



FIRE PROTECTION ANALYSIS PROJECT

– 9220 ZANZIBAR LANE MAPLE GROVE, MN

ABSTRACT

This report outlines the multi-faceted approach for fire protection analysis associated with the selected building in Maple Grove, MN

Vandal, Brian

FPE 596 – Culminating Experience in Fire Protection Engineering

Statement of Disclaimer

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

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Executive Summary

This report contains an analysis of the life safety and fire protection features of a four-story apartment building in Maple Grove, Minnesota. The report is a part of the final project intended to meet the requirements for the Culminating Experience of the California Polytechnic Master of Science Fire Protection Engineering Program.

The apartment building chosen for the analysis is a mixed-use four-story wood-framed structure. The first floor of this structure includes office space for building management, a meeting space, and various electrical and mechanical spaces as well as apartments. There are exit stairways on each end of the structure extending up all four floors, and a center stairway extending up only to the second floor. There is a parking garage in the basement that is comprised of cinder block walls, steel girders for support above, and metal pan with poured concrete for the garage ceiling. The building is fully sprinklered throughout.

This report contains analysis of the prescriptive code requirements as well as the fire protection and life safety features of the apartment structure. Topics discussed include means of egress, fire suppression system, fire alarm and detection and structural fire protection.

Applicable codes, regulations and standards include:

- International Building Code (IBC), 2006 Edition
- Minnesota Building Code, 2006 Edition
- Life Safety Code, NFPA 101, 2006 Edition
- International Fire Code (IFC), 2006 Edition
- Fire Alarm Code, NFPA 72, 2006 Edition
- Fire Sprinkler Code NFPA 13, 2002 Edition
- International Mechanical and Fuel Gas Codes, 2004 Edition
- National Electrical Code, 2005 Edition

This report evaluates the International Code Council model building and fire codes and the National Fire Protection Associations codes and standards as a prescriptive code analysis for

this multi-tenant apartment building. The building is found to be in compliance with the documented codes and standards in effect at the time of building design and assembly.

This report also contains a performance-based evaluation. The performance-based evaluation included in Section 7 of the report describes two design fire scenarios to determine the capability of occupants to safely evacuate in the event of the fire scenario. Both fire scenarios are evaluated for performance-based analysis. Three potential scenarios are as follows:

- An occupancy-specific design fire scenario that is representative of a typical fire for the occupancy.
- A fire that starts in a normally unoccupied room that may endanger large numbers of occupants.
- The most severe fire resulting from the largest possible fuel load characteristic of the normal operation of the building.

Selected Design Fire Scenario 1: The design fire involves a kitchen fire in a fourth story apartment unit adjacent to an east egress stairwell. This kitchen fire is based on unattended oil on a cooktop igniting and enveloping the combustible kitchen elements, spreading to the living room and dining room. The projected heat release rate maximizes at 4.0 MW with a time to peak following the incipient phase estimated at 136 seconds. This fire scenario also includes fire sprinkler heads located as documented on the design drawings, as well as a fire scenario with the apartment door open and closed to evaluate the impact on smoke spread into the hallway which is a common access egress path. Tenability criteria with all safety features engaged was not exceeded at any point during the simulation for this design fire. The available safe egress time (ASET) exceeded the model run time of 450 seconds.

Selected Design Fire Scenario 2: The second design fire involves a fire within the trash room on the first floor, which is adjacent to the center stairway, the elevator, and in close proximity to the east stairway. The fire assumes plastic, wood, and other cellulosic materials such as cardboard with a projected maximum heat release rate of 4.5 MW with a t^2 ramp up curve equivalent to 0.047 kW/s^2 . An additional issue is the trash chute that extends up all four floors. This is a metal lined chute with a temperature-dependent release mechanism. The room is

equipped with smoke detection and fire sprinklers, in addition to the fusible link for the trash chute. The fire is contained within the room for the duration of the fire scenario and the fusible link to the trash chute activates at 165° F. All egress paths in the vicinity of this space maintain tenability during the 9-minute FDS run time of the model.

1.0 Introduction

This report contains an analysis of the life safety and fire protection features of a four-story apartment building in Maple Grove, Minnesota. The building is located at 9220 Zanzibar Lane in Maple Grove. At the time of construction, the 2006 International Fire Code and NFPA 72 Fire Alarm Code were in effect per the state of Minnesota. In addition, the 2006 International Building Code was also in effect per Effective Dates of Minnesota Code Adoption¹. These codes, among others, will be used in the analysis of the prescriptive code requirements. Specific tenability requirements will be used to evaluate a performance-based approach.

1.1 Building Overview

The building chosen for this structural fire analysis project is a four (4) story structure with a garage/basement, equipped with fire sprinklers on all floors. The building, including basement, comprises 109,444 square feet (10,167.7 m²) with building completion in 2008. The four floors are between 15,833 and 17,318 square feet (1470.9 and 1608.9 m²). The building is laid out in the shape of an “L” and is primarily light timber wood construction with a gabled roof on wood trusses covered with asphalt shingles. Steel beams are used in the basement to provide for the large spans of open space for parking. Drywall covering is used on interior walls and ceilings in the living spaces. Exterior wall covering is oriented strand board (OSB) with Tyvek wrap covered by stone, wood shingle, and Hardie plank siding (*Figure IV*).

The structure is in use as an apartment building with fifty-two (52) apartments among floors one (1) through four (4) [*Figures I-III*]. In addition to the living spaces, the first floor also has a community room for tenant use, two (2) common use bathrooms, office space as well as

¹ Minnesota Guide to the State Building Code; https://www.dli.mn.gov/sites/default/files/pdf/sbc_dates.pdf.

several storage and electrical/mechanical spaces. There are three (3) exit stairways on the first and second floors that are positioned on both the east and west ends, as well as one in the center. The stairways are accessed from a common six (6) foot wide hallway on each floor. The center stairway is not present on the 3rd and 4th floors, potentially to avoid the atrium and smoke evacuation requirements. Adjacent to the center stairway is a hydraulic elevator that spans all floors as well as the basement. The main electrical and mechanical equipment is located in the garage/basement on the northwest end, while the fire sprinkler riser equipment is located in the basement on the south side of the structure (Figures V-VI).

1.2 Floor Area

Table I. Floor area at 9220 Zanzibar Lane in Maple Grove, MN

Floor	Floor Area (ft ²)	Floor Area (m ²)
Garage	20,312	1,887
1st Floor	17,318	1,609
2nd Floor	17,117	1,590
3rd Floor	16,721	1,553
4th Floor	15,833	1,471
Attic	22,140	2,057
Total	109,441	10,167

1.3 Floor Layout

In terms of floor layout, Figure I below for the first floor graphically represents how the apartments and common spaces are oriented. The apartments are highlighted in royal blue with all egress doors exiting to the common access hallway, which is highlighted in peach. The stairwells on east and west and in center are outlined with green while common spaces are highlighted in red and light green with the lobby egress in yellow.

Floors 2 through 4 have very similar layouts as in Floor 1; however, Figures II and III reveal the limited mechanical/electrical spaces on these upper floors. All floors still egress into the common access hallways, and as noted, the center stairwell only extends up to the second floor. In the center, highlighted in yellow, is the hydraulic elevator and lobby for tenant access. The elevator operation matrix is not available; however, it is expected that the elevator returns to the first floor when the fire sprinkler system is activated.

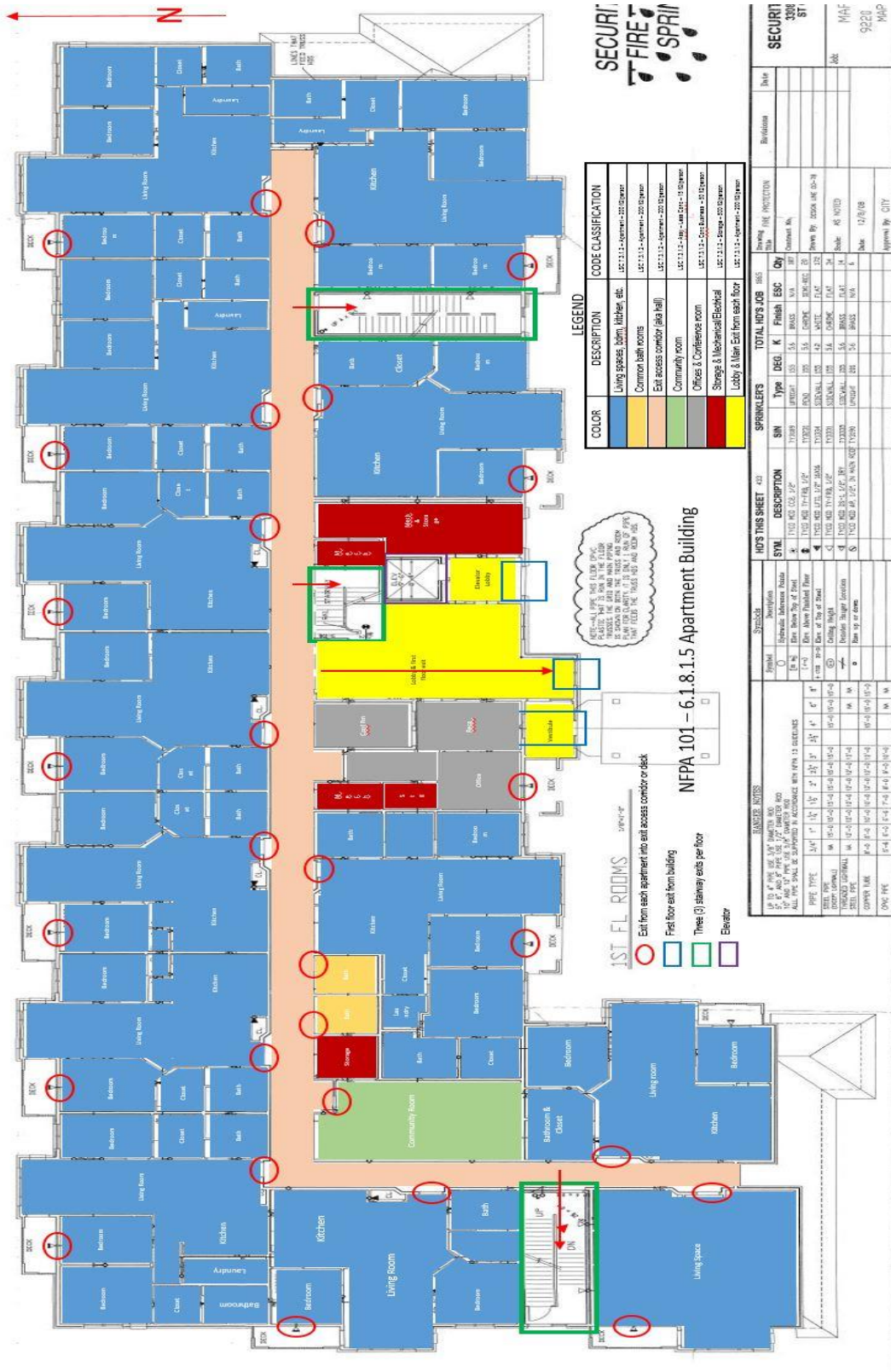
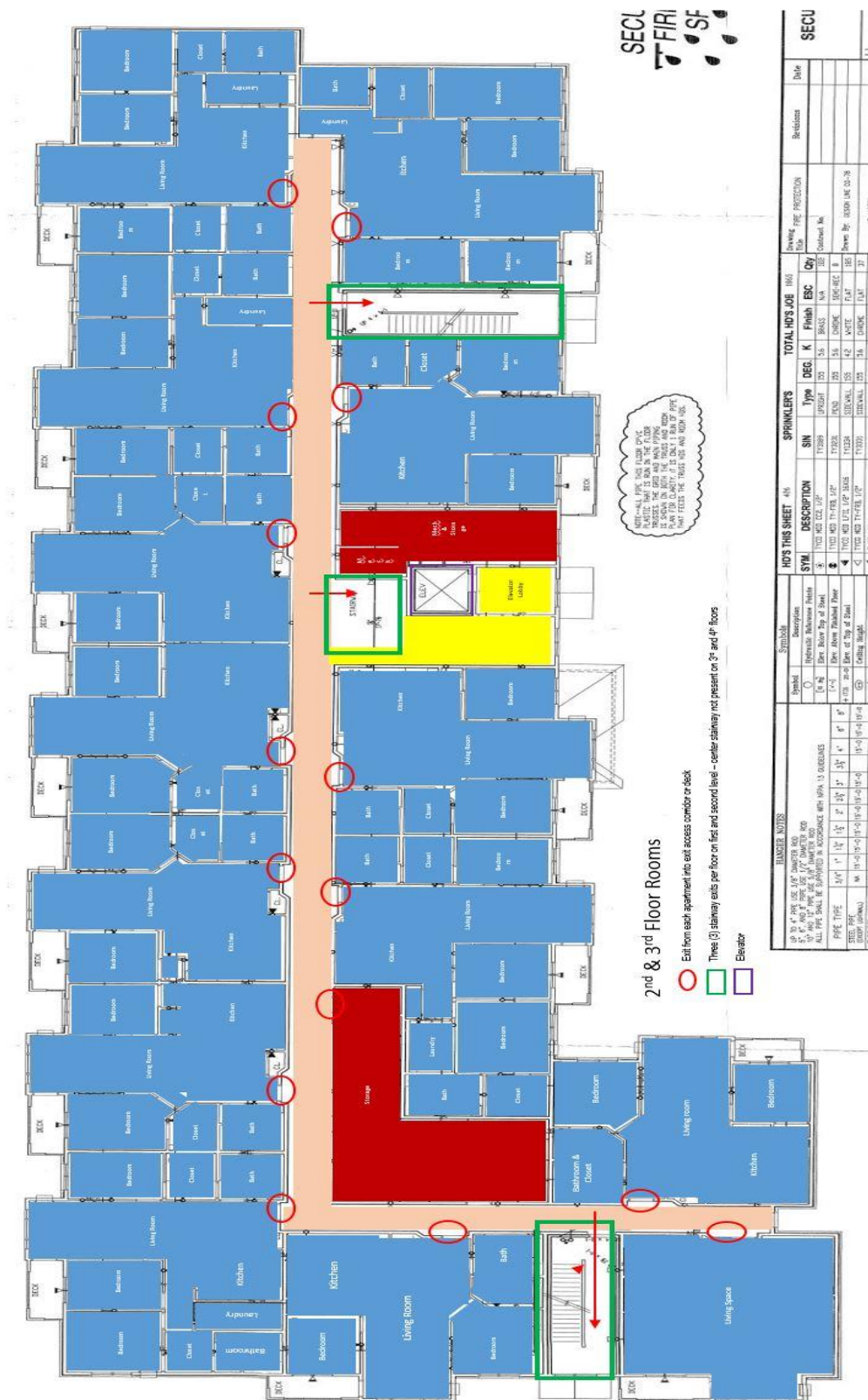


Figure I. First Floor Occupancy Drawing



NOTE: THIS DRAWING IS FOR THE 2ND AND 3RD FLOORS ONLY. IT DOES NOT SHOW THE 1ST FLOOR OR THE 4TH FLOOR. THE 1ST FLOOR IS SHOWN IN THE FLOOR PLAN FOR THE 1ST FLOOR. THE 4TH FLOOR IS SHOWN IN THE FLOOR PLAN FOR THE 4TH FLOOR. THIS DRAWING IS FOR THE 2ND AND 3RD FLOORS ONLY.

2nd & 3rd Floor Rooms

- Exit from each apartment into exit access corridor or deck
- Three (3) stairway exits per floor on first and second level – center stairway not present on 2nd and 3rd floors
- Elevator

DANGER NOTES		HQS THIS SHEET		TOTAL HQS JOB		FLOORING FIRE PROTECTION	
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
○	Exit from each apartment into exit access corridor or deck	○	STAIR	○	STAIR	○	STAIR
□	Three (3) stairway exits per floor on first and second level – center stairway not present on 2 nd and 3 rd floors	□	ELEVATOR	□	ELEVATOR	□	ELEVATOR
□	Elevator	□	UTILITY	□	UTILITY	□	UTILITY
□	Storage	□	STAIR	□	STAIR	□	STAIR

Figure II. Second and Third Floor Occupancy Drawing – 3rd Floor No Stairs in Center

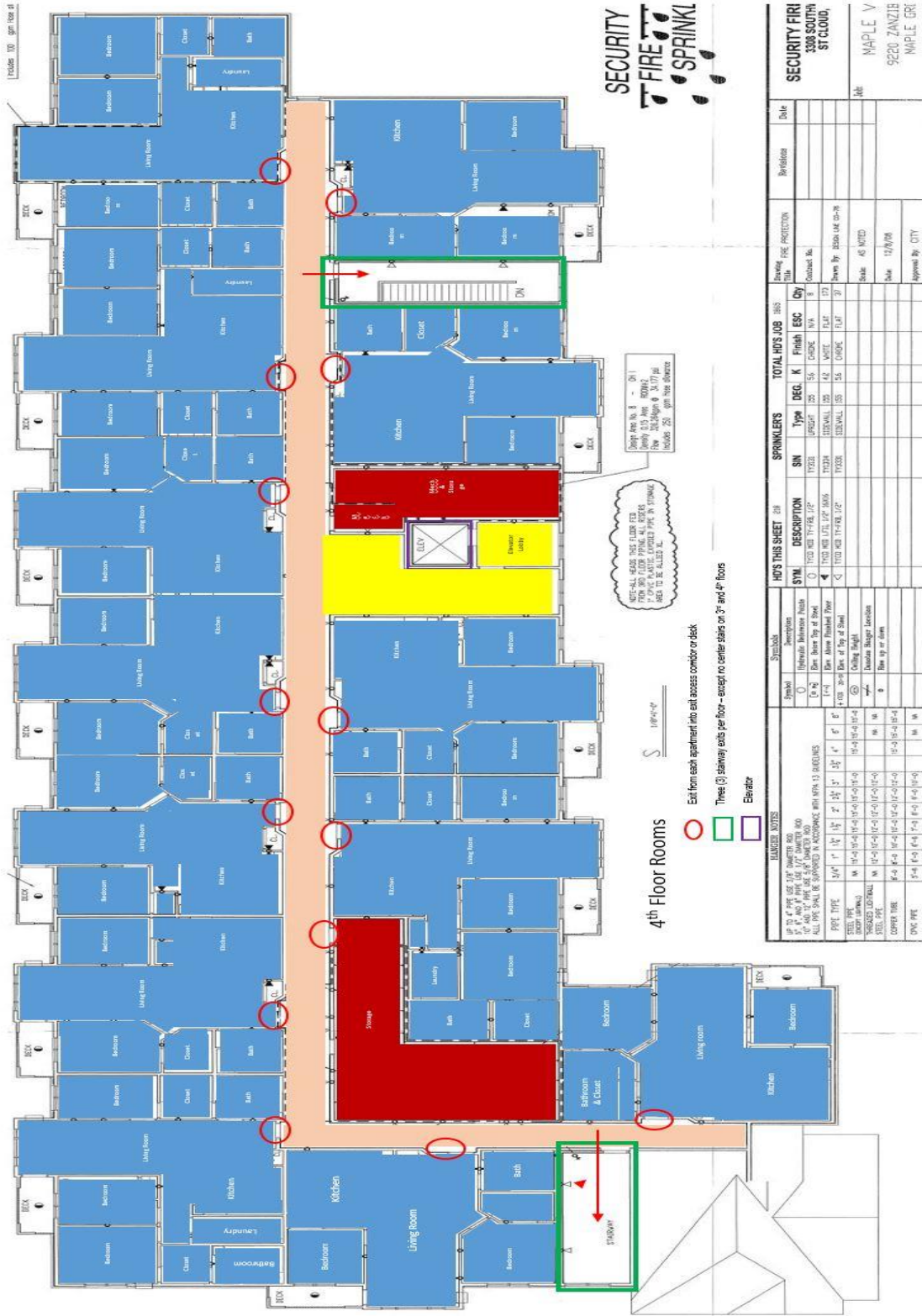


Figure III. Fourth Floor Occupancy Drawing

2.0 Life Safety Analysis

2.1 Occupant Characteristics Affecting Egress

Tenants of the building are primarily permanent, while guests are obviously permitted. All of the units are rentals. Tenants are expected to be of all ages and include those with disabilities. Office personnel are present through the day-time hours, and a building employee is present during non-business hours. The building management does not require any mandatory evacuation training. Tenants would be expected to be familiar with evacuation routes from the building.



Figure IV. Street View of Maple Village Apartment Building

2.2 Occupancy Classifications

According to the International Building Code in Section 310.4, this structure is classified as a residential group R-2, given that the occupancy exceeds sixteen (16) occupants, but is also classified as mixed occupancy. There are no high hazard materials or spaces located within

this building. Within the apartment complex are storage rooms (Section 311 – Group S-2), Utility and Miscellaneous (Group U) for the electrical and mechanical rooms, Business Group B (Section 304) for the office spaces, and Assembly Group B for the community room since its occupancy is less than 50 persons, per Section 303.1.2 Small Assembly.

2.3 Occupancy Separations

According to Section 420 of the International Building Code, this R-2 occupancy must comply with sections 420.2 through 420.5. In 420.2, separation walls between units shall be constructed as fire partitions in accordance with Section 708. According to 708, fire partition walls must have a rating of not less than 1 hour. In 420.3, horizontal separations must comply with Section 711, which references Table 508.4. In a residential occupancy, no floor separation is required, but a Class II construction is required. According to Table 706.4 of the International Building Code, the fire resistance rating of firewalls is a minimum of 2 hours. Specific to the exit stairways, Section 1009.3.1.2 indicates that exit access stairways shall have a fire-resistance rating of not less than 2 hours where connecting four stories or more, and not less than 1 hour where connecting less than four stories. As a result, the center stairway which only extends to the second floor is only required to have a fire-resistance rating of 1 hour, while the east and west stairways require a 2-hour rating.

2.4 Occupant Load Calculation

In Table II on the following page, each space is classified according to Table 7.3.1.2 of the Life Safety Code in order to determine occupancy load factors. While a majority of the space is classified as “Apartments” with an occupancy load factor of 200 ft²/person, there are also storage spaces, electrical/mechanical rooms, office, and assembly spaces. Each space in Table II is listed with its occupancy load factor. The first floor has the largest floor space, with reducing amounts for each floor above. In Figures I-III above, the floor layouts for each floor are listed and color coded for each occupancy load factor determination. The total calculated occupancy load for all four (4) floors is 370 people.

2.5 Exit Capacity Calculations

As noted above, the first and second floors are equipped with three (3) exits. One on the east side, one on the west side, and one in the center of the structure adjacent to the elevator. These exits are accessed by tenants from a common six (6) foot wide hallway on each floor that runs the length of the center of the structure. The third and fourth floors are only equipped with the stairways on the east and west sides. There is no stairway in the center of the structure on these two floors. The stairway doors are 34 inches wide for each, while the stair widths are 44 inches each.

Table II. Occupancy classification per NFPA 101 as well as occupant loading per floor

Space	Use	Area (ft ²)	Occupant Load (LSC)	LSC Section
First Floor	Gross floor space	17318	131	
Apartments	Apartments - 12 @ 1082 sq ft	12982	65	Table 7.3.1.2 - 200 ft ² /person
Community Room	Assembly - Less Concentrated or Collaboration room	600	40	Table 7.3.1.2 - 15 ft ² /person
Access Corridor	Apartments - 1836 sq ft	1836	9	Table 7.3.1.2 - 200 ft ² /person
Storage/Mech	Storage - 500 ft ² /person	500	1	Table 7.3.1.2 - 500 ft ² /person
Office	Office - 50 ft ² person	600	12	Table 7.3.1.2 - 50 ft ² /person
Lobby & Vestibule	Apartments - 200 sq ft	800	4	Table 7.3.1.2 - 200 ft ² /person
Second Floor	Gross floor space	17117	83	
Apartments	Apartments - 13 @ 1082 sq ft	14040	70	Table 7.3.1.2 - 200 ft ² /person
Community Room	Assembly - Less Concentrated or Collaboration room	0	0	Table 7.3.1.2 - 15 ft ² /person
Access Corridor	Apartments - 1836 sq ft	1836	9	Table 7.3.1.2 - 200 ft ² /person
Storage/Mech	Storage - 500 ft ² /person	900	2	Table 7.3.1.2 - 500 ft ² /person
Office	Office - 50 ft ² person	0	0	Table 7.3.1.2 - 50 ft ² /person
Lobby & Vestibule	Apartments - 200 ft ² /person	341	2	Table 7.3.1.2 - 200 ft ² /person
Third Floor	Gross floor space	16721	81	
Apartments	Apartments - 12 @ 1082 sq ft & 1 @ 684 sq ft	13644	68	Table 7.3.1.2 - 200 ft ² /person
Community Room	Assembly - Less Concentrated or Collaboration room	0	0	Table 7.3.1.2 - 15 ft ² /person
Access Corridor	Apartments - 1836 sq ft	1836	9	Table 7.3.1.2 - 200 ft ² /person
Storage/Mech	Storage - 500 ft ² /person	900	2	Table 7.3.1.2 - 500 ft ² /person
Office	Office - 50 ft ² person	0	0	Table 7.3.1.2 - 50 ft ² /person
Lobby & Vestibule	Apartments - 200 ft ² /person	341	2	Table 7.3.1.2 - 200 ft ² /person
Fourth Floor	Gross floor space	15833	76	
Apartments	Apartments - 11 @ 1082 sq ft + 1 @ 684 sq ft	12564	63	Table 7.3.1.2 - 200 ft ² /person
Community Room	Assembly - Less Concentrated or Collaboration room	0	0	Table 7.3.1.2 - 15 ft ² /person
Access Corridor	Apartments - 1836 sq ft	1836	9	Table 7.3.1.2 - 200 ft ² /person
Storage/Mech	Storage - 500 ft ² /person	900	2	Table 7.3.1.2 - 500 ft ² /person
Office	Office - 50 ft ² person	0	0	Table 7.3.1.2 - 50 ft ² /person
Lobby & Vestibule	Apartments - 200 ft ² /person	341	2	Table 7.3.1.2 - 200 ft ² /person
	Total	133786	370	

Table III. Exit capacity calculations for each floor

Exit	Stair Width (In)	Exit Width Factor	Exit Capacity (Exit Width + Width Factor)	Door Width (In)	Exit Width Factor	Exit Capacity (Exit Width + Width Factor)	Limiting Exit Capacity
Floors 1 & 2							
East Stairs	44	0.3	147	34	0.2	170	147
Center Stairs	44	0.3	147	34	0.2	170	147
West Stairs	44	0.3	147	34	0.2	170	147
Total							441
Floors 3 & 4							
East Stairs	44	0.3	147	34	0.2	170	147
West Stairs	44	0.3	147	34	0.2	170	147
Total							294

Excluding the elevator as an exit path, an exit capacity was calculated for both the first and second floors at 147 people per stairway, for a total of 441 people. The stairway widths in Table III indicate that they are the limiting factor in exit capacity. The third and fourth floors, with the center stairway not present, have an exit capacity of 294 people. Given the third floor has a calculated occupancy load of 81 people, and the fourth floor has a calculated occupancy load of 76, there is a significant excess of exit capacity available for these two floors, even without the third set of stairs. With an occupant load of 370, the exit capacity of 441 is sufficient.

2.6 Arrangement of Means of Egress

The east and west stairways exit out of the structure at doorways at the first floor, and the center stairway for floors 1 and 2 exits into the lobby where there are exits out of the structure at the main lobby, vestibule, and elevator lobby. While all first-floor apartments exit into the access corridor, there are also exits onto each deck from each apartment for additional exit capability for those first-floor tenants. It is worth noting that the center stairway exits onto the first floor in an “open-air” fashion. As a result, there is no doorway into the center stairs at the first floor to prevent smoke entry. In case of a fire producing smoke on the first floor, second floor tenants may be forced to exit at either the east or west stairway. Floors 2 through 4 have a calculated load capacity of 240, which is under the 294 exit capacity for these two sets of stairs.

Each of the 12-14 exits from apartments (depending on which floor) exit into the six (6) foot wide hallway, with walls and ceilings in hallways covered with gypsum drywall, meeting the 1-hour fire rating requirement as documented in 30.1.3.3 of the Life Safety Code (LSC). There are no permanent items permitted to be located in hallways that can impede egress to exits. With the minimum of two (2) stairway exits, the requirement of 7.5.1.1.1 in the LSC is met. The two exit stairways are spaced more than half the diagonal length of the structure on the third and fourth floors in order to meet the requirements of 7.5.1.3.2 of the LSC. In addition, the distance from apartment exits to the stairway exits does not exceed 200 feet (30.2.6.3.2), and dead ends at each end of the hallways do not exceed 50 feet (30.2.5.4.2). Even though the Life Safety Code permits a 1-hour rating for sprinklered buildings, the walls and ceilings of exit stairways on the east and west of the structure have a 2-hour fire rating (7.1.3.2 LSC). They also have stairway wall and ceiling finishes of drywall that meet Class A or B requirements (7.1.4.1). In Figures I-III above, the floor layouts for each floor are documented and color coded for each occupancy load factor determination.

2.7 Exit Signage and Emergency Lighting

Sections 30.2.7, 30.2.8, and 30.2.10 of the LSC reference illumination of means of egress, emergency lighting, and marking of means of egress as requirements for this apartment building. All exit doors have an "Exit" sign at the doorway in the hallway ceiling with arrows pointing to the direction of exit. In addition, at each 90-degree turn, an exit sign is placed in the ceiling at the corner, viewable from both directions, with an arrow pointing to the exit doorway(s). An exit sign is located in the hallways of each floor that is illuminated, that is placed in the area where the center elevator is located (or would be on 3rd and 4th floors) so that viewing distance of 100 feet is not exceeded (7.10.1.5.2 LSC).

These "Exit" signs will be illuminated with a battery backup to operate for a minimum of 90 minutes with utility power lost. Tactile signs at each exit door are placed at approximately 48 inches that read: EXIT (7.10.1.3). Illuminated exit signs with a combination of emergency lighting heads with battery backup are also located in each stairway in order to denote exit direction and illuminate the stairway steps to a minimum of 10-foot candles (7.8.1.3 LSC).

The intent is for those exiting the structure to be able to observe an illuminated exit sign at every turn so one is always visible. For all horizontal walkways along the exit routes, emergency lighting with battery backup for 90 minutes (7.9.2.1 LSC) is placed such that walkways are lit to a minimum of 1 foot candle (7.8.1.3 (2)).

2.8 Human Behavior Aspects Regarding Building

Regarding the characteristics of occupants within the building, this structure is in use as apartments/condominiums, so tenants would be expected to be familiar with the structure, including means of egress. The apartments are equipped with an addressable fire alarm system with smoke detectors present in apartments, hallways and other common spaces as required by NFPA 72. This system is monitored and will report to the local fire department if any of the detection devices are activated. The main fire alarm panel is located in the office area adjacent to the lobby. This panel provides visual verification of where in the building the fire alarm detection devices have been activated, either through smoke or heat. The fire sprinkler system is also tied into the fire alarm system with tamper and water flow devices present. If either device is activated (e.g. sprinkler head release, or someone attempting to shut off the water valve), then the monitoring company communicates to the local fire department.

In terms of available safe egress time, the presence of both the fire sprinkler and fire alarm systems would be expected to provide occupants with a relatively quick detection time in order for pre-movement and recognition to begin. The fire alarm system incorporates horns as well as strobes in order to provide both audible and visual cues in case some occupants have disabilities that may affect their perception of these notification appliances. The worst-case scenario would be expected to be a late-night fire in the structure, as most tenants would be asleep as well as a majority of people present in the building. This would also be expected to result in the longest pre-movement and recognition times.

A design fire could include one apartment going to flash-over and spreading into the common hallway as the apartment tenants attempt to escape. This could allow the heat plume to

spread down the hallway ceiling, along with smoke, obscuring the hallway escape path, and exposing other escaping occupants from other apartments on that floor and possibly prevent them from using the common hallway to travel to the exit stairways. This apartment building utilizes self-closing features on all apartment doors that exit into the hallway, and the stairway doors are also self-closing, in order to minimize fire spread.

In these cases, there are expected to be young children as well as older adults who may have mobility issues. If it were a late-night fire, then these issues would increase the pre-movement time for some of the occupants. According to 7.2.13.1 of the LSC, using the elevator as means of egress is not permitted by the Code, since the occupancy exceeds 90 persons. Given that these are semi-permanent occupancies, it is expected that occupants would be aware of others on their floor who may have physical challenges delaying egress. Pre-movement time is estimated at 6 minutes per The National Research Council of Canada issued internal report 660 from June 1994 (discussed below), with projected egress time discussed below in this report.

2.9 Building Evacuation Time – Hand Calculation

In attempting to estimate the time for building evacuation using hand calculation methods, Chapter 4-2 of the NFPA Fire Protection Handbook was consulted for calculation methods for egress prediction. In using this chapter, certain assumptions have been made. It is expected that queuing will occur at the stair way exits as all occupants will start egress at the same time due to fire alarm notification. The prime controlling factor is the two doorways to the stairs. In addition, it is assumed that all occupants are mobile and able to move/exit on their own to an exit in the optimum balance. In terms of occupant responsiveness, an estimate of six (6) minutes for pre-movement time is used.

Additional assumptions are that smoke on the floor due to fire is not impeding occupants in any significant way and paths for exit from the floor are free and clear. Further, no fire is blocking the two or three exit paths on the floors. The stairs are 44" wide and 7"/11" riser to edge dimensions with a 4' x 8' landing at each level of stairway. The total evacuation time

includes time from fire alarm device detection, alarm cue and/or warning, perception, interpretation, and action. Movement time includes time to enter into the stairwells through egress doors and traverse down the stairways. Given that floors 3 and 4 have the most limited egress paths (2) and the longest travel distance, they would be the “worst case” scenario in terms of egress time. The third floor has an occupancy of 81 people and the fourth floor has an occupancy of 76 people. 81 will be used for the hand calculations.

Estimate flow capacity through a stairway door:

- From Table 4.2.8 - max flow through door is 24 persons/minute/Eff Width
- $0.2''/\text{person} = 60 \text{ people/ft actual width}$
- $60 \text{ people/ft(act)} / 24 \text{ people/ft (eff)/min} = 2.5 \text{ min} \times \text{ft(eff)/ft(act)}$
- Effective width = $34'' - 6'' = 28'' = 2.33 \text{ ft}$
- Flow capacity is $24 \times 2.33 = 56 \text{ persons/minute}$
- 81 persons @ 56 persons/minute through each of two doorways < 1.0 minute

Estimate flow capacity in stairway effective width:

- $44'' - 12'' = 32'' (2.66 \text{ ft})$ - This is the limiting factor at max flow rate of 18.5 p/min/ft
- Specific flow = $18.5 \text{ p/min/ft} \times 2.66 \text{ ft} = 49.2 \text{ people/min}$
- As a result, the limiting factor is the stairway at 49.2 people/min.
- 81 persons @ 49.2 people/minute through each of two doorway = 1.0 minute

In estimating speed down stairways: $S = k - akD$ [NFPA Handbook 4-60]

Table 4.2.5: $k = 212$ and $a = 2.86$ (Rise and run at 7/11)

- $S = 212 - (2.86 \times 212 \times 0.175) = 105 \text{ ft/min}$
- Line of travel distance = $12' \times 1.85 = 22.2 \text{ ft}$ [Table 4.2.6 – NFPA FP Handbook]
- 8-foot travel on each landing
- Total floor to floor travel distance of $22.2' + (2 \times 8') = 38.2 \text{ ft}$
- Travel time per floor/person = $38.2 \text{ ft} / 105 \text{ ft/min} = 0.36 \text{ min/floor}$
- @ 4 floors, people on the top floor require $4 \text{ floors} \times 0.36 \text{ min/floor} = 1.44 \text{ minutes}$

In this scenario, it takes 81 people per floor (estimate) six (6) minutes for pre-movement time, one (1) minute to travel from their apartments to the stairway door (~ 200 feet at 3 ft/sec), one (1) minute for all people to navigate into stairway exits for each floor, and then 1.44 minutes to travel down the stairs to the exit from the structure. This results in a total maximum egress time of 9.44 minutes.

2.10 Building Evacuation Time – Comparison Research

Research literature was consulted for evacuation modelling of four (4) story apartment buildings. The National Research Council of Canada issued internal report 660 in June 1994 which documented evacuation studies from a four (4) story apartment building. There were four (4) buildings of similar design that were utilized in different cities. Each drill took place on a weekday between 6:45 PM and 7:30 PM in order to have the largest possible number of occupants at home. During each drill, data was gathered on time to respond to the alarm, direction of movement, the time for all occupants (including disabled and elderly) to reach a safe area, and time to totally evacuate the building (*Table IV*).

Table IV. Evacuation times from four (4) different apartment buildings at 4 stories²

Mean Times Among all Four Buildings

Building	Time to Start (min:sec)	Time to Exit (min:sec)	Time to Move (min:sec)
1	2:30	3:05	0:36
2	8:22	9:36	1:17
3	9:42	10:57	1:15
4	3:08	4:38	1:07

The time to start that was chosen for this apartment building of six (6) minutes, which is consistent with data in the NFPA Fire Protection Handbook³. The movement time of half a

² Evacuation Timing in Apartment Buildings; Proulx, Gyylene & McQueen, Curt; Internal Report No. 660; National Research Council Canada; June 1994.

³ Table 4.2.1 Delay Times Derived from Actual Fires and Evacuation Exercises Reported in Referenced Literature; Section 4 – Human Factors in Emergencies; Fire Protection Handbook; Twentieth Edition, Volumes I and II; Cote, Arthur E.; National Fire Protection Association; Quincy, MA; 2008.

minute to a minute and seventeen seconds is consistent with the hand calculation of 1.44 minutes. Lastly, the time for maximum egress that was calculated at 9.44 minutes is in line with the worst-case scenarios documented above in buildings 2 and 3. The time to descend one floor in the research above averaged sixteen (16) seconds, which is relatively consistent with the hand calculation above of 0.36 minutes (21.6 seconds). It was interesting to note that many residents chose the center stairway closest to the elevator due to their familiarity with entrance and exit in the elevator on a typical basis.

This R-2 occupancy with four (4) floors has a calculated occupancy per NFPA 101 of 370 people with an exit capacity of 440 people. As noted, the center exit stairway is not present on the third and fourth floors. The third and fourth floors have a calculated exit capacity of 294 people, while the calculated occupancy for the third floor is 81 people and the fourth floor has a calculated occupancy load of 76 people. As a result, there is sufficient egress paths for the calculated occupancies of each floor.

The arrangement of the means of egress meet the requirements of exit capacity, while the walls and ceilings in the egress path along the hallways have a 1-hour fire rating as required by the Life Safety Code. The exit stairways also have the required 2-hour fire rating as required as well. Travel distance of egress path of no more than 200 feet as well as dead ends of hallways not exceeding 50 feet are also met.

The exit signage and illumination of signs and egress paths have also been met such that walkways are lit to a minimum of 1 foot candle with emergency lighting backup capable of supplying power for the required 90 minutes. Lastly, the calculated egress path timing is 9.44 minutes, with the time to move estimated to be 6 minutes. This is consistent with research on separate four-story apartment buildings in the referenced Canadian study.

Along with the prescriptive code requirements, there will be a discussion on performance-based requirements for safety of occupants during a fire. The performance-based requirements are evaluated based on tenability performance criteria which is discussed in the Performance Based Requirements section.

3.0 Fire Suppression System Analysis

A combination wet and dry automatic sprinkler system is located on all four (4) floors of the building, the attic space, and in the basement parking garage. Two (2) wet standpipes are located in the basement level at the front of the building in the mechanical space along with a dry standpipe routed to the fire sprinkler heads in the attic space (Figures V-VI). A fourth standpipe is also located in the main fire sprinkler room which is a 4" pipe to the fire department connection. Due to available utility water pressure and flow, no fire pump is required for this building. The sprinkler system is designed and installed in accordance with NFPA 13, 2002 Edition.

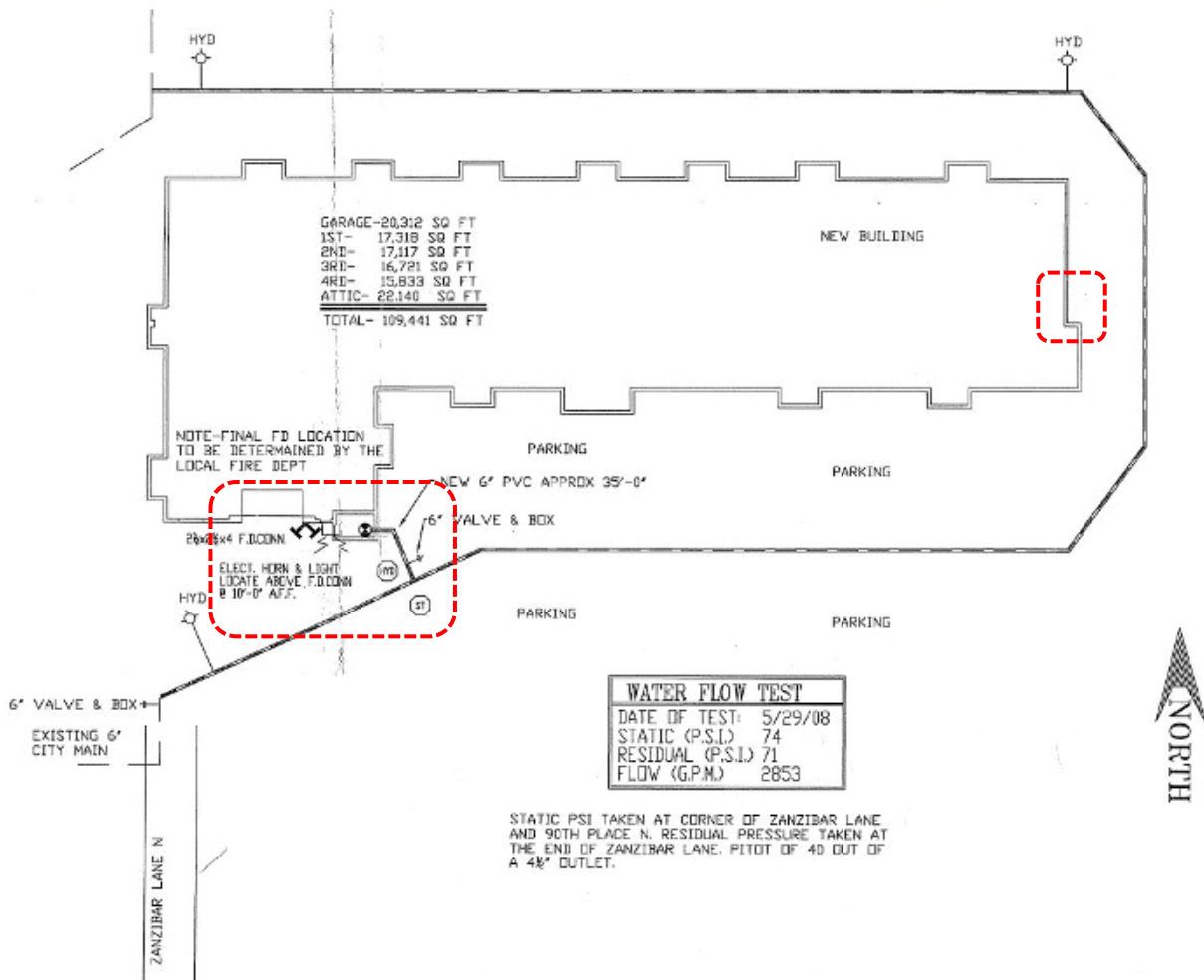


Figure V. Main fire sprinkler standpipe at Southwest corner of structure

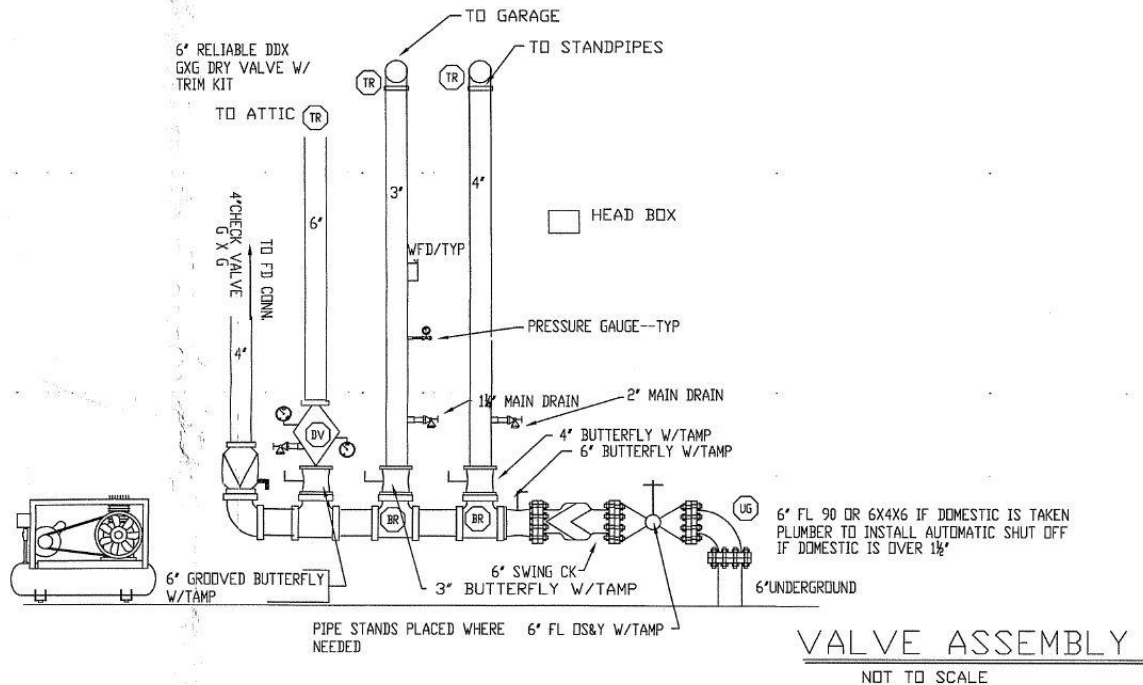


Figure VI. Standpipe Connections at Front Left Side of Building

3.1 Automatic Fire Sprinkler Systems

An automatic sprinkler system in accordance with 2002 NFPA 13 is installed throughout the building. The system is equipped with several types of sprinkler heads. Sprinkler heads in the basement and four (4) floors of living space are Tyco ½” rapid response pendant, sidewall, and upright – depending on the mounting location – rated at 155° F with a 5.6 K factor.

Sprinkler heads located in the attic space are a Tyco ½” pendant and upright with a 5.6 K factor rated at 200° F in the dormers, while the sprinkler heads down the center of the attic space are a Tyco brand ¾” upright with an 8.0 K factor rated at 200° F. The sprinkler system electronic components, such as the tamper and flow devices, are monitored by a central station and interconnected to the fire alarm control panel (FACP).

The wet standpipes that route to the standpipes in the environmentally controlled spaces as well as to the garage provide water flow upon sprinkler head release in one of these spaces. The flow of water causes the water flow device to initiate and provide notification to the

central station. The attic space is not environmentally controlled and as a result, is supplied via a dry sprinkler pipe. In this pipe, no water is present in the dry standpipe and downstream piping due to concerns with water freezing and the resultant potential expansion in these pipes. It is typically filled with pressurized air or nitrogen to minimize corrosion. Once a fire sprinkler head is released, the remote valve in the dry standpipe is released and water flows up the standpipe and to the area where the sprinkler head has released.

3.2 Classification of Sprinkler System Occupancy Hazard Groups

The sprinkler system occupancy hazard groups in the four (4) story apartment building include light hazard and ordinary hazard group 1 per NFPA 13. There are seven (7) design areas throughout the building, which are listed in Table 5 below. The sprinkler system occupancy hazard groups are based on the anticipated quantity and/or combustibility of the contents within each space.

- Light Hazard: Corridors, apartment spaces, offices, restrooms, attic spaces, hotel lobby, and meeting area.
- Ordinary Hazard Group 1: Parking garage, laundry area, trash room, mechanical and electrical room, and storage rooms.

3.3 System Design Criteria

The design criteria for the systems are required to be in accordance with NFPA 13. Applicable design criteria for the apartment building are summarized below. Seven (7) design areas throughout the structure were evaluated in order to determine the maximum design water flow for the fire sprinkler (*Table V*).

- Light Hazard: 0.10 gpm/ft² over 1500 ft². The hose allowance of 100 gpm of water supply for 60 minutes
- Ordinary Hazard Group 1: 0.15 gpm/ft² over 1500 ft². The hose allowance of 250 gpm of water supply for 60 minutes

According to 19.3.3.2.3.1 of NFPA 13, utilizing the density/area method, when using quick response sprinklers, a reduction in the area of operation from 1500 ft² is permitted when the following conditions are met:

- Wet pipe system
- Light or ordinary hazard occupancy
- 20 ft maximum ceiling height
- No unprotected ceiling pockets as allowed by 10.2.9 and 11.2.8 exceeding 32 ft²
- At least 5 sprinklers in design area (11.2.3.2.3.2)

Chapter 5 of NFPA 13, titled *Classification of Occupancies and Commodities*, clarifies what constitutes a light hazard and ordinary hazard group 1 occupancy. These are two of the least hazardous occupancies which is a result of the presence of a limited quantity of combustibles.

