Means of Egress.

7.5.1 General.

7.5.1.1 *Exits shall be located, and exit access shall be arranged, so that exits are readily accessible at all times.*

7.5.1.1.1* *Where exits are not immediately accessible from an open floor area, continuous passageways, aisles, or corridors leading directly to every exit shall be maintained and shall be arranged to provide access for each occupant to not less than two exits by separate ways of travel, unless otherwise provided in **7.5.1.1.3** and **7.5.1.1.4**.*

7.5.1.1.2 *Exit access corridors shall provide access to not less than two approved exits, unless otherwise provided in **7.5.1.1.3** and **7.5.1.1.4**.*

7.5.1.1.3 *The requirements of **7.5.1.1.1** and **7.5.1.1.2** shall not apply where a single exit is permitted in Chapters **11** through **43**.*

7.5.1.1.4 *Where common paths of travel are permitted for an occupancy in Chapters **11** through **43**, such common paths of travel shall be permitted but shall not exceed the limit specified.*

7.5.1.2 *Corridors shall provide exit access without passing through any intervening rooms other than corridors, lobbies, and other spaces permitted to be open to the corridor, unless otherwise provided in **7.5.1.2.1** and **7.5.1.2.2**.*

7.5.1.2.1 *Approved existing corridors that require passage through a room to access an exit shall be permitted to continue to be used, provided that all of the following criteria are met:*

*(1)The path of travel is marked in accordance with Section **7.10**.*

*(2)Doors to such rooms comply with **7.2.1**.*

(3)Such arrangement is not prohibited by the applicable occupancy chapter.

7.5.1.2.2 *Corridors that are not required to be fire resistance rated shall be permitted to discharge into open floor plan areas.*

7.5.1.3 *Remoteness shall be provided in accordance with **7.5.1.3.1** through **7.5.1.3.7**.*

7.5.1.3.1 *Where more than one exit, exit access, or exit discharge is required from a building or portion thereof, such exits, exit accesses, or exit discharges shall be remotely located from each other and be arranged to minimize the possibility that more than one has the potential to be blocked by any one fire or other*

emergency condition.

7.5.1.3.2* *Where two exits, exit accesses, or exit discharges are required, they shall be located at a distance from one another not less than one-half the length of the maximum overall diagonal dimension of the building or area to be served, measured in a straight line between the nearest edge of the exits, exit accesses, or exit discharges, unless otherwise provided in **7.5.1.3.3** through **7.5.1.3.5**.*

7.5.1.3.3 *In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section **9.7**, the minimum separation distance between two exits, exit accesses, or exit discharges, measured in accordance with **7.5.1.3.2**, shall be not less than one-third the length of the maximum overall diagonal dimension of the building or area to be served.*

7.5.1.3.4* *In other than high-rise buildings, where exit enclosures are provided as the required exits specified in **7.5.1.3.2** or **7.5.1.3.3** and are interconnected by not less than a 1-hour fire resistance–rated corridor, exit separation shall be measured along the shortest line of travel within the corridor.*

7.5.1.3.5 *In existing buildings, where more than one exit, exit access, or exit discharge is required, such exits, exit accesses, or exit discharges shall be exempt from the diagonal measurement separation distance criteria of **7.5.1.3.2** and **7.5.1.3.3**, provided that such exits, exit accesses, or exit discharges are remotely located in accordance with **7.5.1.3.1**.*

7.5.1.3.6 *In other than existing buildings, where more than two exits, exit accesses, or exit discharges are required, at least two of the required exits, exit accesses, or exit discharges shall be arranged to comply with the minimum separation distance requirement.*

7.5.1.3.7 *The balance of the exits, exit accesses, or exit discharges specified in **7.5.1.3.6** shall be located so that, if one becomes blocked, the others are available.*

7.5.1.5* *Exit access shall be arranged so that there are no dead ends in corridors, unless permitted by, and limited to the lengths specified in, Chapters **11** through **43**.*

7.5.1.6 *Exit access from rooms or spaces shall be permitted to be through adjoining or intervening rooms or areas, provided that such rooms or areas are accessory to the area served. Foyers, lobbies, and reception rooms constructed as required for corridors shall not be construed as intervening rooms. Exit access shall be arranged so that it is not necessary to pass through any area identified under Protection from Hazards in Chapters **11** through **43**.*

7.5.2 Impediments to Egress. *See also **7.1.9** and **7.2.1.5**.*

7.5.2.1* *Access to an exit shall not be through kitchens, storerooms other than as provided in Chapters **36** and **37**, restrooms, closets, bedrooms or similar spaces, or other rooms or spaces subject to locking, unless passage through such rooms or spaces is permitted for the occupancy by Chapter **18**, **19**, **22**, or **23**.*

7.5.2.2* *Exit access and exit doors shall be designed and arranged to be clearly recognizable.*

7.5.2.2.1 *Hangings or draperies shall not be placed over exit doors or located so that they conceal or obscure any exit, unless otherwise provided in **7.5.2.2.2**.*

7.5.2.2.2 *Curtains shall be permitted across means of egress openings in tent walls, provided that all of the following criteria are met:*

(1)They are distinctly marked in contrast to the tent wall so as to be recognizable as means of egress.
(2)They are installed across an opening that is at least 6 ft (1830 mm) in width.
(3)They are hung from slide rings or equivalent hardware so as to be readily moved to the side to create an unobstructed opening in the tent wall that is of the minimum width required for door openings.

7.6* Measurement of Travel Distance to Exits.

7.6.1* *The travel distance to an exit shall be measured on the floor or other walking surface as follows:*

(1)Along the centerline of the natural path of travel, starting from the most remote point subject to occupancy
(2)Curving around any corners or obstructions, with a 12 in. (305 mm) clearance therefrom
(3)Terminating at one of the following:
(a)Center of the doorway
(b)Other point at which the exit begins
(c)Smoke barrier in an existing detention and correctional occupancy as provided in Chapter 23

7.6.5 *Where measurement includes stairs, the measurement shall be taken in the plane of the tread nosing.*

7.6.6 *The travel distance in any occupied space to not less than one exit, measured in accordance with **7.6.1** through **7.6.5**, shall not exceed the limits specified in this Code. (See **7.6.7**.)*

7.6.7 *Travel distance limitations shall be as provided in Chapters **11** through **43** and, for high hazard areas, shall be in accordance with Section **7.11**.*

7.7 Discharge from Exits.

7.7.1* Exit Termination. *Exits shall terminate directly, at a public way or at an exterior exit discharge, unless otherwise provided in **7.7.1.2** through **7.7.1.4**.*

7.7.1.1 *Yards, courts, open spaces, or other portions of the exit discharge shall be of the required width and size to provide all occupants with a safe access to a public way.*

7.7.1.2 *The requirement of **7.7.1** shall not apply to interior exit discharge as otherwise provided in **7.7.2**.*

7.7.1.3 *The requirement of **7.7.1** shall not apply to rooftop exit discharge as otherwise provided in **7.7.6**.*

7.7.1.4 *Means of egress shall be permitted to terminate in an exterior area for detention and correctional occupancies as otherwise provided in Chapters **22** and **23**.*

7.7.3 Arrangement and Marking of Exit Discharge.

7.7.3.1 *Where more than one exit discharge is required, exit discharges shall be arranged to meet the remoteness criteria of **7.5.1.3**.*

7.7.3.2 *The exit discharge shall be arranged and marked to make clear the direction of egress travel from the exit discharge to a public way.*

7.7.3.3* *Stairs and ramps that continue more than one-half story beyond the level of discharge shall be provided with an approved means to prevent or dissuade occupants from traveling past the level of discharge during emergency building evacuation.*

7.7.4 Components of Exit Discharge. *Doors, stairs, ramps, corridors, exit passageways, bridges, balconies, escalators, moving walks, and other components of an exit discharge shall comply with the detailed requirements of this chapter for such components.*

7.7.5 Signs. *See **7.2.2.5.4**.*

7.8 Illumination of Means of Egress.

7.8.1 General.

7.8.1.1* *Illumination of means of egress shall be provided in accordance with Section **7.8** for every building and structure where required in Chapters **11** through **43**. For the purposes of this requirement, exit access shall include only designated stairs, aisles, corridors, ramps, escalators, and passageways leading to an exit. For the purposes of this requirement, exit discharge shall include only designated stairs, aisles, corridors, ramps, escalators, walkways, and exit passageways leading to a public way.*

7.8.1.2 *Illumination of means of egress shall be continuous during the time that the conditions of occupancy require that the means of egress be available for use, unless otherwise provided in **7.8.1.2.2**.*

7.8.1.2.1 *Artificial lighting shall be employed at such locations and for such periods of time as are necessary to maintain the illumination to the minimum criteria values herein specified.*

7.8.1.2.2* *Unless prohibited by Chapters **11** through **43**, automatic lighting control devices shall be permitted to temporarily turn off the illumination within the means of egress, provided that each lighting control device complies with all of the following:*

(1)In new installations, the lighting control device is listed.

(2)The lighting control device is equipped to automatically energize the controlled lights upon loss of normal power and is evaluated for this purpose.

(3)Illumination timers are provided and are set for a minimum 15-minute duration.

(4)The lighting control device is activated by any occupant movement in the area served by the lighting units.

(5)In new installations, the lighting control device is activated by activation of the building fire alarm system, if provided.

(6)The lighting control device does not turn off any lights relied upon for activation of photoluminescent exit signs or path markers.

(7)The lighting control device does not turn off any battery-equipped emergency luminaires, unit equipment, or exit signs.

7.8.1.2.3* *Energy-saving sensors, switches, timers, or controllers shall be approved and shall not compromise the continuity of illumination of the means of egress required by **7.8.1.2**.*

7.8.1.3 *The floors and other walking surfaces within an exit and within the portions of the exit access and exit discharge designated in **7.8.1.1** shall be illuminated as follows:*

(1)During conditions of stair use, the minimum illumination for new stairs shall be at least 10 ft-candle (108 lux), measured at the walking surfaces.

(2)The minimum illumination for floors and other walking surfaces, other than new stairs during conditions of stair use, shall be to values of at least 1 ft-candle (10.8 lux), measured at the floor.

(3)In assembly occupancies, the illumination of the walking surfaces of exit access shall be at least 0.2 ft-candle (2.2 lux) during periods of performances or projections involving directed light.

*(4)*The minimum illumination requirements shall not apply where operations or processes require low lighting levels.*

7.8.1.4* *Required illumination shall be arranged so that the failure of any single lighting unit does not result in an illumination level of less than 0.2 ft-candle (2.2 lux) in any designated area.*

7.8.1.5 *The equipment or units installed to meet the requirements of Section **7.10** also shall be permitted to serve*

*the function of illumination of means of egress, provided that all requirements of Section **7.8** for such illumination are met.*

7.8.2 Sources of Illumination.

7.8.2.1 *Illumination of means of egress shall be from a source considered reliable by the authority having jurisdiction.*

7.8.2.2 *Battery-operated electric lights and other types of portable lamps or lanterns shall not be used for primary illumination of means of egress. Battery-operated electric lights shall be permitted to be used as an emergency source to the extent permitted under Section **7.9**.*

7.9 Emergency Lighting.

7.9.1 General.

7.9.1.1* *Emergency lighting facilities for means of egress shall be provided in accordance with Section **7.9** for the following:*

*(1)Buildings or structures where required in Chapters **11** through **43***

*(2)Underground and limited access structures as addressed in Section **11.7***

(3)High-rise buildings as required by other sections of this Code

(4)Doors equipped with delayed-egress locks

(5)Stair shafts and vestibules of smokeproof enclosures, for which the following also apply:

(a)The stair shaft and vestibule shall be permitted to include a standby generator that is installed for the smokeproof enclosure mechanical ventilation equipment.

(b)The standby generator shall be permitted to be used for the stair shaft and vestibule emergency lighting power supply.

*(6)New access-controlled egress doors in accordance with **7.2.1.6.2***

7.9.1.2 *For the purposes of **7.9.1.1**, exit access shall include only designated stairs, aisles, corridors, ramps, escalators, and passageways leading to an exit. For the purposes of **7.9.1.1**, exit discharge shall include only designated stairs, ramps, aisles, walkways, and escalators leading to a public way.*

7.9.1.3 *Where maintenance of illumination depends on changing from one energy source to another, a delay of not more than 10 seconds shall be permitted.*

7.9.2 Performance of System.

7.9.2.1 *Emergency illumination shall be provided for a minimum of 1 1/2 hours in the event of failure of normal lighting.*

7.9.2.1.1 *Emergency lighting facilities shall be arranged to provide initial illumination that is not less than an average of 1 ft-candle (10.8 lux) and, at any point, not less than 0.1 ft-candle (1.1 lux), measured along the path of egress at floor level.*

7.9.2.1.2 *Illumination levels shall be permitted to decline to not less than an average of 0.6 ft-candle (6.5 lux) and, at any point, not less than 0.06 ft-candle (0.65 lux) at the end of 1 1/2 hours.*

7.9.2.1.3 *The maximum-to-minimum illumination shall not exceed a ratio of 40 to 1.*

7.9.2.2 *New emergency power systems for emergency lighting shall be at least Type 10, Class 1.5, Level 1, in accordance with **NFPA 110**, Standard for Emergency and Standby Power Systems.*

7.9.2.3* *The emergency lighting system shall be arranged to provide the required illumination automatically in the event of any interruption of normal lighting due to any of the following:*

(1)Failure of a public utility or other outside electrical power supply

(2)Opening of a circuit breaker or fuse

(3)Manual act(s), including accidental opening of a switch controlling normal lighting facilities

7.9.2.4 *Emergency generators providing power to emergency lighting systems shall be installed, tested, and maintained in accordance with **NFPA 110**, Standard for Emergency and Standby Power Systems. Stored electrical energy systems, where required in this Code, other than battery systems for emergency luminaires in accordance with **7.9.2.5**, shall be installed and tested in accordance with **NFPA 111**, Standard on Stored Electrical Energy Emergency and Standby Power Systems.*

7.9.2.5 *Unit equipment and battery systems for emergency luminaires shall be listed to ANSI/UL 924, Standard for Emergency Lighting and Power Equipment.*

7.9.2.6 *Existing battery-operated emergency lights shall use only reliable types of rechargeable batteries provided with suitable facilities for maintaining them in properly charged condition. Batteries used in such lights or units shall be approved for their intended use and shall comply with **NFPA 70**, National Electrical Code.*

7.9.2.7 *The emergency lighting system shall be either continuously in operation or shall be capable of repeated automatic operation without manual intervention.*

7.9.3 Periodic Testing of Emergency Lighting Equipment.

7.9.3.1 *Required emergency lighting systems shall be tested in accordance with one of the three options offered by **7.9.3.1.1**, **7.9.3.1.2**, or **7.9.3.1.3**.*

7.9.3.1.1 *Testing of required emergency lighting systems shall be permitted to be conducted as follows:*

*(1)Functional testing shall be conducted monthly, with a minimum of 3 weeks and a maximum of 5 weeks between tests, for not less than 30 seconds, except as otherwise permitted by **7.9.3.1.1**(2).*

*(2)*The test interval shall be permitted to be extended beyond 30 days with the approval of the authority having jurisdiction.*
(3)Functional testing shall be conducted annually for a minimum of 1 1/2 hours if the emergency lighting system is battery powered.
*(4)The emergency lighting equipment shall be fully operational for the duration of the tests required by **7.9.3.1.1**(1) and (3).*
(5)Written records of visual inspections and tests shall be kept by the owner for inspection by the authority having jurisdiction.

7.9.3.1.2 *Testing of required emergency lighting systems shall be permitted to be conducted as follows:*
(1)Self-testing/self-diagnostic battery-operated emergency lighting equipment shall be provided.
(2)Not less than once every 30 days, self-testing/self-diagnostic battery-operated emergency lighting equipment shall automatically perform a test with a duration of a minimum of 30 seconds and a diagnostic routine.
(3)Self-testing/self-diagnostic battery-operated emergency lighting equipment shall indicate failures by a status indicator.
(4)A visual inspection shall be performed at intervals not exceeding 30 days.
(5)Functional testing shall be conducted annually for a minimum of 1 1/2 hours.
(6)Self-testing/self-diagnostic battery-operated emergency lighting equipment shall be fully operational for the duration of the 1 1/2-hour test.
(7)Written records of visual inspections and tests shall be kept by the owner for inspection by the authority having jurisdiction.

7.9.3.1.3 *Testing of required emergency lighting systems shall be permitted to be conducted as follows:*
(1)Computer-based, self-testing/self-diagnostic battery-operated emergency lighting equipment shall be provided.
(2)Not less than once every 30 days, emergency lighting equipment shall automatically perform a test with a duration of a minimum of 30 seconds and a diagnostic routine.
(3)The emergency lighting equipment shall automatically perform annually a test for a minimum of 1 1/2 hours.
*(4)The emergency lighting equipment shall be fully operational for the duration of the tests required by **7.9.3.1.3**(2) and (3).*
(5)The computer-based system shall be capable of providing a report of the history of tests and failures at all times.

7.10 Marking of Means of Egress.

7.10.1 General.

7.10.1.1 Where Required. *Means of egress shall be marked in accordance with Section **7.10** where required in Chapters **11** through **43**.*

7.10.1.2 Exits.

7.10.1.2.1* *Exits, other than main exterior exit doors that obviously and clearly are identifiable as exits, shall be marked by an approved sign that is readily visible from any direction of exit access.*

7.10.1.2.2* *Horizontal components of the egress path within an exit enclosure shall be marked by approved exit or directional exit signs where the continuation of the egress path is not obvious.*

7.10.1.3 Exit Door Tactile Signage. *Tactile signage shall be provided to meet all of the following criteria, unless otherwise provided in **7.10.1.4**:*
(1)Tactile signage shall be located at each exit door requiring an exit sign.
(2)Tactile signage shall read as follows: EXIT.
(3)Tactile signage shall comply with ICC/ANSI A117.1, American National Standard for Accessible and Usable Buildings and Facilities.

7.10.1.4 Existing Exemption. *The requirements of **7.10.1.3** shall not apply to existing buildings, provided that the occupancy classification does not change.*

7.10.1.5 Exit Access.

7.10.1.5.1 *Access to exits shall be marked by approved, readily visible signs in all cases where the exit or way to reach the exit is not readily apparent to the occupants.*

7.10.1.5.2* *New sign placement shall be such that no point in an exit access corridor is in excess of the rated viewing distance or 100 ft (30 m), whichever is less, from the nearest sign.*

7.10.1.6* Floor Proximity Exit Signs. *Where floor proximity exit signs are required in Chapters **11** through **43**, such signs shall comply with **7.10.3**, **7.10.4**, **7.10.5**, and **7.10.6** for externally illuminated signs and **7.10.7** for internally illuminated signs. Such signs shall be located near the floor level in addition to those signs required for doors or corridors. The bottom of the sign shall be not less than 6 in. (150 mm), but not more than 18 in. (455 mm), above the floor. For exit doors, the sign shall be mounted on the door or adjacent to the door, with the nearest edge*

of the sign within 4 in. (100 mm) of the door frame.

7.10.1.7* Floor Proximity Egress Path Marking. *Where floor proximity egress path marking is required in Chapters **11** through **43**, an approved floor proximity egress path marking system that is internally illuminated shall be installed within 18 in. (455 mm) of the floor. Floor proximity egress path marking systems shall be listed in accordance with ANSI/UL 1994, Standard for Luminous Egress Path Marking Systems. The system shall provide a visible delineation of the path of travel along the designated exit access and shall be essentially continuous, except as interrupted by doorways, hallways, corridors, or other such architectural features. The system shall operate continuously or at any time the building fire alarm system is activated. The activation, duration, and continuity of operation of the system shall be in accordance with **7.9.2**. The system shall be maintained in accordance with the product manufacturing listing.*

7.10.1.8* Visibility. *Every sign required in Section **7.10** shall be located and of such size, distinctive color, and design that it is readily visible and shall provide contrast with decorations, interior finish, or other signs. No decorations, furnishings, or equipment that impairs visibility of a sign shall be permitted. No brightly illuminated sign (for other than exit purposes), display, or object in or near the line of vision of the required exit sign that could detract attention from the exit sign shall be permitted.*

7.10.1.9 Mounting Location. *The bottom of new egress markings shall be located at a vertical distance of not more than 6 ft 8 in. (2030 mm) above the top edge of the egress opening intended for designation by that marking. Egress markings shall be located at a horizontal distance of not more than the required width of the egress opening, as measured from the edge of the egress opening intended for designation by that marking to the nearest edge of the marking.*

7.10.2 Directional Signs.

7.10.2.1 *A sign complying with **7.10.3**, with a directional indicator showing the direction of travel, shall be placed in every location where the direction of travel to reach the nearest exit is not apparent.*

7.10.2.2 *Directional exit signs shall be provided within horizontal components of the egress path within exit enclosures as required by **7.10.1.2.2**.*

7.10.3* Sign Legend.

7.10.3.1 *Signs required by **7.10.1** and **7.10.2** shall read as follows in plainly legible letters, or other appropriate wording shall be used:*

EXIT

7.10.3.2* *Where approved by the authority having jurisdiction, pictograms in compliance with **NFPA 170**, Standard for Fire Safety and Emergency Symbols, shall be permitted.*

7.10.4* Power Source. *Where emergency lighting facilities are required by the applicable provisions of Chapters **11** through **43** for individual occupancies, the signs, other than approved self-luminous signs and listed photoluminescent signs in accordance with **7.10.7.2**, shall be illuminated by the emergency lighting facilities. The level of illumination of the signs shall be in accordance with **7.10.6.3** or **7.10.7** for the required emergency lighting duration as specified in **7.9.2.1**. However, the level of illumination shall be permitted to decline to 60 percent at the end of the emergency lighting duration.*

7.10.5 Illumination of Signs.

7.10.5.1* General. *Every sign required by **7.10.1.2**, **7.10.1.5**, or **7.10.8.1**, other than where operations or processes require low lighting levels, shall be suitably illuminated by a reliable light source. Externally and internally illuminated signs shall be legible in both the normal and emergency lighting mode.*

7.10.5.2* Continuous Illumination.

7.10.5.2.1 *Every sign required to be illuminated by **7.10.6.3**, **7.10.7**, and **7.10.8.1** shall be continuously illuminated as required under the provisions of Section **7.8**, unless otherwise provided in **7.10.5.2.2**.*

7.10.5.2.2* *Illumination for signs shall be permitted to flash on and off upon activation of the fire alarm system.*

7.10.7 Internally Illuminated Signs.

7.10.7.1 Listing. *Internally illuminated signs shall be listed in accordance with ANSI/UL 924, Standard for Emergency Lighting and Power Equipment, unless they meet one of the following criteria:*

(1)They are approved existing signs.

(2)They are existing signs having the required wording in legible letters not less than 4 in. (100 mm) high.

*(3)They are signs that are in accordance with **7.10.1.3** and **7.10.1.6**.*

7.10.7.2* Photoluminescent Signs. *The face of a photoluminescent sign shall be continually illuminated while the building is occupied. The illumination levels on the face of the photoluminescent sign shall be in accordance with its listing. The charging illumination shall be a reliable light source, as determined by the authority having jurisdiction. The charging light source, shall be of a type specified in the product markings.*

7.10.9 Testing and Maintenance.

7.10.9.1 Inspection. *Exit signs shall be visually inspected for operation of the illumination sources at intervals not to exceed 30 days or shall be periodically monitored in accordance with* ***7.9.3.1.3****.*

7.10.9.2 Testing. *Exit signs connected to, or provided with, a battery-operated emergency illumination source, where required in* ***7.10.4****, shall be tested and maintained in accordance with* ***7.9.3****.*

APPENDIX B

Fire Alarm, Detection, and Communication Systems Drawings

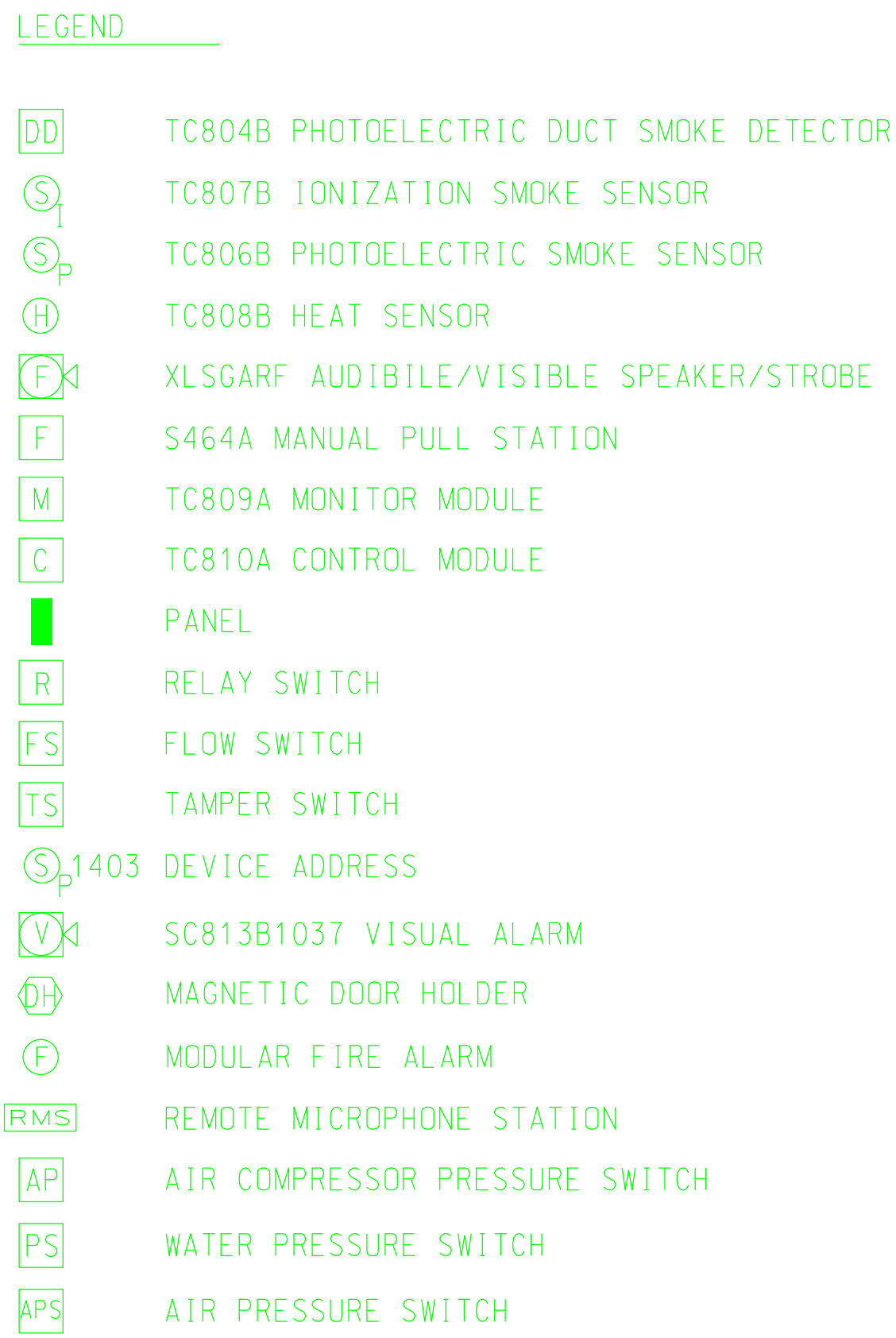


Figure B-1: Fire Detection and Notification Legend

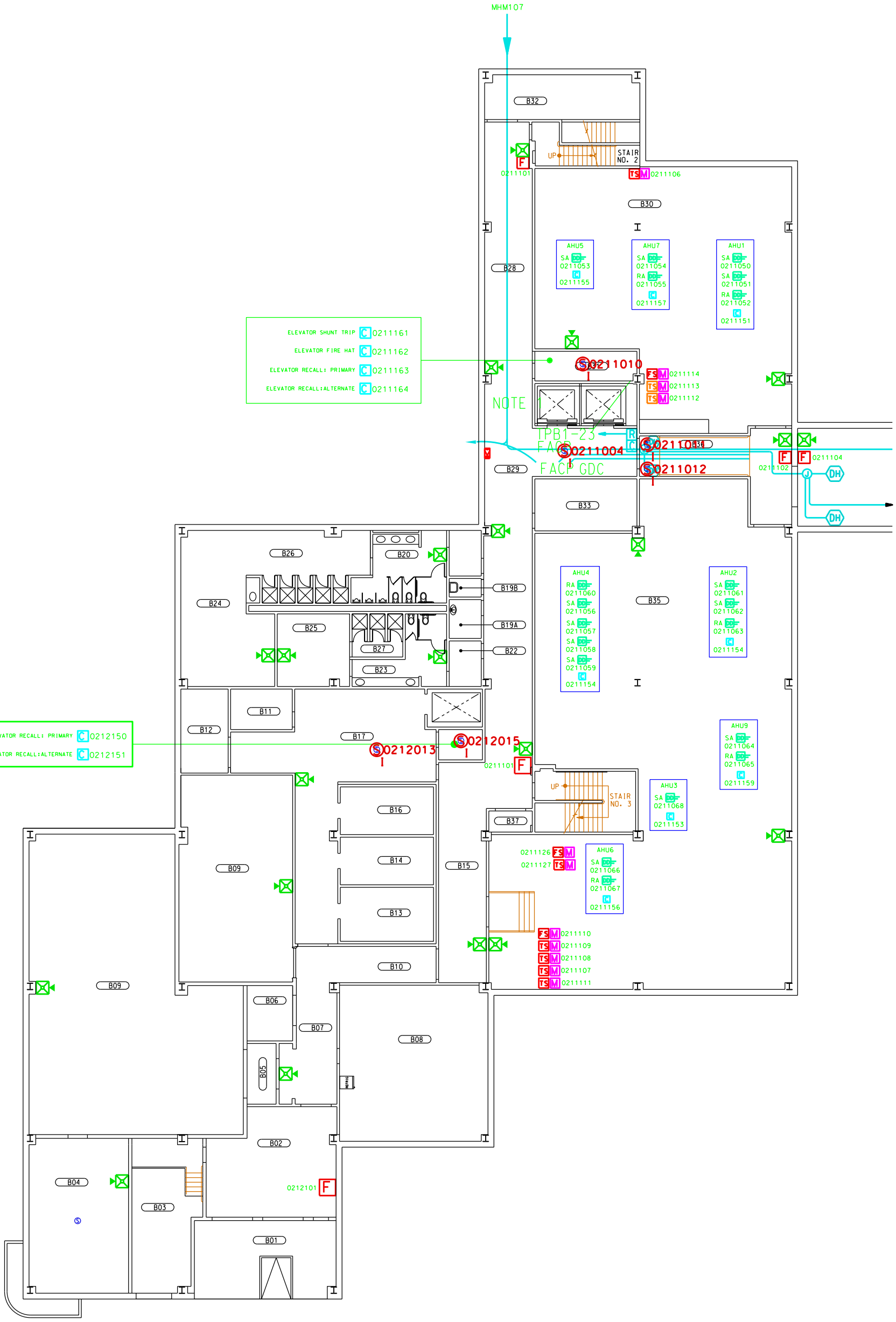


Figure B-2: Basement Fire Detection and Notification Layout

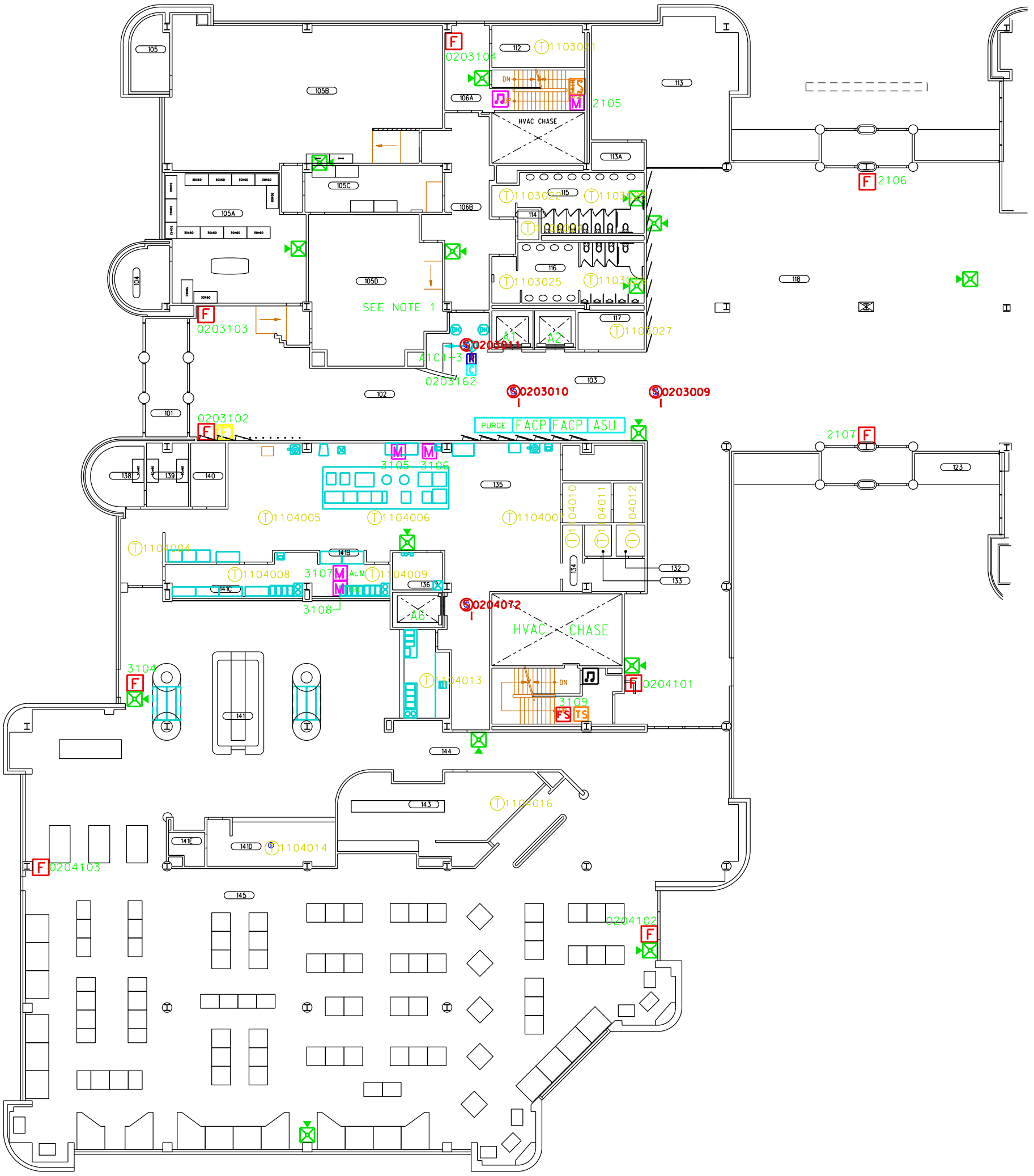


Figure B-3: First Floor Fire Detection and Notification Layout

Figure B-4: Second Floor Fire Detection and Notification Layout

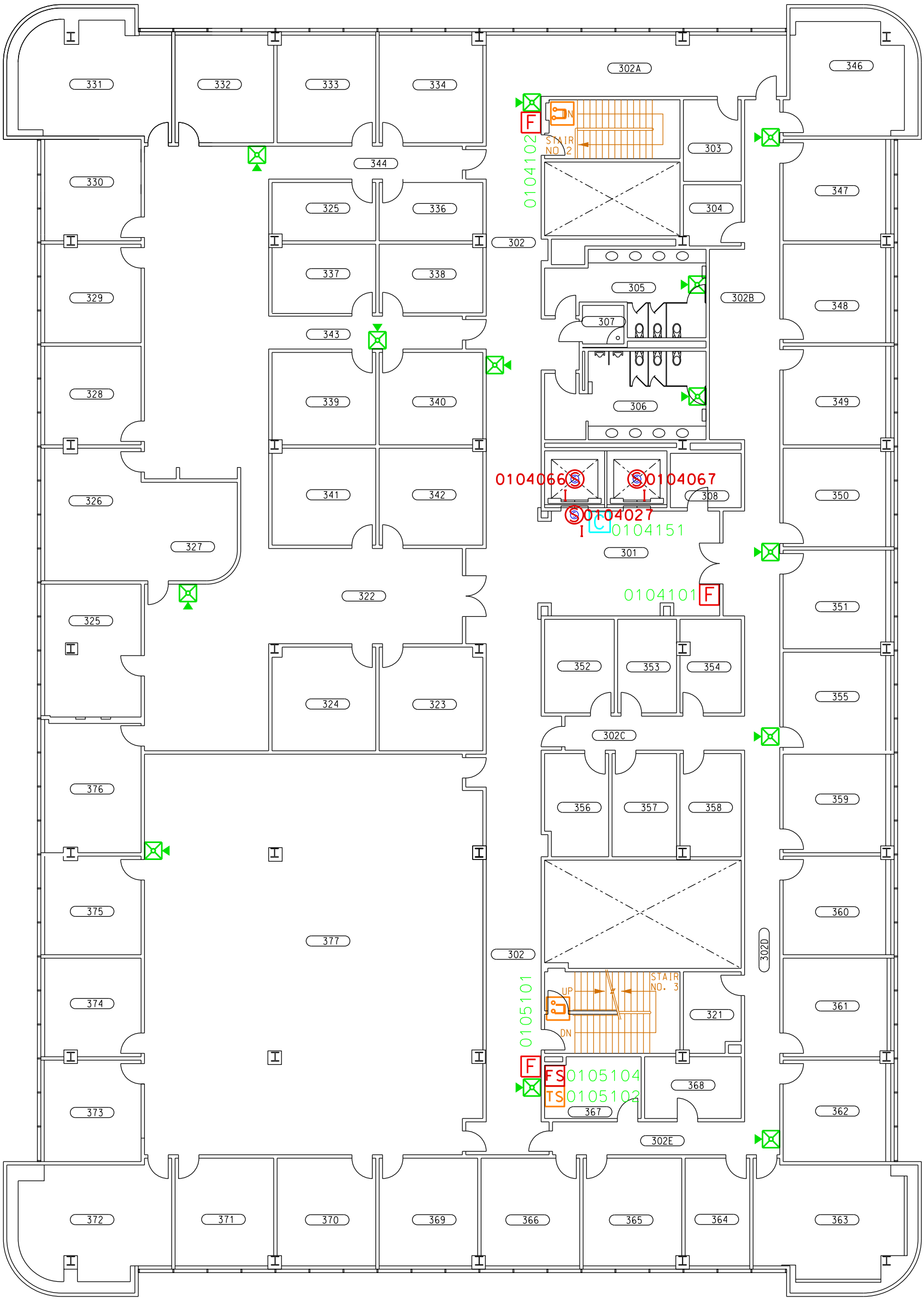


Figure B-5: Third Floor Fire Detection and Notification Layout

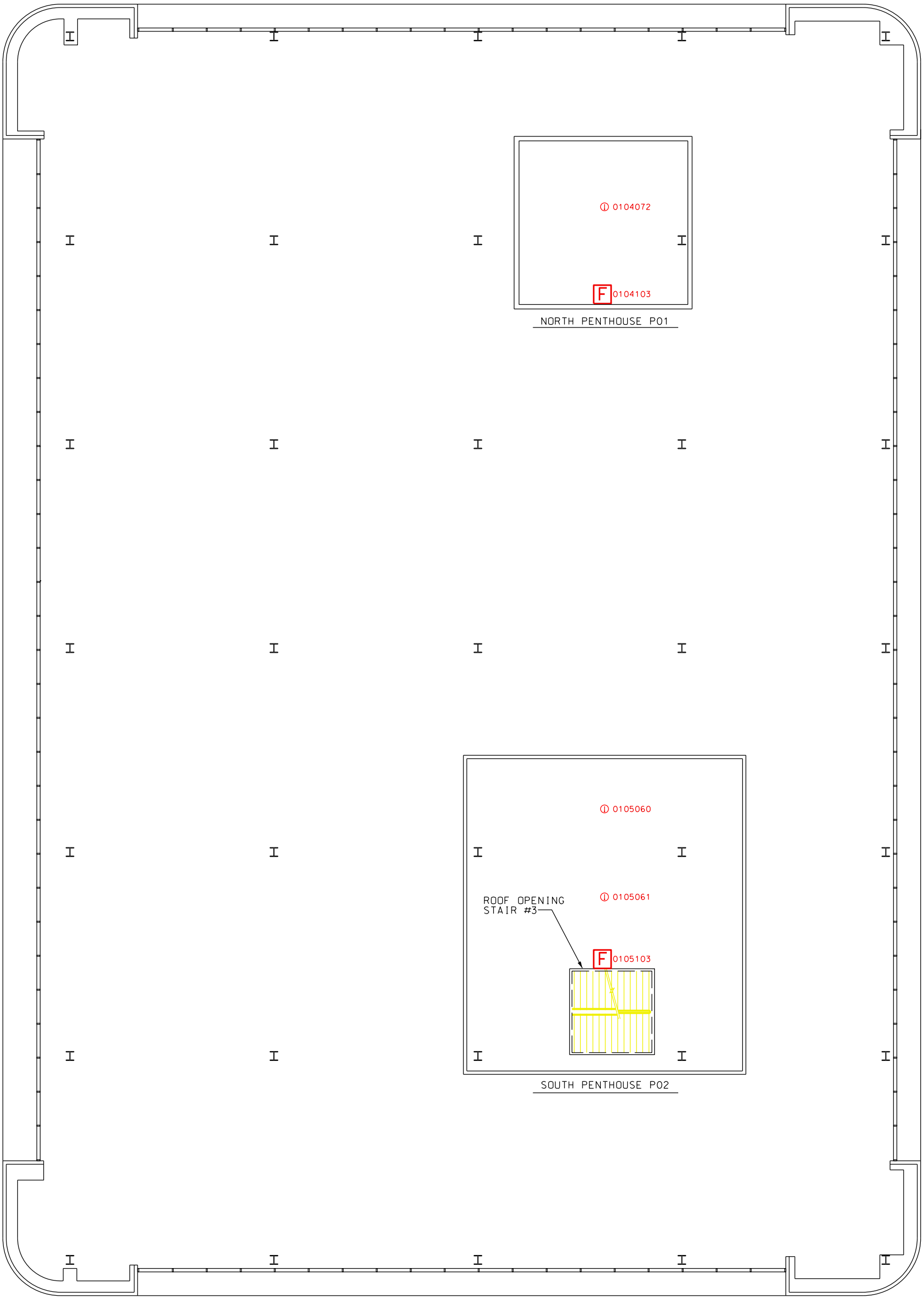


Figure B-6: Roof Level Fire Detection and Notification Layout

APPENDIX C

Voltage Drop Calculations

BPS–1 BATTERY SIZING CALCULATIONS

LOAD	QTY		STANDBY (mA)	TOTAL STANDBY (mA)	ALARM (mA)	TOTAL ALARM (mA)
BPS1–CKT1	1	x	0.00	0.00	1183.00	1183.00
BPS1–CKT2	1	x	0.00	0.00	1295.00	1295.00
BPS1–CKT3	0	x	0.00	0.00	0.00	0.00
BPS1–CKT4	0	x	0.00	0.00	0.00	0.00
XLS–BPS6	1	x	70.00	70.00	190.00	190.00
TOTAL mA			(A)	70.00	(B)	2668.00
TOTAL AMPS				0.070		2.668

POWER SUPPLY RATING: 6.0 AMPS CIRCUIT RATING: 3.0 AMPS

BATTERY CALCULATION

SUPERVISORY HOURS 24 (C) ALARM MINUTES 15 (D)

BATTERY CAPACITY (A.H.) = 1.2 [((A x C) + (0.0167 x B x D))/1000] A.H.= 2.82

A MINIMUM OF 2.82 AMP HOURS OF BATTERY BACKUP WILL SUPERVISE THE SYSTEM FOR 24 HOURS AND OPERATE THE SYSTEM IN ALARM STATE FOR AT LEAST 15 MINUTES. THUS 1 SET OF 6.5 AMP HOUR BATTERIES WILL BE PROVIDED.

Figure C-1: BPS-1 Calculations

Project Name	AUDIO				CIRCUIT IS WITHIN LIMITS
Date	10/31/2005				
Circuit Number	BPS1–CKT1				
Area Covered	BSMT–ZONE–1				Notes.
Nominal System Voltage		24			Wire resistance is based on
Minimum Device Voltage		20			2002 NEC Ch. 9 Table 8–
Total Circuit Current	1.183		Wire Gauge	Ohm's Per 1000	Uncoated DC resistance.
					Solid conductors except gauges
Distance from source to 1st device		192	14	3.19	10 and 12 are for stranded.
Wire Gauge for balance of circuit			14	3.19	Program doubles the resistance
					to allow for 2 wires for both
					positive and negative conductors

Device Number	Model Number	Device Current	Distance from previous device	Voltage At Device	Drop from source	Percent Drop
1–1–1	XLSG4R–S7VM–75	0.182	192	22.55	1.45	6%
1–1–2	XLSG4R–S7VM–75	0.182	98	21.93	2.07	9%
1–1–3	XLSG4R–S7VM–15	0.065	72	21.55	2.45	10%
1–1–4	XLSG4R–S7VM–15	0.065	61	21.26	2.74	11%
1–1–5	XLSG4R–S7VM–15	0.065	47	21.05	2.95	12%
1–1–6	XLSG4R–S7VM–15	0.065	61	20.81	3.19	13%
1–1–7	XLSG4R–S7VM–75	0.182	60	20.59	3.41	14%
1–1–8	XLSG4R–S7VM–75	0.182	61	20.45	3.55	15%
1–1–9	XLSG4R–S7VM–15	0.065	23	20.42	3.58	15%
1–1–10	XLSG4R–S7VM–15	0.065	15	20.40	3.60	15%
1–1–11	XLSG4R–S7VM–15	0.065	99	20.36	3.64	15%
		0.000		20.36	3.64	15%

Alternate Calculations

End of Line Method

Totals		Voltage Drop
Current	Distance	
1.183	789	5.955

Load Centering Method

Totals		Voltage Drop
Current	Distance	
1.183	789	2.978

Figure C-2: BPS-1, Circuit 1 Calculations

Project Name	AUDIO					CIRCUIT IS WITHIN LIMITS
Date	10/31/2005					
Circuit Number	BPS1–CKT2					
Area Covered	BSMT–ZONE–1					Notes.
Nominal System Voltage		24				Wire resistance is based on
Minimum Device Voltage		20				2002 NEC Ch. 9 Table 8–
Total Circuit Current	1.295		Wire Gauge	Ohm's Per 1000		Uncoated DC resistance.
						Solid conductors except gauges
Distance from source to 1st device		170	14	3.19		10 and 12 are for stranded.
Wire Gauge for balance of circuit			14	3.19		Program doubles the resistance
						to allow for 2 wires for both
						positive and negative conductors

Device Number	Model Number	Device Current	Distance from previous device	Voltage At Device	Drop from source	Percent Drop
1–2–1	XLSG4R–S7VM–30	0.093	170	22.60	1.40	6%
1–2–2	XLSG4R–S7VM–30	0.093	30	22.37	1.63	7%
1–2–3	XLSG4R–S7VM–30	0.093	42	22.07	1.93	8%
1–2–4	XLSG4R–S7VM–30	0.093	15	21.97	2.03	8%
1–2–5	XLSG4R–S7VM–15	0.065	44	21.71	2.29	10%
1–2–6	XLSG4R–S7VM–75	0.182	36	21.51	2.49	10%
1–2–7	XLSG4R–S7VM–75	0.182	83	21.16	2.84	12%
1–2–8	XLSG4R–S7VM–75	0.182	67	20.95	3.05	13%
1–2–9	XLSG4R–S7VM–15	0.065	69	20.81	3.19	13%
1–2–10	XLSG4R–S7VM–15	0.065	68	20.70	3.30	14%
1–2–11	XLSG4R–S7VM–75	0.182	15	20.68	3.32	14%
		0.000		20.68	3.32	14%

Alternate Calculations

End of Line Method

Totals		Voltage Drop
Current	Distance	
1.295	639	5.279

Load Centering Method

Totals		Voltage Drop
Current	Distance	
1.295	639	2.640

Figure C-3: BPS-1, Circuit 2 Calculations

Project Name			AUDIO				CIRCUIT IS WITHIN LIMITS
Date			10/31/2005				
Circuit Number			BPS1–CKT3				
Area Covered			SPARE				Notes.
Nominal System Voltage				24			Wire resistance is based on
Minimum Device Voltage				20			2002 NEC Ch. 9 Table 8–
Total Circuit Current			0.000		Wire Gauge	Ohm's Per 1000	Uncoated DC resistance.
							Solid conductors except gauges
Distance from source to 1st device					14	3.07	10 and 12 are for stranded.
Wire Gauge for balance of circuit					14	3.07	Program doubles the resistance
			Distance from previous device	Voltage At Device	Drop from source	Percent Drop	to allow for 2 wires for both positive and negative conductors
Device Number	Model Number	Device Current					
		0.000	0	24.00	0.00	0%	Alternate Calculations
		0.000		24.00	0.00	0%	End of Line Method
		0.000		24.00	0.00	0%	Totals / Voltage
		0.000		24.00	0.00	0%	Current / Distance / Drop
		0.000		24.00	0.00	0%	0.000 / 0 / 0.000
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	Load Centering Method
		0.000		24.00	0.00	0%	Totals / Voltage
		0.000		24.00	0.00	0%	Current / Distance / Drop
		0.000		24.00	0.00	0%	0.000 / 0 / 0.000
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	

Figure C-4: BPS-1, Circuit 3 Calculations

Project Name			AUDIO				CIRCUIT IS WITHIN LIMITS
Date			10/31/2005				
Circuit Number			BPS1–CKT4				
Area Covered			SPARE				Notes.
Nominal System Voltage				24			Wire resistance is based on
Minimum Device Voltage				20			2002 NEC Ch. 9 Table 8–
Total Circuit Current			0.000		Wire Gauge	Ohm's Per 1000	Uncoated DC resistance.
							Solid conductors except gauges
Distance from source to 1st device					14	3.07	10 and 12 are for stranded.
Wire Gauge for balance of circuit					14	3.07	Program doubles the resistance
							to allow for 2 wires for both
			Distance from	Voltage			positive and negative conductors
Device Number	Model Number	Device Current	previous device	At Device	Drop from source	Percent Drop	
		0.000	0	24.00	0.00	0%	Alternate Calculations
		0.000		24.00	0.00	0%	End of Line Method
		0.000		24.00	0.00	0%	Totals / Voltage
		0.000		24.00	0.00	0%	Current / Distance / Drop
		0.000		24.00	0.00	0%	0.000 / 0 / 0.000
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	Load Centering Method
		0.000		24.00	0.00	0%	Totals / Voltage
		0.000		24.00	0.00	0%	Current / Distance / Drop
		0.000		24.00	0.00	0%	0.000 / 0 / 0.000
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	

Figure C-5: BPS-1, Circuit 4 Calculations

BPS–2 BATTERY SIZING CALCULATIONS

LOAD	QTY		STANDBY (mA)	TOTAL STANDBY (mA)	ALARM (mA)	TOTAL ALARM (mA)
BPS2–CKT1	1	x	0.00	0.00	1161.00	1161.00
BPS2–CKT2	1	x	0.00	0.00	1456.00	1456.00
BPS2–CKT3	0	x	0.00	0.00	0.00	0.00
BPS2–CKT4	0	x	0.00	0.00	0.00	0.00
XLS–BPS6	1	x	70.00	70.00	190.00	190.00
TOTAL mA			(A)	70.00	(B)	2807.00
TOTAL AMPS				0.070		2.807

POWER SUPPLY RATING: 6.0 AMPS CIRCUIT RATING: 3.0 AMPS

BATTERY CALCULATION

SUPERVISORY HOURS 24 (C) ALARM MINUTES 15 (D)

BATTERY CAPACITY (A.H.) = 1.2 [((A x C) + (0.0167 x B x D))/1000] A.H.= 2.86

A MINIMUM OF 2.86 AMP HOURS OF BATTERY BACKUP WILL SUPERVISE THE SYSTEM FOR 24 HOURS AND OPERATE THE SYSTEM IN ALARM STATE FOR AT LEAST 15 MINUTES. THUS 1 SET OF 6.5 AMP HOUR BATTERIES WILL BE PROVIDED.

