Fire and Life Safety Analysis

Building 310
The Landing

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Keywords

Performance Based Design, Fire Dynamics Simulator (FDS),

Life Safety Code, Egress

Executive Summary

The purpose of this report is to analyze Building 310 with regards to fire and life safety. Analysis was done both prescriptively and from a performance based design standpoint.

The prescriptive based analysis includes review of the building's design with regards to egress, fire alarm systems, suppression systems, and structural fire protection. The building was reviewed against current NFPA codes and the International Building Code to examine compliance.

The performance-based analysis consists of two different fire scenarios that were examined. The goal was to show that the building met safety criteria and does not pose undue risk to occupants. This method employs alternate criteria and strategies to prove safety in ways other than the prescriptive based codes. The fire scenarios consist of a fire originating in a small office, and another fire originating in the kitchen of a restaurant area.

The building was designed in compliance with all applicable codes, with one exception. A mezzanine located in one of the restaurant areas is under designed and requires another exit. This is shown using both prescriptive codes and performance-based analysis. Other areas of the overall fire protection system of the building are over designed. The sprinkler system has at least one unnecessary branch line. The separating walls of the building have a higher fire rating than is required as well. This report recommends adding one more exit to the mezzanine.

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Building Description

Building 310 contains 10 separate tenant spaces, and consists of a mixed retail and restaurant usage. The building contains a high canopy along the exterior. The construction is non-combustible steel frame, and the area of the building is 24,000 square feet in total. It is a one story complex, with the exception of a mezzanine in one of the spaces. As a one story building, there are no enclosed stairways. There is one exit access corridor between all of the tenant spaces that is not generally accessible to the public. One section of the roof in the pizza restaurant space has a height of 27 feet and 8 inches. The rest of the building has a roof height of 18 feet 6 inches. The building is a host to various restaurants and retail facilities.

Codes Utilized for Design

International Building Code (2006 Edition)
NFPA 101 (2006 Edition)
NFPA 72 (2007 Edition)
NFPA 13 (2007 Edition)
NFPA 25 (2008 Edition)

Codes Utilized for Analysis

International Building Code (2012 Edition)
NFPA 101 (2012 Edition)
NFPA 72 (2013 Edition)
NFPA 13 (2013 Edition)
NFPA 25 (2014 Edition)

Prescriptive Based Design

Structural

Occupancy/Construction Classification

The building can be classified as either business group B occupancy or assembly group A-2. It contains a variety of restaurants in addition to an insurance office, a nail salon, and a ceramics store. The restaurants constitute group A-2 classification, and the other tenant areas constitute group B occupancies. The more conservative of the two options was chosen to fit the entire building. Tenants move into and out of the building fairly frequently, but it is expected that new tenants will continue to be restaurants or other small business types. The group A-2 classification is described in the International Building Code (IBC) Section 303.3, and the group B classification is described in Section 304 of the IBC. The building has a maximum height of 27 feet and 8 inches. Although there is a mezzanine located in one of the tenant buildings, it is still considered a one-story building according to Section 505 of the IBC.

Construction Type

The building has an overall area of 24,000 square feet. The allowable building constructions were determined using Table 503 of the IBC. The building is fully sprinklered, and has a large frontage area on all sides. Due to this, a sprinkler factor and frontage area factor were used to adjust the allowable area for construction types. After these adjustments all of the construction types for group B are allowable for the building. Although type IV is allowable based on area and story limitations in Table 503, it does not apply as it is used for heavy timber construction, and the building is made of steel. See Appendix A for a sample calculation of allowable area modifications.

Required Fire Resistance for Building Elements

The fire resistance ratings for building elements are found in Table 601 of the IBC. The building elements are classified as either type I, II, III, IV, or V, with an A or B sub classification based on required fire resistance.

Type I

Type 1-B classification requires a 2-hour fire resistance rating for the primary structural frame, interior and exterior bearing walls, floor construction, and roof construction. The primary structural frame and interior bearing walls can be reduced to 1-hour fire resistance if they support a roof only. No fire resistance rating is required for nonbearing walls.

Type 1-A classification requires a 3-hour fire resistance rating for the primary structural frame, interior bearing walls, and exterior bearing walls. There is no requirement for interior nonbearing walls and partitions. The floor construction is required to have a 2-hour rating, and the roof construction is required to have a 1.5-hour rating. The primary structural frame and interior bearing walls are allowed to have their resistance rating reduced by 1 hour if they only support a roof structure.

Type II

Type II-A classification requires no fire resistance rating for any elements if the sprinkler system is used to replace all requirements for one hour rated elements. Type II-B classification never requires any fire resistance rating for elements.

Type III

Type III-B classification requires a 2-hour fire resistance rating for exterior walls, and no fire resistance rating for all other building elements. Type III-A classification has the same requirements as type III-B classification if the sprinkler system is used in place of the 1-hour fire rated elements. This is acceptable because the allowable area from Table 503 of the IBC is sufficiently large for the building without a fire sprinkler area increase.

Type IV

Type IV classification pertains to heavy timber construction. The building is steel frame construction, and thus type IV is not applicable.

Type V

Type V-A classification requires a one-hour fire resistance rating for all building elements except for nonbearing walls and partitions. These do not require a fire resistance rating. Since the sprinkler system is used to increase the allowable area, it cannot be used to reduce the fire resistance requirements in this case. For type V-B classification the entire building is allowed to have a zero hour fire resistance rating.

Exterior Walls

Table 602 in the IBC was used to find the fire resistance rating requirements for the exterior walls. The building has over 30 feet of fire separation distance in all directions (see Figure 1 below). Due to this, there is no required fire resistance rating for the exterior walls.

Figure 1. Satellite View of Building 310

Fire Resistance of Building Elements

Columns

The columns are all HSS hollow steel and W shape members. None of the columns are rated for fire resistance. As there is only one floor in the building, all columns support only the roof structure, with the exception of the mezzanine columns.

Floor Assembly

The floor is made up of a 4-inch thick slab on grade foundation. The foundation is reinforced concrete that utilizes various sized deep piles located at column locations.

Mezzanine

The mezzanine was built by the tenant of the Rock Pizza, and is comprised of steel beams and columns. No plans were available for the mezzanine so it is assumed that the mezzanine floor consists of standard steel joists. See Figure 2 below.