Table V. Occupancy hazard classifications for fire sprinkler hydraulic calculations

Design Area	Type	Location	Density [gpm/ft ²]	Flow [gpm]	Pressure [psi]	Hose Allowance [gpm]
1	Light	Attic Dormer	0.1	208.6	58.3	100
2	Light	Attic East	0.1	409.2	61.4	100
3	Light	Attic West	0.1	424.2	56.6	100
4	OH 1	Garage - East	0.15	451.1	54.7	250
5	OH 1	Garage - West	0.15	487.6	45.0	250
6	Light	3rd Flr - East Truss	0.1	280.8	53.6	250
7	Light	3rd Flr - East Apt (4 Heads)	0.1	166.8	41.7	100

3.4 Water Supply

The municipal water supply provides fire sprinkler supply to the building. The water supply has the following characteristics as determined during flow testing.

- Static PSI: 74
- Residual PSI: 71
- Flow (GPM): 2853

The static PSI test was taken at the corner of Zanzibar Lane and 90th Place North which is about 1,000 feet south of the building, and the residual pressure was taken at the end of Zanzibar Lane. The water supply is adequate for the required duration and flowrates. NFPA 13 11.2.3.1.2 requires 250 gpm for the hose allowance stream for 60-90 minutes to be provided for ordinary hazard occupancies and 100 gpm for the hose stream for light hazard occupancies.

3.5 Fire Department Connections

There are two (2) fire department connections on the exterior of the building. One is located at the front of the building to the right of the garage roll up door, and the other is on the east side of the building near the other garage roll up door. These can both be observed in Figure V above.

3.6 Hydraulic Calculation

Seven (7) areas were calculated to ensure that the most demanding hydraulically remote location in the building is evaluated. The areas are in the attic space, garage, and third floor truss and an apartment.

The hydraulic calculation results are summarized in Table V of this report. Multiple hydraulic design areas are feasible as the required pressure and flow have varying flows and required pressures, along with the hose allowance. A hydraulic graph representing the city water supply, the fire pump, and the system demand is provided in Figure VII for the design area. A sprinkler system demand of 487.6 gpm with a hose allowance of 250 gpm at 45.0 psi has been chosen for the water supply demand evaluation. It is evident that the available municipal water supply is more than adequate to supply the remote design locations as calculated (*Figure VII*).

In determining the most demanding area (*see calculations in Appendix*), we first look to Chapter 19 of NFPA 13. This chapter provides detail on determining the area to be evaluated along with the number of sprinklers in the most hydraulically demanding area. All seven areas are either Light or Ordinary Hazard 1 locations while quick/rapid response sprinklers are utilized. As a

result, the density to area of coverage calculation is either 0.1 (Light) or 0.15 (OH1) gpm/ft². Both require an area of sprinkler operation of a minimum 1500 ft². With the allowable reduction of 40% due to the quick/rapid response, the area of coverage can be reduced to 900 ft², while the actual areas for the seven are larger than this.

In determining the length of the rectangular area, L, the area of operation (1,083 ft²) is utilized in the equation, $L = 1.2 * \text{SQRT}(1,083) = 39.5 \text{ ft}$. This length is needed to determine the longest side of the rectangle that is parallel to the main branch. The sprinkler coverage area is limited to 100 ft², and the required number of sprinklers is $1,083/100 \approx 11$.

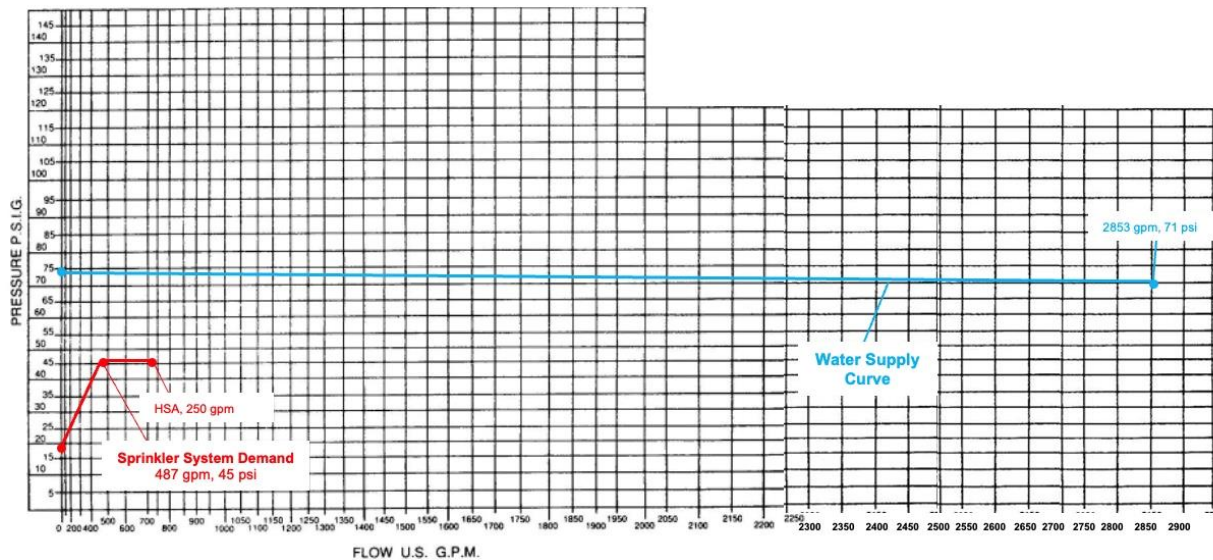


Figure VII. Water supply demand curve for 9220 Zanzibar Lane in Maple Grove, MN

3.7 Inspection Testing and Maintenance Requirements

Several inspection, testing, and maintenance requirements for the sprinkler system in the apartment building exist as required by NFPA 25, in Inspection, Testing and Maintenance of Water-Based Fire Protection Systems. NFPA 25 contains three tables that summarize these requirements. They are Tables 5.1.1.2, 6.1.1.2, and 13.1.1.2. Monthly observations of the sprinkler system are the responsibility of the staff of the building. A sprinkler contractor approved by the AHJ completes annual inspections, testing and maintenance. A table outlining the inspection and testing requirements for fire sprinkler systems is listed in Table VI below.

The installing contractor has placed a permanent sign relevant to inspection, testing and maintenance as outlined in NFPA 25. The sign includes the following:

- (1) Name and location of the facility protected
- (2) Occupancy classification
- (3) Commodity classification
- (4) Presence of high-piled and/or rack storage
- (5) Maximum height of storage planned
- (6) Aisle width planned
- (7) Encapsulation of pallet loads
- (8) Presence of solid shelving
- (9) Flow test data
- (10) Presence of flammable/combustible liquids
- (11) Presence of hazardous materials
- (12) Presence of other special storage

The owner has transitioned to a qualified contractor for ongoing maintenance, testing and inspection of the fire sprinkler system. In addition, written confirmation has been provided to confirm that any change of use of the structure will require a re-evaluation of the fire sprinkler system to meet the changed need. The following ongoing testing and maintenance requirements have been communicated.

As noted above, the building has a combination of wet and dry standpipes for the fire sprinkler system, and there is sufficient water capacity in terms of pressure and flow without the need for a fire pump motor. The spaces within the building are classified as either normal hazard or light hazard for occupancy in terms of sprinkler hydraulic calculations. It is also noted that relevant inspection, testing and maintenance plans were developed and being implemented in periodic frequency. In the following section, the fire alarm and detection system is detailed.

Table VI. Fire Sprinkler System Inspection and Testing Requirements

Table 13.1.1.2 Summary of Valves, Valve Components, and Trim Inspection, Testing, and Maintenance

Item	Frequency	Reference
Inspection		
<i>Backflow Prevention Assemblies</i>		
Reduced pressure	Weekly/monthly	13.6.1
Reduced-pressure detectors	Weekly/monthly	13.6.1
<i>Check Valves</i>		
Interior	5 years	13.4.2.1
<i>Control Valves</i>		
Sealed	Weekly	13.3.2.1
Locked or electrically supervised	Monthly	13.3.2.1.1
<i>Dry Pipe Valves/ Quick-Opening Devices</i>		
Gauges	Weekly/monthly	13.2.7
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
<i>Deluge Valves</i>		
Enclosure (during cold weather)	Daily/weekly	13.4.4.1
Exterior	Monthly	13.4.4.1.5
Interior	Annually/5 years	13.4.4.1.6
Strainers, filters, orifices	5 years	13.4.4.1.7
<i>Fire Department Connections</i>	Quarterly	13.7.1
Testing		
<i>Backflow Prevention Assemblies</i>	Annually	13.7.2
<i>Control Valves</i>		
Position	Annually	13.3.3.1
Operation	Annually	13.3.3.1
Valve Status Test	After the control valve is reopened	13.3.3.4
Supervisory	Annually	13.3.3.5
<i>Deluge Valves</i>		
Trip test	Annually/3 years	13.4.4.2.3
<i>Dry Pipe Valves/ Quick-Opening Devices</i>		
Air leakage	3 years	13.4.4.2.9
Priming water	Quarterly	13.4.4.2.1
Low air pressure alarm	Quarterly	13.4.4.2.6
Quick-opening devices	Quarterly	13.4.4.2.4
Trip test	Annually	13.4.4.2.2
Full flow trip test	3 years	13.4.4.2.2.2
<i>Gauges</i>	5 years	13.2.7
<i>Main Drains</i>	Annually/quarterly	13.2.5
<i>Precision Valves</i>		
Priming water	Quarterly	13.4.3.2.1
Low air pressure alarms	Quarterly/annually	13.4.3.2.10
Trip test	Annually/3 years	13.4.3.2.3
Air leakage	3 years	13.4.3.2.6

4.0 Fire Alarm and Detection

4.1 Overview of Fire Alarm Systems

The building is comprised of one- and two-bedroom apartments with each having heating and cooling systems individual to each unit. Addressable photoelectric smoke detectors are located in each bedroom with a combination smoke and carbon monoxide detector located in the living room area in close proximity to the bedrooms. The bedrooms and living room are also equipped with wall-mounted horn and strobe alarms for both audible and visible signal in the case of an alarm condition. Common hallways are also equipped with ceiling-mounted smoke detectors and wall-mounted strobe alarm devices. Manual pull stations for the fire alarm are located in the paths of egress at each floor. The Honeywell NFS2-3030 Intelligent Addressable Fire Alarm System Notifier NFS2-3030 fire alarm control panel is located on the first floor in the office area while the remote annunciator is located in the first-floor lobby area.

In addition to the fire detection system, the building is also equipped with a wet-pipe fire sprinkler system. The piping is a combination of steel pipe for mains and cross mains and CPVC for runs through apartment rooms. A combination of upright, pendant, and sidewall sprinkler heads are utilized which have a rating of 155° F for living spaces and 200° F for attic spaces. The OS&Y valve is located at the front (A side) of the structure and is monitored via an OSY2 supervisor tamper device. The sprinkler main standpipe is located in the mechanical room in the basement/garage of the structure and is equipped with valve tamper and flow devices that are tied into the fire alarming system.

4.2 Fire Signatures and Detection Devices

For bedrooms, hallways, and other common spaces, a Honeywell Notifier FSP-951 series addressable photoelectric smoke detector with compatible base is used. These are hardwired devices that have a two-wire SLC loop connection and operate at 24 V_{DC}.



Figure VIII. Honeywell Notifier FSP-951 Series Addressable Photoelectric Smoke detector

An addressable device utilizes a multiplexed signal such that the fire alarm panel is programmed to know specifically where that device is located. Each smoke detector has a unique identifier, and the programmer sets this up in the fire alarm system programming so that if a specific device detects heat and/or smoke, the digital display screen will identify where in the structure that device is located. This enables an individual (e.g. fire department personnel) to view the display screen at the fire alarm panel and know specifically where detection devices are located in order to reduce the time to locate the fire.

This model of smoke detector has a sensitivity of 0.5% to 4.0% per foot obscuration and is rated for an operating temperature of 32 - 122° F. The thermal ratings are for a fixed temperature set point of 135° F with a rate-of-rise detection of 15° F per minute. Standby current is listed at 200 μ A at 24 V_{DC} and a maximum current draw of 4.5 mA.

In the living rooms where the furnace/air handler is located are an FCO-951 Series multi-criteria fire/carbon monoxide detector, which is also manufactured by Honeywell and is a Notifier model. It is equipped with photoelectric sensors to detect airborne particles associated with smoke, thermal sensors to detect heat and rate-of-rise (135°F fixed temperature threshold), carbon monoxide sensors to detect the by-products of fire, and infrared sensors in order to discern light patterns in the environment as an additional point for detection determination.

These devices also operate at 24 V_{DC} with operating current at 200 μA and maximum alarm current of 2 mA @ 24 V_{DC}. The following table addresses the carbon monoxide response time:

Table VII. Carbon Monoxide Detector Response for FCO-951 Series Alarm

Alarm thresholds are as follows:

Parts Per Million	Detector Response Time
70 ± 5ppm	60 – 240 min.
150 ± 5ppm	10 – 50 min.
400 ± 10ppm	4 – 15 min.



Figure IX. Honeywell Notifier FCO-951 Series Addressable Fire & Carbon Monoxide detector

For the common spaces, heating and cooling is supplied by multiple HVAC units with the condensing units positioned at the rear of the building. Each unit covers a zone on each floor, such as the office space and vestibule on the first floor, as well as the hallway corridors. Air handling units are positioned in the mechanical rooms for each floor with ductwork routed in the interstitial space of each floor. Encompassed in the air handling units are duct smoke detectors. A Honeywell Notifier FSL-75DNR(A) high sensitivity duct smoke detector (Appendix) is utilized which has a maximum standby current of 230 μA and maximum alarm current of 6.0 mA and operates at 24 V_{DC}.

In addition to the FSP-951 smoke detectors, there are a total of 1,865 fire sprinkler heads installed in the four floors of the structure and the attic space. The most common in the living spaces is a Tyco model LFII sidewall rapid response head (See Appendix). These are rated at 155° F with a K factor of 5.6. These are permitted for use in occupancies up to and including four stories in height per NFPA 13R. These heads incorporate a glass bulb design which keeps the sealing assembly in place. These heads have a 1/2" threaded opening. The following table outlines the maximum spacing per foot along with the flow rate in GPM. The Tyco data sheet indicates a minimum spacing of 8 feet.



Figure X. Tyco Rapid Response LFII Horizontal Sidewall 5.6 K Factor Sprinkler Head

Table VIII. Maximum Spacing for Tyco Model LFII Sidewall Rapid Response Sprinkler Head

Max. Coverage Area (a) Width x Length (d) ft x ft (m x m)	Max. Spacing ft (m)	Minimum Flow and Residual Pressure ^(b, c)				Deflector to Ceiling	Installation Type	Minimum Spacing ft (m)
		Ordinary Temp. Rating 155°F (68°C)		Intermediate Temp. Rating 175°F (79°C)				
		Flow GPM (L/min)	Pressure PSI (bar)	Flow GPM (L/min)	Pressure PSI (bar)			
12 x 12 (3.7 x 3.7)	12 (3.7)	17 (64.3)	9.2 (0.63)	17 (64.3)	9.2 (0.63)	4 in. to 6 in.	1/2 in. recessed using Style 20 Escutcheon or non-recessed per NFPA 13D, 13R, or 13	8 (2.4)
14 x 14 (4.3 x 4.3)	14 (4.3)	19 (71.9)	11.5 (0.79)	19 (71.9)	11.5 (0.79)			
16 x 14 (4.9 x 4.3)	16 (4.9)	20 (75.7)	12.8 (0.88)	20 (75.7)	12.8 (0.88)			
16 x 16 (4.9 x 4.9)	16 (4.9)	24 (90.8)	18.4 (1.27)	24 (90.8)	18.4 (1.27)			
16 x 18 (4.9 x 5.5)	16 (4.9)	26 (98.4)	21.6 (1.49)	26 (98.4)	21.6 (1.49)			
16 x 20 (4.9 x 6.1)	16 (4.9)	29 (109.8)	26.8 (1.85)	29 (109.8)	26.8 (1.85)			
12 x 12 (3.7 x 3.7)	12 (3.7)	20 (75.7)	12.8 (0.88)	20 (75.7)	12.8 (0.88)			
14 x 14 (4.3 x 4.3)	14 (4.3)	22 (83.3)	15.4 (1.06)	22 (83.3)	15.4 (1.06)			
16 x 14 (4.9 x 4.3)	16 (4.9)	24 (90.8)	18.4 (1.27)	24 (90.8)	18.4 (1.27)			
16 x 16 (4.9 x 4.9)	16 (4.9)	28 (106.0)	25.0 (1.72)	28 (106.0)	25.0 (1.72)			
16 x 18 (4.9 x 5.5)	16 (4.9)	31 (117.3)	30.6 (2.11)	31 (117.3)	30.6 (2.11)			
16 x 20 (4.9 x 6.1)	16 (4.9)	37 (140.0)	43.7 (3.01)	37 (140.0)	43.7 (3.01)			

Notes:
a. For coverage area dimensions less than or between those indicated, use the minimum required flow for the next highest coverage area for which hydraulic design criteria are stated.
b. Requirement is based on minimum flow in GPM (LPM) from each sprinkler. The associated residual pressures are calculated using the nominal K-factor. See Hydraulic Design under the Design Criteria section.
c. For NFPA 13 residential applications, the greater of 0.1 gpm/ft² over the design area or the flow in accordance with the criteria in this table must be used.
d. The Width x Length dimension refers to the Width (backwall where the sprinkler is located) times the Length (horizontal throw of sprinkler).

**TABLE A
WET PIPE SYSTEMS
SERIES LFII (TY3334) RESIDENTIAL HORIZONTAL SIDEWALL
AND RECESSED HORIZONTAL SIDEWALL SPRINKLERS (TY3334)
NFPA 13D, 13R AND 13 WET PIPE HYDRAULIC DESIGN CRITERIA**

Incorporated into the incoming fire sprinkler main pipe and components are a System Sensor WFDN waterflow alarm that will put the fire alarm system into alarm mode upon activation, and post indicator butterfly valve (PIB) and outside screw and yoke (OS&Y) valve supervisory switches that will result in a supervisory alarm in the fire alarm control panel.

4.3 Location, Spacing, and Placement of Fire Detection Devices

Chapter 17 of NFPA 72 provides clarification of requirements for location of fire detection initiating devices. As noted previously, the interior walls and ceiling have drywall gypsum covering the wood stud construction and ceiling heights are all 8 feet and are not textured. According to 17.6.3.1.1, the distance between alarms shall not exceed their listed spacing, and there shall be alarms 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% of the ceiling height. In addition, all points on the ceiling shall have an alarm within a distance equal to or less than 0.7 times the listed spacing (0.7S). According to Honeywell, "Notifier recommends spacing alarms in compliance with NFPA 72. In low airflow applications with smooth ceiling, space alarms 30 feet (9.1m)."

The International Fire Code also applies, and in 907.2.11.2, the Code indicates that in Groups R-2, R-3, R-4 and I-1, single or multiple-station smoke detectors shall be installed and maintained in Groups R-2, R-3, R-4 and I-1 regardless of occupant load at all of the following locations:

1. On the ceiling or wall outside of each separate sleeping area in the immediate vicinity of bedrooms.
2. In each room used for sleeping purposes.
3. In each story within a dwelling unit, including basements but not including crawl spaces and uninhabitable attics. In dwellings or dwelling units with split levels and without an intervening door between the adjacent levels, a smoke detector installed on the upper

level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

In terms of carbon monoxide detectors, article 17.12.1 states *“Where required by other governing laws, codes, or standards, carbon monoxide alarms shall be installed in accordance with the following:*

- (1) On the ceiling in the same room as permanently installed fuel-burning appliances, and*
- (2) Centrally located on every habitable level and in every HVAC zone of the building, and*
- (3) Outside each separate dwelling unit, guest room, and guest suite sleeping area within 21 ft (6.4 m) of any door to a sleeping room, with the distance measured along a path of travel, and*
- (4) Other locations where required by applicable laws, codes, or standards, or*
- (5) A performance-based design in accordance with Section 17.3.”*

In terms of carbon monoxide detectors, the International Fire Code states the following:

915.1 General. Carbon monoxide detection shall be installed in new buildings in accordance with Sections 915.1.1 through 915.6. Carbon monoxide detection shall be installed in existing buildings in accordance with Section 1103.9.

915.1.1 Where required. Carbon monoxide detection shall be provided in Group I-1, I-2, I-4 and R occupancies and in classrooms in Group E occupancies in the locations specified in Section 915.2 where any of the conditions in Sections 915.1.2 through 915.1.6 exist.

915.2.1 Dwelling units. Carbon monoxide detection shall be installed in dwelling units outside of each separate sleeping area in the immediate vicinity of the bedrooms.

Where a fuel-burning appliance is located within a bedroom or its attached bathroom, carbon monoxide detection shall be installed within the bedroom.

915.2.2 Sleeping units. Carbon monoxide detection shall be installed in sleeping units.

Exception: Carbon monoxide detection shall be allowed to be installed outside of each separate sleeping area in the immediate vicinity of the sleeping unit where the sleeping unit or its attached bathroom does not contain a fuel-burning appliance and is not served by a forced air furnace.

Based on these requirements, smoke detectors have been placed in each bedroom near the doorway, down the hallways spaced no more than 20 feet, and in common spaces, such as offices, laundry rooms, and the entry way. A combination fire and carbon monoxide detector is placed in the living room area within vicinity of the bedrooms where the furnace/air handlers are located.

4.4 Analysis of Fire Alarm Response

The apartment complex has approximately 13 apartments per floor and the fire scenario projected for both the response time for smoke detection as well as fire sprinkler release is a kitchen cooking fire, where the first material ignited is oil in a pan left unattended. The fire spreads into the wood cabinets, which have a combination of dishes as well as paper and plastic products. Smoke detection response is calculated with the exclusion of the fire sprinkler release. The fire originates in a fourth-floor apartment that is adjacent to the stairs on the east side of the structure (*Figure XI*).

The fire occurs in a two-bedroom apartment with a common space for kitchen, entryway, and living room. The kitchen fire encompassing kitchen, living room, bathroom, and one bedroom (other bedroom door closed). The front door is 3 ft x 7 ft and there is a living room window which is 3 ft x 6 ft and door to deck is glass and steel at 32" x 7 ft. The apartment is 1,250 square feet (*Figure XII*).

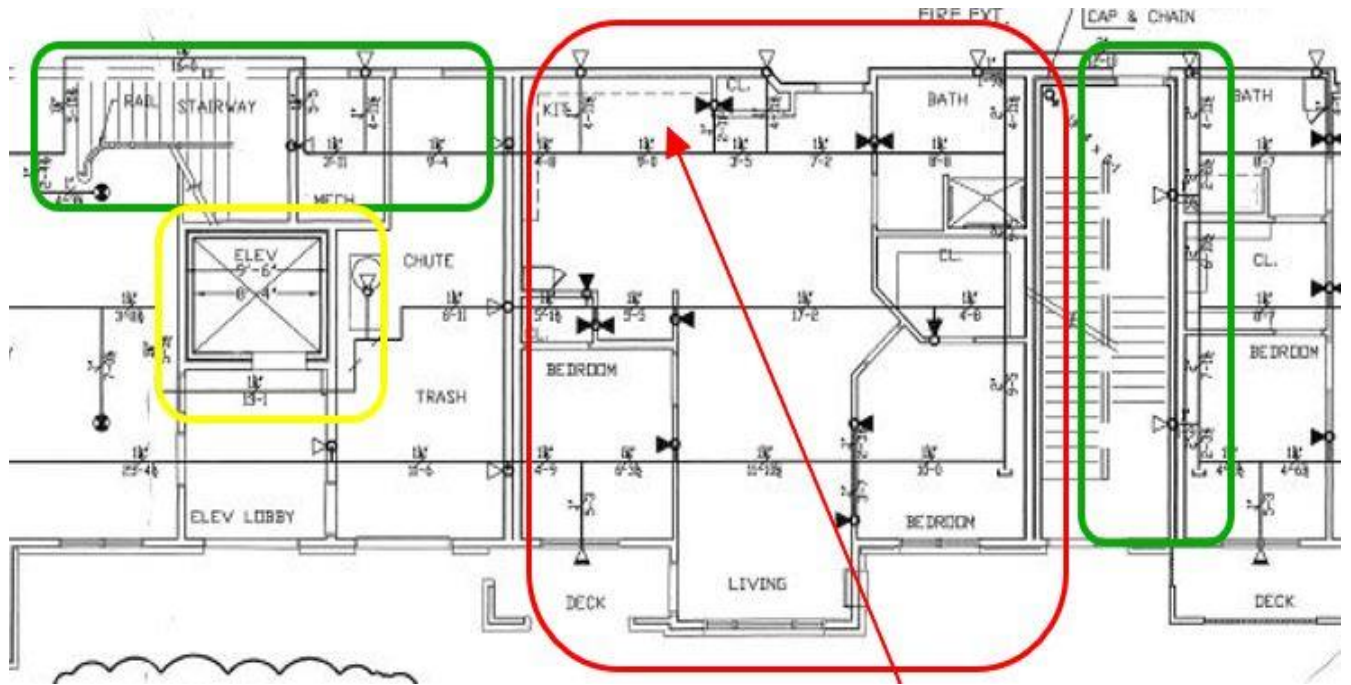


Figure XI. Fire Scenario – Cooking Fire in Kitchen

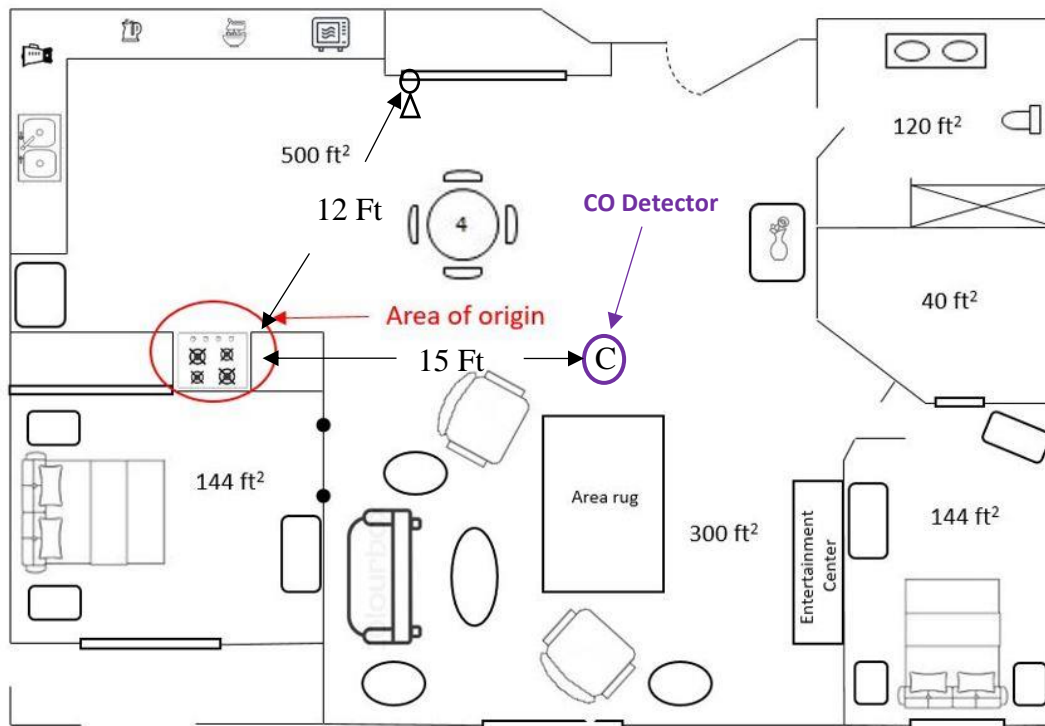


Figure XII. Fire Scenario – Cooking Fire in Kitchen

Cooking oil has a relatively low heat release rate (HRR) while the kitchen cabinets have a heat release rate of 3,000 – 5,000 kW with a time to peak HRR of 450 seconds. The combination fire/CO detector is located 15 feet from the fire area of origin, while the wall-mounted fire sprinkler is mounted 12 feet from the area of origin and is positioned on the wall at a height of 6” from the ceiling. Assuming this fire is a fast growth t^2 fire, with a growth rate coefficient of 0.047 kW/s^2 , and the fire/CO detector has an activation temperature of 57.2° C , the detector will activate in 101 seconds (See Appendix & Figure XIII). The fire/CO detector is assumed to have a low RTI of $5 \text{ (ms)}^{1/2}$. Of note, the doors for each apartment that open into the common hallway are equipped with automatic closing features in order to minimize fire spread from a unit into the hallway and compromising the path of egress for other residents.

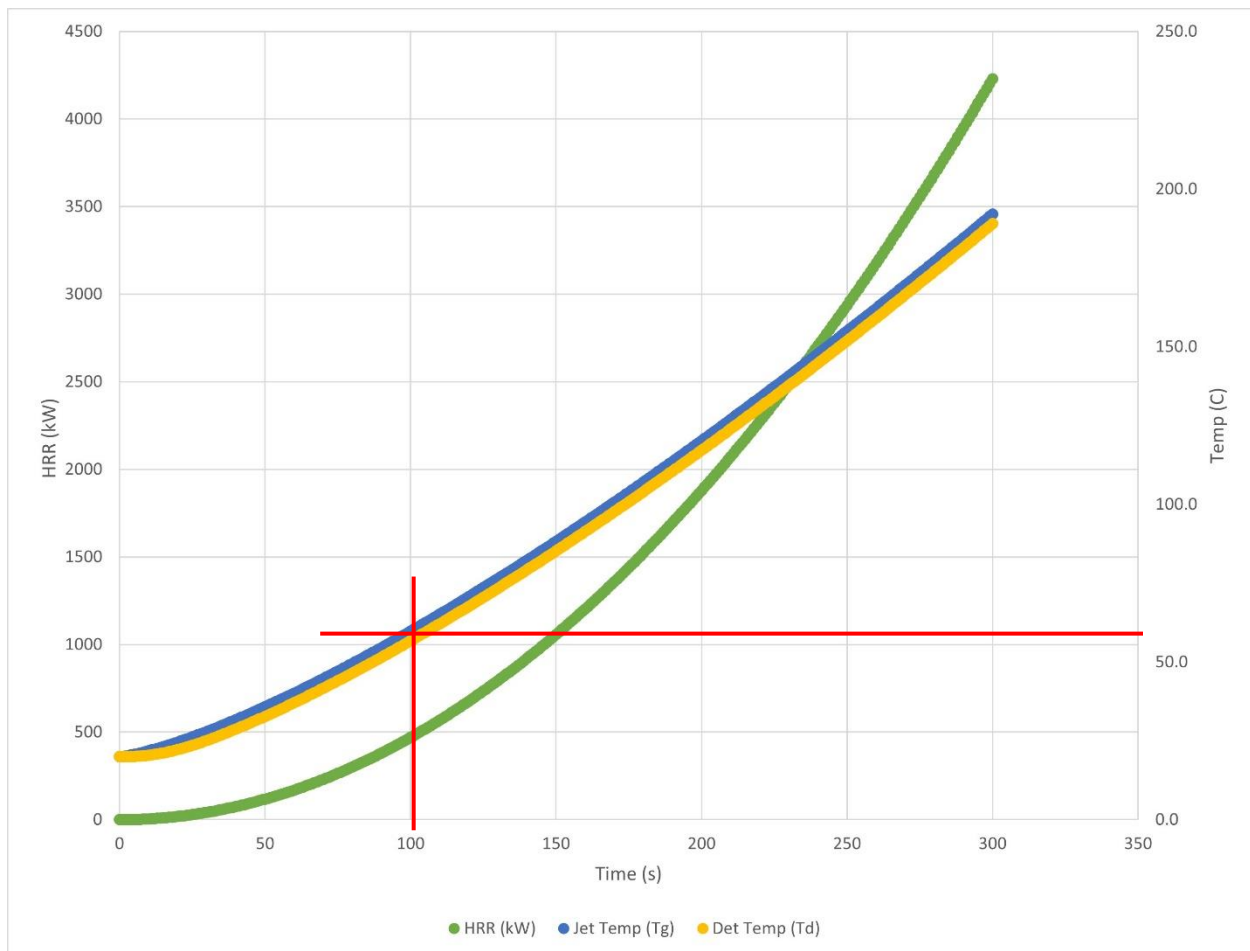


Figure XIII. Fire/CO Alarm Activation with Fast Growth Fire in Kitchen

In the fire sprinkler scenario, the Tyco sidewall pendant is located 12 ft (3.6 m) from the area of origin of the fire. The rapid response sprinkler head has an RTI of 50 (ms)^{1/2} to account for the thermal lag and an activation temperature of 68.3° C. With the thermal lag of the sprinkler head, the activation for the sidewall sprinkler head is 128 seconds (See Appendix & Figure XIV). Given the location of the area of origin of the fire and the location of the fire/CO detector and fire sprinkler head, the detector would activate a short time before the sprinkler head releases.

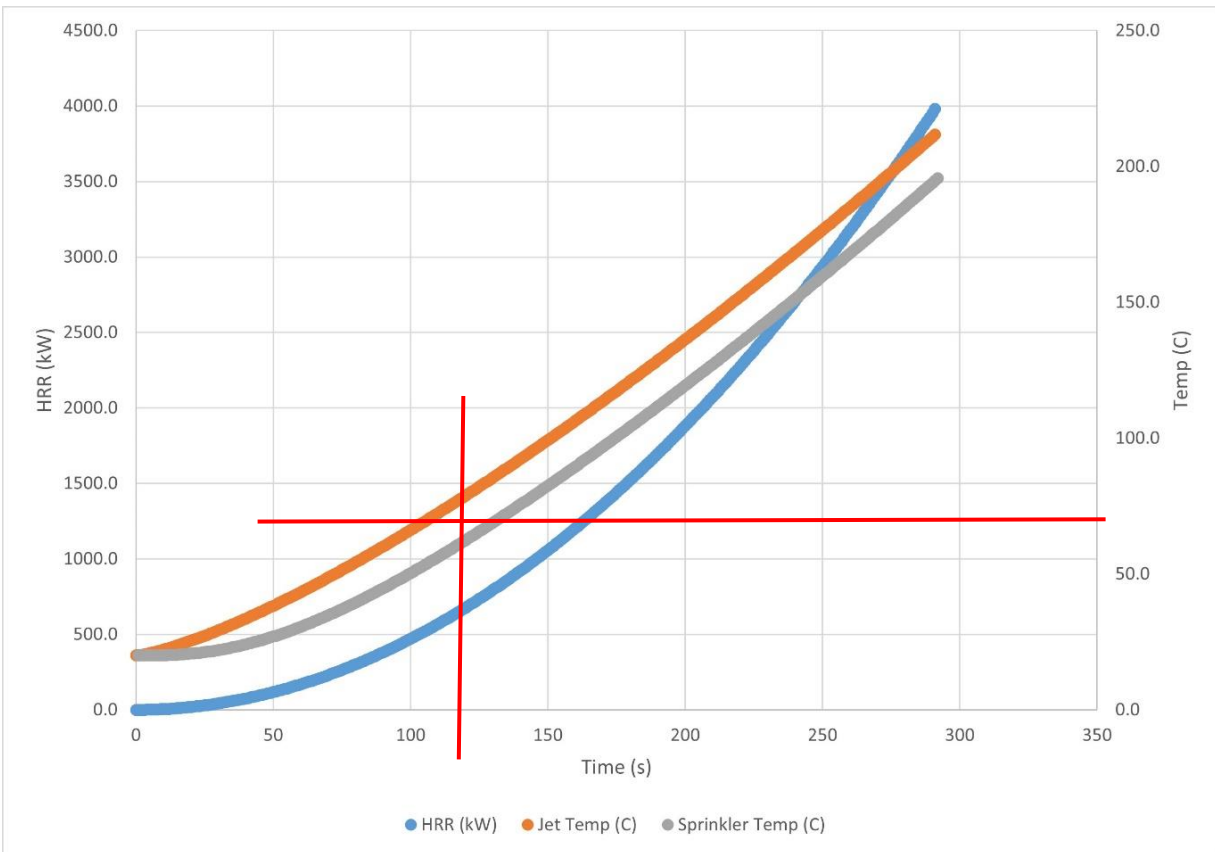


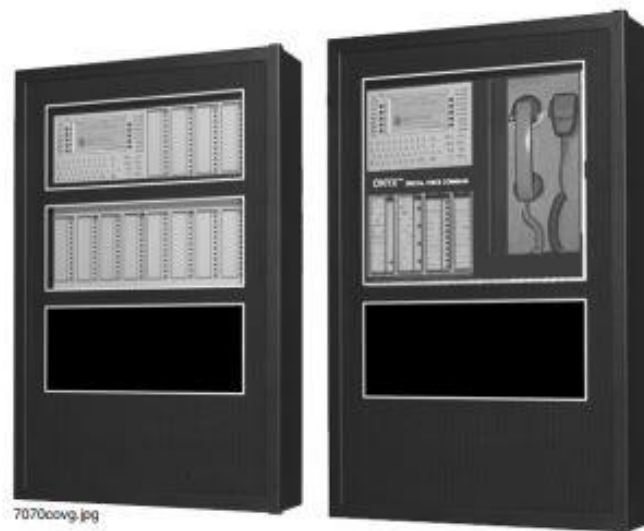
Figure XIV. Fire Sprinkler Activation with Fast Growth Fire in Kitchen

4.5 Fire Alarm System Types and Requirements

In order to accommodate the number of detection and notification appliances in the structure, a Honeywell Notifier NFS2-3030 addressable fire alarm panel is located in the first-floor office area (See Appendix for specifications for all system devices – Figure XV). This panel is designed for

medium to large scale facilities and supports up to 3,180 intelligent addressable devices. The control panel is also equipped with a central station notification feature for automatic notification to the local fire department upon an alarm condition occurring.

On floors 1 – 4, there are 233 smoke detectors, 52 fire/CO detectors, 21 pull stations, 36 strobe appliances, and 184 horn and strobe combination appliances for a total of 526 SLC and NAC devices in the system. In order to accommodate the power requirements for the notification appliance circuit devices, an auxiliary power supply (HPFF12) is located in the electrical room on each floor (See Appendix). The auxiliary power supply is capable of supplying 4 NAC circuits at 24 V_{DC} at 3.0 amps maximum each (*Figures XVI – XVII*).



**NFS2-3030 (left)
and NFS2-3030 with DVC audio option (right)**

Figure XV. Notifier Honeywell NFS2-3030 Intelligent Addressable Fire Alarm System

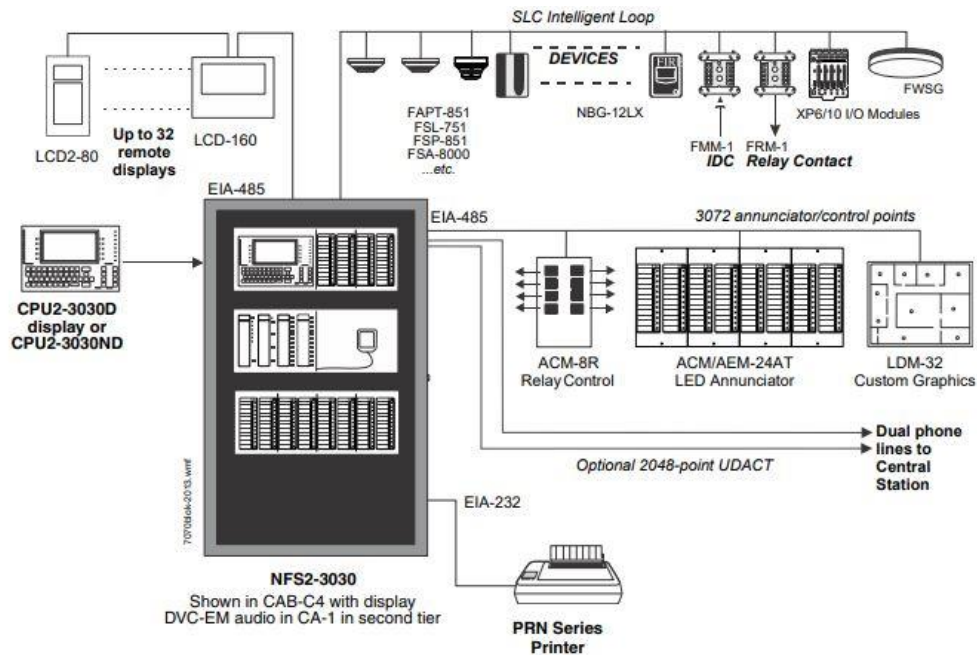


Figure XVI. Notifier Honeywell NFS2-3030 – Typical System Design with SLC & NAC Circuits



Figure XVII. Notifier Honeywell HPFF12 Auxiliary Power Supply for Floors 1 - 4

In Table IX below is an exemplar matrix for the disposition of the alarm, supervisory and trouble signals of the fire alarm system. The manual pull stations, fire sprinkler heads, and water flow appliances in the main risers will all result in an alarm condition upon activation. The smoke and fire/CO detectors will result in localized alarming within each unit and at the fire alarm panel, while the tamper devices in the PIB and OS&Y as well as other conditions will result in either trouble or supervisory signals as outlined in the system operational matrix. The owner utilizes a fire protection contractor to inspect the system on an annual basis and provide emergency services as needed. The building manager has been trained on the basic functions of the fire alarm system, and what actions are required for each type of alarm condition.

Fire alarm wiring is comprised of a 2-wire supply which is designated as a West Penn 60991B which is solid copper at #16 AWG each. This type of cable is utilized for the SLC (signaling line circuit) loop and are routed in the interstitial space on each floor following requirements as outlined in NFPA 70 (National Electrical Code) and NFPA 72. The NAC circuits are routed similarly and are a West Penn 60995B with 2 - #12 AWG solid copper conductors with the rating of UTP (unshielded twisted pair) and FPLP (fire alarm power limited).

Table IX. Exemplar Sequence of Operations Matrix That Addresses Fire Protection Actions

Sequence of Operations	Alarm Cause	System Annunciation & Transmission						System Actions																			
		Fire alarm control panel			Central station			Activate notification devices		Dampers actuate		Remote LED activated (red)		Release electric door locks		Recall elevator to 2nd floor (alter.)		Recall elevator to 1st floor (primary)		Activate exterior horn/strobe		SPF-1 stair pressurization		SPF-2 stair pressurization		Release fire doors	
		Alarm	Trouble	Supervisory	Alarm	Trouble	Supervisory	On	Off																		
Fire Alarm	Level 1 smokes/manual pulls	*			*		*		*		*		*		*		*		*		*		*		*		*
	Level 2 smokes/manual pulls	*			*		*		*		*		*		*		*		*		*		*		*		*
	Kitchen hood suppression	*			*		*		*		*		*		*		*		*		*		*		*		*
	Level 2 MDF room pre-action smokes	*			*		*		*		*		*		*		*		*		*		*		*		*
	Elevator lobby smoke detector (1st floor)	*			*		*		*		*		*		*		*		*		*		*		*		*
	Elevator lobby smoke detector (floors 2-8 & base)	*			*		*		*		*		*		*		*		*		*		*		*		*
Waterflow	Elevator machine room smoke detector	*			*		*		*		*		*		*		*		*		*		*		*		*
	P01 west dry waterflow	*			*		*		*		*		*		*		*		*		*		*		*		*
	P01 east dry waterflow	*			*		*		*		*		*		*		*		*		*		*		*		*
	P1 dry waterflow	*			*		*		*		*		*		*		*		*		*		*		*		*
	Level 1 waterflow	*			*		*		*		*		*		*		*		*		*		*		*		*
	Level 2 waterflow	*			*		*		*		*		*		*		*		*		*		*		*		*
	Level 3 waterflow	*			*		*		*		*		*		*		*		*		*		*		*		*
	Level 2 MDF pre-action waterflow	*			*		*		*		*		*		*		*		*		*		*		*		*
Supervisory	Sprinkler tamper			*			*		*		*		*		*		*		*		*		*		*		*
	Duct smoke detectors			*			*		*		*		*		*		*		*		*		*		*		*
	High/low air supervisory signal			*			*		*		*		*		*		*		*		*		*		*		*
	Generator Running			*			*		*		*		*		*		*		*		*		*		*		*
	ERRS system			*			*		*		*		*		*		*		*		*		*		*		*
General Troubles	AC power failure	*			*		*		*		*		*		*		*		*		*		*		*		*
	Initiating device circuit – open, ground, or short	*			*		*		*		*		*		*		*		*		*		*		*		*
	Notification appliance circuit, open, ground, or short	*			*		*		*		*		*		*		*		*		*		*		*		*
	Communications fault/AES trouble	*			*		*		*		*		*		*		*		*		*		*		*		*
	Low battery	*			*		*		*		*		*		*		*		*		*		*		*		*
Actions	Generator fault	*			*		*		*		*		*		*		*		*		*		*		*		*
	FSCP SPF-1 manual on								*		*		*		*		*		*		*		*		*		*
	FSCP SPF-2 manual on								*		*		*		*		*		*		*		*		*		*

4.6 Fire Alarm Notification Appliances

In terms of notification appliance devices, strobe devices are specified in common egress hallways, while horn/strobe combination appliances are used in living spaces and other common spaces. According to NFPA 72:

18.4.6.1 Where audible appliances are installed to provide signals for sleeping areas, they shall have sound level of 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 or a sound level of at least 75 dBA, whichever is greater, measured at the pillow level in the area required to be served by the system using the A-weighted scale (dBA).

For this structure, a Honeywell Notifier L-Series horn/strobe combination device has been selected. It operates at 24 V_{DC} with a horn rated at 88 dBA with field selectable candela strobe settings of 15 – 185. The maximum current draw for the strobe at 15 candela is 88 mA while the horn in temporal sound pattern at rated voltage is 44 mA for a total of 132 mA.

In terms of location of NAC appliances, NFPA 72 - 18.5.5.1 indicates that wall-mounted appliances shall be mounted such that the entire lens is not less than 80 in. and not greater than 96 in above the finished floor at the mounting height specified using the performance-based alternative of 18.5.5.7. Visual appliances will be spaced such that none exceed 20 ft in spacing so that 15 candela settings will be used on strobes (*See Table X*).

Table X. NFPA 72 – Candela Requirements for Various Room Sizes

Table 18.5.5.1(a) Room Spacing for Wall-Mounted Visual Notification Appliances

Maximum Room Size		Minimum Required Light Output [Effective Intensity (cd)]	
		One Visual Notification Appliance per Room	Four Visual Notification Appliances per Room (One per Wall)
ft	m		
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.

4.7 Power Requirements for Fire Alarm and Communication Systems

With each auxiliary power supply capable of supporting 4 NAC circuits at 3.0 amps maximum each, Tables XI & XII indicate the power requirements for the NAC devices in alarm mode.

Table XI. Honeywell Notifier Fire Alarm System NAC Current Draw Calculation

Honeywell		System Current Draw - HPFF12							
Total Current									
Standby	0.075 A								
Alarm	3.942 A								
Device	Secondary Non-Alarm Current				Secondary Alarm Current				
	Qty		Draw	Non-Alarm	Qty		Draw	Alarm	
1. System Modules									
HPFF12 Main Circuit Board	1	x	0.07500	0.07500	1	x	0.20600	0.20600	
2. NAC #1									
PC2WL15	12	x	0.00000	0.00000	12	x	0.07100	0.85200	
SCRL15	2	x	0.00000	0.00000	2	x	0.04100	0.08200	
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
NAC #1 Totals (Max 3 Amps):				0.00000				0.93400	
3. NAC #2									
PC2WL15	12	x	0.00000	0.00000	12	x	0.07100	0.85200	
SCRL15	2	x	0.00000	0.00000	2	x	0.04100	0.08200	
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
NAC #2 Totals (Max 3 Amps):				0.00000				0.93400	
4. NAC #3									
PC2WL15	12	x	0.00000	0.00000	12	x	0.07100	0.85200	
SCRL15	2	x	0.00000	0.00000	2	x	0.04100	0.08200	
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
NAC #3 Totals (Max 3 Amps):				0.00000				0.93400	
5. NAC #4									
PC2WL15	12	x	0.00000	0.00000	12	x	0.07100	0.85200	
SCRL15	2	x	0.00000	0.00000	2	x	0.04100	0.08200	
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
	0	x	0.00000		0	x	0.00000		
NAC #4 Totals (Max 3 Amps):				0.00000				0.93400	
6. Auxiliary Power									
Auxiliary Device	0	x	0.00000		0	x	0.00000		
Auxiliary Device	0	x	0.00000		0	x	0.00000		
Auxiliary Device	0	x	0.00000		0	x	0.00000		
Auxiliary Device	0	x	0.00000		0	x	0.00000		
Auxiliary Device	0	x	0.00000		0	x	0.00000		
TB4 Totals (Max 2 Amps):				0.00000				0.00000	
7. Compatible Devices not listed									
Other compatible devices	0	x	0.00000		0	x	0.00000		
Other compatible devices	0	x	0.00000		0	x	0.00000		
Other compatible devices	0	x	0.00000		0	x	0.00000		
Total Non-Alarm Load:				0.075	Total Alarm Load:			3.942	

Table XII. Honeywell Notifier Fire Alarm System Power Supply Battery Calculation

Honeywell		Secondary Power Requirements	
HPFF12 Power Supply			
Protected Premises: <u>Maple Grove Apartment Complex</u>		Date: <u>6/30/1905</u>	
Address: _____			
City: <u>Maple Grove</u>	State: <u>MN</u>	Zip: _____	
Prepared By: <u>Brian Vandal</u>		Phone: _____	
Address: _____		Email: _____	
City: _____	State: _____	Zip: _____	

Secondary Load Requirements **2.56** Amp Hours
 Total Secondary Load from the calculation table below.