Figure C-6: BPS-2 Calculations

Project Name			AUDIO				CIRCUIT IS WITHIN LIMITS
Date			10/31/2005				
Circuit Number			BPS2-CKT1				
Area Covered			1STFLR-ZONE-5				Notes.
Nominal System Voltage				24			Wire resistance is based on
Minimum Device Voltage				20			2002 NEC Ch. 9 Table 8-
Total Circuit Current			1.161		Wire Gauge	Ohm's Per 1000	Uncoated DC resistance.
							Solid conductors except gauges
Distance from source to 1st device				243	14	3.19	10 and 12 are for stranded.
Wire Gauge for balance of circuit					14	3.19	Program doubles the resistance
							to allow for 2 wires for both
			Distance from	Voltage			positive and negative conductors
Device Number	Model Number	Device Current	previous device	At Device	Drop from source	Percent Drop	
2-1-1	XLSG4R-S7VM-75	0.182	243	22.20	1.80	7%	Alternate Calculations
2-1-2	XLSG4R-S7VM-75	0.182	116	21.48	2.52	11%	End of Line Method
2-1-3	XLSG4R-S7VM-30	0.093	86	21.04	2.96	12%	Totals / Voltage
2-1-4	XLSG4R-S7VM-30	0.093	30	20.90	3.10	13%	Current / Distance / Drop
2-1-5	XLSG4R-S7VM-75	0.182	21	20.82	3.18	13%	1.161 / 691 / 5.118
2-1-6	XLSG4R-S7VM-15	0.065	79	20.61	3.39	14%	
2-1-7	XLSG4R-S7VM-75	0.182	56	20.48	3.52	15%	Load Centering Method
2-1-8	XLSG4R-S7VM-75	0.182	60	20.41	3.59	15%	Totals / Voltage
		0.000		20.41	3.59	15%	Current / Distance / Drop
		0.000		20.41	3.59	15%	1.161 / 691 / 2.559
		0.000		20.41	3.59	15%	
		0.000		20.41	3.59	15%	

Figure C-7: BPS-2, Circuit 1 Calculations

Project Name			AUDIO					CIRCUIT IS WITHIN LIMITS
Date			10/31/2005					
Circuit Number			BPS2-CKT2					
Area Covered			1STFLR-ZONE-5					Notes.
Nominal System Voltage				24				Wire resistance is based on
Minimum Device Voltage				20				2002 NEC Ch. 9 Table 8-
Total Circuit Current			1.456		Wire Gauge	Ohm's Per 1000		Uncoated DC resistance.
								Solid conductors except gauges
Distance from source to 1st device				189	14	3.19		10 and 12 are for stranded.
Wire Gauge for balance of circuit					14	3.19		Program doubles the resistance
								to allow for 2 wires for both
								positive and negative conductors

Device Number	Model Number	Device Current	Distance from previous device	Voltage At Device	Drop from source	Percent Drop
2-2-1	XLSG4R-S7VM-75	0.182	189	22.24	1.76	7%
2-2-2	XLSG4R-S7VM-75	0.182	69	21.68	2.32	10%
2-2-3	XLSG4R-S7VM-75	0.182	78	21.14	2.86	12%
2-2-4	XLSG4R-S7VM-75	0.182	77	20.69	3.31	14%
2-2-5	XLSG4R-S7VM-75	0.182	57	20.43	3.57	15%
2-2-6	XLSG4R-S7VM-75	0.182	61	20.22	3.78	16%
2-2-7	XLSG4R-S7VM-75	0.182	32	20.14	3.86	16%
2-2-8	XLSG4R-S7VM-75	0.182	71	20.06	3.94	16%
		0.000		20.06	3.94	16%
		0.000		20.06	3.94	16%
		0.000		20.06	3.94	16%
		0.000		20.06	3.94	16%

Alternate Calculations

End of Line Method

Totals		Voltage Drop
Current	Distance	
1.456	634	5.889

Load Centering Method

Totals		Voltage Drop
Current	Distance	
1.456	634	2.945

Figure C-8: BPS-2, Circuit 2 Calculations

Project Name			AUDIO				CIRCUIT IS WITHIN LIMITS
Date			10/31/2005				
Circuit Number			BPS2-CKT3				
Area Covered			SPARE				Notes.
Nominal System Voltage				24			Wire resistance is based on
Minimum Device Voltage				20			2002 NEC Ch. 9 Table 8-
Total Circuit Current		0.000			Wire Gauge	Ohm's Per 1000	Uncoated DC resistance.
							Solid conductors except gauges
Distance from source to 1st device				149	14	3.07	10 and 12 are for stranded.
Wire Gauge for balance of circuit					14	3.07	Program doubles the resistance
			Distance from previous device	Voltage At Device	Drop from source	Percent Drop	to allow for 2 wires for both positive and negative conductors
Device Number	Model Number	Device Current					
		0.000	149	24.00	0.00	0%	Alternate Calculations
		0.000	103	24.00	0.00	0%	End of Line Method
		0.000	143	24.00	0.00	0%	Totals / Voltage Drop
		0.000	126	24.00	0.00	0%	Current / Distance: 0.000 / 604 — 0.000
		0.000	54	24.00	0.00	0%	
		0.000	59	24.00	0.00	0%	
		0.000		24.00	0.00	0%	Load Centering Method
		0.000		24.00	0.00	0%	Totals / Voltage Drop
		0.000		24.00	0.00	0%	Current / Distance: 0.000 / 604 — 0.000
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	

Figure C-9: BPS-2, Circuit 3 Calculations

Project Name		AUDIO					CIRCUIT IS WITHIN LIMITS
Date		10/31/2005					
Circuit Number		BPS2-CKT4					
Area Covered		SPARE					Notes.
Nominal System Voltage			24				Wire resistance is based on
Minimum Device Voltage			20				2002 NEC Ch. 9 Table 8-
Total Circuit Current		0.000		Wire Gauge	Ohm's Per 1000		Uncoated DC resistance.
							Solid conductors except gauges
Distance from source to 1st device				14	3.07		10 and 12 are for stranded.
Wire Gauge for balance of circuit				14	3.07		Program doubles the resistance
			Distance from previous device	Voltage At Device	Drop from source	Percent Drop	to allow for 2 wires for both positive and negative conductors
Device Number	Model Number	Device Current					
		0.000	0	24.00	0.00	0%	Alternate Calculations
		0.000		24.00	0.00	0%	End of Line Method
		0.000		24.00	0.00	0%	Totals / Voltage Drop
		0.000		24.00	0.00	0%	Current / Distance / Voltage Drop
		0.000		24.00	0.00	0%	0.000 / 0 / 0.000
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	Load Centering Method
		0.000		24.00	0.00	0%	Totals / Voltage Drop
		0.000		24.00	0.00	0%	Current / Distance / Voltage Drop
		0.000		24.00	0.00	0%	0.000 / 0 / 0.000
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	

Figure C-10: BPS-2, Circuit 4 Calculations

BPS–3 BATTERY SIZING CALCULATIONS

LOAD	QTY		STANDBY (mA)	TOTAL STANDBY (mA)	ALARM (mA)	TOTAL ALARM (mA)
BPS3–CKT1	1	x	0.00	0.00	745.00	745.00
BPS3–CKT2	1	x	0.00	0.00	563.00	563.00
BPS3–CKT3	0	x	0.00	0.00	0.00	0.00
BPS3–CKT4	0	x	0.00	0.00	0.00	0.00
XLS–BPS6	1	x	70.00	70.00	190.00	190.00
TOTAL mA			(A)	70.00	(B)	1498.00
TOTAL AMPS				0.070		1.498

POWER SUPPLY RATING: 6.0 AMPS CIRCUIT RATING: 3.0 AMPS

BATTERY CALCULATION

SUPERVISORY HOURS 24 (C) ALARM MINUTES 15 (D)

BATTERY CAPACITY (A.H.) = 1.2 [((A x C) + (0.0167 x B x D))/1000] A.H.= 2.47

A MINIMUM OF 2.47 AMP HOURS OF BATTERY BACKUP WILL SUPERVISE THE SYSTEM FOR 24 HOURS AND OPERATE THE SYSTEM IN ALARM STATE FOR AT LEAST 15 MINUTES. THUS 1 SET OF 6.5 AMP HOUR BATTERIES WILL BE PROVIDED.

Figure C-11: BPS-3 Calculations

Project Name			AUDIO					CIRCUIT IS WITHIN LIMITS
Date			10/31/2005					
Circuit Number			BPS3-CKT1					
Area Covered			2NDFLR-ZONE-11					Notes.
Nominal System Voltage				24				Wire resistance is based on
Minimum Device Voltage				20				2002 NEC Ch. 9 Table 8-
Total Circuit Current			0.745					Uncoated DC resistance.
					Wire Gauge	Ohm's Per 1000		Solid conductors except gauges
Distance from source to 1st device				151	14	3.19		10 and 12 are for stranded.
Wire Gauge for balance of circuit					14	3.19		Program doubles the resistance
			Distance from	Voltage				to allow for 2 wires for both
Device Number	Model Number	Device Current	previous device	At Device	Drop from source	Percent Drop		positive and negative conductors
3-1-1	XLSG4R-S7VM-75	0.182	151	23.28	0.72	3%		Alternate Calculations
3-1-2	XLSG4R-S7VM-30	0.093	40	23.14	0.86	4%		End of Line Method
3-1-3	XLSG4R-S7VM-30	0.093	29	23.05	0.95	4%		Totals / Voltage Drop
3-1-4	XLSG4R-S7VM-15	0.065	45	22.94	1.06	4%		Current 0.745 / Distance 452 / Drop 2.148
3-1-5	XLSG4R-S7VM-15	0.065	49	22.85	1.15	5%		
3-1-6	XLSG4R-S7VM-75	0.182	59	22.75	1.25	5%		
3-1-7	XLSG4R-S7VM-15	0.065	79	22.72	1.28	5%		Load Centering Method
		0.000		22.72	1.28	5%		Totals / Voltage Drop
		0.000		22.72	1.28	5%		Current 0.745 / Distance 452 / Drop 1.074
		0.000		22.72	1.28	5%		
		0.000		22.72	1.28	5%		
		0.000		22.72	1.28	5%		

Figure C-12: BPS-3, Circuit 1 Calculations

Project Name			AUDIO					CIRCUIT IS WITHIN LIMITS
Date			10/31/2005					
Circuit Number			BPS3-CKT2					
Area Covered			2NDFLR-ZONE-11					Notes.
Nominal System Voltage				24				Wire resistance is based on
Minimum Device Voltage				20				2002 NEC Ch. 9 Table 8-
Total Circuit Current			0.563		Wire Gauge	Ohm's Per 1000		Uncoated DC resistance.
Distance from source to 1st device				160	14	3.19		Solid conductors except gauges
Wire Gauge for balance of circuit					14	3.19		10 and 12 are for stranded.
								Program doubles the resistance
			Distance from					to allow for 2 wires for both
Device Number	Model Number	Device Current	previous device	Voltage At Device	Drop from source	Percent Drop		positive and negative conductors
3-2-1	XLSG4R-S7VM-75	0.182	160	23.43	0.57	2%		Alternate Calculations
3-2-2	XLSG4R-S7VM-30	0.093	59	23.28	0.72	3%		End of Line Method
3-2-3	XLSG4R-S7VM-30	0.093	85	23.13	0.87	4%		Totals / Voltage
3-2-4	XLSG4R-S7VM-15	0.065	55	23.06	0.94	4%		Current / Distance / Drop
3-2-5	XLSG4R-S7VM-15	0.065	66	23.00	1.00	4%		0.563 / 496 / 1.782
3-2-6	XLSG4R-S7VM-15	0.065	71	22.97	1.03	4%		
		0.000		22.97	1.03	4%		Load Centering Method
		0.000		22.97	1.03	4%		Totals / Voltage
		0.000		22.97	1.03	4%		Current / Distance / Drop
		0.000		22.97	1.03	4%		0.563 / 496 / 0.891
		0.000		22.97	1.03	4%		
		0.000		22.97	1.03	4%		

Figure C-13: BPS-3, Circuit 2 Calculations

Project Name			AUDIO				CIRCUIT IS WITHIN LIMITS
Date			10/31/2005				
Circuit Number			BPS3-CKT3				
Area Covered			SPARE				Notes.
Nominal System Voltage				24			Wire resistance is based on
Minimum Device Voltage				20			2002 NEC Ch. 9 Table 8-
Total Circuit Current			0.000		Wire Gauge	Ohm's Per 1000	Uncoated DC resistance.
							Solid conductors except gauges
Distance from source to 1st device					14	3.07	10 and 12 are for stranded.
Wire Gauge for balance of circuit					14	3.07	Program doubles the resistance
							to allow for 2 wires for both
			Distance from	Voltage			positive and negative conductors
Device Number	Model Number	Device Current	previous device	At Device	Drop from source	Percent Drop	
		0.000	0	24.00	0.00	0%	Alternate Calculations
		0.000		24.00	0.00	0%	End of Line Method
		0.000		24.00	0.00	0%	Totals / Voltage
		0.000		24.00	0.00	0%	Current / Distance / Drop
		0.000		24.00	0.00	0%	0.000 / 0 / 0.000
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	Load Centering Method
		0.000		24.00	0.00	0%	Totals / Voltage
		0.000		24.00	0.00	0%	Current / Distance / Drop
		0.000		24.00	0.00	0%	0.000 / 0 / 0.000
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	

Figure C-14: BPS-3, Circuit 3 Calculations

Project Name		AUDIO					CIRCUIT IS WITHIN LIMITS
Date		10/31/2005					
Circuit Number		BPS3-CKT4					
Area Covered		SPARE					Notes.
Nominal System Voltage			24				Wire resistance is based on
Minimum Device Voltage			20				2002 NEC Ch. 9 Table 8-
Total Circuit Current		0.000		Wire Gauge	Ohm's Per 1000		Uncoated DC resistance.
Distance from source to 1st device				14	3.07		Solid conductors except gauges 10 and 12 are for stranded.
Wire Gauge for balance of circuit				14	3.07		Program doubles the resistance to allow for 2 wires for both positive and negative conductors
Device Number	Model Number	Device Current	Distance from previous device	Voltage At Device	Drop from source	Percent Drop	
		0.000	0	24.00	0.00	0%	Alternate Calculations
		0.000		24.00	0.00	0%	End of Line Method
		0.000		24.00	0.00	0%	Totals: Current 0.000, Distance 0, Voltage Drop 0.000
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	Load Centering Method
		0.000		24.00	0.00	0%	Totals: Current 0.000, Distance 0, Voltage Drop 0.000
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	
		0.000		24.00	0.00	0%	

Figure C-15: BPS-3, Circuit 4 Calculations

BPS–4 BATTERY SIZING CALCULATIONS

LOAD	QTY		STANDBY (mA)	TOTAL STANDBY (mA)	ALARM (mA)	TOTAL ALARM (mA)
BPS4–CKT1	1	x	0.00	0.00	563.00	563.00
BPS4–CKT2	1	x	0.00	0.00	624.00	624.00
BPS4–CKT3	0	x	0.00	0.00	0.00	0.00
BPS4–CKT4	0	x	0.00	0.00	0.00	0.00
XLS–BPS6	1	x	70.00	70.00	190.00	190.00
TOTAL mA			(A)	70.00	(B)	1377.00
TOTAL AMPS				0.070		1.377

POWER SUPPLY RATING: 6.0 AMPS CIRCUIT RATING: 3.0 AMPS

BATTERY CALCULATION

SUPERVISORY HOURS 24 (C) ALARM MINUTES 15 (D)

BATTERY CAPACITY (A.H.) = 1.2 [((A x C) + (0.0167 x B x D))/1000] A.H.= 2.43

A MINIMUM OF 2.43 AMP HOURS OF BATTERY BACKUP WILL SUPERVISE THE SYSTEM FOR 24 HOURS AND OPERATE THE SYSTEM IN ALARM STATE FOR AT LEAST 15 MINUTES. THUS 1 SET OF 6.5 AMP HOUR BATTERIES WILL BE PROVIDED.

Figure C-16: BPS-4 Calculations

Project Name			AUDIO					CIRCUIT IS WITHIN LIMITS
Date			10/31/2005					
Circuit Number			BPS4-CKT1					
Area Covered			3RDFLR-ZONE-17					Notes.
Nominal System Voltage				24				Wire resistance is based on
Minimum Device Voltage				20				2002 NEC Ch. 9 Table 8-
Total Circuit Current			0.563					Uncoated DC resistance.
					Wire Gauge	Ohm's Per 1000		Solid conductors except gauges
Distance from source to 1st device				222	14	3.19		10 and 12 are for stranded.
Wire Gauge for balance of circuit					14	3.19		Program doubles the resistance
			Distance from		Voltage			to allow for 2 wires for both
Device Number	Model Number	Device Current	previous device		At Device	Drop from source	Percent Drop	positive and negative conductors
4-1-1	XLSG4R-S7VM-30	0.093	222		23.20	0.80	3%	Alternate Calculations
4-1-2	XLSG4R-S7VM-30	0.093	30		23.11	0.89	4%	End of Line Method
4-1-3	XLSG4R-S7VM-15	0.065	31		23.04	0.96	4%	Totals / Voltage
4-1-4	XLSG4R-S7VM-15	0.065	54		22.93	1.07	4%	Current / Distance / Drop
4-1-5	XLSG4R-S7VM-75	0.182	60		22.84	1.16	5%	0.563 / 454 / 1.631
4-1-6	XLSG4R-S7VM-15	0.065	57		22.81	1.19	5%	
		0.000			22.81	1.19	5%	Load Centering Method
		0.000			22.81	1.19	5%	Totals / Voltage
		0.000			22.81	1.19	5%	Current / Distance / Drop
		0.000			22.81	1.19	5%	0.563 / 454 / 0.815
		0.000			22.81	1.19	5%	
		0.000			22.81	1.19	5%	

Figure C-17: BPS-4, Circuit 1 Calculations

Project Name			AUDIO					CIRCUIT IS WITHIN LIMITS
Date			10/31/2005					
Circuit Number			BPS4-CKT2					
Area Covered			3RDFLR-ZONE-17					Notes.
Nominal System Voltage				24				Wire resistance is based on
Minimum Device Voltage				20				2002 NEC Ch. 9 Table 8-
Total Circuit Current			0.624		Wire Gauge	Ohm's Per 1000		Uncoated DC resistance.
								Solid conductors except gauges
Distance from source to 1st device				201	14	3.19		10 and 12 are for stranded.
Wire Gauge for balance of circuit					14	3.19		Program doubles the resistance
								to allow for 2 wires for both
			Distance from	Voltage				positive and negative conductors
Device Number	Model Number	Device Current	previous device	At Device	Drop from source	Percent Drop		
4-2-1	XLSG4R-S7VM-15	0.065	201	23.20	0.80	3%		Alternate Calculations
4-2-2	XLSG4R-S7VM-15	0.065	36	23.07	0.93	4%		End of Line Method
4-2-3	XLSG4R-S7VM-15	0.065	75	22.84	1.16	5%		Totals / Voltage
4-2-4	XLSG4R-S7VM-15	0.065	50	22.70	1.30	5%		Current / Distance / Drop
4-2-5	XLSG4R-S7VM-75	0.182	101	22.46	1.54	6%		0.624 / 515 / 2.050
4-2-6	XLSG4R-S7VM-75	0.182	52	22.40	1.60	7%		
		0.000		22.40	1.60	7%	Load	Centering Method
		0.000		22.40	1.60	7%		Totals / Voltage
		0.000		22.40	1.60	7%		Current / Distance / Drop
		0.000		22.40	1.60	7%		0.624 / 515 / 1.025
		0.000		22.40	1.60	7%		
		0.000		22.40	1.60	7%		

Figure C-18: BPS-4, Circuit 2 Calculations

Project Name			AUDIO					CIRCUIT IS WITHIN LIMITS
Date			10/31/2005					
Circuit Number			BPS4-CKT3					
Area Covered			SPARE					Notes.
Nominal System Voltage				24				Wire resistance is based on
Minimum Device Voltage				20				2002 NEC Ch. 9 Table 8-
Total Circuit Current			0.000		Wire Gauge	Ohm's Per 1000		Uncoated DC resistance.
								Solid conductors except gauges
Distance from source to 1st device					14	3.07		10 and 12 are for stranded.
Wire Gauge for balance of circuit					14	3.07		Program doubles the resistance
			Distance from					to allow for 2 wires for both
Device Number	Model Number	Device Current	previous device	Voltage At Device	Drop from source	Percent Drop		positive and negative conductors
		0.000	0	24.00	0.00	0%		Alternate Calculations
		0.000		24.00	0.00	0%		End of Line Method
		0.000		24.00	0.00	0%		Totals / Voltage
		0.000		24.00	0.00	0%		Current / Distance / Drop
		0.000		24.00	0.00	0%		0.000 / 0 / 0.000
		0.000		24.00	0.00	0%		
		0.000		24.00	0.00	0%		
		0.000		24.00	0.00	0%		
		0.000		24.00	0.00	0%		
		0.000		24.00	0.00	0%		
		0.000		24.00	0.00	0%		
		0.000		24.00	0.00	0%		
		0.000		24.00	0.00	0%		
		0.000		24.00	0.00	0%		
		0.000		24.00	0.00	0%		

Load Centering Method

Totals		Voltage
Current	Distance	Drop
0.000	0	0.000

Figure C-19: BPS-4, Circuit 3 Calculations

Project Name	AUDIO				CIRCUIT IS WITHIN LIMITS
Date	10/31/2005				
Circuit Number	BPS4-CKT4				
Area Covered	SPARE				Notes.
Nominal System Voltage		24			Wire resistance is based on
Minimum Device Voltage		20			2002 NEC Ch. 9 Table 8-
Total Circuit Current	0.000		Wire Gauge	Ohm's Per 1000	Uncoated DC resistance.
					Solid conductors except gauges
Distance from source to 1st device			14	3.07	10 and 12 are for stranded.
Wire Gauge for balance of circuit			14	3.07	Program doubles the resistance
					to allow for 2 wires for both
					positive and negative conductors

Device Number	Model Number	Device Current	Distance from previous device	Voltage At Device	Drop from source	Percent Drop
		0.000	0	24.00	0.00	0%
		0.000		24.00	0.00	0%
		0.000		24.00	0.00	0%
		0.000		24.00	0.00	0%
		0.000		24.00	0.00	0%
		0.000		24.00	0.00	0%
		0.000		24.00	0.00	0%
		0.000		24.00	0.00	0%
		0.000		24.00	0.00	0%
		0.000		24.00	0.00	0%
		0.000		24.00	0.00	0%
		0.000		24.00	0.00	0%

Alternate Calculations

End of Line Method

Totals		Voltage Drop
Current	Distance	
0.000	0	0.000

Load Centering Method

Totals		Voltage Drop
Current	Distance	
0.000	0	0.000

Figure C-20: BPS-4, Circuit 4 Calculations

SPEAKER VOLTAGE DROP CALCULATIONS

Project Name	
Date	10/27/05
Circuit Number	AMP-1
Area Covered	BSMT
Nominal Speaker Voltage (25 or 70)	70
Minimum Device Voltage (Calculated see notes)	56
Total Circuit Current in amps	0.314
Total Circuit Power	22.000
Distance from source to 1st device	192
Wire Gauge for balance of circuit	14

Wire Gauge	Ohm's Per 1000
14	3.19
14	3.19

Point to Point Method — CIRCUIT IS WITHIN LIMITS

Totals Current	Totals Distance	Voltage Drop
0.314	1450	1.72

End of Line Voltage 68.28

Percent Drop 2.45%

Load Centering Method — CIRCUIT IS WITHIN LIMITS

Totals Current	Totals Distance	Voltage Drop
0.314	1450	1.454

End of Line Voltage 68.55

Percent Drop 2.08%

End of Line and Load Centering Methods use only the wire gauge for the first device to source

Standard Wire Resistance in Ohms per 1000 feet.

18=7.77 16=4.89 14=3.19 12=1.98 10=1.24

18–14 Awg = Solid Conductors 12–10 Awg = Stranded Conductors

Enter Power in Watts 1/2 W = .5

Device Number	Device Power	Distance from previous device	Calculated Device Current	Voltage At Device	Drop from source	Percent Drop
A1–1	1.000	192	0.014	69.62	0.385	0.55%
A1–2	1.000	98	0.014	69.43	0.573	0.82%
A1–3	1.000	72	0.014	69.30	0.704	1.01%
A1–4	1.000	61	0.014	69.19	0.809	1.16%
A1–5	1.000	47	0.014	69.11	0.887	1.27%
A1–6	1.000	61	0.014	69.02	0.981	1.40%
A1–7	1.000	60	0.014	68.93	1.069	1.53%
A1–8	1.000	61	0.014	68.85	1.152	1.65%
A1–9	1.000	23	0.014	68.82	1.181	1.69%
A1–10	1.000	15	0.014	68.80	1.199	1.71%
A1–11	1.000	99	0.014	68.69	1.307	1.87%
A1–12	1.000	192	0.014	68.50	1.500	2.14%
A1–13	1.000	30	0.014	68.47	1.527	2.18%
A1–14	1.000	42	0.014	68.44	1.562	2.23%
A1–15	1.000	15	0.014	68.43	1.573	2.25%
A1–16	1.000	44	0.014	68.40	1.601	2.29%
A1–17	1.000	36	0.014	68.38	1.620	2.31%
A1–18	1.000	83	0.014	68.34	1.658	2.37%
A1–19	1.000	67	0.014	68.32	1.683	2.40%
A1–20	1.000	69	0.014	68.30	1.701	2.43%
A1–21	1.000	68	0.014	68.29	1.714	2.45%
A1–22	1.000	15	0.014	68.28	1.715	2.45%
			0.000	68.28	1.715	2.45%
			0.000	68.28	1.715	2.45%
			0.000	68.28	1.715	2.45%
			0.000	68.28	1.715	2.45%
			0.000	68.28	1.715	2.45%
			0.000	68.28	1.715	2.45%
			0.000	68.28	1.715	2.45%
			0.000	68.28	1.715	2.45%
Totals	22.000	1450	0.314	End of Line Voltage		68.28

Notes:

Wire resistance is doubled in the calculations for two wires (Positive and Negative)

80% of rated voltage at the end of circuit will result in approximately a 2 dB lower output from the speaker than the rated output for full voltage

Total speaker wattage cannot exceed the wattage rating of the circuit module used (see product specification sheets)

Total wattage load of all circuits connected to an amplifier cannot exceed the wattage rating of the amplifier(s) provided

A 1

40 WATTS AMPS

Figure C-21: AMP-1 Calculations

SPEAKER VOLTAGE DROP CALCULATIONS

Project Name	
Date	10/27/05
Circuit Number	AMP-2
Area Covered	1STFLR
Nominal Speaker Voltage (25 or 70)	70
Minimum Device Voltage (Calculated see notes)	56
Total Circuit Current in amps	0.229
Total Circuit Power	16.000
Distance from source to 1st device	243
Wire Gauge for balance of circuit	14

Wire Gauge	Ohm's Per 1000
14	3.19
14	3.19

Point to Point Method		
CIRCUIT IS WITHIN LIMITS		
Totals		Voltage
Current	Distance	Drop
0.229	1174	1.06
End of Line Voltage		68.94
Percent Drop		1.51%

Load Centering Method		
CIRCUIT IS WITHIN LIMITS		
Totals		Voltage
Current	Distance	Drop
0.229	1174	0.856
End of Line Voltage		69.14
Percent Drop		1.22%

End of Line and Load Centering Methods use only the wire gauge for the first device to source

Standard Wire Resistance in Ohms per 1000 feet.

18=7.77 16=4.89 14=3.19 12=1.98 10=1.24

18-14 Awg = Solid Conductors 12-10 Awg = Stranded Conductors

Device Number	Enter Power in Watts 1/2 W = .5 Device Power	Distance from previous device	Calculated Device Current	Voltage At Device	Drop from source	Percent Drop
A2-1	1.000	243	0.014	69.65	0.354	0.51%
A2-2	1.000	116	0.014	69.49	0.513	0.73%
A2-3	1.000	86	0.014	69.38	0.623	0.89%
A2-4	1.000	30	0.014	69.34	0.658	0.94%
A2-5	1.000	21	0.014	69.32	0.681	0.97%
A2-6	1.000	79	0.014	69.24	0.760	1.09%
A2-7	1.000	56	0.014	69.19	0.811	1.16%
A2-8	1.000	60	0.014	69.14	0.861	1.23%
A2-9	1.000	38	0.014	69.11	0.888	1.27%
A2-10	1.000	69	0.014	69.07	0.932	1.33%
A2-11	1.000	78	0.014	69.02	0.975	1.39%
A2-12	1.000	77	0.014	68.99	1.010	1.44%
A2-13	1.000	57	0.014	68.97	1.031	1.47%
A2-14	1.000	61	0.014	68.95	1.048	1.50%
A2-15	1.000	32	0.014	68.95	1.053	1.50%
A2-16	1.000	71	0.014	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
			0.000	68.94	1.060	1.51%
Totals	16.000	1174	0.229	End of Line Voltage		68.94

Notes:

Wire resistance is doubled in the calculations for two wires (Positive and Negative)

80% of rated voltage at the end of circuit will result in approximately a 2 dB lower output from the speaker than the rated output for full voltage

Total speaker wattage cannot exceed the wattage rating of the circuit module used (see product specification sheets)

Total wattage load of all circuits connected to an amplifier cannot exceed the wattage rating of the amplifier(s) provided

A2

40 WATTS AMPS

Figure C-22: AMP-2 Calculations

SPEAKER VOLTAGE DROP CALCULATIONS

Project Name	
Date	10/27/05
Circuit Number	AMP-3
Area Covered	2NDFLR
Nominal Speaker Voltage (25 or 70)	70
Minimum Device Voltage (Calculated see notes)	56
Total Circuit Current in amps	0.186
Total Circuit Power	13.000
Distance from source to 1st device	151
Wire Gauge for balance of circuit	14

Wire Gauge	Ohm's Per 1000
14	3.19
14	3.19

Point to Point Method

CIRCUIT IS WITHIN LIMITS

Totals Current	Totals Distance	Voltage Drop
0.186	869	0.56

End of Line Voltage 69.44

Percent Drop 0.80%

Load Centering Method

CIRCUIT IS WITHIN LIMITS

Totals Current	Totals Distance	Voltage Drop
0.186	869	0.515

End of Line Voltage 69.49

Percent Drop 0.74%

End of Line and Load Centering Methods use only the wire gauge for the first device to source

Standard Wire Resistance in Ohms per 1000 feet.

18=7.77 16=4.89 14=3.19 12=1.98 10=1.24

18-14 Awg = Solid Conductors 12-10 Awg = Stranded Conductors

Device Number	Enter Power in Watts 1/2 W = .5 Device Power	Distance from previous device	Calculated Device Current	Voltage At Device	Drop from source	Percent Drop
A3-1	1.000	151	0.014	69.82	0.179	0.26%
A3-2	1.000	40	0.014	69.78	0.223	0.32%
A3-3	1.000	29	0.014	69.75	0.252	0.36%
A3-4	1.000	45	0.014	69.71	0.293	0.42%
A3-5	1.000	49	0.014	69.67	0.333	0.48%
A3-6	1.000	59	0.014	69.62	0.376	0.54%
A3-7	1.000	79	0.014	69.57	0.426	0.61%
A3-8	1.000	81	0.014	69.53	0.471	0.67%
A3-9	1.000	59	0.014	69.50	0.498	0.71%
A3-10	1.000	85	0.014	69.47	0.529	0.76%
A3-11	1.000	55	0.014	69.46	0.544	0.78%
A3-12	1.000	66	0.014	69.44	0.556	0.79%
A1-13	1.000	71	0.014	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
			0.000	69.44	0.562	0.80%
Totals	13.000	869	0.186	End of Line Voltage		69.44

Notes:

Wire resistance is doubled in the calculations for two wires (Positive and Negative)

80% of rated voltage at the end of circuit will result in approximately a 2 dB lower output from the speaker than the rated output for full voltage

Total speaker wattage cannot exceed the wattage rating of the circuit module used (see product specification sheets)

Total wattage load of all circuits connected to an amplifier cannot exceed the wattage rating of the amplifier(s) provided

A3

40 WATTS AMPS

Figure C-23: AMP-3 Calculations

SPEAKER VOLTAGE DROP CALCULATIONS

Project Name	
Date	10/27/05
Circuit Number	AMP-4
Area Covered	3RDFLR
Nominal Speaker Voltage (25 or 70)	70
Minimum Device Voltage (Calculated see notes)	56
Total Circuit Current in amps	0.171
Total Circuit Power	12.000
Distance from source to 1st device	222
Wire Gauge for balance of circuit	14

Wire Gauge	Ohm's Per 1000
14	3.19
14	3.19

Point to Point Method

CIRCUIT IS WITHIN LIMITS

Totals Current	Totals Distance	Voltage Drop
0.171	868	0.56

End of Line Voltage 69.44

Percent Drop 0.80%

Load Centering Method

CIRCUIT IS WITHIN LIMITS

Totals Current	Totals Distance	Voltage Drop
0.171	868	0.475

End of Line Voltage 69.53

Percent Drop 0.68%

End of Line and Load Centering Methods use only the wire gauge for the first device to source

Standard Wire Resistance in Ohms per 1000 feet.

18=7.77 16=4.89 14=3.19 12=1.98 10=1.24

18–14 Awg = Solid Conductors 12–10 Awg = Stranded Conductors

Device Number	Enter Power in Watts 1/2 W = .5 Device Power	Distance from previous device	Calculated Device Current	Voltage At Device	Drop from source	Percent Drop
A4–1	1.000	222	0.014	69.76	0.243	0.35%
A4–2	1.000	30	0.014	69.73	0.273	0.39%
A4–3	1.000	31	0.014	69.70	0.301	0.43%
A4–4	1.000	54	0.014	69.65	0.345	0.49%
A4–5	1.000	60	0.014	69.61	0.389	0.56%
A4–6	1.000	57	0.014	69.57	0.426	0.61%
A4–7	1.000	100	0.014	69.52	0.480	0.69%
A4–8	1.000	36	0.014	69.50	0.497	0.71%
A4–9	1.000	75	0.014	69.48	0.524	0.75%
A4–10	1.000	50	0.014	69.46	0.538	0.77%
A4–11	1.000	101	0.014	69.44	0.556	0.79%
A4–12	1.000	52	0.014	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
			0.000	69.44	0.561	0.80%
Totals	12.000	868	0.171	End of Line Voltage		69.44

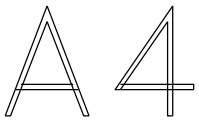
Notes:

Wire resistance is doubled in the calculations for two wires (Positive and Negative)

80% of rated voltage at the end of circuit will result in approximately a 2 dB lower output from the speaker than the rated output for full voltage

Total speaker wattage cannot exceed the wattage rating of the circuit module used (see product specification sheets)

Total wattage load of all circuits connected to an amplifier cannot exceed the wattage rating of the amplifier(s) provided



40 WATTS AMPS

Figure C-24: AMP-4 Calculations

SPEAKER VOLTAGE DROP CALCULATIONS

						Point to Point Method				Load Centering Method	
Project Name						CIRCUIT IS WITHIN LIMITS				CIRCUIT IS WITHIN LIMITS	
Date	10/27/05										
Circuit Number	AMP-5					Totals		Voltage		Totals		Voltage
Area Covered	BSMT-HALLWAYS					Current	Distance	Drop		Current	Distance	Drop
Nominal Speaker Voltage (25 or 70)			70			0.314	3011	3.32		0.314	3011	3.019
Minimum Device Voltage (Calculated see notes)			56			End of Line Voltage		66.68		End of Line Voltage		66.98
Total Circuit Current in amps		0.314		Wire	Ohm's	Percent Drop		4.74%		Percent Drop		4.31%
Total Circuit Power		22.000		Gauge	Per 1000	End of Line and Load Centering Methods use only the wire gauge for the first device to source						
Distance from source to 1st device			400	14	3.19	Standard Wire Resistance in Ohms per 1000 feet.						
Wire Gauge for balance of circuit				14	3.19	18=7.77 16=4.89 14=3.19 12=1.98 10=1.24						
						18-14 Awg = Solid Conductors 12-10 Awg = Stranded Conductors						

Enter Power in Watts 1/2 W = .5		Distance	Cal-	Voltage		
Device Number	Device Power	from previous device	culated Device Current	At Device	Drop from source	Percent Drop
A5-1	1.000	400	0.014	69.20	0.802	1.15%
A5-2	1.000	80	0.014	69.04	0.955	1.36%
A5-3	1.000	59	0.014	68.94	1.063	1.52%
A5-4	1.000	116	0.014	68.74	1.264	1.81%
A5-5	1.000	98	0.014	68.58	1.424	2.03%
A5-6	1.000	66	0.014	68.47	1.527	2.18%
A5-7	1.000	172	0.014	68.22	1.777	2.54%
A5-8	1.000	153	0.014	68.01	1.987	2.84%
A5-9	1.000	260	0.014	67.68	2.318	3.31%
A5-10	1.000	113	0.014	67.55	2.452	3.50%
A5-11	1.000	103	0.014	67.44	2.565	3.66%
A5-12	1.000	176	0.014	67.26	2.741	3.92%
A5-13	1.000	79	0.014	67.19	2.813	4.02%
A5-14	1.000	90	0.014	67.11	2.887	4.12%
A5-15	1.000	194	0.014	66.97	3.029	4.33%
A5-16	1.000	60	0.014	66.93	3.067	4.38%
A5-17	1.000	150	0.014	66.85	3.149	4.50%
A5-18	1.000	103	0.014	66.80	3.196	4.57%
A5-19	1.000	176	0.014	66.74	3.260	4.66%
A5-20	1.000	79	0.014	66.72	3.282	4.69%
A5-21	1.000	90	0.014	66.70	3.298	4.71%
A5-22	1.000	194	0.014	66.68	3.316	4.74%
			0.000	66.68	3.316	4.74%
			0.000	66.68	3.316	4.74%
			0.000	66.68	3.316	4.74%
			0.000	66.68	3.316	4.74%
			0.000	66.68	3.316	4.74%
			0.000	66.68	3.316	4.74%
			0.000	66.68	3.316	4.74%
			0.000	66.68	3.316	4.74%
Totals	22.000	3011	0.314	End of Line Voltage		66.68

Notes:
Wire resistance is doubled in the calculations for two wires (Positive and Negative)
80% of rated voltage at the end of circuit will result in approximately a 2 dB lower output from the speaker than the rated output for full voltage

Total speaker wattage cannot exceed the wattage rating of the circuit module used (see product specification sheets)

Total wattage load of all circuits connected to an amplifier cannot exceed the wattage rating of the amplifier(s) provided

A5

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Figure C-25: AMP-5 Calculations

APPENDIX D

Fire Alarm, Detection, and Communication Systems

Additional Component Information

Honeywell

Excel Life Safety

Fire Alarm System Solutions

XLS1000
Life Safety System

An advanced, networked life safety system designed for large single and multi-site applications

The XLS1000 is a networked life safety system featuring intelligent alarm detection and fast, reliable peer-to-peer communications. Expandable to more than eighty thousand points, it is well suited to large buildings such as hospitals, office towers, and hotels as well as multi-building applications including universities, manufacturing complexes and military bases.

Setting a new standard for protection and performance

- ***Powerful, flexible system architecture*** - As building requirements grow, the system easily expands from a single stand-alone panel to a network linking 64 panels to a LAN network reaching every corner of a large building complex.
- ***Peer communications*** - The XLS1000 features a rapid and reliable peer-to-peer communications network using a multi-priority token passing protocol. Sophisticated data broadcast techniques and a distributed database ensure excellent response time.
- ***Intelligent detectors*** - The XLS1000 system features the Signature Series detectors and modules, each incorporating its own microprocessor. Multi-sensor detectors incorporate various combinations of photoelectric, ionization and thermal sensors in a single unit providing unprecedented levels of protection and virtual elimination of nuisance alarms.
- ***Integrated digital audio*** - The audio evacuation system facilitates safe, orderly evacuation of the building as well as meeting other emergency signaling needs. The system generates eight channels of digitized audio messages simultaneously over a single pair of wires including live broadcast by microphone.
- ***Simplified user interface*** - Access to all network data is available at *every panel*. The Liquid Crystal Display (LCD) is a language-based, menu-driven operator interface which provides prioritized listings of all current alarms. Multiple language capability is also available for worldwide applications.

Comfort *from* Experience.™

ExcelLife Safety

Advanced software features reduce cost of ownership

Because all operations of the XLS1000 Fire Alarm System are controlled by software, the system offers a number of features designed to reduce the cost of owning and operating the system.

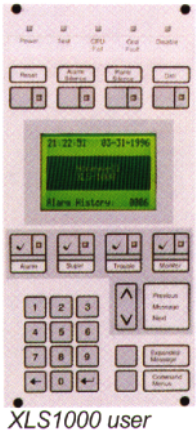
- ***The Signature Series advantage*** - The intelligent Signature Series detectors and modules enhance the performance of the XLS1000 system by providing important system design features including:
  - Multi-sensor technology
  - Microprocessor-based detectors
  - Historical data storage
  - Environment compensation
  - Auto-addressing

Each Signature data circuit supports 125 modules and 125 detectors. Up to 5 circuits can be provided in every panel.

Signature Series life safety devices

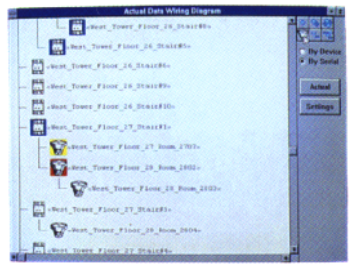
- ***Streamlined start-up*** - The Windows-based System Definition Utility (SDU) allows the programmer to quickly create project-specific system software on site. It defines the network, panels, objects (zones, groups and time-event sequences) and establishes all input-output relationships, including code-mandated system responses. The SDU significantly reduces configuration, documentation and programming time.

- ***Simplified user interface*** - The LCD is designed to support the efforts of an emergency user by displaying both the first event *and* the most recent event. A backlit display of 8 lines/21 characters supports clear, simple event messaging. The user can even select the *type* of event to view using simple switches for alarm, supervisory, trouble, and monitor.



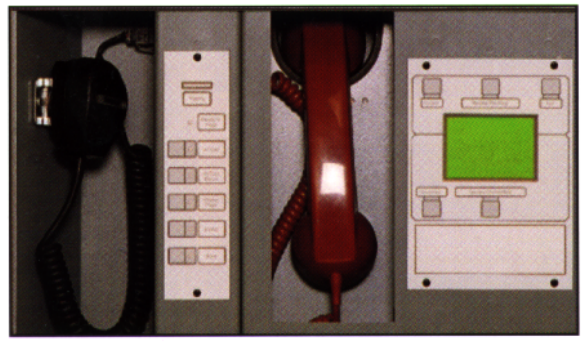
XLS1000 user interface

- ***Economical retrofit applications*** - The XLS1000 system supports both conventional and intelligent detection technology providing migration capability over time and as budgets allow. Existing conventional panels can be replaced or upgraded to new intelligent devices using existing wiring and when upgrading to Signature Series devices, an *electronic map* of the existing installation is generated significantly reducing trouble-shooting time.



Electronic map display

- ***Distributed audio*** - Zone amplifiers and emergency paging and fire phone controls are integral to the XLS1000 panel providing seamless audio communication operation. Eight channels of digitized audio are transmitted over a single pair of wires providing multiple simultaneous messages. This ensures building occupants will receive appropriate messages for their specific location (fire floor, stairwell, elevator) without confusing signal interruption.



XLS1000 emergency paging and fire phone controls

- ***Meets all industry quality standards*** - The XLS1000 life safety system has been designed and manufactured in compliance with ISO 9001 international quality standards. They meet NFPA Standard 72 and are UL, ULC and CSFM listed and FM approved.

A commitment to customer service

Honeywell through its worldwide network of field offices is dedicated to the fulfillment of your life safety goals. We're ready to furnish design and application assistance, installation and commissioning services, employee training and preventive maintenance support. Whatever you ask of us, we promise to do our best to delight you with our products and services, now and in the years ahead.

Honeywell

Home and Building Control
Honeywell Inc.
Honeywell Plaza
Minneapolis, MN 55408

Home and Building Control
Honeywell Limited-Honeywell Limitee
740 Ellesmere Road
Scarborough, Ontario
MIP 2V9

54-2439 2/98

Printed with soy, corn or vegetable inks on paper containing 40% preconsumer waste and 10% postconsumer waste.

MICROMATIC® STANDARD RESPONSE PENDENT SPRINKLER VK202 (K8.0)

TECHNICAL DATA

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

1. DESCRIPTION

The Viking Micromatic® Standard Response Pendent VK202 Sprinkler is a small, thermosensitive, glass-bulb spray sprinkler available in several different finishes, temperature ratings, and K-Factors to meet design requirements. The special Polyester, Polytetrafluoroethylene (PTFE), and Electroless Nickel PTFE (ENT) coatings can be used in decorative applications where colors are desired. In addition, these coatings have been investigated for installation in corrosive atmospheres and are listed/approved as corrosion resistant as indicated in the Approval Charts. (Note: **FM Global approves the ENT coating as corrosion resistant.** FM Global has no approval classification for PTFE and Polyester coatings as corrosion resistant.)

Viking standard response sprinklers may be ordered and/or used as open sprinklers (glass bulb and pip cap assembly removed) on deluge systems. Refer to Ordering Instructions.

2. LISTINGS AND APPROVALS

cULus Listed: Category VNIV

FM Approved: Class Series 2000

VdS Approved: Certificate G414015 and G414016

CE Certified: Standard EN 12259-1, EC-certificate of conformity 0832-CPD-0021 and 0786-CPD-40141

NOTE: Other International approval certificates are available upon request.

Refer to Approval Chart 1 and UL Design Criteria on pages cULus Listing requirements, and refer to Approval Chart 2 and FM Design Criteria for FM Approval requirements that must be followed.