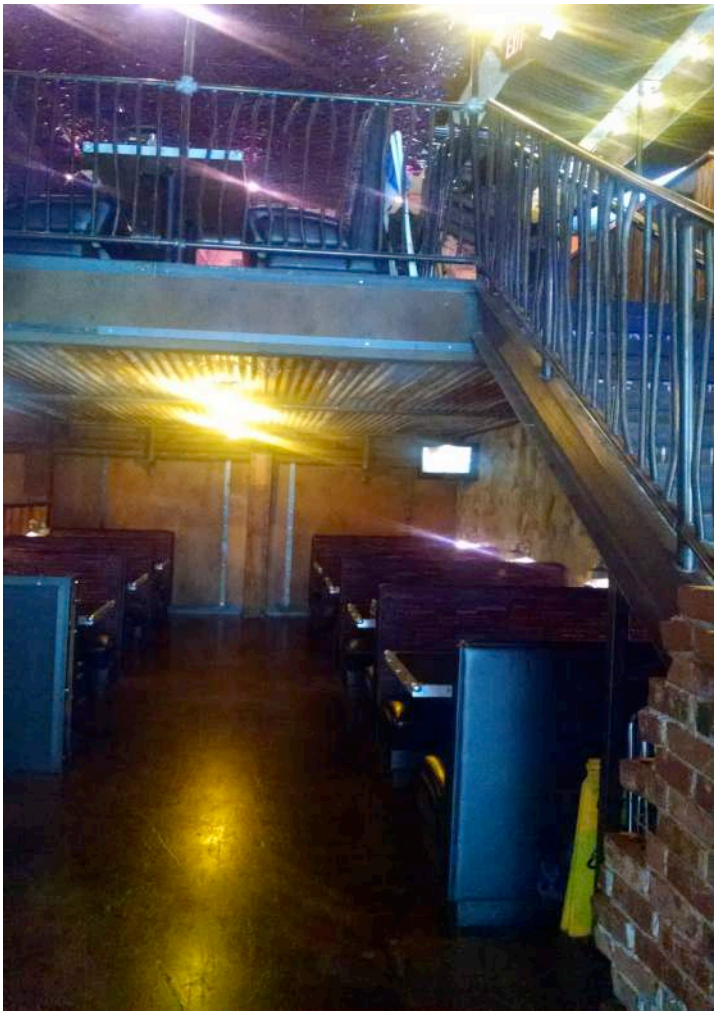


Figure 2. Pizza Restaurant Mezzanine

Roof Assembly

The roof assembly is made up of W,K, and LH series steel joists as well as HSS steel beams. The roof decking consists of ½-inch, 20-gage type HSB steel. The roof assembly is not rated for fire resistance. Canopies attached to the roof are made of HSS beams. These are not rated for fire resistance either.

Exterior Walls

The exterior walls are load bearing steel stud construction. They have 8-inch steel studs at a spacing of 16 inches on center. These walls have either a brick veneer finish or a concrete finish. Walls are rated for 2-hour fire resistance.

Interior Walls and Partitions

The interior walls are constructed with 6-inch metal studs spaced 16 inches on center. Insulation and finish vary by tenant. In most cases the walls are finished with gypsum wallboard on both sides. Walls are rated for 2-hour fire resistance.

Joints and Penetrations

The trash room contains an exhaust fan located near the center of the ceiling. The exhaust fan vents directly to the outside. Details of the exhaust fan were unavailable. In the alarm system section of the analysis on this building, the location of smoke detection devices and duct dampers were assumed. It is possible that one of the duct dampers is actually located in the trash room.

Trash Room

The walls bordering the trash room are designed for a 2-hour fire rating. These walls are 8-inch thick cmu, with 8-inch steel studs spaced at 16 inches on center. They are finished with ½-inch type x gypsum board on the trash room side, and a tenant specified finish on the other side. The trash room is required to be fire rated in accordance with IBC Section 713.13.3. This section requires a 1-hour fire resistance rating for walls, and a ¾ -hour fire rating for doors in a refuse storage room.

Conclusion

The building is Type II-A, II-B, or V-B. Types II-B and V-B require no fire resistance rating under any circumstances. Type II-A does not require any fire resistance rating in the case of this building due to the presence of a sprinkler system. The trash room would be required to have a 1-hour fire rating under each

of the aforementioned classifications. Thus, the real classification of the building could be any of the three, as they are analogous in this situation. The building is overdesigned as it has 2-hour fire rated walls. This is done in order to create separation for tenant spaces in compliance with the life safety code.

Additionally, the building is entirely compliant with the code as far as structural fire resistance is concerned. The only required fire resistance in the trash room was met. There was not enough information to determine for certain if the duct in the trash room contains a smoke detector and damper. If this is one of the locations with this device, then the duct does comply with Section 717.5.2 of the IBC. Otherwise, it does not.

Egress

Occupancy

The building is a mixed-use retail building consisting of assembly, business, and mercantile occupancies. The life safety code and the IBC allow for a mixed use building to be classified based on each occupancy as long as fire barriers are in place between occupancies (IBC Section 508.4, NFPA 101 Section 6.1.14.4). See Table 1 below for occupancies and occupant loads of each tenant space.

Table 1. Occupancy and Occupant Load

Tenant Space	**Description**	**Occupant Load Factor**	**Net/ Gross**	**Occupancy**	**Area (sq. ft)**	**Allowable Occupant Load (persons)**
1	Pizza Restaurant/Bar	15	Net	Assembly	6720	448
*1	Mezzanine	15	Net	Assembly	1321	88
2	Wine & Chocolate Bar	15	Net	Assembly	1172	78
3	Vacant	N/A		N/A		N/A
4	Glazed Art	30	gross	Mercantile	1518	51
5	Cosmetics Store	30	gross	Mercantile	1428	48
6	Vietnamese Café	15	Net	Assembly	1143	76
7	Yogurt Café	15	Net	Assembly	868	58
8	Vacant	N/A		N/A		N/A
9	Nail Salon	100	gross	Business	890	9
10	Insurance Office	100	gross	Business	882	9

* Occupant load factors obtained from Table 7.3.1.2 NFPA 101, 2012 edition and Table 1004.1.2 IBC 2012 edition

*Pizza restaurant area includes mezzanine area

See drawing in Appendix B for the Locations of tenant spaces.

According to the IBC, a nail salon is classified as a business classification (Section 304.1, IBC). Based on the nail salon's area, this would allow for an occupant load of 9 people. There are 10 salon seats. This would mean that the occupancy of the nail salon is at least 10 people, and is probably closer to 15 or 20 people. Sections 7.3.1.3 of the life safety code, and 1004.2 of the IBC do allow for occupant load increases. It is assumed that the authority having jurisdiction granted an occupancy increase for this nail salon. However, based on the business classification and approximated area, this occupancy would be in violation of the IBC code and NFPA 101 without an occupant load increase.

Exit Capacity and Number of Exits

Section 7.4.1.1 of NFPA 101 essentially requires that all fire areas within a building, including mezzanines and balconies, have at least two means of egress. The IBC has a similar standard in Section 1015.1 that states that all occupancies that exceed the maximum occupancy limit listed in Table 1015.1 must have at least two means of egress. For all occupancies examined in this project, that maximum limit is 49 people. Section 38.2.4.3 of the life safety code allows for business occupancies to have only one exit if they have fewer than 100 occupants. They must also have less than 100 ft of travel distance to an exit, and exit directly to the outside. The life safety code allows for a class C mercantile occupancy to have only one exit as long as the distance of travel for an exit is less than or equal to 100 feet when a sprinkler system is present (Section 36.2.2.4, NFPA 101). A class C mercantile occupancy is defined as an occupancy with an area of less than 3000 square feet, and one that is only one story high (Section 36.1.2.2.1, NFPA 101). Based on the IBC and life safety codes, tenant spaces 5, 9, and 10 are allowed to have only one exit. All spaces except for one vacant space and the mezzanine have at least two exits. Section 12.2.4.5 of NFPA 101 states that a balcony or mezzanine in an assembly occupation may have only one exit if the occupant load is less than 50 people. It can be seen in Table 2 that the mezzanine has an occupant load of 88 people. The mezzanine does have some bench type seating, and possibly the occupancy was calculated based on fixed seating. Thus, this would fall under the 50-person threshold established in NFPA 101 and the IBC. Additionally, the area of the mezzanine was approximated as it was built after the tenant moved into the space. These two factors could account for the discrepancy shown. However, based

on assumptions, approximations, and classification of the occupancy as an unconcentrated assembly, the mezzanine is in violation of both the life safety code and the international building code.