Current Draw		Time (hours)	Total (AH)
Secondary Standby Load 0.075 A	x	Required Standby Time	
		24 hours	1.80
Secondary Alarm Load 3.942 A	x	Required Alarm Time (hours)	
		0.084 hours	0.33
Total Secondary Load			2.13
Derating factor			x 1.2
Secondary Load Requirements			2.56 AH

Battery Selection **7** Amp Hours
 Select batteries from the list below.

7.0 AH BAT-1270 Battery (12 volt)

Two Four (two 12VDC sets in parallel)

The calculations indicate that there is more than sufficient electrical current available for all NAC devices, and 7.0-amp hours of battery for each power supply is sufficient to provide the required standby time as well as alarming time. The current flow for each NAC circuit is sufficiently low as well that no voltage drop issues on #12 AWG wire is present considering the resistance per foot over 150 ft is approximately 0.25 Ω. $(0.356 * 450' * 21.6)/6530 = 0.530 \rightarrow 0.530/234 = 0.022 = 2.2\%$.

4.8 Mass Notification Systems

The Notifier Honeywell NFS2-3030 Intelligent addressable fire alarm panel is equipped with an audio feature which is able to communicate through the selected horn and strobe notification appliances which also have the audio feature. In line with various types of repeating audio signal, a voice signal can also be transmitted from the FACP to the horn/strobe devices.

In order to maintain audio information to residents in egress if power is lost, a backup generator is on site that supports the available battery systems within the fire alarm system. This provides redundancy should the batteries within the fire alarm system not provide sufficient operation time due to age or malfunction. Building management is trained on and aware of communication protocols in case of a structure fire. The local fire department has also communicated with building owner and management in order to be aware of the mass notification capabilities of the fire alarm system.

4.9 Inspection, Test and Maintenance

The building was completed in 2008 and fire alarm acceptance testing was completed, documented, and approved by the authority having jurisdiction. The records from the initial acceptance testing, ongoing annual testing, as well as documentation on system repairs is being maintained on site by the original fire alarm system contractor, who continues to maintain the system. This includes specifications, type of system, as-built drawings, system functional matrix, battery and NAC circuit calculations, and NAC circuit voltage drop calculations.

The initial acceptance testing included circuit integrity verification, component level operation verification, and functional testing of all initiating devices. Tamper and flow device operation was also verified. On an annual basis, required functional testing is also completed and tenants are notified of this occurrence. The fire alarm system is put into test mode with communication to central station during this test effort.

Fire alarm system wiring drawings include identification information for each addressable component:

- As-Built Drawings
- Equipment Submittals
- Operation Manuals
- Manufacturer's testing and maintenance requirements

All items on the checklist should be provided prior to testing or maintaining the system. The acceptance testing requirements for a Fire Alarm / Mass Notification System can be found in Chapter 14 of NFPA 72. The test methods for the following can be found in NFPA 72 –Table 14.4.2.2. For routine testing, Table 14.4.2.2 of NFPA 72 indicates which equipment is to be tested.

Control and Interface Equipment Operation

Primary (main) Power Supply

Battery Condition

Transient Voltage Surge Suppressor Conditions

Remote Annunciator Operation

Initiating Device Operation

Duct Alarms

Manual Fire Alarm Pull Stations

Smoke and Fire/CO Alarms

Tamper Supervisory Signal Devices

Standpipe Waterflow and Tamper Device Operation

Notification Appliance Circuit Device Operation - Horn/Strobe and Strobe Only Devices

Sound Pressure Levels

Voice Intelligibility

Mass Notification System Operation

4.10 Smoke Control

There are no atriums present in this structure; however, smoke containment systems are in use within the building. The center stairway is open from the first floor to the second floor but does not extend beyond the second floor. As noted above, there are additional stairways that extend from the first to the fourth floor on both the east and west ends of the building. Both of these stairways have doorways on all floors and are pressurized for minimizing smoke spread into the stairwells. The elevator, which extends to all floors, also has a pressurized space for the elevator hoist way. Separate HVAC systems are used for the pressurization of these spaces, which have been subject to air balance tests during commissioning. Chapter 9 of the Minnesota State Fire Code addresses fire and smoke protection features with exhaust methods as outlined in NFPA 92.

4.11 Summary

The building is equipped with a Honeywell Notifier NFS2-3030 addressable fire alarm system with smoke and/or CO detectors placed in each apartment as well as documented common spaces. The HVAC units for common spaces are also equipped with duct smoke detectors which tie into the addressable fire alarm system. The system also includes visual and audible alarming devices for notification. In addition, the building is also equipped with a fire sprinkler system on all floors and the attic space.

The environmentally controlled spaces are supplied via wet standpipes while the attic space is supplied via a dry pipe with a valve to actuate water flow into the standpipe upon release of a sprinkler head(s). There are a total of 1,865 sprinkler heads in the apartment building, which are Tyco rapid response heads rated at 155° F with a K factor of 5.6 while the sprinkler heads in the attic space are rated at 200°F.

Per the International Fire Code, single or multiple-station smoke detectors are required to be located in the following locations:

1. On the ceiling or wall outside of each separate sleeping area in the immediate vicinity of bedrooms.

2. In each room used for sleeping purposes.
3. In each story within a dwelling unit, including basements but not including crawl spaces and uninhabitable attics. In dwellings or dwelling units with split levels and without an intervening door between the adjacent levels, a smoke detector installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

A cooking fire in an apartment is evaluated as an element of the analysis for the fire protection features of this building. In this scenario, both a smoke/CO detector and a fire sprinkler head are within close proximity to the kitchen oven location that activate within 101 and 128 seconds, respectively. Both strobe and horn/strobe combination devices are used as notification appliances and are initiated upon activation by one of the initiating devices mentioned above. The volume of the horn feature as well as the candela light output from the strobe are specified in NFPA 72.

5.0 Structural Fire Protection

5.1 Building Construction Components

As noted above, this is primarily a light timber wood construction building; however, the basement is comprised of a mix of cinder block, poured concrete, and steel beam construction. Fire-rated construction, compartmentation, and various fire protection systems have been incorporated into the building design in order to minimize damage and loss of life from a fire event.

5.1.1 Concrete Construction

Concrete use is limited to the garage/basement space, with a poured Portland type II concrete slab at a minimum 4" depth and a minimum depth of 40" and thickness of 24" for poured footers. The Minnesota building code lists the minimum compressive strength for a garage in a severe exposure area of 3,500 psi (24 MPa) at 28 days. This rating also requires

that the concrete be air entrained in accordance with ACI 318-14, which can be reduced to 3% if steel trowel finished with a minimum compressive strength of 4,000 psi (27.5 MPa).

Table XIII. Minnesota Requirements on Concrete Construction

TABLE 1904.2
MINIMUM SPECIFIED COMPRESSIVE STRENGTH (f'_c)

TYPE OR LOCATION OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH (f'_c at 28 days, psi)		
	Negligible exposure	Moderate exposure	Severe exposure
Basement walls ^c and foundations not exposed to the weather	2,500	2,500	2,500 ^a
Basement slabs and interior slabs on grade, except garage floor slabs	2,500	2,500	2,500 ^a
Basement walls ^c , foundation walls, exterior walls and other vertical concrete surfaces exposed to the weather	2,500	3,000 ^b	3,000 ^b
Driveways, curbs, walks, patios, porches, carport slabs, steps and other flatwork exposed to the weather, and garage floor slabs	2,500	3,000 ^{b, d}	3,500 ^{b, d}

For SI: 1 pound per square inch = 0.00689 MPa.

a. Concrete in these locations that can be subjected to freezing and thawing during construction shall be of air-entrained concrete in accordance with Section 1904.2.

b. Concrete shall be air entrained in accordance with ACI 318.

c. Structural plain concrete basement walls are exempt from the requirements for exposure conditions of Section 1904.2.

d. For garage floor slabs where a steel trowel finish is used, the total air content required by ACI 318 is permitted to be reduced to not less than 3 percent, provided the minimum specified compressive strength of the concrete is increased to 4,000 psi.

5.1.2 Steel Construction

Steel use is limited to horizontal beams for support of the wood 4 story structure above the garage/basement. The Minnesota building code requires that structural steel members must comply with AISC 360 (American Institute of Steel Construction). All wide flange steel complies with ASTM A992 and tube steel complies with A500, Grade B. Floors 1-4 do not incorporate any steel beams. ASTM A992 has a density of 7,850 kg/m³ with a tensile yield strength of 345 MPa and a tensile ultimate strength of 450 MPa.

5.1.3 Foundation Construction

Considering the building is located in Minnesota, footings in Zone II (Hennepin County), the minimum footing depth is three (3) feet six (6) inches. According to Minnesota Administrative

Rule 1303.1600⁴, when soil, natural or fill, is sand or pit run sand and gravel, and of depth in accordance with minimum footing depth requirements for each zone, slab on grade construction which is structurally designed to support all applied loads is permitted. Sand must contain less than 70 percent material that will pass through a U.S. Standard No. 40 sieve and less than five percent material that will pass through a No. 200 sieve (five percent fines) or be approved by an engineer competent in soil mechanics. Footings for interior bearing walls or columns may be constructed to be integral with the slab on grade for any height building. Footings for exterior bearing walls or columns may be similarly constructed for any height building when supporting soil is as described in this subpart. Footing design must reflect eccentric loading conditions at slab edges, soil bearing capacity, and the requirements of International Building Code, chapter 19.

5.1.4 Columns

All columns are steel rebar reinforced with poured concrete in place. The reinforced concrete columns are only utilized in the basement area for support for steel beams running from front to back of the structure. Two (2) rows of ten (10) columns are installed from side to side of the structure. The columns are spaced on 26 ft centers and the rows are also spaced on 24 ft centers.

5.1.5 Girders and Joist Construction

All girders and beams are wide flange members protected by 5/8" Type X gypsum drywall with penetrations filled with firestopping materials. Primary structural girders are typically W16x26, 26 ft on center. As noted above, these are only utilized in the garage/basement and run from side to side of the structure with two (2) rows of steel beams. Exterior walls for the basement are hollow concrete block supported by the concrete footings.

⁴ Minnesota Administrative Rules 1303.1600 Footing Depth for Frost Protection;
<https://www.revisor.mn.gov/rules/1303.1600/>

5.1.6 Floor & Roof Assemblies

The first floor above the garage is supported by steel beams as documented above. The basement ceiling is covered with 5/8" gypsum drywall with firestopping covering all penetrations. All subsequent floors are supported with horizontal 2" x 12" wood beams. Angled wood members are nailed between the 2" x 12" joists in order to minimize floor noise. This 12" space also acts as an interstitial space for electrical, HVAC, plumbing and fire protection routing. Floors are covered with 3/4" plywood versus particle board. The IBC does not require floor assemblies in Type III-B construction to be fire-resistance rated per Section 711.

The roof of the structure is gabled with a 6 x 12 pitch. Manufactured wood trusses were assembled off site and installed on site via a crane. 3/4" plywood is secured to the wood truss framing and covered with asphalt shingles. The attic space in the roof area is protected via a dry-pipe sprinkler system, whereas the livable space on all other floors is a wet pipe system. 5/8" gypsum drywall is applied to the ceilings below the attic space for fire resistance with all penetrations sealed with fireproofing caulking.

5.1.7 Exterior Walls

The exterior walls of the structure at 9220 Zanzibar Lane are a combination of Hardie plank horizontal siding and faux wood shingles as well as architectural stone veneer materials. A number of apartments are also equipped with small balconies with a depth of approximately six (6) feet and a width of eight (8) feet. Each balcony has a fire sprinkler in the ceiling. Vinyl framed windows are also incorporated into the exterior walls that are equipped with energy efficient multi-pane glass. The Minnesota approved IBC, in Article 1403.4, requires exterior walls to be fire resistance rated per Chapter 7. In Table 602 of the IBC, this R-2 occupancy, which is Type III-B construction, does not require exterior walls to have a fire resistance rating at a minimum of 1 hour as long as fire separation distance is greater than 10 feet⁵. The closest building is 71 feet to the west of this building.

⁵ Minnesota Building Code / International Building Code; <https://up.codes/viewer/minnesota/mn-building-code-2015/chapter/6/types-of-construction#6>.

5.1.8 Interior Walls and Partitions

The building has various types of permanent interior walls, including cast-in-place walls, concrete block walls, two-hour rated gypsum board walls, and one-hour rated gypsum board walls.

The cast-in-place walls are used for elevator enclosures. The cast-in-place walls are nominally 200 mm (8") thick; however, according to Minnesota Fire Code, 1103.4, vertical openings such as an elevator shaft do not require a fire resistance rating for R-2 occupancies. The concrete block walls are used for basement interior walls, surrounding the mechanical and electrical utility rooms. The concrete block walls are also nominally 200 mm (8") thick, but it is assumed that the walls are only partially grouted, providing two-hour fire resistance rating per IBC table 722.3.2.

The two-hour rated gypsum walls are only used as part of the protection of the stairwells on the east and west sides of the structure. The center stairway has a one-hour rated gypsum drywall covering. The interior stairway walls are constructed of 4" wood studs with two layers of 5/8" fire-rated gypsum drywall on each side. The gypsum drywall has all penetrations covered with either drywall mud for finish and all other penetrations covered with firestopping materials.

One hour-rated gypsum walls cover all other interior walls on all four floors and ceilings. According to Article 420.2 of the IBC, titled Separation Walls, walls separating dwelling units in the same building shall be constructed as fire partitions in accordance with Section 708 – Fire Partitions. Article 708.3 indicates that fire partitions shall have a fire-resistance rating of not less than one (1) hour. Per Article 708.4, the corridor walls in a Type III-B construction space do not require 1-hour fire rating. Bathrooms at bath/shower locations are covered with 5/8" green board water resistant drywall.

5.1.9 Door Openings

As noted, the building is protected by a fire sprinkler system. As a result, the corridors per Minnesota Administrative Code 1104.17.1 do not require a fire resistance rating. Corridor doors from the apartments on each floor into the corridor do require a 20-minute fire resistance rating as well as automatic closing features (1104.17.2.1). The apartment doors are metal skinned with solid wood interior with metal door casings.

Each apartment also has an exterior door to a patio. The exterior doors are not fire-resistance rated and have glass full length interior with metal skin with 6" width around exterior of door. With the apartment being four (4) stories, the egress doors on the east and west sides of the building require a two (2) hour fire resistance rating, as do the interior walls of the egress stairways on each end. The common entry door at the front of the facility is a sliding door mechanism with two (2) doors sliding open. The doors are insulated glass with metal around the periphery.

Size of door openings is also specified in Minnesota Administrative Rule 1104.7.1 with the maximum width of a swinging door leaf of 48" and height not less than 80".

5.1.10 Penetrations

Numerous penetrations are present throughout the structure. These include electrical, plumbing, fire sprinkler piping, as well as low voltage wiring, such as cable, phone, and data. In addition, the structure is also equipped with mechanical system ductwork. As noted above, the interstitial space is used for horizontally routing the support systems. Both floor/ceiling penetrations, and wall-to-wall penetrations are covered with gypsum drywall, with any gaps sealed with flexible fire stopping material, such as 3M Fire Barrier putty. Fire stopping materials are also required in all boxes and penetrations in the fire resistance rated walls. This requirement is documented in Minnesota Administrative Rule 7511.1023, titled Penetrations. There is also the reference in the Minnesota Fire Code in Article 703.1.1, titled Fire blocking and Draft stopping, where *"Required fire-blocking and draft stopping in*

combustible concealed spaces shall be maintained to provide continuity and integrity of the construction.”

5.2 Fire Protection Features

The apartment building is fully sprinklered on all floors, including the basement, with an NFPA 13 automatic sprinkler system designed with ordinary hazard protection (OH-1 – 0.15 gpm over 1,500 ft²). Sprinkler heads in the basement and four (4) floors of living space are Tyco ½” rapid response pendant, sidewall, and upright – depending on mounting location – rated at 155° F with a 5.6 K factor. The sprinkler heads located in the attic space are Tyco ½” pendant and upright with a 5.6 K factor in the dormers, while the sprinkler heads down the center of the attic space are a Tyco brand ¾” upright with an 8.0 K factor rated at 200° F. The sprinkler system electronic components are monitored by a central station and interconnected to the fire alarm control panel (FACP).

In addition to the fire sprinkler system the building is equipped with a fire detection system on all floors except the attic space. Duct smoke detectors are utilized in the forced air systems used for the common spaces, such as hallways, and first floor common spaces, such as offices and storage rooms. Each apartment is equipped with a combination ionization and photoelectric smoke detector in all bedrooms. A combination smoke and carbon monoxide alarm is located in the hallway off of the bedrooms as each unit has a forced air fuel gas system in use. In terms of annunciation, the apartments and hallways are equipped with horns, strobe, and combination horn/strobe devices in order to alert tenants of a fire condition.

Walls and ceilings are covered with a minimum 5/8” gypsum drywall and each apartment has a one hour fire rating from the adjacent apartments. The hallway ceiling and walls are also covered with 5/8” gypsum drywall and all penetrations are sealed with fire stopping materials. The exit stairways on each end of the building are also rated at a 2-hour fire protection with the building being 4 stories. Hallways are designed and maintained such that

no obstructions of fuel loads are present that would impact egress or add to fire intensity and spread at these locations.

In combination with the fire detection and annunciation system, which is a Honeywell Notifier addressable system, a mass notification system is also incorporated to notify tenants and guests in the event of a fire condition in order to advise on egress issues from the structure.

5.3 Fire Resistance Analysis

As noted above, at the time of construction, the 2006 International Fire Code and NFPA 72 Fire Alarm Code were in effect per the state of Minnesota. In addition, the 2006 International Building Code was also in effect per Effective Dates of Minnesota Code Adoption. These codes drive the required construction type and materials utilized. These codes also drive the required fire safety strategy for the building and its occupants.

5.3.1 Occupancy Separations

According to Section 420 of the International Building Code, this R-2 occupancy must comply with sections 420.2 through 420.5. In 420.2, separation walls between units shall be constructed as fire partitions in accordance with Section 708. According to 708, fire partition walls must have a rating of not less than 1 hour. In 420.3, horizontal separations must comply with Section 711, which references Table 508.4. In a residential occupancy, no floor separation is required, but a Class II construction is required. According to Table 706.4 of the International Building Code, the fire resistance rating of firewalls is a minimum of 2 hours. Specific to the exit stairways, Section 1009.3.1.2 indicates that exit access stairways shall have a fire-resistance rating of not less than 2 hours where connecting four stories or more, and not less than 1 hour where connecting less than four stories. As a result, the center stairway is only required to have a fire-resistance rating of 1 hour.

5.3.2 Types of Construction

According to the Minnesota Building Code/International Building Code, the R-2 occupancy group has a fire resistance rating requirement for exterior walls of 1 hour if Type III-A, and the “i” footnote indicates that group R-2 building of Type III-B construction, shall not be required to have a fire-resistance rating when the fire separation distance is 10 feet or greater. Type III-B construction has a 0-hour fire-resistance rating requirement for the primary structure, bearing walls, and non-bearing walls and partitions. According to the IBC, Type III-B construction in which the structural elements, interior and exterior walls, are of any materials permitted by this code. More specifically, Type III-B can be light timber construction for structural members.

Table XIV. Construction Types for Minnesota per International Building Code

		TYPE OF CONSTRUCTION								
		Type I		Type II		Type III		Type IV	Type V	
		A	B	A	B	A	B	HT	A	B
GROUP	Ht (Ft)	UL	160	65	55	65	55	65	50	40
R-2	S	UL	11	4	4	4	4	4	3	2
	A	UL	UL	24,000	16,000	24,000	16,000	20,500	12,000	7,000

5.3.3 Allowable Height and Number of Stories

Table 503 of the IBC referenced by the Minnesota Building Code lists the R-2 building group which has a maximum allowable height of 55 feet for Type III-B construction and maximum 4 stories and a square foot requirement per floor of 16,000 ft² (Table XIV). Given the structure is four (4) stories (above grade), exceeds 40 ft, and average per floor square footage is 16,750 ft², it does not meet the Table 503 requirements of the IBC per Minnesota building code requirements.

Section 504 of the IBC allows an exception under Article 504.2 if automatic sprinkler protection is used in the structure. As in this case, the building height can be increased by 20 feet overall and can increase stories by one. The floor area can increase 200% to 32,000 ft² as well with a maximum height of 75 feet per Section 506.3. As a result, this building meets

these requirements given that an automatic sprinkler system is installed on all floors of the structure.

5.3.4 Fire Resistance Floor Diagrams

Figure XVIII below documents the fire separations for the first floor, which is also typical for floors 2-4, except that floors 3 and 4 do not have the central stairway. As a result, there is no need for a 1-hour fire rated wall assembly at this location on floors 3 and 4. It is noted in blue that each apartment is separated by a 1-hour fire wall while the stairways on either end of the structure that provide egress for all occupied floors have a 2-hour fire rating.

As previously noted, the elevator hoist way is comprised of poured in place concrete and has a fire resistance rating of 2 hours. The doors for each apartment open into the hallway and have a minimum 20-minute rating with a self-closing feature. This feature allows for egress of occupants from each apartment and minimization of fire spread from an apartment into the hallway if any apartment is the origin of the fire.

In the basement area, the electrical and mechanical rooms have a 1-hour fire resistance rating while the elevator hoist way is 2-hour rated as well as the stairways on either end of the structure (*Figure XIX*). As previously noted, the basement is primarily open with the steel beams supported on the rebar-reinforced concrete columns. The basement is equipped with fresh air intake louvers for air movement through the ground floor.

5.3.5 Interior Finish Requirements

Interior finish refers to materials that comprise the exposed interior surfaces of a building and that are attached to walls, partitions, ceilings, and other interior construction components. Interior finish materials are classified with the surface flame-spread rating. Interior finish materials for walls and ceilings are grouped in the following classes, in accordance with their surface flame spread characteristics:

Table XV. Interior Wall and Ceiling Finish Requirements by Occupancy

GROUP	SPRINKLERED ¹			NONSPRINKLERED		
	Exit enclosures and exit passageways ^{a,b}	Corridors	Rooms and enclosed spaces ^c	Exit enclosures and exit passageways ^{a,b}	Corridors	Rooms and enclosed spaces ^c
A-1 & A-2	B	B	C	A	A ^d	B ^e
A-3 ^f , A-4, A-5	B	B	C	A	A ^d	C
B, E, M, R-1, R-4	B	C	C	A	B	C
F	C	C	C	B	C	C
H	B	B	C ^g	A	A	B
I-1	B	C	C	A	B	B
I-2	B	B	B ^{h,i}	A	A	B
I-3	A	A ^j	C	A	A	B
I-4	B	B	B ^{h,i}	A	A	B
R-2	C	C	C	B	B	C
R-3	C	C	C	C	C	C
S	C	C	C	B	B	C
U	No restrictions			No restrictions		

For this R-2 occupancy, the IBC specifies the flame spread rating for exit enclosures and passageways, corridors, and rooms is specified as class C considering the building is sprinklered on all floors (Table XV). Interior wall and ceiling finishes are classified in accordance with ASTM E 84. These interior finish materials are grouped in the following classes in accordance with their flame spread and smoke-developed indexes:

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

The walls and ceilings in the living spaces of the structure are covered with a minimum of 5/8" gypsum drywall and have wood trim at floor level and around doorways. The only deviation from this is in the laundry and mechanical rooms. These rooms have a vinyl wall covering up to a height of 48" from floor level.

Section 804 of the IBC regarding interior floor finish requires Class I or II materials per NFPA 253 where Class I is equivalent to 0.45 watts/cm² and Class II is greater than or equal to 0.22 watts/cm². Flooring materials in living spaces are carpeting in hallways and all living spaces except kitchens and bathrooms. Kitchens and bathrooms are laminate or tile floors, as are common access spaces on the first floor, and mechanical rooms and the laundry room.

Approved firestopping material is required in all wall and ceiling gaps and behind all metal electrical junction boxes.

5.4 Summary

As noted above, this is primarily a light timber wood construction building; however, the basement is comprised of a mix of cinder block, poured concrete, and steel beam construction. Fire-rated construction, compartmentation, and various fire protection systems have been incorporated into the building design in order to minimize damage and loss of life from a fire event.

Steel use is limited to horizontal beams for support of the wood 4 story structure above the garage/basement. Considering the building is located in Minnesota, footings in Zone II (Hennepin County) indicate that the minimum footing depth is three (3) feet six (6) inches. All girders and beams are wide flange members protected by 5/8" Type X gypsum drywall with penetrations filled with firestopping materials and primary structural girders are typically W16x26, 26 ft on center.

All columns are steel rebar reinforced with poured concrete in place. The reinforced concrete columns are only utilized in the basement area for support for steel beams running from front to back of the structure. All girders and beams are wide flange members protected by 5/8" Type X gypsum drywall with penetrations filled with firestopping materials. Primary structural girders are typically W16x26, 26 ft on center.

All subsequent floors are supported with horizontal 2" x 12" wood beams. Angled wood members are nailed between the 2" x 12" joists in order to minimize floor noise. This 12" space also acts as an interstitial space for electrical, HVAC, plumbing and fire protection routing. In addition, floors are covered with 3/4" plywood versus particle board. The IBC does not require floor assemblies in Type III-B construction to be fire-resistance rated per Section 711.

The Minnesota approved IBC, in Article 1403.4, requires exterior walls to be fire resistance rated per Chapter 7. In Table 602 of the IBC, this R-2 occupancy, which is Type III-B construction, does not require exterior walls to have a fire resistance rating at a minimum of 1 hour as long as fire separation distance is greater than 10 feet⁶. The closest building is 71 feet to the west of this building. In terms of interior walls, the building has various types of permanent interior walls, including cast-in-place walls, concrete block walls, two-hour rated gypsum board walls, and one-hour rated gypsum board walls. In addition, the corridors per Minnesota Administrative Code 1104.17.1 do not require a fire resistance rating. Corridor doors from the apartments on each floor into the corridor do require a 20-minute fire resistance rating as well as automatic closing features (1104.17.2.1). The apartment doors are metal skinned with solid wood interior with metal door casings.

In terms of fire protection features, the apartment building is fully sprinklered on all floors, including the basement, with an NFPA 13 automatic sprinkler system designed with ordinary hazard protection (OH-1 – 0.15 gpm over 1,500 ft²). The building is also equipped with a fire detection system on all floors except the attic space.

As far as fire resistance analysis, as noted above, the 2006 International Fire Code and NFPA 72 Fire Alarm Code were in effect per the state of Minnesota. In addition, the 2006 International Building Code was also in effect per Effective Dates of Minnesota Code Adoption. According to Section 420 of the International Building Code, this R-2 occupancy must comply with sections 420.2 through 420.5. In 420.2, separation walls between units shall be constructed as fire partitions in accordance with Section 708. According to 708, fire partition walls must have a rating of not less than 1 hour. In 420.3, horizontal separations must comply with Section 711, which references Table 508.4. Figures XVIII and XIX below document the fire resistance features with the basement and floors above.

According to the Minnesota Building Code/International Building Code, the R-2 occupancy group has a fire resistance rating requirement for exterior walls of 1 hour if Type III-A, and

⁶ Minnesota Building Code / International Building Code; <https://up.codes/viewer/minnesota/mn-building-code-2015/chapter/6/types-of-construction#6>.

the “i” footnote indicates that group R-2 building of Type III-B construction, shall not be required to have a fire-resistance rating when the fire separation distance is 10 feet or greater. Table 503 of the IBC referenced by the Minnesota Building Code lists the R-2 building group which has a maximum allowable height of 55 feet for Type III-B construction and maximum 4 stories and a square foot requirement per floor of 16,000 ft², which this building does not meet. However, Section 504 of the IBC allows an exception under Article 504.2 if automatic sprinkler protection is used in the structure. As in this case, the building height can be increased by 20 feet overall and can increase stories by one. The floor area can increase 200% to 32,000 ft² as well with a maximum height of 75 feet per Section 506.3. As a result, this building meets these requirements given that an automatic sprinkler system is installed on all floors of the structure.

In terms of interior finish requirements for this R-2 occupancy, the IBC specifies the flame spread rating for exit enclosures and passageways, corridors, and rooms, which is specified as class C considering the building is sprinklered on all floors. Interior wall and ceiling finishes are classified in accordance with ASTM E 84. These interior finish materials are grouped in the three classes in accordance with their flame spread and smoke-developed indexes. This building has class C with flame spread equivalent to 76-200 and smoke-developed 0-450.

The next section addresses the fire safety management plan, including more detail on the fire sprinkler and fire detection systems. It also includes discussion of structural fire protection, means of egress, and combustible material hazards. Lastly, building owner and supervisory staff responsibilities are outlined.

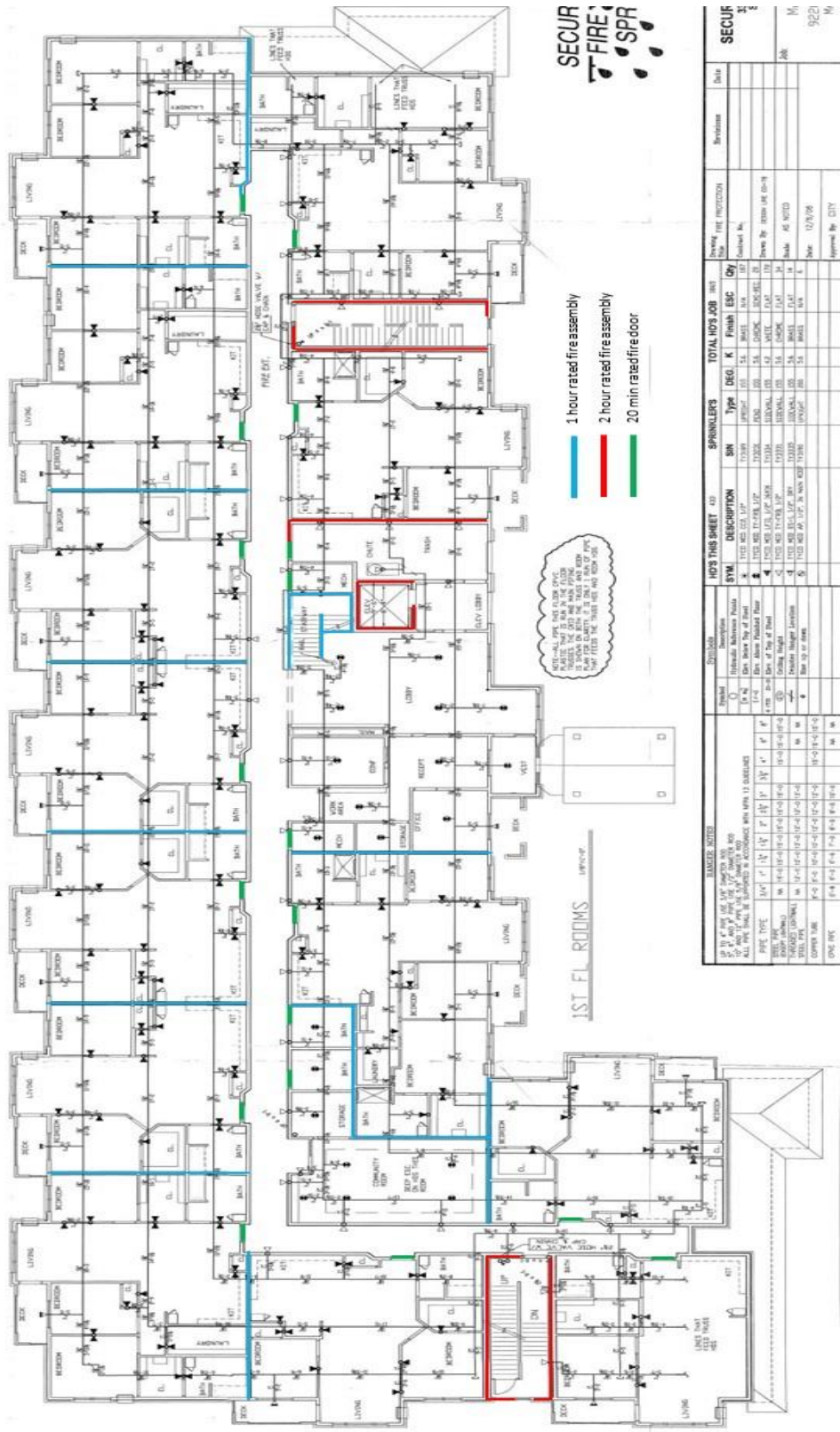


Figure XVIII. First floor layout – fire resistance features

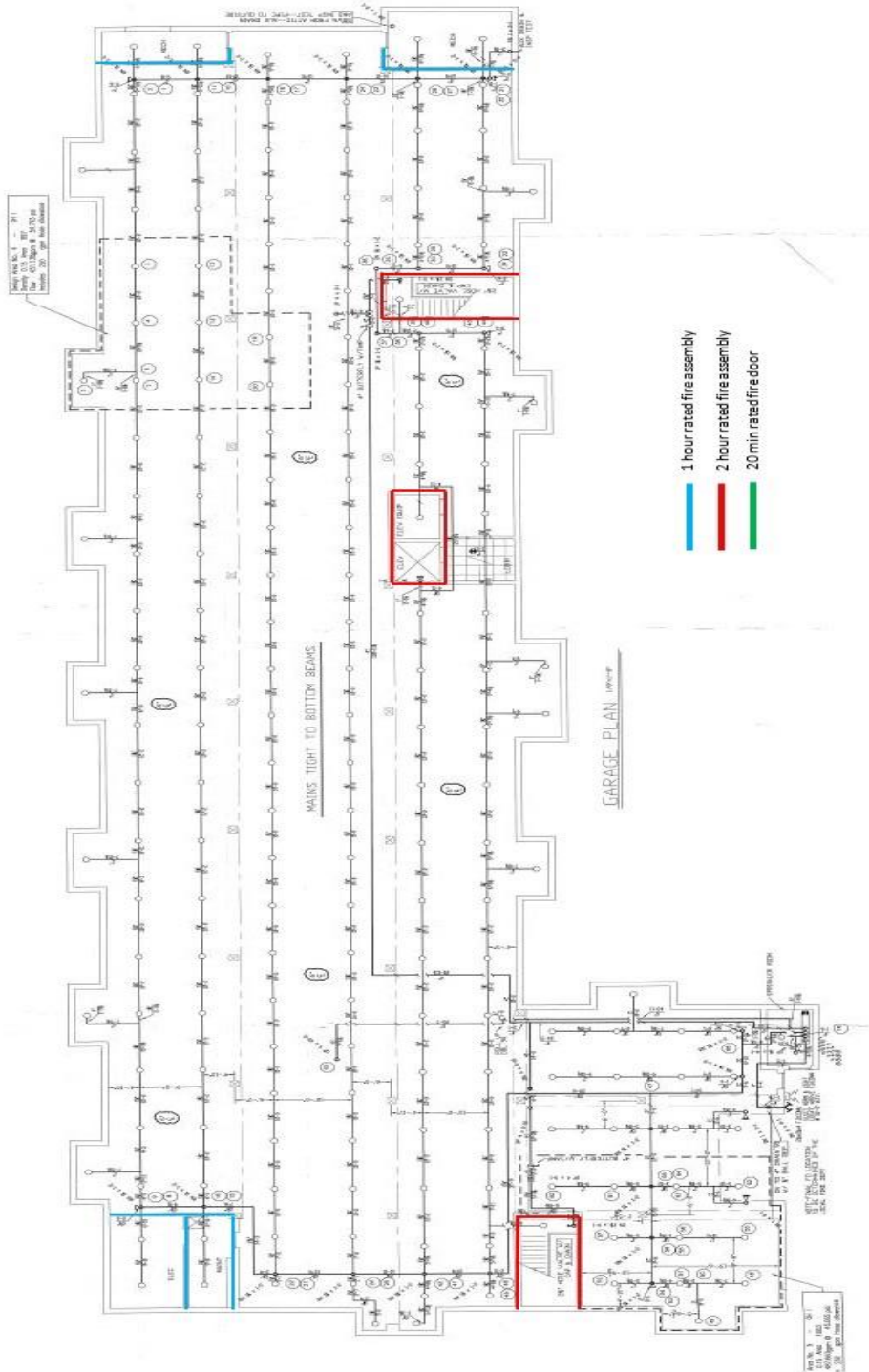


Figure XIX. Basement layout – fire resistance features

6.0 Fire Safety Management Plan

6.1 Fire Safety Systems

6.1.1 Fire Sprinkler System

The building is protected by a fire sprinkler system in which an underground 6" rigid pipe is routed into the building, with a 4" riser pipe routes to standpipes, a 3" riser routes to the garage, a 6" riser routes to the attic, and a 4" pipe is for fire department connection. A water flow test from May of 2008 indicates that the static pressure available is 74 psi with a residual pressure of 71 psi with a flow of 2,853 gpm. Sprinkler heads are routed throughout the ceilings of the four (4) floors, basement, and attic space. The sprinklers have a design density of 0.10 for living spaces, and 0.15 for the basement garage space. The system is designed according to NFPA 13 per Minnesota Administrative Rules 7511.0903 Section 903 titled, Automatic Sprinkler Systems. The rule states the following, "Group R. An automatic sprinkler system shall be provided in accordance with Section 903.3 in Group R occupancies and townhouses as follows...". 250 gpm is also designed for fire department connection allowance.

6.1.2 Fire Detection and Alarm System:

The building is equipped with an addressable fire detection and annunciation system. Addressable photoelectric-type smoke detection devices are installed in all bedrooms with a combination smoke and carbon monoxide detection device installed in the apartment hallway just outside the bedroom spaces. Smoke detectors are also located in common spaces such as the common access hallways, community room, vestibule, and lobby. Smoke detectors are also present at each floor in front of the elevator, with smoke detectors in the elevator pit and elevator mechanical room. The alarm system is set to cause the elevator to recall if the system goes into alarm.

The main fire alarm panel is located on the first floor in the office area at the front middle of the building. A remote annunciator is positioned just inside the vestibule on the first floor as well which communicates the status of the fire alarm system. The fire alarm system is

programmed to dial out to a central station operator in order to notify the fire department in the event the system goes into alarm.

In addition to detection devices, the fire alarm system is equipped with notification appliance devices as well, such as horns, strobes, and combination horn/strobe devices. These are positioned in bedrooms, as well as common living spaces on each floor. In addition, they are also positioned in common spaces as well, such as the community room, common bathrooms, lobby and hallways.

6.1.3 Structural Fire Protection:

As noted above, separation walls between apartments shall be constructed as fire partitions with a rating of not less than 1 hour. Also noted above that the fire resistance rating of firewalls is a minimum of 2 hours. Specific to the exit stairways, the exit access stairways shall have a fire-resistance rating of not less than 2 hours where connecting four stories or more, and not less than 1 hour where connecting less than four stories. The center stairway is only required to have a fire-resistance rating of 1 hour.

Main entry doors to each apartment are equipped with self-closing feature in order to assist in containing any fire within an apartment if the occupant(s) attempt to exit out their main door and down an egress path. During construction, all wall and floor/ceiling penetrations are sealed with fire-resistant compound. This also includes any electrical outlet locations that are located in a firewall.

6.1.4 Means of Egress:

In terms of egress, it is expected that tenants will exit out their main apartment door into a common hallway. There are stairs located on the east and west ends of the building from the fourth floor down. There is a stairway at the center of the building for floors 1 and 2 which exits out a doorway at the front (south) of the building. The hallways and stairways are all equipped with emergency egress lighting to meet the 1 foot-candle requirement. In addition, lighted emergency exit signage is located in hallways and at landings of the stairway in order

to direct people to exterior egress doors. First floor residents are also able to exit out their patio doors if equipped.

6.1.5 Portable Fire Extinguishers:

The building is equipped with portable fire extinguishers, which are located as follows:

- At each stairway on all floors.
- In storage and mechanical/electrical rooms.
- Front office lobby area.

6.2 Combustible Material Hazards

Waste materials are not to be kept in any common spaces, such as hallways. Building management will complete daily checks to ensure that combustible waste materials are not placed in these locations - specifically, those locations in the path of egress. A garbage chute is present on each floor where all occupants can place waste material. A dedicated trash room is located at the front middle of the structure on the first floor. The container for trash is made of non-combustible materials.

The trash chute extends up to all four floors of the apartment structure with latching doors on each floor. It is comprised of 16-gauge stainless steel. NFPA 82, Standard on Incinerators and Waste Handling Systems and Equipment applies to this system. The walls of the trash room have a 2-hour fire resistance rating per NFPA 82, 5.2.2.5.2 and 5.2.3.1.2. The chute discharge door into the trash room is self-closing with a fusible link (NFPA 82, 5.2.3.2) and the gravity chute is protected internally with an automatic fire sprinkler (5.2.6.1.1).

6.3 Building Owner Responsibilities

There are multiple buildings similar to this structure referred to as Maple Village that are owned by Maple Village, LLC. The owner of Maple Village, LLC retained the services of a fire protection engineering firm in order to develop a Fire Safety Plan for this building as well as the other similar structures.

The Fire Safety Plan addresses the following elements:

- Establishment of emergency procedures to be followed at the time of an emergency.
- Appointment and organization of supervisory staff to carry out duties pertaining to the Fire Safety Plan.
- Training of authorized building personnel and building tenants so that they all are aware of their responsibilities during fire safety procedures. This training to include familiarization with applicable codes and standards.
- Periodic training fire drills to be held with tenants participating for familiarization.
- Recognition and management of fire hazards in the building.
- Maintenance of fire sprinkler, fire detection, and egress management systems that are provided for safety of the occupants.
- Provisions of alternate measures for safety of occupants during shutdown of fire protection equipment.
- Verification of test and inspections, as required by the Fire Code, are completed on schedule and that records are maintained.
- Posting and maintaining a copy of the Fire Safety Plan on each floor area in a conspicuous location near means of egress.
- Notification of the Fire Official having jurisdiction regarding changes in the Fire Safety Plan.

6.4 Supervisory Staff Responsibilities

The owners of Maple Village, LLC have designated certain full time staff personnel as supervisors for the Fire Safety Plan. These individuals have been trained on the Fire Safety Plan as well as the applicable codes and standards. These individuals are also trained and responsible for completing periodic safety drills pertaining to the Fire Safety Plan.

Following are the duties of supervisory personnel on shift:

- Ensure that a trained individual in the Fire Safety Plan is always on site and familiar with steps required.

- Ensure that training is provided for all applicable personnel on a periodic basis. Training to be repeated on an annual basis.
- Ensure all exits and egress paths are maintained clear and egress emergency lighting is functional.
- Ensure that a posted diagram is located at applicable locations on each floor to assist in case of an evacuation.
- Ensure that all fire protection components are maintained and functional, including the tamper and flow devices, as well as the fire alarm system itself. Ensure it is capable of communicating to central station in the event of a fire alarm event.
- Staff must have basic knowledge of the fire alarm system and how it functions - specifically knowledge of different notification modes (e.g. supervisory, trouble, alarm, etc.).
- Fire drills:
 - Supervisory personnel are responsible for initiating a fire drill on an annual basis when a majority of residents would be expected to be present. This involves ensuring personnel exit within a reasonable time frame, as well as ensuring emergency egress and notification appliances function properly.
 - At the time of renting a unit, supervisory personnel are responsible to advise the new tenant(s) of the fire drill recurrence as well as providing training documentation for the renter to review.
- Fire alarm system loss of function:
 - In the event the fire alarm system is non-functional, the supervisory personnel are responsible to maintain a fire watch and ensure applicable fire officials are notified of the loss of functionality until corrected.

The full-time staff responsible for the Fire Safety Plan are responsible for the following in the event of a fire event:

- Verify the fire alarm system has communicated to the Fire Department once activated.

- Redundant notification to the Fire Department of the fire event following fire alarm signal.
- Staff are responsible for supervision of the evacuation of the occupants. The building fire alarm system is also equipped with voice notification of a fire alarm event in addition to the horn/strobe devices.
- Communicate the observed conditions of the building upon arrival of fire department first responders.
- Provide information and access for first responders.
- Ensure that the fire alarm system continues to be functional during the fire event to the extent that staff can remain in the building.

6.5 Inspection, Testing, and Maintenance Requirements

Maple Villages, LLC has designated supervisory personnel to complete checks, inspections and/or tests made of fire protection equipment and facilities periodically. The Minnesota Fire Code requires that records of all tests and corrective measures be retained for a period of 3 to 5 years depending on the system. Upon completion of testing, documentation shall be stored in a designated location for future reference.

Following are some of the elements to be addressed:

- *Fire Alarm Systems*

The addressable fire alarm system is to be maintained and functional at all times. The fire alarm system is to be inspected on an annual basis, and any trouble or supervisory signals need to be addressed immediately. If the fire alarm system is non-functional for any reason, the supervisory personnel are responsible for ensuring a fire watch is enacted until the issue is resolved.

- *Exits*

Supervisory personnel are responsible in ensuring that all egress paths are maintained and cleared of any debris. No doors are to be locked which are in the path of egress.

Staff are also responsible for ensuring that all emergency lighting is functioning properly.

- *Fire Department Access*

Supervisory personnel are responsible for ensuring that the fire lane be maintained clear and have access to all control equipment necessary.

- *Portable Extinguishers*

Supervisory personnel to ensure that all portable extinguishers are appropriate classification and have been inspected on an annual basis by a qualified vendor.

- *Standpipe and Hose Systems*

Supervisory personnel to be observant of standpipe and hose systems, and ensure repairs are completed immediately when needed.

- *Automatic Sprinkler Systems*

Ensure fire sprinkler system is maintained on an annual basis by a qualified vendor and flushed as required by the fire code.

- *Emergency Lighting*

Supervisory personnel required to ensure that a qualified vendor inspects all emergency lighting on at least an annual basis to ensure functionality.

- *Voice Communication Systems*

Supervisory personnel to ensure the voice communication system is functioning properly in order to provide information and instructions for occupants during an emergency.

- *Elevators*

Elevators and associated fire detection equipment to be inspected on at least an annual basis by a qualified vendor.

Prescriptive Analysis Summary

Prescriptive analysis of fire protection is a code-based approach to ensuring that the structure meets currently accepted standards for the various elements of the structure and associated systems as outlined in the report above. Specific codes apply to each element of the structure, which include materials for flooring, exterior walls, interior walls, framing materials, roofing, doorways, egress paths and plans, and fire protection systems such as fire sprinklers and fire detection systems.

Applicable codes, regulations and standards include:

- International Building Code (IBC), 2006 Edition
- Minnesota Building Code, 2006 Edition
- Life Safety Code, NFPA 101, 2006 Edition
- International Fire Code (IFC), 2006 Edition
- Fire Alarm Code, NFPA 72, 2006 Edition
- Fire Sprinkler Code NFPA 13, 2002 Edition
- International Mechanical and Fuel Gas Codes, 2004 Edition
- National Electrical Code, 2005 Edition

This report evaluates the International Code Council model building and fire codes and the National Fire Protection Associations codes and standards as a prescriptive code analysis for this this multi-tenant apartment building. The building is found to be in compliance with the documented codes and standards in effect at the time of building design and assembly.

According to the International Building Code in Section 310.4, this structure is classified as a residential group R-2, given that the occupancy exceeds sixteen (16) occupants, but is also classified as mixed occupancy. There are no high hazard materials or spaces located within this building. Within the apartment complex are storage rooms (Section 311 – Group S-2), Utility and Miscellaneous (Group U) for the electrical and mechanical rooms, Business Group B (Section 304) for the office spaces, and Assembly Group B for the community room since its occupancy is less than 50 persons, per Section 303.1.2 Small Assembly.

According to Table 7.3.1.2 of the Life Safety Code in determining occupancy load factor, a majority of the space is classified as “Apartments” with an occupancy load factor of 200 ft²/person. The total calculated occupancy load for all four (4) floors is 370 people. The corresponding exit capacity far exceeds the occupancy load for the four floors. In attempting to estimate the time for building evacuation using hand calculation methods, Chapter 4-2 of the NFPA Fire Protection Handbook was consulted for calculation methods for egress prediction, which results in an egress time of 9.44 minutes.

In terms of fire sprinkler systems, an automatic sprinkler system in accordance with 2002 NFPA 13 is installed throughout the building. The sprinkler system occupancy hazard groups in the four (4) story apartment building include light hazard and ordinary hazard group 1 per NFPA 13. There are seven (7) design areas throughout the building, which are listed in Table 5 below. The sprinkler system occupancy hazard groups are based on the anticipated quantity and/or combustibility of the contents within each space.

- Light Hazard: Corridors, apartment spaces, offices, restrooms, attic spaces, hotel lobby, and meeting area.
- Ordinary Hazard Group 1: Parking garage, laundry area, trash room, mechanical and electrical room, and storage rooms.

The design criteria for the fire sprinkler systems are required to be in accordance with NFPA 13. Applicable design criteria for the apartment building are summarized below. Seven (7) design areas throughout the structure were evaluated in order to determine the maximum design water flow for the fire sprinkler.