3. TECHNICAL DATA

Specifications:

Minimum Operating Pressure: 7 psi (0.5 bar)†
Maximum Working Pressure: 175 psi (12 bar) wwp
Factory tested hydrostatically to 500 psi (34.5 bar)
Thread size: 1/2” NPT, 15 mm BSP, 3/4” NPT, 20 mm BSP
Nominal K-Factor: 8.0 U.S. (115.2 metric**)
Glass-bulb fluid temperature rated to -65 °F (-55 °C)
Overall Length: 2-1/4” (57 mm)

† cULus Listing, FM Approval, and NFPA 13 installs require a minimum of 7 psi (0.5 bar). The minimum operating pressure for CE Approvals ONLY is 5 psi (0.35 bar).

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

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

Material Standards:

Frame Casting: Brass UNS-C84400
Deflector: Phosphor Bronze UNS-C51000†† or Copper UNS-C19500
Bulb: Glass, nominal 5 mm diameter
Belleville Spring Sealing Assembly: Nickel Alloy, coated on both sides with PTFE Tape
Screw: Brass UNS-C36000
Pip Cap and Insert Assembly: Copper UNS-C11000 and Stainless Steel UNS-S30400
For PTFE Coated Sprinklers: Belleville Spring-Exposed, Screw-Nickel Plated, Pip Cap-PTFE Coated
For Polyester Coated Sprinklers: Belleville Spring-Exposed
For ENT coated Sprinklers: Belleville Spring - Exposed, Screw and Pipcap - ENT plated.

††Not for FM Approval.

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

Order Micromatic® and MicromaticHP® Standard Response Pendent Sprinklers by first adding the appropriate suffix for the sprinkler finish and then the appropriate suffix for the temperature rating to the sprinkler base part number.

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

Finish Suffix: Brass = A, Chrome = F, White Polyester = M-/W, Black Polyester = M-/B, Black PTFE = N, Wax Coated = C, Wax Over Polyester = V-/W, ENT = JN

Temperature Suffix: 135 °F (57 °C) = A, 155 °F (68 °C) = B, 175 °F (79 °C) = D, 200 °F (93 °C) = E, 212 °F (100 °C) = M, 286 °F (141 °C) = G, 360 °F (182 °C) = H, 500 °F (260 °C) = L, OPEN = Z (PTFE only).

For example, sprinkler VK202 with a 1/2" thread, Brass finish and a 155 °F (68 °C) temperature rating = Part No. 18269AB

Available Finishes And Temperature Ratings: Refer to Table 1.

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

Sprinkler Wrenches:

A. Standard Wrench: Part No. 10896W/B (available since 2000).
B. Wrench for Recessed Pendent Sprinklers: Part No. 16036W/B* (available since 2011)
C. Optional Protective Sprinkler Cap Remover/Escutcheon Installer Tool** Part No. 15915 (available since 2010.)
D. Wrench for Wax Coated Sprinklers: Part No. 13577W/B* (available since 2006)

*A ½" ratchet is required (not available from Viking).

**Allows use from the floor by attaching a length of 1" diameter CPVC tubing to the tool. Ideal for sprinkler cabinets. Refer to Bulletin F_051808.

Sprinkler Cabinets:

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

4. INSTALLATION

Refer to appropriate NFPA Installation Standards.

5. OPERATION

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

6. INSPECTIONS, TESTS AND MAINTENANCE

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

7. AVAILABILITY

The Viking Micromatic® Standard Response Pendent Sprinkler VK202 is available through a network of domestic and international distributors. See The Viking Corporation web site for the closest distributor or contact The Viking Corporation.

8. GUARANTEE

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

VIKING®

TECHNICAL DATA

MICROMATIC® STANDARD RESPONSE PENDENT SPRINKLER VK202 (K8.0)

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

TABLE 1: AVAILABLE SPRINKLER TEMPERATURE RATINGS AND FINISHES

Sprinkler Temperature Classification	Sprinkler Nominal Temperature Rating[1]	Maximum Ambient Ceiling Temperature[2]	Bulb Color
Ordinary	135 °F (57 °C)	100 °F (38 °C)	Orange
Ordinary	155 °F (68 °C)	100 °F (38 °C)	Red
Intermediate	175 °F (79 °C)	150 °F (65 °C)	Yellow
Intermediate	200 °F (93 °C)	150 °F (65 °C)	Green
High	286 °F (141 °C)	225 °F (107 °C)	Blue
Extra High	360 °F (182 °C)	300 °F (149 °C)	Mauve
Ultra High[3]	500 °F (260 °C)	465 °F (240 °C)	Black

Sprinkler Finishes: Brass, Chrome, White Polyester, Black Polyester, Black PTFE, and ENT

Corrosion-Resistant Coatings[4]: White Polyester, Black Polyester, and Black PTFE in all temperature ratings. ENT in all tempurature ratings except 135 °F (57 °C). Wax-Coated Brass and Wax over Polyester[5] for sprinklers with the following temperature ratings:

155 °F (68 °C) Lt. Brown Wax 175 °F (79 °C) Brown Wax 200 °F (93 °C) Brown Wax 286 °F (141 °C) Dk. Brown Wax[5]

Footnotes

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

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

[3] Sprinklers of Ultra-High temperature rating are intended for use inside ovens, dryers, or similar enclosures with normal operating temperatures above 300 °F (149 °C). Where the ambient temperature around the Ultra-High temperature rated sprinkler is significantly reduced below 300 °F (149 °C), response time may be severely retarded.

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

[5] Wax melting point is 286 °F (141 °C) temperature rated sprinklers.

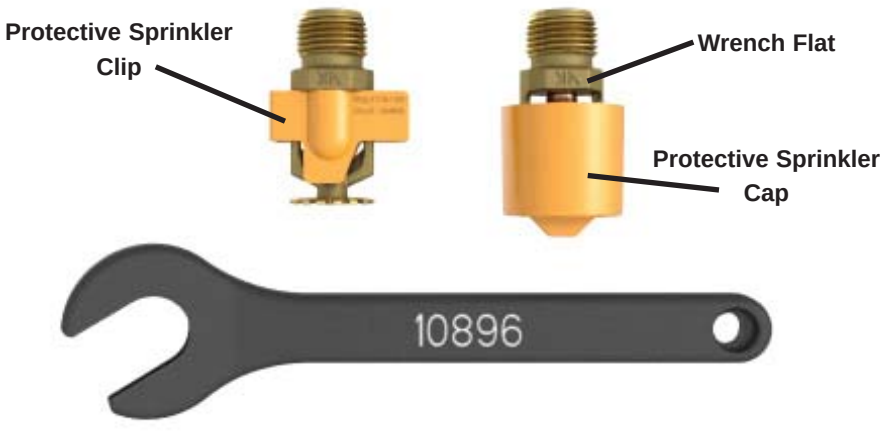


Figure 1: Standard Sprinkler Wrench 10896W/B

MICROMATIC® STANDARD RESPONSE PENDENT SPRINKLER VK202 (K8.0)

TECHNICAL DATA

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
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Approval Chart 1 (UL)

Micromatic® Standard Response Pendent Sprinklers
Maximum 175 PSI (12 bar) WWP

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

Sprinkler Base Part Number[1]	SIN	Thread Size		Nominal K-Factor		Overall Length		Listings and Approvals[3] (Refer also to UL Design Criteria.)				
		NPT	BSP	U.S.	metric[2]	Inches	mm	cULus[4]	VdS	LPCB	CE[8]	[10]
Standard Orifice												
18269[9]	VK202	1/2”	15 mm	8.0	115.2	2-1/4”	57	A1, B4, B1Y, C5, D3, E6, G6Z	A2	--	--	--
18264	VK202	3/4”	20 mm	8.0	115.2	2-1/4”	57	A1, B4, B1Y, C5, D3, E6, G6Z	A2	--	F3, G2Y	--
18267	VK202	--	20 mm	8.0	115.2	2-1/4”	57	A1, B4, B1Y, C5, D3, E6, G6Z	A2	--	F3, G2Y	--
NOTICE - Product Below - Limited Availability (Contact Local Viking Office)												
10223[9]	VK202	1/2”	15 mm	8.0	115.2	2-3/8”	60	A1, B4, B1Y, C5, D3, E6, G6Z	A2	--	--	--
10142	VK202	3/4”	20 mm	8.0	115.2	2-5/16”	59	A1, B4, B1Y, C5, D3, E6, G6Z	A2	A2, B2X	F3, G2X	F3
10170	VK202	--	20 mm	8.0	115.2	2-3/8”	60	A1, B4, B1Y, C5, D3, E6, G6Z	A2	A2, B2X	F3, G2X	F3

Approved Temperature Ratings

A - 135 °F (57 °C), 155 °F (68 °C), 175 °F (79 °C), 200 °F (93 °C), 286 °F (141 °C), and 360 °F (182 °C)

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

C - 286 °F (141 °C)

D - 500 °F (260 °C)[7]

E - 155 °F (68 °C), 175 °F (79 °C), 200 °F (93 °C), 286 °F (141 °C), 360 °F (182 °C), and 500 °F (260 °C)[7]

F - 155 °F (68 °C), 175 °F (79 °C), 200 °F (93 °C), 286 °F (141 °C), and 360 °F (182 °C)

G - 155 °F (68 °C), 175 °F (79 °C), and 200 °F (93 °C)

Approved Finishes

1 - Brass, Chrome, White Polyester[5,6], Black Polyester[5,6], and Black PTFE[5]

2 - Brass, Chrome, White Polyester[6], and Black Polyester[6]

3 - Brass and Chrome

4 - Wax-Coated Brass and Wax Over Polyester[5]

5 - High Temperature 200 °F (93 °C) Wax Coating (corrosion resistant); maximum ambient temperature allowed at ceiling = 150 °F (65 °C)

6 - ENT[5]

Approved Escutcheons

X - Recessed with the Viking Micromatic® Model E-1, E-2, or E-3 Recessed Escutcheon

Y - Standard surface-mounted escutcheon or the Viking Microfast® Model F-1 Adjustable Escutcheon or recessed with the Viking Micromatic® Model E-1, E-2, or E-3 Recessed Escutcheon

Z - Standard surface-mounted escutcheon or re- cessed with the Viking Micromatic® Model E-1

Footnotes

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

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

[3] This table shows the listings and approvals available at the time of printing. Check with the manufacturer for any additional approvals.

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

[5] cULus Listed as corrosion resistant.

[6] Other colors are available on request with the same Listings and Approvals as the standard colors.

[7] Sprinklers of Ultra-High temperature rating are intended for use inside ovens, dryers, or similar enclosures with normal operating temperatures above 300 °F (149 °C). Where the ambient temperature around the Ultra-High temperature rated sprinkler is significantly reduced below 300 °F (149 °C), the response time of the Ultra-High temperature rated sprinkler may be severely retarded.

[8] CE Certified, Standard EN 12259-1, EC-certificate of conformity 0832-CPD-0021 and 0832-CPD-2003.

[9] The 1/2” NPT Large Orifice Sprinkler is listed and approved for retrofit only when installed in accordance with NFPA 13.

[10] MED Certified, Standard EN 12259-1, EC-certificate of conformity 0832-MED-1003 and 0832-MED-1008.

DESIGN CRITERIA - UL

(Also refer to Approval Chart 1.)

cULus Listing Requirements:

The Viking Micromatic® Standard Response Pendent Sprinkler VK202 is cULus Listed as indicated in Approval Chart 1 for installation in accordance with the latest edition of NFPA 13 for standard spray sprinklers.

- Designed for use in Light, Ordinary, and Extra Hazard occupancies.
- The sprinkler installation rules contained in NFPA 13 for standard spray pendent sprinklers must be followed.

IMPORTANT: Always refer to Bulletin Form No. F_091699 - Care and Handling of Sprinklers. Also refer to page SR1-3 for general care, installation, and maintenance information. Viking sprinklers are to be installed in accordance with the latest edition of Viking technical data, the appropriate standards of NFPA, LPCB, APSAD, VdS or other similar organizations, and also with the provisions of governmental codes, ordinances, and standards, whenever applicable.

VIKING®

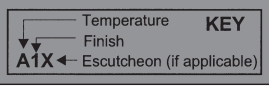
TECHNICAL DATA

MICROMATIC® STANDARD RESPONSE PENDENT SPRINKLER VK202 (K8.0)

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

Approval Chart 2 (FM)

Micromatic® Standard Response Pendent Sprinklers
Maximum 175 PSI (12 bar) WWP



Sprinkler Base Part Number[1]	SIN	Thread Size		Nominal K-Factor		Overall Length		FM Approvals[3] (Refer also to Design Criteria below.)
		NPT	BSP	U.S.	metric[2]	Inches	mm	
Standard Orifice								
18269[7]	VK202	1/2”	15 mm	8.0	115.2	2-1/4”	57	A1, B2, C1, D3, B1Y, E3Z
18264	VK202	3/4”	20 mm	8.0	115.2	2-1/4”	57	A1, B2, C1, D3, B1Y, E3Z
18267	VK202	--	20 mm	8.0	115.2	2-1/4”	57	A1, B2, C1, D3, B1Y, E3Z
NOTICE - Product Below - Limited Availability (Contact Local Viking Office)								
10223[7]	VK202	1/2”	15 mm	8.0	115.2	2-3/8”	60	A1, B2, C1, D3, B1X, E3Z
10142	VK202	3/4”	20 mm	8.0	115.2	2-5/16”	59	A1, B2, C1, D3, B1X, E3Z
10170	VK202	--	20 mm	8.0	115.2	2-3/8”	60	A1, B2, C1, D3, B1X, E3Z

Approved Temperature Ratings

A-135°F(57°C),155°F(68°C),175°F(79°C),200°F(93°C), 286 °F (141 °C), and 360 °F (182 °C)

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

C - 500 °F (260 °C)[5]

D - 155 °F (68 °C), 175 °F (79 °C), 200 °F (93 °C), 286 °F (141 °C), 360 °F (182 °C), and 500 °F (260 °C)[5]

E - 155 °F (68 °C), 175 °F (79 °C), and 200 °F (93 °C)

Approved Finishes

1 - Brass, Chrome, White Polyester[4], and Black Polyester[4]

2 - Wax-Coated Brass (corrosion resistant)

3- ENT[6]

Approved Escutcheons

X - Recessed with the Viking Micromatic® Model E-1, E-2, or E-3 Recessed Escutcheon

Y - Standard surface-mounted escutcheon or the Viking Microfast® Model F-1 Adjustable Escutcheon or recessed with the Viking Micromatic® Model E-1, E-2, or E-3 Recessed Escutcheon

Z - Standard surface-mounted escutcheon or re- cessed with the Viking Micromatic® Model E-1

Footnotes

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

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

[3] This table shows the listings and approvals available at the time of printing. Check with the manufacturer for any additional approvals.

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

[5] Sprinklers of Ultra-High temperature rating are intended for use inside ovens, dryers, or similar enclosures with normal operating temperatures above 300 °F (149 °C). Where the ambient temperature around the Ultra-High temperature rated sprinkler is significantly reduced below 300 °F (149 °C), the response time of the Ultra-High temperature rated sprinkler may be severely retarded.

[6] FM approved as corrosion resistant.

[7] The 1/2” NPT Large Orifice Sprinkler is listed and approved for retrofit only when installed in accordance with NFPA 13.

DESIGN CRITERIA - FM

(Also refer to Approval Chart 2.)

FM Approval Requirements:

The Viking Micromatic® Standard Response Pendent Sprinkler VK202 is is FM Approved as standard response **Non-Storage** pendent sprinkler as indicated in the FM Approval Guide. For specific application and installation requirements, reference the latest applicable FM Loss Prevention Data Sheets (including Data Sheet 2-0). FM Global Loss Prevention Data Sheets contain guidelines relating to, but not limited to: minimum water supply requirements, hydraulic design, ceiling slope and obstructions, minimum and maximum allowable spacing, and deflector distance below the ceiling.

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

IMPORTANT: Always refer to Bulletin Form No. F_091699 - Care and Handling of Sprinklers. Also refer to page SR1-3 for general care, installation, and maintenance information. Viking sprinklers are to be installed in accordance with the latest edition of Viking technical data, the appropriate standards of NFPA, FM Global, LPCB, APSAD, VdS or other similar organizations, and also with the provisions of governmental codes, ordinances, and standards, whenever applicable.

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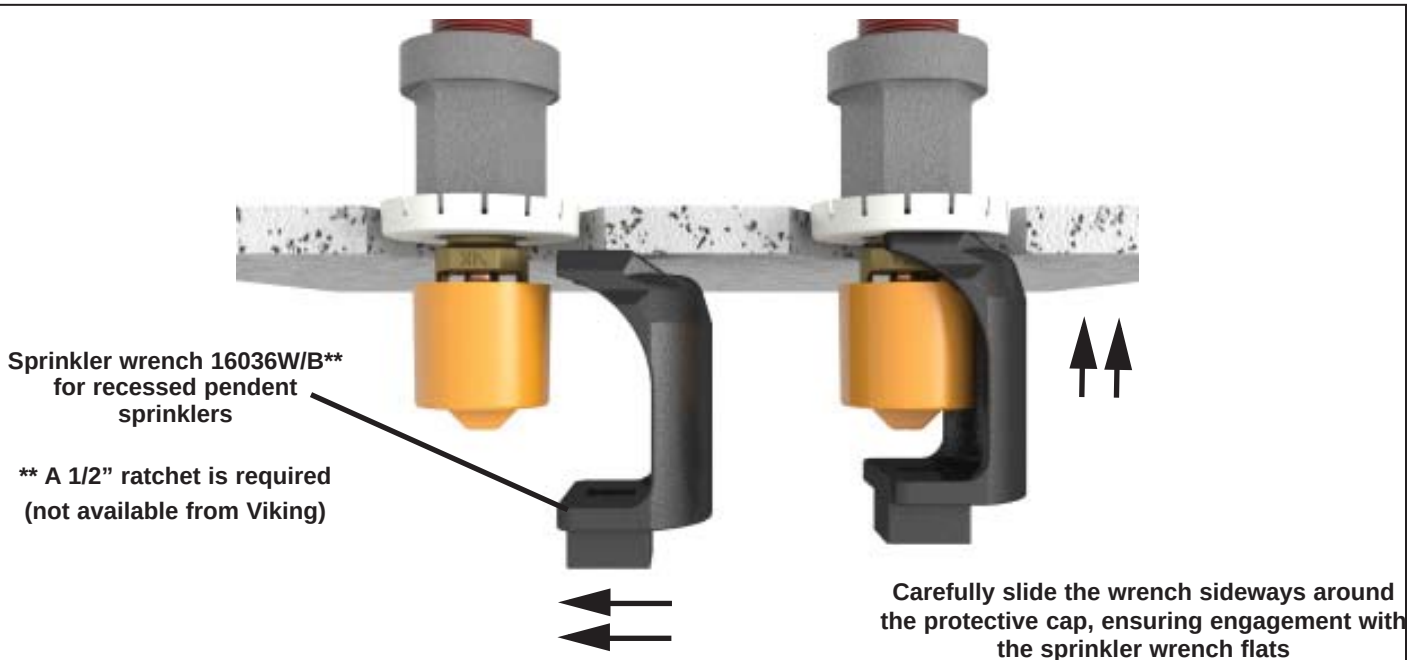

Figure 2: Wrench 16036W/B for Recessed Pendent Sprinklers

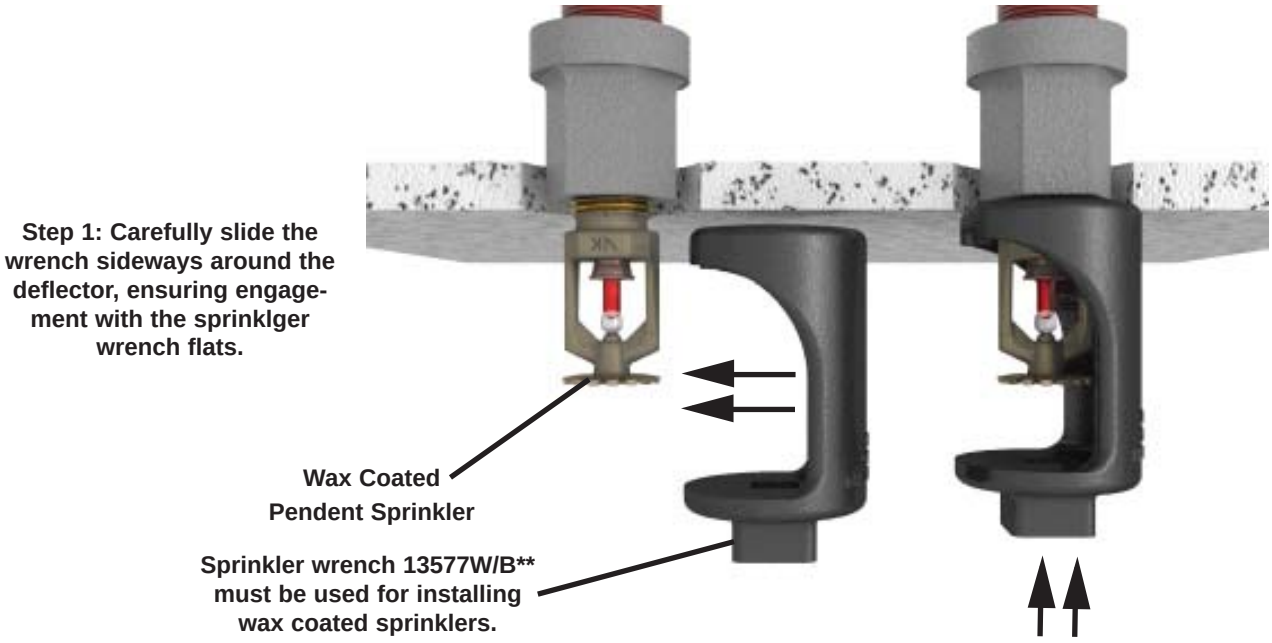

Figure 2: Wrench 13577W/B for Wax Coated Sprinklers

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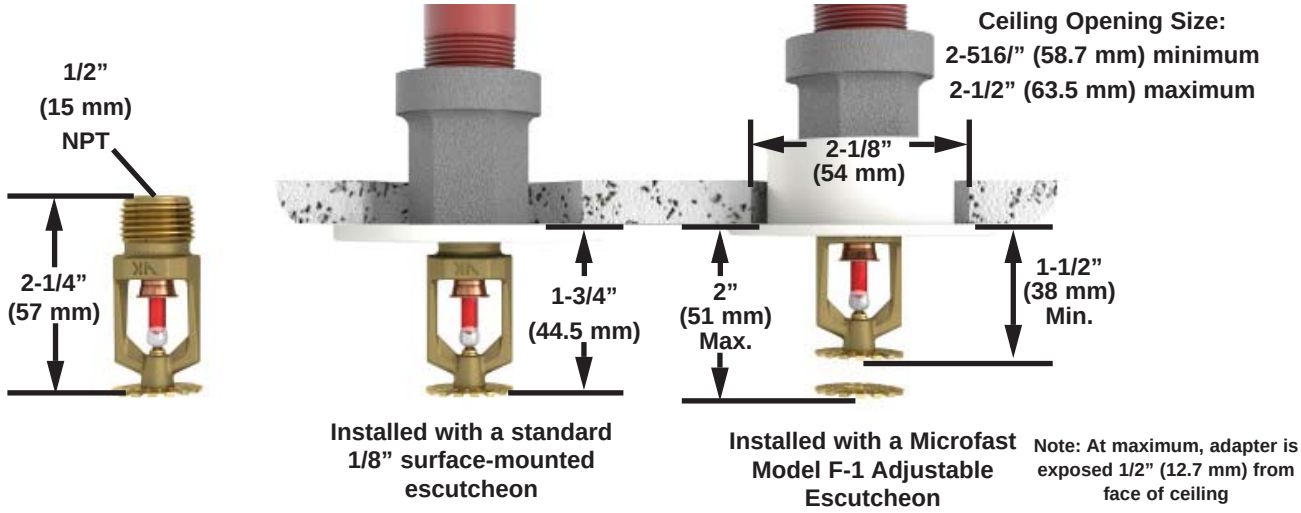

Figure 4: Sprinkler Dimensions with a Standard Escutcheon and the Model F-1 Adjustable Escutcheon

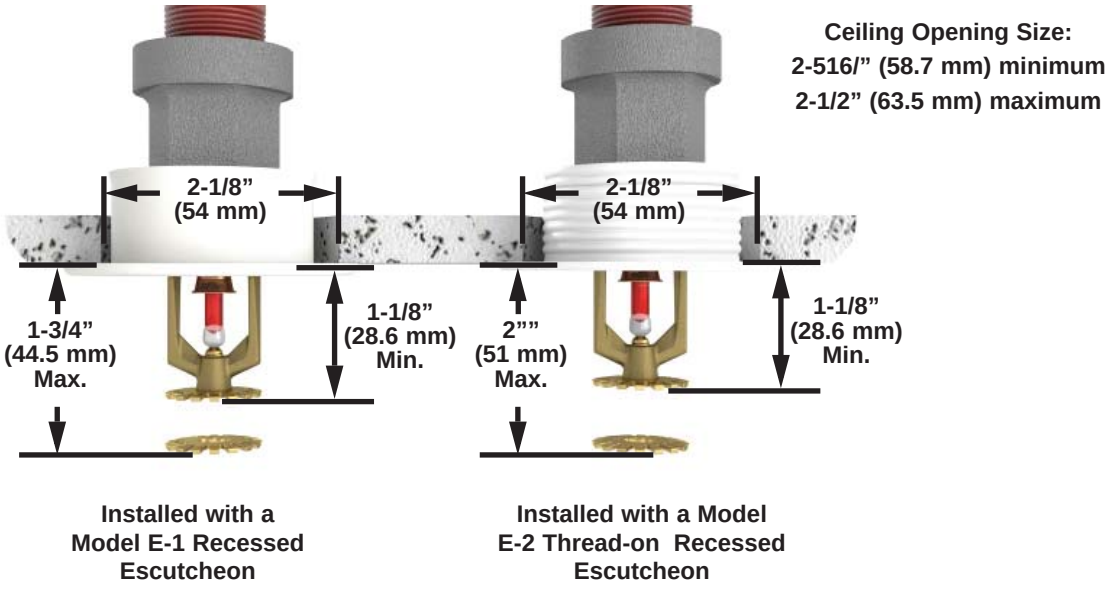

Figure 5: Sprinkler Dimensions with the Model E-1 and E-2 Recessed Escutcheons

Honeywell

TC808B1041(CDN), TC808B1058(CDN), TC808B1066(CDN)

Intelligent Thermal (Heat) Detectors with FlashScan®

General

Honeywell TC808B(CDN) Series intelligent plug-in thermal detectors with integral communication has features that surpass conventional detectors. Point ID capability allows each detector's address to be set with rotary, decimal address switches, providing exact detector locations. TC808B(CDN) Series thermal detectors use an innovative thermistor sensing circuit to produce 135°F/57°C fixed-temperature (TC808B1041/CDN) and rate-of-rise thermal detection (TC808B1058/CDN) in a low-profile package. TC808B1066(CDN) provides fixed high-temperature detection at 190°F/88°C. These thermal detectors provide effective, intelligent property protection in a variety of applications. TC808(CDN) Series detectors are compatible with Honeywell XLS series Fire Alarm Control Panels (FACPs) in CLIP or FlashScan® mode

FlashScan® (U.S. Patent 5,539,389) is a communication protocol that greatly enhances the speed of communication between analog intelligent devices. Intelligent devices communicate in a grouped fashion. If one of the devices within the group has new information, the panel's CPU stops the group poll and concentrates on single points. The net effect is response speed greater than five times that of earlier designs.

Features

- Sleek, low-profile, stylish design.
- State-of-the-art thermistor technology for fast response.
- Rate-of-rise model (TC808B1058/CDN), 15°F (8.3°C) per minute.
- Factory preset fixed temperature at 135°F (57°C); high-temperature model fixed at 190°F (88°C).
- Addressable by device.
- Compatible with FlashScan® and CLIP protocol systems.
- Rotary, decimal addressing (1-99 on CLIP systems, 1-159 on FlashScan systems).
- Two-wire SLC connection.
- Visible LEDs "blink" every time the unit is addressed.
- 360°-field viewing angle of the visual alarm indicators (two bi-color LEDs). LEDs blink green in Normal condition and turn on steady red in Alarm.
- Integral communications and built-in device-type identification.
- Remote test feature from the panel.
- Built-in functional test switch activated by external magnet.
- Walk test with address display (an address of 121 will blink the detector LED 12-(pause)-1).
- Low standby current.
- Backward-compatible.
- Built-in tamper-resistant feature.
- Designed for direct-surface or electrical-box mounting.
- Sealed against back pressure.
- Plugs into separate base for ease of installation and maintenance. Separate base allows interchange of photoelectric, ionization and thermal sensors.

B210-2251.jpg

TC808B1041 in B210LP(A) Base

- SEMS screws for wiring of the separate base.
- Constructed of off-white fire-resistant plastic, designed to commercial standards, and offers an attractive appearance.
- 94-5V plastic flammability rating.
- Remote LED output connection to optional RA100Z(A) remote LED annunciator.
- Optional sounder, relay, and isolator bases.
- Optional flanced surface mounting kit.

Specifications

Size: 2.1" (5.3 cm) high; base determines diameter.

- **B210LP(A):** 6.1" (15.5 cm) diameter.
- **B501(A):** 4.1" (10.4 cm) diameter.
- **B200S(A):** 6.875" (17.46 cm) diameter.
- **B200SR(A):** 6.875" (17.46 cm) diameter.
- **B224RB(A):** 6.2" (15.748 cm) diameter.
- **B224BI(A):** 6.2" (15.748 cm) diameter.

Shipping weight: 4.8 oz. (137 g).

Operating temperature range: TC808B1041(CDN), TC808B1058(CDN), TC808B1066(CDN), TC808B1058(CDN): –20°C to 38°C (–4°F to 100°F); TC808B1066(CDN): –20°C to 66°C (–4°F to 150°F).

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

Relative humidity: 10% – 93% noncondensing.

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

ELECTRICAL SPECIFICATIONS

Voltage range: 15 - 32 volts DC peak.

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

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

Applications

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

Installation

The TC808B Series plug-in intelligent thermal detectors use a separate base to simplify installation, service, and maintenance. Installation instructions are shipped with each detector. A special tool allows maintenance personnel to plug in and remove detectors without using a ladder

Mount base (all base types) on an electrical backbox which is at least 1.5" (3.81 cm) deep. For a chart of compatible junction boxes, see *85-3043*.

NOTE: 1) *Because of the inherent supervision provided by the SLC loop, end-of-line resistors are not required. Wiring "T-taps" or branches are permitted for Style 4 (Class "B") wiring.* ***2)*** *When using relay or sounder bases, consult the TC811A1006(CDN) installation sheet I56-1385 for device limitations between isolator modules and isolator bases.*

Agency Listings and Approvals

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

- **UL Listed:** S1196.
- **ULC Listed:** S6972.
- **FM Approved.**
- **CSFM:** 7272-1130:0206 [TC808B1041(CDN) and TC808B1066(CDN) only].

Product Line Information

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

TC808B1041: Intelligent thermal detector fixed 135°F. Must be mounted to one of the bases listed below.

TC808B1041CDN: Same as TC808B1041 but with ULC Listing.

TC808B1058: Intelligent thermal detector with rate-of-rise feature.

TC808B1058CDN: Same as TC808B1058 but with ULC Listing.

TC808B1066: Intelligent high-temperature 194°F thermal detector.

TC808B1066CDN: Same as TC808B1066 but with ULC Listing.

INTELLIGENT BASES

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

NOTE: *For details about intelligent bases and their mounting, see 85-3043.*

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

B210LPBP: Bulk pack of B210LP; package contains 10.

B501(A): Standard European flangeless mounting base.

B501BP: Bulk pack of B501; package contains 10.

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

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

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

B224BI(A): Intelligent isolator base. Isolates SLC from loop shorts. Maximum: 25 devices between isolator bases; see Note 2 under Installation. Replaces 14507371-005(CDN).

ACCESSORIES

F110: Retrofit flange to convert B210LP(A) to match the 14507371-001(CDN) profile, or to convert older high-profile bases to low-profile.

F110BP: Bulk pack of F110; package contains 15.

F210: Replacement flange for B210LP(A) base.

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

SMB600: Surface mounting kit, flanged.

M02-04-00: Test magnet.

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

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

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

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

This document is not intended to be used for installation purposes. We try to keep our product information up-to-date and accurate. We cannot cover all specific applications or anticipate all requirements. All specifications are subject to change without notice.
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ISO 9001 CERTIFIED ENGINEERING & MANUFACTURING QUALITY SYSTEMS

74-3354-3

Audio Evacuation
Wall Speakers and Strobes
Genesis Series

The Genesis line of speakers and strobes are audible-visible emergency signaling devices. Protruding no more than one inch from the wall, Genesis speakers and speaker-strobes feature textured housings in white or red. Genesis strobes are designed to channel and condition light to produce a highly controllable distribution pattern.

Speaker-strobes feature selectable candela output with a switch located on the bottom of the device. The candela setting is visible even after the device is installed.

All Genesis speakers include a DC blocking capacitor to allow electrical supervision of the audio distribution circuit. The speaker has a sealed back construction for extra durability and improved audibility.

The strobes are designed to flash at the same rate (synchronize) when used with a compatible sychronization source, such as the EG1M-RM synchronization module, E-FSC and E-FSA fire panels, and EBPS series booster supplies.

Features and Specifications

- Xenon light source
- Clear lens
- White or red housing
- Low profile design
- Field selectable candela output via switch
- 1/4, 1/2, 1, and 2 watt selections via switch
- Up to 99dB @ 1m/89dB @ 10ft. output
- DC blocking capacitor for audio circuit supervision
- Fits all standard 4" square electrical boxes – no extension ring or trim plate required
- Operating temperature range: 32ºF to 120ºF (0ºC to 49ºC)

Ordering Information

Description	Cat. No.	Operating Voltage Strobe[1]	Operating Voltage Speaker	Current	Candela Rating	dB at 1m/10ft.[3]	Marking	Color
Speaker Only	**EG4-S2**	24V	25V RMS	—	—	90-99/80-89	None	White
	EG4R-S2	24V	25V RMS	—	—	90-99/80-89	None	Red
	EG4F-S2	24V	25V RMS	—	—	90-99/80-89	FIRE	White
	EG4RF-S2	24V	25V RMS	—	—	90-99/80-89	FIRE	Red
	EG4-S7	24V	70V RMS	—	—	90-99/80-89	None	White
	EG4R-S7	24V	70V RMS	—	—	90-99/80-89	None	Red
	EG4F-S7	24V	70V RMS	—	—	90-99/80-89	FIRE	White
	EG4RF-S7	24V	70V RMS	—	—	90-99/80-89	FIRE	Red
Speaker and Strobes	**EG4-S2VM**	24V	25V RMS	0.096 A - 0.294 A DC; 0.120 A - 0.375 A fwr	Selectable: 15, 30, 75, 110	90-99/80-89	None	White
	EG4R-S2VM	24V	25V RMS	0.096 A - 0.294 A DC; 0.120 A - 0.375 A fwr	Selectable: 15, 30, 75, 110	90-99/80-89	None	Red
	EG4F-S2VM	24V	25V RMS	0.096 A - 0.294 A DC; 0.120 A - 0.375 A fwr	Selectable: 15, 30, 75, 110	90-99/80-89	FIRE	White
	EG4RF-S2VM	24V	25V RMS	0.096 A - 0.294 A DC; 0.120 A - 0.375 A fwr	Selectable: 15, 30, 75, 110	90-99/80-89	FIRE	Red
	EG4-S7VM	24V	70V RMS	0.096 A - 0.294 A DC; 0.120 A - 0.375 A fwr	Selectable: 15, 30, 75, 110	90-99/80-89	None	White

[1]Regulated 16-33V DC/fwr
[2]Current values are UL, RMS ratings.
[3]10ft. dB measurement per UL 464.

DC | 120°F 32°F OP TEMP | 80-89 dB | XENON

FM PENDING

Patents pending.

Audio Evacuation
Wall Speakers and Strobes
Genesis Series

Ordering Information (Continued)

Description	Cat. No.	Operating Voltage		Current[2]	Candela Rating	dB at 1m/10ft.[3]	Marking	Color
		Strobe[1]	Speaker					
Speaker and Strobe	**EG4R-S7VM**	24V	70V RMS	0.096 A - 0.294 A DC; 0.120 A - 0.375 A fwr	Selectable: 15, 30, 75, 110	90-99/80-89	None	Red
	EG4F-S7VM	24V	70V RMS	0.096 A - 0.294 A DC; 0.120 A - 0.375 A fwr	Selectable: 15, 30, 75, 110	90-99/80-89	FIRE	White
	EG4RF-S7VM	24V	70V RMS	0.096 A - 0.294 A DC; 0.120 A - 0.375 A fwr	Selectable: 15, 30, 75, 110	90-99/80-89	FIRE	Red
	EG4F-S7V1575	24V	70V RMS	0.096 A - 0.294 A DC; 0.120 A - 0.375 A fwr	15/75	90-99/80-89	FIRE	White
	EG4RF-S7V1575	24V	70V RMS	0.096 A - 0.294 A DC; 0.120 A - 0.375 A fwr	15/75	90-99/80-89	FIRE	Red

[1]Regulated 16-33V DC/fwr
[2]Current values are UL, RMS ratings.
[3]10ft. dB measurement per UL 464.

Accessories

Description	Cat. No.
Surface mount box, white	**EG4B**
Surface mount box, red	**EG4RB**
Synchronization Module	**EG1M-RM**

Weights and Dimensions

Cat. No.	Approx. Shipping Weight (lb.)
EG4-S2	1.5
EG4R-S2	1.5
EG4F-S2	1.5
EG4RF-S2	1.5
EG4-S2VM	1.5
EG4R-S2VM	1.5
EG4F-S2VM	1.5
EG4RF-S2VM	1.5
EG4-S7	1.5
EG4R-S7	1.5
EG4F-S7	1.5
EG4RF-S7	1.5
EG4-S7VM	1.5
EG4R-S7VM	1.5
EG4F-S7VM	1.5
EG4RF-S7VM	1.5
EG4F-S7V1575	1.5
EG4RF-S7V1575	1.5
EG4B	0.7
EG4RB	0.7

Genesis Speakers and Strobes

Genesis EG4 Series

PENDING

Patents pending

Overview

The Genesis line of life safety signals are the smallest, most compact audible-visible emergency signaling devices in the world. Protruding no more than one inch from the wall, Genesis speakers and speaker-strobes blend with any decor.

Life safety appliances feature textured housings in architecturally neutral white or traditional life safety red.

Thanks to patented breakthrough technology, Genesis strobes do not require bulky specular reflectors. Instead, an exclusive design channels and conditions light to produce a highly controllable distribution pattern.

Speaker-strobes feature selectable candela output with a conveniently-located switch on the bottom of the device. The candela setting remains clearly visible even after final installation.

All Genesis speakers include a DC blocking capacitor to allow electrical supervision of the audio distribution circuit. The speaker with its sealed back construction provides extra durability and improved audibility.

Standard Features

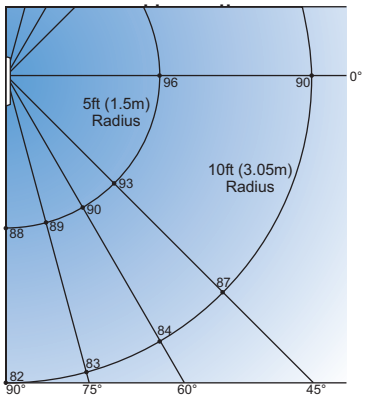
- **Unique low-profile design**
  - The most compact UL/ULC listed speaker-strobe available
  - Ultra-slim, protrudes a mere one inch from the wall
  - Attractive appearance, no visible mounting screws
- **Field configurable – no need to remove the device!**
  - ¼, ½, 1, or 2 watt operation and selectable candela output with convenient switches that remain visible even after the unit is installed
- **Unparalleled performance**
  - loud 90 dBA output ensures clear, crisp audio
  - Exclusive FullLight strobe technology produces the industry's most even light distribution
  - Precision timing electronics meet tough new synchronizing standards for strobes when used with compatibile modules
  - Optional field-configurable temporal strobe output
  - 25 Vrms and 70 Vrms models available, all supplied with a DC blocking capacitor for audio circuit supervision
- **Easy to install**
  - Fits all standard 4" square electrical boxes with plenty of room behind the signal for extra wire – no extension ring or trim plate needed
  - #18 - #12 AWG terminals – ideal for long runs or using existing wiring

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 6dB 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 1W to 2W) will increase the sound pressure level by 3dBA.

Typical Sound Output Distribution dBA Measured in anechoic chamber



Genesis Series Cone Speaker/strobe

Strobe Application

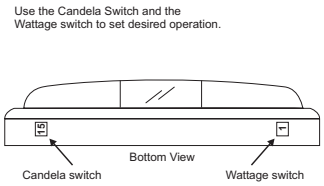
Genesis clear-lensed strobes are UL 1971-listed for use indoors as wall-mounted public-mode notification appliances for the hearing impaired. Prevailing codes require strobes to be used where ambient noise conditions exceed specified levels, where occupants use hearing protection, and in areas of public accommodation.

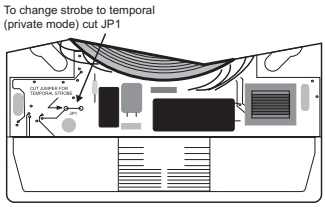
All Genesis strobes meet UL synchronization requirements (within 10 milliseconds over a two-hour period) when used with a synchronization source. Synchronization is important in order to avoid epileptic sensitivity.

Field Configuration

Genesis speakers may be set for ¼, ½, 1, or 2 watt operation. The wattage setting is visible through a small window on the bottom of the device and is changed by simply sliding the switch until the desired setting appears in the window. The speaker does not have to be removed to change the wattage.

Genesis speaker-strobes feature selectable candela output. The output setting is visible through a small window on the bottom of the device and is changed by simply sliding the switch until the desired setting appears in the window. The speaker-strobe does not have to be removed to change the output.



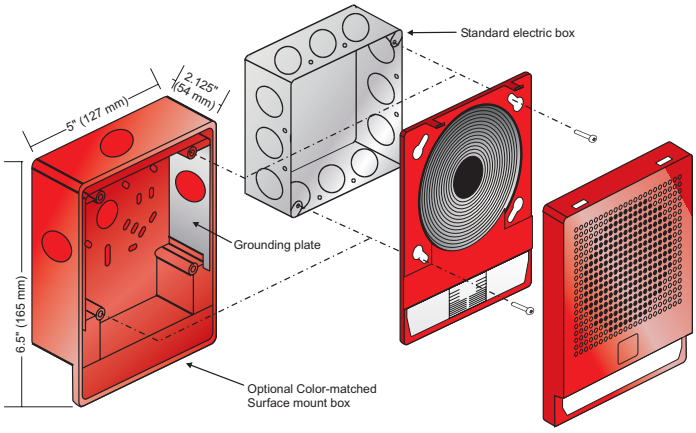


Genesis speaker-strobes may also be configured for temporal flash. This battery-saving feature is intended for private mode signaling only. To set the device for temporal flash, snip the circuit board as shown in the Jumper Locations diagram above.

Installation and Mounting

All models are intended for indoor wall mounted applications only. Speakers and speaker-strobes are flush mounted to a North-American 4" square electrical box, 2 1/8" (54 mm) deep or a European 100 mm square box. Signals may be surface mounted to a Genesis surface-mount box (see ordering information for details).

Two tabs at the top of the signal unlock the cover to facilitate mounting. The shallow depth of Genesis devices leaves room behind the signal for extra wiring. Once installed with the cover in place, no mounting screws are visible.

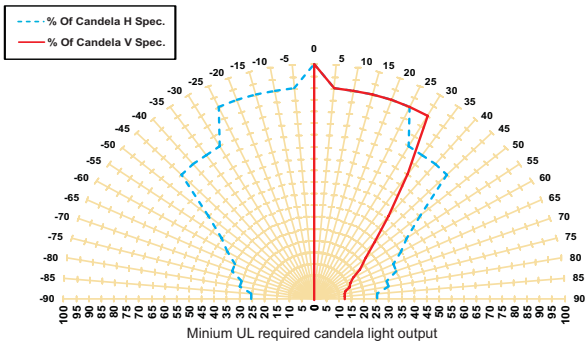


Edwards recommends that these speaker-strobes always be installed in accordance with the latest recognized edition of national and local codes. Refer to installation sheet for mounting height information.

WARNING: These devices will not operate without electrical power. As fires frequently cause power interruptions, we suggest you discuss further safeguards with your local fire protection specialist.

Light output

Per cent of UL rating versus angle



Minium UL required candela light output

UL name plate maximum operating current (RMS-mA)

Cd rating	15	30	75	110
16 Vdc	96	130	239	294
16 Vfwr	120	169	329	375

Typical current, milliamps - average (RMS)

Cd rating	15	30	75	110
20 Vdc	65 (78)	93 (101)	182 (188)	238 (245)
24 Vdc	55 (65)	78 (86)	153 (159)	196 (203)
31 Vdc	45 (53)	63 (69)	120 (124)	151 (157)
20 Vfwr	56 (106)	79 (147)	147 (264)	197 (342)
24 Vfwr	50 (95)	68 (130)	121 (225)	155 (283)
27 Vfwr	44 (84)	60 (115)	107 (200)	137 (251)

Light output switch settings for UL 1971 listed models are selectable by numeric candela value.

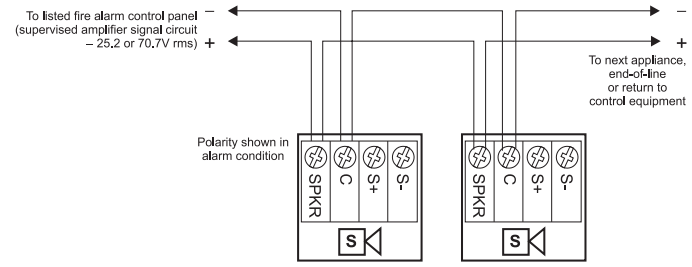
Lens Color	Rating	Switch Position A	Switch Position B	Switch Position C	Switch Position D
Clear	UL 1971	110 cd	75 cd	30 cd	15 cd

** Equivalent Rating*

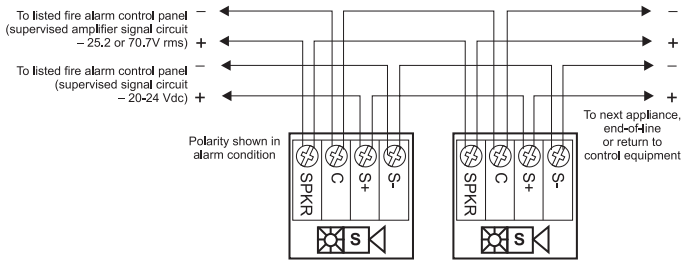
Wiring

Field wiring is connected to Genesis signals with terminals that accommodate #18 to #12 AWG (0.75 mm² to 2.5 mm²) wiring.

Speaker-only Wiriing



Speaker-Strobe Wiring



Specifications

Genesis Speakers and Speaker-Strobes	
Housing	Red or white textured UV stabilized, color impregnated engineered plastic.
Dimensions	Height: 6.5” (165 mm). Width: 5” (127 mm). Depth to wall: 1” (25 mm).
Mounting (indoor wall mount only)	Flush: North-American 4” square box, 2 1/8” (54 mm) deep. Surface: model EG4B (white) or EG4RB (red) surface mount box.
Wire Connections	Screw terminals: separate polarized inputs for speaker and strobe, #18 to #12 AWG (0.75 mm² to 2.5 mm²) wire size
Operating environment	32-120° F (0-49° C) ambient temperature; 0-93% relative humidity.
Agency Listings	UL 1971, UL 1638, UL 1480, ULC S526, ULC S541, CSFM, MEA (FM pending) (All models comply with ADA Code of Federal Regulation Chapter 28 Part 36 Final Rule.)

Speakers	
Input/Operating Volts	25 VRMS or 70 VRMS. See ordering information.
Speaker Taps/Output*	2 W = 89 dBA; 1 W = 86 dBA; ½ W = 83 dBA; ¼ W = 80 dBA
Speaker Cone	Speaker frequency response: 250 to 5,000 Hz. Optimized for voice intelligibility. 4-inch (102mm) mylar cone, sealed back construction.