Table 2. Exit Capacity

Tenant Space	Description	Number of Exits	Capacity/Exit (people)	Capacity Total (people)	Capacity AccepTable?
1	Pizza Restaurant/Bar	6	180	1080	YES
*1	Mezzanine	1	147	147	YES
2	Wine & Chocolate Bar	2	180	360	YES
3	Vacant	2	180	360	N/A
4	Glazed Art	3	180	540	YES
5	Cosmetics Store	2	180	360	YES
6	Vietnamese Café	2	180	360	YES
7	Yogurt Café	2	180	360	YES
8	Vacant	1	180	180	N/A
9	Nail Salon	2	180	360	YES
10	Insurance Office	2	180	360	YES
*All exits are 36" doors except for mezzanine, which is 44" stair					
*Double doors are considered to be 2 exits					

Exit Arrangement/Remoteness of Means of Egress

NFPA 101, Section 7.5.1.3.3, requires that exits be separated by a distance of at least one third of the diagonal of the fire area that they are located in. This applies when a sprinkler system is present. IBC Section 1015.2.1 has essentially the same requirement. The building examined is fully sprinklered, and thus compliance was based off of these codes. The life safety code states that the distance between exits must be measured from the nearest points of the doorway (shortest distance). The

IBC is less clear in defining a measurement method. Thus, the method from NFPA 101 was used as it provides the most conservative value possible for exit distance. All of the rooms requiring two or more exits did comply with these codes. See Table 3 below, and drawings in Appendix B for more information.

Table 3. Remoteness of Means of Egress					
Tenant Space	**Description**	**Diagonal (ft)**	**1/3 of Diagonal**	**Exit Distance (ft)**	**AccepTable?**
1	Pizza Restaurant/Bar	120	40.0	95	YES
*1	Mezzanine	N/A	N/A	N/A	N/A
2	Wine & Chocolate Bar	53	17.7	43	YES
3	Vacant	53	17.7	45	YES
4	Glazed Art	58	19.3	48	YES
5	Cosmetics Store	56	18.7	51	YES
6	Vietnamese Café	57	19.0	35	YES
7	Yogurt Café	48	16.0	22	YES
8	Vacant	48	16.0	N/A	N/A
9	Nail Salon	42	14.0	35	YES
10	Insurance Office	41	13.7	31	YES
*See pages attached for determination of diagonals and distance between exits					
*Measurements Have been rounded to the nearest foot					

Horizontal exits

There are no horizontal exits in this building.

Required Fire Resistance

The only stairs found in the building are from the mezzanine in the pizza restaurant space. These do not constitute a stairway as they are open to the rest of the room, and they do not connect separate floors. Section 12.3.1 of NFPA 101 allows for mezzanine stairs to be open and unprotected, as long as the mezzanine is open to the main assembly area.

The main exit corridor and separations between tenants do have required fire resistive barriers. Each occupancy in the building is separated, and thus must be separated by a fire resistance barrier (IBC Section 508.4, NFPA 101 Section 6.1.14.4). Table 508.4 in the IBC and Table 6.1.14.4.1 both essentially state the same requirements for fire resistance separation between occupancies. In the case of the building examined, the maximum fire resistance required for separation that would be encountered based on these tables is 2 hours. This requirement is found between business and mercantile occupancies, mercantile and assembly occupancies, and business and assembly occupancies with greater than 300 occupants. As the designers of the building were not aware of all future tenants, it is assumed that they used these expected occupancies to base their separation fire ratings off of. All of the walls in the building are designed for 2-hour fire resistsance. However, both the IBC and life safety code allow for a 1-hour reduction in fire resistance rating with the presence of an automatic sprinkler system (footnote Table 6.1.14.4 NFPA 101, IBC Table 508.4). This yields a required fire resistance rating of 1 hour.

The exit corridor is required to have a 1-hour fire resistance rating. Both IBC Table 1018.1 and NFPA 101 Section 12.3.6 allow for a corridor not to be fire rated if a sprinkler system is present. However, the corridor is fire rated for 1-hour resistance to keep separation between the occupancies.

Exit Signs

Both the IBC and NFPA 101 state that exit signs must be placed at any exit or means of egress that is not readily visible by occupants (IBC 1011.1, NFPA 101 7.10.1.5.1). All exits to the outside are glass doors. These exits are considered to be very visible to occupants and thus do not require signage. Exit signs are placed at all interior exits into the main corridor. Additionally, one exit sign is placed at the corridor intersection between the exterior door next to the trash room and the passageway coming from the pizza restaurant. This sign at the intersection satisfies the requirement that no point in an exit corridor can be more than 100 ft from the viewing of an exit sign (NFPA 7.10.1.5.2, IBC 1011.1). Exit signs must be illuminated at all times per IBC 1011.5, and NFPA 101, 7.10.5.2.1. Additionally, IBC Section 1011.6.3. ,and NFPA 101 Section 7.9.2.1. require that emergency

signs have a secondary power source capable of illuminating signs for 90 minutes after primary power failure. See Appendix B for exit sign locations.

Interior finish requirements

Life Safety Code

According to the life safety code, with the presence of a sprinkler system, the assembly occupancies must have at least class B rated interior wall and ceiling finishes for the exits. With a sprinkler system, classes A, B, or C are allowable for the corridor or other spaces. The life safety code allows for class A, B, or C interior finish to be used on exits, corridors, and other spaces for the mercantile and business occupancy spaces. No classification is required by the life safety code for interior floor finishes in this area due to the presence of a sprinkler system (Table A.10.2.2, NFPA 101).

International Building Code

The international building code requires that exits and corridors in assembly spaces have an interior finish of class B or better, and interior finish of class C or better for other spaces. The IBC allows for class B or better for the exits on mercantile spaces, and classes A, B, or C for corridors and other areas in mercantile or business spaces. The international building code requires that the interior floor finish pass the “pill test” to be used (IBC 804.4.2).

Application to Building 310

The main corridor is allowed to have a finish of class A, B, or C material according to the life safety code. The corridor would have to be finished with a class B or better in order to follow the most conservative occupancy classification in the IBC. No exit passageways or stairways are present to be evaluated by the finish requirements, and thus the remaining areas are allowed to be finished with class A, B, or C material according to either code. The floor finish does not need to be classified for either code, and need only pass the “pill test” for the IBC.

Pre-movement and Movement

Chapters 3-11 and 3-12 of the SPFE handbook outline various factors that can have a significant impact on pre-movement and movement times. These factors can stem from the building itself or from occupant characteristics. A description of relevant factors is given below.

Fire Alarm System

The fire alarm system takes the longest to respond of all notification systems. Many people in fire situations respond more quickly when notified by another person.

Building Layout

A complex building layout will make escape in a fire situation more difficult. However, the layout of building 310 is relatively simple, and there are not many areas in the entire building where an exterior door is not readily visible. This leads to the conclusion that reduction in egress time due to building layout will be minimal for this situation.