- Light Hazard: 0.10 gpm/ft² over 1500 ft². The hose allowance of 100 gpm of water supply for 60 minutes
- Ordinary Hazard Group 1: 0.15 gpm/ft² over 1500 ft². The hose allowance of 250 gpm of water supply for 60 minutes

The most remote area comprises 11 sprinklers in an area of operation of 1,083ft².

Chapter 5 of NFPA 13, titled Classification of Occupancies and Commodities, clarifies what constitutes a light hazard and ordinary hazard group 1 occupancy. These are two of the least hazardous occupancies which is a result of the presence of a limited quantity of combustibles.

Chapter 17 of NFPA 72 provides clarification of requirements for location of fire detection initiating devices. The fire detection and alarming system requirements are outlined in the standard and are used to confirm the placement of components and operation of the system. Minnesota building code requirements are also utilized to address structural fire protection features which include supporting steel and concrete structures, as well as wall, floor, and roof assemblies.

7.0 Performance Based Evaluation

Following a review of the prescriptive code analysis of this four-story apartment building, the purpose of this analysis is to evaluate the performance-based design of the building in order to determine if it is adequate and allows for safe egress of occupants under two design fire scenarios based on egress modeling software and fire dynamic simulation (FDS). These computational software programs assist in evaluating the conditions brought about by the design fires and whether occupants are able to avoid untenable conditions during the available safe egress time (ASET), which can be compared against the required safe egress time (RSET).

A performance-based design per the SFPE Engineering Handbook in Chapter 37 is “an engineering approach to fire protection design based on agreed upon fire safety goals and objectives, deterministic and/or probabilistic analysis of fire scenarios, and quantitative base of design alternatives gains the fire safety goals and objectives using accepted engineering tools, methodologies, and performance criteria.”

The performance-based evaluation is utilized to evaluate two design fire scenarios:

- Fire in the trash room on the first floor

- Kitchen cooking fire in a fourth-floor apartment which is in close proximity to the east exit set of stairs.

Per Chapter 7 of the Fire Protection Handbook, it is referenced that NFPA 101 provides eight design fire scenarios that should be considered in the development of a performance-based design. These design fire scenarios are as follows:

- 1. An occupancy-specific design fire scenario that is representative of a typical fire for the occupancy.**
2. An ultrafast-developing fire in the primary means of egress, with interior doors open at the start of the fire.
- 3. A fire that starts in a normally unoccupied room that may endanger large numbers of occupants.**
4. A fire that originates in a concealed wall or ceiling space adjacent to a large, occupied room
5. A slowly developing fire, shielded from fire protection systems, in close proximity to a high-occupancy area.
6. The most severe fire resulting from the largest possible fuel load characteristic of the normal operation of the building.
7. An outside exposure fire.
8. A fire originating in ordinary combustibles with each passive or active fire protection system individually rendered ineffective; this scenario is not required where it can be shown that the level of reliability and the design performance in the absence of the system are acceptable to the authority having jurisdiction (AHJ).

Scenarios 1 and 3 have been selected for the design and structural fire analysis. For design fire 1, a cooking fire in the kitchen is the representative typical fire. In this case, the self-closing feature of the front door into the common hallway malfunctions and does not close after the tenant exits the apartment following observance of the fire. The resultant fire

would be projected to impact the ceiling/floor joists for the floor above in terms of structural analysis as well as allow smoke and fire to spread down the common hallway.

For the design fire 2, the scenario involves a fire in the trash room on the first floor. There is a large amount of combustible materials, including wood, plastics and paper in the room which is equipped with a trash chute going up to all floors.

Two computational software programs will be used for this performance-based evaluation, which are the Fire Dynamics Simulator (FDS) with the graphical user interface software Pyrosim. The two design fires listed above will be evaluated to determine whether or not occupants who are not intimate with the ignition of the fire can safely evacuate before untenable conditions within the path of egress are reached.

7.1 Tenability Performance Criteria

In terms of tenability analysis, there are four (4) methods that can be utilized to avoid exposing the occupants to untenable conditions:

- Method 1: Detailed performance criteria that ensures that the occupants are not incapacitated by fire effects utilizing the SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings.
- Method 2: For each design fire scenario, it can be demonstrated that each space within the apartment building would be fully evacuated before the smoke and toxic gas in that space would descend to a level lower than six (6) feet above the floor.
- Method 3: For each design fire scenario, it can be demonstrated that an occupied room(s) within the apartment building will not experience the smoke and toxic gas layer descending lower than six (6) feet.
- Method 4: For each design fire scenario, it can be demonstrated that no fire effects will reach any occupied room(s) within the apartment building.

This building is fully sprinklered, and various fire scenarios could be modeled to determine the impact of sprinklers being released in the event of a fire. The modeling would include

analysis on temperature and heat flux, and fractional effective doses of carbon monoxide and hydrogen cyanide. In addition to wood in building framing and furniture, there are also various items of furniture, bedding, plastics, and textiles. A computer simulation of various fire scenarios can be run in order to determine resulting smoke conditions. From this data, Haber's rule of dose equal to concentration multiplied by exposure time in order to determine the fractional effective dose from CO, HCN, CO₂, HCl, and other toxic gases. As carbon monoxide is typically the largest content in smoke, Stewart's equation can be utilized to determine the exposure to occupants that would increase carboxy-hemoglobin level. This is based on the activity level of the occupant and how much volume of air is breathed in over time, combined with the exposure dose. 30% COHb is known to cause incapacitation, while 50% COHb or greater can result in death.

7.2 Tenability Analysis

One of the methods suggested by the SFPE Handbook for estimating whether a building or design meets tenability-related performance criteria is to determine, for specific design fire scenarios, whether each room's occupants will be able to egress the building before the smoke and toxic gas descends to within 6 feet above the floor. This method involves evaluation of the location, behavior, and egress of occupants as well.

This method was used regarding the performance-based tenability analysis of the four-story apartment building in Maple Grove. Tenability limits are typically specified in terms of four criteria: visibility, temperature, radiant exposure and combustion gas toxicity. For this analysis, untenable conditions were determined to exist when the following values of each criteria were reached:

- Visibility < 10 meters
- Temperature >120°C
- Radiant Heat Flux >2.5 kW/m²
- Carbon Monoxide >1,200 ppm

The visibility criteria was established based on Chapter 61 of the SFPE Handbook. This handbook documents visibility and human behavior in smoke conditions. Table 61.3 recommends allowable smoke visibility that permits safe egress without adverse health effects. The two values are based on familiarity with the structure being egressed. In this case, the majority of occupants are expected to be familiar with egress paths from the building. The two values for familiar and unfamiliar are four to thirteen meters of visibility, respectively. The visibility tenability value selected for passage through smoke such as in corridors or other escape routes is set at a visibility distance of ten meters.

With respect to temperature exposure, a maximum temperature of 120° C was considered since that is the point at which skin will start to feel pain or burn in more than 60 seconds. The maximum exposure temperature for moist air is documented at approximately 60° C. For this analysis, a value of 120° C was chosen to represent temperature-related untenability as noted in Chapter 63 of the SFPE Handbook.

In addition, the tenability limit for radiant heat flux was set at 2.5 kW/m². The SFPE Handbook indicates a maximum heat flux of 2.5kW/m² as a tenability limit for radiant exposure for those present. That is a commonly accepted level at which skin will generally feel pain. In Chapter 63 of the SFPE Handbook, it states:

“Exposure to air temperatures above approximately 121° C (or to radiant heat fluxes above 2.5 kW/m²) leads to pain to exposed skin followed by body surface burns and hyperthermia if exposure is prolonged. Respiratory tract burns can also occur if exposure to heated air is sufficient to cause facial burns.”

The CO level of 1,200 ppm was chosen because at that level, a 30-minute exposure will cause incapacitation. As noted in “Tenability Criteria in Unique Situations and Atypical Buildings”, it is known that most fire deaths are caused by inhalation of toxic gases, oxygen deprivation and similar effects by what is referred to as “smoke inhalation”. There are multiple toxic gases occurring in combustion, but it is known that fires occurring in under-ventilated or oxygen-deprived conditions tend to produce greater amounts of carbon monoxide (CO) and HCN. The tenability limits that are sustainable for occupants reduces over time of exposure.

The curve related to exposure over time indicates approaching 10-30 minutes is in the CO range at 1200 ppm.

The performance-based analysis conducted for this evaluation of the four-story apartment building is aided by computer numerical simulation programs including FDS (fire dynamic simulator) with the assistance of Pyrosim for visual model development. These software programs are utilized in order to computer-numerically generate the conditions related to tenability so that this information can be used to evaluate the performance-based egress in terms of RSET (required safe egress time) and ASET (available safe egress time).

7.3 Fire & Egress Modeling

Until development of FDS, a two-zone model was frequently used to evaluate fire conditions within a structure where combustion was taking place. FDS provides for specifying the room size(s), structural materials used, fire size and type, ventilation features, and fluid flows due to convection. In support of the FDS software, a graphic representation can be viewed using an application referred to as Smokeview. This enables the user to monitor the progress of combustion and smoke movement, as well as monitor the speed of air movement, temperature changes, visibility in areas of the structure, and toxic gas presence at various locations. In addition to the hand calculation methods, occupant movement can also be evaluated through computer numerical analysis via Pathfinder.

7.3.1 Fire and Egress Modeling Software

FDS is referred to as computational fluid dynamics (CFD) model of fire-driven fluid flow. The software solves numerically a form of the Navier-Stokes equations appropriate for low-speed, thermally driven flow, with an emphasis on smoke and heat transport from fires, according to the Thunderhead Engineering website. Version 6 of this software application, along with the graphical user interface of Pyrosim will be used to evaluate the smoke and fire spread throughout the structure in order to determine the impact on occupants present during the

fire event. The software enables the user to specify various features related to the fire including heat release rate, fire growth rate and decay, and presence of soot and CO yields. The user can also enter specific information about the walls, floor, and ceiling materials, and can also specify features and dimensions of furniture throughout the model area.

7.3.2 Assumptions Related to FDS Fire Simulations

The FDS model has been created using the FDS program as well as the graphical user interface software referred to as Pyrosim. Only the section of the building requiring analysis of tenability of occupants was created and evaluated in Pyrosim. The intent of the fire dynamic simulator model is not intended to evaluate the impact to the entire building of a localized fire, but to evaluate the tenability of occupants on the floor and area of fire origin during fire identification and occupant egress.

In terms of grid cell size, a grid sensitivity analysis was completed in order to ensure that the cell size adequately captured the fluid flow changes. An FDS mesh size calculator can also be used to ensure the grid size relative to the mesh (physical space for enclosure being evaluated) size. The variables impacting this calculation are heat release rate, air density, specific heat of air, the gravitational constant, and the ambient temperature. According to the FDS User Guide, *“In general, you should build an FDS input file using a relatively coarse mesh, and then gradually refine the mesh until you do not see appreciable differences in your results. This is referred to as a mesh sensitivity study.”* The cell size chosen for these FDS models is 16 cm. As noted in the appendix, the grid size calculator indicates a coarse setting in the apartment model of approximately 42 cm, while the moderate is 16 cm and the fine is 10 cm. Given the large area of analysis (interior space as well as hallway and exit stairway) the coarse setting was utilized for an initial run; however, the output was understandably coarse and did not provide sufficient detail around the exit stairway in order to confirm tenability for egressing residents. As a result, the Pyrosim model was utilized with a moderate setting of 16 cm grid size. This provided sufficient detail to confirm tenability conditions for

egressing residents from the apartment as well as hallway on the fourth floor. Grid size analysis is included in the Appendix.

Smokeview is the companion software of FDS that provides visualization of the numerical results of fire conditions. It provides for visualization of smoke and fire movement, while also offering two-dimensional viewing planes referred to as “slices”. These slices can be specified in both vertical and horizontal planes in the computational model. For this project, slices containing information on temperature, visibility and CO volume fraction will be included in the simulation to provide information for a horizontal plane that is six feet above the floor in order to assist in evaluating the tenability conditions for occupants within the fire area.

7.4 Design Fire Scenario – Kitchen Cooking Fire – 4th Floor

This first design fire occurs in a two-bedroom apartment on the fourth floor with a common space for kitchen, entryway, and living room (*Figure XX*). The kitchen fire encompasses the kitchen, living room, bathroom, and one bedroom (other bedroom door closed). The front door is 3 ft x 7 ft and there is a living room window which is 3 ft x 6 ft and the door to the deck is glass and steel at 32 inches x 7 ft. The apartment is 1250 ft². There is a window in the east bedroom that is 3 ft x 3 ft and this door is open. The bedroom with the deck door is closed at the time of the fire, so the deck door is not impacting the ventilation of the fire.

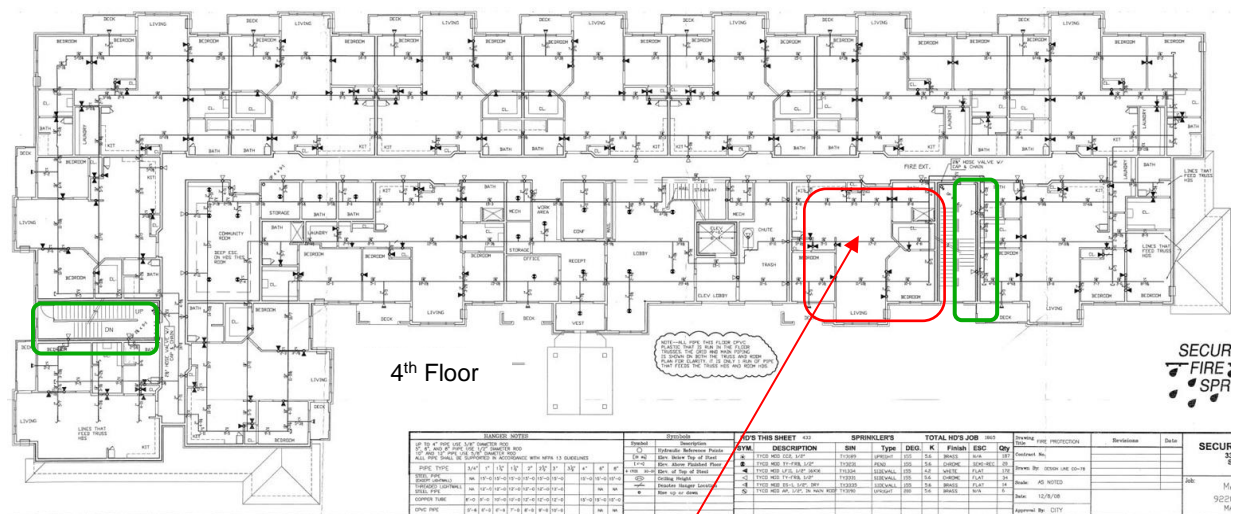


Figure XX. Fire Scenario – Cooking Fire in Kitchen

7.4.1 Fuel Load and Heat Release Rate of Design Fire

Cooking oil has a relatively low heat release rate (HRR) while the kitchen cabinets and associated furniture for an open apartment with kitchen have a heat release rate of 3,000 – 5,000 kW with a time to peak HRR of 136 seconds⁷. A nominal heat release rate of 4,000 kW was used for this design fire analysis. The combination fire/CO alarm is located 15 feet from the fire area of origin, while the wall-mounted fire sprinkler is mounted 12 feet from the area of origin and is positioned on the wall at a height of 6" from the ceiling. The determination is that this fire is a fast growth t^2 fire, with a growth rate coefficient of 0.0469 kW/s^2 (Fig. XXI).

The doors for each apartment open into the common hallway and could compromise the path of egress for other residents. If we assume the sprinkler system was temporarily non-functional in this first-floor apartment, the compartment fire has the potential to impact the wood 2 x 12 joists in the ceiling that are covered by 5/8" gypsum drywall. The average fire load density for an apartment kitchen was found to average 552 MJ/m^2 ⁷.

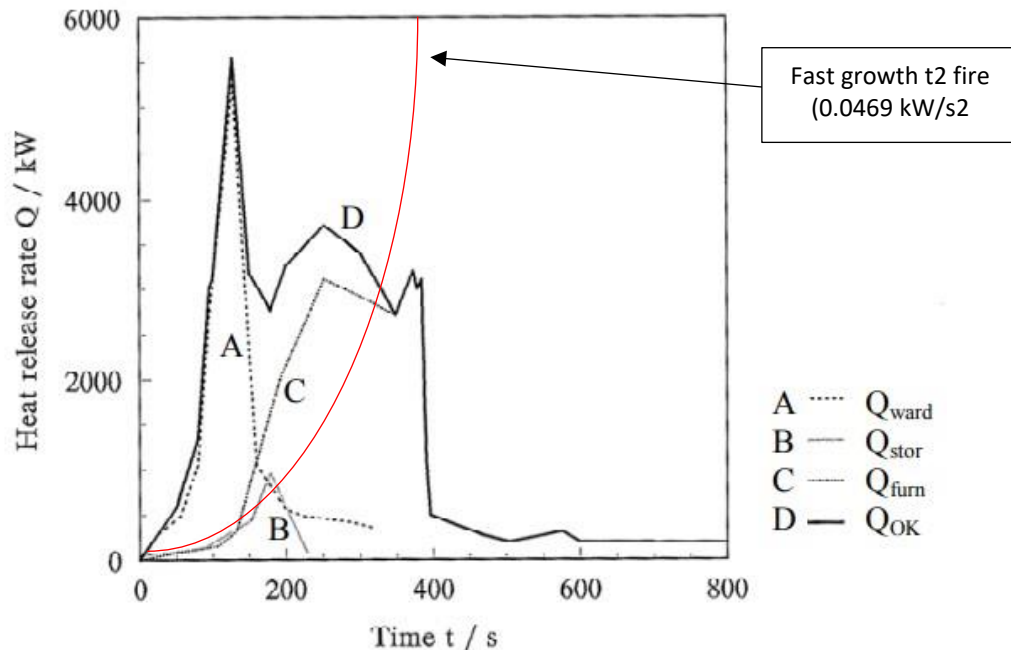


Figure XXI. Modeled Heat Release Rate – Kitchen Fire in Apartment⁸

⁷ Fire load and fire growth characteristics in modern high-rise buildings, Fire Safety Journal, Volume 135, February 2023.

⁸ Heat Release Rate of an Open Kitchen Fire of Small Residential Units in Tall Buildings, Chow, W.K., The Hong Kong Polytechnic University, Hong Kong S.A.R. (China), beelize@polyu.edu.hk, 2014.

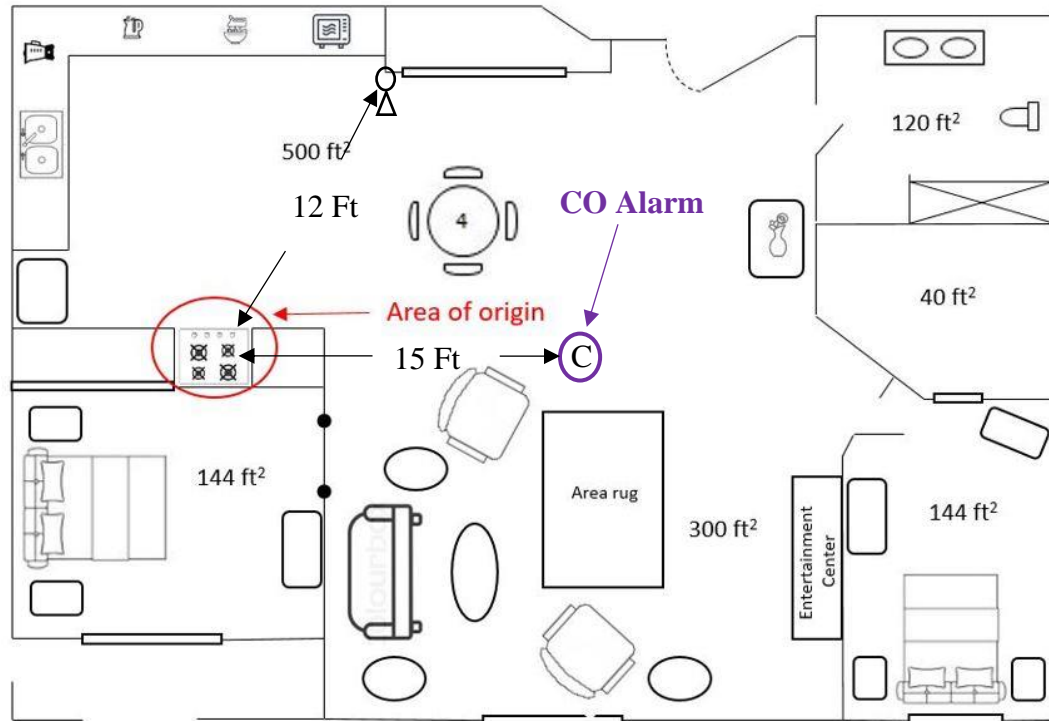


Figure XXII. Fire Scenario – Cooking Fire in Kitchen

The fire load density of the compartment is estimated to be 780 MJ/m^2 ⁷. The heat of combustion for the compartment is estimated to be 20 MJ/kg , as the primary fuel source is wood materials. Based on this being a fast growth t^2 fire, the design curve for heat release rate is set in the FDS model at a ramp up from 0 to 136 seconds to full HRR, with a steady state HRR until 350 seconds, and then ramp down to 600 seconds (Figure XXI).

7.4.2 Design Fire 1 – FDS Fire Model Analysis

The apartment as noted in Figure XXII was modeled in FDS to include the apartment layout, the egress stairwell to the east of the structure as well as to the west. The common hallway was also modelled in order to include this space in the egress path for tenability conditions during the model fire. A burner was set up in the kitchen with a heat release rate of $4,000 \text{ kW}$. Polyurethane was utilized with a soot yield of 0.13 and a CO yield of 0.031 ⁹.

⁹ The fire toxicity of polyurethane foams, McKenna, Sean Thomas & Hull,, Terence Richard, Fire Science Reviews, 2016.

Polyurethane was chosen due to the number of plastic kitchen appliances, plates, and kitchen implements, as well as the upholstered furniture for the dining room chairs and living room furniture in the open concept living and kitchen space. The soot yield of 0.13 was chosen as it was determined from a 50% polyurethane and 50% wood combination¹⁰ The CO yield of 0.031 is between stoichiometric and a fuel rich flame in terms of equivalence ratio. The fire sprinkler heads as well as the apartment common space smoke detectors were placed in the FDS model in locations mirroring the available building drawing.

Interior walls and ceiling are modeled as gypsum drywall, and doorways were all modelled as open. The FDS model was run with two different scenarios – front door (to common egress hallway) as open and as closed. It is expected that the front door to all apartments have a self-closing feature. Vertical and horizontal slices are included in the FDS model in order to provide visual information on temperature, soot and visibility, and carbon monoxide presence. The horizontal slice was placed at a Z height of 2.0 m in order to assist in determination of tenability criteria within the design space (*Figure XXIII*).

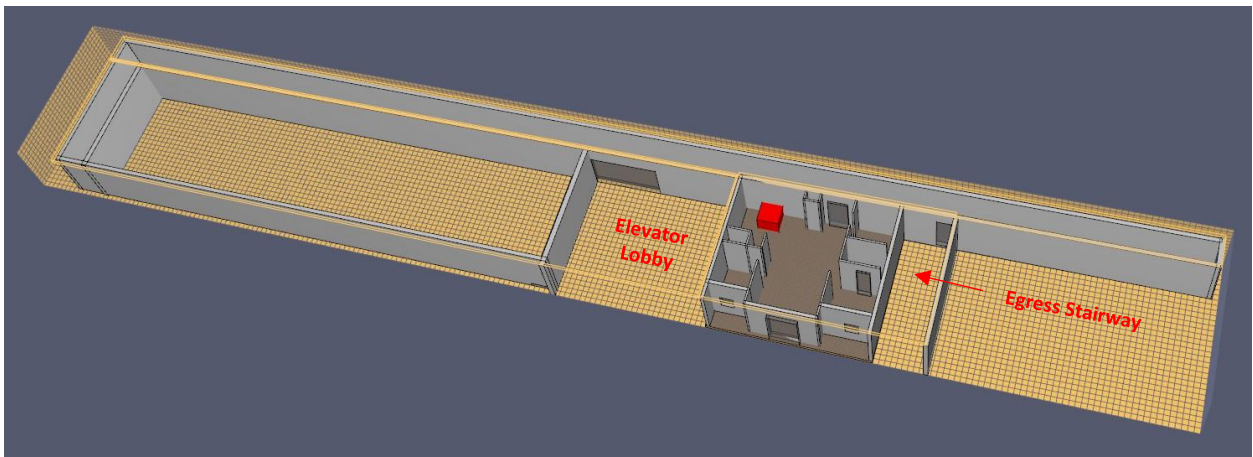


Figure XXIII. FDS Model – 4th Floor Apartment near East Stairwell – Door Open

The first FDS model analyzed in Pyrosim involves the 4th floor apartment with the apartment door closed. The sprinkler heads within the apartment, of which there are ten (10), respond within 20 seconds of fire initiation. Smoke detector response, of which there are three (3) –

¹⁰ Robbins, A.P. and C.A. Wade. 2007. Soot Yield Values for Modelling Purposes – Residential Occupancies, BRANZ Study Report 185. BRANZ Ltd, Porirua, New Zealand.

one in each bedroom and one in the common space, initiate within seconds of fire initiation (Figures XXIV & XXV).

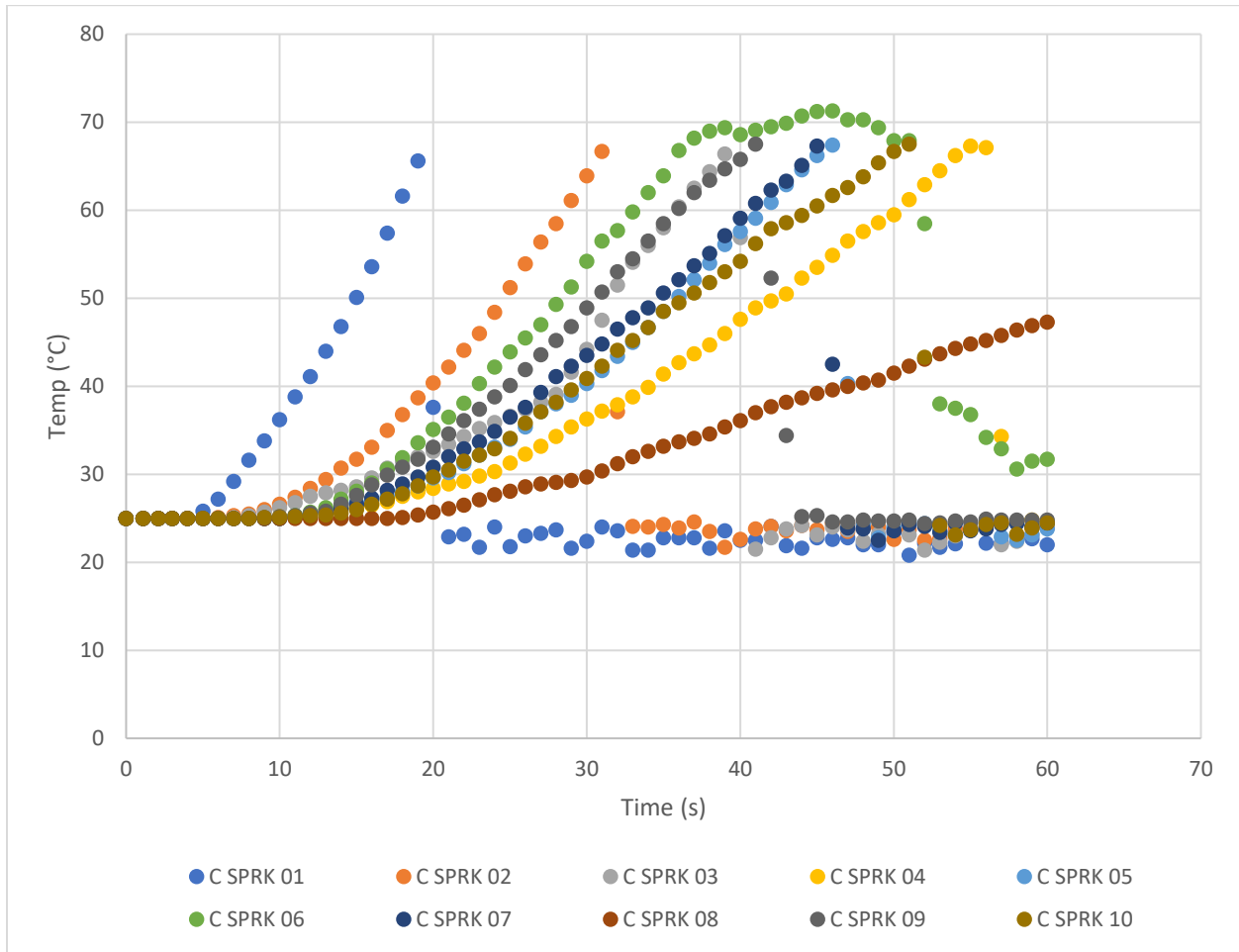


Figure XXIV. Sprinkler Response – 4th Floor Apartment near East Stairwell

Smoke fills the apartment space within one minute but does not spread into the common hallway during the required safe egress time (Figure XXVI). While the apartment quickly becomes untenable, even with the sprinkler activations throughout the unit, the common access path of egress maintains tenable conditions throughout the required safe egress time where tenants are expected to move within 6 minutes (Figures XXVII – XXVIII). This drives home how critical the entry doorway to each apartment is in terms of fire resistance.

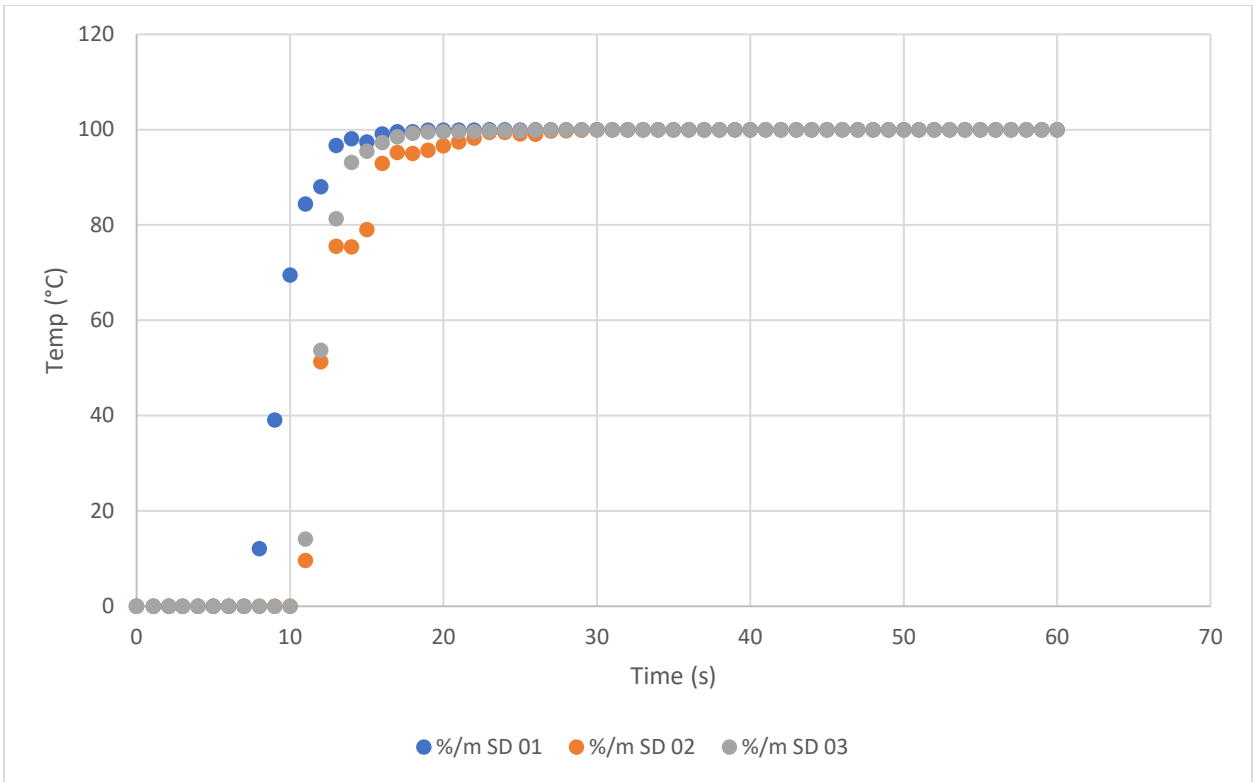


Figure XXV. Smoke detector Response – 4th Floor Apartment near East Stairwell

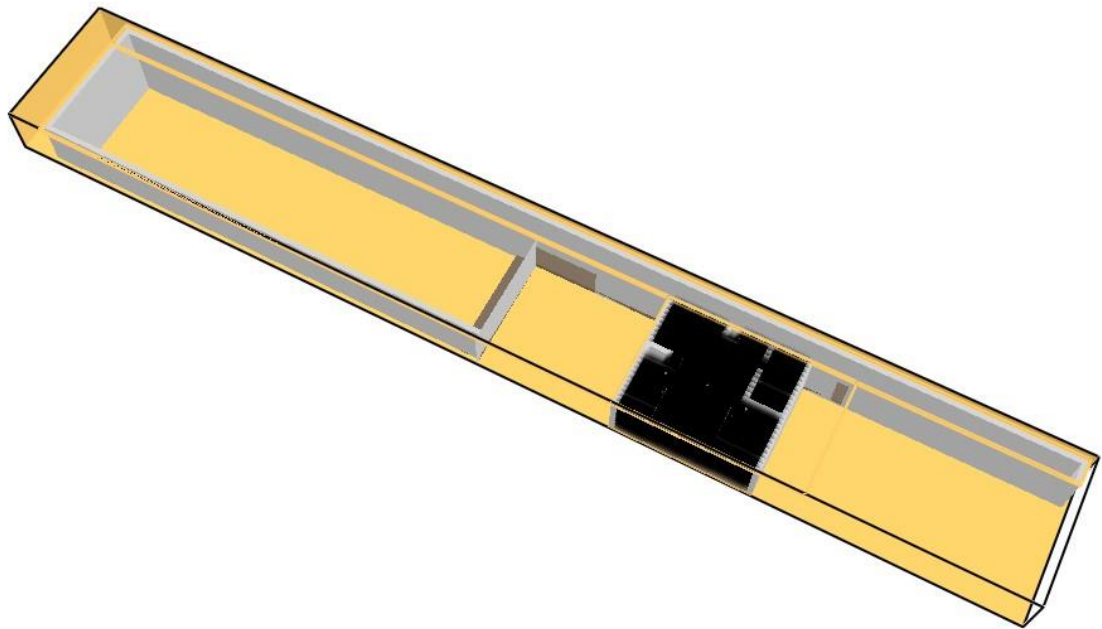


Figure XXVI. Smoke has filled apartment on 4th floor at 6 minutes

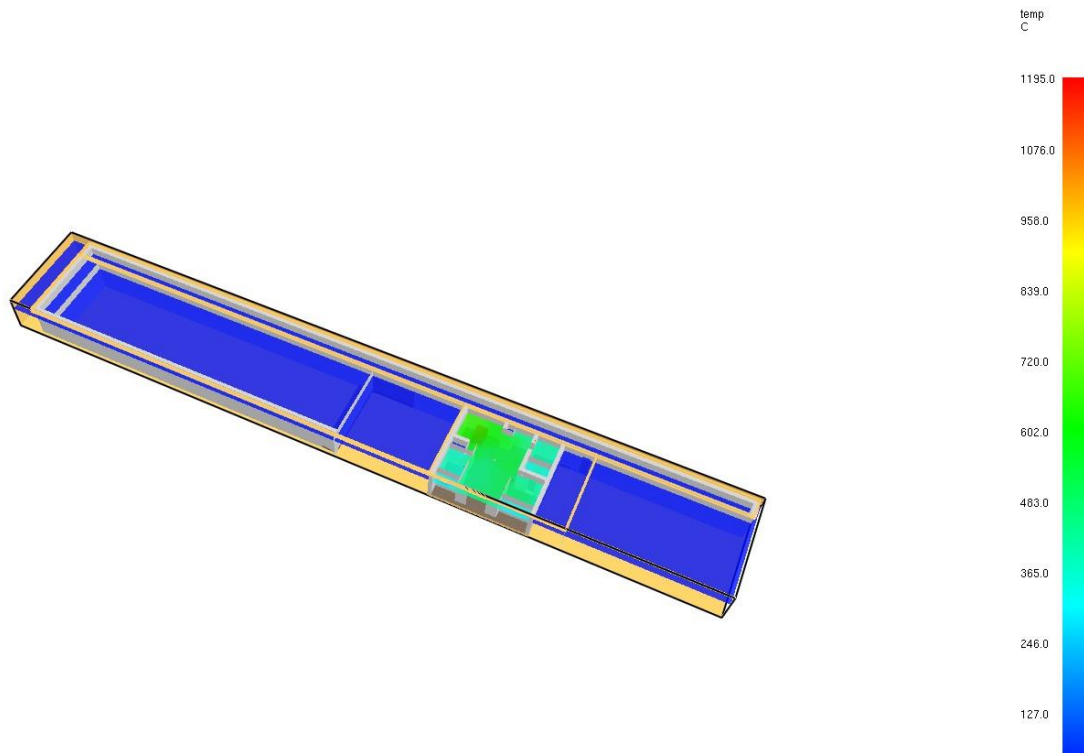


Figure XXVII. Apartment on 4th floor at 6 minutes – flashover in apt but hallway tenable

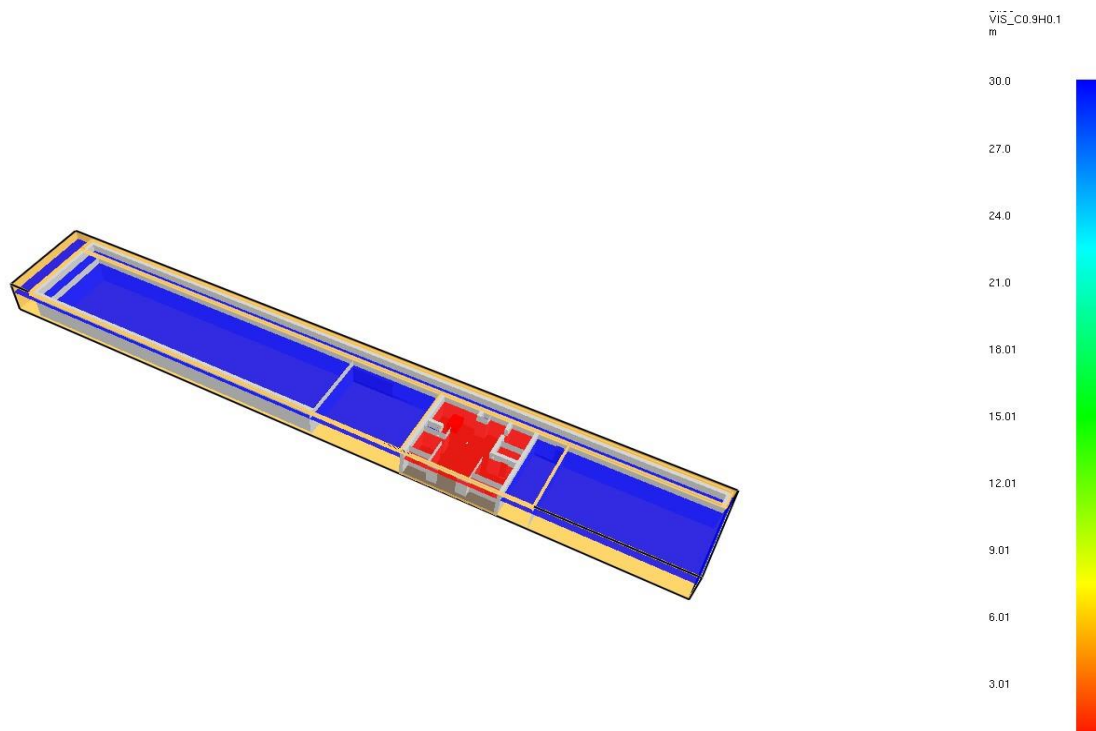


Figure XXVIII. Apartment on 4th floor at 6 minutes – visibility in egress path tenable

As an exercise where compartmentation is compromised, the FDS model was run with the egress door to the hallway from the apartment staying open after the occupants egressed from the apartment. In this case, smoke fills the hallway and visibility quickly becomes untenable along the entire length of hallway within one and a half (1.5) minutes (*Figure XXIX*). This is established as the available safe egress time (ASET). Well below the required pre-movement time estimated at 6 minutes. Temperature conditions become untenable in the eastern section of the hallway within 3 minutes (*Figures XXX-XXXI*). As a result, tenants on the fourth floor on the east wing are unable to safely egress from their apartments within the available safe egress time. Each apartment is equipped with its own air conditioning/heating equipment, so smoke would not be expected to enter other portions of the building since the common access ventilation is only present in hallways and other common spaces.

Calculations for required safe egress time (RSET) is included in the Appendix. Overall, pre-movement, flow capacity through the stairway door, flow capacity in the stairway width, and speed down the stairway results in an RSET of 9:44 minutes. In terms of pre-movement, the RSET for that portion is estimated at 6 minutes. This is based on multiple egress tests in 4 story residential apartment buildings. The range of time to start movement from apartments varies widely from 2:30 minutes up to 9:42 minutes. An average of 6:00 minutes is estimated for this movement.

Available safe egress time in this performance-based analysis, as stated above, is based on maintaining the four criteria from their apartment doorway to the exit stairway:

- Visibility < 10 meters
- Temperature >120°C
- Radiant Heat Flux >2.5 kW/m²
- Carbon Monoxide >1,200 ppm

A slice in the Z plane at a height of 2.0 meters is entered in the FDS model to document conditions at a height of approximately 6 feet. The primary concern is the ability of tenants who reside in apartments to the east of the east stairway, as well as those in close proximity to the west of the fire-affected apartment to traverse the hallway to an exit stairwell on the fourth floor.

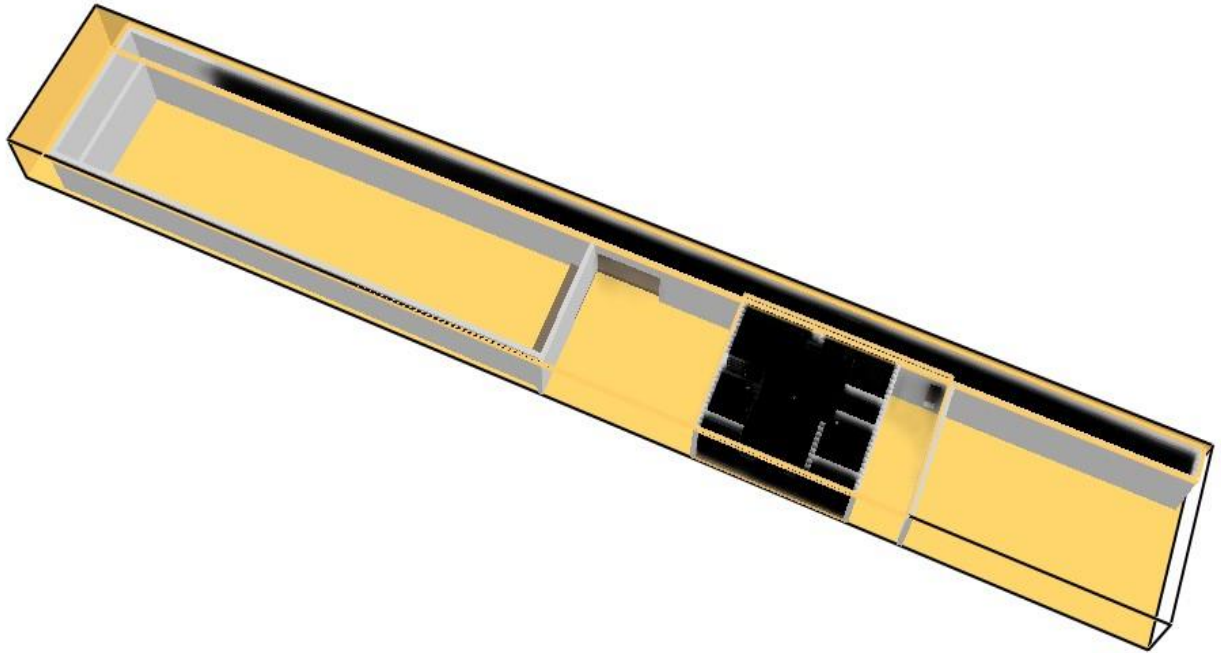


Figure XXIX. 4th Floor Apartment at 1 minute & door open – smoke in egress path untenable

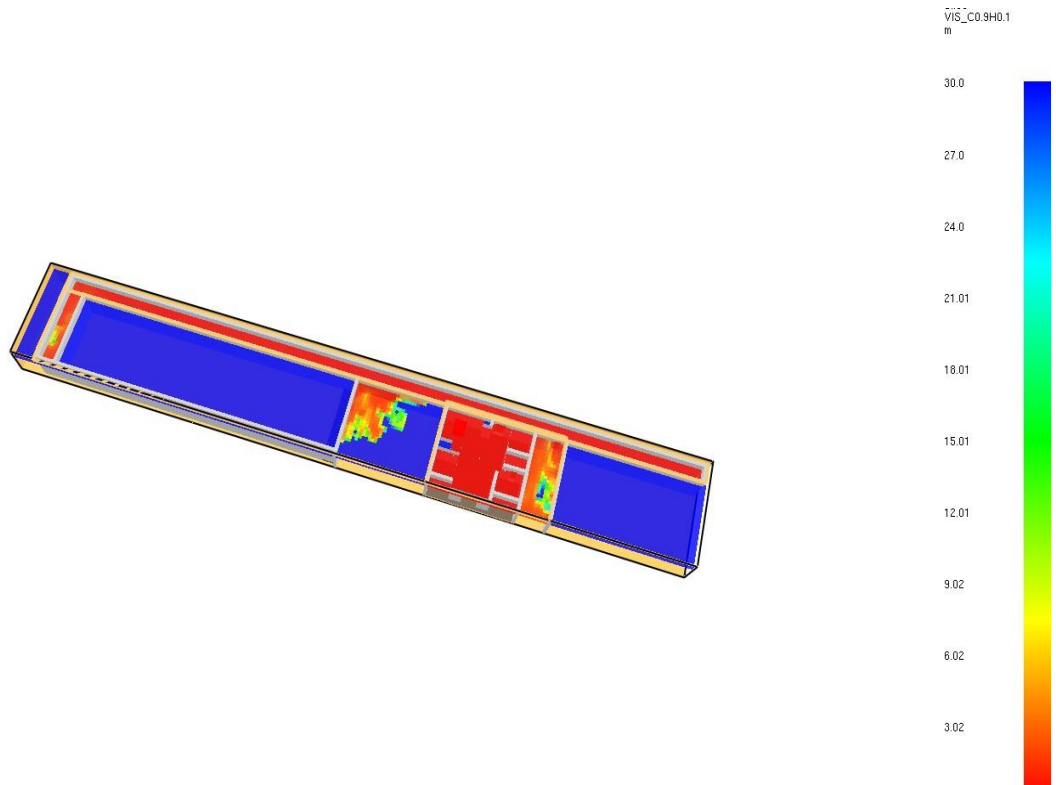


Figure XXX. Apartment on 4th floor at 1.5 minutes w/ door open –visibility untenable

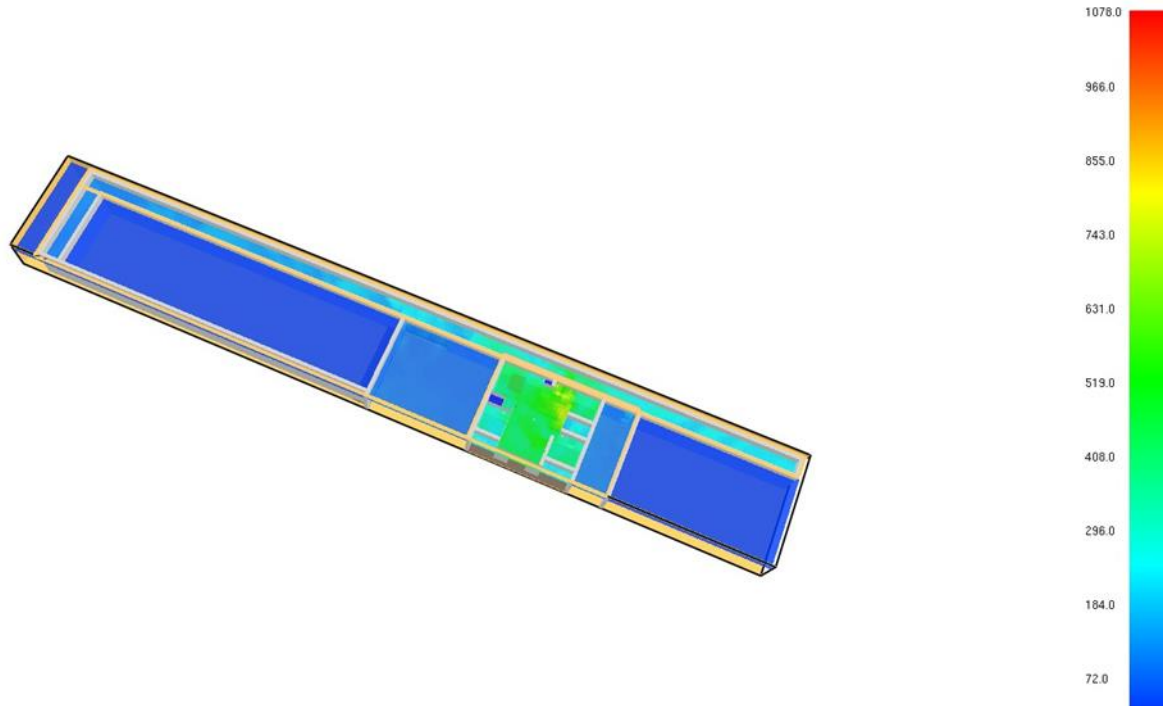


Figure XXXI. Apartment on 4th floor at 3 minutes w/ door open –temperature untenable

7.5 Design Fire Scenario 2 – Trash Room Fire

This fire occurs in the trash room on the first floor. This room is located between the elevator and elevator lobby on the left, and a two-bedroom apartment on the right (*Figure XXXII*). A mechanical room is located closer to the hallway on the left side. All walls are 2x4 wood joists with 5/8" gypsum drywall covering. The walls are also covered with fiber-reinforced plastic (FRP) up to four (4) feet from finished floor around the entire room. A standard person-door at 3 ft x 7 ft is on the north end of the room, and 6 ft x 7 ft wide roll-up door on the south end. Fiber-reinforced plastic is a composite material comprised of a polymer material reinforced with fibers. The polymer can be an epoxy, vinyl ester, or polyester thermosetting plastic, while the fibers are typically glass (in fiberglass), carbon, aramid, or basalt. The FRP is utilized to protect the walls from physical damage in this room.