Strobes	
Strobe Output Rating	UL 1971, ULC S526: selectable 15 cd, 30 cd, 75 cd, or 110 cd output UL 1971: 15 cd (fixed 15/75 cd models) UL 1638, ULCS526: 75 cd (fixed 15/75 cd models)
Strobe Operating Voltage	16 - 33 Vdc Regulated, 16-33 V Full wave rectified (UL Voltage Designations “Regulated 24” and “24 fwr”)
Strobe Flash Rate	One flash per second.
Strobe Flash Synchronization	All strobes: one flash per second (fps) within 200 milliseconds over 30 minutes on common circuit. All strobes: Synchronization source required to comply with UL 1971 synchronization standard. Temporal setting (private mode only): synchronized to temporal output on the same circuit.
Synchronization Sources	E-NAC, EG1M-RM, EBPS6A, EBPS10A, E-FSA64, E-FSA250, E-FSC 3, 5, & 10 zone.
Strobe Lens Material	Polycarbonate

** Measured in reverberant room using 400-4,000 Hz band limited pink noise per UL 1480.*

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Ordering Information

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.
All speaker-strobes include field-selectable ¼, ½, 1, or 2 watt taps

Model	Housing	Marking	Lens	Strobe	Speaker	Ship Wt.
Life safety Appliances (c/w running man icon screen printed on housing)						
EG4-S2	White	None	Clear	Selectable 15, 30, 75, or 110 cd	25 Volt	1.5 lbs. (0.68 kg)
EG4R-S2	Red	None				
EG4F-S2	White	FIRE				
EG4RF-S2	Red	FIRE				
EG4-S2VM	White	None				
EG4R-S2VM	Red	None				
EG4F-S2VM	White	FIRE				
EG4RF-S2VM	Red	FIRE				
EG4-S7	White	None		Selectable 15, 30, 75, or 110 cd	70 Volt	
EG4R-S7	Red	None				
EG4F-S7	White	FIRE				
EG4RF-S7	Red	FIRE				
EG4-S7VM	White	None				
EG4R-S7VM	Red	None				
EG4F-S7VM	White	FIRE				
EG4RF-S7VM	Red	FIRE				

Accessories

EG4B	Surface mount box, white	0.7 (0.32)
EG4RB	Surface mount box, red	0.7 (0.32)

APPENDIX E

Additional Pertinent NFPA 25 Code Sections for National Fire Alarm and Signaling Code

10.6 Power Supplies.

10.6.1 Scope. The provisions of this section shall apply to power supplies used for protected premises fire alarm systems, supervising station alarm systems, public emergency alarm reporting systems, and emergency communications systems and equipment.
10.6.2 Code Conformance. All power supplies shall be installed in conformity with the requirements of ***NFPA 70***, *National Electrical Code*, for such equipment and with the requirements indicated in this subsection.
10.6.3 Power Supply Sources.

10.6.3.1 Power shall be supplied in compliance with either **10.6.3.2** or **10.6.4**.
10.6.3.2 Unless configured in compliance with **10.6.4**, at least two independent and reliable power supplies shall be provided, one primary and one secondary.
10.6.3.3 Each power supply shall be of adequate capacity for the application.
10.6.3.4 Monitoring the integrity of power supplies shall be in accordance with **10.6.9**.

10.6.4 Uninterruptible Power Supplies (UPS).

10.6.4.1 The UPS device shall be configured in compliance with **NFPA 111**, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*, for a Type O, Class 24, Level 1 system.
10.6.4.2 The UPS device shall comply with the requirements of **10.6.5**.
10.6.4.3 Failure of the UPS shall result in the initiation of a trouble signal in accordance with Section **10.15**.

10.6.5 Primary Power Supply.

10.6.5.1 Branch Circuit. The branch circuit supplying the fire alarm equipment(s) or emergency communication system(s) shall supply no other loads and shall be supplied by one of the following:

(1) Commercial light and power

(2) An engine-driven generator or equivalent in accordance with **10.6.11.2**, where a person specifically trained in its operation is on duty at all times

(3) An engine-driven generator or equivalent arranged for cogeneration with commercial light and power in accordance with **10.6.11.2**, where a person specifically trained in its operation is on duty at all times

10.6.5.2 Circuit Identification and Accessibility.

10.6.5.2.1 The location of the branch circuit disconnecting means shall be permanently identified at the control unit.
10.6.5.2.2 System circuit disconnecting means shall be permanently identified as to its purpose in accordance with the following:

(1) "FIRE ALARM" for fire alarm systems

(2) "EMERGENCY COMMUNICATIONS" for emergency communications systems

(3) "FIRE ALARM/ECS" for combination fire alarm and emergency communications systems

10.6.5.2.3 For fire alarm and/or signaling systems, the circuit disconnecting means shall have a red marking.
10.6.5.2.4 The red marking shall not damage the overcurrent protective devices or obscure the manufacturer's markings.
10.6.5.2.5 The circuit disconnecting means shall be accessible only to authorized personnel.

10.6.5.3 Mechanical Protection. The branch circuit(s) and connections shall be protected against physical damage.
10.6.5.4 Circuit Breaker Lock. Where a circuit breaker is the disconnecting means, a listed breaker locking device shall be installed.
10.6.5.5 Overcurrent Protection. An overcurrent protective device of suitable current-carrying capacity that is capable of interrupting the maximum short-circuit current to which it can be subject shall be provided in each ungrounded conductor.

10.6.6* Continuity of Power Supplies.

10.6.6.1 The secondary power supply shall automatically provide power to the protected premises system within 10 seconds whenever the primary power supply fails to provide the minimum voltage required for proper operation.
10.6.6.2 The secondary power supply shall automatically provide power to the supervising station facility and

equipment within 60 seconds whenever the primary power supply fails to provide the minimum voltage required for proper operation.
10.6.6.3 Required signals shall not be lost, interrupted, or delayed by more than 10 seconds as a result of the primary power failure.

10.6.6.3.1 Storage batteries dedicated to the system or UPS arranged in accordance with the provisions of **NFPA 111**, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*, shall be permitted to supplement the secondary power supply to ensure required operation during the transfer period.
10.6.6.3.2 Where a UPS is employed in **10.6.6.3.1**, a positive means for disconnecting the input and output of the UPS system while maintaining continuity of power supply to the load shall be provided.

10.6.7 Secondary Power Supply.

10.6.7.1 Secondary Power Operation.

10.6.7.1.1 Operation on secondary power shall not affect the required performance of a system or supervising station facility, including alarm, supervisory, and trouble signals and indications.
Exception: While operating on secondary power, audio amplifier monitoring shall be required only when an alarm is present.

10.6.7.2* Capacity.

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

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

(2) The secondary power supply for in-building fire emergency voice/alarm communications service shall be capable of operating the system under quiescent load for a minimum of 24 hours and then shall be capable of operating the system during a fire or other emergency condition for a period of 15 minutes at maximum connected load.

(3) The secondary power supply capacity for supervising station facilities and equipment shall be capable of supporting operations for a minimum of 24 hours.

(4) The secondary power supply for high-power speaker arrays used for wide-area mass notification systems shall be in accordance with **24.4.4.4.2.2**.

(5) The secondary power supply for textual visible appliances shall be in accordance with **24.4.4.4.7.1**.

(6) The secondary power supply capacity for emergency command centers of a wide-area mass notification systems shall be capable of supporting operations for a minimum of 24 hours.

(7) The secondary power supply for in-building mass notification systems shall be capable of operating the system under quiescent load for a minimum of 24 hours and then shall be capable of operating the system during emergency condition for a period of 15 minutes at maximum connected load.

(8) The secondary power supply for two-way radio communications enhancement systems shall be in accordance with **24.5.2.5.5**.

10.6.7.2.2 The secondary power supply capacity required shall include all power supply loads that are not automatically disconnected upon the transfer to secondary power supply.

10.6.7.3* Secondary Power Supply for Protected Premises Fire Alarm Systems and Emergency Communications Systems.

10.6.7.3.1 The secondary power supply shall consist of one of the following:

(1) A storage battery dedicated to the system arranged in accordance with **10.6.10**

(2) An automatic-starting, engine-driven generator serving the branch circuit specified in **10.6.5.1** and arranged in accordance with **10.6.11.3.1**, and storage batteries dedicated to the system with 4 hours of capacity arranged in accordance with **10.6.10**

10.6.7.3.2 Secondary circuits that provide power to the control unit and are not integral to the unit shall be protected against physical damage.

10.6.7.4 Secondary Power Supply for Supervising Station Facilities.

10.6.7.4.1 The secondary power supply shall consist of one of the following:

(1) Storage batteries dedicated to the supervising station equipment arranged in accordance with **10.6.10**

(2) A branch circuit of an automatic-starting, engine-driven generator arranged in accordance with **10.6.11.3.2.1** and **10.6.11.3.2.2**, and storage batteries dedicated to the supervising station equipment with 4 hours of capacity arranged in accordance with **10.6.10**

(3) A branch circuit of multiple engine-driven generators, at least one of which is arranged for automatic starting in accordance with **10.6.11.3.2.1** and **10.6.11.3.2.2**

10.6.7.4.2 Where a secondary power supply for supervising station facilities in accordance with **10.6.7.4.1**(3) is used, the following shall apply:

(1) Each generator shall be capable of supplying the energy required.

(2) Generators that are started manually shall be arranged in accordance with **10.6.11.3.2.3** and **10.6.11.3.2.4**.

(3) When manual-start generators are employed, a person trained in the procedure of starting the generator shall be on duty at all times.

10.6.8 Power Supply for Remotely Located Control Equipment.

10.6.8.1* Additional power supplies, where provided for control units, circuit interfaces, or other equipment essential to system operation, and located remotely from the main control unit, shall be comprised of a primary and secondary power supply that shall meet the same requirements as those of **10.6.1** through **10.6.6** and **10.6.9**.
10.6.8.2 The location of any remotely located power supply shall be identified at the master control unit.
10.6.8.3 The master control unit display shall be permitted to satisfy the requirement of **10.6.8.2**.
10.6.8.4 The location of any remotely located power supply shall be identified on the record drawings.

10.6.9 Monitoring Integrity of Power Supplies.

10.6.9.1 Unless otherwise permitted or required by **10.6.9.1.3** and **10.6.9.1.6**, all primary and secondary power supplies shall be monitored for the presence of voltage at the point of connection to the system.

10.6.9.1.1 Failure of either supply shall result in a trouble signal in accordance with Section **10.15**.
10.6.9.1.2 Where the digital alarm communicator transmitter (DACT) is powered from a protected premises fire alarm system control unit, power failure indication shall be in accordance with **10.6.9.1**.
10.6.9.1.3 Monitoring shall not be required for a power supply for supplementary equipment.
10.6.9.1.4 Monitoring shall not be required for the neutral of a three-, four-, or five-wire alternating current (ac) or direct current (dc) supply source.
10.6.9.1.5 Monitoring shall not be required for the main power supply in a central station, provided that the fault condition is otherwise indicated so as to be obvious to the operator on duty.
10.6.9.1.6 Monitoring shall not be required for the output of an engine-driven generator that is part of the secondary power supply, provided that the generator is tested weekly in accordance with Chapter **14**.

10.6.9.2* Power supply sources and electrical supervision for digital alarm communications systems shall be in accordance with Sections **10.6**, **10.6.9**, **10.19**, and **12.6**.
10.6.9.3* Unless prohibited by the authority having jurisdiction, supervising station alarm systems shall be arranged to delay transmission of primary power failure signals for a period ranging from 60 minutes to 180 minutes.
10.6.9.4 Power supervisory devices shall be arranged so as not to impair the receipt of fire alarm or supervisory signals.

10.6.10* Storage Batteries.

10.6.10.1 Marking.

10.6.10.1.1 Batteries shall be marked with the month and year of manufacture using the month/year format.
10.6.10.1.2 Where the battery is not marked with the month/year by the manufacturer, the installer shall obtain the date-code and mark the battery with the month/year of battery manufacture.

10.6.10.2 Location. Storage batteries shall be located so that the equipment, including overcurrent devices, are not adversely affected by battery gases and shall conform to the requirements of ***NFPA 70***, *National Electrical Code*, Article 480.

10.6.10.2.1 Cells shall be suitably insulated against ground faults.
10.6.10.2.2 Cells shall be suitably insulated against crosses.
10.6.10.2.3 Cells shall be mounted in such a manner so as to be protected from physical damage.
10.6.10.2.4 Racks shall be suitably protected against deterioration.
10.6.10.2.5 If not located in or adjacent to the control unit, the batteries and their charger location shall be permanently identified at the control unit.

10.6.10.3 Battery Charging.

10.6.10.3.1 Adequate facilities shall be provided to automatically maintain the battery fully charged under all conditions of normal operation.
10.6.10.3.2 Adequate facilities shall be provided to recharge batteries within 48 hours after fully charged batteries have been subject to a single discharge cycle as specified in **10.6.7.2**.
10.6.10.3.3 Upon attaining a fully charged condition, the charge rate shall not be so excessive as to result in battery damage.
10.6.10.3.4* Batteries shall be either trickle- or float-charged.
10.6.10.3.5 Supervising stations shall maintain spare parts or units available, which shall be used to restore failed charging capacity prior to the consumption of one-half of the capacity of the batteries for the supervising station equipment.

10.6.10.4 Overcurrent Protection.

10.6.10.4.1 The batteries shall be protected against excessive load current by overcurrent devices.
10.6.10.4.2 The batteries shall be protected from excessive charging current by overcurrent devices or by automatic current-limiting design of the charging source.

10.6.10.5 Metering. The charging equipment shall provide either integral meters or readily accessible terminal facilities for the connection of portable meters by which the battery voltage and charging current can be determined.

10.6.10.6 Monitoring Integrity of Battery Charger.

10.6.10.6.1 Means for monitoring integrity appropriate for the batteries and charger employed shall be provided to detect a battery charger failure.
10.6.10.6.2 Failure of the battery charger shall result in the initiation of a trouble signal in accordance with Section **10.15**.

17.6 Heat-Sensing Fire Detectors.

17.6.1 General.

17.6.1.1* *The heat detection design documentation shall state the required performance objective of the system.*
17.6.1.2 *Designs not in accordance with **17.6.1.3** shall be deemed prescriptive designs and shall be designed in accordance with the prescriptive requirements of this chapter.*
17.6.1.3* *Performance-based designs shall be executed in accordance with Section **17.3**.*
17.6.1.4* *Spot-type heat detectors shall include in their installation instructions, technical data, and listing documentation the operating temperature and response time index (RTI) as determined by the organization listing the device.*

17.6.2 Temperature.

17.6.2.1 Classification. *Heat-sensing fire detectors of the fixed-temperature or rate-compensated, spot type shall be classified as to the temperature of operation in accordance with **Table 17.6.2.1**.*

Table 17.6.2.1 Temperature Classification and Color Code for Heat-Sensing Fire Detectors

Temperature Classification	Temperature Rating Range °F	Temperature Rating Range °C	Maximum Ceiling Temperature °F	Maximum Ceiling Temperature °C	Color Code
Low*	100–134	39–57	80	28	Uncolored
Ordinary	135–174	58–79	115	47	Uncolored
Intermediate	175–249	80–121	155	69	White
High	250–324	122–162	230	111	Blue
Extra high	325–399	163–204	305	152	Red
Very extra high	400–499	205–259	380	194	Green
Ultra high	500–575	260–302	480	249	Orange

*Intended only for installation in controlled ambient areas. Units shall be marked to indicate maximum ambient installation temperature.

17.6.2.2 Marking.

17.6.2.2.1 Color Coding.

17.6.2.2.1.1 *Heat-sensing fire detectors of the fixed-temperature or rate-compensated, spot type shall be marked with a color code in accordance with* ***Table 17.6.2.1****.*
17.6.2.2.1.2 *If the overall color of a heat-sensing fire detector is the same as the color code marking required for that detector, one of the following arrangements, applied in a contrasting color and visible after installation, shall be employed:*

(1) Ring on the surface of the detector

(2) Temperature rating in numerals at least 3/8 in. (9.5 mm) high

17.6.2.2.2 Operating Temperature.

17.6.2.2.2.1 *Heat-sensing fire detectors shall be marked with their listed operating temperature.*
17.6.2.2.2.2 *Heat-sensing fire detectors where the alarm threshold is field adjustable shall be marked with the temperature range.*
17.6.2.2.2.3 *Spot-type heat detectors shall also be marked with their RTI.*

17.6.2.3* Ambient Ceiling Temperature. *Detectors having fixed-temperature or rate-compensated elements shall be selected in accordance with* ***Table 17.6.2.1*** *for the maximum expected ambient ceiling temperature. The temperature rating of the detector shall be at least 20°F (11°C) above the maximum expected temperature at the ceiling.*

17.6.3 Location and Spacing.

17.6.3.1 Smooth Ceiling.

17.6.3.1.1* Spacing. *One of the following requirements shall apply:*

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

(2) All points on the ceiling shall have a detector within a distance equal to or less than 0.7 times the listed spacing (0.7S).

17.6.3.1.2 Irregular Areas. *For irregularly shaped areas, the spacing between detectors shall be permitted to be greater than the listed spacing, provided that the maximum spacing from a detector to the farthest point of a sidewall or corner within its zone of protection is not greater than 0.7 times the listed spacing.*
17.6.3.1.3 Location.

17.6.3.1.3.1 *Unless otherwise modified by* ***17.6.3.2.2****,* ***17.6.3.3.2****, or* ***17.6.3.7****, spot-type heat-sensing fire detectors shall be located on the ceiling not less than 4 in. (100 mm) from the sidewall or on the sidewalls between 4 in. and 12 in. (100 mm and 300 mm) from the ceiling.*

17.6.3.1.3.2 *Unless otherwise modified by* ***17.6.3.2.2***, ***17.6.3.3.2***, *or* ***17.6.3.7***, *line-type heat detectors shall be located on the ceiling or on the sidewalls not more than 20 in. (510 mm) from the ceiling.*

17.6.3.2* Solid Joist Construction.

17.6.3.2.1 Spacing. *The design spacing of heat detectors, where measured at right angles to the solid joists, shall not exceed 50 percent of the listed spacing.*
17.6.3.2.2 Location. *Detectors shall be mounted at the bottom of the joists.*

17.6.3.3* Beam Construction.

17.6.3.3.1 Spacing.

17.6.3.3.1.1 *A ceiling shall be treated as a smooth ceiling if the beams project no more than 4 in. (100 mm) below the ceiling.*
17.6.3.3.1.2 *Where the beams project more than 4 in. (100 mm) below the ceiling, the spacing of spot-type heat detectors at right angles to the direction of beam travel shall be not more than two-thirds of the listed spacing.*
17.6.3.3.1.3 *Where the beams project more than 18 in. (460 mm) below the ceiling and are more than 8 ft (2.4 m) on center, each bay formed by the beams shall be treated as a separate area.*

17.6.3.3.2 Location. *Where beams are less than 12 in. (300 mm) in depth and less than 8 ft (2.4 m) on center, detectors shall be permitted to be installed on the bottom of beams.*

17.6.3.4* Sloping Ceilings (Peaked and Shed).

17.6.3.4.1 Spacing.

17.6.3.4.1.1 Ceiling Slope Less Than 30 Degrees. *For a ceiling slope of less than 30 degrees, all detectors shall be spaced using the height at the peak.*
17.6.3.4.1.2 Ceiling Slopes of 30 Degrees or Greater. *All detectors, other than those located in the peak, shall be spaced using the average slope height or the height of the peak.*
17.6.3.4.1.3 *Spacing shall be measured along a horizontal projection of the ceiling in accordance with the type of ceiling construction.*

17.6.3.4.2 Location.

17.6.3.4.2.1 *A row of detectors shall first be located at or within 36 in. (910 mm) of the peak of the ceiling.*
17.6.3.4.2.2 *Additional detectors shall be located as determined in* ***17.6.3.4.1***.

17.6.3.5 High Ceilings.

17.6.3.5.1* *On ceilings 10 ft to 30 ft (3.0 m to 9.1 m) high, heat detector spacing shall be reduced in accordance with* ***Table 17.6.3.5.1*** *prior to any additional reductions for beams, joists, or slope, where applicable.*

Table 17.6.3.5.1 Heat Detector Spacing Reduction Based on Ceiling Height

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

*Exception: **Table 17.6.3.5.1** shall not apply to the following detectors, which rely on the integration effect:*

*(1) Line-type electrical conductivity detectors (see **3.3.66.11**)*

*(2) Pneumatic rate-of-rise tubing heat detectors (see **3.3.66.15**)*

In these cases, the manufacturer's published instructions shall be followed for appropriate alarm point and spacing.

***17.6.3.5.2* Spacing Minimum.** The minimum spacing of heat detectors shall not be required to be less than 0.4 times the height of the ceiling.*

***17.6.3.6* Integral Heat Sensors on Combination and Multi-Sensor Detectors.** A heat-sensing detector integrally mounted on a smoke detector shall be listed for not less than 50 ft (15.2 m) spacing.*
***17.6.3.7 Other Applications.** Where a detector is used in an application other than open area protection, the manufacturer's published instructions shall be followed.*
***17.6.3.8 Alternative Design Methods.** Annex **B** shall be permitted to be used as one alternative design method for determining detector spacing.*

17.7 Smoke-Sensing Fire Detectors.

17.7.1 General.

17.7.1.1 *The smoke detection design documentation shall state the required performance objective of the system.*
17.7.1.2 *Designs not in accordance with **17.7.1.3** shall be deemed prescriptive designs and shall be designed in accordance with the prescriptive requirements of this chapter.*
17.7.1.3 *Performance-based designs shall be executed in accordance with Section **17.3**.*
17.7.1.4 *The prescriptive requirements in this section shall be applied only where detectors are installed in ordinary indoor locations.*
17.7.1.5 *Where smoke detectors are being installed to control the spread of smoke, they shall be installed in accordance with the requirements of **17.7.5**.*

17.7.1.6 *Smoke detectors shall be installed in all areas where required by other governing laws, codes, or standards or by other parts of this Code.*
17.7.1.7 *The selection and placement of smoke detectors shall take into account both the performance characteristics of the detector and the areas into which the detectors are to be installed to prevent nuisance and unintentional alarms or improper operation after installation.*
17.7.1.8 *Unless specifically designed and listed for the expected conditions, smoke detectors shall not be installed if any of the following ambient conditions exist:*

(1) Temperature below 32°F (0°C)

(2) Temperature above 100°F (38°C)

(3) Relative humidity above 93 percent

(4) Air velocity greater than 300 ft/min (1.5 m/sec)

17.7.1.9 *The location of smoke detectors shall be based on an evaluation of potential ambient sources of smoke, moisture, dust, or fumes, and electrical or mechanical influences, to minimize nuisance alarms.*
17.7.1.10 *The effect of stratification below the ceiling shall be taken into account. The guidelines in Annex **B** shall be permitted to be used.*

17.7.2 Sensitivity.*

17.7.2.1 *Smoke detectors shall be marked with their nominal production sensitivity and tolerance (percent per foot obscuration), as required by the listing.*
17.7.2.2 *Smoke detectors that have provision for field adjustment of sensitivity shall have an adjustment range of not less than 0.6 percent per foot obscuration.*
17.7.2.3 *If the means of adjustment of sensitivity is on the detector, a method shall be provided to restore the detector to its factory calibration.*
17.7.2.4 *Detectors that have provision for program-controlled adjustment of sensitivity shall be permitted to be marked with their programmable sensitivity range only.*

17.7.3 Location and Spacing.

17.7.3.1* General.

17.7.3.1.1 *The location and spacing of smoke detectors shall be based upon the anticipated smoke flows due to the plume and ceiling jet produced by the anticipated fire, as well as any pre-existing ambient airflows that could exist in the protected compartment.*
17.7.3.1.2 *The design shall account for the contribution of the following factors in predicting detector response to the anticipated fires to which the system is intended to respond:*

(1) Ceiling shape and surface

(2) Ceiling height

(3) Configuration of contents in the protected area

(4) Combustion characteristics and probable equivalence ratio of the anticipated fires involving the fuel loads within the protected area

(5) Compartment ventilation

(6) Ambient temperature, pressure, altitude, humidity, and atmosphere

17.7.3.1.3 *If the intent is to protect against a specific hazard, the detector(s) shall be permitted to be installed closer to the hazard in a position where the detector can intercept the smoke.*

17.7.3.2* Spot-Type Smoke Detectors.

17.7.3.2.1* *Spot-type smoke detectors shall be located on the ceiling or, if on a sidewall, between the ceiling and 12 in. (300 mm) down from the ceiling to the top of the detector.*
17.7.3.2.2* *To minimize dust contamination, smoke detectors, where installed under raised floors, shall be mounted only in an orientation for which they have been listed.*
17.7.3.2.3 *On smooth ceilings, spacing for spot-type smoke detectors shall be in accordance with* ***17.7.3.2.3.1*** *through* ***17.7.3.2.3.4****.*

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

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

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

17.7.3.2.3.2 *In all cases, the manufacturer's published instructions shall be followed.*
17.7.3.2.3.3 *Other spacing shall be permitted to be used depending on ceiling height, different conditions, or response requirements.*
17.7.3.2.3.4 *For the detection of flaming fires, the guidelines in Annex* ***B*** *shall be permitted to be used.*

17.7.3.2.4* *For solid joist and beam construction, spacing for spot-type smoke detectors shall be in accordance with* ***17.7.3.2.4.1*** *through* ***17.7.3.2.4.6****.*

17.7.3.2.4.1 *Solid joists shall be considered equivalent to beams for smoke detector spacing guidelines.*
17.7.3.2.4.2 *For level ceilings, the following shall apply:*

(1) For ceilings with beam depths of less than 10 percent of the ceiling height (0.1 H), smooth ceiling spacing shall be permitted. Spot-type smoke detectors shall be permitted to be located on ceilings or on the bottom of beams.

(2) For ceilings with beam depths equal to or greater than 10 percent of the ceiling height (0.1 H), the following shall apply:

(a) Where beam spacing is equal to or greater than 40 percent of the ceiling height (0.4 H), spot-type detectors shall be located on the ceiling in each beam pocket.

(b) Where beam spacing is less than 40 percent of the ceiling height (0.4 H), the following shall be permitted for spot detectors:

i. Smooth ceiling spacing in the direction parallel to the beams and at one-half smooth ceiling spacing in the direction perpendicular to the beams

ii. Location of detectors either on the ceiling or on the bottom of the beams

(3) For beam pockets formed by intersecting beams, including waffle or pan-type ceilings, the following shall apply:*

*(a) For beam depths less than 10 percent of the ceiling height (0.1 H), spacing shall be in accordance with **17.7.3.2.4.2**(1).*

*(b) For beam depths greater than or equal to 10 percent of the ceiling height (0.1 H), spacing shall be in accordance with **17.7.3.2.4.2**(2).*

(4) For corridors 15 ft (4.6 m) in width or less having ceiling beams or solid joists perpendicular to the corridor length, the following shall apply:*

(a) Smooth ceiling spacing shall be permitted.

(b) Location of spot-type smoke detectors on ceilings, sidewalls, or the bottom of beams or solid joists

(5) For rooms of 900 ft² (84 m²) or less, the following shall be permitted:

(a) Use of smooth ceiling spacing

(b) Location of spot-type smoke detectors on ceilings or on the bottom of beams

17.7.3.5 Raised Floors and Suspended Ceilings. *Spaces beneath raised floors and above suspended ceilings shall be treated as separate rooms for smoke detector spacing purposes. Detectors installed beneath raised floors or above suspended ceilings, or both, including raised floors and suspended ceilings used for environmental air, shall not be used in lieu of providing detection within the room.*

17.7.4 Heating, Ventilating, and Air-Conditioning (HVAC).

17.7.4.1* *In spaces served by air-handling systems, detectors shall not be located where airflow prevents operation of the detectors.*
17.7.4.2 *In under-floor spaces and above-ceiling spaces that are used as HVAC plenums, detectors shall be listed for the anticipated environment as required by **17.7.1.8**. Detector spacings and locations shall be selected on the basis of anticipated airflow patterns and fire type.*
17.7.4.3* *Detectors placed in environmental air ducts or plenums shall not be used as a substitute for open area detectors. Where detectors are used for the control of smoke spread, the requirements of **17.7.5** shall apply. Where open area protection is required, **17.7.3** shall apply.*
17.7.4.4 *Detectors placed in environmental air ducts or plenums shall be permitted to be either supervisory or alarm initiating devices.*

17.7.5* Smoke Detectors for Control of Smoke Spread.

17.7.5.1* ***Classifications.*** *Smoke detectors installed and used to prevent smoke spread by initiating control of fans, dampers, doors, and other equipment shall be classified in the following manner:*

(1) Area detectors that are installed in the related smoke compartments

(2) Detectors that are installed in the air duct systems

(3) Video image smoke detection that is installed in related smoke compartments

17.7.5.2* ***Limitations.***

17.7.5.2.1 *Detectors that are installed in the air duct system in accordance with **17.7.5.1**(2) shall not be used as a substitute for open area protection.*
17.7.5.2.2 *Where open area protection is required, **17.7.3** shall apply.*

17.7.5.3* ***Purposes.***

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**.*
***17.7.5.3.2** If smoke detectors are used to initiate selectively the operation of equipment to control smoke spread, the requirements of **17.7.5.4.2.2** shall apply.*
***17.7.5.3.3** If detectors are used to initiate the operation of smoke doors, the requirements of **17.7.5.6** shall apply.*
***17.7.5.3.4** If duct detectors are used to initiate the operation of smoke dampers within ducts, the requirements of **17.7.5.5** shall apply.*

17.7.5.4 Application.

***17.7.5.4.1 Area Smoke Detectors Within Smoke Compartments.** Area smoke detectors within smoke compartments shall be permitted to be used to control the spread of smoke by initiating operation of doors, dampers, and other equipment.*

17.7.5.4.2* Smoke Detection for Air Duct System.

***17.7.5.4.2.1 Supply Air System.** Where the detection of smoke in the supply air system is required by other NFPA standards, a detector(s) listed for the air velocity present and that is located in the supply air duct downstream of both the fan and the filters shall be installed.*
Exception: Additional smoke detectors shall not be required to be installed in ducts where the air duct system passes through other smoke compartments not served by the duct.
***17.7.5.4.2.2* Return Air System.** Unless otherwise modified by **17.7.5.4.2.2(A)** or **17.7.5.4.2.2(B)**, if the detection of smoke in the return air system is required by other NFPA standards, a detector(s) listed for the air velocity present shall be located where the air leaves each smoke compartment, or in the duct system before the air enters the return air system common to more than one smoke compartment.*

***(A)** Additional smoke detectors shall not be required to be installed in ducts where the air duct system passes through other smoke compartments not served by the duct.*
***(B)** Where total coverage smoke detection is installed in accordance with **17.5.3.1** in all areas of the smoke compartment served by the return air system, installation of additional detector(s) listed for the air velocity present where the air leaves each smoke compartment, or in the duct system before the air enters in the return air system shall not be required, provided that their function is accomplished by the design of the total coverage smoke detection system.*

17.7.5.5 Location and Installation of Detectors in Air Duct Systems.

***17.7.5.5.1** Detectors shall be listed for the purpose for which they are being used.*
17.7.5.5.2 Air duct detectors shall be installed in such a way as to obtain a representative sample of the airstream. This installation shall be permitted to be achieved by any of the following methods:*

(1) Rigid mounting within the duct

(2) Rigid mounting to the wall of the duct with the sensing element protruding into the duct

(3) Installation outside the duct with rigidly mounted sampling tubes protruding into the duct

(4) Installation through the duct with projected light beam

***17.7.5.5.3** Detectors shall be mounted in accordance with the manufacturer's published instructions and shall be accessible for cleaning by providing access doors or control units in accordance with **NFPA 90A**, Standard for the Installation of Air-Conditioning and Ventilating Systems.*
***17.7.5.5.4** The location of all detectors in air duct systems shall be permanently and clearly identified and recorded.*
***17.7.5.5.5** Detectors mounted outside of a duct that employs sampling tubes for transporting smoke from inside the duct to the detector shall be designed and installed to allow verification of airflow from the duct to the detector.*
***17.7.5.5.6** Detectors shall be listed for operation over the complete range of air velocities, temperature, and humidity expected at the detector when the air-handling system is operating.*
***17.7.5.5.7** All penetrations of a return air duct in the vicinity of detectors installed on or in an air duct shall be sealed to prevent entrance of outside air and possible dilution or redirection of smoke within the duct.*

17.14 Manually Actuated Alarm-Initiating Devices.

17.14.1 *Manually actuated alarm-initiating devices for initiating signals other than for fire alarm shall be permitted if the devices are differentiated from manual for fire alarm boxes by a color other than red and labeling.*
17.14.2 *Combination manual fire alarm boxes and guard's signaling stations shall be permitted.*
17.14.3 *Manually actuated alarm-initiating devices shall be securely mounted.*
17.14.4 *Manually actuated alarm-initiating devices shall be mounted on a background of contrasting color.*
17.14.5 *The operable part of a manually actuated alarm-initiating device shall be not less than 42 in. (1.07 m) and not more than 48 in. (1.22 m) from the finished floor.*
17.14.6 *Manually actuated alarm-initiating devices shall be permitted to be single action or double action.*
17.14.7* *Listed protective covers shall be permitted to be installed over single- or double-action manually actuated alarm-initiating devices.*
17.14.8 *Manual fire alarm boxes shall comply with* ***17.14.8.1*** *through* ***17.14.8.6****.*

17.14.8.1 *Manual fire alarm boxes shall be used only for fire alarm initiating purposes.*
17.14.8.2 *Manual fire alarm boxes shall be installed so that they are conspicuous, unobstructed, and accessible.*
17.14.8.3* *Unless installed in an environment that precludes the use of red paint or red plastic, manual fire alarm boxes shall be red in color.*
17.14.8.4 *Manual fire alarm boxes shall be located within 5 ft (1.5 m) of each exit doorway on each floor.*
17.14.8.5* *Additional manual fire alarm boxes shall be provided so that the travel distance to the nearest manual fire alarm box will not exceed 200 ft (61 m), measured horizontally on the same floor.*
17.14.8.6 *Manual fire alarm boxes shall be mounted on both sides of grouped openings over 40 ft (12.2 m) in width, and within 5 ft (1.5 m) of each side of the grouped opening.*

18.4 Audible Characteristics.

18.4.1 General Requirements.

18.4.1.1* *An average ambient sound level greater than 105 dBA shall require the use of a visible notification appliance(s) in accordance with Section* ***18.5*** *where the application is public mode or Section* ***18.6*** *where the application is private mode.*
18.4.1.2* *The total sound pressure level produced by combining the ambient sound pressure level with all audible notification appliances operating shall not exceed 110 dBA at the minimum hearing distance.*
18.4.1.3* *Sound from normal or permanent sources, having a duration greater than 60 seconds, shall be included when measuring maximum ambient sound level. Sound from temporary or abnormal sources shall not be required to be included when measuring maximum ambient sound level.*
18.4.1.4 *Audible notification appliances for alert and evacuation signal tones shall meet the requirements of* ***18.4.3*** *(Public Mode Audible Requirements),* ***18.4.4*** *(Private Mode Audible Requirements),* ***18.4.5*** *(Sleeping Area Requirements), or* ***18.4.6*** *(Narrow Band Tone Signaling for Exceeding Masked Thresholds), as applicable.*

18.4.1.4.1* *The designer of the audible notification system shall identify the rooms and spaces that will have audible notification and those where audible notification will not be provided.*
18.4.1.4.2* *Unless otherwise required by other sections of this Code, the coverage area for audible occupant notification shall be as required by other governing laws, codes, or standards. Where the other governing laws, codes, or standards require audible occupant notification for all or part of an area or space, coverage shall only be required in occupiable areas as defined in* ***3.3.178****.*
18.4.1.4.3 *The sound pressure levels that must be produced by the audible appliances in the coverage areas to meet the requirements of this Code shall be documented by the system designer during the planning and design of the notification system. The greater of the expected average ambient sound pressure level or expected maximum sound pressure level having a duration of at least 60 seconds shall also be documented for the coverage area by the system designer to ensure compliance with* ***18.4.3****,* ***18.4.4****,* ***18.4.5****, or* ***18.4.6*** *for the coverage area.*
18.4.1.4.4 *The design sound pressure levels to be produced by the notification appliances for the various coverage areas shall be documented for use during acceptance testing of the system.*
18.4.1.4.5 *Where required by the authority having jurisdiction, documentation of the design sound pressure levels for the various coverage areas shall be submitted for review and approval.*

18.4.1.5* *Voice messages shall not be required to meet the audibility requirements of* ***18.4.3*** *(Public Mode Audible Requirements),* ***18.4.4*** *(Private Mode Audible Requirements),* ***18.4.5*** *(Sleeping Area Requirements), or* ***18.4.6*** *(Narrow Band Tone Signaling for Exceeding Masked Thresholds), but shall meet the intelligibility requirements of*

18.4.10 *where voice intelligibility is required.*
18.4.1.6 *Audible notification appliances used for exit marking shall not be required to meet the audibility requirements of* ***18.4.3*** *(Public Mode Audible Requirements),* ***18.4.4*** *(Private Mode Audible Requirements),* ***18.4.5*** *(Sleeping Area Requirements), or* ***18.4.6*** *(Narrow Band Tone Signaling for Exceeding Masked Thresholds), except as required by* ***18.4.7*** *(Exit Marking Audible Appliance Requirements).*

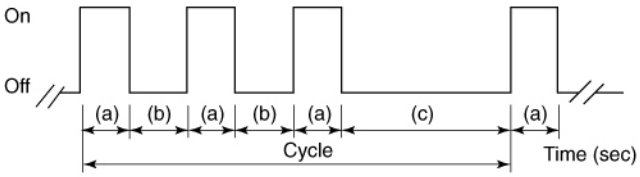
18.4.2 Distinctive Evacuation Signal.

18.4.2.1* *To meet the requirements of Section* ***10.10****, the alarm audible signal pattern used to notify building occupants of the need to evacuate (leave the building) or relocate (from one area to another) shall be the standard alarm evacuation signal consisting of a three-pulse temporal pattern. The pattern shall be in accordance with* ***Figure 18.4.2.1*** *and shall consist of the following in this order:*

(1) "On" phase lasting 0.5 second ±10 percent

(2) "Off" phase lasting 0.5 second ±10 percent for three successive "on" periods

(3) "Off" phase lasting 1.5 seconds ±10 percent



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%

Exception: Where approved by the authority having jurisdiction, continued use of the existing consistent evacuation signaling scheme shall be permitted.
18.4.2.2 *A single-stroke bell or chime sounded at "on" intervals lasting 1 second ±10 percent, with a 2-second ±10 percent "off" interval after each third "on" stroke, shall be permitted.*
18.4.2.3 *The signal shall be repeated for a period appropriate for the purposes of evacuation of the building, but for not less than 180 seconds. The minimum repetition time shall be permitted to be manually interrupted.*
18.4.2.4* *The standard evacuation signal shall be synchronized within a notification zone.*

18.4.3* Public Mode Audible Requirements.

18.4.3.1* *To ensure that audible public mode signals are clearly heard, unless otherwise permitted by* ***18.4.3.2*** *through* ***18.4.3.5****, they shall have a sound level at least 15 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds, whichever is greater, measured 5 ft (1.5 m) above the floor in the area required to be served by the system using the A-weighted scale (dBA).*
18.4.3.2 *Where approved by the authority having jurisdiction or other governing codes or standards, the requirements for audible signaling shall be permitted to be reduced or eliminated when visible signaling is provided in accordance with Section* ***18.5****.*
18.4.3.3 *Audible alarm notification appliances installed in elevator cars shall be permitted to use the audibility criteria for private mode appliances detailed in* ***18.4.4.1****.*
18.4.3.4 *If approved by the authority having jurisdiction, audible alarm notification appliances installed in restrooms shall be permitted to use the audibility criteria for private mode appliances detailed in* ***18.4.4.1****.*
18.4.3.5 *A signaling system arranged to stop or reduce ambient noise shall comply with* ***18.4.3.5.1*** *through* ***18.4.3.5.3****.*

18.4.3.5.1 *A signaling system arranged to stop or reduce ambient noise shall produce a sound level at least 15 dB above the reduced average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds after reduction of the ambient noise level, whichever is greater, measured 5 ft (1.5 m) above the floor in the area required to be served by the system using the A-weighted scale (dBA).*
18.4.3.5.2 *Visible notification appliances shall be installed in the affected areas in accordance with Sections*

18.5 *or* ***18.6****.*

18.4.3.5.3 *Relays, circuits, or interfaces necessary to stop or reduce ambient noise shall meet the requirements of Chapters* ***10****,* ***12****,* ***21****, and* ***23****.*

18.5* Visible Characteristics — Public Mode.

18.5.1* Visible Signaling.

18.5.1.1 *Public mode visible signaling shall meet the requirements of Section* ***18.5*** *using visible notification appliances.*

18.5.1.2* *The coverage area for visible occupant notification shall be as required by other governing laws, codes, or standards. Where the other governing laws, codes, or standards require visible occupant notification for all or part of an area or space, coverage shall only be required in occupiable areas as defined in* ***3.3.178****.*

18.5.2 Area of Coverage.

18.5.2.1 *The designer of the visible notification system shall document the rooms and spaces that will have visible notification and those where visible notification will not be provided.*

18.5.2.2* *Unless otherwise specified or required by other sections of this Code, the required coverage area for visible occupant notification shall be as required by other governing laws, codes, or standards.*

18.5.2.3 *Where required by the authority having jurisdiction, documentation of the effective intensity (cd) of the visible appliances for the area of coverage shall be submitted for review and approval.*

18.5.3 Light, Color, and Pulse Characteristics.

18.5.3.1 *The flash rate shall not exceed two flashes per second (2 Hz) nor be less than one flash every second (1 Hz) throughout the listed voltage range of the appliance.*

18.5.3.2 *A maximum pulse duration shall be 0.2 second with a maximum duty cycle of 40 percent.*

18.5.3.3 *The pulse duration shall be defined as the time interval between initial and final points of 10 percent of maximum signal.*

18.5.3.4* *Lights used for fire alarm signaling only or to signal the intent for complete evacuation shall be clear or nominal white and shall not exceed 1000 cd (effective intensity).*

18.5.3.5 *Lights used to signal occupants to seek information or instructions shall be clear, nominal white, or other color as required by the emergency plan and the authority having jurisdiction for the area or building.*

18.5.3.6* *The strobe synchronization requirements of this chapter shall not apply where the visible notification appliances located inside the building are viewed from outside of the building.*

18.5.4* Appliance Photometrics. *The light output shall comply with the polar dispersion requirements of ANSI/UL 1971, Standard for Signaling Devices for the Hearing Impaired, or equivalent.*

18.5.5 Appliance Location.

18.5.5.1* *Wall-mounted appliances shall be mounted such that the entire lens is not less than 80 in. (2.03 m) and not greater than 96 in. (2.44 m) above the finished floor or at the mounting height specified using the performance-based alternative of* ***18.5.5.6****.*

18.5.5.2 *Where low ceiling heights do not permit wall mounting at a minimum of 80 in. (2.03 m), wall mounted visible appliances shall be mounted within 6 in. (150 mm) of the ceiling. The room size covered by a strobe of a given value shall be reduced by twice the difference between the minimum mounting height of 80 in. (2.03 m) and the actual lower mounting height.*

18.5.5.3* *Visible appliances listed for mounting parallel to the floor shall be permitted to be located on the ceiling or suspended below the ceiling.*

18.5.5.4* Spacing in Rooms.

18.5.5.4.1 *Spacing shall be in accordance with either* ***Table 18.5.5.4.1(a)*** *and* ***Figure 18.5.5.4.1*** *or* ***Table 18.5.5.4.1(b)****.*

Table 18.5.5.4.1(a) Room Spacing for Wall-Mounted Visible Appliances

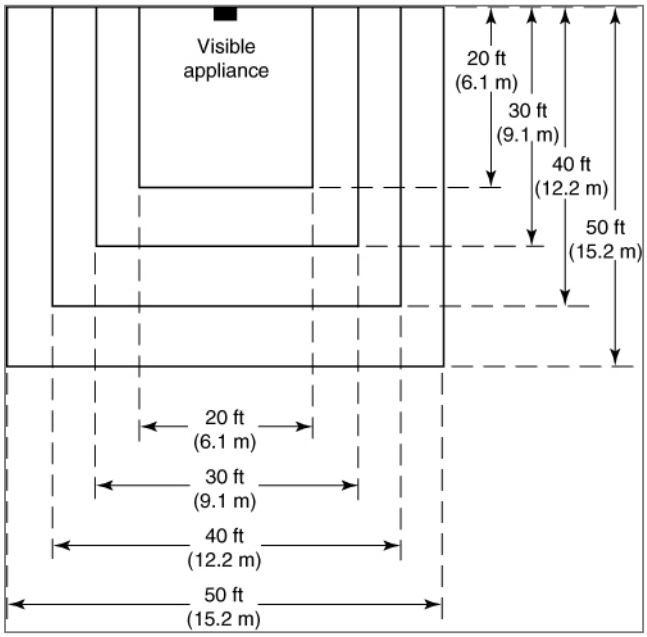
Maximum Room Size		Minimum Required Light Output [Effective Intensity (cd)]	
ft	m	One Light per Room	Four Lights per Room (One Light per Wall)
20 × 20	6.10 × 6.10	15	NA
28 × 28	8.53 × 8.53	30	NA
30 × 30	9.14 × 9.14	34	NA
40 × 40	12.2 × 12.2	60	15
45 × 45	13.7 × 13.7	75	19
50 × 50	15.2 × 15.2	94	30
54 × 54	16.5 × 16.5	110	30
55 × 55	16.8 × 16.8	115	30
60 × 60	18.3 × 18.3	135	30
63 × 63	19.2 × 19.2	150	37
68 × 68	20.7 × 20.7	177	43
70 × 70	21.3 × 21.3	184	60
80 × 80	24.4 × 24.4	240	60
90 × 90	27.4 × 27.4	304	95
100 × 100	30.5 × 30.5	375	95
110 × 110	33.5 × 33.5	455	135
120 × 120	36.6 × 36.6	540	135
130 × 130	39.6 × 39.6	635	185

NA: Not allowable.

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

*This does not preclude mounting lens at lower heights.



18.5.5.4.2 *Visible notification appliances shall be installed in accordance with* ***Table 18.5.5.4.1(a)*** *or* ***Table 18.5.5.4.1(b)*** *using one of the following:*

- *(1) A single visible notification appliance.*
- *(2)* Two groups of visible notification appliances, where visual appliances of each group are synchronized, in the same room or adjacent space within the field of view. This shall include synchronization of strobes operated by separate systems.*
- *(3) More than two visible notification appliances or groups of synchronized appliances in the same room or adjacent space within the field of view that flash in synchronization.*

18.5.5.4.3 *Room spacing in accordance with* ***Table 18.5.5.4.1(a)*** *and* ***Figure 18.5.5.4.1*** *for wall-mounted appliances shall be based on locating the visible notification appliance at the halfway distance of the wall.*
18.5.5.4.4 *In square rooms with appliances not centered or in nonsquare rooms, the effective intensity (cd) from one visible wall-mounted notification appliance shall be determined by maximum room size dimensions obtained either by measuring the distance to the farthest wall or by doubling the distance to the farthest adjacent wall, whichever is greater, as required by* ***Table 18.5.5.4.1(a)*** *and* ***Figure 18.5.5.4.1****.*
18.5.5.4.5 *If a room configuration is not square, the square room size that allows the entire room to be encompassed or allows the room to be subdivided into multiple squares shall be used.*
18.5.5.4.6* *If ceiling heights exceed 30 ft (9.14 m), ceiling-mounted visible notification appliances shall be suspended at or below 30 ft (9.14 m) or at the mounting height determined using the performance-based alternative of* ***18.5.5.6****, or wall-mounted visible notification appliances shall be installed in accordance with* ***Table 18.5.5.4.1(a)****.*
18.5.5.4.7 ***Table 18.5.5.4.1(b)*** *shall be used if the ceiling-mounted visible notification appliance is at the center of the room. If the ceiling-mounted visible notification appliance is not located at the center of the room, the effective intensity (cd) shall be determined by doubling the distance from the appliance to the farthest wall to obtain the maximum room size.*

18.5.5.5* Spacing in Corridors.

18.5.5.5.1 *The installation of visible notification appliances in corridors 20 ft (6.1 m) or less in width shall be in accordance with the requirements of either* ***18.5.5.4*** *or* ***18.5.5.5****.*
18.5.5.5.2 *Paragraph* ***18.5.5.5*** *shall apply to corridors not exceeding 20 ft (6.1 m) in width.*
18.5.5.5.3 *In a corridor application, visible appliances shall be rated not less than 15 cd.*
18.5.5.5.4 *Corridors greater than 20 ft (6.1 m) wide shall comply with the spacing requirements for rooms in accordance with* ***18.5.5.4****.*
18.5.5.5.5* *Visible notification appliances shall be located not more than 15 ft (4.57 m) from the end of the corridor with a separation not greater than 100 ft (30.5 m) between appliances.*

18.5.5.5.6 *If there is an interruption of the concentrated viewing path, such as a fire door, an elevation change, or any other obstruction, the area shall be treated as a separate corridor.*
18.5.5.5.7 *In corridors where more than two visible notification appliances are in any field of view, they shall flash in synchronization.*
18.5.5.5.8 *Wall-mounted visible notification appliances in corridors shall be permitted to be mounted on either the end wall or the side wall of the corridor in accordance with spacing requirements of* ***18.5.5.5.5****.*

18.5.5.6* Performance-Based Alternative.

18.5.5.6.1 *Any design that provides a minimum of 0.0375 lumens/ft² (0.4036 lumens/m²) of illumination at any point within the covered area at all angles specified by the polar dispersion planes for wall- or ceiling-mounted visual appliances in ANSI/UL 1971, Standard for Signaling Devices for the Hearing Impaired, or equivalent, as calculated for the maximum distance from the nearest visual notification appliance, shall be permitted in lieu of the requirements of* ***18.5.5****, excluding* ***18.5.5.7****.*
18.5.5.6.2 *Documentation provided to the authority having jurisdiction shall include the following:*

(1) Inverse Square Law calculations using each of the vertical and horizontal polar distribution angles in ANSI/UL 1971, Standard for Signaling Devices for the Hearing Impaired, or equivalent.