Training

Highly trained staff and occupants will be much more efficient in an evacuation scenario, as they know the layout of the building and the locations of exits. In a retail building such as the one examined, the occupants will most likely have no relevant training. Additionally, it is doubtful that staff will have sufficient numbers in all areas to effectively streamline the evacuation of occupants.

Frequency of False Alarms

False alarms will make occupants feel like the situation is less urgent in the case of a real fire alarm. This could significantly increase pre-movement times and adversely affect egress speed. This building does have a significant number of false alarms due to tampering with pull stations, which could potentially be a threat to evacuation time.

Familiarity

Occupants with some knowledge of the layout of the building will most likely be able to navigate more efficiently during an evacuation.

Responsibility

People generally do not feel responsible for a fire alarm going off. They expect that someone else will take care of the problem, and guide them as to what to do. This leads to a fairly strong reliance on staff action.

Social Affiliation

People will tend to try and gather with others that they care about. This can have a significant impact on egress time if the group is not located together at the beginning of an alarm. A couple of the tenant spaces are family oriented restaurants. This could have a significant effect on egress when one considers the distance from bathrooms, or the mezzanine in the pizza restaurant, to the most distant seating areas.

Commitment

Essentially, people who are invested in their current task are less likely to respond quickly to an alarm. The building houses a ceramics store, and various restaurants. People eating or painting a vase will be more reluctant to stop and exit the building.

Alertness and Limitations

Various limitations can affect the egress times of occupants. Alcohol and drug consumption can have a large effect on the alertness of occupants. Even simple fatigue could affect the mental alertness of occupants. Two of the tenant spaces have bars as part of their restaurant function. Due to this, alcohol consumption could be a significant factor in egress time. This is especially true during late night events or happy hour events.

Impairment

In addition to diminishing alertness and initial response to a fire alarm, impairment can diminish egress speed during evacuation as well. Andrew K. Pantelis wrote a paper on the effect of alcohol consumption and egress times in fire situations. Although this paper does not constitute a comprehensive study, with only 10 occupants examined, the results paint a fairly clear picture. Table 4 below summarizes the results of his findings. Almost all of the occupants had significantly increased egress times even below the legal driving limit at the 0.06% BAC level. Some of these were even higher than a 50% increase in egress time.[2]

Table 4. Alcohol and Egress

Table 1

Egress Time (seconds) at Increasing Breath Alcohol Concentration (BrAC) Levels

	BrAC Levels				
	0.00%	0.03%	0.06%	0.09%	0.12%
Subject 1	39.00	45.05	54.88	58.90	64.10
Subject2	56.86	40.20	48.85	52.67	59.01
Subject 3	46.25	55.08	59.85	63.65	74.81
Subject 4	31.99	36.50	47.75	57.19	79.37
Subject 5	32.12	34.05	47.34	49.08	51.07
Subject 6	32.54	38.10	41.87	43.09	49.83
Subject 7	61.80	63.91	68.68	75.34	87.82
Subject 8	28.40	33.05	36.90	41.66	59.38
Subject 9	25.66	33.75	40.80	43.03	49.75
Subject 10	45.28	53.50	66.44	79.08	----

Note. Subject 10 did not complete the evolution at BrAC 0.12%

Source: Pantelis, Andrew. "IMPACT OF ALCOHOL CONSUMPTION ON FIRE EGRESS." *Fema.gov*. Prince George's County Fire and Emergency Medical Services Department, 1 Jan. 2008. Web. <http://www.usfa.fema.gov/pdf/efop/efo42811.pdf>.

Disability

Fairly large portions of the US have some sort of mobile limiting disability. The SPFE handbook states that around 15% of the US population is reported as having some form of disability. If similarities can be drawn from a Canadian census, then it could be estimated that three quarters of these disabilities are movement limiting. Tables 3-12.4, 3-12.5, and 3-12.6 of the SFPE Handbook show some quantitative data on the speed of movement of people with disabilities. This could have a significant impact on egress time in each of the tenant spaces located in the building under consideration, especially the stairs for the mezzanine.

Occupant Activities

According to Table 3-11.13 in the SFPE Handbook, almost 28% of a study population of Americans re-entered a fire scenario, and almost 23% of the same population fought the fire. This study included residential occupancies. The percentage of people to re-enter or fight a fire would probably be significantly lower for the building in question. However, it is not inconceivable that some people would return to a tenant space during a fire for items or people left behind. These people could have an effect on egress as they would be traveling against the flow, and may impede the movement of others.

Alarm Systems

Fire Detection Devices

Smoke detector

There is one smoke detector located in the fire alarm utility room above the fire alarm control panel (FACP). This is in accordance with NFPA 72 Section 10.4.4. The smoke detector is a 2-wire photoelectric type smoke detector. The model is D285, and is made by Bosch. It is assumed that this detector is attached to a D287 base. See Appendix C for smoke detector specifications and device locations drawing.

Duct Smoke Detectors

There are 4 duct smoke detectors located throughout the building. Information on the location of these detectors was unavailable and was thus assumed. One detector was placed over a kitchen area and the other 3 were placed in centralized areas of tenant spaces. See roof plan in Appendix C for duct smoke detector locations. The duct smoke detectors in use are SL-2000 detectors manufactured by Air Products and Controls Inc. These detectors will shut down their respective attached RTU units in the case of an alarm state. They are also equipped with trouble relay contacts that supervise the input power, presence of the detector cover, and removal of the detector head. See data sheet in Appendix C for duct detector specifications.

Sprinklers

Four different sprinkler models were used in the sprinkler system for this building. Most sprinklers were wet system sprinklers. However, in outdoor areas and the trash room, dry head sprinklers were utilized. All of the sprinkler heads act as fixed temperature heat detectors. Glass bulbs located in the sprinkler heads are filled with a certain liquid. When enough heat is absorbed by this bulb, gas inside the bulb will expand and shatter the bulb. This actuates the sprinkler and begins the

flow of water. Almost all sprinkler heads are designed to actuate at 155 degrees Fahrenheit in this building. However, two of the sprinklers are designed to actuate at 200 degrees Fahrenheit because they are located above ceramic firing kilns. See Appendix D for sprinkler drawing and the location of sprinklers in the kiln room.

Other Initiating Devices

Water Flow Switch

There is a water flow switch located near the sprinkler riser. This will relay an alarm signal back to the FACP when water begins to flow, and allow sprinklers to act as alarm signaling devices. The water flow device is a model AFD40, made by System Sensor, and is designed for a 4-inch pipe. See Appendix C for data sheet and specifications of water flow device.

Pull Stations

Pull stations are located at the entrance to each tenant space. All tenants are responsible for providing fire protection equipment in their respective spaces. Pull station models differed from space to space. Due to this, and lack of drawings, all pull stations were analyzed as the E-278 Edwards Signaling pull station. This type of pull station is a double action manual station. See Appendix C for data sheet on pull station specifications.

Detector Code Compliance

Almost all fire detection devices found in Building 310 are sprinkler heads. These all follow the spacing requirements for the sprinkler system, and follow NFPA 13. This has been analyzed in more detail in the suppression section of this report. See sprinkler drawing in Appendix D for sprinkler locations. All detectors are compliant with code.