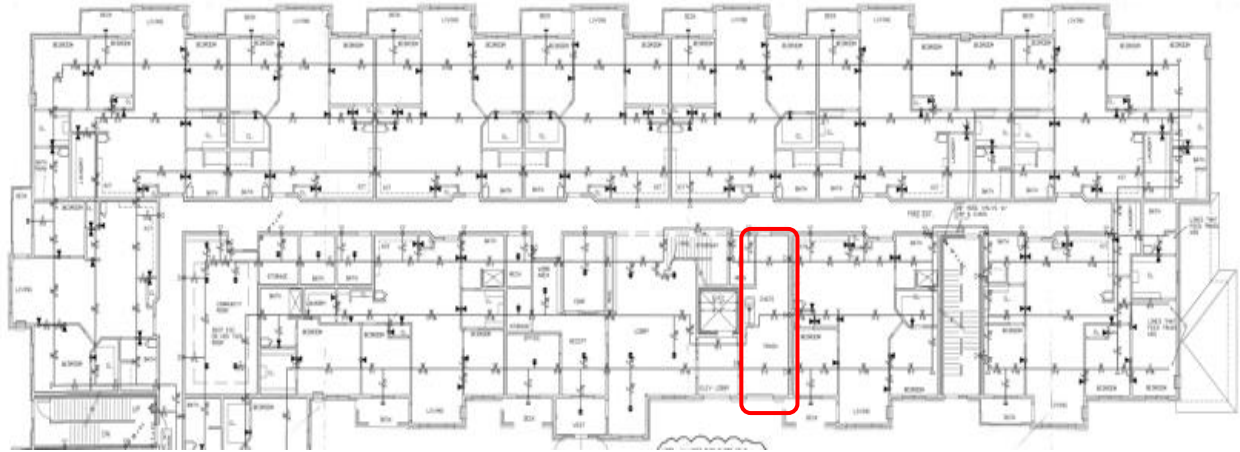


Figure XXXII. Fire Scenario – Trash Fire in Trash Room on First Floor

The room is 10 ft wide by 30 ft long and 8 ft high. This gives the room an area of 675 ft². The ceiling is covered with 5/8" Type X drywall over the 2x12 wood joists. As in the first fire scenario, the wood joists are 16 feet in length and 16 inches on center. The walls on the north, west and south sides are 1-hour fire rated, while the wall to the east is a 2-hour firewall with double joist framing.

A trash chute is located on the west wall in the north-south center of the room which extends up to all floors and is installed per NFPA 82 – Waste and Linen Handling Systems. The trash chute extends up through the roof, and is fitted with a vent cap. The interior of the chute is 16-gauge steel with self-closing, self-latching doors on each floor and the hatch is rated at 1.5 hours. The discharge door at the bottom of the chute is equipped with a fusible link that will melt (165° F) in case of a fire and cause the door cover to slide shut and seal off the chute. The intent of course is to prevent the trash chute acting as a chimney and allowing fire to spread up to the other floors through the chute.

7.5.1 Fuel Load and Heat Release Rate of Design Fire

The ignition scenario is that a large load of trash is located in this room that has not been emptied in some time. Trash from tenants has been placed in multiple large plastic rolling bins. There are also stacks of wood pallets in the room that were not authorized but were placed in the room anyway. The determination is that this fire is a fast growth t² fire, with a

growth rate coefficient of 0.0469 kW/s². The heat of combustion for the compartment is based on multiple fuel sources, such as wood materials, plastics, cardboard, paper and rubber (Table XVI). Following are some common values of materials:

Table XVI. Common Values of Materials Found in Trash Room

Materials	Calorific value in MJ/kg
Polythene cover	17.5
Poly Propylene	42.66
Wood	18.6
Carton box	16.9
Paper (average)	16.3
Centre cushion foam	40
Rubber	27.5

Given the plastic, wood, paper and rubber materials, it is estimated that the fire load density of the compartment is 2500 MJ/m². The nominal heat release rate is estimated at 4500 kW. Based on this being a fast growth t² fire, the design curve for heat release rate is set in the FDS model at a ramp up from 0 to 310 seconds to full HRR, with a steady state HRR until 400 seconds, and then ramp down to 600 seconds (Figure XXXIII).

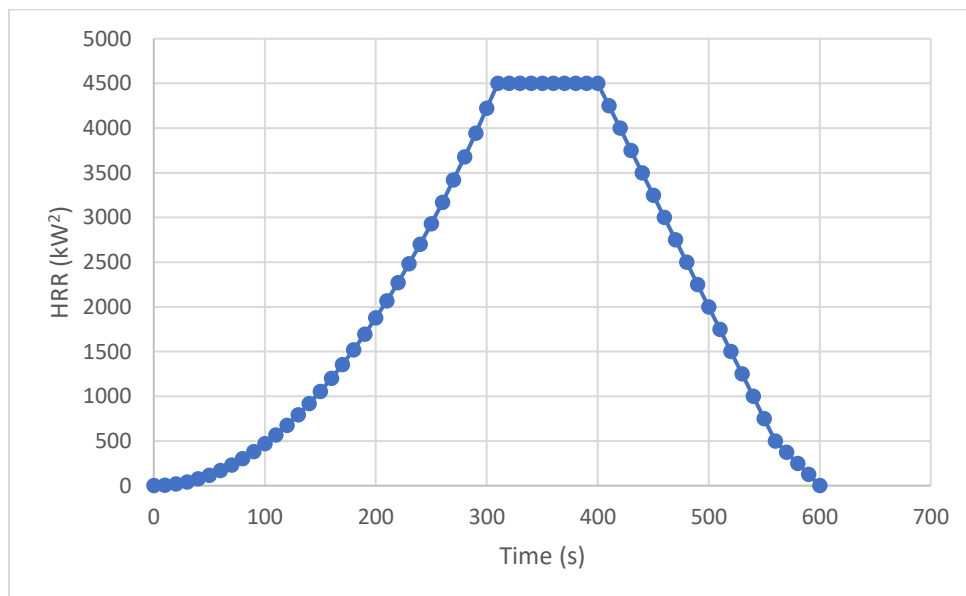


Figure XXXIII. Heat Release Rate – Trash Fire in Trash Room on First Floor¹¹

¹¹ Heat Release Rates of Multiple Transient Combustibles, USNRC, NIST TN2102, McGrattan, K., July 2020.

7.5.2 Design Fire 2 – FDS Fire Model Analysis

The trash room as noted in Figures XXXIV-XXXV was modeled in FDS to include the room, as well as the trash chute up to the roof. The elevator, lobby, mechanical room, and stairway are included. A burner was set up in the center of the trash room with a heat release rate of 4,500 kW. Polyurethane was utilized with a soot yield of 0.13 and a CO yield of 0.031. The fire sprinkler heads were placed in the FDS model in locations mirroring the available building drawing.

Interior walls and ceiling are modeled as gypsum drywall, and doorways were all modelled as closed while the roll up door is modeled with a 1" gap at the bottom. A horizontal slice is included in the FDS model in order to provide visual information on temperature, soot and visibility, and carbon monoxide presence. The horizontal slice was placed at a Z height of 2.0 m in order to assist in determination of tenability criteria within the design space.

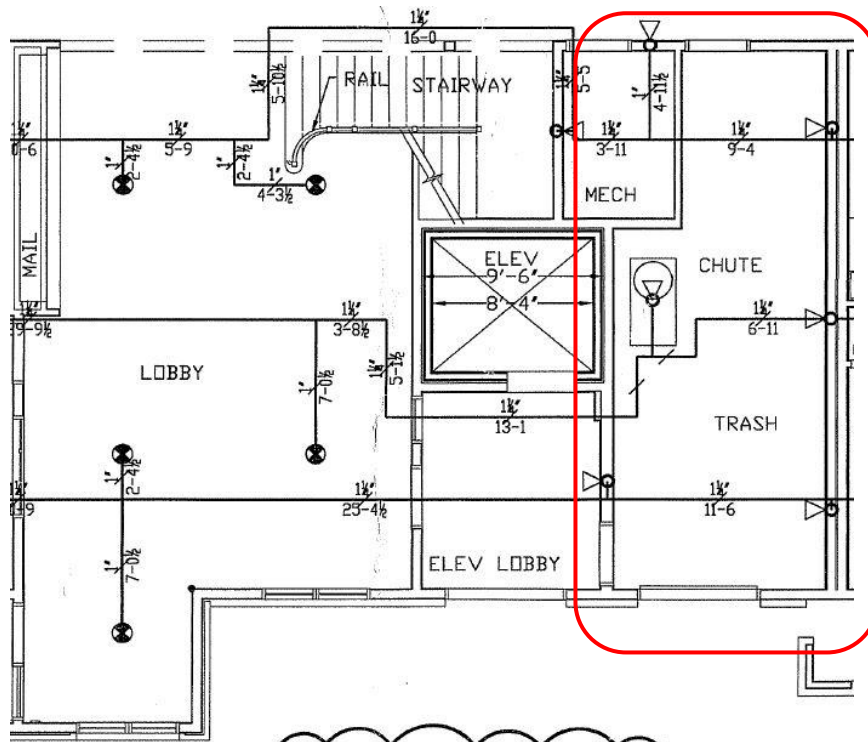


Figure XXXIV. Fire Scenario – Trash Fire in Trash Room on First Floor

The trash room is adjacent to an apartment on the east side and the elevator and elevator lobby on the left side with the main lobby on to the west of the elevator. Three (3) fire sprinklers are located on the east wall in the trash room with a heat detector (165° F) representing the fusible link for the trash chute. Fire is modeled in the center area of the trash room near to the location of the heat detector. A gap is modeled in the bottom of the location where a roll up door would be located to allow for fresh air intake from gaps.

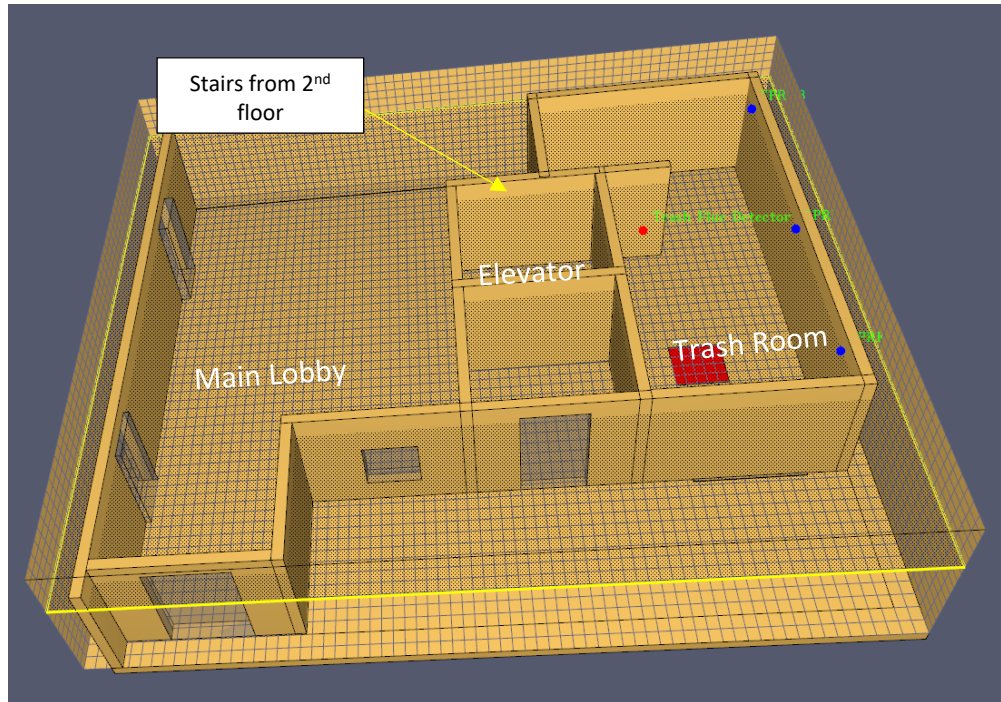


Figure XXXV. Fire Scenario – Trash Fire in Trash Room on First Floor

The fire and smoke progress rapidly in the trash room with temperatures nearing flashover within 1 minute (Fig. XXXVIII). The fire sprinklers operate between 40 and 100 seconds with temperatures in the compartment highest where the gap in the roll up door allows entrained air to enter (Figs. XXXVI-XXXVII). Fire is contained within the trash room for 9 minutes which is the duration of required safe egress time from the structure. This allows the occupants from the second floor to egress down the center stairway and prevents smoke from entering the first and second floor common hallways. The sprinklers result in reducing the room temperature while visibility in the room remains low through the duration of the required safe egress time (Figs. XXXVIII-XL).

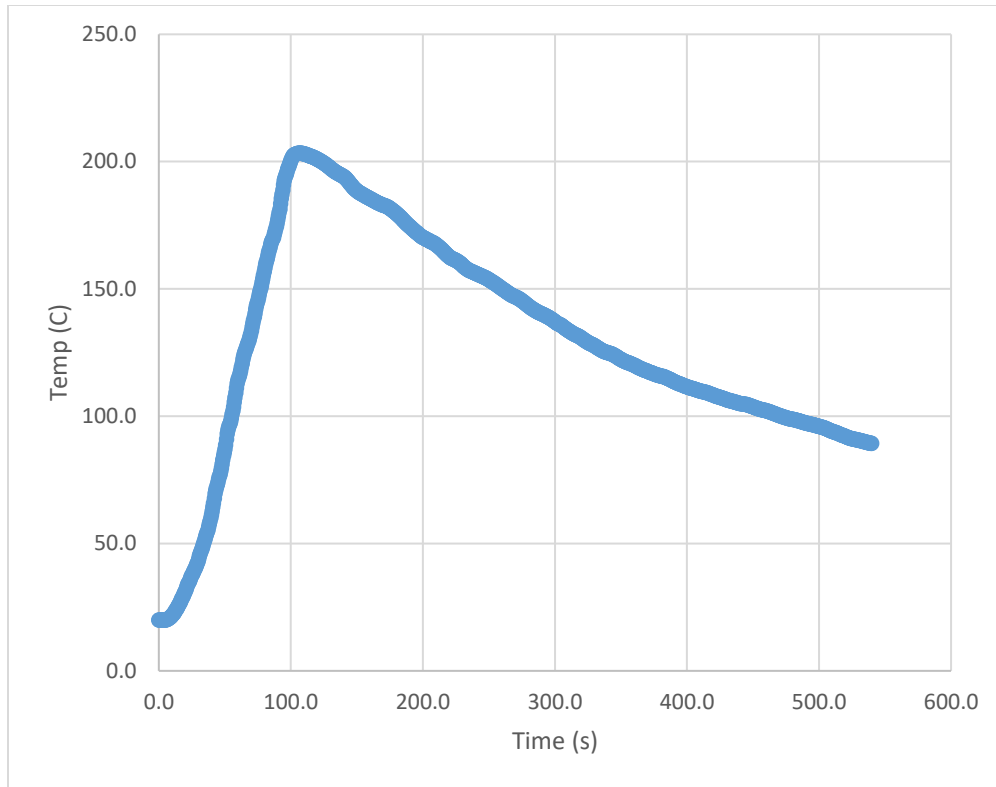


Figure XXXVI. Trash Fire in Trash Room on First Floor – Chute Detector

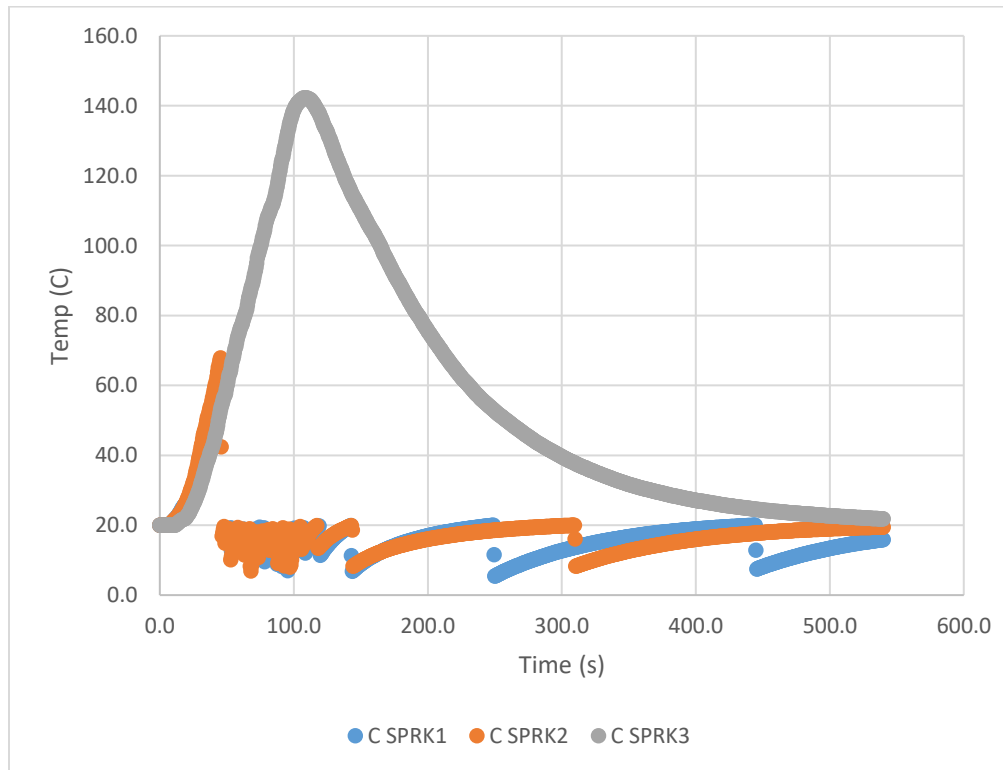


Figure XXXVII. Trash Fire in Trash Room on First Floor – 3 Sprinklers

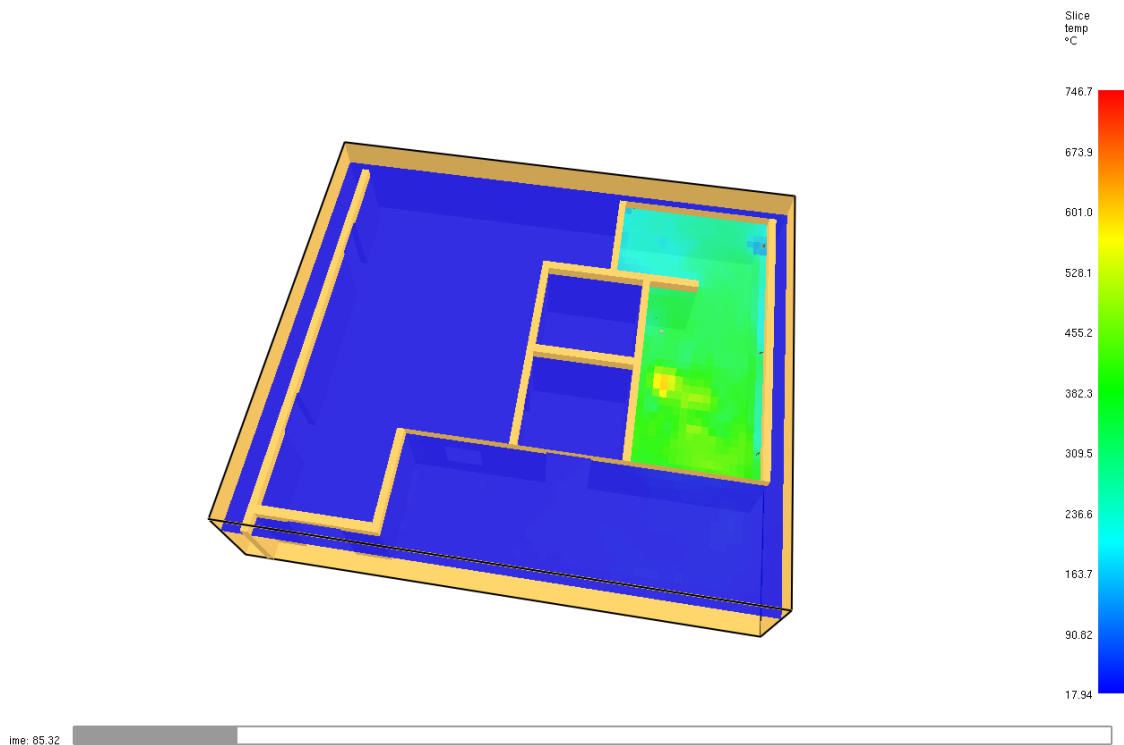


Figure XXXVIII. Trash Fire in Trash Room on First Floor – Near flashover

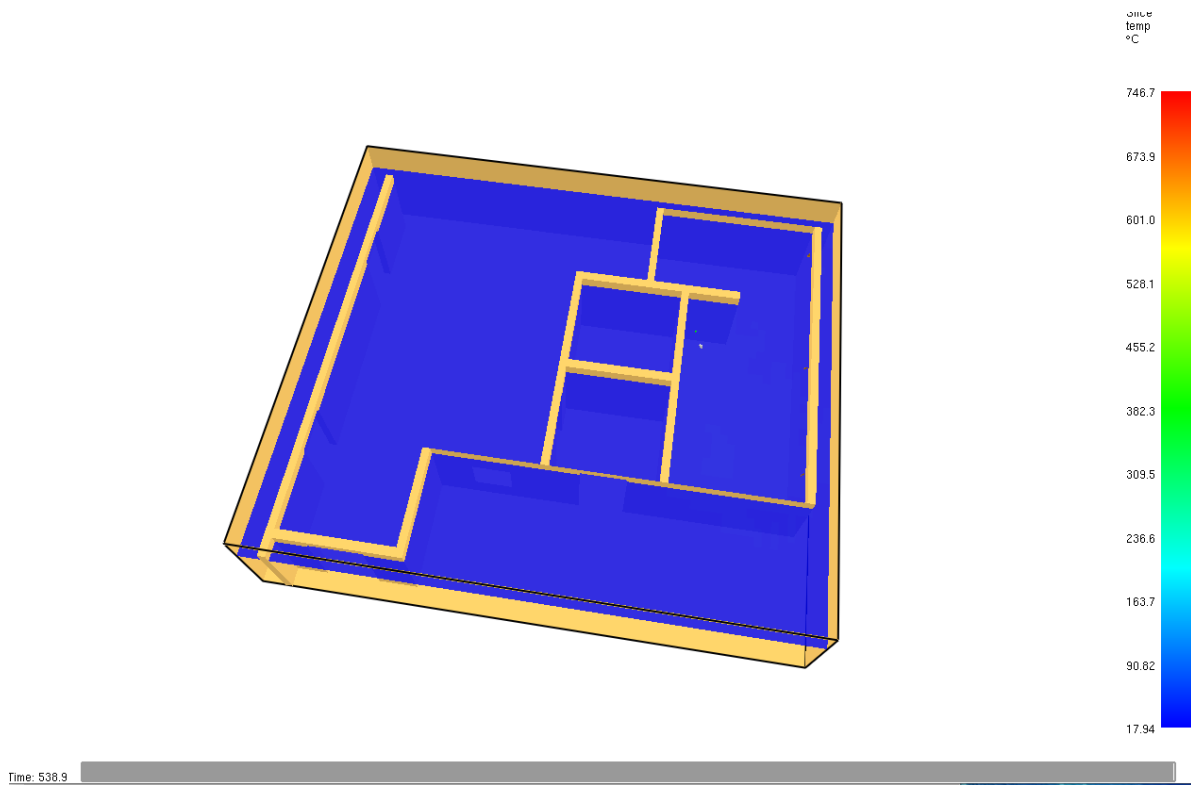


Figure XXXIX. Trash Fire in Trash Room on First Floor – Temp Drop from Sprinklers

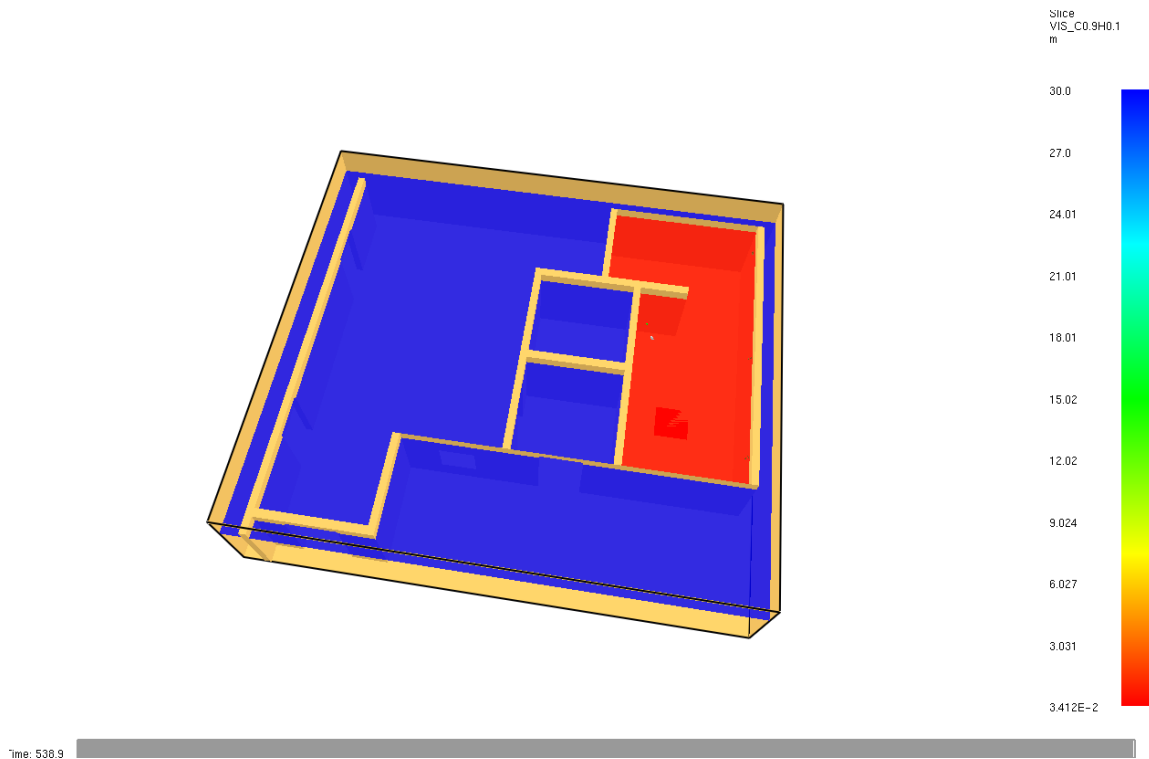


Figure XL. Trash Fire in Trash Room on First Floor – Low Visibility at 9 min

8.0 Conclusion

As noted in this report, the required safe egress time has been established at 9 minutes per calculations and available studies. Available safe egress time has been determined using FDS-6. Structure compartmentation, room finishes, protection systems, and fire conditions were implemented to determine if tenability was exceeded at any point. Tenability limits were set using accepted values from the SFPE Handbook. The only fire scenario that resulted in untenable conditions during the simulation time of 9 minutes involved an open door into the common hallway in the 4th floor apartment. With the doors closed, conditions outside the rooms of origin never became untenable. Therefore, the fire and life safety systems were determined to pass the performance-based analysis.

The prescriptive analysis of this apartment building was completed using the applicable editions of the Minnesota and International Building Codes along with the editions of numerous NFPA codes and standards in use during the building design. Active and passive

protection of the structure and the occupants was analyzed in this project. Passive structural protections were found to be adequate by meeting code requirements for fire-resistance ratings of structural and non-structural members, occupancy separation, allowable height and area, and fire separation distance. Fire sprinklers and the associated standpipe systems provided active protection for the structure.

The water supply capacity and associated hydraulic calculations meet applicable code requirements and provide sufficient water pressure and supply throughout the structure. The fire alarm and detection system within the building provides notification to occupants through audible and visual notifications and illumination for egress. Lastly, egress design of the building was evaluated. Occupancy loads for the building were calculated with egress capacity for common hallways and stairways. The east and west stairwells traversing all four floors, as well as the center stairwell for the first and second floors are adequate to provide egress capacity for all of the calculated occupants. Travel distances, common path of travel, and length of dead ends were compared to code requirements and found to be adequate. Based on these active and passive features, the apartment building meets the prescriptive code requirements for life safety and required safe egress time.

The performance-based analysis of this Maple Grove apartment building identified multiple possible fire scenarios specific to the structure. Two of these, a fire in a fourth story apartment building and a fire in the trash room on the first floor, were analyzed using FDS-6 computer simulations. Required safe egress time was both calculated as well as compared to available egress studies previously completed. The RSET has been established at 9 minutes for pre-movement and egress out of the building from all four floors.

In terms of available safe egress time (ASET) in the scenario with the door open in the fourth-floor apartment, temperatures in the eastern section of the common access hallway at the exit stairway entrance exceed tenability limits within 1.5 minutes. The entire fourth floor common access hallway exceeds temperature tenability limits within 4 minutes. The ASET is further reduced as the visibility in the hallway is reduced to less than 3 meters within 0.5

minutes at the eastern egress stairway entrance and along the full length of the hallway on the fourth floor within 1.5 minutes.

Room compartmentation, both active and passive protections, fire heat release rate estimates, along with estimated soot and carbon monoxide yields, were entered in order to determine if established tenability limits were exceeded at any point. Tenability limits were set using accepted values from the SFPE Handbook. The only fire scenario that resulted in exceeding tenability limits involved forcing a common access doorway to remain open to the hallway from the 4th story apartment. Based on the FDS-6 modeling analysis, the building active and passive protection systems result in the building meeting the performance-based analysis tenability requirements.

8.1 Recommendations

All of the elements related to fire safety have been evaluated in this project – to include the structural elements of all four floors and the basement and attic, the flammability characteristics of interior walls, ceiling and floors, as well as the characteristics of the exterior. This includes the fire-resistive exterior walls such as Hardieplank, stone, and associated materials. Additional elements include fire alarm and fire sprinkler systems, compartmentation, and egress characteristics. Important elements such as fire-stopping of gaps in living and common access spaces are assumed to be in place but are workmanship issues as much as a design issue.

One issue that should be addressed is providing sufficient standby power for elevator use for fire department personnel to assist those residents who may be handicapped per IBC §1007.4 (2003) and §1003.2.13.3 (2000). In buildings with four or more stories above or below the level of exit discharge, at least one accessible means of egress must be an elevator with standby power and emergency signaling devices. The elevator should be designed to remain operational even when utility electrical service is lost. They are used by emergency responders to move personnel and fire-fighting equipment and to provide assisted rescue. Like all elevators, they are not to be used independently by building occupants in

emergencies. This would also likely assist in egress illumination for stairwells as common travel paths as these components are known to have batteries that fail to function after short periods of time.

As in all structures, a major recommendation should involve housekeeping issues with respect to existing system maintenance and testing. Smoke detectors, fire sprinkler components, egress illumination, and common access clear path of travel are all issues that need to be monitored to ensure that these systems will function appropriately when needed. Another housekeeping issue is ensuring all self-closing features for doors are properly calibrated and improperly propping doors open is not permitted as compartmentation is critical to prevent smoke spread.

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Appendix

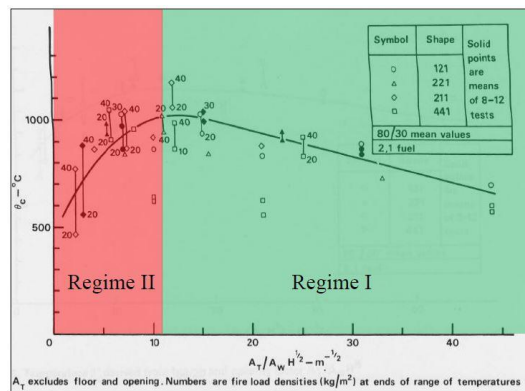
Scenario 1: Calculations - Kitchen Cooking Fire – 4th Floor Apartment

- $Q = \chi m f'' A_f \Delta H_c$
 - $m f''$ – rate of volatiles supplied from fuel surface to the fire
 - A_f – fuel surface area
 - ΔH_c – Heat of combustion
 - χ – factor (< 1.0) to account for incomplete combustion

- $Q_f = Q / A_f$
 - The average fire load densities were found to be 807 MJ/m² for kitchens; 393 MJ/m² for dining rooms; 288 MJ/m² for basement living rooms; 534 MJ/m² for Primary bedrooms and 594 MJ/m² for secondary bedrooms.¹²

- Thomas – $Q_{FO} = 7.8 A_T + 378 A_0 (H_0)^{1/2} = 7.8 * 50 + 378 * 3.8 * (3)^{1/2} = \mathbf{2,878 \text{ kW}}$
 - A_T – Total Internal Surface Area [m²] = 95 m²
 - A_0 – Area of Opening [m²] = 3 m²
 - H_0 – Height of Opening [m] = 2 m
 - Q_{FO} – HRR for Flashover [kW]

- Ventilation factor – $A_T / (A_0 (H_0)^{1/2}) = 95 / (3 * 2^{1/2}) = \mathbf{22.6 \text{ m}^{-1/2}}$



- **Regime 1**

900° C

¹² Determination of fire load and heat release rate for high-rise residential buildings, 2014 International Symposium on Safety Science and Technology, Liu, J., Chow, W.K., 2014, Published by Elsevier Ltd., The Authors.

Scenario 1: Calculations - Kitchen Cooking Fire – 4th Floor Apartment

- Margaret Law Hand Calculations:

- $T_{\max} = 6000(1 - e^{-0.1\Omega})/(\Omega)^{1/2}$
 - $\Omega = (A_t - A_v) / (A_v * H_v^{1/2}) = (220 - 3)/(3 * 2^{1/2}) = 51.1 \text{m}^{-0.5}$
- $T_{\max} = 6000(1 - e^{-0.1 * 51.1})/(51.1^{1/2}) = 834.3^\circ \text{C}$
- $F_v = A_v * (H_v)^{1/2} / A_t = 3 * 2^{1/2} / 95 = 0.04$
- Duration of heating = $0.00013e_t/(F_v) = 0.00013 * 807 / (0.04) = 2.6$

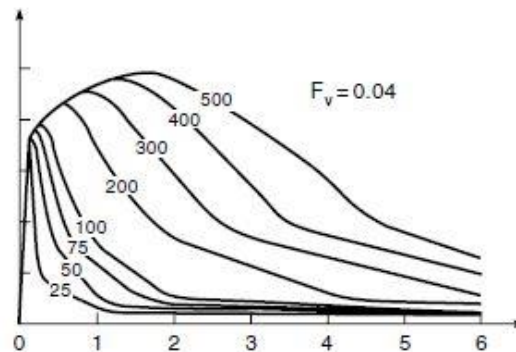


Figure 3.13 Time-temperature curves for different ventilation factors and fuel loads (MJ/m² total surface area). Reproduced from Magnusson and Thelandersson (1970) by permission of Fire Safety Engineering Department, Lund University

- Time Equivalent Formula:

- $T_e = A_f * e_f / (\Delta H_c * (A_v * (A_t - A_v))^{1/2})$
- $A_f = 95 \text{ m}^2$
- $A_v = (3 * 7 + 3 * 6) \text{ ft}^2 = 38 \text{ ft}^2 = 3.5 \text{ m}^2$
- $\Delta H_c = 20 \text{ MJ/kg}$
- $e_f = 1000 \text{ MJ/m}^2$
- $A_t = L * W * 2 + L * H * 2 + w * H * 2 - W_0 * H_0$
- $A_t = 2369 \text{ ft}^2 - 38 \text{ ft}^2 = 220 \text{ m}^2 - 3.5 \text{ m}^2 = 216.6 \text{ m}^2$
- $T_e = (95 * 1000) / (20 * (3.5 * (216.6 - 3.5))^{1/2}) = 95000 / 1022 = 92.9 \text{ minutes} = 1.55 \text{ hours}$

Scenario 1: Fire Plume

- Alpert's Correlation
 - Sprinkler Side Wall with Spacing = 10 ft = 3m = r
 - Ceiling height, H = 8 ft = 2.4 m
 - $r/H = 3/2.4 = 1.25 > 0.18$ Δ High r/H
 - $T_{cj} - T_{\infty} = 5.38/H(Q/r)^{2/3} = 5.38/2.4 * (2878/3)^{2/3} = 218^{\circ} C$
 - $U_{cj} = 0.195 * ((Q^{1/3} * H^{1/2}) / R^{5/6}) = 1.72 \text{ m/s}$

Scenario 1: 2 x 12 Joist Loading

b = inches (Nominal 2")

d = inches (Nominal 12")

$F_b =$ psi (Actual Bending Stress)

16 ft beam
Dead load = 20 psf Live load = 40 psf

$w_D = (20 + 40) * 16 = 60 \text{ psf}$

$w_L = (40 \text{ psf})(16 \text{ ft}) = 40 \text{ psf}$

$w_T = 1.2(60) + 0.5(40) = 92 \text{ psf}$

$M_T = w_T L^2 / 8 = 2944 \text{ lbf} \quad \mathbf{35328 \text{ lb-in}}$

Charring Rate in/min

$\phi M_{allow} = \phi Z_x F_b \quad \phi = 1$

$S = bd^2/6 = 31.64 \text{ in}^3$ (Section Modulus)

$Z_x = (b_f - 2z) * (d_f - z)^2 / 6$

$I = bd^3/12 = 178 \text{ in}^4$ (Moment of Inertia)

$z = 7 * (t/20) \text{ mm}$ for $t < 0.276 * (t/0.787 \text{ in})$
7 mm for $t \geq 0.276 \text{ in}$

$b \times d \rightarrow b_f \times d_f$

$b_f = b - 2c$

Depth to char front: $c = \beta t$

$d_f = d - c$

Deflection: $\Delta = 5 * W * L^4 / (384 * E * I) < L/360$

$\Delta = (5 * 92 * 192^4) / (384 * 2559000 * 178)$

$\Delta = 0.298$

$L/360 = (16 * 12) / 360 = 0.533333333$

$M_{allow} = F_b * Z = 63281.25$

2 x 12 - 16 Ft Span @ $F_b = 2000$ Douglas Fir

$W = 2636$

$w = 164$

$F_v = 117$

$E = 2559$

$F_b = 2000$

$Z = bd^2/6 = 31.64$

Scenario 2: Calculations - Waste Material Fire – Trash Room 1st Floor

- $Q = \chi m f'' A_f \Delta H_c$
 - $m f''$ – rate of volatiles supplied from fuel surface to the fire
 - A_f – fuel surface area
 - ΔH_c – Heat of combustion
 - X – factor (< 1.0) to account for incomplete combustion
- $Q_f = Q / A_f$
 - The fire load densities is estimated at 2500 MJ/m² for the wood pallets, plastic waste bins, and bags of garbage with paper, plastic, and wood materials.¹³
- Thomas – $Q_{FO} = 7.8 A_T + 378 A_0 (H_0)^{1/2} = 7.8 * 62.7 + 378 * 3.3 * (2)^{1/2} = \mathbf{2,253 \text{ kW}}$
 - A_T – Total Internal Surface Area [m²] = 62.7 m²
 - A_0 – Area of Opening [m²] = 3.3 m²
 - H_0 – Height of Opening [m] = 2 m
 - Q_{FO} – HRR for Flashover [kW]
- Ventilation factor – $A_T / (A_0 (H_0)^{1/2}) = 62.7 / (3.3 * 2^{1/2}) = \mathbf{13.4 \text{ m}^{-1/2}}$
 - **Regime 1 - 1000° C**

Scenario 1: Calculations - Kitchen Cooking Fire – 4th Floor Apartment

- Margaret Law Hand Calculations:
 - $T_{max} = 6000(1 - e^{-0.1\Omega}) / (\Omega)^{1/2}$
 - $\Omega = (A_t - A_v) / (A_v * H_v^{1/2}) = (62.7 - 3.3) / (3.3 * 2^{1/2}) = \mathbf{12.7 \text{ m}^{-0.5}}$
 - $T_{max} = 6000(1 - e^{-0.1 * 12.7}) / (12.7^{1/2}) = \mathbf{1210.8^\circ \text{ C}}$
 - $F_v = A_v * (H_v)^{1/2} / A_t = 3.3 * 2^{1/2} / 62.7 = \mathbf{0.07}$
- Time Equivalent Formula:
 - $T_e = A_f * e_f / (\Delta H_c * (A_v * (A_t - A_v))^{1/2})$

¹³ Determination of fire load and heat release rate for high-rise residential buildings, 2014 International Symposium on Safety Science and Technology, Liu, J., Chow, W.K., 2014, Published by Elsevier Ltd., The Authors.