(2) The calculations shall account for the effects of polar distribution using one of the following:

(a) The percentages from the applicable table(s) in ANSI/UL 1971, Standard for Signaling Devices for the Hearing Impaired, or equivalent

(b) The actual results of laboratory tests of the specific appliance to be used as recorded by the listing organization

APPENDIX F

Fire Suppression Systems Drawings

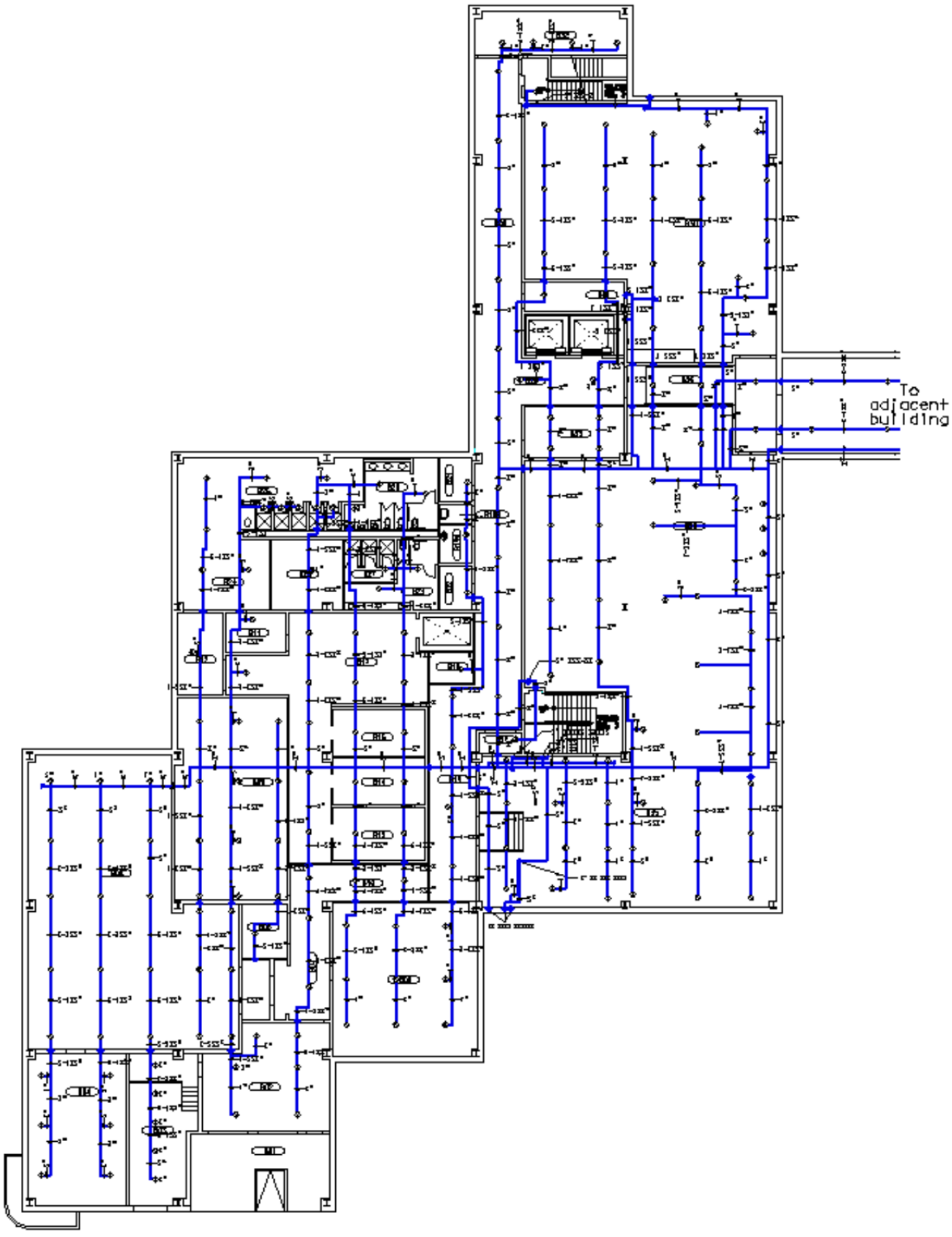


Figure F-1: Basement Fire Sprinkler Piping Layout

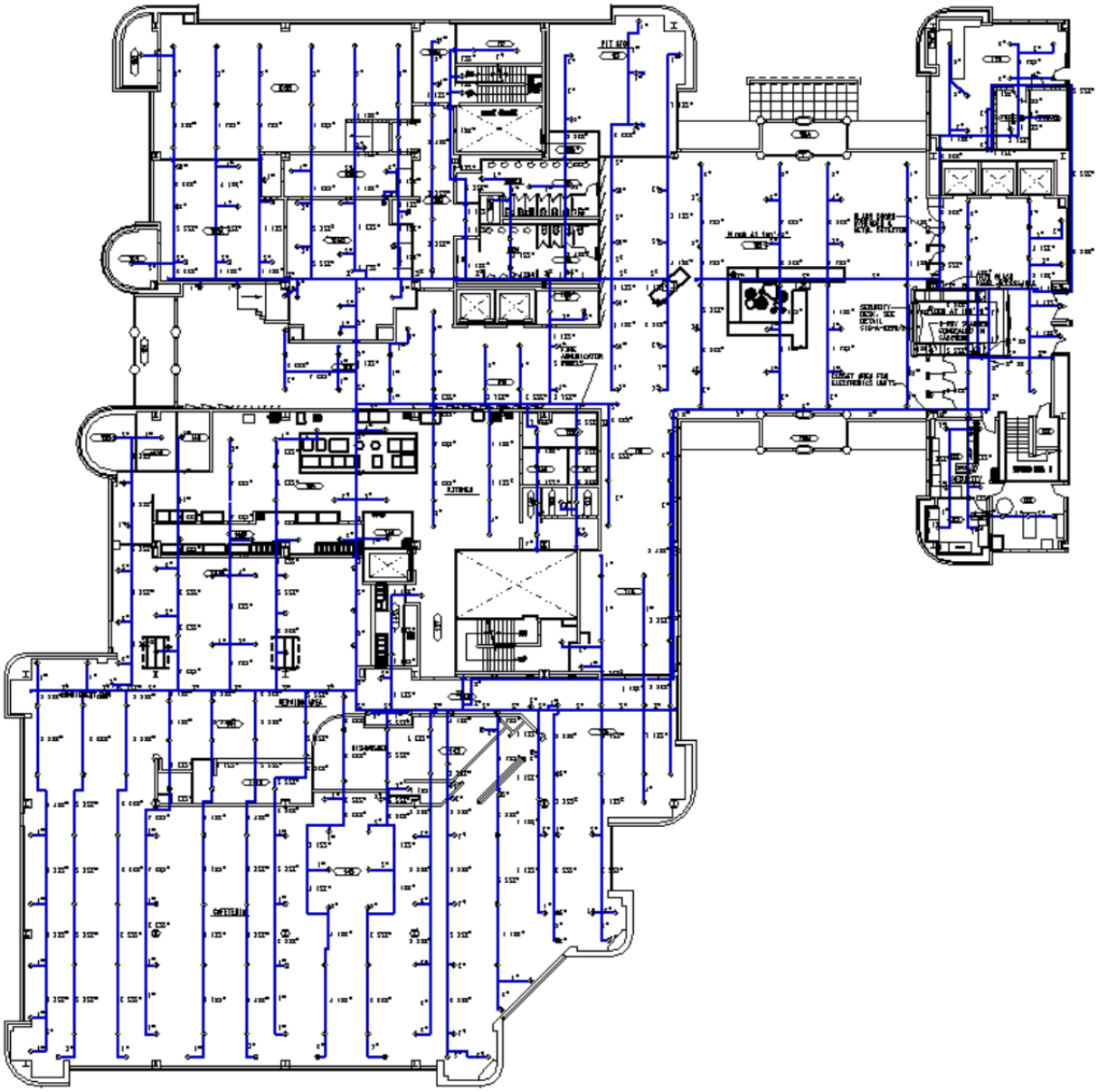


Figure F-2: First Floor Fire Sprinkler Piping Layout

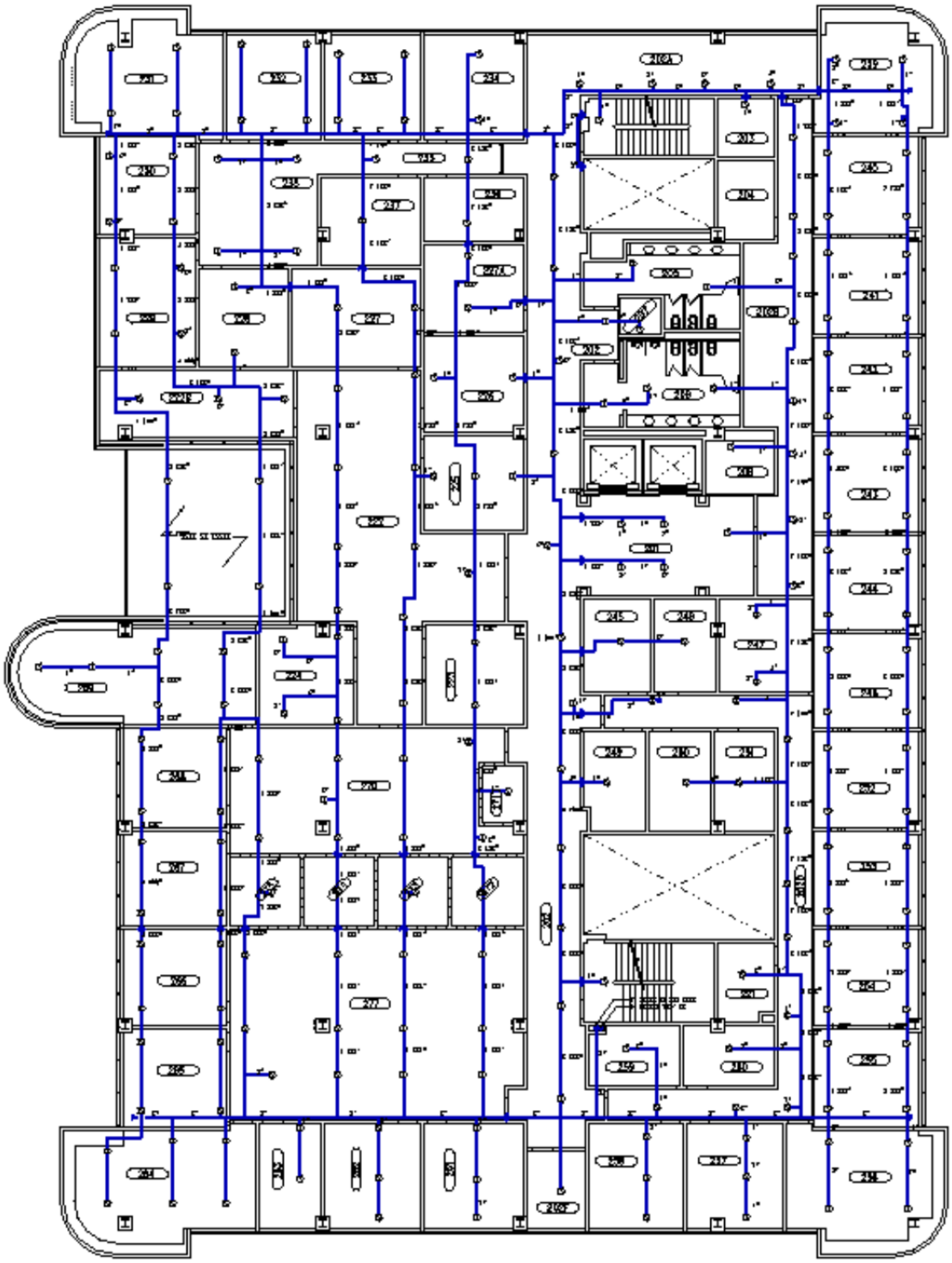


Figure F-3: Second Floor Fire Sprinkler Piping Layout

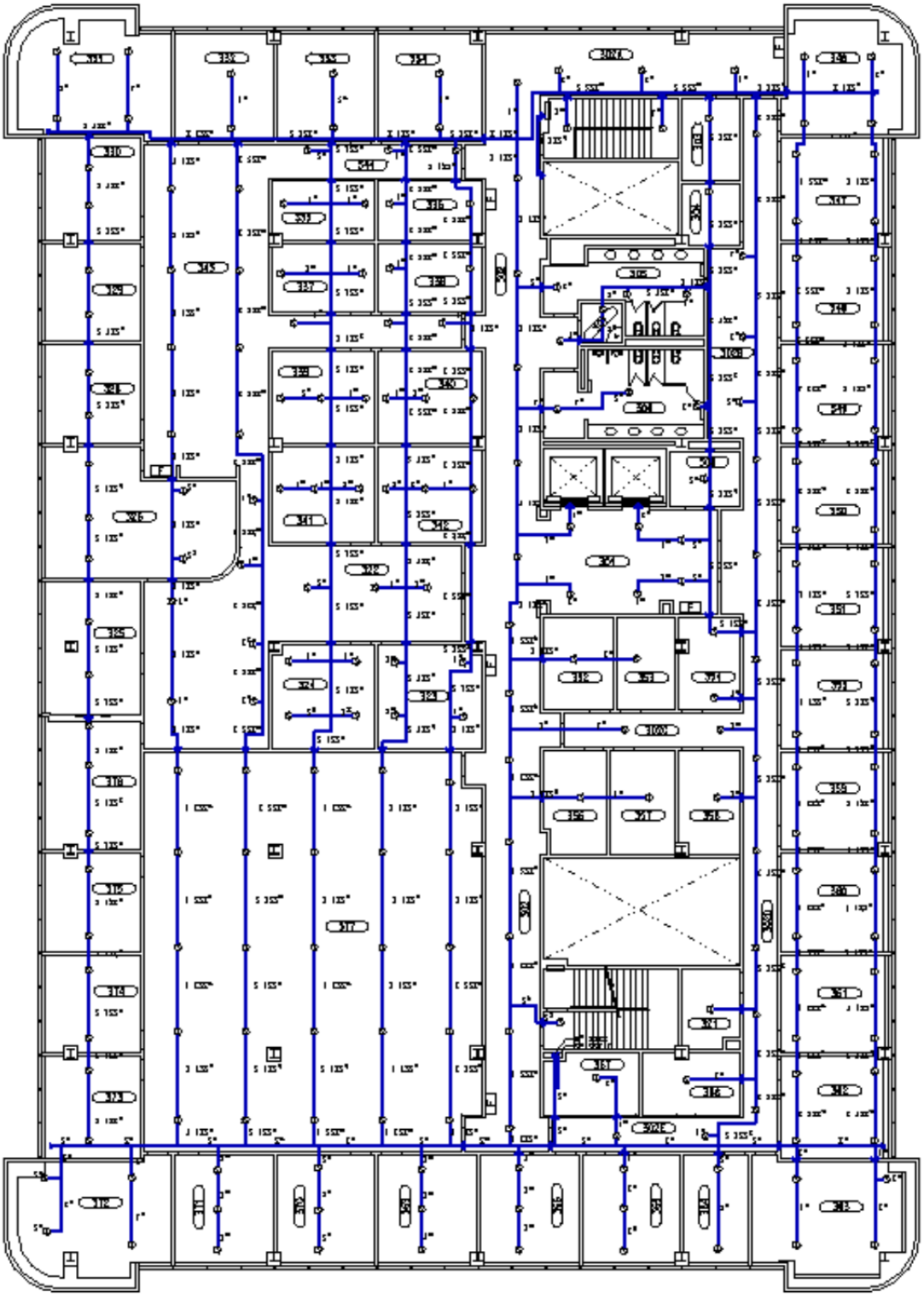


Figure F-4: Third Floor Fire Sprinkler Piping Layout

APPENDIX G

Manual Hydraulic Calculations Table

HYDRAULIC CALCULATIONS

CONTRACT NAME Room 377 SHEET 1 OF 1

NOZZLE IDENT. AND LOCATION		FLOW IN GPM	PIPE SIZE	PIPE FITTINGS AND DEVICES	EQUIV. PIPE LENGTH	FRICTION LOSS PSI/FT	PRESSURE SUMMARY	NORMAL PRESSURE	NOTES
									D = 0.10 gpm/ft² K = 5.6
1	BL=1	q Q 15	1 1/2" (1.610)		L 11 F T 11	C=120 .01	Pt 7.2 Pe Pf .1	Pt Pv Pn	R = A*D = (150)(.1) = 15 P = (Q/K)² = (15/5.6)² = 7.2
2		q 15.1 Q 30.1	1 1/2" (1.610)		L 13 F T 13	C=120 .03	Pt 7.3 Pe Pf .4	Pt Pv Pn	q = K√P = 5.6√7.3 = 15.1
3		q 15.5 Q 45.6	1 1/2" (1.610)		L 12 F T 12	C=120 .07	Pt 7.7 Pe Pf .8	Pt Pv Pn	q = K√P = 5.6√7.7 = 15.5
4		q 16.3 Q 61.9	1 1/2" (1.610)		L 12 F T 12	C=120 .13	Pt 8.5 Pe Pf 1.6	Pt Pv Pn	q = K√P = 5.6√8.5 = 16.3
6	CM to BL2	q Q 61.9	3" (3.068)		L 10 F T 10	C=120 .01	Pt 10.1 Pe Pf .1	Pt Pv Pn	K = Q/√P = 61.9/√10.1 K = 19.5
	BL2 to BL3	q 62.3 Q 124.2	3" (3.068)		L 16 F T 10	C=120 .02	Pt 10.2 Pe Pf .2	Pt Pv Pn	q = K√P = 19.5√10.2 = 62.3
	BL3 to BL4	q 62.9 Q 187.1	3" (3.068)		L 10 F T 10	C=120 .04	Pt 10.4 Pe Pf .4	Pt Pv Pn	q = K√P = 19.5√10.4 = 62.9
	BL4 to BL5	q 64.1 Q 251.2	3" (3.068)		L 10 F T 10	C=120 .1	Pt 10.8 Pe Pf 1	Pt Pv Pn	q = K√P = 19.5√10.8 = 64.1
	BL5 to Riser	q Q 251.2	3" (3.068)	Elbow	L 29 F 7 T 36	C=120 .1	Pt 11.8 Pe Pf 3.6	Pt Pv Pn	K = Q/√P = 251.2/√11.8 K = 73.1
		q Q			L F T		Pt 15.4 Pe Pf	Pt Pv Pn	
		q Q			L F T		Pt Pe Pf	Pt Pv Pn	
							Pt		

American Fire Sprinkler Association
12750 Merit Drive, Suite 350, Dallas, Texas 75251
Tele: 214.349.5965
Fax: 214.343.8898
www.firesprinkler.org

APPENDIX H

Fire Suppression Systems

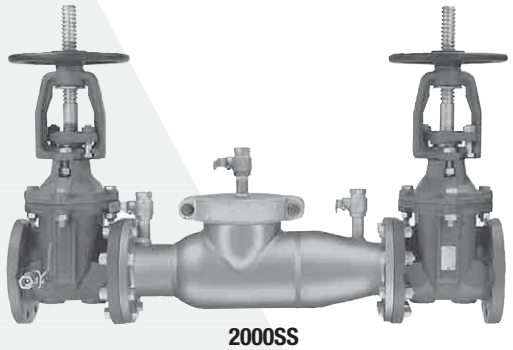
Additional Component Information

Series 2000SS

Double Check Valve Assemblies

Sizes: 2½" – 12" (65 – 300mm)

LEAD FREE*



2000SS

Features

- Cam-Check Assembly provides low head loss
- Short lay length is ideally suited for retrofit installations
- Stainless Steel body is half the weight of competitive designs reducing installation and shipping cost
- Stainless steel construction provides long term corrosion protection and maximum strength
- Single top access cover with two-bolt grooved style coupling for ease of maintenance
- No special tools required for servicing
- Compact construction allows for smaller vaults and enclosures
- May be installed in horizontal or vertical "flow up" position

Available Models

Suffix:

NRS – non-rising stem resilient seated gate valves

OSY – UL/FM outside stem and yoke resilient seated gate valves

**OSY FxG – flanged inlet gate connection and grooved outlet gate connection

**OSY GxF – grooved inlet gate connection and flanged outlet gate connection

**OSY GxG – grooved inlet gate connection and grooved outlet gate connection

LG – less gates

Available with grooved NRS gate valves - consult factory**

Post indicator plate and operating nut available – consult factory**

**Consult factory for dimensions

***The wetted surface of this product contacted by consumable water contains less than one quarter of one percent (0.25%) of lead by weight.**

Series 2000SS Double Check Valve Assemblies are designed to prevent the reverse flow of polluted water from entering into the potable water system. This series can be applied, where approved by the local authority having jurisdiction, on non-health hazard installations. Features short end-to-end dimensions, lightweight stainless steel body, and low head loss.

Specifications

A Double Check Valve Assembly shall be installed at each noted location to prevent the unwanted reversal of polluted water into the potable water supply. The main valve body shall be manufactured from 300 series stainless steel to provide corrosion resistance, 100% lead free through the waterway. The double check shall consist of two independently operated spring loaded cam-check valves, required test cocks, and optional inlet and outlet resilient seated shutoff valves. Each cam-check shall be internally loaded and provide a positive drip tight closure against the reverse flow of liquid caused by backsiphonage or backpressure. The modular cam-check includes a stainless steel spring and cam-arm, rubber faced disc and a replaceable seat. There shall be no brass or bronze parts used within the cam-check valve assembly. The valve cover shall be held in place through the use of a single grooved style two-bolt coupling. The main assembly shall consist of two independently operating torsion spring check assemblies, two resilient seated isolation valves, and four ball valve type test cocks. The assembly shall be an Ames Company Series 2000SS.

Materials

All internal metal parts: 300 Series stainless steel

Main valve body: 300 Series stainless steel

Check assembly: Noryl®

Flange dimension in accordance with AWWA Class D

Noryl® is a registered trademark of General Electric Company.

Pressure — Temperature

Temperature Range: 33°F – 110°F (5°C – 43°C)

Maximum Working Pressure: 175psi (12.06 bar)

Standards

AWWA C510-92, CSA B64.5

Approvals

ASSE 1015

CLASSIFIED c UL us (OSY ONLY)

FM Approved

For 12" approvals consult factory

Job Name _____ Contractor _____

Job Location _____ Approval _____

Engineer _____ Contractor's P.O. No. _____

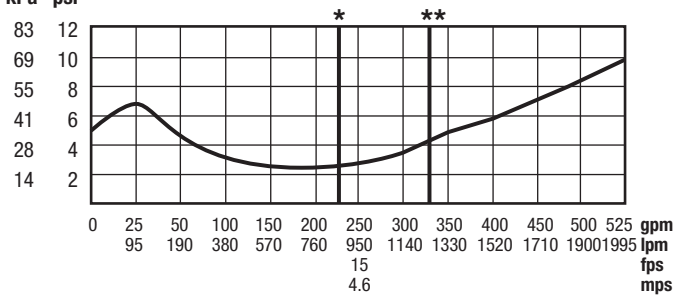
Approval _____ Representative _____

Ames product specifications in U.S. customary units and metric are approximate and are provided for reference only. For precise measurements, please contact Ames Technical Service. Ames reserves the right to change or modify product design, construction, specifications, or materials without prior notice and without incurring any obligation to make such changes and modifications on Ames products previously or subsequently sold.

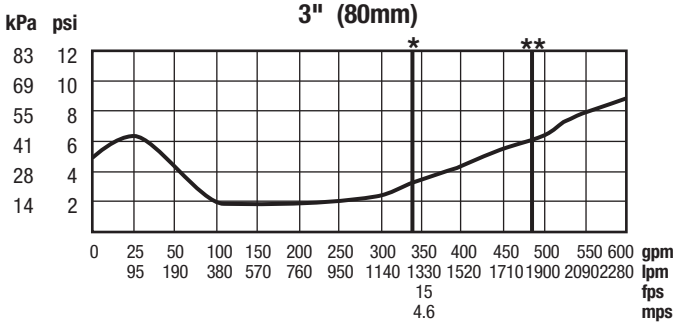
Capacities

Rated working pressure 175psi (12.06 bar) * Rated flow **UL Tested

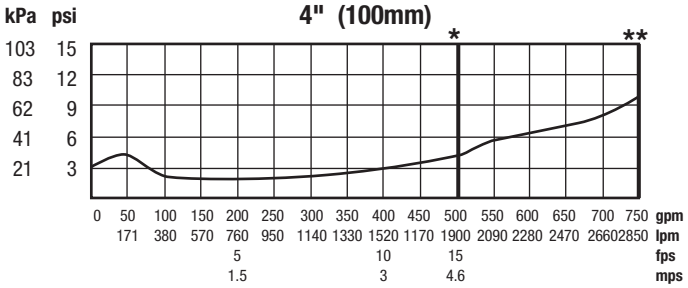
2½" (65mm)



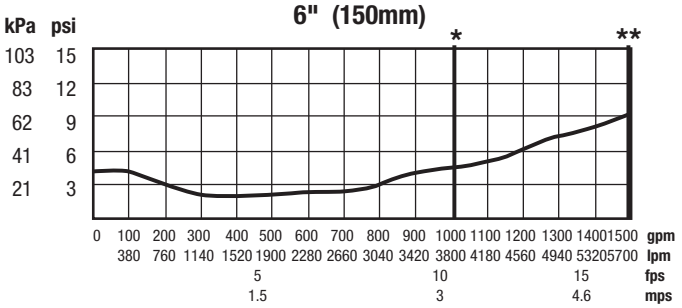
3" (80mm)



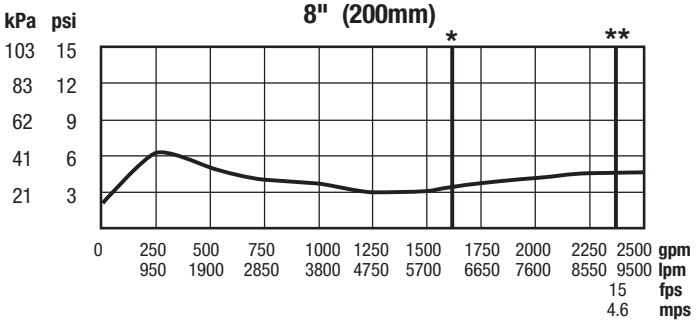
4" (100mm)



6" (150mm)



8" (200mm)



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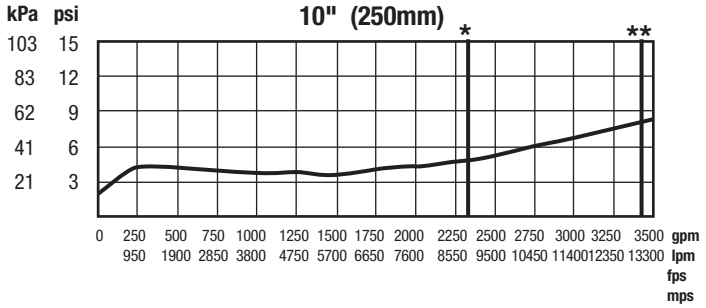

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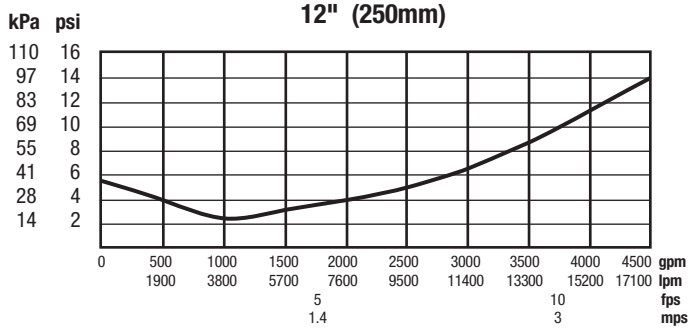
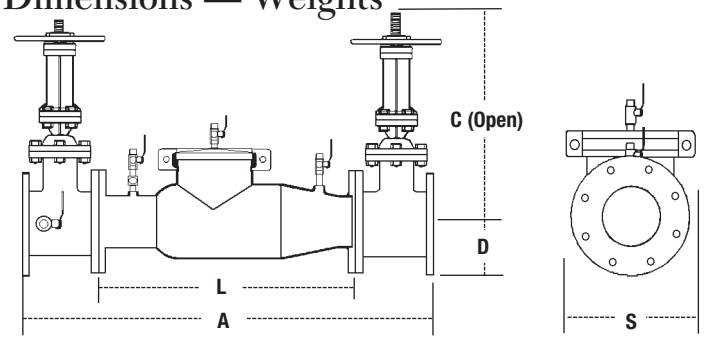


Dimensions — Weights



SIZE (DN)		DIMENSIONS												WEIGHT			
		A		C (OSY)		C(NRS)		D		L		S		w/Gates		w/o Gates	
in.	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*lb.*	*kg.*	*lb.*	*kg.*
2½	65	37	965	16⅜	416	9⅜	238	3½	89	22	559	7	178	140	64	53	24
3	80	38	965	18⅞	479	10¼	260	3¾	95	22	559	7½	191	215	98	55	25
4	100	40	1016	22¾	578	12 3/16	310	4½	114	22	559	9	229	225	102	58	26
6	150	48½	1232	30⅛	765	16	406	5½	140	27½	699	11	279	375	170	105	48
8	200	52½	1334	37¾	959	19 15/16	506	6¾	171	29½	749	13½	343	561	254	169	77
10	250	55½	1410	45¾	1162	23 13/16	605	8	200	29½	749	16	406	763	346	179	81
12	300	57½	1461	53⅛	1349	26¾	679	9½	241	29½	749	19	483	1033	469	209	95

AMES FIRE & WATERWORKS

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U.S. GREEN BUILDING COUNCIL MEMBER

ISO 9001-2008 CERTIFIED

A Watts Water Technologies Company

USA: Backflow- Sacramento, CA • Tel. (916) 928-0123 • Fax (916) 928-9333
Control Valves- Houston, TX • Tel. (713) 943-0688 • Fax (713) 944-9445
Canada: Burlington, ON • Tel. (905) 332-4090 • Fax (905) 332-7068

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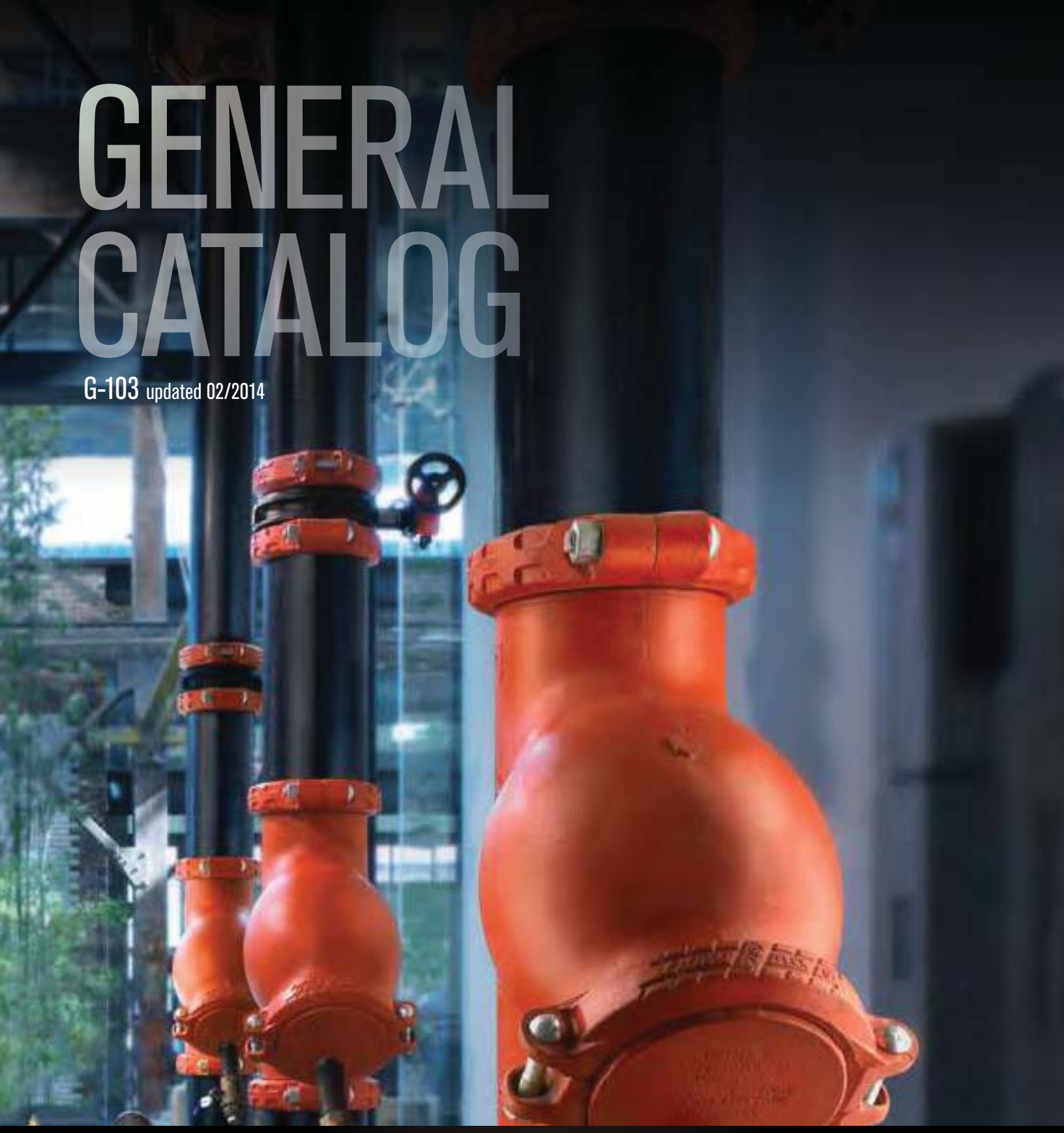
GENERAL CATALOG

G-103 updated 02/2014



Victaulic®

WHERE INNOVATION AND SOLUTIONS ARE JOINED TOGETHER

Since the first patent in 1919, Victaulic® has delivered innovative pipe joining solutions that help customers succeed worldwide. Look inside many of the world's most recognizable landmarks and industrial facilities, and you'll find Victaulic® solutions at work making bold design innovations possible, speeding time to completion, allowing for unpredictable seismic movements and setting the stage for scalability.

Today, Victaulic® supports its customers with manufacturing facilities and branches located around the globe including our world headquarters location in Easton, Pennsylvania, USA. Our international presence ensures that our worldwide customers are served with speed and efficiency.

As the world's leading producer of grooved mechanical pipe joining systems, Victaulic® has been delivering global innovative solutions across diverse business lines including building services, clean water and wastewater, fire protection, industrial construction, maritime, mining, oil, gas and chemical, power generation as well as custom castings.

From concept to commissioning, Victaulic® provides the technologies and services necessary to simplify your next project.

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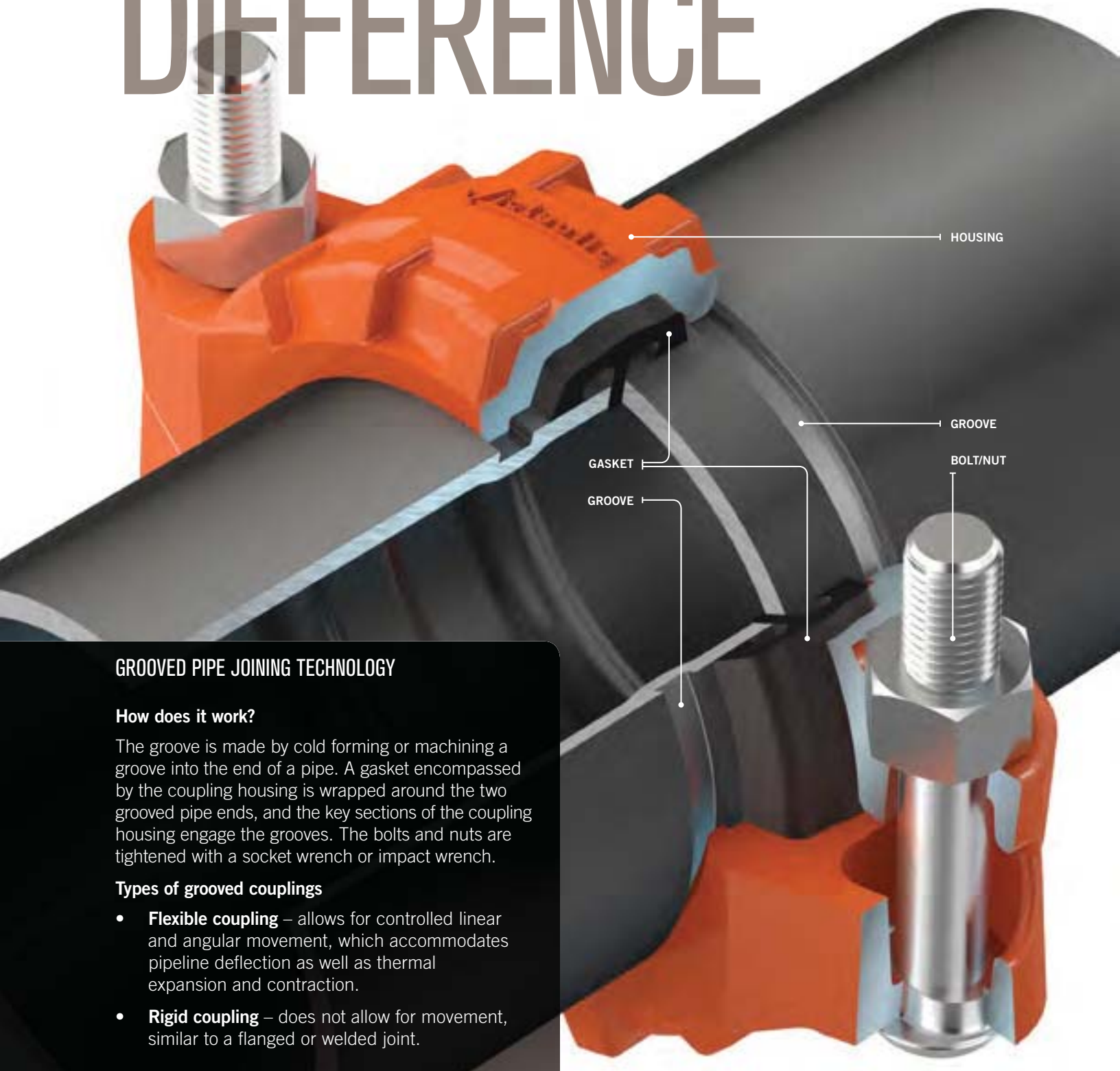
THE VICTAULIC® DIFFERENCE



GROOVED PIPE JOINING TECHNOLOGY

How does it work?

The groove is made by cold forming or machining a groove into the end of a pipe. A gasket encompassed by the coupling housing is wrapped around the two grooved pipe ends, and the key sections of the coupling housing engage the grooves. The bolts and nuts are tightened with a socket wrench or impact wrench.

Types of grooved couplings

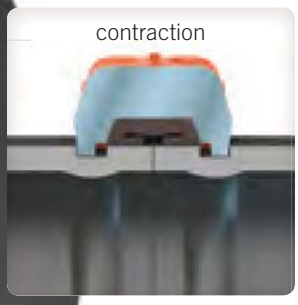
- **Flexible coupling** – allows for controlled linear and angular movement, which accommodates pipeline deflection as well as thermal expansion and contraction.
- **Rigid coupling** – does not allow for movement, similar to a flanged or welded joint.

At the core of all the benefits that Victaulic® solutions bring to a project – such as productivity, safety, design flexibility and quality – are the unique features of our products.

VICTAULIC® GROOVED END PIPING SYSTEMS PROVIDE:

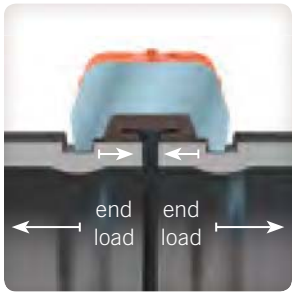
Easy system maintenance and expansion – through simple coupling disassembly that allows for easy access.

Alignment ease – through a design that allows for full rotation of the pipe and system components before tightening.



Flexibility – with the inherent axial movement and deflection properties of flexible couplings in a groove system. May be used to accommodate pipeline thermal expansion and contraction, misalignment and settlement, and seismic stress absorption.

Noise and vibration attenuation – by isolating the transference of vibration at each joint.



Self restrained pipe joints – Couplings engage the pipe grooves to hold the pipes against full pressure thrust loads without the need of supplemental restraints.

Rigidity – with an angled pad design that provides positive clamping of the pipe to resist torsional and flexural loads.

Gasket Materials

Victaulic® offers a wide variety of synthetic rubber gaskets for a broad range of applications. For most water applications, the Victaulic® Grade "E" EPDM (ethylene propylene diene monomer) gasket compound is compatible. Victaulic® Grade "E" material has premium performance properties with respect to aging and resistance to heat and hot water. Heat aging tests at +250°F | +121°C conducted on this material show essentially no change in physical properties. This situation is further enhanced when this rubber is subjected to an essentially non-oxidative environment, such as a gasket in a water piping system. For example, aging tests in a non-oxidative atmosphere show essentially no change in physical properties of this material even when tested at temperatures up to +350°F | +177°C.

Since water has no deteriorating effect on the elastomer, temperature is the only limiting factor to be considered in determining the life expectancy of the elastomer in water service. The superior performance of the Grade "E" elastomer permits its use for hot water service up to +230°F | +110°C. The Grade "E" gasket is superior to previous gasket materials by all performance barometers, including high and low temperature limits, tensile strength, chemical resistance and shelf life.

Gasket/Seal/O-Ring Data

Victaulic® offers a variety of synthetic rubber gaskets/seals/o-rings for the widest range of applications. To assure the maximum life for the service intended, proper gasket selection and specification in ordering is essential. The foremost consideration is temperature, along with concentration of product, duration of service and continuity of service. Temperatures beyond the compatibility limits have a degrading effect on the polymer.

Services listed are General Service Guidelines only. It should be noted that there are services for which these gaskets/seals/o-rings are not compatible. Reference should always be made to the latest Gasket Chemical Services Guide (**download publication GSG-100**) for specific service guidelines and for a listing of services which are not compatible.

Gasket guidelines apply only to Victaulic® gaskets, seals and o-rings. Guidelines for a particular service do not necessarily imply compatibility of the coupling housing, related fittings or other components for the same service.

These guidelines do not apply to rubber-lined or rubber seal valves or other rubber-lined products. Victaulic® gaskets are clearly marked as part of the mold with the gasket size, style and compound for easy identification.

Potable Water Listings and Classifications

Grade "E" EPDM, Grade "E" Vic-Plus™, Grade "E2", Grade "EHP" and Grade "EHP" Vic-Plus™ gaskets are UL Classified in accordance with ANSI/NSF 61 for cold (+86°F | +30°C) and hot (+180°F | +82°C) potable water service and ANSI/NSF 372. **Download publication 02.06** for more details.

Victaulic® Grade "M" halogenated butyl gasket material (which is typically used with our AWWA sized products) is UL Classified in accordance with ANSI/NSF 61 for cold (+86°F | +30°C) potable water service and ANSI/NSF 372. **Download publication 02.06** for more details.

Vic-Press® Schedule 10S couplings and fittings: UL Classified in accordance with ANSI/NSF 61 for cold +73°F | +23°C and hot +180°F | +82°C potable water service with "E" and "H" o-rings and ANSI/NSF 372. **Download publication 02.06** for more details.

In addition to the above, the standard black asphalt coating used on our cement lined AWWA size fittings is NSF 61 Listed. As the coating is the only material that comes in contact with the water, NSF 61 compliant coatings are commercially available and may be applied to our products. For more details about Victaulic® gasket construction and testing, **download submittal 05.01**.

Gasket Lubricant

Thorough lubrication of the gasket exterior, including the lips and/or pipe ends and housing interiors, is essential for proper installation. Use Victaulic® Lubricant for installation. Other compatible material, such as silicone and others may be used on Grades "E" or "L" gaskets. Victaulic® Lubricant is available in a box of (12) 4 fluid ounce | 114 milliliter tubes or in 1 quart | 946 milliliters containers.

Important Note: Victaulic® Lubricant is not compatible for use with high-density polyethylene (HDPE) pipe.

ALWAYS USE LUBRICANT FOR PROPER COUPLING ASSEMBLY.

Valve Seals

Victaulic® Gasket Selection Guide (05.01) does not include Victaulic® seals for valves. Refer to the individual Victaulic® valve submittal for information on the seals available for each valve.

⚠ WARNING

- **To assure maximum life for the service intended, proper gasket selection and specification in ordering is essential. For specific chemical and temperature compatibility, refer to the Gasket Selection and Chemical Services sections. The information shown defines general ranges for all compatible fluids.**

Failure to select the proper rubber compound may result in personal injury or property damage, improper installation, joint leakage or joint failure.

Standard Gaskets — IPS

Grade[1]	Temp. Range[1]	Compound	Color Code	General Service Guidelines
E	–30°F to +230°F –34° C to +110° C	EPDM	Green Stripe	May be specified for hot water service within the specified temperature range plus a variety of dilute acids, oil-free air and many chemical services. UL Classified in accordance with ANSI/NSF 61 for cold +73°F | +23°C and hot +180°F | +82°C potable water service and ANSI/NSF 372. **NOT COMPATIBLE FOR USE WITH PETROLEUM SERVICES.**
EHP[2]	–30°F to +250°F –34°C to +120°C	EPDM	Red and Green Stripes	May be specified for hot water service within the specified temperature range. UL Classified in accordance with ANSI/NSF 61 for cold +73°F | +23°C and hot +180°F | +82°C potable water service and ANSI/NSF 372. **NOT COMPATIBLE FOR USE WITH PETROLEUM SERVICES.**
T	–20°F to +180°F –29° C to +82° C	Nitrile	Orange Stripe	May be specified for petroleum products, hydrocarbons, air with oil vapors, vegetable and mineral oils within the specified temperature range. **Not compatible for use with hot, dry air over +140°F | +60°C and water over +150°F | +66°C. NOT COMPATIBLE FOR USE WITH HOT WATER SERVICES.**
E (Type A)[3]	Ambient	EPDM	Violet Stripe	Applicable for wet and dry (oil-free air) sprinkler services only. For dry services FlushSeal® gaskets may be specified. **NOT COMPATIBLE FOR USE WITH HOT WATER SERVICES.**
E2	Ambient	EPDM	Double Green Stripe	UL Classified in accordance with ANSI/NSF 61 for cold +73°F | +23°C and hot +180°F | +82°C potable water service and ANSI/NSF 372. **NOT COMPATIBLE FOR USE WITH PETROLEUM SERVICES.**

[1] For specific chemical and temperature compatibility, refer to the Gasket Selection Guide (05.01) which includes the Gasket Chemical Services Short Report or refer to the Gasket Chemical Services Guide Long Report (GSG-100) located on victaulic.com. The information shown defines general ranges for all compatible fluids.

[2] The Grade EHP gasket is only available on Style 107, 607 and 177 couplings.

[3] Vic-Plus™ pre-lubricated gasket.

Special Gaskets — IPS

Grade	Temp. Range[1]	Compound	Color Code	General Service Guidelines
M2	–40°F to +160°F –40° C to +71° C	Epichlorohydrin	White Stripe	Specially compounded to provide superior service for common aromatic fuels at low temperatures. Also suitable for certain ambient temperature water services.
V	–30°F to +180°F –34° C to +82° C	Neoprene	Yellow Stripe	May be specified for hot lubricating oils and certain chemicals. Good oxidation resistance. Will not support combustion.
O	+20°F to +300°F –7° C to +149° C	Fluoroelastomer	Blue Stripe	May be specified for many oxidizing acids, petroleum oils, halogenated hydrocarbons, lubricants, hydraulic fluids, organic liquids and air with hydrocarbons. **NOT COMPATIBLE FOR USE WITH HOT WATER SERVICES.**
L	–30°F to +350°F –34° C to +177° C	Silicone	Red Gasket	May be specified for dry heat, air without hydrocarbons to +350°F | +177°C and certain chemical services.
A	+20°F to +180°F –7° C to +82° C	White Nitrile	White Gasket	No carbon black content. May be used for food. Meets FDA requirements. Conforms to CFR Title 21 Part 177.2600. **Not compatible for use with hot, dry air over +140°F | +60°C and water over +150°F | +66°C. NOT COMPATIBLE FOR USE WITH HOT WATER SERVICES.**
HMT (T EndSeal®)	–20ºF to +150ºF –29ºC to +66ºC	Nitrile	Orange and Silver Stripes	Specially compounded with excellent oil resistance and a high modulus for resistance to extrusion. May be specified for petroleum products, air with oil vapors, vegetable and mineral oils within the specified temperature range. For maximum gasket life under pressure extremes, the temperature should be limited to +120°F | +49°C. **NOT COMPATIBLE FOR USE WITH HOT WATER SERVICES OVER +150°F | +66°C OR FOR HOT, DRY AIR OVER +140°F | +60°C.**
EF	–30°F to +230°F –34°C to +110°C	EPDM	Green "X"	May be specified for hot and cold water service within the specified temperature range plus a variety of dilute acids, oil-free air and many chemical services. Also meets hot and cold potable water requirements per DVGW, KTW, ÖVGW, SVGW and French ACS (Crecep), approved for W534, approved for EN681-1 Type WA cold potable and Type WB hot potable water service. **NOT COMPATIBLE FOR USE WITH PETROLEUM SERVICES.**
EW	–30°F to +230°F –34°C to +110°C	EPDM	Green "W"	May be specified for hot water service within the specified temperature range plus a variety of dilute acids, oil-free air and many chemical services. WRAS approved material to BS 6920 for cold and hot potable water service up to +149°F | +65°C UL Classified in accordance with ANSI/NSF 61 for cold +73°F | +23°C and hot +180°F | +82°C potable water service and ANSI/NSF 372. **NOT COMPATIBLE FOR USE WITH PETROLEUM SERVICES.**

[1] For specific chemical and temperature compatibility, refer to the **Gasket Selection Guide (05.01)** which includes the Gasket Chemical Services Short Report or refer to the **Gasket Chemical Services Guide Long Report (GSG-100)** located on **victaulic.com**. The information shown defines general ranges for all compatible fluids.