Fire Alarm System and Signal Requirements

The fire alarm control panel utilized by the building is an Intelliknight 5808, and is made by Honeywell. This panel receives tamper, alarm, and trouble signals from

the entire building. An annunciator is built into the FACP. Originally the design called for a Silent Knight 5208 FACP, but has been updated. The FACP is attached to an SK 5496 power module. This attachment allows for 4 output circuits and additional power for the FACP. The FACP is also connected to the AES Intellinet 7750-F-8 RF subscriber unit. This wireless communicator alerts the central station monitoring system to alarm, tamper, and trouble signals received at the FACP. See data sheets in Appendix C for FACP and attachment specifications.

Sections 10.10, 10.12, 10.13, 10.14, and 10.15 of NFPA 72 apply to this alarm system. Section 10.10 of NFPA 72 states that all signals need to be distinct from each other. Section 10.12 of NFPA 72 stipulates that the allowable time lag between activation of an initiating device and annunciation at the control panel is 10 seconds. It also deals with the requirements for deactivating an alarm signal. Section 10.13 deals with deactivation of notification appliances. Audible and visible notification appliances should deactivate simultaneously. Section 10.14 deals with supervisory signals. The allowable time lag between activation of a supervisory signal and visible or audible notification is 90 seconds. This section also describes the stipulations for deactivation of supervisory signals. Section 10.15 deals with trouble signals. It details the requirements for setting a trouble signal back to normal, and the time lag allowable for the FACP or other specified location to receive notice of this. The procedures for deactivating trouble signals are also covered in this section. All of these signals should be protected to ensure that only authorized personnel have the capability of deactivating them, and resetting the system.

Notification Devices

No plans of current tenant spaces, and little information was available in determining types of notification devices. All audiovisual devices were assumed to be horn strobes rather than just strobes. This was done to ensure conservative voltage drop and power calculations.

Horn Strobes

The ceiling mounted horn strobes are System Sensor PC2R horn strobes. Wall mounted horn strobes are P2R model horn strobes. The outdoor horn strobe is a System Sensor P2RK model. These are 2-wire, standard cd horn strobes. They have either 15 cd or 115 cd visual output. They have an 84 dB high temporal audible output. The 15 cd horn strobes are located in bathrooms. These are indicated with an asterisk on the device locations drawing in Appendix C. All other horn strobes are 115 cd. The outdoor horn strobe is made to be weather proof and is virtually identical to the indoor horn strobes otherwise. See Appendix C for data sheets, specifications, and device locations drawing.

Notification Appliance Code Compliance

The building has been designed as a business classification type building. Based on this, ambient noise was considered to have an average of 55 dBA (NFPA 72 Table A18.4.3). The sound output must be at least 15 dBA above ambient (NFPA 72, 18.4.3.1), which means that there must be a minimum sound level of 70 dBA in any area.

All horn strobes have a sound output of 84 dBA at 10 ft. Using the 6 dBA rule, the output will drop to 78dBA at 20 ft, 72dBA at 40 ft, and 70dBA at around 53 ft. The 115cd visual devices are appropriate for 55X55 ft rooms. See Table 18.5.5.4a and Table18.5.5.4b in Figure 3 below. This means that each horn strobe is adequate for a 53X53 ft room area, excluding bathroom horn strobes. All bathrooms are smaller than 20X20 ft and thus 15 cd horn strobes are adequate.

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

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

NA: Not allowable.

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

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

*This does not preclude mounting lens at lower heights.

Figure 3. Notification Appliance Spacing

Some areas in the building have questionable coverage or are not covered at all. One of these areas is a vacant tenant space. As an unoccupied space there are no notification appliances present, but they must be added once a new tenant moves in. The other is an area under the mezzanine in the pizza restaurant area. This area is technically covered if one were to look solely at horizontal distance from the adjacent horn strobes. However, the horn strobes are mounted over 20ft off of the ground. The area under the mezzanine has a height of about 10ft from floor to ceiling. It seems that the second floor of this area could block audio and visual output, and has questionable coverage. All other areas have adequate coverage.

Tenants in this building leave, and are replaced fairly frequently. During these times a fair amount of construction work can occur during the moving phase of the tenants. It follows that the ambient noise level in adjacent spaces would be much higher than designed for during these times. As such, the audibility of notification devices is most likely inadequate during these phases.

Power Calculations

The battery power for the fire alarm system must be capable of operating the system in a non-alarm mode for 24 hours, and an alarm mode for 5 minutes (NFPA 72, Section 10.6.7.2.1). A safety factor of 20% must also be included in battery calculations. Table 5 summarizes the power calculations performed to check the required power supply for the alarm system. Table 6 summarizes the total amount of battery capacity required for the system. See Appendix C for calculations of values in Table 6. The required battery capacity is 8.5 amp-hours. The system has two 12 amp-hour batteries, so the secondary power is more than adequate.

Table 5. Power Calculations

Part and Description	**QTY**	**Standby Current (mA) Per Unit**	**Alarm Current (mA) Per Unit**	**Standby Current (mA) Total**	**Alarm Current (mA) Total**
SK-5808 Fire Panel	1	170	365	170	365
SK-5496 Power Module	1	40	160	40	160
Smoke Detector D285	1	0.08	100	0.08	100
Duct Smoke Detector	4	14	68	56	272
Horn/Strobe Wall	8	0	218	0	1744
Horn/Strobe Ceiling	11	0	218	0	2398
Horn/Strobe Bathroom (15cd)	7	0	79	0	553
Pull Station	17	0.35	0.5	5.95	8.5
Waterflow Switch	3	0.3	0.3	0.9	0.9
			Total (mA)	272.9	5601.4

Table 6. Required Battery Capacity

Total Standby Current Required (amps)	6.6
Total Alarm Current Required (amps)	0.5
Safety Factor	1.2
Required Battery Capacity (amp-hours)	8.5

Voltage Drop Calculations

Table 7. Voltage Drop Calculations

NAC#1 (orange)			
Device	Qty	Current Draw Per Device (amps)	Total
15cd Horn Strobe	2	0.079	0.158
115cd Horn Strobe	7	0.218	1.526
		Total	1.684
Length (ft)	Resistance (ohms/1000ft)	Voltage Drop	% Voltage Drop
130	1.98	0.87	3.6
Voltage at last Device		19.43	
NAC#2 (red)			
Device	Qty	Current Draw Per Device (amps)	Total
15cd Horn Strobe	3	0.079	0.237
115cd Horn Strobe	8	0.218	1.744
		Total	1.981
Length (ft)	Resistance (ohms/1000ft)	Voltage Drop	% Voltage Drop
170	1.98	1.33	5.6
Voltage at last Device		18.97	
NAC#3 (green)			
Device	Qty	Current Draw Per Device (amps)	Total
15cd Horn Strobe	1	0.079	0.079
115cd Horn Strobe	5	0.218	1.09
		Total	1.169
Length (ft)	Resistance (ohms/1000ft)	Voltage Drop	% Voltage Drop
130	1.98	0.60	2.5
Voltage at last Device		19.70	

*Note: Wire size is 12 AWG

Voltage drop calculations were performed in order to ensure that all notification appliance circuits (NACs) were adequate in terms of voltage drop and current usage. The results of these calculations are summarized in Table 7 above. Each NAC has a 2-amp limit. No plans were available for NACs, or any circuits, and these had to be designed. The SK 5496 power adapter allows for 4 NAC circuits, or a combination of NAC circuits and auxiliary power. It was deemed that 3 NAC

circuits were adequate, and the last circuit was used for auxiliary power purposes. The minimum voltage at an operating device is 16 volts. All NACs had a much higher voltage at the location of their respective last devices. The NACs are adequate with regards to voltage drop. See Appendix C for drawing of NACs.