- $A_f = 62.7 \text{ m}^2$
- $A_v = (6 \cdot 6) \text{ ft}^2 = 36 \text{ ft}^2 = 3.3 \text{ m}^2$
- $\Delta H_c = 25 \text{ MJ/kg}$
- $e_f = 2500 \text{ MJ/m}^2$
- $A_t = L \cdot W \cdot 2 + L \cdot H \cdot 2 + w \cdot H \cdot 2 - W_0 \cdot H_0$
- $A_t = 2274 \text{ ft}^2 = 211 \text{ m}^2$
- $T_e = (62.7 \cdot 1000) / (20 \cdot (3.3 \cdot (211 - 3.3))^{1/2}) = \mathbf{119.7 \text{ minutes} = 2 \text{ hours}}$

Scenario 2: Fire Plume

- Alpert's Correlation
 - Sprinkler Side Wall with Spacing = 10 ft = 3m = r
 - Ceiling height, H = 8 ft = 2.4 m
 - $r/H = 3/2.4 = 1.25 > 0.18$ Δ High r/H
 - $T_{c_j} - T_\infty = 5.38/H(Q/r)^{2/3} = 5.38/(2.4) \cdot (2253/3)^{2/3} = \mathbf{185^\circ \text{ C}}$
 - $U_{c_j} = 0.195 \cdot ((Q^{1/3} \cdot H^{1/2})/R^{5/6}) = \mathbf{1.58 \text{ m/s}}$

Scenario 2: 2 x 12 Joist Loading

b = inches (Nominal 2")
 d = inches (Nominal 12")
 $F_b =$ psi (Actual Bending Stress)

16 ft beam
 Dead load = 20 psf Live load = 40 psf

$w_D = (20 + 40) \cdot 16 = 60 \text{ psf}$

$w_L = (40 \text{ psf})(16 \text{ ft}) = 40 \text{ psf}$

$w_T = 1.2(60) + 0.5(40) = 92 \text{ psf}$

$M_T = w_T L^2 / 8 = 2944 \text{ lbf} \quad \mathbf{35328 \text{ lb-in}}$

Charring Rate in/min

$S = bd^2/6 = 31.64 \text{ in}^3$ (Section Modulus)

$\phi M_{allow} = \phi Z_x F_b \quad \phi = 1$

$Z_x = (b_f - 2z) \cdot (d_f - z)^2 / 6$

$I = bd^3/12 = 178 \text{ in}^4$ (Moment of Inertia)

$z = \begin{matrix} 7 * (t/20) \text{ mm} & \text{for } t < 0.276 * (t/0.787 \text{ in}) \\ 7 \text{ mm} & \text{for } t \geq 0.276 \text{ in} \end{matrix}$

$b \times d \rightarrow b_f \times d_f$

$b_f = b - 2c$

Depth to char front: $c = \beta t$

$d_f = d - c$

Deflection: $\Delta = 5*W*L^4 / (384*E*I) < L/360$

$\Delta = (5*92*192^4) / (384*2559000*178)$

$\Delta = \mathbf{0.298}$

$L/360 = (16*12)/360 = \mathbf{0.533333333}$

$M_{allow} = F_b*Z = 63281.25$

2 x 12 - 16 Ft Span @ $F_b = 2000$ Douglas Fir

$W = 2636$

$w = 164$

$F_v = 117$

$E = 2559$

$F_b = 2000$

$Z = bd^2/6 = 31.64$

Scenario 3: Vehicle Fire - Garage

- **Joist moment capacity calculation**
 - Dead load (WD) = 20 psf (plus weight of subject beam)
 - Live load (WL) = 100 psf (2012 IBC, Table 1607.1 – 25. Residential – Public Rooms)
- **Joist dimensions and weight calculations:**
 - 7.9 m (26 ft) length
 - 26 plf weight
 - Tributary area of 3.9 m (13 ft) on each side of the beam (one-way spanning in short direction)
 - All loads uniform
 - $W_D = (20 \text{ psf})(26 \text{ ft}) + 26 \text{ plf} = 520 \text{ plf} + 26 \text{ plf} = \mathbf{546 \text{ plf} (0.546 \text{ klf})}$
 - $W_L = (100 \text{ psf})(19.685 \text{ ft}) = \mathbf{1,968.5 \text{ plf} (1.9685 \text{ klf})}$
- **Factored load calculation**
 - The factored load due to fire is $1.2D + 0.5L$

- $W_{T,F} = 1.2W_D + 0.5W_L = (1.2)(0.564 \text{ klf}) + (0.5)(1.9685 \text{ klf}) = \mathbf{1.66 \text{ klf}}$
(factored)
- Maximum moment using factored load: $M_{max} = wl^2/8 = 1.66 \text{ klf} * (26 \text{ ft}) = \mathbf{43.16 \text{ k-ft}}$
- Deflection using unfactored load: $W_T = W_D + W_L = 0.546 \text{ klf} + 1.9685 \text{ klf} = \mathbf{2.51 \text{ klf}}$
- $\Phi M_N = \Phi f_y Z_x = 0.9 * 50 \text{ ksi} * (44.2 \text{ in}^3/12) = \mathbf{165.75 \text{ k-ft}}$
- $R_f = M_f/M_n = 43.16/165.75 = 0.26$
- Max deflection on joist:
$$\Delta_{max} = 5W_T L^4 / 384EI = (5)(2.51 \text{ klf})(26 \text{ ft})^4 / (384)(29000 \text{ ksi})(301 \text{ in}^4/144) = \mathbf{0.25 \text{ ft} = 3.0 \text{ inches}}$$

- **Joist maximum allowable deflection (failure)**

- $\Delta L = L/360 = 26 / 360 = \mathbf{0.072 \text{ ft} = 0.86 \text{ inches}}$

- **Fire Resistance of Steel Beam with 5/8" Gypsum Drywall Cover**

- $R = 2.17 * [h(W'/D)/2]^{0.75}$ (Imperial units)
 - R – fire resistance in hours
 - h – total thickness of gypsum wallboard [in (mm)]
 - D – heated perimeter of the structural steel column [in (mm)]
 - $D = 4a + 2b - 2c = 4*5.5 + 2*15.69 - 2*0.25 = 52.88$
 - W' – total weight of the structural steel column and gypsum wallboard protection in lbs/ft (kg/m)
 - $W' = W + 50hD/144 = 26 + (50*0.625*52.88)/144 = 37.5$
 - **@ 5/8" Drywall - $R = 2.17 * [(0.625*(37.5/52.88))/2]^{0.75} = \mathbf{0.7 \text{ hours}}$**
 - **@ 2 x 5/8" Drywall - $R = 2.17 * [(0.625*2*(37.5/52.88))/2]^{0.75} = \mathbf{1.2 \text{ hours}}$**

- **Alpert Ceiling Jet - High R/H:**

- $R/H = 12' / 10' = 1.2$ (R/H > 0.18)

- $T_{cj} - T_{\infty} = 5.38/H * (Q/R)^{2/3} = 5.38/10 * (5000/12)^{2/3} = 30^{\circ} \text{C}$
- $U_{cj} = 0.195 * (Q^{1/3} * H^{1/2} / R^{5/6}) = 0.195 * (5000^{1/3} * 10^{1/2} / 12^{5/6}) = 1.33 \text{ m/s}$

Section 4.3: Fire Detection and Fire Sprinkler Device Activation:

Smoke Detector Response Calculations:

RTI =		5 [ms^(1/2)]	*Assumption	Fast t ² Growth Fire
r =		4.5 [m]		
Jet Temp =	$5.38 * (Q/r)^{2/3} / H$	[C]	192.4	
U jet =	$(0.197 * Q^{1/3} * H^{1/2}) / r^{5/6}$	[m/s]		
Tdet Equation =	$T_d^{i+1} = (U_{cj})^{1/2} / RTI * (T_g^i - T_d^i) dT + T_d^i$	[C]		
dT =		1 [sec]		
Detector spacing		10.605 [Ft]		
r/H =		1.5		
Temperature rise for response (per Table B.4.7.5.3 - Average) =		7.8° C (14° F)		

Fire Sprinkler Response Calculations:

RTI =		25 [ms^(1/2)]	*Assumption	Fast t ² Growth Fire
r =		3.6 [m]		
Jet Temp =	$5.38 * (Q/r)^{2/3} / H$	[C]	192.4	
U jet =	$(0.195 * Q^{1/3} * H^{1/2}) / r^{5/6}$	[m/s]		
Tdet Equation =	$T_d^{i+1} = (U_{cj})^{1/2} / RTI * (T_g^i - T_d^i) dT + T_d^i$	[C]		
dT =		1 [sec]		
Detector spacing		8.484 [Ft]		
r/H =		1.2		
Temperature rise for response (per Table B.4.7.5.3 - Average) =		7.8° C (14° F)		

Section 7.3.1 Required Safe Egress Calculation – 9.5 Minutes Total:

- ▶ RSET – Pre movement time = **6 minutes**

Mean Times Among all Four Buildings

Building	Time to Start (min:sec)	Time to Exit (min:sec)	Time to Move (min:sec)
1	2:30	3:05	0:36
2	8:22	9:36	1:17
3	9:42	10:57	1:15
4	3:08	4:38	1:07

Evacuation Timing in 4 Story Apartment Buildings¹

Estimate flow capacity through a stairway door:

- From Table 4.2.8 - max flow through door is 24 persons/minute/Eff Width
- $0.2''/\text{person} = 60 \text{ people}/\text{ft actual width}$
- $60 \text{ people}/\text{ft}(\text{act}) / 24 \text{ people}/\text{ft}(\text{eff})/\text{min} = 2.5 \text{ min} \times \text{ft}(\text{eff})/\text{ft}(\text{act})$
- Effective width = $34'' - 6'' = 28'' = 2.33 \text{ ft}$
- Flow capacity is $24 \times 2.33 = 56 \text{ persons}/\text{minute}$
- 81 persons @ 56 persons/minute through each of two doorways **< 1.0 minute**

Estimate flow capacity in stairway effective width:

- $44'' - 12'' = 32'' (2.66 \text{ ft})$ - This is the limiting factor at max flow rate of 18.5 p/min/ft
- Specific flow = $18.5 \text{ p}/\text{min}/\text{ft} \times 2.66 \text{ ft} = 49.2 \text{ people}/\text{min}$
- As a result, the limiting factor is the stairway at 49.2 people/min.
- 81 persons @ 49.2 people/minute through each of two doorway = **1.0 minutes**

In estimating speed down stairways: $S = k - akD$ [NFPA Handbook 4-60]

Table 4.2.5: $k = 212$ and $a = 2.86$ (Rise and run at 7/11)

- $S = 212 - (2.86 \times 212 \times 0.175) = 105 \text{ ft}/\text{min}$
- Line of travel distance = $12' \times 1.85 = 22.2 \text{ ft}$ [Table 4.2.6 – NFPA FP Handbook]
- 8 foot travel on each landing
- Total floor to floor travel distance of $22.2' + (2 \times 8') = 38.2 \text{ ft}$
- Travel time per floor/person = $38.2 \text{ ft} / 105 \text{ ft}/\text{min} = 0.36 \text{ min}/\text{floor}$
- @ 4 floors, people on the top floor require $4 \text{ floors} \times 0.36 \text{ min}/\text{floor} = \mathbf{1.44 \text{ minutes}}$

Section 7.3.2 Mesh Size Calculator – Apartment Fire Scenario:

- Inputs:

Enter the x, y, z dimensions (meters) and your expected HRR

X _{min}	-35	X _{max}	21
Y _{min}	0	Y _{max}	8
Z _{min}	0	Z _{max}	3

Heat Release Rate (Q) 4000 kW

Density (ρ_{∞}) 1.204 kg / m³

Specific Heat (c_p) 1.005 kJ / kg-K

Ambient Temperature (T_{∞}) 293 K

Gravity (g) 9.81 m / s²

[Calculate suggested cell sizes »](#)

To use the old MESH Size Calculator, [click here](#)

The characteristic fire diameter D^* is 1.67

Coarse



When $D^*/dx = 4$: the suggested coarse cell size is 41.74 cm

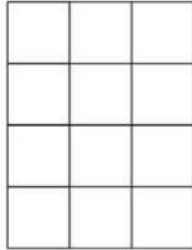
Your MESH line for FDS is:

&MESH IJK=135,20,8, XB=-35,21,0,8,0,3 /

You entered:
X_{min}: -35 X_{max}: 21
Y_{min}: 0 Y_{max}: 8
Z_{min}: 0 Z_{max}: 3
dx: 0.417

Your actual dx(es) are 0.415 0.4 0.375 (meters)
Your distances are 56 8 3 (meters)
Your total number of cells is 21,600

Moderate



When $D^*/dx = 10$: the suggested moderate cell size is 16.7 cm

Your MESH line for FDS is:

&MESH IJK=360,48,18, XB=-35,21,0,8,0,3 /

You entered:

X_{min} : -35 X_{max} : 21

Y_{min} : 0 Y_{max} : 8

Z_{min} : 0 Z_{max} : 3

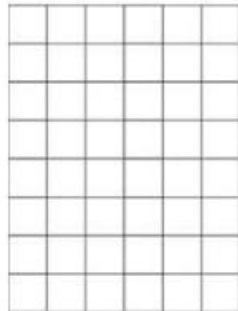
dx: 0.167

Your actual dx(es) are 0.156 0.167 0.167 (meters)

Your distances are 56 8 3 (meters)

Your total number of cells is 311,040

Fine



When $D^*/dx = 16$, the suggested fine cell size is 10.44 cm

Your MESH line for FDS is:

&MESH IJK=540,80,30, XB=-35,21,0,8,0,3 /

You entered:

X_{min} : -35 X_{max} : 21

Y_{min} : 0 Y_{max} : 8

Z_{min} : 0 Z_{max} : 3

dx: 0.104

Your actual dx(es) are 0.104 0.1 0.1 (meters)

Your distances are 56 8 3 (meters)

Your total number of cells is 1,296,000

Calculations – Most Demanding Area – Fire Sprinkler:

Design Area	Type	Location	Density [gpm/ft ²]	Flow [gpm]	Pressure [psi]	Hose Allowance [gpm]
1	Light	Attic Dormer	0.1	208.6	58.3	100
2	Light	Attic East	0.1	409.2	61.4	100
3	Light	Attic West	0.1	424.2	56.6	100
4	OH 1	Garage - East	0.15	451.1	54.7	250
5	OH 1	Garage - West	0.15	487.6	45.0	250
6	Light	3rd Flr - East Truss	0.1	280.8	53.6	250
7	Light	3rd Flr - East Apt (4 Heads)	0.1	166.8	41.7	100

- Ordinary Group 1 0.15/1500 gpm/ft²/ft²
- For ceiling height ≥ 10 ft and ≤ 20 ft, $y = (-3x)/2 + 55$ where x is ceiling height
 - $(-3*10)/2 + 55 = 40\%$ --→ $1500*0.4 = 600$ so area = 900 ft²
- For the rectangular area = 1,083 ft², $L = 1.2*\text{SQRT}(1,083) = 39.5$ ft
- $1,083/100 = 10.83 \approx 11$ sprinklers

PIBV2 and PIBV2A

Post Indicator/Butterfly Valve Supervisory Switches



by Honeywell

Conventional Initiating Devices

General

System Sensor's PIBV2 and PIBV2A supervisory switches monitor the open position of post indicator and butterfly control valves.

Robust construction. The PIBV2(A) consists of a rugged housing, intended for indoor and outdoor use. When installed with the actuator in the vertical position, the PIBV2(A) is NEMA 3R rated per UL.

Application flexibility. The PIBV2(A) features a flexible design that accommodates post indicator, butterfly, and many other types of wall post, recessed wall post and pressure reducing valves. The PIBV2(A)'s unique bi-directional actuator allows the unit to be installed in either rising or falling flag installations.

Simplified operation. Installation is made easier with the PIBV2(A)'s single-side conduit entrance. By providing a direct conduit pathway to the electrical source, right angle fittings are not required. Installation is further simplified by the PIBV2(A)'s adjustable length actuator, which eliminates the need for cutting the shaft.

Reliable performance. The PIBV2(A) is equipped with tamper resistant cover screws to prevent unauthorized entry. Inside, two sets of SPDT (Form-C) synchronized switches are enclosed in a durable terminal block to assure reliable performance.

Features

- NEMA 3R rated enclosure.
- Bi-directional actuator accommodates rising or falling flags.
- Single-side conduit entry does not require right-angle fittings.
- Adjustable length actuator eliminates the need for cutting the shaft.
- Accommodates up to 12 AWG (3.31 mm²) wire.
- Two SPDT contacts are enclosed in a durable terminal block for added strength.
- 100% synchronization activates both alarm panel and local bell simultaneously.

Specifications

Contact ratings: two sets of SPDT (Form-C). 10.0 A @ 125/250 VAC, 2.5 A @ 24 VDC.

Overall switch dimensions: 4.25" H x 3.5" W x 3.25" D (10.8 cm x 8.9 cm x 8.2 cm).

Maximum stem extension: 3-5/32" (8.0 cm).

Mounting: 1/2" NPT nipple. **Acceptable PIBV2(A) mounting positions:** actuator vertical (pointing DOWN), or actuator horizontal. **The following mounting position is NOT acceptable:** actuator vertical (pointing UP).

Conduit entrances: one single side open for 1/2" conduit.

Operating temperature range: 32°F to 120°F (0°C to 49°C).

Enclosure rating: UL indoor/outdoor; NEMA 3R when mounted with the actuator vertical.



1785ph1.png

Cover tamper switch: standard with ULC model PIBV2A; optional for UL model, P/N 546-7000.

Shipping weight: 2 lbs. (0.9 kg).

Service use:

- Automatic Sprinkler: NFPA 13.
- One or Two Family Dwelling: NFPA 13D.
- Residential Occupancies up to 4 stories: NFPA 13R.
- National Fire Alarm Code: NFPA 72.

U.S. Patent No.: 5,213,205

Engineering Specifications

Model shall be model number PIBV2(A) Post Indicator Butterfly Valve supervisory switch as manufactured by System Sensor. PIBV2(A) shall be installed on each valve as designated on the drawings and/or as specified herein. Switches shall be mounted so as not to interfere with the normal operation of the valve and shall be adjusted to operate within two revolutions of the valve control or when the valve flag has moved no more than one-fifth of the distance from its normal position. The mechanism shall be contained in a weatherproof die cast metal housing, which shall provide a side entrance for 1/2" conduit and incorporate a 1/2" NPT nipple for attachment to the valve body. A grounding provision is provided. The switch assembly shall include two switches each with a rated capacity of 10.0 A @ 125/250 VAC and 2.5 A @ 24 VDC. The cover shall contain tamper-resistant screws for which a security wrench will be provided with each switch. PIBV2(A) shall be Underwriters Laboratories listed for indoor or outdoor use. The PIBV2(A) shall be Factory Mutual, CSFM, and MEA approved.

Agency Listings and Approvals

The listings and approvals below apply to the PIBV2 or PIBV2A supervisory switches. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL/ULC** Listed: file S739.
- **ULC** Listed: file CS169 (*model PIBV2A*).
- **CSFM** approved: file 7770-1209:149, 7770-1653:118.
- **FM** approved.
- **MEA** approved: file 427-91-E, 167-93-E.
- **BSA** approved: file 750-76-SA.

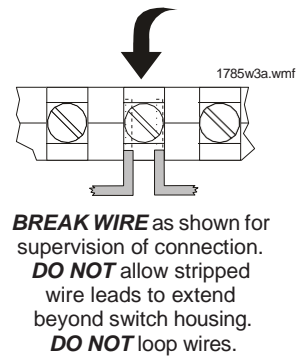
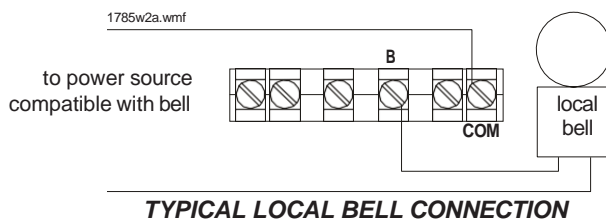
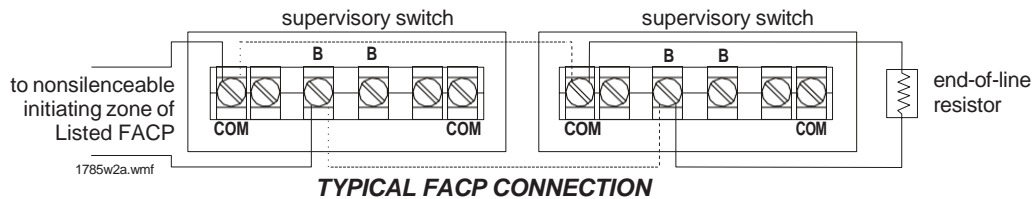
Product Line Information

PIBV2: Post Indicator/Butterfly Valve supervisory switch.

PIBV2A: ULC model, Post Indicator/Butterfly Valve supervisory switch.

546-7000: Cover tamper switch kit.

Wiring Diagrams



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www.notifier.com

NBG-12LX

Addressable Manual Pull Station



by Honeywell

Intelligent/Addressable Devices

General

The Notifier NBG-12LX is a state-of-the-art, dual-action (i.e., requires two motions to activate the station) pull station that includes an addressable interface for any Notifier intelligent control panel except FireWarden series panels, and the NSP-25 panel. Because the NBG-12LX is addressable, the control panel can display the exact location of the activated manual station. This leads fire personnel quickly to the location of the alarm.

Features

- Maintenance personnel can open station for inspection and address setting without causing an alarm condition.
- Built-in bicolor LED, which is visible through the handle of the station, flashes in normal operation and latches steady red when in alarm.
- Handle latches in down position and the word “ACTIVATED” appears to clearly indicate the station has been operated.
- Captive screw terminals wire-ready for easy connection to SLC loop (accepts up to 12 AWG/3.25 mm² wire).
- Can be surface mounted (with SB-10 or SB-I/O) or semi-flush mounted. Semi-flush mount to a standard single-gang, double-gang, or 4" (10.16 cm) square electrical box.
- Smooth dual-action design.
- Meets ADAAG controls and operating mechanisms guidelines (Section 4.1.3[13]); meets ADA requirement for 5 lb. maximum activation force.
- Highly visible.
- Attractive shape and textured finish.
- Key reset.
- Includes Braille text on station handle.
- Optional trim ring (BG12TR).
- Meets UL 38, Standard for Manually Actuated Signaling Boxes.
- Up to 99 NBG-12LX stations per loop on CLIP protocol loops.
- Up to 159 NBG-12LX stations per loop on FlashScan® protocol loops.
- Dual-color LED blinks green to indicate normal on FlashScan® systems.

Construction

Shell, door, and handle are molded of durable polycarbonate material with a textured finish.

Specifications

- **Shipping Weight:** 9.6 oz. (272.15 g)
- **Normal operating voltage:** 24 VDC.
- **Maximum SLC loop voltage:** 28.0 VDC.
- **Maximum SLC standby current:** 375 μ A.
- **Maximum SLC alarm current:** 5 mA.
- **Temperature Range:** 32°F to 120°F (0°C to 49°C)
- **Relative Humidity:** 10% to 93% (noncondensing)
- **For use indoors in a dry location**



The NBG-12LX
Addressable Manual Pull Station

Installation

The NBG-12LX will mount semi-flush into a single-gang, double-gang, or standard 4" (10.16 cm) square electrical outlet box, or will surface mount to the model SB-10 or SB-I/O surface backbox. If the NBG-12LX is being semi-flush mounted, then the optional trim ring (BG12TR) may be used. The BG12TR is usually needed for semi-flush mounting with 4" (10.16 cm) or double-gang boxes (not with single-gang boxes).

Operation

Pushing in, then pulling down on the handle causes it to latch in the down/activated position. Once latched, the word “ACTIVATED” (in bright yellow) appears at the top of the handle, while a portion of the handle protrudes from the bottom of the station. To reset the station, simply unlock the station with the key and pull the door open. This action resets the handle; closing the door automatically resets the switch.

Each manual station, on command from the control panel, sends data to the panel representing the state of the manual switch. Two rotary decimal switches allow address settings (1 – 159 on FlashScan® systems, 1 – 99 on CLIP systems).

Architectural/Engineering Specifications

Manual Fire Alarm Stations shall be non-coded, with a key-operated reset lock in order that they may be tested, and so designed that after actual Emergency Operation, they cannot be restored to normal except by use of a key. An operated station shall automatically condition itself so as to be visually detected as activated. Manual stations shall be constructed of red-colored polycarbonate material with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in white letters, 1.00 inches (2.54 cm) or larger. Stations shall be suitable for surface mounting on matching backbox SB-10 or SB-I/O; or semi-flush mounting on a standard single-gang, double-gang, or

4" (10.16 cm) square electrical box, and shall be installed within the limits defined by the Americans with Disabilities Act (ADA) or per national/local requirements. Manual Stations shall be Underwriters Laboratories listed.

Manual stations shall connect with two wires to one of the control panel SLC loops. The manual station shall, on command from the control panel, send data to the panel representing the state of the manual switch. Manual stations shall provide address setting by use of rotary decimal switches.

The loop poll LED shall be clearly visible through the front of the station. The LED shall flash while in the normal condition, and stay steadily illuminated when in alarm.

Product Line Information

NBG-12LX: Dual-action addressable pull station. Includes key locking feature. (Listed for Canadian and non-Canadian applications.)

NBG-12LXSP: Spanish/English labelled version.

NBG-12LXP: Portuguese labelled version.

SB-10: Surface backbox; metal.

SB-I/O: Surface backbox; plastic.

BG12TR: Optional trim ring.

17021: Keys, set of two.

NY-Plate: New York City trim plate.

Agency Listings and Approvals

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/ULC Listed:** S692 (listed for Canadian and non-Canadian applications).
- **MEA:** 67-02-E.
- **CSFM:** 7150-0028:0199.
- **FDNY:** COA #6085 (NFS2-640), COA #6098 (NFS2-3030).
- **BSMI:** CI313066760047.
- **U.S. Coast Guard.**
- **Lloyd's Register.**
- **FM Approved.**

Patented: U.S. Patent No. D428,351; 6,380,846; 6,314,772; 6,632,108.

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www.notifier.com

BAT Series Batteries

Sealed Lead-Acid



Power Supplies

General

BAT Series Batteries are Power-Sonic brand batteries. BAT Series (or Power-Sonic brand) batteries are recommended for secondary power or backup power for all NOTIFIER fire alarm control equipment.

Features

- Provide secondary power for control panels.
- Sealed and maintenance-free.
- Overcharge protected.
- Easy handling with leak-proof construction.
- Ruggedly constructed, high-impact case (ABS).
- Long service life.
- Compact design.

Agency Listings and Approvals

The listings and approvals below apply to BAT Series Batteries. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL Recognized Components:** MH20845 (*Power-Sonic*).



Ordering Information

BAT-1250-BP: 10-unit bulk pack of BAT-1250 (12 V 5 AH).

BAT-1270-BP: 5-unit bulk pack of BAT-1270 (12 V 7 AH).

BAT-12120-BP: 4-unit bulk pack of BAT-12120 (12V 12 AH).

BAT-12180-BP: 2-unit bulk pack of BAT-12180 (12 V 18 AH).

BAT-12260-BP: 2-unit bulk pack of BAT-12260 (12 V 26 AH).

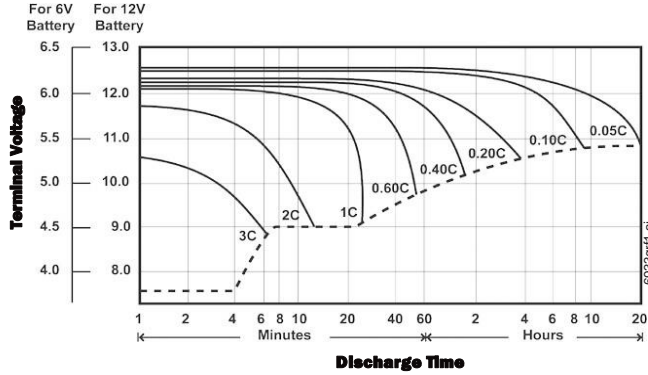
BAT-12550: single battery (12 V 55 AH).

BAT-121000: single battery (12 V 100 AH).

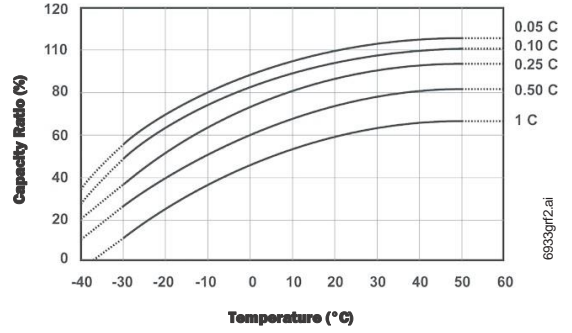
Part Number Reference & Specifications

Part Number	Power-Sonic Part Number	Battery Description			DIMENSIONS									
		Nominal Voltage V	Nominal Capacity @ 20 hr. rate A.H.		Width		Depth		Height		Height over terminal		Weight	
					in.	mm	in.	mm	in.	mm	in.	mm	lb.	kg.
BAT-1250	PS-1250	12	5	sealed	3.54	90	2.76	70	3.98	101	4.21	107	3.50	1.59
BAT-1270	PS-1270	12	7	sealed	5.95	151	2.56	65	3.7	94	3.86	98	4.8	2.18
BAT-12120	PS-12120	12	12	sealed	5.95	151	3.86	98	3.7	94	3.94	100	7.92	3.59
BAT-12180	PS-12180	12	18	sealed	7.13	181	3.00	76	6.59	167	6.59	167	12.6	5.72
BAT-12260	PS-12260	12	26	sealed	6.5	167	6.97	177	4.92	125	4.92	125	17	7.71
BAT-12550	PS-12550	12	55	sealed	9.04	230	5.45	138	8.15	207	8.98	228	36	16.33
BAT-121000	PS-121000	12	100	sealed	12	305	6.6	168	8.15	207	8.98	228	68	30.84

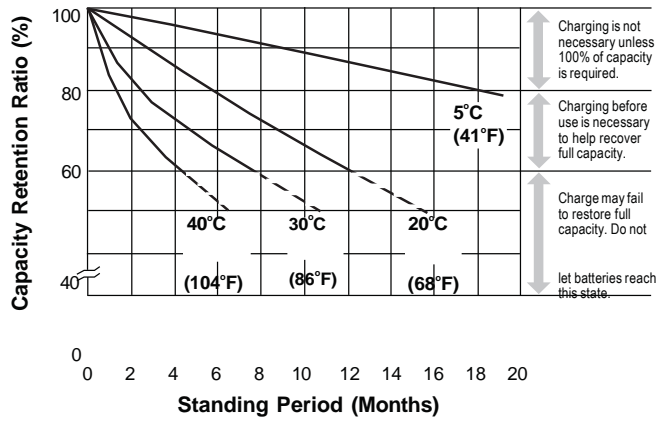
Discharge Characteristic Curves at 20°C (68°F)



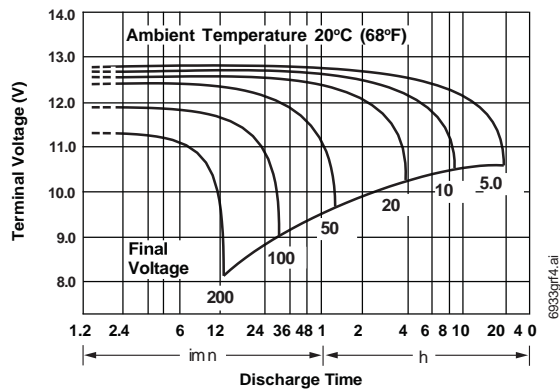
Effect of Temperature on Capacity



PS-121000 Shelf-Life and Storage



PS-121000 Discharge Characteristics



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NFS2-3030

Intelligent Addressable Fire Alarm System



by Honeywell

Intelligent Fire Alarm Control Panels

General

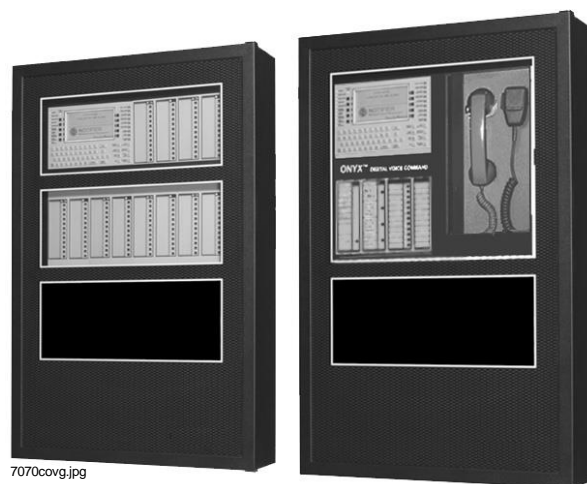
The NFS2-3030 is an intelligent Fire Alarm Control Panel (FACP) designed for medium- to large-scale facilities. Fire emergency detection and evacuation are extremely critical to life safety, and the NFS2-3030 is ideally suited for these applications. The NFS2-3030 is part of the ONYX® Series of products from NOTIFIER. The NFS2-3030 is ideal for virtually any application because it features a modular design that is configured per project requirements. With one to ten Signaling Line Circuits (SLCs), the NFS2-3030 supports up to 3,180 intelligent addressable devices.

Information is critical to fire evacuation personnel, and the NFS2-3030's large 640-character Liquid Crystal Display (LCD) presents vital information to operators concerning a fire situation, fire progression, and evacuation details.

A host of other options are available, including single- or multi-channel voice; firefighter's telephone; LED, LCD, or PC-based graphic annunciators; networking; advanced detection products for challenging environments; wireless fire protection; and many additional options.

Features

- Certified for seismic applications when used with the appropriate seismic mounting kit.
- Approved for Marine applications when a marine-listed version is used with marine-listed compatible equipment. See *DN-60688*.
- Complies with UL 2572 Mass Notification Systems (NFS2-3030 version 20 or higher).
- One to ten isolated intelligent Signaling Line Circuits (SLC) Style 4, 6 or 7.
- Wireless fire protection using SWIFT Smart Wireless Integrated Fire Technology. See *DN-60820*.
- Up to 159 detectors and 159 modules per SLC; 318 devices per loop/3,180 per FACP or network node.
 - Detectors can be any mix of ion, photo, thermal, or multi-sensor; wireless detectors are available for use with the FWSG.
 - Modules include addressable pull stations, normally open contact devices, two-wire smoke detectors, notification, or relay; wireless modules are available for use with the FWSG.
- Large 16 line, 640 character LCD backlit display or use display-less as a network node.
- Network options:
 - High-speed network for up to 200 nodes (NFS2-3030, NFS2-640, NFS-320(C), NFS-320SYS, NCA-2, DVC-EM, ONYXWorks, NFS-3030, NFS-640, and NCA).
 - Standard network for up to 103 nodes (NFS2-3030, NFS2-640, NFS-320(C), NFS-320SYS, NCA-2, DVC-EM, ONYXWorks, NCS, NFS-3030, NFS-640, NCA, AFP-200, AFP-300/400, AFP-1010, and AM2020). Up to 54 nodes when DVC-EM is used in network paging.
- Built-in Alarm, Trouble, Security, and Supervisory relays.
- VeriFire® Tools online/offline program option.
- With built-in Degraded Mode operation, the system is capable of general alarm if a fire alarm condition is present even if the central processing unit (CPU) fails.
- Weekly Occupancy Schedules allow changing sensitivity by time of day and day of week.
- EIA-485 annunciators, including custom graphics.
- History file with 4000-event capacity in nonvolatile memory, plus separate 1000-event alarm-only file.
- Advanced history filters allow sorting by event, time, date, or address.
- Alarm Verification selection per point, with automatic counter.
- Autoprogramming and Walk Test reports.
- Multiple central station communication options:
 - Standard UDACT
 - Internet
 - Internet/GSM
- Positive Alarm Sequence (PAS) Presignal.
- Silence Inhibit and Auto Silence timer options.
- Field-programmable on panel or on PC, with VeriFire Tools program, also check, compare.
- Non-alarm points for lower priority functions.
- Remote ACK/Signal Silence/System Reset/Drill via monitor modules.
- Up to 1000 powerful Boolean logic equations.
- Supports SCS Series smoke control system in both HVAC and FSCS modes.
- FM6320 approved Gas Detection System with FMM-4-20 module and any FM listed gas detector.
- EIA-232 printer port.
- EIA-485 annunciator port.



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**NFS2-3030 (left)
and NFS2-3030 with DVC audio option (right)**

640-CHARACTER DISPLAY FEATURES

- Backlit, 640-character display.
- Program keypad: full QWERTY keypad.
- Up to nine users, each with a password and selectable access levels.
- **11 LED indicators:** Power; Fire Alarm; Pre-Alarm; Security; Supervisory; System Trouble; Other Event; Signals Silenced; Point Disabled; CPU Failure; Controls Active.
- **Membrane Switch Controls:** Acknowledge; Signal Silence; Drill; System Reset; Lamp Test.
- **LCD Display:** 640 characters (16 lines x 40 characters) with long-life LED backlight.

FLASHSCAN® INTELLIGENT FEATURES

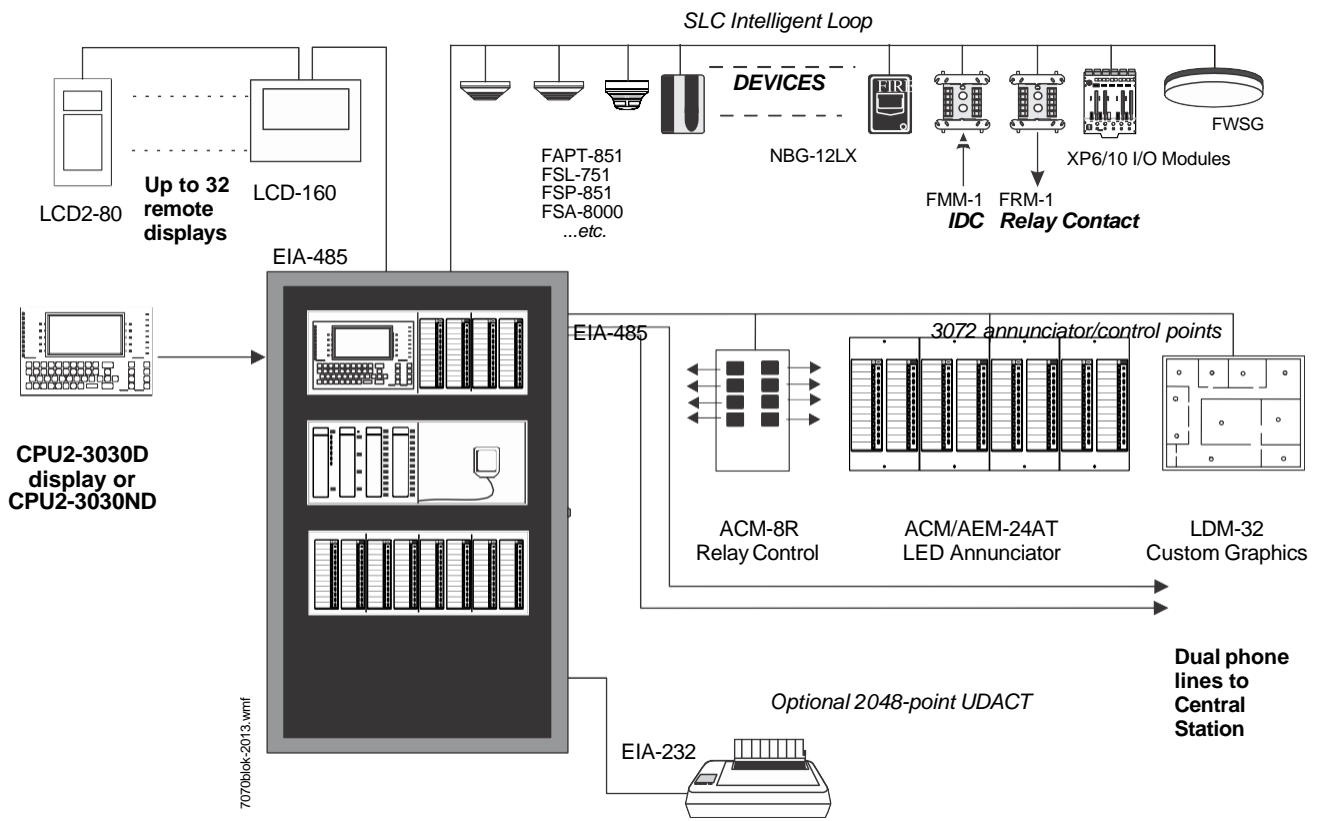
- Polls up to 318 devices on each loop in less than two seconds.
- Activates up to 159 outputs in less than five seconds.
- Multicolor LEDs blink device address during Walk Test.
- Fully digital, high-precision protocol (U.S. Patent 5,539,389).
- Manual sensitivity adjustment — up to nine levels.
- Pre-alarm ONYX intelligent sensing — up to nine levels.
- Sensitivity levels:
 - **Ion** – 0.5 to 2.5%/foot obscuration.
 - **Photo** – 0.5 to 2.35%/foot obscuration.
 - **Laser (VIEW®)** – 0.02 to 2.0%/foot obscuration.

- **Acclimate Plus™** – 0.5 to 4.0%/foot obscuration.
- **IntelliQuad** – 1.0 to 4.0%/foot obscuration.
- **IntelliQuad™ PLUS** – 1.0 to 4.0%/foot obscuration
- Drift compensation (U.S. Patent 5,764,142).
- Multi-detector algorithm involves nearby detectors in alarm decision (U.S. Patent 5,627,515).
- Automatic detector sensitivity testing (NFPA-72 compliant).
- Maintenance alert (two levels).
- Self-optimizing pre-alarm.
- Programmable activation of sounder/relay bases during alarm or pre-alarm.
- Read Status displays the level of detector cleanliness.

FSL-751 VIEW® (VERY INTELLIGENT EARLY WARNING) SMOKE DETECTION TECHNOLOGY

- Advanced ONYX intelligent sensing algorithms differentiate between smoke and non-smoke signals (U.S. Patent 5,831,524).
- Addressable operation pinpoints the fire location.
- Early warning performance comparable to the best aspiration systems at a fraction of the lifetime cost.

Sample System Options



NFS2-3030

Shown in CAB-C4 with display
DVC-EM audio in CA-1 in second tier

PRN Series Printer

NOTE: CPU2-3030 firmware version 14.0 (and higher) can support LCD-160 on the RDP port, or LCD2-80 in terminal mode, but not

FAPT-851 ACCLIMATE PLUS™ LOW-PROFILE INTELLIGENT MULTI-SENSOR

- Detector automatically adjusts sensitivity levels without operator intervention or programming. Sensitivity increases with heat.
- Microprocessor-based technology; combination photo and thermal technology.
- Low-temperature signal at 40°F ± 5°F (4.44°C ± 2.77°C).

FSC-851 INTELLIQUAD

ADVANCED MULTI-CRITERIA DETECTOR

- Detects all four major elements of a fire (smoke, heat, CO, and flame).
- Automatic drift compensation of smoke sensor and CO cell.
- High nuisance-alarm immunity.

INTELLIGENT FAAST® DETECTORS FSA-5000, FSA-8000, FSA-20000 AND FSA-20000P

- Connects directly to the SLC loop of compatible ONYX series panels.
- Provides five event thresholds that can be individually programmed with descriptive labels for control-by-event programming; uses five detector addresses.
- Uses patented particle separator and field-replaceable filter to remove contaminants.
- Advanced algorithms reject common nuisance conditions
- FSA-5000 covers 5,000 square feet through one pipe.
- FSA-8000 covers 8,000 square feet through one pipe.
- FSA-20000 covers 28,800 square feet through one to four pipes.
- FSA-20000P covers 28,800 square feet through one to four addressable pipes. Supports addressable pipes to pinpoint location of alarm events.

FCO-851 INTELLIQUAD™ PLUS

ADVANCED MULTI-CRITERIA FIRE/CO DETECTOR

- Detects all four major elements of a fire.
- Separate signal for life-safety CO detection.
- Optional addressable sounder base for Temp-3 (fire) or Temp-4(CO) tone.
- Automatic drift compensation of smoke sensor and CO cell.
- High nuisance-alarm immunity.

FMM-4-20 GAS DETECTION MODULE

- Interface to industry-standard linear scale 4-20 mA sensors.
- Five programmable thresholds.
- FM Approved, Class 6320 (Stationary Gas Sensors/ Detectors).

SWIFT WIRELESS

- Self-healing mesh wireless protocol.
- Each SWIFT Gateway supports up to 50 devices: 1 wireless gateway and up to 49 SWIFT devices.
- Up to 4 wireless gateways can be installed with overlapping network coverage.

RELEASING FEATURES

- Ten independent hazards.
- Sophisticated cross-zone (three options).
- Delay timer and Discharge timers (adjustable).
- Abort (four options).

VOICE AND TELEPHONE FEATURES

- Up to eight channels of digital audio.

- 35 watt, 50 watt, 75 watt, and 100/125 watt digital amplifiers (DAA2/DAX series and DS series).
- Solid state message generation.
- Hard-wired voice control module options.
- Firefighter telephone option.
- 30- to 120-watt analog amplifiers (AA Series).
- Backup tone generator and amplifier option.

FlashScan® Exclusive World-Leading Detector Protocol

At the heart of the NFS2-3030 is a set of detection devices and device protocol — FlashScan (U.S. Patent 5,539,389). FlashScan is an all-digital protocol that gives superior precision and high noise immunity.

As well as giving quick identification of an active input device, this protocol can also activate many output devices in a fraction of the time required by competitive protocols. This high speed also allows the NFS2-3030 to have the largest device per loop capacity in the industry — 318 points — yet every input and output device is sampled in less than two seconds.

The microprocessor-based FlashScan® detectors have bicolor LEDs that can be coded to provide diagnostic information, such as device address during Walk Test.

ONYX Intelligent Sensing

ONYX Intelligent Sensing is a set of software algorithms that provide the NFS2-3030 with industry-leading smoke detection capability. These complex algorithms require many calculations on each reading of each detector, and are made possible by the very high-speed microcomputer used by the NFS2-3030.

Drift Compensation and Smoothing. Drift compensation allows the detector to retain its original ability to detect actual smoke, and resist false alarms, even as dirt accumulates. It reduces maintenance requirements by allowing the system to automatically perform the periodic sensitivity measurements required by NFPA 72. Smoothing filters are also provided by software to remove transient noise signals, usually caused by electrical interference.

Maintenance Warnings. When the drift compensation performed for a detector reaches a certain level, the performance of the detector may be compromised, and special warnings are given. There are three warning levels: (1) Low Chamber value; (2) Maintenance Alert, indicative of dust accumulation that is near but below the allowed limit; (3) Maintenance Urgent, indicative of dust accumulation above the allowed limit.

Sensitivity Adjust. Nine sensitivity levels are provided for alarm detection. These levels can be set manually, or can change automatically between day and night. Nine levels of pre-alarm sensitivity can also be selected, based on predetermined levels of alarm. Pre-alarm operation can be latching or self-restoring, and can be used to activate special control functions.

Self-Optimizing Pre-Alarm. Each detector may be set for “Self-Optimizing” pre-alarm. In this special mode, the detector “learns” its normal environment, measuring the peak analog readings over a long period of time, and setting the pre-alarm level just above these normal peaks.

Cooperating Multi-Detector Sensing. A patented feature of ONYX Intelligent Sensing is the ability of a smoke sensor to consider readings from nearby sensors in making alarm or pre-alarm decisions. Without statistical sacrifice in the ability to resist false alarms, it allows a sensor to increase its sensitivity to actual smoke by a factor of almost two to one.

Field Programming Options

Autoprogram is a timesaving feature. The FACP “learns” what devices are physically connected and automatically loads them in the program with default values for all parameters. Requiring less than one minute to run, this routine allows the user to have almost immediate fire protection in a new installation, even if only a portion of the detectors are installed.

Keypad Program Edit. The NFS2-3030, like all NOTIFIER intelligent panels, has the exclusive feature of program creation and editing capability from the front panel keypad, while continuing to provide fire protection. The architecture of the NFS2-3030 software is such that each point entry carries its own program, including control-by-event links to other points. This allows the program to be entered with independent per-point segments, while the NFS2-3030 simultaneously monitors other (already installed) points for alarm conditions.

VERIFIRE® TOOLS

VeriFire® Tools is an offline programming and test utility that can greatly reduce installation programming time, and increase confidence in the site-specific software. It is Windows® based and provides technologically advanced capabilities to aid the installer. The installer may create the entire program for the NFS2-3030 in the comfort of the office, test it, store a backup file, then bring it to the site and download from a laptop into the panel.

Product Line Information

- “Configuration Guidelines” on page 4
- “Main System Components” on page 4
- “Networking Options” on page 4
- “Auxiliary Power Supplies and Batteries” on page 4
- “Audio Options” on page 5
- “Compatible Devices, EIA-232 Ports” on page 5
- “Compatible Devices, EIA-485 Ports” on page 5
- “Compatible Intelligent Devices” on page 5
- “Enclosures, Chassis, and Dress Plates” on page 6
- “Other Options” on page 7

CONFIGURATION GUIDELINES

Stand-alone and network systems require a main display. On single-FACP systems (one NFS2-3030D), the display option is the CPU2-3030D. On network systems (two or more networked fire panel nodes), at least one NCA-2, NCS, or ONYXWorks annunciation device is required. Options listed as follows.

MAIN SYSTEM COMPONENTS

CPU2-3030D: NFS2-3030 Primary Display. CPU2-3030D ships with keypad/display installed; includes 640-character backlit LCD display, QWERTY programming and control keypad. CPU2-3030 is a central processing unit and requires an AMPS-24(E) power supply. For English ULC applications, use CPU2-3030DC. Non-English versions are available: CPU2-3030D-FR, CPU2-3030D-HE, CPU2-3030D-KO, CPU2-3030D-PO, CPU2-3030D-SC, CPU2-3030D-SP, CPU2-3030D-TC, and CPU2-3030D-TH. For English Marine applications order CPU2-3030D-M; for non-English Marine applications order CPU2-3030D-M and the appropriate KP-KIT-XX. (See DN-60688.)

CPU2-3030ND: CPU2-3030 without display. Non-English versions are available: CPU2-3030ND-FR, CPU2-3030ND-HE, CPU2-3030ND-KO, CPU2-3030ND-PO, CPU2-3030ND-SC, CPU2-3030ND-SP, CPU2-3030ND-TC.

LCM-320: Loop Control Module. Provides one SLC. NFS2-3030 supports up to five LCM-320s and five LEM-320 expanders for a total of ten SLCs. See DN-6881.

LEM-320: Loop Expander Module. Expands an LCM-320. See DN-6881.

SAMPLE SYSTEM: *Four-loop NFS2-3030 with display: CPU2-3030D, DP-DISP, two BMP-1s, CHS-M3, two LCM-320s, two LEM-320s, AMPS-24, SBB-A4, DR-A4, BP2-4, BB-100, batteries.*

NETWORKING OPTIONS

NCA-2: Network Control Annunciator, 640 characters. An alternate primary display for CPU2-3030 can be provided by the NCA-2, NCS, or ONYXWorks. Using NCA-2 as primary display enables non-English languages. On network systems (two or more networked fire panel nodes), one network display (either NCA-2, NCS, or ONYXWorks) is required for every system. On network systems, the NCA-2 connects (and requires) a standard Network Communication Module or High-Speed Network Communication Module. Mounts in a row of FACP node or in two annunciator positions. Mounting options include the DP-DISP, ADP-4B, or in an annunciator box, such as the ABS-2D. In CAB-4 top-row applications, a DP-DISP and two BMP-1 blank modules are required for mounting. Non-English versions are available: NCA-2-FR, NCA-2-HE, NCA-2-KO, NCA-2-PO, NCA-2-SC, NCA-2-SP, NCA-2-TC, NCA-2-TH. For English ULC applications, order NCA-2C; for marine applications, order NCA-2-M; for non-English marine applications order NCA-2-M and appropriate KP-KIT-XX. See DN-7047.

NCM-W, NCM-F: Standard Network Communications Modules. Wire and multi-mode fiber versions available. See DN-6861.

HS-NCM-W/MF/SF/WMF/WSF/MFSF: High-speed Network Communications Modules that can connect to two nodes. Wire, single-mode fiber, multi-mode fiber, and media conversion models are available. See DN-60454.

RPT-W, RPT-F, RPT-WF: Standard-network repeater board with wire connection (RPT-W), multi-mode fiber connection (RPT-F), or allowing a change in media type between wire and fiber (RPT-WF). Not used with high-speed networks. See DN-6971.

ONYXWorks: UL-listed graphics PC workstation, ONYXWorks GUI software, and computer hardware. See DN-7048 for specific part numbers.

NFN-GW-EM-3: NFN Gateway, embedded. (Replaces NFN-GW-EM.) See DN-60499.

NWS-3: NOTI•FIRE•NET™ Web Server. See DN-6928.

CAP-GW: Common Alerting Protocol Gateway. See DN-60756.

VESDA-HLI-GW: VESDAnet high-level interface gateway. See DN-60753.

LEDSIGN-GW: UL-listed sign gateway. Interfaces with classic and high-speed NOTI•FIRE•NET networks through the NFN Gateway. See DN-60679.

OAX2-24V: UL-listed LED sign, used with LEDSIGN-GW. See DN-60679.

AUXILIARY POWER SUPPLIES AND BATTERIES

AMPS-24(E): One required for each NFS2-3030. Addressable power supply and battery charger with two 24 VDC outputs. Addressable by any FlashScan® or CLIP mode FACP. Charges 7 to 200 AH batteries. Occupies up to five addresses on an SLC, depending on configuration. Primary input power for panel. See DN-6883.

APS2-6R: Auxiliary Power Supply. Provides up to 6.0 amperes of power for peripheral devices. Includes battery input and

transfer relay, and overcurrent protection. Mounts on two of four positions on a CHS-4L or CHS-4 chassis. See DN-5952.

ACPS-610: 6.0 A or 10.0 A addressable charging power supply. See DN-60244.

FCPS-24S6/-24S8: Remote 6 A and 8 A power supplies with battery charger. See DN-6927.

BAT Series: Batteries. AMPS-24 uses two 12 volt, 7 to 200 AH batteries. See DN-6933.

AUDIO OPTIONS

NOTE: See "Enclosures, Chassis, and Dress Plates" on page 6 for mounting hardware.

DVC-EM: Digital Voice Command, digital audio processor with message storage for up to 32 minutes of standard quality (4 minutes at high quality) digital audio. See DN-7045.

DVC-RPU: Digital Voice Command Remote Paging Unit for use with DVC-EM. Includes the keypad/display. See DN-60726.

DS-DB: Digital Series Distribution Board, provides bulk amplification capabilities to the DVC-EM while retaining digital audio distribution capabilities. Can be configured with up to four DS-AMPs, supplying high-level risers spread throughout an installation. See DN-60565.

DVC-KD: DVC-EM keypad for local annunciation and controls; status LEDs and 24 user-programmable buttons. See DN-7045.

DS-AMP/E: 125W, 25 VRMS, or 100W, 70VRMS. 70VRMS requires DS-XF70V step-up transformer. Digital Series Amplifier, part of the DS-DB system. See DN-60663.

DS-RFM, DS-FM, DS-SFM: Fiber conversion modules for DVC-EM, DS-DB distribution board, and DAA2/DAX Series amplifiers. See DN-60633.

DAA2-5025(E): 50W, 25 Vrms Digital Audio Amplifier assembly with power supply; includes chassis. See DN-60556.

DAA2-5070(E): 50W, 70.7 Vrms Digital Audio Amplifier assembly with power supply; includes chassis. See DN-60556.

DAA2-7525(E): 75W, 25 Vrms digital audio amplifier assembly with power supply; includes chassis. See DN-60556.

DAX-3525(E): 35W, 25 Vrms Digital Audio Amplifier assembly with power supply, includes chassis. See DN-60561.

DAX-3570(E): 35W, 70.7 Vrms Digital Audio Amplifier assembly with power supply, includes chassis. See DN-60561.

DAX-5025(E): 50W, 25 Vrms Digital Audio Amplifier assembly with power supply, includes chassis. See DN-60561.

DAX-5070(E): 50W, 70.7 Vrms Digital Audio Amplifier assembly with power supply, includes chassis. See DN-60561.

TELH-1: Firefighter's Telephone Handset for use with the DVC-EM when mounted in the CA-2 chassis. See DN-7045.