AWWA Coupling Gaskets

Grade	Temp. Range[1]	Compound	Color Code	General Service Guidelines
S	–20° F to +180° F –29° C to +82° C	Nitrile	Orange Stripe	Specially compounded to conform to ductile pipe surfaces. May be specified for petroleum products, air with oil vapors, vegetable and mineral oils within the specified temperature range. **Not compatible for use with hot, dry air over +140°F | +60°C and water over +150°F | +66°C. NOT COMPATIBLE FOR USE WITH HOT WATER SERVICES.**
M	–20° F to +200° F –29° C to +93° C	Halogenated Butyl	Brown Stripe	May be specified for water service within the specified temperature range plus a variety of dilute acids, oil-free air and many chemical services. Readily conforms to ductile iron pipe surfaces. UL Classified in accordance with ANSI/NSF 61 for cold +86°F | +30°C potable water service and ANSI/NSF 372. **NOT COMPATIBLE FOR USE WITH PETROLEUM SERVICES.**

[1] For specific chemical and temperature compatibility, refer to the **Gasket Selection Guide (05.01)** which includes the Gasket Chemical Services Short Report or refer to the **Gasket Chemical Services Guide Long Report (GSG-100)** located on **victaulic.com**. The information shown defines general ranges for all compatible fluids.

Vic-Press® Seals

Grade	Temp. Range[1]	Compound	Color Code	General Service Guidelines
H	–20° F to +210° F –29° C to +98° C	Hydrogenated Nitrile Butadiene Rubber (HNBR)	Two Orange Stripes	May be specified for hot petroleum/water mixtures, hydrocarbons, air with oil vapors, vegetable and mineral oils, engine oil and transmission oil. UL Classified in accordance with ANSI/NSF 61 for cold +73°F | +23°C and hot +180°F | +82°C potable water service and ANSI/NSF 372.
	Standard Seal: Vic-Press® products will ship with Grade "H" seal unless otherwise specified on order.			
E	–30° F to +250° F –34° C to +121° C	EPDM	Green Stripe	May be specified for hot water service, dilute acids, oil-free air, chemical services. UL Classified in accordance with ANSI/NSF 61 for cold +73°F | +23°C and hot +180°F | +82°C potable water service and ANSI/NSF 372. **NOT COMPATIBLE FOR USE WITH PETROLEUM OR STEAM SERVICES.**
O	+20° F to +300° F +6° C to +149° C	Fluoroelastomer	Blue Stripe	May be specified for oxidizing acids, petroleum oils, halogenated hydrocarbons, lubricants, hydraulic fluids, organic liquids, and air with hydrocarbons. **NOT COMPATIBLE FOR USE WITH HOT WATER OR STEAM SERVICES.**

[1] For specific chemical and temperature compatibility, refer to the **Gasket Selection Guide (05.01)** which includes the Gasket Chemical Services Short Report or refer to the **Gasket Chemical Services Guide Long Report (GSG-100)** located on **victaulic.com**. The information shown defines general ranges for all compatible fluids.

VBSP O-rings

Grade	Temp. Range[1]	Compound	Color Code	General Service Guidelines
E	-30ºF to +230ºF -34ºC to +110ºC	EPDM	N/A	Cold and hot water within allowable temperature range; dilute acids; excellent resistance to the deteriorative effects of ozone, oxygen, heat and most chemicals not involving hydrocarbons. **NOT COMPATIBLE FOR USE WITH PETROLEUM SERVICES.**
L	-30ºF to +350ºF -34ºC to +177ºC	Silicone	N/A	Dry, hot air applications; excellent resistance to many chemicals. **NOT COMPATIBLE FOR USE WITH HOT WATER OR STEAM SERVICES.**
I	-40ºF to +160ºF -40ºC to +71ºC	Isoprene	N/A	Water; saltwater; sewage; good resistance to oxygen and dilute acids.

[1] For specific chemical and temperature compatibility, refer to the **Gasket Selection Guide (05.01)** which includes the Gasket Chemical Services Short Report or refer to the **Gasket Chemical Services Guide Long Report (GSG-100)** located on **victaulic.com**. The information shown defines general ranges for all compatible fluids.

VBSP Gaskets

Grade	Temp. Range[1]	Compound	Color Code	General Service Guidelines
T	-20ºF to +180ºF -28ºC to +82ºC	Nitrile	N/A	Water; petroleum products, vegetable and mineral oils; air with oil vapors within allowable temperature.
O	+20ºF to +300ºF -7ºC to +149ºC	Fluoroelastomer	N/A	Outstanding resistance to heat and most chemicals.
V	-30ºF to +180ºF -34ºC to +82ºC	Neoprene	N/A	Water and wastewater; good resistance to ozone, effects of UV and some oils.

[1] For specific chemical and temperature compatibility, refer to the **Gasket Selection Guide (05.01)** which includes the Gasket Chemical Services Short Report or refer to the **Gasket Chemical Services Guide Long Report (GSG-100)** located on **victaulic.com**. The information shown defines general ranges for all compatible fluids.

Introduction

This Victaulic® General Catalog has been written for the piping system installer, designer, specification writer and owner as a basic reference guide for data about Victaulic® mechanical piping methods. This catalog is organized to provide information in the context and form most readily usable. For easy identification of major sections of interest, see the condensed table of contents on pg. i, for a fully detailed index, see pg. 125. For more detailed information, **download Design Data 26.01**.

Important Information

Victaulic® standard grooved pipe couplings are designed for use with pipe grooved to meet Victaulic® groove specifications and Victaulic® grooved end fittings, valves, and related grooved end components only. They are not intended for use with plain end pipe and/or fittings. Victaulic® plain end couplings are designed for use only with plain end or beveled end steel pipe (unless otherwise indicated) and Victaulic® plain end fittings. **Victaulic® plain end couplings must not be used with grooved end or threaded end pipe and/or fittings. Nor are they intended for use with Advanced Groove System (AGS) components used on 14–72" | 350–1825 mm pipe sizes.**

Pipe must be prepared to meet Victaulic® specifications outlined for each specific product style. Performance data listed herein is based on proper pipe preparation. The proper gasket must be selected for the service intended. **It should be noted that there are various services for which Victaulic® gaskets are not recommended. Reference should always be made to the latest Victaulic® Gasket Selection Guide (download submittal 05.01) for specific gasket service recommendations and for a listing of services which are not recommended. Gaskets for Victaulic® products always must be lubricated for proper assembly.** Gasket lubricant must meet manufacturer's specifications. Thorough lubrication of the gasket exterior, including the lips and/or pipe ends and housing interiors, is essential to prevent gasket pinching. Lubrication assists proper gasket seating and alignment during installation.

Victaulic® has a complete line of tools for preparing pipe to Victaulic® specifications. Use of these tools is recommended in preparing pipe to receive Victaulic® products. Always read and understand the Tool Operating Instructions supplied with every Victaulic® tool prior to using any tools. All data contained herein, is subject to change without notice.

Notice

The technical and performance data, weights, dimensions and specifications published in this catalog supersede all previously published data.

Victaulic® maintains a policy of continual product improvement and, therefore, reserves the right to change product specifications, designs, and standard equipment without notice and without incurring obligation.

For the most up-to-date Victaulic® product information, please visit **victaulic.com**.

The material presented in this catalog is intended for piping design reference in utilization of Victaulic® products for their intended application. It is not intended as a substitute for competent, professional assistance which is an obvious requisite to any specific application.

Design

Reference should always be made to design information available at no charge on request from Victaulic®. Good piping practices should always prevail. Specific pressures, temperatures, external or internal loads, performance standards and tolerances must never be exceeded. Many applications require recognition of special conditions, code requirements and use of safety factors. Qualified engineers must make these decisions.

While every effort has been made to ensure its accuracy, Victaulic®, its subsidiaries and affiliated companies, make no express or implied warranty of any kind respecting the information contained in this catalog or the material referred to herein.

Anyone making use of the information or material contained herein does so at their own risk and assumes any and all liability resulting from such use.

Installation

Reference should always be made to the specific Victaulic® Field Installation Handbook for the product you are installing. The following is a list of handbooks that can be requested for free from Victaulic®:

I-100	General Handbook
I-300	AWWA Products Handbook
I-P500	Vic-Press® Handbook
I-600	Copper Products Handbook
I-900	HDPE Products Handbook

Handbooks are included with each shipment of Victaulic® products for complete installation and assembly data, and are available in PDF format on our website at **victaulic.com**.

Global Pipe Size Designations

Victaulic® product data is utilized worldwide and all technical data is shown in both imperial (U.S.) and metric terms. The following chart shows a comparison between typical metric and IPS pipe sizes.

Nominal Imperial Inches – Size Group	Outside Diameter mm/Spec Ref	DIN mm	JIS mm	ANSI inches	China Standard (GB) mm
½	21.3 mm	15	15 A/21.7 mm	½	15*/21.3 mm
¾	26.7 mm	20/26.9 mm	20 A/27.2 mm	¾	20*/26.9 mm
1	33.4 mm	25/33.7 mm	25 A/34 mm	1	25*/33.7 mm
1¼	42.2 mm	32/42.4 mm	32 A/42.7 mm	1 1/4	32*/42.4 mm
1½	48.3 mm	40	40 A/48.6 mm	1 1/2	40*/48.3 mm
2	60.3 mm	DN & ISO 50	50 A/60.5 mm	2	50*/60.3 mm
2½	73.1 mm	—	—	2 ½	—
3	76.1 mm DIN/ISO (3 OD)	DN & ISO 65	65 A/76.3 mm	—	65*/76.1 mm
	88.9 mm	DN & ISO 80	JIS 80 A	3	80*/88.9 mm
4	108 mm China and old DIN	DIN 108 mm	—	—	108 mm
	114.3 mm	DN & ISO 100	JIS 100 A	4	100*/114.3 mm
5	133 mm China and old DIN	DIN 133 mm	—	—	133 mm
	139.7 mm DIN/ISO (5.5 OD)	DN & ISO 125	125 A/139.8 mm	—	125*/139.7 mm
	141.3 mm	—	—	5	—
6	159 mm China and old DIN	DIN 159 mm	—	—	159 mm
	165.1 mm JIS (6.5 OD)	—	150 A/165.2 mm	—	—
	168.3 mm	DN & ISO 150	—	6	150*/168.3 mm
8	216.3 JIS	—	JIS 200 A	—	—
	219.1 mm	DN 200	—	8	219.1 mm
10	267.4 JIS	—	JIS 250 A	—	—
	273 mm	DN 250	—	10	273 mm
12	318.5 JIS	—	JIS 300 A	—	—
	323.9 mm	DN 300	—	12	323.9 mm
14	355.6 mm	DN 350	JIS 350 A	14	355.6 mm
	377 mm China	—	—	—	377 mm
16	406.4 mm	DN 400	JIS 400 A	16	406.4 mm
	426 mm China	—	—	—	426 mm
18	457.2 mm	DN 450	JIS 450 A	18	457.2 mm
	480 mm China	—	—	—	480 mm
20	508 mm	DN 500	JIS 500 A	20	508 mm
	530 mm China	—	—	—	530 mm
22	558.8 mm	—	JIS 550 A	22	559 mm

Continued on next page.

Design Data

Nominal Imperial Inches – Size Group	Outside Diameter mm/Spec Ref	DIN mm	JIS mm	ANSI inches	China Standard (GB) mm
24	610 mm	DN 600	JIS 600 A	24	610 mm
	630 mm China	—	—	—	630 mm
26	660 mm	—	JIS 650 A	26	660 mm
28	711 mm	DN 700	—	28	711 mm
30	762 mm	—	—	30	762 mm
32	813 mm	DN 800	—	32	813 mm
34	864 mm	—	—	34	864 mm
36	914 mm	DN 900	—	36	914 mm
40	1016 mm	DN 1000	—	40	1016 mm
42	1067 mm	DN 1050	—	42	1067 mm
44	1118 mm	DN 1100	—	44	1118 mm
46	1168 mm	DN 1150	—	46	1168 mm
48	1219 mm	DN 1200	—	48	1219 mm
54	1372 mm	DN 1350	JIS 1372	54	1372 mm
56	1422 mm	DN 1400	JIS 1422	56	1422 mm
60	1524 mm	DN 1500	JIS 1524	60	1524 mm

GENERAL NOTES:

Nominal designations are used where the actual OD of the pipe matches the ANSI size. Otherwise both the nominal and actual OD are listed.
China sizes are listed as actual OD in mm. China sizes in shaded boxes are tubing sizes.

* Nominal sizes

Imperial (U.S.)/Metric Conversion Chart

This chart is provided as a guide for converting imperial and metric measurements provided within this catalog.

Convert Imperial (U.S.) to Metric						Convert Metric to Imperial (U.S.)
25.4	×	Inches (In.)	⇔	Millimeters (mm)	×	0.03937
0.3048	×	Feet (Ft.)	⇔	Meters (m)	×	3.281
0.4536	×	Pounds (Lbs.)	⇔	Kilograms (kg)	×	2.205
28.35	×	Ounces (Oz.)	⇔	Grams (g)	×	0.03527
6.894	×	Pressure (psi)	⇔	Kilopascals (kPa)	×	0.145
0.069	×	Pressure	⇔	Bar	×	14.5
4.45	×	End Load (Lbs.)	⇔	Newtons (N)	×	0.2248
1.356	×	Torque (Lb. Ft.)	⇔	Newton Meters (N•m)	×	0.738
F – 32 ÷ 1.8		Temp.(°F)	⇔	Celsius (°C)		C + 17.78 × 1.8
745.7	×	Horsepower (hp)	⇔	Watts (w)	×	1.341×10^{-3}
3.785	×	Gal. per Min. (GPM)	⇔	Liters per Min. (L/M)	×	0.2642
3.785	×	10^{-3} Gal. per Min. (GPM)	⇔	Cubic Meters per Min. (m^3/m)	×	264.2

WARRANTY:

We warrant all products to be free from defects in materials and workmanship under normal conditions of use and service. Our obligation under this warranty is limited to repairing or replacing at our option at our factory any product which shall within one year after delivery to original buyer be returned with transportation charges prepaid, and which our examination shall show to our satisfaction to have been defective.

THIS WARRANTY IS MADE EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. THE BUYER'S SOLE AND EXCLUSIVE REMEDY SHALL BE FOR THE REPAIR OR REPLACEMENT OF DEFECTIVE PRODUCTS AS PROVIDED HEREIN. THE BUYER AGREES THAT NO OTHER REMEDY (INCLUDING, BUT NOT LIMITED TO, INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR LOST PROFITS, LOST SALES, INJURY TO PERSON OR PROPERTY OR ANY OTHER INCIDENTAL OR CONSEQUENTIAL LOSS) SHALL BE AVAILABLE TO HIM.

Victaulic® neither assumes nor authorizes any person to assume for it any other liability in connection with the sale of such products.

This warranty shall not apply to any product which has been subject to misuse, negligence or accident, which has been repaired or altered in any manner outside of a Victaulic® factory or which has been used in a manner contrary to Victaulic® instructions or recommendations. Victaulic® shall not be responsible for design errors due to inaccurate or incomplete information supplied by Buyer or its representatives.

Items purchased by Victaulic® and resold will have the original equipment manufacturer's warranty extended to Victaulic® customers.

PRODUCT CERTIFICATIONS:

Fire Protection

ACTIVFIRE – ActivFire Register of Fire Protection Equipment (Australia)

CCCF – China Certification Center for Fire Protection Products (China)

CFPSC – Chinese Fire Protection Safety Center (Taiwan)

CNBOP – Centrum Naukowo-Badawcze Ochrony Przeciwpozarowej (Poland)

CNPP- Centre National de Prévention et de Protection (France)

CTPC – Consiliul Technic Permanent Pentru Constructii (Romania)

cULus – Underwriter's Laboratories, LLC (USA)

EMI – Epitesugyi Minosegellenorzo Innovacious (Hungary)

FDNY – City of New York Fire Department (USA)

FM – FM Approvals (USA)

HDB – Singapore Housing Development Board (Singapore)

KFI – Korea Fire Industry Technology Institute (Korea)

LPCB – Loss Prevention Certification Board (UK)

SBSC – Svensk Brand & Säkerhets Certifiering AB (Sweden)

TFRI – Tanjin Fire Research Institute of Ministry of Public Security (China)

TSU – Technický Skúšobný Ústav Pieštany, š.p. (Slovakia)

TSUS – Technický Skúšobný Ústav Stavebný, n.o. (Slovakia)

TZUS – Technický a Zkuševní Ústav Stavební Praha, s.p. (Czech Republic)

UKRFIRESERT – State Certification Center (Ukraine)

UL – Underwriter's Laboratories, LLC (USA)

ULC – Underwriter's Laboratories of Canada (Canada)

VdS – Verband der Schadenverhütung GmbH (Germany)

VKF – Vereinigug Kantonaler Feuerversicherungen (Switzerland)

VNIIPO – Russia Fire Protection Science & Research Institute (Russia)

Zagrebinspekt (Croatia)

Potable Water

ÁNTSZ – Állami Népegészségügyi És Tisztiorvosi Szologálat (Hungary)

ARPA – Agenzia Regionale per la Protezione dell'Ambiente (Italy)

DVGW – Deutscher Verein des Gas- und Wasserfaches e.V. (Germany)

Eurofins – ACS : Attestation de Conformité Sanitaire (France)

HZJZ – Croatian National Institute of Public Health (Croatia)

NSF – NSF International (USA)

ÖVGW – Österreichische Vereinigung für das Gas- und Wasserfach (Austria)

PZH – Panstwowy Zaklad Higieny (Poland)

RUVZPP – Regionálny úrad verejného zdravotníctva so sídlom v Poprade (Slovakia)

SAI – SAI Global (Australia)

SPAN – Suruhanjaya Perkhidmatan Air Negara (Malaysia)

SVGW – Schweizerischer Verein des Gas- und Wasserfaches (Sweden)

UL – Underwriter's Laboratories, LLC (USA)

WRAS – Water Regulations Advisory Scheme (UK)

ZUOVA – ZDRAVOTNÍ ÚSTAV se sídlem v Ostrave (Czech Republic)

Maritime

ABS – American Bureau of Shipping (USA)

BV – Bureau Veritas (France)

CCG – Canadian Coast Guard (Canada)

CSS – China Classification Society (China)

DNV – Det Norske Veritas (Norway)

GL – Germanischer Lloyd (Germany)

KRS – Korean Registry of Shipping (Korea)

LR– Lloyd's Register of Shipping (UK)

RINA – Registro Italiano Navale (Italy)

USCG – US Coast Guard (USA)

HVAC

CSTB - Centre Scientifique et Technique du Bâtiment (France)

ITB – Instytut Techniki Budowlanej (Poland)

Sercons Europe BV (Russia)

Plumbing

IAPMO – International Association of Plumbing & Mechanical Officials (USA)

ICC-ES – International Code Council- Evaluation Service (USA)

NSF – NSF International (USA)

COMPLIANCE:

Codes/Standards

ANSI – American National Standards Institute (USA)

API – American Petroleum Institute (USA)

APSAD – Assemblée Plenière Société Assurance Dommage (France)

AS/NZS – Standards Australia and Standards New Zealand (AU & NZ)

ASTM – American Society for Testing and Materials (USA)

AWWA – American Water Works Association (USA)

BOCA – Building Officials and Code Administrators (USA)

CSA – Canadian Standards Association (Canada)

CSFM – California State Fire Marshal (USA)

GOST R – Gosstandart (Russia)

IPC – International Plumbing Code (USA)

ISO – International Standards Organization (Global)

NACE – National Association of Corrosion Engineers (USA)

NFPA – National Fire Protection Association (USA)

SBCCI – Southern Building Code Congress International (USA)

UPC – Uniform Plumbing Code (USA)

Pressure Equipment Safety

(97/23/EC) PED – Pressure Equipment Directive (Europe)

CSA B51 – "Boiler, Pressure Vessel, and Pressure Piping Code" (Canada)

CRN – Canadian Registration Number per CSA B51 (Canada)

(EU/305/2011) CPR – Construction Products Regulation- Fire safety products (Europe)

Chemical Safety / Recycling

(EC/1907/2006) REACH– Registration, Evaluation, Authorization, and Registration of Chemicals (Europe)

(2002/95/EC) RoHS – Restriction of Hazardous Substances Directive (Europe)

(2002/96/EC) WEEE – Waste Electrical and Electronic Equipment Directive (Europe)

Building Services

NBC – National Building Code (Canada)

PSB – TUV SUD PSB Singapore (Singapore)

Explosive Environments

(94/9/EC) ATEX – Equipment and protective systems for potentially explosive atmospheres (Europe)

Seismic

OSHPD – Office of Statewide Health Planning and Development (USA)

Tools and Machinery

(2006/42/EC) MD – Machinery Directive (Europe)

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APPENDIX I

NFPA 72 – National Fire Alarm and Signaling Code, (2013 Edition) Information and Tables

NFPA 72 – National Fire Alarm and Signaling Code

Chapter 14 Inspection, Testing, and Maintenance

14.1 Application.

14.1.1 *The inspection, testing, and maintenance of systems, their initiating devices, and notification appliances shall comply with the requirements of this chapter.*

14.1.2 *The inspection, testing, and maintenance of single- and multiple-station smoke and heat alarms and household fire alarm systems shall comply with the requirements of this chapter.*

14.1.3 *Procedures that are required by other parties and that exceed the requirements of this chapter shall be permitted.*

14.1.4 *The requirements of this chapter shall apply to both new and existing systems.*

14.1.5 *The requirements of Chapter **7** shall apply where referenced in Chapter **14**.*

14.2 General.

14.2.1 Purpose.

14.2.1.1* *The purpose for initial and reacceptance inspections is to ensure compliance with approved design documents and to ensure installation in accordance with this Code and other required installation standards.*

14.2.1.2* *The purpose for initial and reacceptance tests of fire alarm and signaling systems is to ensure system operation in accordance with the design documents.*

14.2.1.3* *The purpose for periodic inspections is to assure that obvious damages or changes that might affect the system operability are visually identified.*

14.2.1.4* *The purpose for periodic testing is to statistically assure operational reliability.*

14.2.2 Performance.

14.2.2.1 Performance Verification. *To ensure operational integrity, the system shall have an inspection, testing, and maintenance program.*

14.2.2.1.1 *Inspection, testing, and maintenance programs shall satisfy the requirements of this Code and conform to the equipment manufacturer's published instructions.*

14.2.2.1.2 *Inspection, testing, and maintenance programs shall verify correct operation of the system.*

14.2.2.2 Impairments/Deficiencies.

14.2.2.2.1 *The requirements of Section **10.21** shall be applicable when a system is impaired.*

14.2.2.2.2 *System deficiencies shall be corrected.*

14.2.2.2.3 *If a deficiency is not corrected at the conclusion of system inspection, testing, or maintenance, the system owner or the owner's designated representative shall be informed of the impairment in writing within 24 hours.*

14.2.3 Responsibilities.

14.2.3.1* *The property or building or system owner or the owner's designated representative shall be responsible for inspection, testing, and maintenance of the system and for alterations or additions to this system.*

14.2.3.2 *Where the property owner is not the occupant, the property owner shall be permitted to delegate the authority and responsibility for inspecting, testing, and maintaining the fire protection systems to the occupant, management firm, or managing individual through specific provisions in the lease, written use agreement, or management contract.*

14.2.3.3 *Inspection, testing, or maintenance shall be permitted to be done by the building or system owner or a person or organization other than the building or system owner if conducted under a written contract.*

14.2.3.4 *Where the building or system owner has delegated any responsibilities for inspection, testing, or maintenance, a copy of the written delegation required by **14.2.3.3** shall be provided to the authority having jurisdiction upon request.*

14.2.3.5 *Testing and maintenance of central station service systems shall be performed under the contractual arrangements specified in **26.3.3**.*

14.2.3.6* Service Personnel Qualifications and Experience. *Service personnel shall be qualified and experienced in accordance with the requirements of **10.5.3**.*

14.2.4* Notification.

14.2.4.1 *Before proceeding with any testing, all persons and facilities receiving alarm, supervisory, or trouble signals and all building occupants shall be notified of the testing to prevent unnecessary response.*

14.2.4.2 *At the conclusion of testing, those previously notified (and others, as necessary) shall be notified that testing has been concluded.*

14.2.4.3 *The owner or the owner's designated representative and service personnel shall coordinate system testing to prevent interruption of critical building systems or equipment.*

14.2.5 System Documentation. *Prior to system maintenance or testing, the record of completion and any information required by Chapter **7** regarding the system and system alterations, including specifications, wiring*

diagrams, and floor plans, shall be provided by the owner or a designated representative to the service personnel upon request.

14.2.5.1 *The provided documentation shall include the current revisions of all fire alarm software and the revisions of software of any systems with which the fire alarm software interfaces.*

14.2.5.2 *The revisions of fire alarm software, and the revisions of the software in the systems with which the fire alarm software interfaces, shall be verified for compatibility in accordance with the requirements of* ***23.2.2.1.1****.*

14.2.6 Releasing Systems. *Requirements pertinent to testing the fire alarm systems initiating fire suppression system releasing functions shall be covered by* ***14.2.6.1*** *through* ***14.2.6.6****.*

14.2.6.1 *Testing personnel shall be qualified and experienced in the specific arrangement and operation of a suppression system(s) and a releasing function(s) and shall be cognizant of the hazards associated with inadvertent system discharge.*

14.2.6.2 *Occupant notification shall be required whenever a fire alarm system configured for releasing service is being serviced or tested.*

14.2.6.3 *Discharge testing of suppression systems shall not be required by this Code.*

14.2.6.4 *Suppression systems shall be secured from inadvertent actuation, including disconnection of releasing solenoids or electric actuators, closing of valves, other actions, or combinations thereof, for the specific system, for the duration of the fire alarm system testing.*

14.2.6.5 *Testing shall include verification that the releasing circuits and components energized or actuated by the fire alarm system are electrically monitored for integrity and operate as intended on alarm.*

14.2.6.6 *Suppression systems and releasing components shall be returned to their functional operating condition upon completion of system testing.*

14.2.7 Interface Equipment and Emergency Control Functions.

14.2.7.1* *Testing personnel shall be qualified and experienced in the arrangement and operation of interface equipment and emergency control functions.*

14.2.7.2 *Testing shall be accomplished in accordance with* ***Table 14.4.3.2****.*

14.2.8 Automated Testing.

14.2.8.1 *Automated testing arrangements that provide equivalent means of testing devices to those specified in* ***Table 14.4.3.2*** *at a frequency at least equivalent to those specified in* ***Table 14.4.3.2*** *shall be permitted to be used to comply with the requirements of this chapter.*

14.2.8.2 *Failure of a device on an automated test shall result in an audible and visual trouble signal.*

14.2.9* ***Performance-Based Inspection and Testing.*** *As an alternate means of compliance, subject to the authority having jurisdiction, components and systems shall be permitted to be inspected and tested under a performance-based program.*

14.2.10* ***Test Plan.***

14.2.10.1 *A test plan shall be written to clearly establish the scope of the testing for the fire alarm or signaling system.*

14.2.10.2 *The test plan and results shall be documented with the testing records.*

14.3 Inspection.

14.3.1* *Unless otherwise permitted by* ***14.3.2****, visual inspections shall be performed in accordance with the schedules in* ***Table 14.3.1*** *or more often if required by the authority having jurisdiction.*

Table 14.3.1 *column 2 heading was revised by a tentative interim amendment (TIA).*

Table 14.3.1 Visual Inspection

	Component	Initial Acceptance	Periodic Frequency	Method	Reference
1.	All equipment	X	Annual	Ensure there are no changes that affect equipment performance. Inspect for building modifications, occupancy changes, changes in environmental conditions, device location, physical obstructions, device orientation, physical damage, and degree of cleanliness.	14.3.4
2.	Control equipment:				
	(a) Fire alarm systems monitored for alarm, supervisory, and trouble signals			Verify a system normal condition.	
	(1) Fuses	X	Annual		
	(2) Interfaced equipment	X	Annual		
	(3) Lamps and LEDs	X	Annual		
	(4) Primary (main) power supply	X	Annual		
	(5) Trouble signals	X	Semiannual		
	(b) Fire alarm systems unmonitored for alarm, supervisory, and trouble signals			Verify a system normal condition.	
	(1) Fuses	X	Weekly		
	(2) Interfaced equipment	X	Weekly		
	(3) Lamps and LEDs	X	Weekly		
	(4) Primary (main) power supply	X	Weekly		
	(5) Trouble signals	X	Weekly		
3.	Reserved				
4.	Supervising station alarm systems — transmitters			Verify location, physical condition, and a system normal condition.	
	(a) Digital alarm communicator transmitter (DACT)	X	Annual		
	(b) Digital alarm radio transmitter (DART)	X	Annual		
	(c) McCulloh	X	Annual		
	(d) Radio alarm transmitter (RAT)	X	Annual		
	(e) All other types of communicators	X	Annual		
5.	In-building fire emergency voice/alarm communications equipment	X	Semiannual	Verify location and condition.	
6.	Reserved				
7.	Reserved				
8.	Reserved				
9.	Batteries			Inspect for corrosion or leakage. Verify tightness of connections. Verify marking of the month/year of manufacture (all types).	10.6.10
	(a) Lead-acid	X	Monthly	Visually inspect electrolyte level.	
	(b) Nickel-cadmium	X	Semiannual		
	(c) Primary (dry cell)	X	Monthly		
	(d) Sealed lead-acid	X	Semiannual		
10.	Reserved				

(continues)

Table 14.3.1 *Continued*

	Component	Initial Acceptance	Periodic Frequency	Method	Reference
11.	Remote annunciators	X	Semiannual	Verify location and condition.	
12.	Notification appliance circuit power extenders	X	Annual	Verify proper fuse ratings, if any. Verify that lamps and LEDs indicate normal operating status of the equipment.	10.6
13.	Remote power supplies	X	Annual	Verify proper fuse ratings, if any. Verify that lamps and LEDs indicate normal operating status of the equipment.	10.6
14.	Transient suppressors	X	Semiannual	Verify location and condition.	
15.	Reserved				
16.	Fiber-optic cable connections	X	Annual	Verify location and condition.	
17.	Initiating devices			Verify location and condition (all devices).	
	(a) Air sampling				
	(1) General	X	Semiannual	Verify that in-line filters, if any, are clean.	17.7.3.6
	(2) Sampling system piping and sampling ports	X		Verify that sampling system piping and fittings are installed properly, appear airtight, and are permanently fixed. Confirm that sampling pipe is conspicuously identified. Verify that sample ports or points are not obstructed.	17.7.3.6
	(b) Duct detectors				
	(1) General	X	Semiannual	Verify that detector is rigidly mounted. Confirm that no penetrations in a return air duct exist in the vicinity of the detector. Confirm the detector is installed so as to sample the airstream at the proper location in the duct.	17.7.5.5
	(2) Sampling tube	X		Verify proper orientation. Confirm the sampling tube protrudes into the duct in accordance with system design.	17.7.5.5
	(c) Electromechanical releasing devices	X	Semiannual		
	(d) Fire extinguishing system(s) or suppression system(s) switches	X	Semiannual		
	(e) Manual fire alarm boxes	X	Semiannual		
	(f) Heat detectors	X	Semiannual		
	(g) Radiant energy fire detectors	X	Quarterly	Verify no point requiring detection is obstructed or outside the detector's field of view.	17.8
	(h) Video image smoke and fire detectors	X	Quarterly	Verify no point requiring detection is obstructed or outside the detector's field of view.	17.7.7; 17.11.5
	(i) Smoke detectors (excluding one- and two-family dwellings)	X	Semiannual		
	(j) Projected beam smoke detectors	X	Semiannual	Verify beam path is unobstructed.	
	(k) Supervisory signal devices	X	Quarterly		
	(l) Waterflow devices	X	Quarterly		
18.	Reserved				

Table 14.3.1 *Continued*

	Component	Initial Acceptance	Periodic Frequency	Method	Reference
19.	Combination systems			Verify location and condition (all types).	
	(a) Fire extinguisher electronic monitoring device/systems	X	Semiannual		
	(b) Carbon monoxide detectors/systems	X	Semiannual		
20.	Fire alarm control interface and emergency control function interface	X	Semiannual	Verify location and condition.	
21.	Guard's tour equipment	X	Semiannual	Verify location and condition.	
22.	Notification appliances			Verify location and condition (all appliances).	
	(a) Audible appliances	X	Semiannual		
	(b) Audible textual notification appliances	X	Semiannual		
	(c) Visible appliances				
	(1) General	X	Semiannual		18.5.5
	(2) Candela rating	X		Verify that the candela rating marking agrees with the approved drawings.	18.5.5
23.	Exit marking audible notification appliances	X	Semiannual	Verify location and condition.	
24.	Reserved				
25.	Area of refuge two-way communication system	X	Annual	Verify location and condition.	
26.	Reserved				
27.	Supervising station alarm systems — receivers				
	(a) Signal receipt	X	Daily	Verify receipt of signal.	
	(b) Receivers	X	Annual	Verify location and normal condition.	
28.	Public emergency alarm reporting system transmission equipment			Verify location and condition.	
	(a) Publicly accessible alarm box	X	Semiannual		
	(b) Auxiliary box	X	Annual		
	(c) Master box				
	(1) Manual operation	X	Semiannual		
	(2) Auxiliary operation	X	Annual		
29.	Reserved				
30.	Mass notification system				
	(a) Monitored for integrity			Verify a system normal condition.	
	(1) Control equipment				
	(i) Fuses	X	Annual		
	(ii) Interfaces	X	Annual		
	(iii) Lamps/LED	X	Annual		
	(iv) Primary (main) power supply	X	Annual		
	(2) Secondary power batteries	X	Annual		
	(3) Initiating devices	X	Annual		
	(4) Notification appliances	X	Annual		

(continues)

Table 14.3.1 *Continued*

Component	Initial Acceptance	Periodic Frequency	Method	Reference
30. Mass notification system *(continued)*				
(b) Not monitored for integrity; installed prior to adoption of the 2010 edition			Verify a system normal condition.	
(1) Control equipment				
(i) Fuses	X	Semiannual		
(ii) Interfaces	X	Semiannual		
(iii) Lamps/LED	X	Semiannual		
(iv) Primary (main) power supply	X	Semiannual		
(2) Secondary power batteries	X	Semiannual		
(3) Initiating devices	X	Semiannual		
(4) Notification appliances	X	Semiannual		
(c) Antenna	X	Annual	Verify location and condition.	
(d) Transceivers	X	Annual	Verify location and condition.	

14.3.2 *Devices or equipment that is inaccessible for safety considerations (e.g., continuous process operations, energized electrical equipment, radiation, and excessive height) shall be permitted to be inspected during scheduled shutdowns if approved by the authority having jurisdiction.*

14.3.3 *Extended intervals shall not exceed 18 months.*

14.3.4 *The visual inspection shall be made to ensure that there are no changes that affect equipment performance.*

14.4 Testing.

14.4.1 Initial Acceptance Testing.

14.4.1.1 *All new systems shall be inspected and tested in accordance with the requirements of Chapter **14**.*

14.4.1.2 *The authority having jurisdiction shall be notified prior to the initial acceptance test.*

14.4.2* Reacceptance Testing.

14.4.2.1 *When an initiating device, notification appliance, or control relay is added, it shall be functionally tested.*

14.4.2.2 *When an initiating device, notification appliance, or control relay is deleted, another device, appliance, or control relay on the circuit shall be operated.*

14.4.2.3 *When modifications or repairs to control equipment hardware are made, the control equipment shall be tested in accordance with **Table 14.4.3.2**, items 1(a) and 1(d).*

14.4.2.4 *When changes are made to site-specific software, the following shall apply:*

(1) All functions known to be affected by the change, or identified by a means that indicates changes, shall be 100 percent tested.

(2) In addition, 10 percent of initiating devices that are not directly affected by the change, up to a maximum of 50 devices, also shall be tested and correct system operation shall be verified.

*(3) A revised record of completion in accordance with **7.5.6** shall be prepared to reflect these changes.*

14.4.2.5 *Changes to the system executive software shall require a 10 percent functional test of the system, including a test of at least one device on each input and output circuit to verify critical system functions such as notification appliances, control functions, and off-premises reporting.*

14.4.3* Test Methods.

14.4.3.1* *At the request of the authority having jurisdiction, the central station facility installation shall be inspected for complete information regarding the central station system, including specifications, wiring diagrams, and floor plans that have been submitted for approval prior to installation of equipment and wiring.*

14.4.3.2* *Systems and associated equipment shall be tested according to **Table 14.4.3.2**.*

Table 14.4.3.2 was revised by tentative interim amendments (TIAs).

Table 14.4.3.2 Testing

	Component	Initial Acceptance	Periodic Frequency	Method
1.	All equipment	X		See Table 14.3.1.
2.	Control equipment and transponder			
	(a) Functions	X	Annually	Verify correct receipt of alarm, supervisory, and trouble signals (inputs); operation of evacuation signals and auxiliary functions (outputs); circuit supervision, including detection of open circuits and ground faults; and power supply supervision for detection of loss of ac power and disconnection of secondary batteries.
	(b) Fuses	X	Annually	Verify rating and supervision.
	(c) Interfaced equipment	X	Annually	Verify integrity of single or multiple circuits providing interface between two or more control units. Test interfaced equipment connections by operating or simulating operation of the equipment being supervised. Verify signals required to be transmitted at the control unit.
	(d) Lamps and LEDs	X	Annually	Illuminate lamps and LEDs.
	(e) Primary (main) power supply	X	Annually	Disconnect and test all secondary (standby) power under maximum load, including all alarm appliances requiring simultaneous operation. Reconnect all secondary (standby) power at end of test. Test redundant power supplies separately.
3.	Fire alarm control unit trouble signals			
	(a) Audible and visual	X	Annually	Verify operation of control unit trouble signals. Verify ring-back feature for systems using a trouble-silencing switch that requires resetting.
	(b) Disconnect switches	X	Annually	If control unit has disconnect or isolating switches, verify performance of intended function of each switch. Verify receipt of trouble signal when a supervised function is disconnected.
	(c) Ground-fault monitoring circuit	X	Annually	If the system has a ground detection feature, verify the occurrence of ground-fault indication whenever any installation conductor is grounded.
	(d) Transmission of signals to off-premises location	X	Annually	Actuate an initiating device and verify receipt of alarm signal at the off-premises location. Create a trouble condition and verify receipt of a trouble signal at the off-premises location. Actuate a supervisory device and verify receipt of a supervisory signal at the off-premises location. If a transmission carrier is capable of operation under a single- or multiple-fault condition, activate an initiating device during such fault condition and verify receipt of an alarm signal and a trouble signal at the off-premises location.
4.	Supervising station alarm systems — transmission Equipment			
	(a) All equipment	X	Annually	*Test all system functions and features in accordance with the equipment manufacturer's published instructions for correct operation in conformance with the applicable sections of Chapter 26. Except for DACT, actuate initiating device and verify receipt of the correct initiating device signal at the supervising station within 90 seconds. Upon completion of the test, restore the system to its functional operating condition. If test jacks are used, conduct the first and last tests without the use of the test jack.
	(b) Digital alarm communicator transmitter (DACT)	X	Annually	Except for DACTs installed prior to adoption of the 2013 edition of NFPA 72 that are connected to a telephone line (number) that is also supervised for adverse conditions by a derived local channel, ensure connection of the DACT to two separate means of transmission. Test DACT for line seizure capability by initiating a signal while using the telephone line (primary line for DACTs using two telephone lines) for a telephone call. Ensure that the call is interrupted and that the communicator connects to the digital alarm receiver. Verify receipt of the correct signal at the supervising station. Verify each transmission attempt is completed within 90 seconds from going off-hook to on-hook.

(continues)

Table 14.4.3.2 *Continued*

Component	Initial Acceptance	Periodic Frequency	Method
4. Supervising station alarm systems — transmission Equipment			
(b) Digital alarm communicator transmitter (DACT) *(continued)*			Disconnect the telephone line (primary line for DACTs using two telephone lines) from the DACT. Verify indication of the DACT trouble signal occurs at the premises fire alarm control unit within 4 minutes of detection of the fault. Verify receipt of the telephone line trouble signal at the supervising station. Restore the telephone line (primary line for DACTs using two telephone lines), reset the fire alarm control unit, and verify that the telephone line fault trouble signal returns to normal. Verify that the supervising station receives the restoral signal from the DACT. Disconnect the secondary means of transmission from the DACT. Verify indication of the DACT trouble signal occurs at the premises fire alarm control unit within 4 minutes of detection of the fault. Verify receipt of the secondarey means trouble signal at the supervising station. Restore the secondary means of transmission, reset the fire alarm control unit, and verify that the trouble signal returns to normal. Verify that the supervising station receives the restoral signal from the secondary transmitter. Cause the DACT to transmit a signal to the DACR while a fault in the telephone line (number) (primary line for DACTs using two telephone lines) is simulated. Verify utilization of the secondary communication path by the DACT to complete the transmission to the DACR.
(c) Digital alarm radio transmitter (DART)	X	Annually	Disconnect the primary telephone line. Verify transmission of a trouble signal to the supervising station by the DART occurs within 4 minutes.
(d) McCulloh transmitter	X	Annually	Actuate initiating device. Verify production of not less than three complete rounds of not less than three signal impulses each by the McCulloh transmitter. If end-to-end metallic continuity is present and with a balanced circuit, cause each of the following four transmission channel fault conditions in turn, and verify receipt of correct signals at the supervising station: (1) Open (2) Ground (3) Wire-to-wire short (4) Open and ground If end-to-end metallic continuity is not present and with a properly balanced circuit, cause each of the following three transmission channel fault conditions in turn, and verify receipt of correct signals at the supervising station: (1) Open (2) Ground (3) Wire-to-wire short
(e) Radio alarm transmitter (RAT)	X	Annually	Cause a fault between elements of the transmitting equipment. Verify indication of the fault at the protected premises, or transmission of trouble signal to the supervising station.
(f) Performance-based technologies	X	Annually	Perform tests to ensure the monitoring of integrity of the transmission technology and technology path. Where a single communications path is used, disconnect the communication path. Manually initiate an alarm signal transmission or allow the check-in (handshake) signal to be transmitted automatically.[b] Verify the premises unit annunciates the failure within 200 seconds of the transmission failure. Restore the communication path. Where multiple communication paths are used, disconnect both communication paths. Manually initiate an alarm signal transmission. Verify the premises control unit annunciates the failure within 200 seconds of the transmission failure. Restore both communication paths.
5. Emergency communications equipment			
(a) Amplifier/tone generators	X	Annually	Verify correct switching and operation of backup equipment.
(b) Call-in signal silence	X	Annually	Operate/function and verify receipt of correct visual and audible signals at control unit.
(c) Off-hook indicator (ring down)	X	Annually	Install phone set or remove phone from hook and verify receipt of signal at control unit.
(d) Phone jacks	X	Annually	Visually inspect phone jack and initiate communications path through jack.

Table 14.4.3.2 *Continued*

Component	Initial Acceptance	Periodic Frequency	Method
(e) Phone set	X	Annually	Activate each phone set and verify correct operation.
(f) System performance	X	Annually	Operate the system with a minimum of any five handsets simultaneously. Verify voice quality and clarity.
6. Engine-driven generator	X	Monthly	If an engine-driven generator dedicated to the system is used as a required power source, verify operation of the generator in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems*, by the building owner.
7. Secondary (standby) power supply[c]	X	Annually	Disconnect all primary (main) power supplies and verify the occurrence of required trouble indication for loss of primary power. Measure or verify the system's standby and alarm current demand and verify the ability of batteries to meet standby and alarm requirements using manufacturer's data. Operate general alarm systems a minimum of 5 minutes and emergency voice communications systems for a minimum of 15 minutes. Reconnect primary (main) power supply at end of test.
8. Uninterruptible power supply (UPS)	X	Annually	If a UPS system dedicated to the system is used as a required power source, verify by the building owner operation of the UPS system in accordance with NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*.
9. Battery tests			Prior to conducting any battery testing, verify by the person conducting the test, that all system software stored in volatile memory is protected from loss.
(a) Lead-acid type			
(1) Battery replacement	X	Annually	Replace batteries in accordance with the recommendations of the alarm equipment manufacturer or when the recharged battery voltage or current falls below the manufacturer's recommendations.
(2) Charger test	X	Annually	With the batteries fully charged and connected to the charger, measure the voltage across the batteries with a voltmeter. Verify the voltage is 2.30 volts per cell ±0.02 volts at 77°F (25°C) or as specified by the equipment manufacturer.
(3) Discharge test	X	Annually	With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery.
(4) Load voltage test	X	Semiannually	With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery. Verify the battery does not fall below 2.05 volts per cell under load.
(5) Specific gravity	X	Semiannually	Measure as required the specific gravity of the liquid in the pilot cell or all of the cells. Verify the specific gravity is within the range specified by the manufacturer. Although the specified specific gravity varies from manufacturer to manufacturer, a range of 1.205–1.220 is typical for regular lead-acid batteries, while 1.240–1.260 is typical for high-performance batteries. Do not use a hydrometer that shows only a pass or fail condition of the battery and does not indicate the specific gravity, because such a reading does not give a true indication of the battery condition.
(b) Nickel-cadmium type			
(1) Battery replacement	X	Annually	Replace batteries in accordance with the recommendations of the alarm equipment manufacturer or when the recharged battery voltage or current falls below the manufacturer's recommendations.
(2) Charger test[d]	X	Annually	With the batteries fully charged and connected to the charger, place an ampere meter in series with the battery under charge. Verify the charging current is in accordance with the manufacturer's recommendations for the type of battery used. In the absence of specific information, use 1/10 to 1/25 of the battery rating.
(3) Discharge test	X	Annually	With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery.
(4) Load voltage test	X	Semiannually	With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery. Verify the float voltage for the entire battery is 1.42 volts per cell, nominal, under load. If possible, measure cells individually.

(continues)

Table 14.4.3.2 *Continued*

Component	Initial Acceptance	Periodic Frequency	Method
9. Battery tests *(continued)*			
(c) Sealed lead-acid type			
(1) Battery replacement	X	Annually	Replace batteries in accordance with the recommendations of the alarm equipment manufacturer or when the recharged battery voltage or current falls below the manufacturer's recommendations.
(2) Charger test	X	Annually	With the batteries fully charged and connected to the charger, measure the voltage across the batteries with a voltmeter. Verify the voltage is 2.30 volts per cell ±0.02 volts at 77°F (25°C) or as specified by the equipment manufacturer.
(3) Discharge test	X	Annually	With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery.
(4) Load voltage test	X	Semiannually	Verify the battery performs under load, in accordance with the battery manufacturer's specifications.
10. Public emergency alarm reporting system — wired system	X	Daily	Manual tests of the power supply for public reporting circuits shall be made and recorded at least once during each 24-hour period. Such tests shall include the following: (1) Current strength of each circuit. Changes in current of any circuit exceeding 10 percent shall be investigated immediately. (2) Voltage across terminals of each circuit inside of terminals of protective devices. Changes in voltage of any circuit exceeding 10 percent shall be investigated immediately. (3)[a] Voltage between ground and circuits. If this test shows a reading in excess of 50 percent of that shown in the test specified in (2), the trouble shall be immediately located and cleared. Readings in excess of 25 percent shall be given early attention. These readings shall be taken with a calibrated voltmeter of not more than 100 ohms resistance per volt. Systems in which each circuit is supplied by an independent current source (Forms 3 and 4) require tests between ground and each side of each circuit. Common current source systems (Form 2) require voltage tests between ground and each terminal of each battery and other current source. (4) Ground current reading shall be permitted in lieu of (3). If this method of testing is used, all grounds showing a current reading in excess of 5 percent of the supplied line current shall be given immediate attention. (5) Voltage across terminals of common battery on switchboard side of fuses. (6) Voltage between common battery terminals and ground. Abnormal ground readings shall be investigated immediately. Tests specified in (5) and (6) shall apply only to those systems using a common battery. If more than one common battery is used, each common battery shall be tested.
11. Remote annunciators	X	Annually	Verify the correct operation and identification of annunciators. If provided, verify the correct operation of annunciator under a fault condition.
12. Reserved			
13. Reserved			
14. Reserved			
15. Conductors — metallic			
(a) Stray voltage	X	N/A	Test all installation conductors with a volt/ohmmeter to verify that there are no stray (unwanted) voltages between installation conductors or between installation conductors and ground. Verify the maximum allowable stray voltage does not exceed 1 volt ac/dc, unless a different threshold is specified in the published manufacturer's instructions for the installed equipment.
(b) Ground faults	X	N/A	Test all installation conductors, other than those intentionally and permanently grounded, for isolation from ground per the installed equipment manufacturer's published instructions.
(c) Short-circuit faults	X	N/A	Test all installation conductors, other than those intentionally connected together, for conductor-to-conductor isolation per the published manufacturer's instructions for the installed equipment. Also test these same circuits conductor-to-ground.