Inspection, Maintenance, and Testing

The property owner is responsible for all testing and maintenance (NFPA 72 Section 14.2.3.1). Inspection, testing, and maintenance must be carried out by qualified personnel in accordance with Section 10.5.3 of NFPA 72. This entails that they must be certified, registered, or licensed to inspect and test the fire alarm system. The building examined in this project is inspected and tested by Fire Protection Inc. See attached inspection forms in Appendix C. The property owner must retain as-built drawings, operation and maintenance manuals, and a written sequence of operations (NFPA 72 Section 14.6.1.1). Inspection and testing records must be retained until one year after the subsequent test (NFPA 72 Section 14.6.2.1). The code states that the system equipment shall be maintained according to manufacturer's instructions (NFPA 72 Section 14.5).

Prior to any testing or inspection all parties affected must be notified (NFPA 72 Section 14.2.4). This would include the building owner, staff, and all tenants. Additionally, prior to testing or inspection, system documentation must be provided to the service personnel by the building owner (NFPA 72 Section 14.2.5). This includes any system updates or alterations, wiring diagrams, floor plans, and specifications.

Visual inspections must be performed in accordance with Table 14.3.1 of NFPA 72, which lays out the inspection schedule of each item in the fire alarm system. The FACP, wireless communicator, and remote power supply must be inspected annually. The trouble signals, battery, smoke detector, pull stations, duct smoke detectors, and horn strobes must be inspected semiannually. The waterflow device and supervisory switches must be inspected quarterly.

Testing of the fire alarm system must be done in accordance with Table 14.4.3.2 of NFPA 72. This table stipulates that the entire system must be tested initially for acceptance. The code requires testing of any devices added. Also circuits must be

tested when any device on the circuit is removed. Additionally a test of 10% of the system must occur when software is updated. Control equipment, interfaced equipment, the main power supply, trouble signals, supervising station transmission equipment, the secondary power supply, batteries, pull stations, smoke detectors, duct smoke detectors, control valves, and notification appliances must be tested annually. Batteries must also undergo load voltage tests semiannually. The waterflow switch must be tested semiannually as well.

Suppression

Sprinklers

The system utilizes a wet sprinkler system containing automatic sprinklers. All of the sprinklers used are extended coverage sprinklers and are Tyco products. All sprinklers are wet type sprinklers except for those located outdoors or in the trash room. These areas utilize dry sprinkler heads.

Building Supply

A looped 12-inch main runs through the entirety of the surrounding shopping area. This main can provide 5000 GPM of flow. A static pressure of 145psi and a residual pressure of 120 psi are available at the riser. The supply comes in from the underground system and is piped through a 6-inch pipe above ground to the riser. See Appendix D for supply connection detail.

Riser

The riser is located in a separate room attached to the building. It is a 4-inch riser made by Simplex Grinnel. The riser contains a Tyco BFV-1 butterfly valve, a 4-inch central riser manifold with a test valve, and a pressure gauge. See Appendix D for riser detail.

FDC Connection

A fire department connection is located near the supply connection on the outside of the building. The piping to the connection contains a 4-inch check valve and a 4X1 drain elbow with a ball drip. See Appendix D for FDC connection detail. See Appendix D sprinkler drawing for locations of riser, FDC connection, and riser detail.

Special Consideration

Special consideration had to be taken for sprinkler design in the area with the ceramic kilns. The kiln room itself has an occupancy classification of Ordinary Hazard group I. Due to this, sprinkler flow and pressure to the area did not need to be increased. However, a higher temperature rating had to be used for the sprinklers above the kilns because of their heat production. These sprinklers have a temperature rating of 200 degrees Fahrenheit, whereas all others have a temperature rating of 155 degrees Fahrenheit. See Appendix D for location of kiln room.

Building Occupancy Classification and Design Criteria

All of the tenant spaces would classify as ordinary hazard I type occupancies except for the mercantile occupancies. The mercantile occupancies are ordinary hazard II occupancy. The building is classified as an ordinary hazard II type building in order to be conservative due to the presence of the mercantile occupancy areas.

Two areas were considered for calculation as the most demanding areas based on inspection. Their design criteria and results of demand calculations are summarized in Table 8 and Table 9 below. See drawings in Appendix D for locations of each area.

Table 8. Calculated Area 1	
Occupancy Classification	Ordinary Hazard II
Design Density	0.2 gpm/sq. ft
Area of operation	1500 sq. ft
Sprinkler Type	Extended Coverage
Sprinkler Models	TY5137-Upright, TY5339- Sidewall
Sprinklers Operating	11
K-factor	11.2
Hose Stream Allowance	250 GPM
Duration of Supply	90 min
Demand at Supply Node (Computer Calculation)	
Flow (including HSA)	967.7 GPM
Pressure	138.65 psi
Demand at Supply Node (Hand Calculation)	
Flow (including HSA)	973 GPM
Pressure	124.5 psi

Table 9. Calculated Area 2	
Occupancy Classification	Ordinary Hazard II
Design Density	0.2 gpm/sq. ft
Area of operation	1500 sq. ft
Sprinkler Type	Extended Coverage
Sprinkler Models	TY5137-Upright, TY3335- Sidewall
Sprinklers Operating	12
K-factor	11.2, 5.6
Hose Stream Allowance	250 GPM
Duration of Supply	90 min
Demand at Supply Node (Computer Calculation)	
Flow (including HSA)	920.87 GPM
Pressure	89.36 psi

Calculations

The most demanding area was found readily using inspection and the program Autosprink Version 11. However, the branch lines are not symmetrical so the traditional method of substituting a K value for a branch line could not be used. Due to this asymmetrical setup, the most demanding branch line was found to be the middle branch line, and not the branch line farthest from the riser. Because of this, the method for finding the required flow in the other two branch lines was iterative in nature, and the program EES was used as a solver for these lines. See Appendix D for hand calculations and computer calculations.

Software Used

The software used for the computer calculation values was Autosprink VR11. EES was also used for part of the hand calculations. All sprinklers had to be approximated, as none of the exact models were found within the Autosprink system.

Computer Calculations Vs Hand Calculations

The computer calculations and hand calculations for the most remote area are fairly similar. The computer calculated demand for flow and pressure are 967.7 GPM and 138.65 psi respectively. The demand for flow and pressure from the hand calculations are 973gpm and 124.5 psi respectively. The difference between the two calculation methods is less than 10% and much of this discrepancy is likely due to rounding in the hand calculations.

Over Design of Sprinkler System

Calculated area 1 was the most demanding so it was considered for further analysis. A normal sprinkler system designed for ordinary hazard II requires 300 GPM of flow. The spacing for the sprinklers in this area is 16ft by 16ft. The required amount of flowing sprinklers would usually be 6 sprinklers. The area also has 3 sprinklers under a canopy as required by NFPA 13, Section 8.15.7. This would result in a total requirement of 9 sprinklers. However, the design has 11 flowing sprinklers. After further analysis it has been determined that one of the branch lines and 2 of the sprinklers found in the most demanding area are unnecessary if the design of the sprinkler system is adjusted. The removal of this branch line would significantly reduce flow and pressure demand, and the resulting demand would be closer to what is expected in this scenario. See Appendix D for drawings, and recommended changes.