CMIC-1: Microphone used with DVC/DVC-EM. Included with CA-2 chassis assembly. See DN-7045.

RM-1/RM-1SA: Remote microphone assemblies, mount on ADP-4 (RM-1) dress panel or CAB-RM/-RMR (RM-1SA) stand-alone cabinets. See DN-6728.

AA-30: Audio Amplifier, 30 watts, 25 Vrms. Includes amplifier and audio input supervision, backup input, and automatic switchover, power supply, cables. See DN-3224.

AA-120/AA-100: Audio Amplifier. AA-120 is 120 watts, 25 Vrms. AA-100 is 100 watts, 70.7 Vrms. The amplifier contains an integral chassis for mounting to a CAB-B4, -C4, or -D4 backbox (consumes one row). Includes audio input and amplified output supervision, backup input, and automatic switchover to backup tone. See DN-3224.

DAA Series Digital Audio Amplifiers: Legacy DAA Series amplifiers are compatible with DVC systems running SR4.0. For specific information on DAA-50 series amplifiers, refer to DN-7046. For information on DAA-7525 Series, refer to DN-60257.

COMPATIBLE DEVICES, EIA-232 PORTS

PRN-7: 80-column printer. See DN-60897

VS4095/5: Printer, 40-column, 24 V. Order from Keltron, Inc. See DN-3260.

DPI-232: Direct Panel Interface, specialized modem for extending serial data links to remotely located FACPs and/or peripherals. See DN-6870.

COMPATIBLE DEVICES, EIA-485 PORTS

ACM-24AT: ONYX® Series ACS annunciator – up to 96 points of annunciation with Alarm or Active LED, Trouble LED, and switch per circuit. Active/Alarm LEDs can be programmed (by powered-up switch selection) by point to be red, green, or yellow; the Trouble LED is always yellow. See DN-6862.

AEM-24AT: Same LED and switch capabilities as ACM-24AT; expands the ACM-24AT to 48, 72, or 96 points. See DN-6862.

ACM-48A: ONYX® Series ACS annunciator – up to 96 points of annunciation with Alarm or Active LED per circuit. Active/Alarm LEDs can be programmed (by powered-up switch selection) in groups of 24 to be red, green, or yellow. Expandable to 96 points with one AEM-48A. See DN-6862.

AEM-48A: Same LED capabilities as ACM-48A; expands the ACM-48A to 96 points. See DN-6862.

ACM-8R: Remote Relay Module with eight Form-C contacts. Can be located up to 6,000 ft. (1828.8 m) from panel on four wires. See DN-3558.

LCD-160: Liquid Crystal Display annunciator, 160-character backlit. Can store character sets for multiple languages. LCD-160C is used for ULC applications. See DN-6940.

LCD2-80: Terminal and ACS mode. 80-character, backlit LCD display. Mounts up to 6,000 ft. (1828.8 m) from panel. Up to 32 per FACP. See LCD2-80 (DN-60548).

SCS Series: Smoke control station; eight (expandable to 16) circuits. See DN-4818.

TM-4: Transmitter Module. Includes three reverse-polarity circuits and one municipal box circuit. Mounts in panel module position (as in single-address mode applications) or in CHS-M3 position. See DN-6860.

UDACT-2: Universal Digital Alarm Communicator Transmitter, 636 channel. See DN-60686.

UZC-256: Programmable Universal Zone Coder provides positive non-interfering successive zone coding. Microprocessor-controlled, field-programmable from IBM®-compatible PCs (requires optional programming kit). Mounts on a CHS-4 series chassis within NFS2-3030.

COMPATIBLE INTELLIGENT DEVICES

NOTE: "A" suffix indicates ULC-Listed model.

FWSG Wireless SWIFT Gateway: Addressable gateway supports wireless SLC devices. Not appropriate for ULC applications. See DN-60820.

FSA-5000: Intelligent FFAST® XS Fire Alarm Aspiration Sensing Technology. Intelligent aspirating smoke detector for applications up to 5,000 sq.ft. For Canadian applications, order FSA-5000A.

FSA-8000: Intelligent FFAST® XM Fire Alarm Aspiration Sensing Technology. Intelligent aspirating smoke detector for applications up to 8,000 sq.ft. For Canadian applications, order FSA-8000A. See DN-60792.

FSA-20000: Intelligent FFAST® XT Fire Alarm Aspiration Sensing Technology. Intelligent aspirating smoke detector for applications up to 28,800 sq.ft. For Canadian applications, order FSA-20000A. See DN-60849.

FSA-20000P FFAST® XT PRO Intelligent Aspiration Detector For applications up to 28,800 sq. ft. (2601 sq. m.) through one to four addressable pipes. See DN-60792

FSB-200(A): Intelligent beam smoke detector. See DN-6985.

FSB-200S(A): Intelligent beam smoke detector with integral sensitivity test. See DN-6985.

FSC-851(A): FlashScan IntelliQuad Advanced Multi-Criteria Detector. See DN-60412.

FCO-851(A): FlashScan IntelliQuad PLUS Advanced Multi-Criteria Fire/CO Detector. See DN-60689.

FSI-851(A): Low-profile FlashScan ionization detector. See DN-6985.

FSP-851(A): Low-profile FlashScan photoelectric detector. See DN-6935.

FSP-851R(A): Low-profile intelligent photoelectric sensor, remote test capable. For use with DNR(W). See DN-6935.

FSP-851T(A): Low-profile FlashScan photoelectric detector with 135°F (57°C) thermal. See DN-6935.

FST-851(A):: FlashScan thermal detector 135°F (57°C). See DN-6936.

FST-851R(A): FlashScan thermal detector 135°F (57°C) with rate-of-rise. See DN-6936.

FST-851H(A): FlashScan 190°F (88°C) high-temperature thermal detector. See DN-6936.

FAPT-851(A): FlashScan Acclimate Plus™ low-profile multi-sensor detector. See DN-6937.

FSL-751(A): FlashScan VIEW® laser photo detector. See DN-6886.

DNR(A): InnovairFlex low-flow non-relay duct-detector housing (order FSP-851 separately). Replaces FSD-751PL/FSD-751RPL. See DN-60429.

DNRW(A): Same as above with NEMA-4 rating, watertight. See DN-60429.

B224RB: Low-profile relay base. See DN-60054.

B224BI: Isolator base for low-profile detectors. See DN-60054.

B210LP: Low-profile base. Standard U.S. style. Replaces B710LP. See DN-60054.

B501(A): European-style, 4" (10.16 cm) base. See DN-60054.

B200S: Intelligent programmable sounder base, capable of producing a variety of tone patterns including ANSI Temporal 3. Compatible with synchronization protocol. See DN-60054.

B200S-LF: Low-frequency version of B200S. See DN-60054.

B200SCOA: Based on B200SA, with added CO detector markings in English/French. For Canadian applications only.

B200SR: Sounder base, Temporal 3 or Continuous tone. See DN-60054.

B200SR-LF: Low-frequency version of B200SR. See DN-60054.

FMM-1(A):: FlashScan monitor module. See DN-6720.

FDM-1(A): FlashScan dual monitor module. See DN-6720.

FZM-1(A): FlashScan two-wire detector monitor module. See DN-6720.

FMM-101(A): FlashScan miniature monitor module. See DN-6720.

FMM-4-20: FlashScan 4-20 mA protocol monitor module. See DN-60411.

FCM-1(A): FlashScan control module. See DN-6724.

FCM-1-REL(A): FlashScan releasing control module. See DN-60390.

FTM-1(A): Firephone Telephone Module connects a remote firefighter telephone to a centralized telephone console. Reports status to panel. Wiring to jacks and handsets is supervised. See DN-6989.

FRM-1(A): FlashScan relay module. See DN-6724.

FDRM-1(A): FlashScan dual monitor/dual relay module. See DN-60709.

NBG-12LX: Manual pull station, addressable. See DN-6726.

ISO-X: Isolator module. See DN-2243.

ISO-6: Six Fault isolator module. For Canadian applications order ISO-6A. See DN-60844.

XP6-C(A): FlashScan six-circuit supervised control module. See DN-6924.

XP6-MA(A): FlashScan six-zone interface module; connects intelligent alarm system to two-wire conventional detection zone. See DN-6925.

XP6-R(A): FlashScan six-relay (Form-C) control module. See DN-6926.

XP10-M(A): FlashScan ten-input monitor module. See DN-6923.

SLC-IM: SLC integration module, for VESDAnet detectors. See DN-60755.

ENCLOSURES, CHASSIS, AND DRESS PLATES

CAB-4 Series Enclosure: NFS2-3030 mounts in a standard CAB-4 Series enclosure (available in four sizes, "A" through "D"). Backbox and door ordered separately; requires BP2-4 battery plate. A trim ring option is available for semi-flush mounting. See DN-6857.

EQ Series Cabinets: EQ series cabinets will house amplifiers, power supplies, battery chargers and control modules. EQ cabinets are available in three sizes, "B" through "D". See DN-60229.

CAB-BM Marine System: Protects equipment in shipboard and waterfront applications. Order CPU2-3030D-M; for non-English marine applications order CPU2-3030D and appropriate KP-KIT-XX. Also order **BB-MB** for systems using 100 AH batteries. For a full list of required and optional equipment, see DN-60688.

CHS-M3: Mounting chassis for CPU2-3030. One required for each CPU2-3030D/3030ND.

CA-2: Chassis for FACP control panel when DVC-EM is used with firefighter's telephone. Mounts in the top two rows of a CAB-4 series enclosure.

DP-DISP: Dress panel for top row in cabinet with CPU2- 3030D installed.

DP-1B: Blank dress panel. Provides dead-front panel for unused tiers; covers DAA2/DAX series or AA-series amplifier. See DN-7046.

CHS-BH1: Battery chassis; holds two 12.0 AH batteries. Mounts on the left side of DAA2 chassis. See DN-7046.

CA-1: Chassis, occupies one tier of a CAB-4 Series enclosure. The left side accommodates one DVC-EM and a DVC-KD (optional); and the right side houses a CMIC-1 microphone and its well (optional). See DN-7045.

CA-2: Chassis assembly, occupies two tiers of a CAB-4 Series enclosure. The left side accommodates one DVC-EM mounted

on a half-chassis and one NFS2-3030 or NCA-2 mounted on a half-chassis. The right side houses a microphone/handset well. The CA-2 assembly includes CMIC-1 microphone. ADDR Series doors with two-tier visibility are available for use with the CA-2 configuration: ADDR-B4, ADDR-C4, ADDR-D4 (below).

ADDR-B4: Two-tier-sized door designed for use with the CA-2 chassis configuration. ADDR Series doors are similar to CAB-4 Series "DR" doors, but a clear window space exposes the top two tiers of the CAB-4 enclosure. Use an SBB-B4 backbox with the ADDR-B4. See *DN-7045, DN-6857*.

ADDR-C4: Three-tier-sized door designed for use with the CA-2 chassis configuration. ADDR Series doors are similar to CAB-4 Series "DR" doors, but a clear window space exposes the top two tiers of the CAB-4 enclosure. Use an SBB-C4 backbox with the ADDR-C4. See *DN-7045, DN-6857*.

ADDR-D4: Four-tier-sized door designed for use with the CA-2 chassis configuration. ADDR Series doors are similar to CAB-4 Series "DR" doors, but a clear window space exposes the top two tiers of the CAB-4 enclosure. Use an SBB-D4 backbox with the ADDR-D4. See *DN-7045, DN-6857*.

DPA-1: Dress panel, used with the CA-1 chassis when configured with a DVC-EM, DVC-KD, and CMIC-1. See *DN-7045*.

DPA-2: Dress Panel used with the CA-2 chassis assembly.

DPA-1A4: Dress panel, used with the CA-1 chassis when the CMIC-1 is not used. Provides mounting options on right two bays for two ACS annunciators, or for blank plates. See *DN-7045*.

ADP-4B: Annunciator dress plate. Mounts in rows 2, 3 or 4 of a CAB-4 series enclosure. Used with ACS series annunciators.

BMP-1: Blank module for unused module positions.

DP-1B: Blank dress panel. Provides dead-front panel for unused tiers; covers DAA2/DAX series or AA-series amplifier.

BP2-4: Battery plate, required.

CHS-4L: Low-profile four-position Chassis. Mounts two AA-30 amplifiers.

CHS-4N: Chassis for mounting up to four APS-6Rs.

CHS-6: Chassis used with the XP6 and XP10 Multi-Modules. Mounts up to six modules in any CAB-4 series row.

NFS-LBB: Battery Box. The NFS-LBB is used to mount up to two 55 AH batteries. Dimensions: Box: 24" (610 mm) wide x 14" (356 mm) high x 7.75" (197 mm) deep. Door: 24.125" (613 mm) wide x 14.25" (362 mm) high; door adds 0.0625" (approx. 1.6 mm) to depth.

BACKBOXES

NOTE: "C" suffix indicates ULC-Listed model.

BB-100: Backbox for batteries and power supplies. The BB-100 is used to mount up to two 100 AH batteries and power supply, if needed. 30" (76.20 cm) wide x 25" (63.50 cm) high x 7.5" (19.05 cm) deep; depth includes door.

BB-200: Backbox for batteries and power supplies. Holds up to four 100 AH batteries (200 AH capacity) and power supply. 30" (76.20 cm) wide x 36" (91.44 cm) high x 7.5" (19.05 cm) deep; depth includes door.

BB-UZC: Backbox for housing the UZC-256 for applications where the UZC will not fit in panel enclosure. Black; for red, order BB-UZC-R. See *DN-3404*.

ABF-1B(C) Annunciator Flush Box

ABF-1DB(C) Annunciator Flush Box with Door. UL/ULC Listed.

ABF-2B Annunciator Flush Box

ABF-2DB(C) Annunciator Flush Box with Door

ABF-4B Annunciator Flush Box

ABS-1TB(C) Annunciator Surface Box

ABS-1B(C) Annunciator Surface Box

ABS-2B Annunciator Surface Box

ABS-2D(C) Annunciator Surface Box

ABS-4D(C) Annunciator Surface Box

SEISKIT-CAB: Seismic mounting kit. Required for seismic-certified applications with NFS2-3030 and other equipment mounted in CAB-4 Series Enclosures. Includes battery bracket for two 26 AH batteries.

SEISKIT-LBB: Seismic kit for the NFS-LBB. Includes battery bracket for two 55 AH batteries.

OTHER OPTIONS

411: Slave digital alarm communicator. See *DN-6619*.

411UDAC: Digital alarm communicator. See *DN-6746*.

IPDACT-2, IPDACT Internet Monitoring Module: Connects to primary and secondary DACT telephone output ports for internet communications over customer-provided Ethernet connection. Requires compatible Teldat VisorALARM Central Station Receiver. Can use DHCP or static IP. See *DN-60408*.

IPCHSKIT: IP Communicator Chassis Mounting Kit. For mounting an IPDACT-2/2UD onto the panel chassis or CHS-4 series chassis. Use IPENC for external mounting applications.

IPSPLT: Y-adaptor option allow connection of both panel dialer outputs to one IPDACT-2/2UD cable input.

IPENC: External enclosure for IPDACT, includes IPBRKT mounting bracket; Red; for black, order IPENC-B.

IPGSM-4G: Internet and Digital Cellular Fire Alarm Communicator. Provides selectable configurable paths: cellular only, IP only, or IP primary with cellular backup. Connects to the primary and secondary ports of a DACT. For Canadian applications order IPGSM-4GC. See *DH-60769*.

NOTE: For other options including compatibility with retrofit equipment, refer to the panel's installation manual, the SLC manual, and the Device Compatibility Document.

System Specifications

SYSTEM CAPACITY

- Intelligent Signaling Line Circuits 1 expandable to 10
- Intelligent detectors 159 per loop
- Addressable monitor/control modules 159 per loop
- Programmable software zones over 2000
- ACS annunciators
per CPU2-3030 32 address x 64 or 96 points

NOTE: The CPU2-3030 can support up to 96 annunciator address points per ACM-24AT/-48A.

SPECIFICATIONS

Primary Input Power:

- AMPS-24: 110-120 VAC, 50/60 Hz, 4.5 A maximum.
- AMPS-24E: 240 VAC, 50/60 Hz, 2.25 A maximum.

DC Output:

- Main 24 VDC: Up to 5.0 A
- Aux 24 VDC: Up to 5.0 A
- 5 VDC: Up to 0.15 A.

Current draw (Standby/Alarm):

- CPU2-3030D board: 0.340 A.
- CPU2-3030ND board: 0.120 A.
- LCM-320: 0.130 A.
- LEM-320: 0.100 A.

– AMPS-24(E)*: 0.13 A.

(Draws power from secondary power source only.)

NOTE: See *AMPS-24(E) Manual 51907* for a complete current draw calculation sheet and details of input and output values.

Battery charger range: 7 AH – 200 AH. Use separate cabinet for batteries over 26 AH.

Float Rate: 27.6 V.

SHIPPING WEIGHT

- CPU2-3030D: 5.95 lb (2.70 kg).
- CPU2-3030ND: 2.90 lb (1.32 kg).

TEMPERATURE AND HUMIDITY RANGES

This system meets NFPA requirements for operation at 0 – 49°C/32 – 120°F and at a relative humidity 93% ± 2% RH (noncondensing) at 32°C ± 2°C (90°F ± 3°F). However, the useful life of the system's standby batteries and the electronic components may be adversely affected by extreme temperature ranges and humidity. Therefore, it is recommended that this system and its peripherals be installed in an environment with a normal room temperature of 15 – 27°C/60 – 80°F.

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:** S635.
- **ULC Listed:** S527-11.
- **MEA:** 232-06-E.
- **Fire Dept. of New York:** COA#6211.
- **CSFM:** 7165-0028:0224 (Commercial).
- **FM Approved.**
- **FM6320 Approved.** Class 6320 for Gas Detection.
- **City of Chicago.**
- **City of Denver.**
- **Singapore Productivity and Standards Board (PSB).**
- **CCCF listed.**
- **Fire Services Department (Hong Kong).**

Marine Applications: Marine approved systems must be configured using components itemized in this document. (See Main System Components, in "Product Line Information.") Specific connections and requirements for those components are described in the installation document, PN 54756. When these requirements are followed, systems are approved by the following agencies:

- **US Coast Guard** 161.002/55/0 (Standard 46 CFR and 161.002).
- **Lloyd's Register** 11/600013 (ENV 3 category).
- **American Bureau of Shipping** (ABS) Type Approval.

NOTE: For information on marine applications, see DN-60688.

STANDARDS

The NFS2-3030 complies with the following UL Standards and NFPA 72, International Building Code (IBC), and California Building Code (CBC) Fire Alarm Systems requirements:

- **UL 864** (Fire).
- **UL 1076** (Burglary).
- **UL 2572** (Mass Notification Systems). (NFS2-3030 version 20 or higher)
- **ULC-S527-11** Standard for the Installation of Fire Alarm Systems.
- **LOCAL** (Automatic, Manual, Waterflow and Sprinkler Supervisory).
- **AUXILIARY** (Automatic, Manual and Waterflow) (requires TM-4).
- **REMOTE STATION** (Automatic, Manual, Waterflow and Sprinkler Supervisory) (requires TM-4).
- **PROPRIETARY** (Automatic, Manual, Waterflow and Sprinkler Supervisory). *Not applicable for FM.*
- **EMERGENCY VOICE/ALARM.**
- **OT, PSDN** (Other Technologies, Packet-switched Data Network).
- **IBC 2012, IBC 2009, IBC 2006, IBC 2003, IBC 2000** (Seismic).
- **CBC 2007** (Seismic).

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OSY2 and OSY2A

Outside Screw and Yoke (OS&Y) Supervisory Switches



by Honeywell

Conventional Initiating Devices

General

System Sensor's OSY2 and OSY2A supervisory switches monitor the open position of an Outside Screw and Yoke (OS&Y) type gate valve.

Robust construction. The OSY2(A) consists of a rugged housing, intended for indoor and outdoor use. When installed with the actuator in the vertical position, the OSY2(A) is NEMA 3R rated per UL.

Application flexibility. The OSY2(A) features a user-friendly mounting bracket and adjustable shaft to permit mounting to most OS&Y valves, ranging in size from 1" to 12" (2.54 to 30.48 cm). Its right-angle design and wide bracket span provides maximum clearance for valve components, accommodating troublesome valves. Removing OSY2(A)'s gate valve bracket allows the unit to monitor side-bracket-style pressure reducing valves.

Simplified operation. Installation is made easier with the OSY2(A)'s single-side conduit entrance. By providing a direct conduit pathway to the electrical source, right angle fittings are not required. Installation is further simplified by the OSY2(A)'s adjustable-length actuator, which eliminates the need for cutting the shaft.

Reliable performance. The OSY2(A) is equipped with tamper-resistant cover screws to prevent unauthorized entry. Inside, two sets of SPDT (Form-C) synchronized switches are enclosed in a durable terminal block to assure reliable performance.

Features

- NEMA 3R rated enclosure.
- User-friendly mounting bracket fits newer valve yokes.
- Single-side conduit entry does not require right-angle fittings.
- Adjustable length actuator eliminates the need for cutting the shaft.
- Accommodates up to 12 AWG (3.31 mm²) wire.
- Three-position switch monitors vandal and valve-close signals.
- Two SPDT contacts are enclosed in a durable terminal block for added strength.
- 100% synchronization activates both alarm panel and local bell simultaneously.

Specifications

Contact ratings: two sets of SPDT (Form-C). 10.0 A @ 125/250 VAC, 2.5 A @ 6/12/24 VDC.

Dimensions: overall switch: 5.75" H x 3.5" W x 3.25" D (14.6 cm x 8.9 cm x 8.2 cm). **Bracket span dimensions:** 2.25" H x 6.75" W x 1.0" D (5.7 cm x 17.1 cm x 8.2 cm). **Maximum stem extension:** 2.625" (6.7 cm).

Mounting: Acceptable OSY2(A) mounting positions: actuator vertical (pointing DOWN), or actuator horizontal. **The following mounting position is NOT acceptable:** actuator vertical (pointing UP).

Conduit entrances: one single side open for 1/2" conduit.

Operating temperature range: 32°F to 120°F (0°C to 49°C).



60139ph1.png

NOTE: The OSY2(A) will operate from -40°F to 120°F (-40°C to 49°C); however, UL does not test control valve supervisory switches below 32°F (0°C).

Enclosure rating: UL indoor/outdoor; NEMA 3R when mounted with the actuator vertical.

Cover tamper switch: standard with ULC model OSY2A; optional for UL model, P/N 546-7000.

Shipping weight: 2.8 lbs. (1.3 kg).

Service use:

- Automatic Sprinkler: NFPA 13.
- One or Two Family Dwelling: NFPA 13D.
- Residential Occupancies up to 4 stories: NFPA 13R.
- National Fire Alarm Code: NFPA 72.

U.S. Patent Nos.: 5,478,038; 5,213,205

Engineering Specifications

Model shall be model number OSY2(A) supervisory switch as manufactured by System Sensor. OSY2(A) shall be installed on each valve as designated on the drawings and/or as specified herein. Switches shall be mounted so as not to interfere with the normal operation of the valve and shall be adjusted to operate within two revolutions of the valve control or when the stem has moved no more than one-fifth of the distance from its normal position. The mechanism shall be contained in a weatherproof die-cast metal housing, which shall provide a side entrance for 1/2" conduit and incorporate the necessary facilities for attachment to the valve. A grounding provision is provided. The switch assembly shall include two switches each with a rated capacity of 10.0 A @ 125/250 VAC and 2.5 A @ 24 VDC. The cover shall contain tamper-resistant screws for which a security wrench will be provided with each switch. OSY2(A) shall be Underwriters Laboratories listed for indoor or outdoor use. The OSY2(A) shall be Factory Mutual, CSFM, and MEA approved.

Agency Listings and Approvals

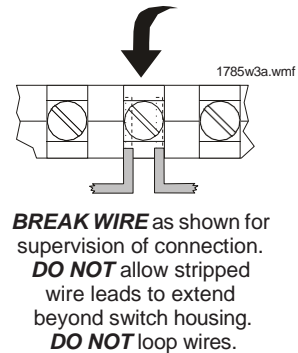
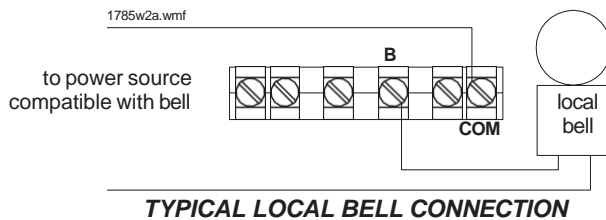
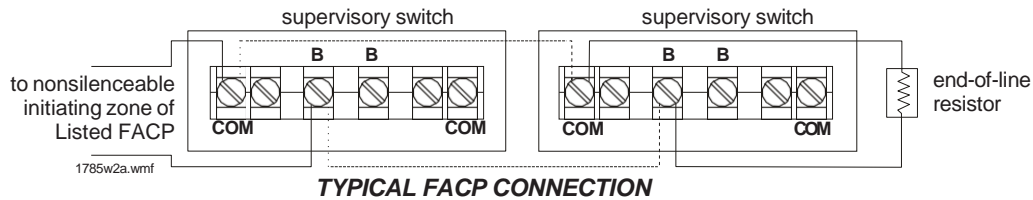
The listings and approvals below apply to the OSY2 or OSY2A supervisory switches. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL** Listed: file S739.
- **ULC** Listed: file S739 (*model OSY2A*).
- **CSFM** approved: file 7770-1653:118.
- **FM** approved.
- **MEA** approved: file 167-93-E.

Product Line Information

- OSY2:** Outside Screw and Yoke (OS&Y) supervisory switch.
- OSY2A:** ULC model, Outside Screw and Yoke (OS&Y) supervisory switch.
- 546-7000:** Cover tamper switch kit.
- WFDW:** Replacement tamper proof wrench for cover.

Wiring Diagrams



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FSL-751DNR(A)

High Sensitivity Duct Smoke Detector



by Honeywell

Intelligent Devices

General

The FSL-751DNR(A) high sensitivity duct smoke detector provides dependable performance for management of fans, blowers, and air conditioning systems by using an intelligent laser smoke sensor residing in an efficient housing design that samples air currents passing through a duct. The twist-in, twist-out FSL-751DNR high sensitivity laser smoke detector head allows easy removal for quick cleaning, maintenance, and replacement without removing the duct housing. The laser detector achieves sensitivities as low 0.02 percent-per-foot by using a laser diode instead of a standard LED light source in the sensing chamber. Many sensitive areas cannot tolerate even small amounts of smoke. This FSL-751DNR detector is designed to protect valuable assets and operations where systems must remain online at all times.

Some ideal applications for the FSL-751DNR high sensitivity duct smoke detector include:

- Telecommunications switching facilities
- Cellular telephone infrastructure
- Integrated circuit fabrication facilities
- Computer rooms
- Clean rooms

NFPA 76, Section 8.5.3.1.2.3 *Very Early Warning Fire Protection*, calls for sensors to be mounted at the return air location for a space in the following instances.

A. "Where stand-alone packed HVAC units are installed, sensors or ports shall be installed where return air is brought back to the unit."

B. "Sensors or ports shall be installed such that each covers no greater than 0.4 m² (4 ft²) of the return air opening."

The FSL-751DNR high sensitivity duct smoke detector is designed to satisfy NFPA 76 for Very Early Warning Fire Protection.

NOTE: Unless otherwise specified, the term FSL-751DNR refers to both the FSL-751DNR and ULC-listed FSL-751DNR(A).

Specifications

PHYSICAL SPECIFICATIONS

Size:

- **Rectangular:** 14.38 in (37 cm) Length; 5 in (12.7 cm) Width; 2.5 in (6.6 cm) Depth
- **Square:** 7.75 in (19.7 cm) Length; 9 in (22.9 cm) Width ; 2.5 in (6.35 cm) Depth

Shipping Weight: 2.0 lbs (0.9 kg)

Operating Temperature Range: 32°F to 100°F (0°C to 38°C)

Storage Temperature Range: -22°F to 100°F (-30°C to 38°C)

Operating Humidity Range: 10% to 93% relative humidity

Air Duct Velocity: 300 to 4000 ft/min. (0.5 to 20.32 m/sec.)

ELECTRICAL SPECIFICATIONS

Voltage: 24 VDC

Power Supply Voltage: 15 to 32 VDC

Current Requirements (using no accessories)



60333covdnr.jpg

- **Max. Standby Current:** 230 μ A @ 24 VDC (without communication); 330 μ A @ 24 VDC (one communication every 5 sec. with LED enabled)
- **Max. Alarm Current:** 6. mA (LED on)

Features

- Temperature Range of 32°F to 100°F (0°C to 38°C)
- Air Velocity Rating from 300 to 4,000 fpm
- 24 VDC operation
- Versatile mounting options: Easy and quick mounting to round or rectangular ducts from 1 ft to 12 ft (0.3 m to 3.7 m) wide
- Patented sampling tube installs from front or back of the detector with no tools required.
- New Cover-tamper signal
- Increased wiring space with a newly added 3/4-inch conduit
- Clear cover for convenient visual inspection
- Remote testing capability (requires auxiliary 24VDC power)
- 3 year warranty

Architectural/Engineering Specifications

The high sensitivity air duct smoke detector shall be a Notifier model FSL-751DNR high sensitivity duct smoke detector. The detector shall be UL Listed per UL 268A, Standard for Smoke Detectors for Duct Applications, specifically for use in air handling systems. The detector shall operate at air velocities from 300 feet per minute to 4000 feet per minute. The detector shall have an operating temperature of 32°F to 100°F (0°C to 38°C). The detector housing shall be equipped with an integral mounting base capable of accommodating laser smoke detector heads; it shall fit both square and rectangular footprints; it shall be capable of local testing via magnetic switch or remote testing using the RTS151KEY or RTS151 Remote Test Station. The duct detector housing shall incorporate an airtight smoke chamber in compliance with UL Standard 268A. The housing shall be capable of mounting to rectangular or round ducts up to 12 feet wide without adapter brackets. Sampling tubes shall be installed after the housing is mounted to the duct by passing through the duct housing. Terminal connections shall be of the strip and clamp method suitable for 12 to 18 AWG wiring.

Agency Listings and Approvals

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:** S1115
- **ULC Listed:** S911
- **CSFM:** 3240-0028:0205

Ordering Information

NOTE: (A) suffix denotes Canadian product.

FSL-751DNR: High sensitivity duct smoke detector. (Replaces FSL-751D)

FSL-751DNRA: ULC-listed high sensitivity duct smoke detector. (Replaces FSL-751D)

FSL-751(A): Replacement intelligent laser sensor head. (For ULC-listed model, order "A" version.)

ACCESSORIES

DST-1: Metal sampling tube duct widths up to 1 ft (0.3 m).

DST-1.5: Metal sampling tube duct widths 1 ft to 2 ft (0.3 m to 0.6 m)

DST-3: Metal sampling tube duct widths 2 ft to 4 ft (0.6 m to 2.4 m)

DST-5: Metal sampling tube duct widths 4 ft to 8 ft (1.2 m to 2.4 m)

DST-10: Metal sampling tube duct widths 8 ft to 12 ft (2.4 m to 3.7 m)

DCOIL: Remote Test Coil (included)

ETX: Metal exhaust tube duct width 1ft (0.3 m)

P48-21-00: End cap for sampling tubes, metal.

RTS151(A): Remote test station.

RTS151KEY(A): Remote test station with key.

RA100Z(A): Remote annunciator alarm LED.

M02-04-00: Test magnet.

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HPFF12(E) and HPFF12CM(E)

12 Amp and 24-Volt Power Supplies



Power Supplies

Description

The Honeywell HPFF12(E) and HPFF12CM(E) are Notification Appliance Circuit (NAC) Expander Power Supplies designed to extend the power capabilities of existing NACs and provide power for auxiliary devices. The HPFF12 and HPFF12CM connects to any 12 or 24V Fire Alarm Control Panel (FACP) or operates stand-alone.

They provide regulated and filtered 24VDC power to four NAC's and an auxiliary output. The NAC outputs are rated at 3.0 amps each and the auxiliary output is rated at 2.0 amps (this output is continuously supplied, even in alarm, and therefore must be taken into account for power supply loading and battery size calculations). The combined output cannot exceed 12.0 amps.

The HPFF12 and HPFF12CM provide independent output circuit supervision so in the event of a NAC fault they can notify the attached FACP. In addition they have a trouble memory feature that displays past troubles (by NAC) for rapid diagnostics. Synchronization is built in for five appliance brands.

The HPFF12 and HPFF12CM have two fully independent supervised initiating circuits that can be used for synchronized strobes and coded horns. Their NAC outputs may be configured as any of the following:

- four Class B (Style Y)
- two Class A (Style Z)
- two Class B and one Class A
- four Class A with the optional HPP31076 Class A adapter

These power supplies contain an internal Battery charger capable of charging up to 26.0 amp-hour (AH) batteries.

The HPFF12 is mounted in a lockable wall cabinet that can accommodate up to two 18AH batteries. The HPFF12CM is designed to mount in Notifier's equipment series enclosure (order separately). Each HPFF12CM can accommodate two 12AH batteries.

One of the most challenging aspects of a retrofit application is locating the existing End-of-Line (EOL) resistor. In these applications that have EOL values other than the 3.9k normally used with the HPFF12, a single resistor matching the existing EOL can be used as a reference for all the outputs. This feature speeds installation and system checkout because the actual EOL does not need to be located and changed in the circuit. The reference resistor must be within the range of 1.9k to 25k.

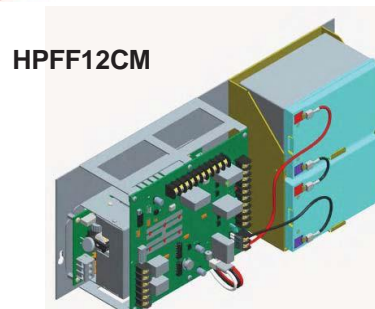
NOTE: 4 separate programming resistors for the HPFF12 are provided in the hardware kit shipped with each HPFF12(E) and HPFF12CM(E). They are 3.9K (5 of these are provided, need only 1 for programming), 2.2K (1 each), 4.7K (1 each) and 10K (1 each)

Features

- Four (4) power limited supervised notification application circuits (NAC's) capable of supplying +24VDC at 3.0 amp maximum each.
- NAC output circuits may be configured as any of the following:
 - Four Class B (Style Y).
 - Two Class B & one Class A.
 - Two Class A (Style Z).



HPFF12



HPFF12CM

- Four Class A (requires the HPP31076 Class A adapter).
- Four field-programmable operational modes:
 - Pass-through.
 - Temporal generator.
 - Sync generator.
 - Pass-through Filtered.
- Temporal coding and sync protocols compatible with the following notification appliance brands:
 - System Sensor.
 - Faraday.
 - Amseco.
 - Cooper-Wheelock.
 - Gentex.
- Protocol pass-through for synchronizing large systems.
- Two fully independent supervised input/output control circuits.
- Redundant activation operation for survivability.
- Supports FACP's Selectable Silence ability.
- 2.0 amp auxiliary continuously supplied output.
- Eight status LEDs.
- Supervised AC input, battery voltage, auxiliary output, charger, and earth ground faults.
- Trouble indication for supervision of the following:
 - NAC circuits.
 - Auxiliary output.
 - AC input.
 - Battery charger voltage.
 - Earth ground faults.
- Optional two-hour delay for AC loss.
- Separate Trouble and AC Fail Form-C relay contacts.

- The Trouble Form-C relay contacts selectable for immediate or a 2 hour delay with AC failure.
- 26 AH battery charger capability:
 - HPFF12(E) supports two 12V 18AH batteries
 - HPFF12CM(E) supports two 12V 12AH batteries per unit.
- NAC Overload protection and indication.
- Provision for mounting single or 6 circuit addressable control or relay modules inside the enclosure. (Use mounting kit PN 90475.)
- Standard Honeywell key and lock can be replaced with the NOTIFIER key and lock.

Specifications

Primary Input Power: 120VAC, 60Hz, 5.0A standard; 240VAC, 50Hz, 2.80A on units with E suffix.

Secondary Power: 24 volt operation: two 7-26 AH batteries.

Battery Charging Capacity: Up to 26 AH batteries.

HPFF12 Cabinet: Holds up to two 18AH batteries.

HPFF12CM: Holds up to two 12AH batteries.

Total Output Current: 12.0A max. **Standby Current:** 0.075 A.

Auxiliary Power Output: 2.0A under all conditions.

NAC Output Ratings: 24VDC fully regulated, 3.0A max per circuit (12.0A total).

End-of-Line Resistor Range: 1.9K to 25k ohm, ½ watt. Product ships with 4 separate programming resistors. They are 3.9K (5 each - only need one for programming), 2.2K (1 each), 4.7K (1 each) and 10K (1 each)

Common Trouble/ Relay Fail Relay: 2.0A at 30VDC.

Input Control Circuits: compatible with 12 and 24 VDC control panel NACs.

Input Control Current (alarm): 5.68 mA @ 12 VDC, 12.28 mA @ 24 VDC.

Temperature Rating: 32°F to 120°F (0°C to 49°C).

Relative Humidity: 10% to 93% non-condensing.

Cabinet Dimensions:

- **HPFF12 Cabinet:** 16.65" W x 19.0" H x 5.2" D (42.29 cm W x 48.26 cm H x 13.23 cm D).
- **Large equipment enclosure:**
 - **EQBB-B4:** 24" W x 28.5" H x 5.16" D (60.96 cm W x 72.39 cm H x 13.1 cm D).
 - **EQBB-C4:** 24" W x 37.13" H x 5.16" D (60.96 cm W x 71.36 cm H x 13.1 cm D).
 - **EQBB-D4:** 24" W x 45.75" H x 5.16" D (60.96 cm W x 116.21 cm H x 13.1 cm D).

Product Line Information

HPFF12: 12.0A fire rated power supply. Unit includes red enclosure, battery cable and installation instructions. 120VAC/60Hz.

HPFF12E: 240VAC/50Hz version of HPFF12.

HPFF12CM: 12.0A fire rated power supply (chassis mounted). Unit includes mounting hardware, battery cable and instructions

for installation in large equipment enclosure. 120VAC/60Hz.

HPFF12CME: 240VAC/50Hz version of HPFF12CM.

HPP31076: Class A (Style Z) NAC Adaptor. Increase Class A circuits from 2 to 4.

XP6-C: Six-circuit supervised addressable control module activated through FACP programming on a select basis to control power supply activation or output.

FCM-1: Supervised addressable control module activated through FACP programming to activate power supply.

90474: Mounting kit; required to attach an addressable module onto the control circuit board (included with supply).

BAT Series: Batteries HPFF12CM(E) utilizes two 12 volt, 7 to 26AH batteries.

See DN-6857. See DN-6875 for details. **EQ Series Enclosures:** For mounting HPFF12CM power supplies, consists of a backbox and locking door. Black. Three sizes available. Ordered separately. See DN-60229.

- **EQBB-B4:** Backbox for mounting one HPFF12CM. Requires EQDR-B4 door.
- **EQBB-C4:** Backbox for mounting one HPFF12CM. Requires EQDR-C4 door.
- **EQBB-D4:** Backbox for mounting one HPFF12CM. Requires EQDR-D4 door.

17045KIT: Notifier key and lock set.

Listings and Approvals

Listings and approvals below apply to all. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. UL 864 9th Edition.

- **UL Listed:** S24562
- Seismic Certification of Non-Structural Electrical Components and Systems
- **FM Approved**
- **CSFM:** 7315-1637:0102

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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.



Made in the U.S. A.

For more information, contact Notifier. Phone: (203) 484-7161, FAX: (203) 484-7118.
www.notifier.com

Indoor Selectable-Output Horns, Strobes, and Horn Strobes for Wall Applications



Audio/Visual Devices

General

The L-Series offers the most versatile and easy-to-use line of horns, strobes, and horn strobes in the industry with lower current draws and modern aesthetics. With white and red plastic housings, standard and small footprint devices, and plain, FIRE-printed devices, L-Series can meet virtually any application requirement.

The L-Series product line of wall-mount horns, strobes, and horn strobes include a variety of features that increase their application versatility while simplifying installation. All devices feature plug-in designs with minimal intrusion into the back box, making installations fast and foolproof while virtually eliminating costly and time-consuming ground faults.

To further simplify installation and protect devices from construction damage, L-Series utilizes a universal mounting plate for all standard and compact models with an onboard shorting spring, so installers can test wiring continuity before the device is installed.

Installers can also easily adapt devices to suit a wide range of application requirements using field-selectable candela settings, automatic selection of 12- or 24-volt operation, and a rotary switch for horn tones with two volume selections.

Features

- Updated modern aesthetics.
- Small profile devices for Horns and Horn Strobes.
- Plug-in design with minimal intrusion into the back box.
- Tamper-resistant construction.
- Automatic selection of 12- or 24-volt operation at 15 and 30 candela.
- Field-selectable candela settings on wall units: 15, 30, 75, 95, 110, 135, and 185.
- Horn rated at 88+ dBA at 16 volts.
- Rotary switch for horn tone and two volume selections.
- Universal mounting plate for all standard and all compact wall units.
- Mounting plate shorting spring checks wiring continuity before device installation.
- Electrically Compatible with legacy SpectrAlert® and SpectrAlert Advance devices.
- Compatible with MDL3 sync module.
- Listed for wall mounting only.

Architectural/Engineering Specifications

General: L-Series standard horns, strobes, and horn strobes shall mount to a standard 2" x 4" x 1 7/8" back box, 4" x 4" x 1 1/2" back box, 4" octagon back box, or double-gang back box. L-Series compact products shall mount to a single-gang 2" x 4" x 1 7/8" back box. A universal mounting plate shall be used for mounting ceiling and wall products for all standard-size models and a separate universal mounting plate shall be used for mounting compact wall models. The notification appliance circuit wiring shall terminate at the universal mounting plate. Also, L-Series products, when used with the Sync•Circuit™ Module accessory, shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal



P2RL



P2GWL



SGWL



HWL

12 or 24 volts. When used with the Sync•Circuit Module, 12-volt-rated notification appliance circuit outputs shall operate between 8.5 and 17.5 volts; 24-volt-rated c appliance circuit outputs shall operate between 16.5 and 33 volts. Indoor L-Series products shall operate between 32 and 120 degrees Fahrenheit from a regulated DC or full-wave rectified unaltered power supply. Strobes and horn strobes shall have field-selectable candela settings including 15, 30, 75, 95, 110, 135, and 185.

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

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

Synchronization Module. The module shall be a Sync•Circuit model MDL3 listed to UL 464 and shall be approved for fire protective service. The module shall synchronize SpectrAlert strobes at 1 Hz and horns at temporal three. Also, while operating the strobes, the module shall silence the horns on horn strobe models over a single pair of wires. The module shall mount to a 4¹¹/₁₆" x 4¹¹/₁₆" x 2¹/₈" back box. The module shall also control two Style Y (class B) circuits or one Style Z (class A) circuit. The module shall synchronize multiple zones. Daisy chaining two or more synchronization modules together will synchronize all the zones they control. The module shall not operate on a coded power supply.

PHYSICAL/ELECTRICAL SPECIFICATIONS

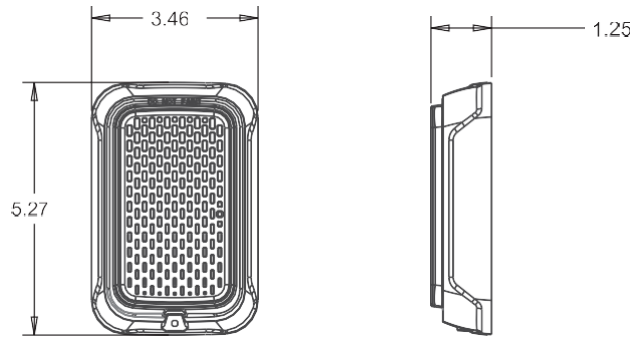
- **Standard Operating Temperature:** 32°F to 120°F (0°C to 49°C).
- **Humidity Range:** 10 to 93% non-condensing.
- **Strobe Flash Rate:** 1 flash per second.
- **Nominal Voltage:** Regulated 12 DC or regulated 24 DC/ FWR¹ (full wave rectified).
- **Operating Voltage Range²:** 8 to 17.5 V (12 V nominal) or 16 to 33 V (24 V nominal).
- **Operating Voltage Range:** MDL3 Sync Module 8.5 to 17.5 V (12 V nominal) or 16.5 to 33 V (24 V nominal).
- **Input Terminal Wire Gauge:** 12 to 18 AWG.
- **Wall-Mount Dimensions (including lens):** 5.6" L x 4.7" W x 1.25" D (143 mm L x 119 mm W x 32 mm D).
- **Compact Wall-Mount Dimensions (including lens):** 5.26" L x 3.46" W x 1.93" D (133 mm L x 88 mm W x 49 mm D).
- **Horn Dimensions:** 5.6" L x 4.7" W x 1.25" D (143 mm L x 119 mm W x 32 mm D).
- **Compact Horn Dimensions:** 5.25" L x 3.45" W x 1.25" D (133mm L x 88mm W x 32mm D).

NOTE:

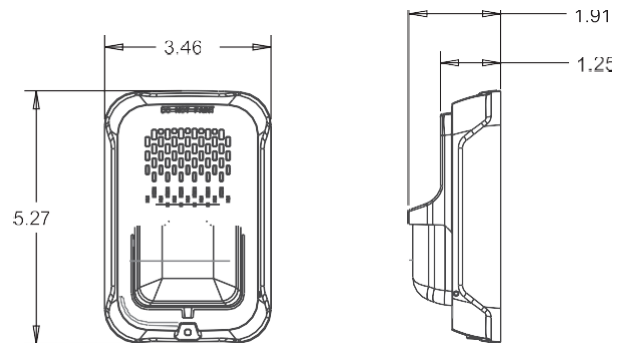
1. Full Wave Rectified (FWR) voltage is a non-regulated, time-varying power source that is used on some power supply and panel outputs.
2. P, S, PC, and SC products will operate at 12 V nominal only for 15 cd and 30 cd.

L-Series Drawings

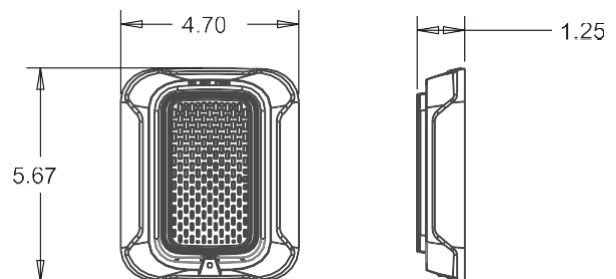
Compact Horn



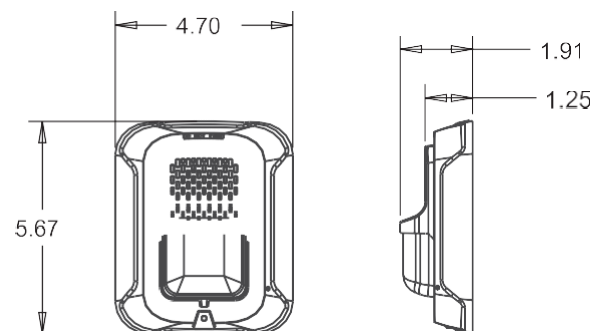
Compact Combo



Horn



Combo



UL Current Draw Data

UL MAX. STROBE CURRENT DRAW (MA RMS)

Candela	8-17.5 Volts	16-33 Volts	
	DC	DC	FWR
15	88	43	60
30	143	63	83
75	N/A	107	136
95	N/A	121	155
110	N/A	148	179
135	N/A	172	209
185	N/A	222	257

UL MAX. HORN CURRENT DRAW (MA RMS)

The 3.1k is the sound of the mini-horns. The EM (which stands for Electro-mechanical) is the sound of the SpectrAlert Advance line which uses an algorithm that hops frequencies between 2Hz and 4Hz.

Sound Pattern	dB	8-17.5 Volts	16-33 Volts	
		DC	DC	FWR
Temporal	High	39	44	54
Temporal	Low	28	32	54
Non-Temporal	High	43	47	54
Non-Temporal	Low	29	32	54
3.1 KHz Temporal	High	39	41	54
3.1 KHz Temporal	Low	29	32	54
3.1 KHz Non-Temporal	High	42	43	54
3.1 KHz Non-Temporal	Low	28	29	54
Coded	High	43	47	54
3.1 KHz Coded	High	42	43	54

UL MAX. CURRENT DRAW (MA RMS), 2-WIRE HORN STROBE, CANDELA RANGE (15-115 CD)

The 3.1k is the sound of the mini-horns. The EM (which stands for Electro-mechanical) is the sound of the SpectrAlert Advance line which uses an algorithm that hops frequencies between 2Hz and 4Hz.