Table 14.4.3.2 *Continued*

Component	Initial Acceptance	Periodic Frequency	Method
(d) Loop resistance	X	N/A	With each initiating and indicating circuit installation conductor pair short-circuited at the far end, measure and record the resistance of each circuit. Verify that the loop resistance does not exceed the limits specified in the published manufacturer's instructions for the installed equipment.
(e) Circuit integrity	X	N/A	For initial and reacceptance testing, confirm the introduction of a fault in any circuit monitored for integrity results in a trouble indication at the fire alarm control unit. Open one connection at not less than 10 percent of the initiating devices, notification appliances and controlled devices on every initiating device circuit, notification appliance circuit, and signaling line circuit. Confirm all circuits perform as indicated in Sections 23.5, 23.6, and 23.7.
	N/A	Annually	For periodic testing, test each initiating device circuit, notification appliance circuit, and signaling line circuit for correct indication at the control unit. Confirm all circuits perform as indicated in Sections 23.5, 23.6, and 23.7.
16. Conductors — nonmetallic			
(a) Fiber optics	X	N/A	Test the fiber-optic transmission line by the use of an optical power meter or by an optical time domain reflectometer used to measure the relative power loss of the line. Test result data must meet or exceed ANSI/TIA 568-C.3, *Optical Fiber Cabling Components Standard*, related to fiber-optic lines and connection/splice losses and the control unit manufacturer's published specifications.
(b) Circuit integrity	X	N/A	For initial and reacceptance testing, confirm the introduction of a fault in any circuit monitored for integrity results in a trouble indication at the fire alarm control unit. Open one connection at not less than 10 percent of the initiating devices, notification appliances, and controlled devices on every initiating device circuit, notification appliance circuit, and signaling line circuit. Confirm all circuits perform as indicated in Sections 23.5, 23.6, and 23.7.
	N/A	Annually	For periodic testing, test each initiating device circuit, notification appliance circuit, and signaling line circuit for correct indication at the control unit. Confirm all circuits perform as indicated in Sections 23.5, 23.6, and 23.7.
17. Initiating devices[f]			
(a) Electromechanical releasing device			
(1) Nonrestorable-type link	X	Annually	Verify correct operation by removal of the fusible link and operation of the associated device. Lubricate any moving parts as necessary.
(2) Restorable-type link[g]	X	Annually	Verify correct operation by removal of the fusible link and operation of the associated device. Lubricate any moving parts as necessary.
(b) Fire extinguishing system(s) or suppression system(s) alarm switch	X	Annually	Operate the switch mechanically or electrically and verify receipt of signal by the fire alarm control unit.
(c) Fire–gas and other detectors	X	Annually	Test fire–gas detectors and other fire detectors as prescribed by the manufacturer and as necessary for the application.
(d) Heat detectors			
(1) Fixed-temperature, rate-of-rise, rate of compensation, restorable line, spot type (excluding pneumatic tube type)	X	Annually (see 14.4.4.5)	Perform heat test with a listed and labeled heat source or in accordance with the manufacturer's published instructions. Assure that the test method for the installed equipment does not damage the nonrestorable fixed-temperature element of a combination rate-of-rise/fixed-temperature element detector.
(2) Fixed-temperature, nonrestorable line type	X	Annually	Do not perform heat test. Test functionality mechanically and electrically. Measure and record loop resistance. Investigate changes from acceptance test.
(3) Fixed-temperature, nonrestorable spot type	X	See Method	After 15 years from initial installation, replace all devices or have 2 detectors per 100 laboratory tested. Replace the 2 detectors with new devices. If a failure occurs on any of the detectors removed, remove and test additional detectors to determine either a general problem involving faulty detectors or a localized problem involving 1 or 2 defective detectors. If detectors are tested instead of replaced, repeat tests at intervals of 5 years.
(4) Nonrestorable (general)	X	Annually	Do not perform heat tests. Test functionality mechanically and electrically.
(5) Restorable line type, pneumatic tube only	X	Annually	Perform heat tests (where test chambers are in circuit), with a listed and labeled heat source or in accordance with the manufacturer's published instructions of the detector or conduct a test with pressure pump.

(continues)

Table 14.4.3.2 *Continued*

Component	Initial Acceptance	Periodic Frequency	Method
17. Initiating devices[f]			
(d) Heat detectors *(continued)*			
(6) Single- and multiple-station heat alarms	X	Annually	Conduct functional tests according to manufacturer's published instructions. Do not test nonrestorable heat detectors with heat.
(e) Manual fire alarm boxes	X	Annually	Operate manual fire alarm boxes per the manufacturer's published instructions. Test both key-operated presignal and general alarm manual fire alarm boxes.
(f) Radiant energy fire detectors	X	Semiannually	Test flame detectors and spark/ember detectors in accordance with the manufacturer's published instructions to determine that each detector is operative. Determine flame detector and spark/ember detector sensitivity using any of the following: (1) Calibrated test method (2) Manufacturer's calibrated sensitivity test instrument (3) Listed control unit arranged for the purpose (4) Other approved calibrated sensitivity test method that is directly proportional to the input signal from a fire, consistent with the detector listing or approval If designed to be field adjustable, replace detectors found to be outside of the approved range of sensitivity or adjust to bring them into the approved range. Do not determine flame detector and spark/ember detector sensitivity using a light source that administers an unmeasured quantity of radiation at an undefined distance from the detector.
(g) Smoke detectors — functional test			
(1) In other than one- and two-family dwellings, system detectors	X	Annually	[h]Test smoke detectors in place to ensure smoke entry into the sensing chamber and an alarm response. Use smoke or a listed and labeled product acceptable to the manufacturer or in accordance with their published instructions. Other methods listed in the manufacturer's published instructions that ensure smoke entry from the protected area, through the vents, into the sensing chamber can be used.
(2) Single- and multiple-station smoke alarms connected to protected premises systems	X	Annually	Perform a functional test on all single- and multiple-station smoke alarms connected to a protected premises fire alarm system by putting the smoke alarm into an alarm condition and verifying that the protected premises system receives a supervisory signal and does not cause a fire alarm signal.
(3) System smoke detectors used in one- and two-family dwellings	X	Annually	Conduct functional tests according to manufacturer's published instructions.
(4) Air sampling	X	Annually	Test with smoke or a listed and labeled product acceptable to the manufacturer or in accordance with their published instructions. Test from the end sampling port or point on each pipe run. Verify airflow through all other ports or points.
(5) Duct type	X	Annually	In addition to the testing required in Table 14.4.3.2(g)(1) and Table 14.4.3.2(h), test duct smoke detectors that use sampling tubes to ensure that they will properly sample the airstream in the duct using a method acceptable to the manufacturer or in accordance with their published instructions.
(6) Projected beam type	X	Annually	Test the detector by introducing smoke, other aerosol, or an optical filter into the beam path.
(7) Smoke detector with built-in thermal element	X	Annually	Operate both portions of the detector independently as described for the respective devices.
(8) Smoke detectors with control output functions	X	Annually	Verify that the control capability remains operable even if all of the initiating devices connected to the same initiating device circuit or signaling line circuit are in an alarm state.
(h) Smoke detectors — sensitivity testing			
In other than one- and two-family dwellings, system detectors	N/A	See 14.4.4.3	[i]Perform any of the following tests to ensure that each smoke detector is within its listed and marked sensitivity range: (1) Calibrated test method (2) Manufacturer's calibrated sensitivity test instrument (3) Listed control equipment arranged for the purpose

Table 14.4.3.2 *Continued*

Component	Initial Acceptance	Periodic Frequency	Method
			(4) Smoke detector/control unit arrangement whereby the detector causes a signal at the control unit when its sensitivity is outside its listed sensitivity range (5) Other calibrated sensitivity test method approved by the authority having jurisdiction
(i) Carbon monoxide detectors/carbon monoxide alarms for the purposes of fire detection	X	Annually	Test the devices in place to ensure CO entry to the sensing chamber by introduction through the vents, to the sensing chamber of listed and labeled product acceptable to the manufacturer or in accordance with their published instructions.
(j) Initiating devices, supervisory			
(1) Control valve switch	X	Annually	Operate valve and verify signal receipt to be within the first two revolutions of the handwheel or within one-fifth of the travel distance, or per the manufacturer's published instructions.
(2) High- or low-air pressure switch	X	Annually	Operate switch and verify receipt of signal is obtained where the required pressure is increased or decreased a maximum 10 psi (70 kPa) from the required pressure level.
(3) Room temperature switch	X	Annually	Operate switch and verify receipt of signal to indicate the decrease in room temperature to 40°F (4.4°C) and its restoration to above 40°F (4.4°C).
(4) Water level switch	X	Annually	Operate switch and verify receipt of signal indicating the water level raised or lowered a maximum 3 in. (70 mm) from the required level within a pressure tank, or a maximum 12 in. (300 mm) from the required level of a nonpressure tank. Also verify its restoral to required level.
(5) Water temperature switch	X	Annually	Operate switch and verify receipt of signal to indicate the decrease in water temperature to 40°F (4.4°C) and its restoration to above 40°F (4.4°C).
(k) Mechanical, electrosonic, or pressure-type waterflow device	X	Semiannually	Water shall be flowed through an inspector's test connection indicating the flow of water equal to that from a single sprinkler of the smallest orifice size installed in the system for wet-pipe systems, or an alarm test bypass connection for dry-pipe, pre-action, or deluge systems in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.
(l) Multi-sensor fire detector or multi-criteria fire detector or combination fire detector	X	Annually	Test each of the detection principles present within the detector (e.g., smoke/heat/CO, etc.) independently for the specific detection principle, regardless of the configuration status at the time of testing. Also test each detector in accordance with the published manufacturer's instructions. Test individual sensors together if the technology allows individual sensor responses to be verified. Perform tests as described for the respective devices by introduction of the physical phenomena to the sensing chamber of element, and an electronic check (magnets, analogue values, etc.) is not sufficient to comply with this requirement. Confirm the result of each sensor test through indication at the detector or control unit. Where individual sensors cannot be tested individually, test the primary sensor.[j] Record all tests and results.
18. Special hazard equipment			
(a) Abort switch (dead-man type)	X	Annually	Operate abort switch and verify correct sequence and operation.
(b) Abort switch (recycle type)	X	Annually	Operate abort switch and verify development of correct matrix with each sensor operated.
(c) Abort switch (special type)	X	Annually	Operate abort switch and verify correct sequence and operation in accordance with authority having jurisdiction. Observe sequencing as specified on as-built drawings or in system owner's manual.
(d) Cross-zone detection circuit	X	Annually	Operate one sensor or detector on each zone. Verify occurrence of correct sequence with operation of first zone and then with operation of second zone.
(e) Matrix-type circuit	X	Annually	Operate all sensors in system. Verify development of correct matrix with each sensor operated.
(f) Release solenoid circuit[k]	X	Annually	Verify operation of solenoid.
(g) Squibb release circuit	X	Annually	Use AGI flashbulb or other test light approved by the manufacturer. Verify operation of flashbulb or light.
(h) Verified, sequential, or counting zone circuit	X	Annually	Operate required sensors at a minimum of four locations in circuit. Verify correct sequence with both the first and second detector in alarm.
(i) All above devices or circuits or combinations thereof	X	Annually	Verify supervision of circuits by creating an open circuit.

(continues)

Table 14.4.3.2 *Continued*

Component	Initial Acceptance	Periodic Frequency	Method
19. Combination systems			
(a) Fire extinguisher electronic monitoring device/system	X	Annually	Test communication between the device connecting the fire extinguisher electronic monitoring device/system and the fire alarm control unit to ensure proper signals are received at the fire alarm control unit and remote annunciator(s) if applicable.
(b) Carbon monoxide[l] device/system	X	Annually	Test communication between the device connecting the carbon monoxide device/system and the fire alarm control unit to ensure proper signals are received at the fire alarm control unit and remote annunciator(s) if applicable.
20. Interface equipment[m]	X	See 14.4.4.4	Test interface equipment connections by operating or simulating the equipment being supervised. Verify signals required to be transmitted are received at the control unit. Test frequency for interface equipment is the same as the frequency required by the applicable NFPA standard(s) for the equipment being supervised.
21. Guard's tour equipment	X	Annually	Test the device in accordance with the manufacturer's published instructions.
22. Alarm notification appliances			
(a) Audible[n]	X	N/A	For initial and reacceptance testing, measure sound pressure levels for signals with a sound level meter meeting ANSI S1.4a, *Specifications for Sound Level Meters*, Type 2 requirements. Measure sound pressure levels throughout the protected area to confirm that they are in compliance with Chapter 18. Set the sound level meter in accordance with ANSI S3.41, *American National Standard Audible Evacuation Signal*, using the time-weighted characteristic F (FAST).
	N/A	Annually	°For periodic testing, verify the operation of the notification appliances.
(b) Audible textual notification appliances (speakers and other appliances to convey voice messages)	X	N/A	For initial and reacceptance testing, measure sound pressure levels for signals with a sound level meter meeting ANSI S1.4a, *Specifications for Sound Level Meters*, Type 2 requirements. Measure sound pressure levels throughout the protected area to confirm that they are in compliance with Chapter 18. Set the sound level meter in accordance with ANSI S3.41, *American National Standard Audible Evacuation Signal*, using the time-weighted characteristic F (FAST). Verify audible information to be distinguishable and understandable and in compliance with 14.4.11.
	N/A	Annually	°For periodic testing, verify the operation of the notification appliances.
(c) Visible	X	N/A	Perform initial and reacceptance testing in accordance with the manufacturer's published instructions. Verify appliance locations to be per approved layout and confirm that no floor plan changes affect the approved layout. Verify that the candela rating marking agrees with the approved drawing. Confirm that each appliance flashes.
	N/A	Annually	For periodic testing, verify that each appliance flashes.
23. Exit marking audible notification appliance	X	Annually	Perform tests in accordance with manufacturer's published instructions.
24. Emergency control functions[p]	X	Annually	For initial, reacceptance, and periodic testing, verify emergency control function interface device activation. Where an emergency control function interface device is disabled or disconnected during initiating device testing, verify that the disabled or disconnected emergency control function interface device has been properly restored. [
25. Area of refuge two-way communication system	X	Annually	At a minimum, test the two-way communication system to verify operation and receipt of visual and audible signals at the transmitting and receiving unit respectively. Operate systems with more than five stations with a minimum of five stations operating simultaneously. Verify voice quality and clarity.
26. Special procedures			
(a) Alarm verification	X	Annually	Verify time delay and alarm response for smoke detector circuits identified as having alarm verification.
(b) Multiplex systems	X	Annually	Verify communications between sending and receiving units under both primary and secondary power. Verify communications between sending and receiving units under open-circuit and short-circuit trouble conditions.

Table 14.4.3.2 *Continued*

Component	Initial Acceptance	Periodic Frequency	Method
			Verify communications between sending and receiving units in all directions where multiple communications pathways are provided. If redundant central control equipment is provided, verify switchover and all required functions and operations of secondary control equipment. Verify all system functions and features in accordance with manufacturer's published instructions.
27. Supervising station alarm systems — receiving equipment			
(a) All equipment	X	Monthly	Perform tests on all system functions and features in accordance with the equipment manufacturer's published instructions for correct operation in conformance with the applicable sections of Chapter 26. Actuate initiating device and verify receipt of the correct initiating device signal at the supervising station within 90 seconds. Upon completion of the test, restore the system to its functional operating condition. If test jacks are used, perform the first and last tests without the use of the test jack.
(b) Digital alarm communicator receiver (DACR)	X	Monthly	Disconnect each transmission means in turn from the DACR, and verify audible and visual annunciation of a trouble signal in the supervising station. Cause a signal to be transmitted on each individual incoming DACR line (path) at least once every 6 hours (24 hours for DACTs installed prior to adoption of the 2013 edition of *NFPA 72*). Verify receipt of these signals.
(c) Digital alarm radio receiver (DARR)	X	Monthly	Cause the following conditions of all DARRs on all subsidiary and repeater station receiving equipment. Verify receipt at the supervising station of correct signals for each of the following conditions: (1) AC power failure of the radio equipment (2) Receiver malfunction (3) Antenna and interconnecting cable failure (4) Indication of automatic switchover of the DARR (5) Data transmission line failure between the DARR and the supervising or subsidiary station
(d) McCulloh systems	X	Monthly	Test and record the current on each circuit at each supervising and subsidiary station under the following conditions: (1) During functional operation (2) On each side of the circuit with the receiving equipment conditioned for an open circuit Cause a single break or ground condition on each transmission channel. If such a fault prevents the functioning of the circuit, verify receipt of a trouble signal. Cause each of the following conditions at each of the supervising or subsidiary stations and all repeater station radio transmitting and receiving equipment; verify receipt of correct signals at the supervising station: (1) RF transmitter in use (radiating) (2) AC power failure supplying the radio equipment (3) RF receiver malfunction (4) Indication of automatic switchover
(e) Radio alarm supervising station receiver (RASSR) and radio alarm repeater station receiver (RARSR)	X	Monthly	Cause each of the following conditions at each of the supervising or subsidiary stations and all repeater station radio transmitting and receiving equipment; verify receipt of correct signals at the supervising station: (1) AC power failure supplying the radio equipment (2) RF receiver malfunction (3) Indication of automatic switchover, if applicable
(f) Private microwave radio systems	X	Monthly	Cause each of the following conditions at each of the supervising or subsidiary stations and all repeater station radio transmitting and receiving equipment; verify receipt of correct signals at the supervising station: (1) RF transmitter in use (radiating) (2) AC power failure supplying the radio equipment (3) RF receiver malfunction (4) Indication of automatic switchover

(continues)

Table 14.4.3.2 *Continued*

Component	Initial Acceptance	Periodic Frequency	Method
27. Supervising station alarm systems — receiving equipment *(continued)*			
(g) Performance-based technologies	X	Monthly	Perform tests to ensure the monitoring of integrity of the transmission technology and technology path. Where a single communications path is used, disconnect the communication path. Verify that failure of the path is annunciated at the supervising station within 60 minutes of the failure (within 5 minutes for communication equipment installed prior to adoption of the 2013 edition of *NFPA 72*). Restore the communication path. Where multiple communication paths are used, disconnect both communication paths and confirm that failure of the path is annunciated at the supervising station within not more than 6 hours of the failure (within 24 hours for communication equipment installed prior to adoption of the 2013 edition of *NFPA 72*). Restore both communication paths.
28. Public emergency alarm reporting system transmission equipment			
(a) Publicly accessible alarm box	X	Semiannually	Actuate publicly accessible initiating device(s) and verify receipt of not less than three complete rounds of signal impulses. Perform this test under normal circuit conditions. If the device is equipped for open circuit operation (ground return), test it in this condition as one of the semiannual tests.
(b) Auxiliary box	X	Annually	Test each initiating circuit of the auxiliary box by actuation of a protected premises initiating device connected to that circuit. Verify receipt of not less than three complete rounds of signal impulses.
(c) Master box			
(1) Manual operation	X	Semiannually	Perform the tests prescribed for 28(a).
(2) Auxiliary operation	X	Annually	Perform the tests prescribed for 28(b).
29. Low-power radio (wireless systems)	X	N/A	The following procedures describe additional acceptance and reacceptance test methods to verify wireless protection system operation: (1) Use the manufacturer's published instructions and the as-built drawings provided by the system supplier to verify correct operation after the initial testing phase has been performed by the supplier or by the supplier's designated representative. (2) Starting from the functional operating condition, initialize the system in accordance with the manufacturer's published instructions. Confirm the alternative communications path exists between the wireless control unit and peripheral devices used to establish initiation, indication, control, and annunciation. Test the system for both alarm and trouble conditions. (3) Check batteries for all components in the system monthly unless the control unit checks all batteries and all components daily.
30. Mass notification systems			
(a) Functions	X	Annually	At a minimum, test control equipment to verify correct receipt of alarm, supervisory, and trouble signals (inputs); operation of evacuation signals and auxiliary functions (outputs); circuit supervision, including detection of open circuits and ground faults; and power supply supervision for detection of loss of ac power and disconnection of secondary batteries.
(b) Fuses	X	Annually	Verify the rating and supervision.
(c) Interfaced equipment	X	Annually	Verify integrity of single or multiple circuits providing interface between two or more control units. Test interfaced equipment connections by operating or simulating operation of the equipment being supervised. Verify signals required to be transmitted at the control unit.
(d) Lamps and LEDs	X	Annually	Illuminate lamps and LEDs.
(e) Primary (main) power supply	X	Annually	Disconnect all secondary (standby) power and test under maximum load, including all alarm appliances requiring simultaneous operation. Reconnect all secondary (standby) power at end of test. For redundant power supplies, test each separately.
(f) Audible textual notification appliances (speakers and other appliances to convey voice messages)	X	Annually	Measure sound pressure level with a sound level meter meeting ANSI S1.4a, *Specifications for Sound Level Meters*, Type 2 requirements. Measure and record levels throughout protected area. Set the sound level meter in accordance with ANSI S3.41, *American National Standard Audible Evacuation Signal*, using the time-weighted characteristic F (FAST). Record the maximum output when the audible emergency evacuation signal is on. Verify audible information to be distinguishable and understandable.

Table 14.4.3.2 *Continued*

Component	Initial Acceptance	Periodic Frequency	Method
(g) Visible	X	Annually	Perform test in accordance with manufacturer's published instructions. Verify appliance locations to be per approved layout and confirm that no floor plan changes affect the approved layout. Verify that the candela rating marking agrees with the approved drawing. Confirm that each appliance flashes.
(h) Control unit functions and no diagnostic failures are indicated	X	Annually	Review event log file and verify that the correct events were logged. Review system diagnostic log file; correct deficiencies noted in file. Delete unneeded log files. Delete unneeded error files. Verify that sufficient free disk space is available. Verify unobstructed flow of cooling air is available. Change/clean filters, cooling fans, and intake vents.
(i) Control unit reset	X	Annually	Power down the central control unit computer and restart it.
(j) Control unit security	X	Annually	If remote control software is loaded onto the system, verify that it is disabled to prevent unauthorized system access.
(k) Audible/visible functional test	X	Annually	Send out an alert to a diverse set of predesignated receiving devices and confirm receipt. Include at least one of each type of receiving device.
(l) Software backup	X	Annually	Make full system software backup. Rotate backups based on accepted practice at site.
(m) Secondary power test	X	Annually	Disconnect ac power. Verify the ac power failure alarm status on central control equipment. With ac power disconnected, verify battery voltage under load.
(n) Wireless signals	X	Annually	Check forward/reflected radio power is within specifications.
(o) Antenna	X	Annually	Check forward/reflected radio power is within specifications. Verify solid electrical connections with no observable corrosion.
(p) Transceivers	X	Annually	Verify proper operation and mounting is not compromised.

[a]Some transmission equipment (such as but not limited to cable modems, fiber-optic interface nodes, and VoIP interfaces) are typically powered by the building's electrical system using a standby power supply that does not meet the requirements of this Code. This is intended to ensure that the testing authority verifies full standby power as required by Chapter 10. Additionally, refer to Table 14.4.3.2, Items 7 through 9 for secondary power supply testing.

[b]The automatic transmission of the check-in (handshake) signal can take up to 60 minutes to occur.

[c]See Table 14.4.3.2, Item 4(a) for the testing of transmission equipment.

[d]Example: 4000 mAh × ½₅ = 160 mA charging current at 77°F (25°C).

[e]The voltmeter sensitivity has been changed from 1000 ohms per volt to 100 ohms per volt so that the false ground readings (caused by induced voltages) are minimized.

[f]Initiating devices such as smoke detectors used for elevator recall, closing dampers, or releasing doors held in the open position that are permitted by the Code *(see* NFPA *101, Life Safety Code, 9.6.3)* to initiate supervisory signals at the fire alarm control unit (FACU) should be tested at the same frequency (annual) as those devices when they are generating an alarm signal. They are not supervisory devices, but they initiate a supervisory signal at the FACU.

[g]Fusible thermal link detectors are commonly used to close fire doors and fire dampers. They are actuated by the presence of external heat, which causes a solder element in the link to fuse, or by an electric thermal device, which, when energized, generates heat within the body of the link, causing the link to fuse and separate.

[h]Note, it is customary for the manufacturer of the smoke detector to test a particular product from an aerosol provider to determine acceptability for use in smoke entry testing of their smoke detector/ smoke alarm. Magnets are not acceptable for smoke entry tests.

[i] There are some detectors that use magnets as a manufacturer's calibrated sensitivity test instrument.

[j]For example, it might not be possible to individually test the heat sensor in a thermally enhanced smoke detector.

[k]Manufacturer's instructions should be consulted to ensure a proper operational test. No suppression gas or agent is expected to be discharged during the test of the solenoid. See Test Plan of 14.2.10.

[l]Testing of CO device should be done to the requirements of NFPA 720, *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment.*

[m]A monitor module installed on an interface device is not considered a supervisory device and therefore not subject to the quarterly testing frequency requirement. Test frequencies for interface devices should be in accordance with the applicable standard. For example, fire pump controller alarms such as phase reversal are required to be tested annually. If a monitor module is installed to identify phase reversal on the fire alarm control panel, it is not necessary to test for phase reversal four times a year.

[n]Chapter 18 would require 15 dB over average ambient sound for public mode spaces. Sometimes the ambient sound levels are different from what the design was based upon. Private operating mode would require 10 dB over average ambient at the location of the device.

[o]Where building, system, or occupancy changes have been observed, the owner should be notified of the changes. New devices might need to be installed and tested per the initial acceptance testing criteria.

[p]See A.14.4.3.2, and Table 14.4.3.2, Item 24.

14.4.3.3 *Video image smoke and flame detectors shall be inspected, tested, and maintained in accordance with the manufacturer's published instructions.*

Paragraph 14.4.3.4 was added by a tentative interim amendment (TIA).

14.4.3.4 *Gas detectors shall be inspected, tested, and maintained in accordance with manufacturers' published instructions.*

14.4.4* Testing Frequency. *Unless otherwise permitted by other sections of this Code, testing shall be performed in accordance with the schedules in* ***Table 14.4.3.2*** *or more often if required by the authority having jurisdiction.*

14.4.4.1 *Devices or equipment that are inaccessible for safety considerations (e.g., continuous process operations, energized electrical equipment, radiation, and excessive height) shall be permitted to be tested during scheduled shutdowns if approved by the authority having jurisdiction. Extended intervals shall not exceed 18 months.*

14.4.4.2 *If automatic testing is performed at least weekly by a remotely monitored fire alarm control unit specifically listed for the application, the manual testing frequency shall be permitted to be extended to annually. **Table 14.4.3.2** shall apply.*

14.4.4.3* *In other than one- and two-family dwellings, sensitivity of smoke detectors shall be tested in accordance with **14.4.4.3.1** through **14.4.4.3.7**.*

14.4.4.3.1 *Sensitivity shall be checked within 1 year after installation.*

14.4.4.3.2 *Sensitivity shall be checked every alternate year thereafter unless otherwise permitted by compliance with **14.4.4.3.3**.*

14.4.4.3.3 *After the second required calibration test, if sensitivity tests indicate that the device has remained within its listed and marked sensitivity range (or 4 percent obscuration light gray smoke, if not marked), the length of time between calibration tests shall be permitted to be extended to a maximum of 5 years.*

14.4.4.3.3.1 *If the frequency is extended, records of nuisance alarms and subsequent trends of these alarms shall be maintained.*

14.4.4.3.3.2 *In zones or in areas where nuisance alarms show any increase over the previous year, calibration tests shall be performed.*

14.4.4.3.4 *To ensure that each smoke detector is within its listed and marked sensitivity range, it shall be tested using any of the following methods:*

(1) Calibrated test method

(2) Manufacturer's calibrated sensitivity test instrument

(3) Listed control equipment arranged for the purpose

(4) Smoke detector/fire alarm control unit arrangement whereby the detector causes a signal at the fire alarm control unit where its sensitivity is outside its listed sensitivity range

(5) Other calibrated sensitivity test methods approved by the authority having jurisdiction

14.4.4.3.5 *Unless otherwise permitted by **14.4.4.3.6**, smoke detectors found to have a sensitivity outside the listed and marked sensitivity range shall be cleaned and recalibrated or be replaced.*

14.4.4.3.6 *Smoke detectors listed as field adjustable shall be permitted to either be adjusted within the listed and marked sensitivity range, cleaned, and recalibrated, or be replaced.*

14.4.4.3.7 *The detector sensitivity shall not be tested or measured using any device that administers an unmeasured concentration of smoke or other aerosol into the detector or smoke alarm.*

14.4.4.4 *Test frequency of interfaced equipment shall be the same as specified by the applicable NFPA standards for the equipment being supervised.*

14.4.4.5 *Restorable fixed-temperature, spot-type heat detectors shall be tested in accordance with **14.4.4.5.1** through **14.4.4.5.4**.*

14.4.4.5.1 *Two or more detectors shall be tested on each initiating circuit annually.*

14.4.4.5.2 *Different detectors shall be tested each year.*

14.4.4.5.3 *Test records shall be kept by the building owner specifying which detectors have been tested.*

14.4.4.5.4 *Within 5 years, each detector shall have been tested.*

14.4.4.6* *Circuit and pathway testing of each monitored circuit or pathway shall be conducted with initial acceptance or reacceptance testing to verify signals are indicated at the control unit for each of the abnormal conditions specified in Sections **23.5** through **23.7**.*

Paragraph 14.4.5 was revised by a tentative interim amendment. (TIA).

14.4.11* Voice Intelligibility.

14.4.11.1 *Voice communication using prerecorded messages and manual voice announcements shall be verified as being intelligible in accordance with the requirements of **18.4.10**.*

14.4.11.2 *Intelligibility shall not be required to be determined through quantitative measurements.*

14.4.11.3 *Quantitative measurements as described in Annex **D** shall be permitted but shall not be required.*

14.5 Maintenance.

14.5.1 *System equipment shall be maintained in accordance with the manufacturer's published instructions.*

14.5.2 *The frequency of maintenance of system equipment shall depend on the type of equipment and the local ambient conditions.*

14.5.3 *The frequency of cleaning of system equipment shall depend on the type of equipment and the local ambient conditions.*

14.5.4 *All apparatus requiring rewinding or resetting to maintain normal operation shall be rewound or reset as promptly as possible after each test and alarm.*

14.5.5 *Unless otherwise permitted by **14.5.6**, the retransmission means as defined in Section **26.3** shall be tested at intervals of not more than 12 hours.*

14.5.6 *When the retransmission means is the public-switched telephone network, testing shall be permitted at weekly intervals to confirm its operation to each communications center.*

14.5.7 *As a part of the testing required in* ***14.5.5****, the retransmission signal and the time and date of the retransmission shall be recorded in the central station.*

14.6 Records.

14.6.1* Permanent Records. *After successful completion of acceptance tests approved by the authority having jurisdiction, the requirements in* ***14.6.1.1*** *through* ***14.6.1.3*** *shall apply.*

14.6.1.1 *A set of reproducible as-built installation drawings, operation and maintenance manuals, and a written sequence of operation shall be provided to the building owner or the owner's designated representative.*

14.6.1.2* Site-Specific Software.

14.6.1.2.1 *For software-based systems, a copy of the site-specific software shall be provided to the system owner or owner's designated representative.*

14.6.1.2.2 *A copy of the site-specific software shall be stored on-site in nonvolatile, nonerasable, nonrewritable memory.*

14.6.1.3 *The system owner shall be responsible for maintaining these records for the life of the system for examination by any authority having jurisdiction. Paper or electronic media shall be permitted.*

14.6.2 Maintenance, Inspection, and Testing Records.

14.6.2.1 *Records shall be retained until the next test and for 1 year thereafter.*

14.6.2.2 *For systems with restorable fixed-temperature, spot-type heat detectors tested over multiple years, records shall be retained for the 5 years of testing and for 1 year thereafter.*

14.6.2.3 *The records shall be on a medium that will survive the retention period. Paper or electronic media shall be permitted.*

14.6.2.4 *A record of all inspections, testing, and maintenance shall be provided in accordance with* ***7.8.2****.*

14.6.3 Supervising Station Records. *For supervising station alarm systems, records pertaining to signals received at the supervising station that result from maintenance, inspection, and testing shall be maintained for not less than 12 months.*

14.6.3.1 *Records shall be permitted to be maintained on either paper or electronic media.*

14.6.3.2 *Upon request, a hard copy record shall be provided to the authority having jurisdiction.*

14.6.4 Simulated Operation Note. *If the operation of a device, circuit, fire alarm control unit function, or special hazard system interface is simulated, it shall be noted on the inspection/test form that the operation was simulated.*

APPENDIX J

NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, (2014 Edition) Information and Tables

NFPA 25 – Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

Chapter 4 General Requirements

4.1 Responsibility of Property Owner or Designated Representative.

4.1.1* Responsibility for Inspection, Testing, Maintenance, and Impairment. *The property owner or designated representative shall be responsible for properly maintaining a water-based fire protection system.*

4.1.1.1 *Inspection, testing, maintenance, and impairment procedures shall be implemented in accordance with those established in this document and in accordance with the manufacturer's instructions.*

4.1.1.2 *Inspection, testing, and maintenance shall be performed by qualified personnel.*

4.1.1.3* *Where the property owner or designated representative is not the occupant, the property owner or designated representative shall be permitted to delegate the authority for inspecting, testing, maintenance, and the managing of impairments of the fire protection system to a designated representative.*

4.1.1.4 *Where a designated representative has received the authority for inspecting, testing, maintenance, and the managing of impairments, the designated representative shall comply with the requirements identified for the property owner or designated representative throughout this standard.*

4.1.2* Freeze Protection. *The property owner or designated representative shall ensure that water-filled piping is maintained at a minimum temperature of 40°F (4°C) unless an approved antifreeze solution is utilized.*

4.1.2.1 *All areas of the building containing water-filled piping that does not have another means of freeze protection shall be maintained at a minimum temperature of 40°F (4°C).*

4.1.2.2 *Aboveground water-filled pipes that pass through open areas, cold rooms, passageways, or other areas exposed to temperatures below 40°F (4°C), protected against freezing by insulating coverings, frostproof casings, listed heat tracing systems, or other reliable means, shall be maintained at temperatures between 40°F (4°C) and 120°F (48.9°C).*

4.1.2.3 *Where other approved means of freeze protection for water-filled piping as described in **4.1.2.2** are utilized, they shall be inspected, tested, and maintained in accordance with this standard.*

4.1.3* Accessibility. *The property owner or designated representative shall provide ready accessibility to components of water-based fire protection systems that require inspection, testing, and maintenance.*

4.1.4 Notification of System Shutdown or Testing. *The property owner or designated representative shall notify the authority having jurisdiction, the fire department, if required, and the alarm-receiving facility before testing or shutting down a system or its supply.*

4.1.4.1 *The notification of system shutdown or test shall include the purpose for the shutdown or test, the system or component involved, the estimated time of shutdown or test, and the expected duration of the shutdown or test.*

4.1.4.2 *The authority having jurisdiction, the fire department, and the alarm-receiving facility shall be notified when the system, supply, or component is returned to service or when the test is complete.*

4.1.5* Corrections and Repairs.

4.1.5.1* *The property owner or designated representative shall correct or repair deficiencies or impairments that are found during the inspection, test, and maintenance required by this standard.*

4.1.5.2 *Corrections and repairs shall be performed by qualified maintenance personnel or a qualified contractor.*

4.1.6* Changes in Occupancy, Use, Process, or Materials. *The property owner or designated representative shall not make changes in the occupancy, the use or process, or the materials used or stored in the building without evaluation of the fire protection systems for their capability to protect the new occupancy, use, or materials.*

4.1.6.1 *The evaluation required by **4.1.6** shall not be considered part of the normal inspection, testing, and maintenance required by this standard.*

4.1.6.2 *The evaluation shall consider factors that include, but are not limited to, the following:*

(1) Occupancy changes such as converting office or production space into warehousing
(2) Process or material changes such as metal stamping to molded plastics
(3) Building revisions such as relocated walls, added mezzanines, and ceilings added below sprinklers
(4) Removal of heating systems in spaces with piping subject to freezing

4.1.7* Addressing Changes in Hazard.

4.1.7.1 *Where changes in the occupancy, hazard, water supply, storage commodity, storage arrangement, building modification, or other condition that affects the installation criteria of the system are identified, the property owner or designated representative shall promptly take steps to evaluate the adequacy of the installed system in order to protect the building or hazard in question.*

4.1.7.2 *Where the evaluation reveals that the installed system is inadequate to protect the building or hazard in question, the property owner or designated representative shall make the required corrections.*

4.1.7.3 *Corrections shall be approved.*

4.1.8 Valve Location. *The location of shutoff valves shall be identified at the system riser or other approved locations.*

4.1.9 Information Sign.

4.1.9.1 *A permanently marked metal or rigid plastic information sign shall be placed at the system control riser supplying an antifreeze loop, dry system, preaction system, or auxiliary system control valve.*

4.1.9.2 *Each sign shall be secured with a corrosion-resistant wire, chain, or other approved means and shall indicate at least the following information:*

(1) Location of the area served by the system
(2) Location of auxiliary drains and low-point drains for dry pipe and preaction systems
(3) The presence and location of antifreeze or other auxiliary systems
(4) The presence and location(s) of heat tape

4.1.10 Impairments.

4.1.10.1 *Where an impairment to a water-based fire protection system occurs or is identified during inspection, testing, or maintenance activities, the procedures outlined in Chapter **15** shall be followed, including the attachment of a tag to the impaired system.*

4.1.10.2 *Where a water-based fire protection system is returned to service following an impairment, the system shall be verified to be working properly by means of an appropriate inspection or test as described in the table "Summary of Component Replacement [Action] Requirements" in the applicable chapters of this document.*

4.2 Manufacturer's Corrective Action. *Manufacturers shall be permitted to make modifications to their own listed product in the field with listed devices that restore the original performance as intended by the listing, where acceptable to the authority having jurisdiction.*

4.3 Records.

4.3.1* *Records shall be made for all inspections, tests, and maintenance of the system and its components and shall be made available to the authority having jurisdiction upon request.*

4.3.1.1* *Records shall be permitted to be stored and accessed electronically.*

4.3.2 *Records shall indicate the following:*

(1) The procedure/activity performed (e.g., inspection, test, or maintenance)
(2) The organization that performed the activity
(3) The required frequency of the activity
(4) The results and date of the activity
(5) The name and contact information of the qualified contractor or owner, including lead person for activity

4.3.3* *Records shall be maintained by the property owner.*

4.3.4 *As-built system installation drawings, hydraulic calculations, original acceptance test records, and device manufacturer's data sheets shall be retained for the life of the system.*

4.3.5 *Subsequent records shall be retained for a period of 1 year after the next inspection, test, or maintenance of that type required by the standard.*

4.4 Water Supply Status. *During inspection, testing, and maintenance, water supplies, including fire pumps, shall remain in service unless under constant attendance by qualified personnel or unless impairment procedures in Chapter **15** are followed.*

4.5* Inspection. *System components shall be inspected at intervals specified in the appropriate chapters.*

4.6 Testing.

4.6.1 *All components and systems shall be tested to verify that they function as intended.*

4.6.2 *The frequency of tests shall be in accordance with this standard.*

4.6.3 *Fire protection system components shall be restored to full operational condition following testing, including reinstallation of plugs and caps for auxiliary drains and test valves.*

4.6.4* *Test results shall be compared with those of the original acceptance test (if available) and with the most recent test results.*

4.6.5* *When a component or subsystem is adjusted, repaired, reconditioned, or replaced, it shall be tested in accordance with the original acceptance test required for that subsystem or the requirements where specified by the standard.*

4.6.6* Automated Testing. (Reserved)

4.7* Performance-Based Programs. *As an alternative means of compliance and where approved by the authority having jurisdiction, components and systems shall be permitted to be inspected, tested, and maintained under a performance-based program.*

4.8* Maintenance. *Maintenance shall be performed to keep the system equipment operable or to make repairs.*

4.9 Safety.

4.9.1 General. *Inspection, testing, and maintenance activities shall be conducted in accordance with applicable safety regulations.*

4.9.2 Confined Spaces. *Legally required precautions shall be taken prior to entering confined spaces such as tanks, valve pits, or trenches.*

4.9.3 Fall Protection. *Legally required equipment shall be worn or used to prevent injury from falls to personnel.*

4.9.4 Hazards. *Precautions shall be taken to address any hazards, such as protection against drowning where working on the top of a filled embankment or a supported, rubberized fabric tank, or over open water or other liquids.*

4.9.5* Hazardous Materials.

4.9.5.1 *Legally required equipment shall be used where working in an environment with hazardous materials present.*

4.9.5.2 *The property owner or designated representative shall advise anyone performing inspection, testing, and maintenance on any system under the scope of this document, with regard to hazardous materials stored on the premises.*

4.9.6* Electrical Safety. *Legally required precautions shall be taken when testing or maintaining electric controllers for motor-driven fire pumps.*

Chapter 5 Sprinkler Systems

5.1 General.

5.1.1 Minimum Requirements.

5.1.1.1 *This chapter shall provide the minimum requirements for the routine inspection, testing, and maintenance of sprinkler systems.*

5.1.1.2 ***Table 5.1.1.2*** *shall be used to determine the minimum required frequencies for inspection, testing, and maintenance.*

Table 5.1.1.2 Summary of Sprinkler System Inspection, Testing, and Maintenance

Item	Frequency	Reference
Inspection		
Gauges (dry, preaction, and deluge systems)	Weekly/quarterly	5.2.4.2, 5.2.4.3, 5.2.4.4
Control valves		Table 13.1.1.2
Waterflow alarm devices	Quarterly	5.2.5
Valve supervisory signal devices	Quarterly	5.2.5
Supervisory signal devices (except valve supervisory switches)	Quarterly	5.2.5
Gauges (wet pipe systems)	Quarterly	5.2.4.1
Hydraulic nameplate	Quarterly	5.2.6
Buildings	Annually (prior to freezing weather)	4.1.1.1
Hanger/seismic bracing	Annually	5.2.3
Pipe and fittings	Annually	5.2.2
Sprinklers	Annually	5.2.1
Spare sprinklers	Annually	5.2.1.4
Information sign	Annually	5.2.8
Fire department connections		Table 13.1.1.2
Valves (all types)		Table 13.1.1.2
Obstruction, internal inspection of piping	5 years	14.2
Heat trace	Per manufacturer's requirements	5.2.7
Test		
Waterflow alarm devices		
Mechanical devices	Quarterly	5.3.3.1
Vane and pressure switch–type devices	Semiannually	5.3.3.2
Valve supervisory signal devices		Table 13.1.1.2
Supervisory signal devices (except valve supervisory switches)		Table 13.1.1.2
Main drain		Table 13.1.1.2
Antifreeze solution	Annually	5.3.4
Gauges	5 years	5.3.2
Sprinklers (extra-high or greater temperature solder type)	5 years	5.3.1.1.1.4
Sprinklers (fast-response)	At 20 years and every 10 years thereafter	5.3.1.1.1.3
Sprinklers	At 50 years and every 10 years thereafter	5.3.1.1.1
Sprinklers	At 75 years and every 5 years thereafter	5.3.1.1.1.5
Sprinklers (dry)	At 10 years and every 10 years thereafter	5.3.1.1.1.6
Sprinklers (in harsh environments)	5 years	5.3.1.1.2
Valves (all types)		Table 13.1.1.2
Valve status test		13.3.1.2.1
Maintenance		
Valves (all types)		Table 13.1.1.2
Low-point drains (dry pipe system)		13.4.4.3.2
Sprinklers and automatic spray nozzles protecting commercial cooking equipment and ventilation systems	Annually	5.4.1.9
Investigation		
Obstruction		14.3

5.1.2 Valves and Connections. *Valves and fire department connections shall be inspected, tested, and maintained in accordance with Chapter **13**.*

5.1.3 Obstruction Investigations. *The procedures outlined in Chapter **14** shall be followed where there is a need to conduct an obstruction investigation.*

5.1.4 Impairments. *The procedures outlined in Chapter **15** shall be followed where an impairment to protection occurs.*

5.1.5 Hose Connections. *Hose connections shall be inspected, tested, and maintained in accordance with Chapters **6** and **13**.*

5.2* Inspection.

5.2.1 Sprinklers.

5.2.1.1 *Sprinklers shall be inspected from the floor level annually.*

5.2.1.1.1 *Sprinklers shall not show signs of leakage; shall be free of corrosion, foreign materials, paint, and physical damage; and shall be installed in the correct orientation (e.g., upright, pendent, or sidewall).*

5.2.1.1.2 *Any sprinkler that shows signs of any of the following shall be replaced:*

(1) Leakage
(2) Corrosion*
(3) Physical damage
(4) Loss of fluid in the glass bulb heat-responsive element
(5) Loading*
(6) Painting unless painted by the sprinkler manufacturer

5.2.1.1.3 *Any sprinkler that has been installed in the incorrect orientation shall be corrected by repositioning the branchline, drop, or sprig, or shall be replaced.*

5.2.1.1.4 *Sprinklers installed in concealed spaces such as above suspended ceilings shall not require inspection.*

5.2.1.1.5 *Sprinklers installed in areas that are inaccessible for safety considerations due to process operations shall be inspected during each scheduled shutdown.*

5.2.1.1.6 *Escutcheons and coverplates for recessed, flush, and concealed sprinklers shall be replaced if found missing during the inspection.*

5.2.1.1.7 *Escutcheons for pendent sprinklers that are not recessed, flush, or concealed shall not be required to be replaced if found missing during the inspection.*

5.2.2* Pipe and Fittings. *Sprinkler pipe and fittings shall be inspected annually from the floor level.*

5.2.2.1 *Pipe and fittings shall be in good condition and free of mechanical damage, leakage, and corrosion.*

5.2.2.2 *Sprinkler piping shall not be subjected to external loads by materials either resting on the pipe or hung from the pipe.*

5.2.2.3 *Pipe and fittings installed in concealed spaces such as above suspended ceilings shall not require inspection.*

5.2.2.4 *Pipe and fittings installed in areas that are inaccessible for safety considerations due to process operations shall be inspected during each scheduled shutdown.*

5.2.3* Hangers and Seismic Braces. *Sprinkler pipe hangers and seismic braces shall be inspected annually from the floor level.*

5.2.3.1 *Hangers and seismic braces shall not be damaged, loose, or unattached.*

5.2.3.2 *Hangers and seismic braces that are damaged, loose, or unattached shall be replaced or refastened.*

5.2.3.3 *Hangers and seismic braces installed in concealed spaces such as above suspended ceilings shall not require inspection.*

5.2.3.4 *Hangers and seismic bracing installed in areas that are inaccessible for safety considerations due to process operations shall be inspected during each scheduled shutdown.*

5.2.4 Gauges.

5.2.4.1 *Gauges on wet pipe and deluge sprinkler systems shall be inspected quarterly to ensure that they are in good condition and that normal water supply pressure is being maintained.*

5.2.4.2 *Gauges on dry and preaction systems shall be inspected weekly to ensure that normal air or nitrogen and water pressures are being maintained.*

5.2.4.3 *Where air pressure supervision is connected to a constantly attended location, gauges shall be inspected monthly.*

5.2.4.4 *For dry pipe or preaction systems protecting freezers with two air pressure gauges on the air line(s) between the compressor and the dry pipe or preaction valve, the air pressure gauge near the compressor shall be compared weekly to the pressure gauge above the dry pipe or preaction valve.*

5.2.4.4.1 *When the gauge near the compressor is reading higher than the gauge near the dry pipe valve, the air line in service shall be taken out of service, and the alternate air line opened to equalize the pressure.*

5.2.4.4.2 *The air line taken out of service shall be internally inspected, shall have all ice blockage removed, and shall be reassembled for use as a future alternate air line.*

5.2.5 Waterflow Alarm and Supervisory Signal Initiating Device. *Waterflow alarm and supervisory signal initiating devices shall be inspected quarterly to verify that they are free of physical damage.*

5.2.6* Hydraulic Design Information Sign. *The hydraulic design information sign shall be inspected quarterly to verify that it is provided, attached securely to the sprinkler riser, and is legible.*

5.2.6.1 *A hydraulic design information sign that is missing or illegible shall be replaced.*

5.2.6.2 *A pipe schedule system shall have a hydraulic design information sign that reads "Pipe Schedule System."*

5.2.7 Heat Tracing. *Heat tracing shall be inspected and maintained in accordance with manufacturer's requirements.*

5.2.8 Information Sign. *The information sign required by **4.1.9** shall be inspected annually to verify that it is provided, securely attached, and legible.*

5.2.9* General Information Sign. *The general information sign required by **NFPA 13** shall be inspected annually to verify that it is provided, securely attached, and legible.*

5.3 Testing.

5.3.1* Sprinklers.