Inspection, Testing, and Maintenance

Maintenance of the sprinkler system is the responsibility of the site property manager. A contract for a sprinkler contractor to perform routine maintenance, testing, and inspection is in place. The contractor does inspections annually. On site maintenance crews do routine cleaning of the sprinkler room. They do visual inspection to the extent that leakage or severe corrosion will be reported to the building manager. NFPA 25 must be followed for all maintenance, testing, and inspection procedures. New inspections must be carried out every time there is a change in building occupancy, reduction in water supply, change in building structure or interior, or changes with the water meter or backflow preventer. See

tables from NFPA 25 in Appendix D. Table 10 below summarizes specific maintenance requirements for the sprinkler system.

Table 10. Sprinkler System Maintenance Requirements

System Component	**Maintenance Requirements**
Sprinklers	Most of the sprinkler system must be tested after 50 years, and every 10 years after that. There are 9 sprinklers in the system that are classified as dry sprinklers. These must be tested every 10 years. 1% or a minimum of 4 of the sprinklers should be tested. 6 sprinklers must be kept on site for extra supply. <u>Things to look for during inspection:</u> Correct installation of sprinklers with regards to the type of sprinkler (pendent, upright, sidewall) Note the type of sprinkler installed, date of installation, and year of manufacture Check to ensure that all sprinklers have the proper termperature rating Any sprinklers showing signs of loading, corrosion, or unauthorized painting must be replaced. Proper coating should be applied to avoid corrosion

Valves	Should be inspected annually. Valves should be cleaned and replaced based on manufacturer's instructions.
Pipe and Fittings	The piping and fittings must be inspected annually. The inspector should check for leaks, corrosion or things hanging off of pipes.
Signs	Should be inspected annually. The inspector must ensure that they are not absent, legible, and attached.
Standpipe and Hose System	The standpipe system should be inspected annually. Any damage to piping or valves will require repair or replacement.
Building	The inspector must check the building annually prior to the time of freezing temperatures. During this time pipes must be kept above 40 degrees Fahrenheit or an antifreeze solution must be utilized. Buildings should be inspected in the spring after freezing times have passed as well.
Hangers and Seismic	Inspection of hangers should occur annually.

Bracing	The inspector will look for damage, corrosion, loose supports, and ensure that nothing is hanging off of the supports. Any seriously corroded or damaged supports must be replaced.
Gauges	Gauges should be checked annually by the inspecting party. The inspector must make sure that they are in working condition and that the water supply pressure is being maintained. Gauges should be tested every 5 years.
Fire Department Connection	Should be inspected quarterly. Ensure that connections are visible and undamaged.
Special Considerations	Maintenance crew or crew of pizza establishment must clean ovens monthly. Due to the combustion of solids with these ovens they present a significant fire hazard if not cleaned.

Performance Based Design

Tenability criteria in performance-based design is based off of the idea that available safe escape time (ASET) must be greater than required safe escape time (RSET). The required safe escape time involves various factors (see Figure 4 below). The evacuation time for RSET can be calculated by hand or using an egress computer model such as PATHFINDER. ASET is calculated using computer modeling, and will be done with Fire Dynamics Simulator (FDS) and Pyrosim in this report.

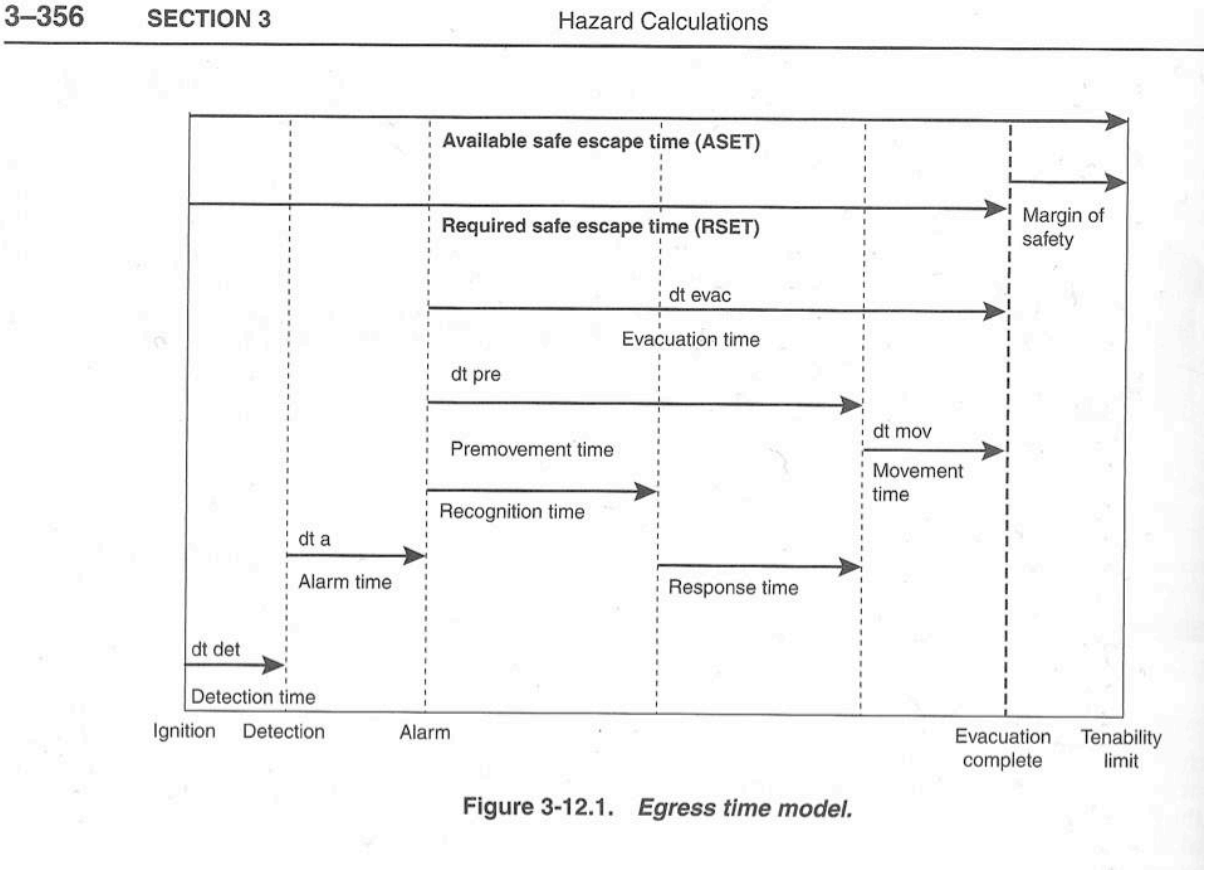


Figure 4. ASET and RSET

Hand Calculated Egress Time

The SFPE method as described in section 3 Chapter 13 of the SFPE handbook was used to calculate a total egress time of 2.27 minutes for the entire building. See Appendix E for calculation of this egress time.