	DC Input: 8-17.5 Volts		DC Input: 16-33 Volts							FWR Input: 16 FWR						
	15 cd	30 cd	15 cd	30 cd	75 cd	95 cd	110 cd	135 cd	185 cd	15 cd	30 cd	75 cd	95 cd	110 cd	135 cd	185 cd
Temporal High	98	158	54	74	121	142	162	196	245	83	107	156	177	198	234	287
Temporal Low	93	154	44	65	111	133	157	184	235	68	91	145	165	185	223	271
Non-Temporal High	106	166	73	94	139	160	182	211	262	111	135	185	207	230	264	316
Non-Temporal Low	93	156	51	71	119	139	162	190	239	79	104	157	175	197	235	283
3.1K Temporal High	93	156	53	73	119	140	164	190	242	81	105	155	177	196	234	284
3.1K Temporal Low	91	154	45	66	112	133	160	185	235	68	90	145	166	186	222	276
3.1K Non-Temporal High	99	162	69	90	135	157	175	208	261	104	131	177	204	230	264	326
3.1K Non-Temporal Low	93	156	52	72	119	138	162	192	242	77	102	156	177	199	234	291

HORN TONES AND SOUND OUTPUT DATA: HORN AND HORN STROBE OUTPUT (DBA)

The 3.1k is the sound of the mini-horns. The EM (which stands for Electro-mechanical) is the sound of the SpectrAlert Advance line which uses an algorithm that hops frequencies between 2Hz and 4Hz.

In the coded positions, temporal coding must be provided by the NAC. If the NAC voltage is held constant, the horn output will remain constantly on.

Pos.	Sound Pattern	dB	8-17.5 Volts	16-33 Volts	
			DC	DC	FWR
1	Temporal	High	84	89	89
2	Temporal	Low	75	83	83
3	Non-Temporal	High	85	90	90
4	Non-Temporal	Low	76	84	84
5	3.1 KHz Temporal	High	83	88	88
6	3.1 KHz Temporal	Low	76	82	82
7	3.1 KHz Non-Temporal	High	84	89	89
8	3.1 KHz Non-Temporal	Low	77	83	83
9†	Coded	High	85	90	90
10†	3.1 KHz Coded	High	84	89	89

†Settings 9 and 10 are not available on the 2-wire horn strobes.

Agency Listings and Approvals

The listings and approvals below apply to L-series devices. 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/ULC-Listed**
 - S4011 Wall Horn Strobes
 - S5512 Wall Strobes
 - S5512 Wall Horns
 - S5512 Strobe-only ALERT devices
- **FM Approved** (All except ALERT models)
- **CSFM Listed:** 7135-1653:0503 (Wall Horns and Wall Horn Strobes), 7125-1653:0504 (Wall Strobes)

Product Line Information

WALL HORN STROBES

P2WL(A)(-E)(-F), P2RL(A)(-E)(-F). 2-Wire, Horn Strobe (White, Red).

P2GWL(A)(-E)(-F), P2GRL(A)(-E)(-F). 2-Wire, Compact Horn Strobe (White, Red).

P2WL(A)-P, P2RL(A)-P. 2-Wire, Horn Strobe, Plain (White, Red).

P2WL-SP, P2RL-SP. 2-Wire, Horn Strobe, FUEGO (White, Red).

WALL STROBES

SWL(A)(-E)(-F), SRL(A)(-E)(-F). Strobe, Red (White, Red).

SGWL(A)(-E)(-F), SGRL(A)(-E)(-F). Compact Strobe (White, Red).

SWL(A)-P, SRL(A)-P. Strobe, Plain (White, Red).

SRL-SP. Strobe, FUEGO (Red).

SWL-CLR-ALERT. Strobe, ALERT (White).

SWL-ALERT. Strobe, Wall, Amber Lens, ALERT (White).

HORNS

HWL(A), HRL(A). Horn (White, Red).

HGWL(A), HGRL(A). Compact Horn (White, Red).

ACCESSORIES

TR-2W, TR-2. Universal Wall Trim Ring (White, Red).

SBBWL, SBBRL. Wall Surface Mount Back Box (White, Red).

SBBGWL, SBBGRL. Compact Wall Surface Mount Back Box (White, Red).

NOTE: "A" suffix indicates ULC-Listed model. ULC-listed devices include required French labeling. See Agency Listings for listing details.

NOTE: "A" suffix indicates ULC-listed models, ULC models have FIRE/FEU marking on cover.

NOTE: ULC-listed models add "-E" suffix for English only "FIRE" marking on cover.

NOTE: ULC-listed models add "-F" suffix for French only "FEU" marking on cover.

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www.notifier.com

FSP-951 Series Addressable Photoelectric Smoke Detectors

The NOTIFIER® FSP-951 Series intelligent plug-in smoke detectors are designed for both performance and aesthetics, and are direct replacements for the FSP-851 Series. A new modern, sleek, contemporary design and enhanced optical sensing chamber is engineered to sense smoke produced by a wide range of combustion sources in accordance with more stringent code standards.

The FSP-951 Series detector sensitivity can be programmed in the control panel software. Sensitivity is continuously monitored and reported to the panel. Point ID capability allows each detector's address to be set with rotary, decimal address switches, providing exact detector location for selective maintenance when chamber contamination reaches an unacceptable level. Dual electronic thermistors add 135°F (57°C) fixed temperature thermal sensing on the FSP-951T. The FSP-951R is a remote test capable detector for use with DNR Series duct detector housings. FSP-951 series detectors are available for both FlashScan® and CLIP applications as designated.

Features

SLC LOOP:

- Two-wire SLC loop connection
- Unit uses base for wiring
- Compatible with FlashScan® and CLIP protocol systems
- Stable communication technique with noise immunity

ADDRESSING:

- Addressable by device
- Rotary, decimal addressing
(Refer to the *NOTIFIER panel manuals* for device capacity.)

ARCHITECTURE:

- Sleek, low-profile, stylish design
- Unique single-source design to respond quickly and dependably to a broad range of fires
- Integral communications and built-in device-type identification
- Built-in tamper resistant feature
- Remote test feature from the panel
- Walk test with address display (an address on 121 will blink the detector LED: 12-[pause]-1 (*FlashScan systems only*))
- Built-in functional test switch activated by external magnet
- Removable cover and insect-resistant screen for simple field cleaning
- Expanded color options

OPERATION:

- Designed to meet UL 268 7th Edition
- Factory preset at 1.5% nominal sensitivity for panel alarm threshold level
- LED "blinks" when the unit is polled (communicating with the fire panel) and latches in alarm.
- Low standby current

MECHANICALS:

- Sealed against back pressure
- SEMS screws for wiring of the separate base
- Designed for direct-surface or electrical-box mounting
- Plugs into separate base for ease of installation and maintenance



- Separate base allows interchange of photoelectric, ionization and thermal sensors

OPTIONS:

- Optional relay, isolator, and sounder bases

Installation

FSP-951 Series plug-in intelligent smoke detectors use a detach-able base to simplify installation, service and maintenance. Installation instructions are shipped with each detector.

Mount detector 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 *DN-60054*.

NOTE: 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 only. When using relay or sounder bases, consult the ISO-X(A) installation sheet 156-1380 for device limitations between isolator modules and isolator bases.

Construction

These detectors are constructed of fire-resistant plastic. The FSP-951 Series plug-in intelligent smoke detectors are designed to commercial standards and offer an attractive appearance.

Operation

Each FSP-951 Series detector uses one of the panel's addresses (total limit is panel dependent) on the NOTIFIER Signaling Line Circuit (SLC). It responds to regular polls from the control panel and reports its type and the status. If it receives a test command from the panel (or a local magnet test), it stimulates its electronics and reports an alarm. It blinks its LEDs when polled and turns the LEDs on when commanded by the panel. The FSP-951 Series offers features and performance that represent the latest in smoke detector technology.

Product Line Information

NOTE: “-IV” suffix indicates CLIP and FlashScan device.

FSP-951: White, low-profile intelligent photoelectric sensor, FlashScan only

FSP-951A: Same as FSP-951 but with ULC listing

FSP-951-IV: Ivory, low-profile intelligent photoelectric sensor

FSP-951A-IV: Same as FSP-951-IV but with ULC listing

FSP-951T: White, same as FSP-951 but includes a built-in 135°F (57°C) fixed-temperature thermal device, FlashScan only

FSP-951TA: Same as FSP-951T but with ULC listing

FSP-951T-IV: Ivory, same as FSP-951T but includes a built-in 135°F (57°C) fixed-temperature thermal device

FSP-951TA-IV: Same as FSP-951T-IV but with ULC listing

FSP-951R: White, low-profile intelligent photoelectric sensor, remote test capable, for use with DNR/DNRW, FlashScan only

FSP-951RA: Same as FSP-951R but with ULC listing, for use with DNRA

FSP-951R-IV: Ivory, low-profile intelligent photoelectric sensor, remote test capable, for use with DNR/DNRW

FSP-951RA-IV: Same as FSP-951R-IV but with ULC listing, for use with DNRA

INTELLIGENT BASES

NOTE: For details on intelligent bases, see DN-60981.

B300-6: White, 6” base, standard flanged low-profile mounting base (CSFM: 7300-1653:0109)

B300-6-IV: Ivory, 6” base, standard flanged low-profile mounting base (CSFM: 7300-1653:0109)

B300A-6: Same as B300-6, ULC listed

B300A-6-IV: Ivory, 6” standard flanged low-profile mounting base, ULC listed

B300-6-BP: Bulk pack of B300-6, package contains 10

B501-WHITE: White, 4” standard European flangeless mounting base. UL/ULC listed (CSFM: 7300-1653:0109)

B501-BL: Black, 4” standard European flangeless mounting base. UL/ULC listed (CSFM: 7300-1653:0109)

B501-IV: Ivory color, 4” standard European flangeless mounting base. UL/ULC listed (CSFM: 7300-1653:0109)

B501-WHITE-BP: Bulk pack of B501-WHITE contains 10

B224RB-WH: White, relay base (CSFM: 7300-1653:0216)

B224RB-IV: Ivory, relay base (CSFM: 7300-1653:0216)

B224RBA-WH: White, relay base, ULC listing

B224RBA-IV: Ivory, relay base, ULC listing

B224BI-WH: White, isolator detector base (CSFM: 7300-1653:0216)

B224BI-IV: Ivory isolator detector base (CSFM: 7300-1653:0216)

B224BIA-WH: White, isolator detector base, ULC listing

B224BIA-IV: Ivory isolator detector base, ULC listing

B200S-WH: White, Intelligent addressable 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. Uses FlashScan protocol. (CSFM: 7300-1653:0213)

B200S-IV: Ivory, Intelligent addressable 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. Uses FlashScan protocol. (CSFM: 7300-1653:0213)

B200SA-WH: Same as B200S-WH, ULC listing

B200SA-IV: Same as B200S-IV, ULC listing

B200SCOA-WH: White, Intelligent, programmable sounder base in English/French (required in Canada for ULC applications with CO Series detector applications)

B200SCOA-IV: Ivory Intelligent, programmable sounder base in English/French (required in Canada for ULC applications with CO Series detector applications, ULC listing)

B200S-LF-WH: White, Low Frequency Intelligent, programmable sounder base. Produces a fundamental frequency of 520 Hz +/- 10% with a square wave or its equivalent; designed to meet the NFPA 72 sleeping space requirement. (CSFM: 7300-1653:0238)

B200S-LF-IV: Ivory, Low Frequency Intelligent, programmable sounder base. Produces a fundamental frequency of 520 Hz +/- 10% with a square wave or its equivalent; designed to meet the NFPA 72 sleeping space requirement. (CSFM: 7300-1653:0238)

B200SR-WH: White, Intelligent sounder base capable of producing sound output with ANSI Temporal 3 or continuous tone. Intended for retrofit applications. (CSFM: 7300-1653:0213)

B200SR-IV: Ivory, Intelligent sounder base capable of producing sound output with ANSI Temporal 3 or continuous tone. Intended for retrofit applications. (CSFM: 7300-1653:0213)

B200SRA-WH: Same as B200SR-WH with, ULC listing

B200SRA-IV: Same as B200SR-IV in Ivory color, ULC listing

B200SR-LF-WH: White, Low Frequency Intelligent, programmable sounder base. Produces a fundamental frequency of 520 Hz +/- 10% with a square wave or its equivalent; designed to meet the NFPA 72 sleeping space requirement. Intended for retrofit applications. (CSFM: 7300-1653:0238)

B200SR-LF-IV: Ivory, Low Frequency Intelligent, programmable sounder base. Produces a fundamental frequency of 520 Hz +/- 10% with a square wave or its equivalent; designed to meet the NFPA 72 sleeping space requirement. Intended for retrofit applications. (CSFM: 7300-1653:0238)

MOUNTING KITS AND ACCESSORIES

TR300: White, replacement flange for B210LP(A) base

TR300-IV: Ivory, replacement flange for B210LP(A) base

RA100Z(A): Remote LED annunciator. 3-32 VDC. Mounts to a U.S. single-gang electrical box. For use with B501(A) and B300-6(A).

M02-04-00: Test magnet

M02-09-00: Test magnet with telescoping handle

CK300: Color Kit (includes cover and trim ring), white, 10-pack

CK300-IV: Color Kit (includes cover and trim ring), ivory, 10-pack

CK300-BL: Color Kit (includes cover and trim ring), black, 10-pack

Sensitivity:

- UL Applications: 0.5% to 4.0% per foot obscuration.
- ULC Applications: 0.5% to 3.5% per foot obscuration

Size: 2.0" (5.3 cm) high; base determines diameter

- **B300-6:** 6.1" (15.6 cm) diameter
- **B501:** 4" (10.2 cm) diameter

For a complete list of detector bases see DN-60981

Shipping weight: 3.4 oz. (95 g)

Operating temperature range:

- FSP-951: 32°F to 122°F (0°C to 50°C)
- FSP-951T Series: 32°F to 100°F (0°C to 38°C)
- FSP-951R Series installed in a DNR/DNRW, -4°F to 158°F (-20°C to 70°C)

UL/ULC Listed Velocity Range: 0-4000 ft/min. (1219.2 m/min.), suitable for installation in ducts

Relative humidity: 10% – 93% non-condensing

Thermal ratings: fixed-temperature set point 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.): 200µA @ 24 VDC (one communication every 5 seconds with LED enabled)

Max current: 4.5 mA @ 24 VDC ("ON")

DETECTOR SPACING AND APPLICATIONS

NOTIFIER recommends spacing detectors in compliance with NFPA 72. In low airflow applications with smooth ceiling, space detectors 30 feet (9.1m). For specific information regarding detector spacing, placement, and special applications refer to NFPA 72. A *System Smoke Detector Application Guide*, document A05-1003, is available at www.systemsensor.com.

Listings and Approvals

Listings and approvals below apply to the FSP-951 Series detectors. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- UL/ULC Listing: S1115
- FM Approved
- CSFM: 7272-0028:0503



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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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Country of Origin: Mexico

NOTIFIER

12 Clintonville Road
Northford, CT 06472
203.484.7161
www.notifier.com



FCO-951 Series Advanced Multi-Criteria Fire/CO Detector

General Description

The IntelliQuad® PLUS FCO-951-IV and FCO-951A-IV advanced multi-criteria fire/CO detector is a plug-in, addressable device that provides both fire and carbon monoxide (CO) detection. The detector combines four separate sensing elements in one unit to sense multiple components of a fire: smoke, CO, light/flame, and heat. This approach enables enhanced sensitivity to real fire with heightened immunity to nuisance particulates. For CO, the detector's electrochemical sensing cell creates a separate signal for life safety CO detection.

Multiple sensors and communication can greatly reduce nuisance alarms compared to single sensing methods. Sophisticated algorithms maximize the advantages of the sensor types creating our best detection strategy offering heightened immunity to nuisance particulate and enhanced sensitivity to real fire.

- Photoelectric sensors detect airborne particles associated with smoke.
- Thermal sensors detect heat and rate-of-rise (135°F fixed temperature threshold).
- Carbon Monoxide sensors detect this by-product of fire for accurate fire detection.
- Infrared sensors discern light patterns in the environment as an additional data point for alarm determination.

This ability to reject certain nuisance alarm triggers, such as theater smoke, supports the use of the IntelliQuad PLUS Series detector in applications where moderate to heavy nuisance conditions exist that might cause single sensing detectors to false alarm.

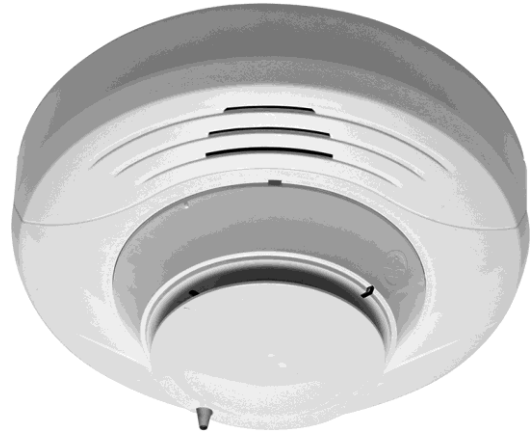
The IntelliQuad PLUS Series detector meets both UL 268 7th edition and UL 521 listing requirements for fire detection as well as the UL 2075 standard for system-connected life safety carbon monoxide detection. Canadian models meet listing requirements of CAN/ULC S529, CAN/ULC S530 and CSA 6.19-01.

Released through the incomplete burning of various fuels, CO is a colorless, odorless and deadly gas that is virtually impossible to detect with the human senses. Because the potential exists for dangerous levels of CO to accumulate in almost any building, legislation mandating the use of CO detection in commercial spaces continues to grow.

B200S series intelligent sounder bases (B200SCOA series in Canada) are recommended for use with FCO-951 Series IntelliQuad PLUS. These bases can generate either a Temp 3 pattern for fire or a Temp 4 pattern for CO alarm indication. The B200S/B200SCOA series bases recognize the System Sensor synchronization protocol, for use as a component of the general evacuation signal — along with other System Sensor horns, horn strobes, and chimes — when connected to a power supply or Fire Alarm Control Panel (FACP) output capable of generating the System Sensor synchronization pulses.

Features

- Unique ability to detect all four major elements of a fire
- Separate CO detection signal
- Highest nuisance alarm immunity
- Automatic drift compensation for smoke and CO sensors
- Uses only one address on the SLC
- RealTest® CO testing capability
- UL 268 7th edition, UL 521, and UL 2075 listed; CAN/ULC S529, CAN/ULC S530 and CSA 6.19-01 listed



FCO-951 Multi-Criteria Fire/CO Detector installed in B200S-WH sounder base

- Separate audible signal for fire or CO alarm when used with a B200S series base (B200SCOA series in Canada)
- 10-year CO cell with end-of-life warning
- New modern profile
- Expanded color options

Specifications

PHYSICAL

- Height: 2.7" (69 mm) installed in B200S series sounder base
- Diameter: 6.875" (175 mm) installed in B200S series sounder base
- Weight: 3.4 oz. (95 g)
- Color: White (-IV models are ivory)
- Operating Humidity Range: 15% to 90% Relative Humidity, Non-condensing
- Operating Temperature Range: 32°F to 100°F (0°C to 38°C)
- Air Velocity: 0 to 4000 ft./min. (0 to 1219.2 m/min.)

ELECTRICAL SPECIFICATIONS

- Operating Voltage Range: 15 to 32 VDC
- Operating Current @ 24 VDC: 200 uA (one communication every 5 seconds with green LED blink on communication)
- Maximum Alarm Current: 2 mA @ 24 VDC (one communication every 5 seconds with red LED solid on)
- Maximum Current: 4.5 mA @ 24 VDC (one communication every 5 seconds with amber LED solid on)
- Isolator Load Rating: 0.0063

CO MONITORING UL STANDARD REFERENCE

Alarm thresholds are as follows:

Parts Per Million	Detector Response Time
70 ± 5ppm	60 – 240 min.
150 ± 5ppm	10 – 50 min.
400 ± 10ppm	4 – 15 min.

Standards

Per UL standard 2075, the FCO-951 Series has been tested to the sensitivity limits defined in UL Standard 2034.

UL Standard: UL 268 7th Edition

ULC Standard: CAN/ULC S529

Agency Listings and Approvals

The listings and approvals below apply to the FCO-951 Series. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult the factory for the latest listing status.

UL/ULC: S1111

CSFM: 7272-0028:0510

Ordering Information

FCO-951: Advanced multi-criteria fire/CO detector, FlashScan, white, UL listed. For ivory, order FCO-951-IV.

FCO-951A: Advanced multi-criteria fire/CO detector, FlashScan, white, ULC listed. For ivory, order FCO-951A-IV.

BASES

Note: Canadian CO applications require base B200SCOA-W/IV.

B501-WHITE: 4" Mounting base, white

B501-WHITE-BP: 4" mounting base, white, 10-pack

B501-IV: 4" Mounting base, ivory

B501-BL: 4" Mounting base, black

B300-6: 6" Flanged mounting base, white

B300-6-BP: 6" Flanged mounting base, white, 10-pack

B300-6-IV: 6" Flanged mounting base, ivory

B200S-WH: Intelligent addressable sounder base, white

B200S-IV: Intelligent addressable sounder base, ivory

B200SCOA-WH: Intelligent addressable sounder base for Canadian CO applications, white, ULC-listed

B200SCOA-IV: Intelligent addressable sounder base for Canadian CO applications, ivory, ULC-listed

B200S-LF-WH: Intelligent addressable sounder base, low-frequency, white, UL-listed

B200S-LF-IV: Intelligent addressable sounder base, low-frequency, ivory, UL-listed

B224BI-WH: Isolator base, white

B224BI-IV: Isolator base, ivory

B224RB-WH: Relay base, white

B224RB-IV: Relay base, ivory

ACCESSORIES

SMB600: Surface mounting kit (flanged)

TR300: Trim ring, white

TR300-IV: Trim ring, ivory

CK300-IR: IR color kit (includes cover and trim ring), white, 10-pack

CK300-IR-IV: IR color kit (includes cover and trim ring), ivory, 10-pack

CK300-IR-BL: IR color kit (includes cover and trim ring), black, 10-pack. *Note: Not for use in Canadian CO applications*

RA100Z(A): Remote LED annunciator

M02-04-00: Detector test magnet

M02-09-00: Telescoping test magnet

ACCESSORIES



RA100Z(A)
Remote LED Annunciator



CK300-IR-BL
Color Kit



TR300
Trim Ring



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RAPID RESPONSE Series LFII Residential Sprinklers 5.6 K-factor Horizontal Sidewall, NFPA 13 Optimized Wet Pipe Systems

General Description

The TYCO RAPID RESPONSE Series LFII (TY3334) Residential Horizontal Sidewall Sprinklers are decorative, fast response, frangible bulb sprinklers designed for use in residential occupancies such as homes, apartments, dormitories, and hotels. When enhanced flow characteristics for residential portions of any occupancy per NFPA 13 is the major consideration, the Series LFII (TY3334) should be the first choice.

When higher flow demands are required for residential sprinklers used in an NFPA 13 design, the large 5.6 K-factor of the Series LFII (TY3334) is an attractive choice. Although mostly intended where residential sprinklers are to be used in an NFPA 13 design, the Series LFII (TY3334) can also be used in wet pipe residential sprinkler systems for one- and two-family dwellings and mobile homes per NFPA 13D, and wet pipe residential sprinkler systems for residential occupancies up to and including four stories in height per NFPA 13R.

The recessed version of the Series LFII (TY3334) is intended for use in areas with finished walls. It employs a two-piece Style 20 Recessed Escutcheon. The Recessed Escutcheon provides 1/4 in. (6.4 mm) of recessed adjustment or up to 1/2 in. (12.7 mm) of total adjustment from the flush mounting surface

IMPORTANT

Refer to Technical Data Sheet TFP2300 for warnings pertaining to regulatory and health information.

Always refer to Technical Data Sheet TFP700 for the "INSTALLER WARNING" that provides cautions with respect to handling and installation of sprinkler systems and components. Improper handling and installation can permanently damage a sprinkler system or its components and cause the sprinkler to fail to operate in a fire situation or cause it to operate prematurely.

position. The adjustment provided by the Recessed Escutcheon reduces the accuracy to which the pipe nipples to the sprinklers must be cut.

The Series LFII (TY3334) has been designed with heat sensitivity and water distribution characteristics proven to help in the control of residential fires and to improve the chance for occupants to escape or be evacuated.

Corrosion-resistant coatings, where applicable, are utilized to extend the life of copper alloy sprinklers beyond that which would otherwise be obtained when exposed to corrosive atmospheres. Although corrosion-resistant coated sprinklers have passed the standard corrosion tests of the applicable Approval agencies, the testing is not representative of all possible corrosive atmospheres. Consequently, it is recommended that the end user be consulted with respect to the suitability of these coatings for any given corrosive environment. The effects of ambient temperature, concentration of chemicals, and gas/chemical velocity should be considered, as a minimum, along with the corrosive nature of the chemical to which the sprinklers will be exposed.

NOTICE

The Series LFII (TY3334) Residential Horizontal Sidewall Sprinklers described herein must be installed and maintained in compliance with this document and with the applicable standards of the NATIONAL FIRE PROTECTION ASSOCIATION (NFPA), in addition to the standards of any authorities having jurisdiction. Failure to do so may impair the performance of these devices.

The owner is responsible for maintaining their fire protection system and devices in proper operating condition. Contact the installing contractor or product manufacturer with any questions.



Sprinkler Identification Number (SIN)

TY3334

Technical Data

Approvals

UL and C-UL Listed

Certified to all requirements of NSF/ANSI 61

Note: Sprinklers with a polyester finish are UL Listed as corrosion-resistant sprinklers.

See the Design Criteria section for details on these approvals.

Maximum Working Pressure

Maximum 175 psi (12,1 bar)

Temperature Rating

155°F (68°C) or 175°F (79°C)

Discharge Coefficient

K= 5.6 GPM/psi^{1/2} (80,6 LPM/bar^{1/2})

Finishes

Natural Brass, Pure White Polyester Coated, Signal White Polyester Coated, or Chrome Plated

Components:

- 1 - Frame
- 2 - Button Assembly
- 3 - Sealing Assembly
- 4 - Bulb
- 5 - Compression Screw
- 6 - Deflector*

* Temperature rating is indicated on top of Deflector.

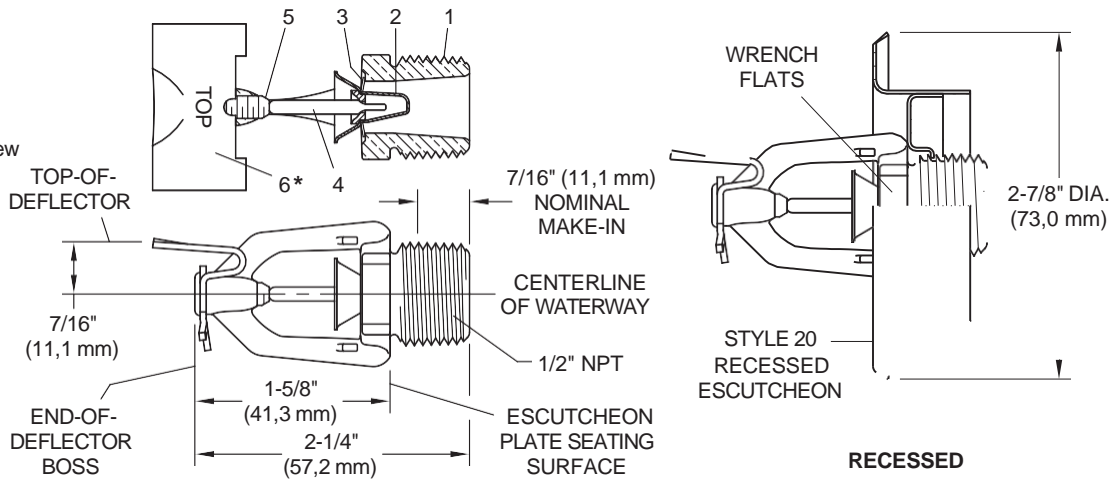


FIGURE 1
RAPID RESPONSE SERIES LFI RESIDENTIAL HORIZONTAL SIDEWALL AND RECESSED HORIZONTAL SIDEWALL SPRINKLER (TY3334)

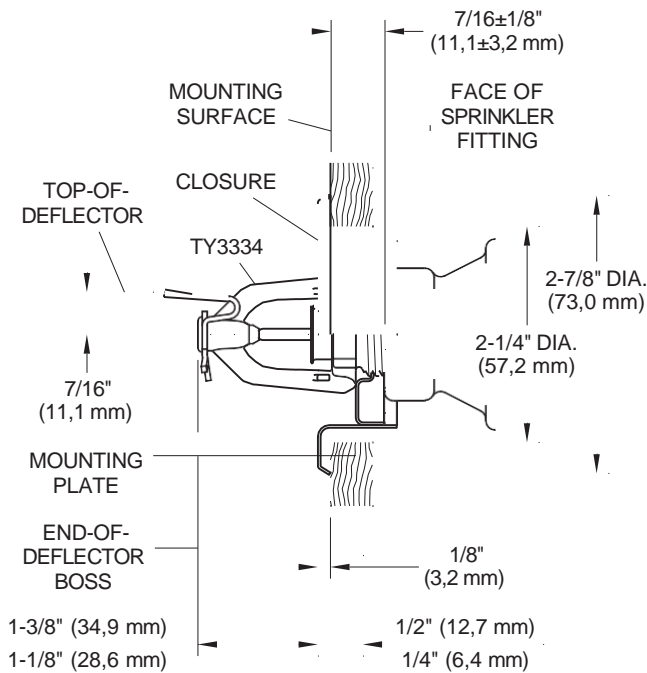


FIGURE 2
STYLE 20 RECESSED ESCUTCHEON FOR USE WITH THE RAPID RESPONSE SERIES LFI RESIDENTIAL HORIZONTAL SIDEWALL SPRINKLER (TY3334)

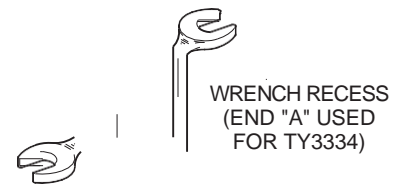


FIGURE 3
W-TYPE 6 SPRINKLER WRENCH

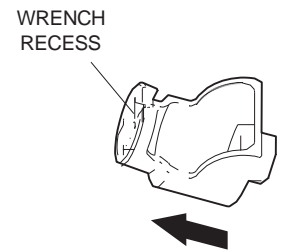


FIGURE 4
W-TYPE 7 RECESSED SPRINKLER WRENCH

Physical Characteristics

Frame	Brass
Button	Copper
Sealing Assembly .	Beryllium Nickel w/ TEFLON
Bulb	3 mm dia. Glass
Compression Screw	Brass
Deflector	Bronze

Operation

The glass bulb contains a fluid that expands when exposed to heat. When the rated temperature is reached, the fluid expands sufficiently to shatter the glass bulb allowing the sprinkler to activate and flow water.

Design Criteria

The TYCO RAPID RESPONSE Series LFII (TY3334) Residential Horizontal Sidewall Sprinklers are UL and C-UL Listed for installation in accordance with this section.

Residential Sprinkler Design Guide

When conditions exist that are outside the scope of the provided criteria, refer to the Residential Sprinkler Design Guide TFP490 for the manufacturer's recommendations that may be acceptable to the local authority having jurisdiction.

System Type

Only wet pipe systems may be utilized.

Ceiling Type

Smooth flat horizontal, or beamed, or sloped, in accordance with the 2013 Edition of NFPA 13D, 13R, or 13 as applicable.

Hydraulic Design (NFPA 13D and 13R)

For systems designed to NFPA 13D or NFPA 13R, the minimum required sprinkler flow rate are given in Table A as a function of temperature rating and the maximum allowable coverage areas. The sprinkler flow rate is the minimum required discharge from each of the total number of design sprinklers as specified in NFPA 13D or NFPA 13R.

Hydraulic Design (NFPA 13)

For systems designed to NFPA 13, the number of design sprinklers is to be the four most hydraulically demanding sprinklers. The minimum required discharge from each of the four sprinklers is to be the greater of the following:

- The flow rates given in Table A as a function of temperature rating and the maximum allowable coverage area.

- A minimum discharge of 0.1 gpm/ft² over the "design area" comprised of the four most hydraulically demanding sprinklers for the actual coverage areas being protected by the four sprinklers.

Obstruction To Water Distribution

Sprinklers are to be located in accordance with the obstruction rules of NFPA 13D, 13R, and 13 as applicable for residential sprinklers as well as with the obstruction criteria described within the TYCO Technical Data Sheet TFP490.

Operational Sensitivity

The sprinklers are to be installed with an end-of deflector-boss to wall distance of 1-1/4 in. to 6 in.

In addition the top-of-deflector-to-ceiling distance is to be within the range (Table A) being hydraulically calculated.

Sprinkler Spacing

The minimum spacing between sprinklers is 8 ft (2,4 m) when installed with a top-of-deflector-to-ceiling distance of 4 in. to 6 in. (100 to 150 mm). The minimum spacing between sprinklers is 9 ft (2,7 m) when installed with a top-of-deflector-to-ceiling distance of 6 in. to 12 in. (150 to 300 mm). The maximum spacing between sprinklers cannot exceed the width of the coverage area (see Table A) being hydraulically calculated (for example, maximum 12 ft for a 12 ft x 12 ft coverage area, or 16 ft for a 16 ft x 20 ft coverage area).

Installation

The TYCO RAPID RESPONSE Series LFII (TY3334) Residential Horizontal Sidewall Sprinkler must be installed in accordance with this section.

General Instructions

Do not install any bulb-type sprinkler if the bulb is cracked or there is a loss of liquid from the bulb. With the sprinkler held horizontally, a small air bubble should be present. The diameter of the air bubble is approximately 1/16 in. (1,6 mm).

A leak-tight 1/2 in. NPT sprinkler joint should be obtained by applying a minimum to maximum torque of 7 to 14 lb-ft (9,5 to 19,0 N·m). Higher levels of torque can distort the sprinkler Inlet with consequent leakage or impairment of the sprinkler.

Do not attempt to compensate for insufficient adjustment in the Sprinkler by under- or over-tightening the sprinkler. Re-adjust the position of the sprinkler fitting to suit.

Series LFII Horizontal Sidewall Sprinklers

The Series LFII Horizontal Sidewall Sprinklers must be installed in accordance with the following instructions.

Step 1. Horizontal sidewall sprinklers are to be installed in the horizontal position with their centerline of waterway perpendicular to the back wall and parallel to the ceiling. The word "TOP" on the Deflector is to face towards the ceiling with the front edge of the Deflector parallel to the ceiling.

Step 2. With pipe thread sealant applied to the pipe threads, hand tighten the sprinkler into the sprinkler fitting.

Step 3. Tighten the sprinkler into the sprinkler fitting using only the W-Type 6 Sprinkler Wrench (Figure 3). With reference to Figure 1, the W-Type 6 Sprinkler Wrench is to be applied to the wrench flats.

Series LFII Recessed Horizontal Sidewall Sprinklers

The Series LFII Recessed Horizontal Sidewall Sprinklers must be installed in accordance with the following instructions.

Step A. Recessed horizontal sidewall sprinklers are to be installed in the horizontal position with their centerline of waterway perpendicular to the back wall and parallel to the ceiling. The word "TOP" on the Deflector is to face towards the ceiling.

Step B. After installing the Style 20 Mounting Plate over the sprinkler threads and with pipe thread sealant applied to the pipe threads, hand tighten the sprinkler into the sprinkler fitting.

Step C. Tighten the sprinkler into the sprinkler fitting using only the W-Type 7 Recessed Sprinkler Wrench (see Figure 4). With reference to Figure 1, the W-Type 7 Recessed Sprinkler Wrench is to be applied to the sprinkler wrench flats.

Step D. After the wall has been installed or the finish coat has been applied, slide on the Style 20 Closure over the Series LFII Sprinkler and push the Closure over the Mounting Plate until its flange comes in contact with the wall.

Max. Coverage Area ^(a) Width x Length ^(d) ft x ft (m x m)	Max. Spacing ft (m)	Minimum Flow and Residual Pressure ^(b, c)						Deflector to Ceiling	Installation Type	Minimum Spacing ft (m)
		Ordinary Temp. Rating 155°F (68°C)		Intermediate Temp. Rating 175°F (79°C)						
		Flow GPM (L/min)	Pressure PSI (bar)	Flow GPM (L/min)	Pressure PSI (bar)					
12 x 12 (3,7 x 3,7)	12 (3,7)	17 (64,3)	9.2 (0,63)	17 (64,3)	9.2 (0,63)	4 in. to 6 in.	1/2 in. recessed using Style 20 Escutcheon or non-recessed per NFPA 13D, 13R, or 13	8 (2,4)		
14 x 14 (4,3 x 4,3)	14 (4,3)	19 (71,9)	11.5 (0,79)	19 (71,9)	11.5 (0,79)					
16 x 14 (4,9 x 4,3)	16 (4,9)	20 (75,7)	12.8 (0,88)	20 (75,7)	12.8 (0,88)					
16 x 16 (4,9 x 4,9)	16 (4,9)	24 (90,8)	18.4 (1,27)	24 (90,8)	18.4 (1,27)					
16 x 18 (4,9 x 5,5)	16 (4,9)	26 (98,4)	21.6 (1,49)	26 (98,4)	21.6 (1,49)					
16 x 20 (4,9 x 6,1)	16 (4,9)	29 (109,8)	26.8 (1,85)	29 (109,8)	26.8 (1,85)					
12 x 12 (3,7 x 3,7)	12 (3,7)	20 (75,7)	12.8 (0,88)	20 (75,7)	12.8 (0,88)	6 in. to 12 in.				
14 x 14 (4,3 x 4,3)	14 (4,3)	22 (83,3)	15.4 (1,06)	22 (83,3)	15.4 (1,06)					
16 x 14 (4,9 x 4,3)	16 (4,9)	24 (90,8)	18.4 (1,27)	24 (90,8)	18.4 (1,27)					
16 x 16 (4,9 x 4,9)	16 (4,9)	28 (106,0)	25.0 (1,72)	28 (106,0)	25.0 (1,72)					
16 x 18 (4,9 x 5,5)	16 (4,9)	31 (117,3)	30.6 (2,11)	31 (117,3)	30.6 (2,11)					
16 x 20 (4,9 x 6,1)	16 (4,9)	37 (140,0)	43.7 (3,01)	37 (140,0)	43.7 (3,01)					

Notes:

- a. For coverage area dimensions less than or between those indicated, use the minimum required flow for the next highest coverage area for which hydraulic design criteria are stated.
- b. Requirement is based on minimum flow in GPM (LPM) from each sprinkler. The associated residual pressures are calculated using the nominal K-factor. See Hydraulic Design under the Design Criteria section.
- c. For NFPA 13 residential applications, the greater of 0.1 gpm/ft² over the design area or the flow in accordance with the criteria in this table must be used.
- d. The Width x Length dimension refers to the Width (backwall where the sprinkler is located) times the Length (horizontal throw of sprinkler).

TABLE A
WET PIPE SYSTEMS
SERIES LFII (TY3334) RESIDENTIAL HORIZONTAL SIDEWALL
AND RECESSED HORIZONTAL SIDEWALL SPRINKLERS (TY3334)
NFPA 13D, 13R AND 13 WET PIPE HYDRAULIC DESIGN CRITERIA

Care and Maintenance

The TYCO RAPID RESPONSE LFII (TY3334) Residential Horizontal Sidewall Sprinklers must be maintained and serviced in accordance with this section.

Before closing a fire protection system main control valve for maintenance work on the fire protection system which it controls, permission to shut down the affected fire protection system must be obtained from the proper authorities and all personnel who may be affected by this action must be notified.

Absence of an Escutcheon Plate may delay the sprinkler operation in a fire situation.

The owner must assure that the sprinklers are not used for hanging of any objects and that the sprinklers are only cleaned by means of gently dusting with a feather duster; otherwise, non-operation in the event of a fire or inadvertent operation may result.

Sprinklers which are found to be leaking or exhibiting visible signs of corrosion must be replaced.

Automatic sprinklers must never be painted, plated, coated, or otherwise altered after leaving the factory. Modified sprinklers must be replaced. Sprinklers that have been exposed to corrosive products of combustion, but have not operated, should be replaced if they cannot be completely cleaned by wiping the sprinkler with a cloth or by brushing it with a soft bristle brush.

Care must be exercised to avoid damage to the sprinklers - before, during, and after installation. Sprinklers damaged by dropping, striking, wrench twist/slippage, or the like, must be replaced. Also, replace any sprinkler that has a cracked bulb or that has lost liquid from its bulb. See the Installation section for additional information.

The owner is responsible for the inspection, testing, and maintenance of their fire protection system and devices in compliance with this document, as well as with the applicable standards of the NATIONAL FIRE PROTECTION ASSOCIATION, for example, NFPA 25, in addition to the standards of any other authorities having jurisdiction. Contact the installing contractor or product manufacturer with any questions.

Automatic sprinkler systems are recommended to be inspected, tested, and maintained by a qualified Inspection Service in accordance with local requirements and/or national code.

Limited Warranty

For warranty terms and conditions, visit www.tyco-fire.com.

Ordering Procedure

Contact your local distributor for availability. When placing an order, indicate the full product name and Part Number (P/N).

Sprinkler Assembly

Series LFII (TY3334), K=5.6, Residential Horizontal Sidewall Sprinkler, (specify) temperature rating, (specify) finish, P/N (specify):

155°F (68°C)

Natural Brass	51-524-1-155
Pure White (RAL9010)	
Polyester ^{1, 2}	51-524-3-155
Signal White (RAL9003)	
Polyester ¹	51-524-4-155
Chrome Plated	51-524-9-155

175°F (79°C)

Natural Brass	51-524-1-175
Pure White (RAL9010)	
Polyester ^{1, 2}	51-524-3-175
Signal White (RAL9003)	
Polyester ¹	51-524-4-175
Chrome Plated	51-524-9-175

1. UL Listed as corrosion-resistant.
2. Eastern Hemisphere sales only.

Recessed Escutcheon

Specify: Style 20 Recessed Escutcheon with (specify*) finish, P/N (specify*).

* Refer to Technical Data Sheet TFP770.

Sprinkler Wrench

Specify: W-Type 6 Sprinkler Wrench, P/N 56-000-6-387

Specify: W-Type 7 Sprinkler Wrench, P/N 56-850-4-001



WFDN Series Waterflow Detector

The System Sensor WFDN series is compatible with schedule 7 through 40 steel pipe, for sizes 2 in. through 4 in. and compatible with schedule 10 through 40 steel pipe, sizes 5 in. through 8 in., and can be mounted in a vertical or horizontal position.

Features

- New directional cover allows installers and inspectors to easily see the direction of flow
- UL-listed models are NEMA 4 rated
- New cover provides a better seal, is lighter weight, not painted and corrosion resistant
- Sealed retard mechanism immune to dust and other contaminants
- Less exposed metal reduces shock hazard, plastic cover acts as insulator and is resistant to arcing
- Visual switch activation
- Audible switch activation (73 dBA)
- Field-replaceable timer/switch assembly
- Accommodates up to 12 AWG wire
- Switch Synchronization activates both alarm panel and local bell or horn strobe
- Tamper-resistant cover screws
- Improved water sealing
- Reduced product weight
- Wire-ready terminals
- Improved wiring with new terminal block layout
- Snap-in optional cover tamper switch
- Improved timer repeatability and accuracy

Agency Listings



The new **WFDN Series** waterflow detectors from **System Sensor** consists of a rugged, NEMA 4-rated enclosure that is more damage resistant than previous metal designs. The waterflow detector is designed for both indoor and outdoor use, with the widest available temperature range, from 32°F to 150°F. They are also approved for installation on the widest range of pipe schedules, sizes 2 in. through 4 in. are approved for installation on pipe schedules 7 through 40.

UL-listed models are equipped with tamper-resistant cover screws to prevent unauthorized entry. Inside, two sets of SPDT (Form C) synchronized switches are enclosed in a durable terminal block with new layout designed to make wiring easy with wire ready terminals, COM terminals are on a different elevation, large barrier between switches and easy to read raised textured lettering all make wiring easy. An optional cover tamper switch is available, securely snaps into place, no tools required.

The WFDN series incorporates a mechanical time delay feature, which minimizes the risk of false alarm due to pressure surges or air trapped in the fire sprinkler system. The larger and easy to turn timer dial makes setting the waterflow detector easy with high contrast pad printed markings. The dial offers three tabs to help with turning, with one larger tab located on the dial position for approximately 60 seconds, a notch is also indicated on the dial to locate approximately 30 seconds making setting the detector in dimly lit locations easy.

The WFDN series is designed for accuracy and repeatability. The detector also offers improved performance during vibration in riser applications where detectors are exposed to a large inrush of water.

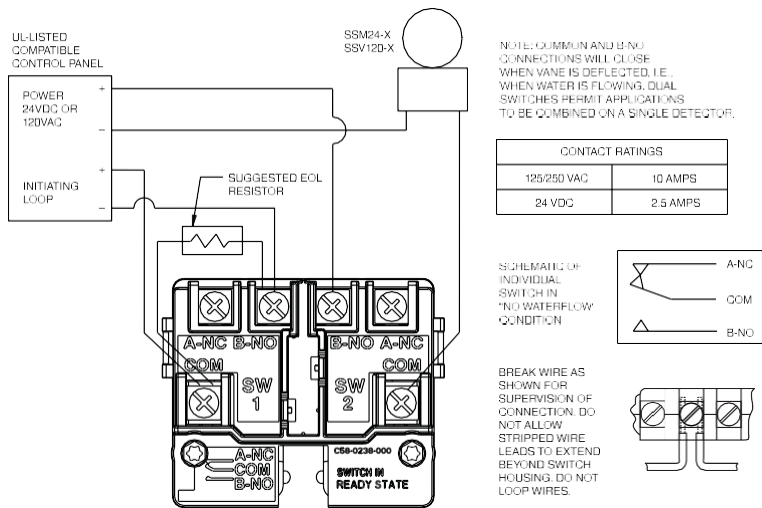
Waterflow Detector Specifications

Engineering Specifications

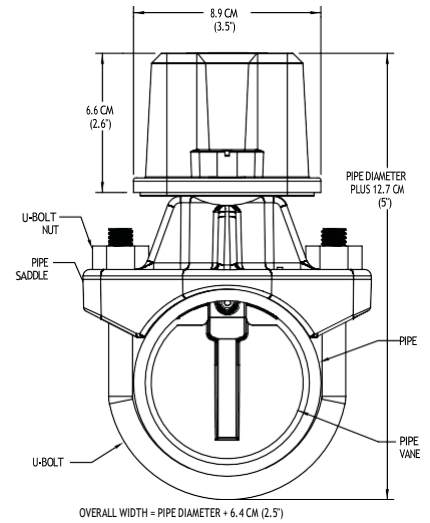
Vane-type waterflow detectors shall be installed on system piping as designated on the drawing and/or as specified herein. Detectors shall mount on any clear pipe span of the appropriate nominal size, either a vertical upflow or horizontal run, at least 6 in. from any fittings that may change water direction, flow rate, or pipe diameter or no closer than 24 in. from a valve or drain. Detectors shall have a sensitivity in the range of 4 to 10 gallons per minute and a static pressure rating of 450 psi for 2 in. – 8 in. pipes. The detector shall respond to waterflow in the specified direction after a preset time delay that is field adjustable. The delay mechanism shall be a sealed mechanical pneumatic unit with visual and audible indication of actuation. The actuation mechanism shall include a ethylene vinyl acetate vane inserted through a hole in the pipe and connected by a mechanical linkage to the delay mechanism. Outputs shall consist of dual SPDT switches (Form C contacts). Two conduit entrances for standard fittings of commonly used electrical conduit shall be provided on the detectors. A grounding provision is provided. Unless noted, enclosures shall be NEMA 4 listed by Underwriters Laboratories Inc. All detectors shall be listed by Underwriters Laboratories Inc. for indoor or outdoor use.

Standard Specifications			
Static Pressure Rating	450 PSI	Operating Temperature Range	32°F to 150°F (0°C to 66°C)
Maximum Surge	18 Feet Per Second (FPS)	Enclosure Rating*	NEMA 4 – suitable for indoor/outdoor use
Triggering Threshold Bandwidth (Flow Rate)	4–10 GPM	Cover Tamper Switch	Standard with ULC models, optional for UL models, part no. CTS
Conduit Entrances	Two openings for ½ in. conduit. NEMA 4 rated plugs	Service Use	Automatic Sprinkler: NFPA-13 One or Two Family Dwelling: NFPA 13D Residential Occupancies up to 4 Stories: NFPA 13R National Fire Alarm Code: NFPA-72
Contact Ratings	Two sets of SPDT (Form C) 10.0 A, ½ HP @ 125/250 VAC 2.5 A @ 6/12/24 VDC	Warranty	3 Years
Compatible Pipe	Steel water pipe, schedule 7 through 40*		

WFDN Field Wiring Diagram



Overall Dimensions, Installed



Ordering Information

UL Model	ULC Model	Pipe Size	Hole Size	Shipping Weights
WFD20N	WFD20NA	2 in.	1¼ in.	2.6 lbs.
WFD25N	WFD25NA	2½ in.	1¼ in.	2.6 lbs.
WFD30N	WFD30NA	3 in.	2 in.	3.1 lbs.
WFD40N	WFD40NA	4 in.	2 in.	4.0 lbs.
WFD50N	WFD50NA	5 in.	2 in.	4.9 lbs.
WFD60N	WFD60NA	6 in.	2 in.	5.6 lbs.
WFD80N	WFD80NA	8 in.	2 in.	7.3 lbs.

Accessories

FS-RT	Delay mechanism and switch assembly
CTS	Tamper-proof switch kit
WFDW	Tamper-proof wrench for cover

* 2 in. - 4 in. rated for use with Schedule 7 through 40 pipe, 6 in. - 8 in. rated for use with Schedule 10 through 40 pipe.



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

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