5.3.1.1 *Where required by this section, sample sprinklers shall be submitted to a recognized testing laboratory acceptable to the authority having jurisdiction for field service testing.*

5.3.1.1.1 *Where sprinklers have been in service for 50 years, they shall be replaced or representative samples from one or more sample areas shall be tested.*

5.3.1.1.1.1 *Test procedures shall be repeated at 10-year intervals.*

5.3.1.1.1.2 *Sprinklers manufactured prior to 1920 shall be replaced.*

5.3.1.1.1.3* *Sprinklers manufactured using fast-response elements that have been in service for 20 years shall be replaced or representative samples shall be tested and then retested at 10-year intervals.*

5.3.1.1.1.4* *Representative samples of solder-type sprinklers with a temperature classification of extra high [325°F (163°C)] or greater that are exposed to semicontinuous to continuous maximum allowable ambient temperature conditions shall be tested at 5-year intervals.*

5.3.1.1.1.5 *Where sprinklers have been in service for 75 years, they shall be replaced or representative samples from one or more sample areas shall be submitted to a recognized testing laboratory acceptable to the authority having jurisdiction for field service testing and repeated at 5-year intervals.*

5.3.1.1.1.6* *Dry sprinklers that have been in service for 10 years shall be replaced or representative samples shall be tested and then retested at 10-year intervals.*

5.3.1.1.2* *Where sprinklers are subjected to harsh environments, including corrosive atmospheres and corrosive water supplies, on a 5-year basis, either sprinklers shall be replaced or representative sprinkler samples shall be tested.*

5.3.1.1.3 *Where historical data indicate, longer intervals between testing shall be permitted.*

5.3.1.2* *A representative sample of sprinklers for testing per **5.3.1.1.1** shall consist of a minimum of not less than four sprinklers or 1 percent of the number of sprinklers per individual sprinkler sample, whichever is greater.*

5.3.1.3 *Where one sprinkler within a representative sample fails to meet the test requirement, all sprinklers within the area represented by that sample shall be replaced.*

5.3.1.3.1 *Manufacturers shall be permitted to make modifications to their own sprinklers in the field with listed devices that restore the original performance as intended by the listing, where acceptable to the authority having jurisdiction.*

5.3.2* Gauges.

5.3.2.1 *Gauges shall be replaced every 5 years or tested every 5 years by comparison with a calibrated gauge.*

5.3.2.2 *Gauges not accurate to within 3 percent of the full scale shall be recalibrated or replaced.*

5.3.2.3 *Where multiple system risers are supplied by a common water supply source with gauges located at the same elevation, and the gauges for all systems read within 3 percent of the other(s), only one gauge shall be required to be tested to determine if replacement is required.*

5.3.3 Waterflow Alarm Devices.

5.3.3.1 *Mechanical waterflow alarm devices including, but not limited to, water motor gongs, shall be tested quarterly.*

5.3.3.2* *Vane-type and pressure switch–type waterflow alarm devices shall be tested semiannually.*

5.3.3.3 *Testing waterflow alarm devices on wet pipe systems shall be accomplished by opening the inspector's test connection.*

5.3.3.3.1 *Where freezing weather conditions or other circumstances prohibit use of the inspector's test connection, the bypass connection shall be permitted to be used.*

5.3.3.4 *Fire pumps shall not be taken out of service during testing unless constantly attended by qualified personnel or all impairment procedures contained in Chapter **15** are followed.*

5.3.3.5* *Testing waterflow alarm devices on dry pipe, preaction, or deluge systems shall be accomplished by using the bypass connection.*

5.4 Maintenance.

5.4.1 Sprinklers.

5.4.1.1 *Where a sprinkler has been removed for any reason, it shall not be reinstalled.*

5.4.1.2* *Replacement sprinklers shall have the proper characteristics for the application intended, which include the following:*

(1) Style
(2) Orifice size and K-factor
(3) Temperature rating
(4) Coating, if any
(5) Deflector type (e.g., upright, pendent, sidewall)
(6) Design requirements

5.4.1.2.1* *Spray sprinklers shall be permitted to replace old-style sprinklers.*

5.4.1.2.2 *Replacement sprinklers for piers and wharves shall comply with **NFPA 307**, Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves.*

5.4.1.3 *Only new, listed sprinklers shall be used to replace existing sprinklers.*

5.4.1.4* *Special and quick-response sprinklers as defined by **NFPA 13**, Standard for the Installation of Sprinkler Systems, shall be replaced with sprinklers of the same orifice, size, temperature range and thermal response characteristics, and K-factor.*

5.4.1.5* *A supply of at least six spare sprinklers shall be maintained on the premises so that any sprinklers that have operated or been damaged in any way can be promptly replaced.*

5.4.1.5.1 *The sprinklers shall correspond to the types and temperature ratings of the sprinklers in the property.*

5.4.1.5.2 *The sprinklers shall be kept in a cabinet located where the temperature in which they are subjected will at no time exceed 100°F (38°C).*

5.4.1.5.3 *Where dry sprinklers of different lengths are installed, spare dry sprinklers shall not be required, provided that a means of returning the system to service is furnished.*

5.4.1.5.4 *The stock of spare sprinklers shall include all types and ratings installed and shall be as follows:*

(1) For protected facilities having under 300 sprinklers — no fewer than 6 sprinklers
(2) For protected facilities having 300 to 1000 sprinklers — no fewer than 12 sprinklers
(3) For protected facilities having over 1000 sprinklers — no fewer than 24 sprinklers

5.4.1.5.5* *One sprinkler wrench as specified by the sprinkler manufacturer shall be provided in the cabinet for each type of sprinkler installed to be used for the removal and installation of sprinklers in the system.*

5.4.1.5.6 *A list of the sprinklers installed in the property shall be posted in the sprinkler cabinet.*

5.4.1.5.6.1* *The list shall include the following:*

(1) Sprinkler identification number (SIN) if equipped; or the manufacturer, model, orifice, deflector type, thermal sensitivity, and pressure rating
(2) General description
(3) Quantity of each type to be contained in the cabinet
(4) Issue or revision date of the list

5.4.1.6* *Sprinklers shall not be altered in any respect or have any type of ornamentation, paint, or coatings applied after shipment from the place of manufacture.*

5.4.1.7 *Sprinklers and automatic spray nozzles used for protecting commercial-type cooking equipment and ventilating systems shall be replaced annually.*

5.4.1.7.1 *Where automatic bulb-type sprinklers or spray nozzles are used and annual examination shows no buildup of grease or other material on the sprinklers or spray nozzles, such sprinklers and spray nozzles shall not be required to be replaced.*

5.4.2 **Dry Pipe Systems.*** *Dry pipe systems shall be kept dry at all times.*

5.4.2.1 *During nonfreezing weather, a dry pipe system shall be permitted to be left wet if the only other option is to remove the system from service while waiting for parts or during repair activities.*

5.4.2.2 *Refrigerated spaces or other areas within the building interior where temperatures are maintained at or below 40°F (4.0°C) shall not be permitted to be left wet.*

5.4.2.3 *Air driers shall be maintained in accordance with the manufacturer's instructions.*

5.4.2.4 *Compressors used in conjunction with dry pipe sprinkler systems shall be maintained in accordance with the manufacturer's instructions.*

Chapter 6 Standpipe and Hose Systems

6.1 General.

6.1.1 Minimum Requirements.

6.1.1.1 *This chapter shall provide the minimum requirements for the routine inspection, testing, and maintenance of standpipe and hose systems.*

6.1.1.2 ***Table 6.1.1.2*** *shall be used to determine the minimum required frequencies for inspection, testing, and maintenance.*

Table 6.1.1.2 Summary of Standpipe and Hose Systems Inspection, Testing, and Maintenance

Item	Frequency	Reference
Inspection		
Control valves		Table 13.1.1.2
Pressure-regulating devices		Table 13.1.1.2
Piping	Annually	6.2.1
Hose connections		Table 13.1.1.2]
Cabinet	Annually	NFPA 1962
Gauges	Weekly/quarterly	6.2.2
Hose	Annually	NFPA 1962
Hose storage device	Annually	NFPA 1962
Hose nozzle	Annually and after each use	NFPA 1962
Hydraulic design information sign	Annually	6.2.3
Hose valves		Table 13.1.1.2
Hose connection		Table 13.1.1.2
Test		
Waterflow alarm devices		Table 13.1.1.2
Valve supervisory devices		Table 13.1.1.2
Supervisory signal devices (except valve supervisory switches)		Table 13.1.1.2
Hose storage device	Annually	NFPA 1962
Hose	5 years/3 years	NFPA 1962
Pressure control valve		Table 13.1.1.2
Pressure-reducing valve		Table 13.1.1.2
Hydrostatic test	5 years	6.3.2
Flow test	5 years	6.3.1
Main drain test		Table 13.1.1.2
Hose valves		Table 13.1.1.2
Hose connections		Table 13.1.1.2
Valve status test		13.3.1.2.1
Maintenance		
Hose connections	Annually	Table 6.1.2
Valves (all types)	Annually/as needed	Table 13.1.1.2
Hose valves		Table 13.1.1.2

6.1.2 ***Table 6.1.2*** *shall be used for the inspection, testing, and maintenance of all classes of standpipe and hose systems.*

Table 6.1.2 Standpipe and Hose Systems

Component/Checkpoint	Corrective Action
Hose Connections	
Cap missing	Replace
Fire hose connection damaged	Repair
Valve handles missing	Replace
Cap gaskets missing or deteriorated	Replace
Valve leaking	Close or repair
Visible obstructions	Remove
Restricting device missing	Replace
Manual, semiautomatic, or dry standpipe — valve does not operate smoothly	Lubricate or repair
Piping	
Damaged piping	Repair
Control valves damaged	Repair or replace
Missing or damaged pipe support device	Repair or replace
Damaged supervisory signal initiating device	Repair or replace
Hose	
Inspect	Remove and inspect the hose, including gaskets, and rerack or rereel at intervals in accordance with NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*
Mildew, cuts, abrasions, and deterioration evident	Replace with listed lined, jacketed hose
Coupling damaged	Replace or repair
Gaskets missing or deteriorated	Replace
Incompatible threads on coupling	Replace or provide thread adapter
Hose not connected to hose rack nipple or valve	Connect
Hose test outdated	Retest or replace in accordance with NFPA 1962
Hose Nozzle	
Hose nozzle missing	Replace with listed nozzle
Gasket missing or deteriorated	Replace
Obstructions	Remove
Nozzle does not operate smoothly	Repair or replace
Hose Storage Device	
Difficult to operate	Repair or replace
Damaged	Repair or replace
Obstruction	Remove
Hose improperly racked or rolled	Remove
Nozzle clip in place and nozzle correctly contained?	Replace if necessary
If enclosed in cabinet, will hose rack swing out at least 90 degrees?	Repair or remove any obstructions
Cabinet	
Inspect overall condition for corroded or damaged parts	Repair or replace parts; replace entire cabinet if necessary
Difficult to open	Repair
Cabinet door will not open fully	Repair or move obstructions
Door glazing cracked or broken	Replace
If cabinet is break-glass type, is lock functioning properly?	Repair or replace
Glass break device missing or not attached	Replace or attach
Not properly identified as containing fire equipment	Provide identification
Visible obstructions	Remove
All valves, hose, nozzles, fire extinguisher, etc., easily accessible	Remove any material not related

6.1.3 *Checkpoints and corrective actions outlined in* ***Table 6.1.2*** *shall be followed to determine that components are free of corrosion, foreign material, physical damage, tampering, or other conditions that adversely affect system operation.*

6.1.4 *Valves and fire department connections shall be inspected, tested, and maintained in accordance with Chapter* ***13****.*

6.1.5 *The procedures outlined in Chapter **14** shall be followed where there is a need to conduct an obstruction investigation.*

6.1.6 *Where the inspection, testing, and maintenance of standpipe and hose systems results or involves a system that is out of service, the impairment procedures outlined in Chapter **15** shall be followed.*

6.1.7 *Where approved by the authority having jurisdiction, existing hose shall be permitted to be removed and shall not be recorded as a deficiency.*

6.2 Inspection.

6.2.1 Components. *Components of standpipe and hose systems shall be visually inspected annually or as specified in **Table 6.1.1.2**.*

6.2.2 Gauges.

6.2.2.1 *Gauges on automatic wet and semiautomatic dry standpipe systems shall be inspected quarterly to ensure that they are in good condition and that normal water supply pressure is being maintained.*

6.2.2.2 *Gauges on automatic dry standpipe systems shall be inspected weekly to ensure that normal air or nitrogen and water pressure are being maintained.*

6.2.2.3 *Where air pressure supervision is connected to a constantly attended location, gauges shall be inspected monthly.*

6.2.3* Hydraulic Design Information Sign. *The hydraulic design information sign for standpipe systems shall be inspected annually to verify that it is provided, attached securely, and legible.*

6.2.3.1 *A hydraulic design information sign that is missing or illegible shall be replaced.*

6.2.3.2 *A standpipe system that was not sized by hydraulic design shall have a hydraulic design information sign that reads "Pipe Schedule System."*

6.3 Testing. *Where water damage is a possibility, an air test shall be conducted on the system at 25 psi (1.7 bar) prior to introducing water to the system.*

6.3.1 Flow Tests.

6.3.1.1* *A flow test shall be conducted every 5 years on all Class I and Class III standpipe systems to verify that the required flow and pressure are available at the hydraulically most remote hose valve outlet(s) while flowing the standpipe system demand.*

6.3.1.1.1 *Where a flow test of the hydraulically most remote outlet(s) is not practical, the authority having jurisdiction shall be consulted for the appropriate location for the test.*

6.3.1.2* *The standpipe system demand shall include 500 gpm (1892 L/min) for the first standpipe and 250 gpm (946 L/min) for each additional standpipe until the total system demand is simultaneously flowing.*

6.3.1.2.1* *The 250 gpm (946 L/min) required from each additional standpipe shall be allowed to be flowed from the most convenient hose valve on that standpipe.*

6.3.1.2.2* *Where the 250 gpm (946 L/min) cannot be flowed from each additional standpipe, the authority having jurisdiction shall determine where the additional flow can be taken.*

6.3.1.3 *The standpipe system demand shall be based on the design criteria in effect at the time of the installation.*

6.3.1.3.1 *Where the standpipe system demand cannot be determined, the authority having jurisdiction shall determine the standpipe system demand.*

6.3.1.3.2 *The actual test method(s) and performance criteria shall be discussed in advance with the authority having jurisdiction.*

6.3.1.4 *Standpipes, sprinkler connections to standpipes, or hose stations equipped with pressure-reducing valves or pressure-regulating valves shall have these valves inspected, tested, and maintained in accordance with the requirements of Chapter **13**.*

6.3.1.5 *A main drain test shall be performed on all standpipe systems with automatic water supplies in accordance with the requirements of Chapter **13**.*

6.3.1.5.1 *The test shall be performed at the low point drain for each standpipe or the main drain test connection where the supply main enters the building (when provided).*

6.3.1.5.2 *Pressure gauges shall be provided for the test and shall be maintained in accordance with **5.3.2**.*

6.3.2 Hydrostatic Tests.

6.3.2.1* *Hydrostatic tests of not less than 200 psi (13.8 bar) pressure for 2 hours, or at 50 psi (3.4 bar) in excess of the maximum pressure, where maximum pressure is in excess of 150 psi (10.3 bar), shall be conducted*

every 5 years on manual standpipe systems and semiautomatic dry standpipe systems, including piping in the fire department connection.

6.3.2.1.1 *Manual wet standpipes that are part of a combined sprinkler/standpipe system shall not be required to be tested in accordance with* ***6.3.2.1****.*

6.3.2.2 *The hydrostatic test pressure shall be measured at the low elevation point of the individual system or zone being tested.*

6.3.2.2.1 *The inside standpipe piping shall show no leakage.*

6.3.3 Waterflow Alarm and Supervisory Alarm Devices.

6.3.3.1 *Where provided, waterflow alarm and supervisory alarm devices shall be tested in accordance with* ***13.2.6*** *and* ***13.3.3.5****.*

6.3.3.2 *Where freezing conditions necessitate a delay in testing, tests shall be performed as soon as weather allows.*

6.3.4* Gauges.

6.3.4.1 *Gauges shall be replaced every 5 years or tested every 5 years by comparison with a calibrated gauge.*

6.3.4.2 *Gauges not accurate to within 3 percent of the full scale shall be recalibrated or replaced.*

6.4 Maintenance.

6.4.1 *Maintenance and repairs shall be in accordance with* ***6.1.3*** *and* ***Table 6.1.2****.*

6.4.2 *Equipment that does not pass the inspection or testing requirements shall be repaired and tested again or replaced.*

6.5 Component Action Requirements.

6.5.1 *Whenever components in standpipe and hose systems are adjusted, repaired, reconditioned, or replaced, the actions required in* ***Table 6.5.1*** *shall be performed.*

Table 6.5.1 Summary of Component Replacement Action Requirements

Component	Adjust	Repair	Replace	Required Action
Water Delivery Components				
Control valves	X	X	X	See Chapter 13
Hose valve pressure-regulating devices	X	X	X	See Chapter 13
System pressure-regulating devices	X	X	X	See Chapter 13
Piping	X	X	X	Hydrostatic test in conformance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*
Fire hose			X	No action required
Fire hose		X		Perform hydrostatic test in accordance with NFPA 1962
Hose valve	X	X	X	See Chapter 13
Fire department connections	X	X	X	See Chapter 13
Backflow prevention device	X	X	X	See Chapter 13
Alarm and Supervisory Components				
Vane-type waterflow	X	X	X	Operational test using inspector's test connection
Pressure switch–type waterflow	X	X	X	Operational test using inspector's test connection
Water motor gong	X	X	X	Operational test using inspector's test connection
Valve supervisory device	X	X	X	Operational test for receipt of alarms and verification of conformance with NFPA 14 and/or NFPA 72, *National Fire Alarm and Signaling Code*
Status-Indicating Components				
Gauges			X	Verify at 0 psi (0 bar) and system working pressure
System Housing and Protection Components				
Cabinet	X	X	X	Verify compliance with NFPA 14
Hose storage rack	X	X	X	Verify compliance with NFPA 14
Testing and Maintenance Components				
Drain riser	X	X	X	Inspect for leaks while flowing from connection above the repair
Auxiliary drains	X	X	X	Inspect for leaks at system working pressure
Main drain	X	X	X	Inspect for leaks and residual pressure during main drain test
Structural Components				
Hanger/seismic bracing	X	X	X	Verify conformance with NFPA 14
Pipe stands	X	X	X	Verify conformance with NFPA 14
Informational Components				
Identification signs	X	X	X	Verify conformance with NFPA 14
Hydraulic placards	X	X	X	Verify conformance with NFPA 14

6.5.2 *Where the original installation standard is different from the cited standard, the use of the appropriate installing standard shall be permitted.*

6.5.3 *These actions shall not require a design review, which is outside the scope of this standard.*

Chapter 13 Valves, Valve Components, and Trim

13.1* General.

13.1.1 Minimum Requirements.

13.1.1.1 *This chapter shall provide the minimum requirements for the routine inspection, testing, and maintenance of valves, valve components, and trim.*

13.1.1.2 ***Table 13.1.1.2*** *shall be used to determine the minimum required frequencies for inspection, testing, and maintenance.*

Table 13.1.1.2 Summary of Valves, Valve Components, and Trim Inspection, Testing, and Maintenance

Item	Frequency	Reference
Inspection		
Control Valves		
Sealed	Weekly	13.3.2.1
Locked or electrically supervised	Monthly	13.3.2.1.1
Valve Supervisory Signal Initiating Device	Quarterly	13.3.2.1.2
Alarm Valves		
Exterior	Monthly	13.4.1.1
Interior	5 years	13.4.1.2
Strainers, filters, orifices	5 years	13.4.1.2
Check Valves		
Interior	5 years	13.4.2.1
Preaction/Deluge Valves		
Enclosure (during cold weather)	Daily/weekly	13.4.3.1
Exterior	Monthly	13.4.3.1.6
Interior	Annually/5 years	13.4.3.1.7
Strainers, filters, orifices	5 years	13.4.3.1.8
Dry Pipe Valves/ Quick-Opening Devices		
Gauges	Weekly/monthly	13.4.4.1.2.4, 13.4.4.1.2.5
Enclosure (during cold weather)	Daily/weekly	13.4.4.1.1
Exterior	Monthly	13.4.4.1.4
Interior	Annually	13.4.4.1.5
Strainers, filters, orifices	5 years	13.4.4.1.6
Pressure-Reducing and Relief Valves		
Sprinkler systems	Quarterly	13.5.1.1
Hose connections	Annually	13.5.2.1
Hose racks	Annually	13.5.3.1
Fire pumps		
Casing relief valves	Weekly	13.5.7.1, 13.5.7.1.1
Pressure-relief valves	Weekly	13.5.7.2, 13.5.7.2.1
Backflow Prevention Assemblies		
Reduced pressure	Weekly/monthly	13.6.1
Reduced-pressure detectors	Weekly/monthly	13.6.1
Fire Department Connections	Quarterly	13.7.1
Testing		
Main Drains	Annually/quarterly	13.2.5, 13.2.5.1, 13.3.3.4
Gauges	5 years	13.2.7.2
Waterflow Alarms	Quarterly/semiannually	13.2.6
Control Valves		
Position	Annually	13.3.3.1
Operation	Annually	13.3.3.1
Supervisory	Semiannually	13.3.3.5
Preaction/Deluge Valves		
Priming water	Quarterly	13.4.3.2.1
Low air pressure alarms	Quarterly/annually	13.4.3.2.13, 13.4.3.2.14
Full flow	Annually	13.4.3.2.2
Air leakage	3 years	13.4.3.2.6

13.2 General Provisions.

13.2.1 *The property owner or designated representative shall have manufacturers' literature available to provide specific instructions for inspecting, testing, and maintaining the valves and associated equipment.*

13.2.2 *All pertinent personnel, departments, authorities having jurisdiction, or agencies shall be notified that testing or maintenance of the valve and associated alarms is to be conducted.*

13.2.3* *All system valves shall be protected from physical damage and shall be accessible.*

13.2.4 *Before opening a test or drain valve, it shall be verified that adequate provisions have been made for drainage.*

13.2.5* ***Main Drain Test.*** *A main drain test shall be conducted annually for each water supply lead-in to a building water-based fire protection system to determine whether there has been a change in the condition of the water supply.*

13.2.5.1 *Where the lead-in to a building supplies a header or manifold serving multiple systems, a single main drain test shall be permitted.*

13.2.5.2 *In systems where the sole water supply is through a backflow preventer and/or pressure-reducing valves, the main drain test of at least one system downstream of the device shall be conducted on a quarterly basis.*

13.2.5.3 *When there is a 10 percent reduction in full flow pressure when compared to the original acceptance test or previously performed tests, the cause of the reduction shall be identified and corrected if necessary.*

13.2.6 Alarm Devices.

13.2.6.1 *Mechanical waterflow alarm devices, including but not limited to water motor gongs, shall be tested quarterly.*

13.2.6.2 *Vane-type and pressure switch–type waterflow devices shall be tested semiannually.*

13.2.7 Gauges.

13.2.7.1 *Gauges shall be inspected monthly to verify that they are in good condition and that normal pressure is being maintained.*

13.2.7.1.1 *Where other sections of this standard have different frequency requirements for specific gauges, those requirements shall be used.*

13.2.7.2 *Gauges shall be replaced every 5 years or tested every 5 years by comparison with a calibrated gauge.*

13.2.7.3 *Gauges not accurate to within 3 percent of the full scale shall be recalibrated or replaced.*

13.2.8 Records. *Records shall be maintained in accordance with Section **4.3**.*

13.3 Control Valves in Water-Based Fire Protection Systems.

13.3.1* *Each control valve shall be identified and have a sign indicating the system or portion of the system it controls.*

13.3.1.1 *Systems that have more than one control valve that must be closed to work on a system shall have a sign on each affected valve referring to the existence and location of other valves.*

13.3.1.2* *When a normally open valve is closed, the procedures established in Chapter **15** shall be followed.*

13.3.1.2.1 *When the valve is returned to service, a valve status test (either main or sectional drain, as appropriate) shall be conducted to determine that the valve is not closed.*

13.3.1.3 *Each normally open valve shall be secured by means of a seal or a lock or shall be electrically supervised in accordance with the applicable NFPA standards.*

13.3.1.4 *Normally closed valves shall be secured by means of a seal or shall be electrically supervised in accordance with the applicable NFPA standard.*

13.3.1.5 *Sealing or electrical supervision shall not be required for hose valves.*

13.3.2 Inspection.

13.3.2.1 *All valves shall be inspected weekly.*

13.3.2.1.1 *Valves secured with locks or supervised in accordance with applicable NFPA standards shall be permitted to be inspected monthly.*

13.3.2.1.2 *Control valve supervisory alarm devices shall be inspected quarterly to verify that they are free of physical damage.*

13.3.2.1.3 *After any alterations or repairs, an inspection shall be made by the property owner or designated representative to ensure that the system is in service and all valves are in the normal position and properly sealed, locked, or electrically supervised.*

13.3.2.2* *The valve inspection shall verify that the valves are in the following condition:*

(1) In the normal open or closed position

(2) Sealed, locked, or supervised*

(3) Accessible

(4) Post indicator valves (PIVs) are provided with correct wrenches

(5) Free from external leaks

(6) Provided with applicable identification

13.3.3 Testing.

13.3.3.1 *Each control valve shall be operated annually through its full range and returned to its normal position.*

13.3.3.2* *Post indicator valves shall be opened until spring or torsion is felt in the rod, indicating that the rod has not become detached from the valve.*

13.3.3.2.1 *This test shall be conducted every time the valve is closed.*

13.3.3.3 *Post indicator and outside screw and yoke valves shall be backed a one-quarter turn from the fully open position to prevent jamming.*

13.3.3.4 *A main drain test shall be conducted any time the control valve is closed and reopened at system riser.*

13.3.3.5* Supervisory Switches.

13.3.3.5.1 *Valve supervisory switches shall be tested semiannually.*

13.3.3.5.2 *A distinctive signal shall indicate movement from the valve's normal position during either the first two revolutions of a hand wheel or when the stem of the valve has moved one-fifth of the distance from its normal position.*

13.3.3.5.3 *The signal shall not be restored at any valve position except the normal position.*

13.3.4 Maintenance.

13.3.4.1 *The operating stems of outside screw and yoke valves shall be lubricated annually.*

13.3.4.2 *The valve then shall be completely closed and reopened to test its operation and distribute the lubricant.*

13.4 System Valves.

13.4.1 Inspection of Alarm Valves. *Alarm valves shall be inspected as described in **13.4.1.1** and **13.4.1.2**.*

13.4.1.1* *Alarm valves and system riser check valves shall be externally inspected monthly and shall verify the following:*

(1) The gauges indicate normal supply water pressure is being maintained.

(2) The valve is free of physical damage.

(3) All valves are in the appropriate open or closed position.

(4) The retarding chamber or alarm drains are not leaking.

13.4.1.2* *Alarm valves and their associated strainers, filters, and restriction orifices shall be inspected internally every 5 years unless tests indicate a greater frequency is necessary.*

13.4.1.3 Maintenance.

13.4.1.3.1 *Internal components shall be cleaned/repaired as necessary in accordance with the manufacturer's instructions.*

13.4.1.3.2 *The system shall be returned to service in accordance with the manufacturer's instructions.*

13.4.2 Check Valves.

13.4.2.1 Inspection. *Valves shall be inspected internally every 5 years to verify that all components operate correctly, move freely, and are in good condition.*

13.4.2.2 Maintenance. *Internal components shall be cleaned, repaired, or replaced as necessary in accordance with the manufacturer's instructions.*

13.4.4 Dry Pipe Valves/Quick-Opening Devices.

13.4.4.1 Inspection.

13.4.4.1.1 *Valve enclosures for preaction and deluge valves subject to freezing shall be inspected daily during cold weather to verify a minimum temperature of 40°F (4°C).*

13.4.4.1.1.1 *Valve enclosures equipped with low temperature alarms shall be inspected weekly.*

13.4.4.1.1.2 *Low temperature alarms, if installed in valve enclosures, shall be inspected annually at the beginning of the heating season to verify that they are free of physical damage.*

13.4.4.1.2 Gauges.

13.4.4.1.2.1 *The gauge on the supply side of the dry pipe valve shall indicate that the normal supply water pressure is being maintained.*

13.4.4.1.2.2 *The gauge on the system side of the dry pipe valve shall indicate that the proper ratio of air or nitrogen pressure to water supply pressure is being maintained in accordance with the manufacturer's instructions.*

13.4.4.1.2.3* *The gauge on the quick-opening device, if provided, shall indicate the same pressure as the gauge on the system side of the dry pipe valve.*

13.4.4.1.2.4 *Gauges on systems with low air or nitrogen pressure alarms shall be inspected monthly.*

13.4.4.1.2.5 *Gauges on systems other than those with low air or nitrogen pressure alarms shall be inspected weekly.*

13.4.4.1.3 *Systems with auxiliary drains shall require a sign at the dry or preaction valve indicating the number of auxiliary drains and location of each individual drain.*

13.4.4.1.4 *The dry pipe valve shall be externally inspected monthly to verify the following:*

(1) The valve is free of physical damage.

(2) All trim valves are in the appropriate open or closed position.

(3) The intermediate chamber is not leaking.

13.4.4.1.5 *The interior of the dry pipe valve shall be inspected annually when the trip test is conducted.*

13.4.4.1.6 *Strainers, filters, and restricted orifices shall be inspected internally every 5 years unless tests indicate a greater frequency is necessary.*

13.4.4.2 Testing.

13.4.4.2.1* *The priming water level shall be tested quarterly.*

13.4.4.2.2* *Each dry pipe valve shall be trip tested annually during warm weather.*

13.4.4.2.2.1 *Dry pipe valves protecting freezers shall be trip tested in a manner that does not introduce moisture into the piping in the freezers.*

13.4.4.2.2.2* *Every 3 years and whenever the system is altered, the dry pipe valve shall be trip tested with the control valve fully open and the quick-opening device, if provided, in service.*

13.4.4.2.2.3* *During those years when full flow testing in accordance with **13.4.4.2.2.2** is not required, each dry pipe valve shall be trip tested with the control valve partially open.*

13.4.4.2.2.4 *When refilling a dry system, the air supply shall be capable of restoring normal air pressure in the system within 30 minutes.*

13.4.4.2.2.5 *The requirements of **13.4.4.2.2.4** shall not apply in refrigerated spaces maintained below 5°F (–15°C), where normal system air pressure shall be permitted to be restored within 60 minutes.*

13.4.4.2.3 *Grease or other sealing materials shall not be applied to the seating surfaces of dry pipe valves.*

13.4.4.2.4* *Quick-opening devices, if provided, shall be tested quarterly.*

13.4.4.2.5 *A tag or card that shows the date on which the dry pipe valve was last tripped, and the name of the person and organization conducting the test, shall be attached to the valve.*

13.4.4.2.5.1 *Separate records of initial air and water pressure, tripping air pressure, and dry pipe valve operating conditions shall be maintained on the premises for comparison with previous test results.*

13.4.4.2.5.2 *Records of tripping time shall be maintained for full flow trip tests.*

13.4.4.2.6 *Low air pressure alarms, if provided, shall be tested quarterly in accordance with the manufacturer's instructions.*

13.4.4.2.7 *Low temperature alarms, if installed in valve enclosures, shall be tested annually at the beginning of the heating season.*

13.4.4.2.8 *Automatic air pressure maintenance devices, if provided, shall be tested annually during the dry pipe valve trip test in accordance with the manufacturer's instructions.*

13.4.4.2.9 *Dry pipe systems shall be tested once every 3 years for gas leakage, using one of the following test methods:*

(1) A gas (air or nitrogen) pressure test at 40 psi (3.2 bar) shall be performed for 2 hours.

(a) The system shall be permitted to lose up to 3 psi (0.2 bar) during the duration of the test.

(b) Gas leaks shall be addressed if the system loses more than 3 psi (0.2 bar) during this test.

(2) With the system at normal system pressure, the gas source (nitrogen supply, compressor, or shop air) shall be shut off for 4 hours. If the low pressure alarm goes off within this period, the leaks shall be addressed.

13.4.4.3 Maintenance.

13.4.4.3.1 *During the annual trip test, the interior of the dry pipe valve shall be cleaned thoroughly, and parts replaced or repaired as necessary.*

13.4.4.3.2* *Auxiliary drains in dry pipe sprinkler systems shall be drained after each operation of the system, before the onset of freezing weather conditions, and thereafter as needed.*

13.5 Pressure-Reducing Valves and Relief Valves.

13.5.1 Inspection and Testing of Sprinkler Pressure-Reducing Valves. *Sprinkler pressure-reducing valves shall be inspected and tested as described in **13.5.1.1** and **13.5.1.2**.*

13.5.1.1 *All valves shall be inspected quarterly to verify that the valves are in the following condition:*

(1) In the open position

(2) Not leaking

(3) Maintaining downstream pressures in accordance with the design criteria

(4) In good condition, with handwheels installed and unbroken

13.5.1.2* *A full flow test shall be conducted on each valve at 5-year intervals and shall be compared to previous test results.*

13.5.1.2.1 *Adjustments shall be made in accordance with the manufacturer's instructions.*

13.5.1.3 *A partial flow test adequate to move the valve from its seat shall be conducted annually.*

13.5.2 Hose Connection Pressure-Regulating Devices.

13.5.2.1 *All devices shall be inspected annually to verify the following:*

(1) The handwheel is not broken or missing.

(2) The outlet hose threads are not damaged.

(3) No leaks are present.

(4) The hose adapter and the cap are not missing.

13.5.2.2* *A full flow test shall be conducted on each device at 5-year intervals and shall be compared to previous test results.*

13.5.2.2.1 *Adjustments shall be made in accordance with the manufacturer's instructions.*

13.5.2.3 *A partial flow test adequate to move the device from its seat shall be conducted annually.*

13.5.3 Hose Rack Assembly Pressure-Regulating Devices.

13.5.3.1 *All devices shall be inspected annually to verify the following:*

(1) The handwheel is not missing or broken.

(2) No leaks are present.

13.5.3.2 *A full flow test shall be conducted on each device at 5-year intervals and compared to previous test results.*

13.5.3.2.1 *Adjustments shall be made in accordance with the manufacturer's instructions.*

13.5.3.3 *A partial flow test adequate to move the device from its seat shall be conducted annually.*

13.5.4 Master Pressure-Regulating Devices.

13.5.4.1* *Devices shall be inspected weekly to verify that the devices are in the following condition:*

(1) *The downstream pressures are maintained in accordance with the design criteria.*

(2) The supply pressure is in accordance with the design criteria.

(3) The devices are not leaking.

(4) The devices and trim are in good condition.

13.5.4.2* *A partial flow test adequate to move the valve from its seat shall be conducted quarterly.*

13.5.4.3* *A full flow test shall be conducted on each valve annually and shall be compared to previous test results.*

13.5.4.4 *When valve adjustments are necessary, they shall be made in accordance with the manufacturer's instructions.*

13.5.5 Pressure-Reducing Valves.

13.5.5.1 *All pressure-reducing valves installed on fire protection systems not covered by **13.5.1**, **13.5.2**, **13.5.3**, or **13.5.4** shall be inspected in accordance with **13.5.1.1**.*

13.5.5.2 *All pressure-reducing valves installed on fire protection systems not covered by **13.5.1**, **13.5.2**, **13.5.3**, or **13.5.4** shall be tested in accordance with **13.5.1.2**.*

13.5.6 Hose Valves.

13.5.6.1 Inspection.

13.5.6.1.1 *Hose valves shall be inspected quarterly to verify that the valves are in the following condition:*

(1) Hose caps are in place and not damaged.

(2) Hose threads are not damaged.

(3) Valve handles are present and not damaged.

(4) Gaskets are not damaged or showing signs of deterioration.

(5) No leaks are present.

(6) Valves are not obstructed or otherwise not capable of normal operation.

13.5.6.1.2 *Hose valves shall be inspected to ensure that hose caps are in place and not damaged.*

13.5.6.1.3 *Hose threads shall be inspected for damage.*

13.5.6.1.4 *Valve handles shall be present and not damaged.*

13.5.6.1.5 *Gaskets shall be inspected for damage or deterioration.*

13.5.6.1.6 *Hose valves shall be inspected for leaks.*

13.5.6.1.7 *Hose valves shall be inspected to ensure no obstructions are present.*

13.5.6.1.8 *Hose valves shall be inspected to ensure that restricting devices are present.*

13.5.6.2 Testing.

13.5.6.2.1* *Class I and Class III standpipe system hose valves shall be tested annually by fully opening and closing the valves.*

13.5.6.2.1.1 *Class I and Class III standpipe system hose valves that are difficult to operate or leak shall be repaired or replaced.*

13.5.6.2.2* *Hose valves on hose stations attached to sprinkler systems and Class II standpipe systems shall be tested every 3 years by opening and closing the valves.*

13.5.6.2.2.1 *Hose valves on hose stations attached to sprinkler systems and Class II standpipe systems that are difficult to operate or leak shall be repaired or replaced.*

13.5.6.3 Maintenance. *Hose valves that do not operate smoothly or open fully shall be lubricated, repaired, or replaced.*

13.6 Backflow Prevention Assemblies.

13.6.1 Inspection. *Inspection of backflow prevention assemblies shall be as described in* ***13.6.1.1*** *through* ***13.6.1.4****.*

13.6.1.1 *The isolation valves on double check assemblies (DCA) and double check detector assemblies (DCDA) shall be inspected weekly to ensure that the valves are in the normal open position.*

13.6.1.1.1 *Valves secured with locks or electrically supervised in accordance with applicable NFPA standards shall be inspected monthly.*

13.6.1.2 *The isolation valves on reduced-pressure assemblies (RPA) and reduced-pressure detector assemblies (RPDA) shall be inspected weekly to ensure that the valves are in the normal open position.*

13.6.1.2.1 *Valves secured with locks or electrically supervised in accordance with applicable NFPA standards shall be inspected monthly.*

13.6.1.2.2* *RPAs and RPDAs shall be inspected weekly to ensure that the differential-sensing valve relief port is not continuously discharging.*

13.6.1.3 *After any testing or repair, an inspection by the property owner or designated representative shall be made to ensure that the system is in service and all isolation valves are in the normal open position and properly locked or electrically supervised.*

13.6.1.4* *Backflow prevention assemblies shall be inspected internally every 5 years to verify that all components operate correctly, move freely, and are in good condition.*

13.6.2 Testing.

13.6.2.1* *All backflow preventers installed in fire protection system piping shall be exercised annually by conducting a forward flow test at a minimum flow rate of the system demand.*

13.6.2.1.1 *Where water rationing is enforced during shortages lasting more than 1 year, an internal inspection of the backflow preventer to ensure the check valves will fully open shall be permitted in lieu of conducting the annual forward flow test.*

13.6.2.1.2 *The forward flow test shall not be required where annual fire pump testing causes the system flow rate to flow through the backflow preventer device.*

13.6.2.2 *Where hydrants or inside hose stations are located downstream of the backflow preventer, the forward flow test shall include hose stream demand.*

13.6.2.3 *Where connections do not permit verification of the forward flow test at the minimum flow rate of system demand, tests shall be conducted at the maximum flow rate possible.*

13.6.3 Maintenance. *Maintenance of all backflow prevention assemblies shall be conducted by a qualified individual following the manufacturer's instructions in accordance with the procedure and policies of the authority having jurisdiction.*

13.7 Fire Department Connections.

13.7.1 *Fire department connections shall be inspected quarterly to verify the following:*

(1) The fire department connections are visible and accessible.
(2) Couplings or swivels are not damaged and rotate smoothly.
(3) Plugs or caps are in place and undamaged.
(4) Gaskets are in place and in good condition.
(5) Identification signs are in place.
(6) The check valve is not leaking.
(7) The automatic drain valve is in place and operating properly.
(8) The fire department connection clapper(s) is in place and operating properly.
(9) Interior of the connection is inspected for obstructions.*

13.7.2 *Components shall be repaired or replaced as necessary in accordance with the manufacturer's instructions.*

13.7.3 *Any obstructions that are present shall be removed.*

13.7.4 *The piping from the fire department connection to the fire department check valve shall be hydrostatically tested at 150 psi (10 bar) for 2 hours at least once every 5 years.*

13.8 Component Testing Requirements.

13.8.1 *Whenever a valve, valve component, and/or valve trim is adjusted, repaired, reconditioned, or replaced, the action required in* ***Table 13.8.1*** *shall be performed.*

Table 13.8.1 Summary of Component Replacement Action Requirements

Component	Adjust	Repair/ Recondition	Replace	Inspection, Test, and Maintenance Procedures
Water delivery components				
Post indicator and wall indicator valves	X	X	X	(1) Inspect for leaks at system pressure (2) Perform full operational test conforming to 13.3.3.1 (3) Perform spring torsion inspection conforming to 13.3.3.1 and 13.3.3.2 (4) Verify target visibility at shut and full open position (5) Test supervisory device (6) Main drain test
Control valves other than post indicator and wall indicator valves	X	X	X	(1) Inspect for leaks at system pressure (2) Perform full operational test conforming to 13.3.3.1 (3) Perform spring torsion inspection for OS&Y valves conforming to 13.3.3.2 (4) Verify supervisory device (5) Main drain test
Alarm check valve	X	X	X	(1) Inspect for leaks at system pressure per 13.4.1 (2) Test all alarms and supervisory signals affected by the alarm valve (3) Main drain test
Dry pipe valve	X	X	X	(1) Inspect for leaks at system pressure (2) Trip test per 13.4.4.2 (3) Inspect condition of valve seat (4) Test all dry pipe system alarms and supervisory signals (5) Main drain test
Deluge/preaction valve	X	X	X	(1) Inspect for leaks at system pressure per 13.4.3 (2) Trip test (3) Inspect condition of valve seat (4) Test all deluge/preaction system alarms and supervisory signals (5) Main drain test
Quick-opening device	X	X	X	(1) Inspect for leaks at system pressure per 13.4.4.2.2 (2) Trip test (3) Main drain test
Pressure-regulating device — hose valves	X	X	X	(1) Inspect for leaks at system pressure per 13.5.1 (2) Full flow test (3) Main drain test (Only when a control valve has been closed)
Pressure-regulating devices — other than hose valves	X	X	X	(1) Inspect for leaks at system pressure per Section 13.5 (2) Test pressure setting with full flow and without flow (3) Test supervisory device and alarm (4) Main drain test
Hose valve	X	X	X	(1) Inspect for leaks at system pressure per 13.5.6 (2) Main drain test

(continues)

Table 13.8.1 *Continued*

Component	Adjust	Repair/ Recondition	Replace	Inspection, Test, and Maintenance Procedures
Backflow prevention device	X	X	X	(1) Inspect for leaks at system pressure per Section 13.6 (2) Forward flow test per 13.6.2.1 (3) Test supervisory device and alarm (4) Main drain test
Check valves	X	X	X	(1) Inspect for leaks at system pressure per 13.4.2 (2) Inspect for leaking through check valve (3) Main drain test
Fire department connection	X	X		(1) Inspect for leaks at system pressure per Section 13.7 (2) Main drain test (Only when a control valve has been closed)
Fire department connection — sprinkler system(s)			X	(1) Isolate and hydrostatic test for 2 hours at 150 psi (10 bar) (2) Main drain test (Only when a control valve has been closed)
Fire department connection — other than sprinkler system(s)			X	(1) Isolate and hydrostatic test for 2 hours at 50 psi (3.5 bar) above the normal working pressure [200 psi (14 bar) minimum] (2) Main drain test (Only when a control valve has been closed)
Strainers	X	X	X	Inspect and clean in accordance with manufacturer's instructions
Main drain valves	X	X	X	Main drain test per 13.2.5
Gauges			X	Calibrate per 13.2.7
Alarm and supervisory components				
Alarm device	X	X	X	Test for conformance with NFPA 13 and/or *NFPA 72*
Supervisory device	X	X	X	Test for conformance with NFPA 13 and/or *NFPA 72*
System protection components				
Pressure relief valve — fire pump installation	X	X	X	See 8.3.3.3 and 13.5.7
Pressure relief valve — other than fire pump installation			X	Verify relief valve is listed or approved for the application and set to the correct pressure
Informational components				
Identification signs	X	X	X	Inspect for compliance with NFPA 13 and 13.3.1

13.8.2 *Where the original installation standard is different from the cited standard, the use of the appropriate installing standard shall be permitted.*

13.8.3* *These actions shall not require a design review.*

Chapter 14 Internal Piping Condition and Obstruction Investigation

14.1* General. *This chapter shall provide the minimum requirements for conducting investigations of fire protection system piping for possible sources of materials that could cause pipe blockage.*

14.2 Assessment of Internal Condition of Piping.

14.2.1* *An assessment of the internal condition of piping shall be conducted on a frequency determined by* ***14.2.1.1*** *or* ***14.2.1.2*** *for the purpose of inspecting for the presence of foreign organic and inorganic material.*

14.2.1.1 *An assessment of the internal condition of piping shall be conducted at a minimum of every 5 years or in accordance with* ***14.2.1.2*** *for the purpose of inspecting for the presence of foreign organic and inorganic material.*

14.2.1.2* *Where an assessment frequency has been established by an approved risk analysis, the assessment shall be performed at a frequency determined by the approved risk analysis.*

14.2.1.3 *Tubercules or slime, if found, shall be tested for indications of microbiologically influenced corrosion (MIC).*

14.2.1.4* *If the presence of sufficient foreign organic or inorganic material is found to obstruct pipe or sprinklers, an obstruction investigation shall be conducted as described in Section* ***14.3****.*

14.2.1.5 *Nonmetallic pipe shall not be required to comply with Section* ***14.2****.*

14.2.2* *In buildings having multiple wet pipe systems, every other system shall have an assessment of the internal condition of piping as described in* ***14.2.1****.*

14.2.2.1 *During the next inspection frequency required by* ***14.2.1.1*** *or* ***14.2.1.2****, the alternate systems not assessed during the previous assessment shall be assessed as described in* ***14.2.1****.*

14.2.2.2 *If foreign organic and/or inorganic material is found in any system in a building, all systems shall be assessed.*

14.3 Obstruction Investigation and Prevention.

14.3.1* *An obstruction investigation shall be conducted for system or yard main piping wherever any of the following conditions exist:*

(1) Defective intake for fire pumps taking suction from open bodies of water
(2) The discharge of obstructive material during routine water tests
(3) Foreign materials in fire pumps, in dry pipe valves, or in check valves
(4) Foreign material in water during drain tests or plugging of inspector's test connection(s)
(5) Unknown materials are heard in the system piping during draining, refilling, or otherwise flowing water through the system
(6) Plugged sprinklers
(7) The presence of sufficient foreign organic or inorganic material is found in the pipe
(8) Failure to flush yard piping or surrounding public mains following new installations or repairs
(9) A record of broken public mains in the vicinity
(10) Abnormally frequent false tripping of a dry pipe valve(s)
(11) A system that is returned to service after an extended shutdown (greater than 1 year)
(12) There is reason to believe that the sprinkler system contains sodium silicate or highly corrosive fluxes in copper systems
(13) A system has been supplied with raw water via the fire department connection
(14) Pinhole leaks
(15) A 50 percent increase in the time it takes water to travel to the inspector's test connection from the time the valve trips during a full flow trip test of a dry pipe sprinkler system when compared to the original system acceptance test

14.3.2* *Systems shall be examined for internal obstructions where conditions exist that could cause obstructed piping.*

14.3.2.1 *If the condition has not been corrected or the condition is one that could result in obstruction of the piping despite any previous flushing procedures that have been performed, the system shall be examined for internal obstructions every 5 years.*

14.3.2.2* *Internal examination shall be performed at the following minimum four points:*

(1) System valve
(2) Riser
(3) Cross main
(4) Branch line

14.3.2.3* *Alternative nondestructive examination methods shall be permitted.*

14.3.3* *If an obstruction investigation indicates the presence of sufficient material to obstruct pipe or sprinklers, a complete flushing program shall be conducted by qualified personnel.*

14.3.4 *Tubercules or slime, if found during an obstruction investigation, shall be tested for indications of microbiologically influenced corrosion (MIC).*

14.4 Ice Obstruction. *Dry pipe or preaction sprinkler system piping that protects or passes through freezers or cold storage rooms shall be inspected internally on an annual basis for ice obstructions at the point where the piping enters the refrigerated area.*

14.4.1 *Alternative nondestructive examinations shall be permitted.*

14.4.2 *All penetrations into the cold storage areas shall be inspected and, if an ice obstruction is found, additional pipe shall be examined to ensure no ice blockage exists.*