Assumptions

Various assumptions were made in order to perform the calculation of egress time. It is impossible to judge the actions of occupants during a real fire scenario, and it would be impossible to try and calculate any sort of egress time without making assumptions. The first assumption was made specifically for the building analyzed, and the remaining assumptions are made whenever the SFPE method is used to calculate egress time. These assumptions are listed below.

1. Assume that the pizza restaurant space is the limiting space for egress time based on inspection. The space has the most occupants by far, and has a stairway that will limit egress.

2. Assume that either stairways or doors will be choke points, and thus control egress from the area. This results in the assumption that calculated flow rate is the same as the maximum flow rate for exits.

3. Assume all occupants use exits optimally.

4. Assume all occupants start evacuation at the same time.

Uses and Limitations

Many of the assumptions stated above would not be accurate in a real life scenario. The method used for calculating egress time ignores all factors affecting pre-movement and movement mentioned earlier. Many occupants are alerted to the occurrence of a fire by notification of another occupant. This would mean that the assumption of occupants starting evacuation simultaneously is highly idealized. Occupants using exits optimally is also an idealization. It does not account for collisions or decision making of occupants. The assumption of a constant steady

flow rate is also an idealization. Changes in density in certain areas, and differences in speed between occupants would affect the flow rate of people. Based on these factors, the calculated egress time should be considered a minimum value.

Computer Model

Pathfinder version 2014.3.1020X64 was utilized to model the building. Occupants were placed randomly. Geometry was imported into Pathfinder from Autocad 3d.

Behavior Modes

Two different behavior modes are available for use in Pathfinder. These modes are Steering Mode and SFPE Mode. SFPE mode does not consider each occupant in 3d space. This means that occupants can occupy the same space in the model. They are controlled by the flow rates calculated through exit doors and stairways. This mode uses the assumptions outlined above, and in the SFPE handbook. In Steering Mode, the occupants do occupy 3d space. They are assigned a 1-foot comfort distance. This means that they will attempt to keep a 1 foot distance between each other at all times. This mode also accounts for collisions. Occupants essentially try to optimize travel by avoiding obstacles and moving to the nearest exit. See Appendix E for examples of Steering and SFPE modes.

Comparison to Hand Calculation

The time for all occupants to evacuate in SFPE Mode was 2.12 minutes, and 1.76 minutes in Steering Mode. The hand calculation yielded an evacuation time of 2.27 minutes, which is very close to the calculated evacuation time provided by Pathfinder's SFPE mode. This makes sense as this mode and the hand calculation are based off of the same assumptions. Steering Mode, which accounts for collisions in 3d space, and is not based off of door flow limits, has a faster calculated egress time.

Uses and Limitations

Pathfinder is based off of optimization in many regards. All occupants begin evacuation at the same time. There is no consideration of decision making of

occupants. For instance, no occupants go against the flow of egress or decide to use a different door than they had originally intended. There are various complexities to pre-movement and movement of occupants that would be very hard if not impossible to model with a computer program. Due to these things, the Pathfinder simulation should be used as a minimum estimate, and not a stand-alone method of determining egress time in a building.

Tenability

There are four allowable methods that can be used for the performance-based design of a building in the life safety code. These methods are outlined in section A.5.2.2.

FED

Additionally, Fractional Effective Doses(FED) can be used to estimate the exposure of occupants to untenable conditions with regards to time. This method is used to measure incapacitation or death due to fire exposure of occupants with regards to time. The procedure of the method is outlined in section 2, chapter 6 of the SFPE Handbook.

Fire Scenario 1

Kitchen Fire

According to FEMA, cooking fires were the cause of 46.3% of confined fires, and 10.3% of unconfined fires in restaurants between 2007 and 2009 (See Table 11 and Figure 5). This makes them the leading ignition source in restaurants, and it was assumed for this report that this trend currently continues. The ignition source for the restaurant fire in scenario 1 was a cooking fire based on this data.

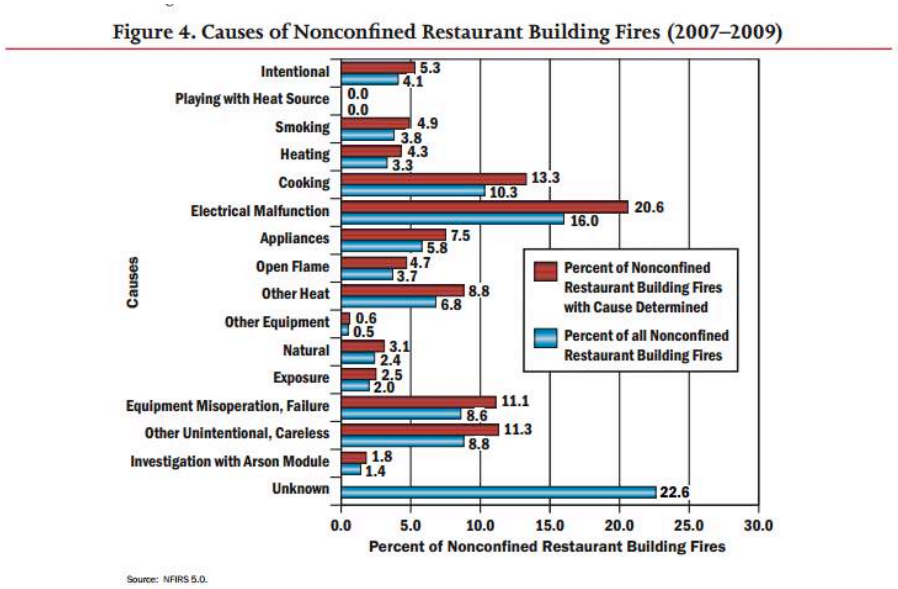


Figure 5. Causes of Restaurant Fire

Table 11. Restaurant Fires by Type

Table 1. Restaurant Building Fires by Type of Incident (2007–2009)

Incident Type	Percent
Confined fires	57.1
Cooking fire, confined to container	46.3
Chimney or flue fire, confined to chimney or flue	3.4
Incinerator overload or malfunction, fire confined	0.2
Fuel burner/boiler malfunction, fire confined	1.9
Commercial compactor fire, confined to rubbish	0.2
Trash or rubbish fire, contained	5.0
Nonconfined fires	42.9
Total	100.0

Source: NFIRS 5.0.

Source: "Restaurant Building Fires." *Topical Fire Report Series* 12.1 (2011). *FEMA*. FEMA. Web. <http://www.usfa.fema.gov/downloads/pdf/statistics/v12i1.pdf>.

The first fire scenario analyzed consists of a cooking oil ignition source that spreads to a nearby pallet load of food packaging items. It is regular practice in the pizza restaurant for employees to stack food items in the kitchen during the storage process for food items.

Model

The heat release rate value for the cooking oil ignition source was modeled as 116 kw based on a value found in a study done by Hyeong Jin-Kim and David G. Lilley.[1] The heat release of the pallet was then added to this value to get the total heat release rate of the fire. A heat release rate(HRR) for a single pallet of packaged fruit/berry baskets is available from the SFPE Handbook. See Appendix E for a graph of heat release rate versus time for this fuel load. The fire size has been modeled with the same footprint as Pallet A in Table 3-1.2 of the SFPE Handbook. The fire used for simulation has dimensions of 0.75x1.14x1.22m. The heat release rate used for the FDS simulation can be seen in Figure 6 below. The pallet was placed directly adjacent to the cooking stoves.

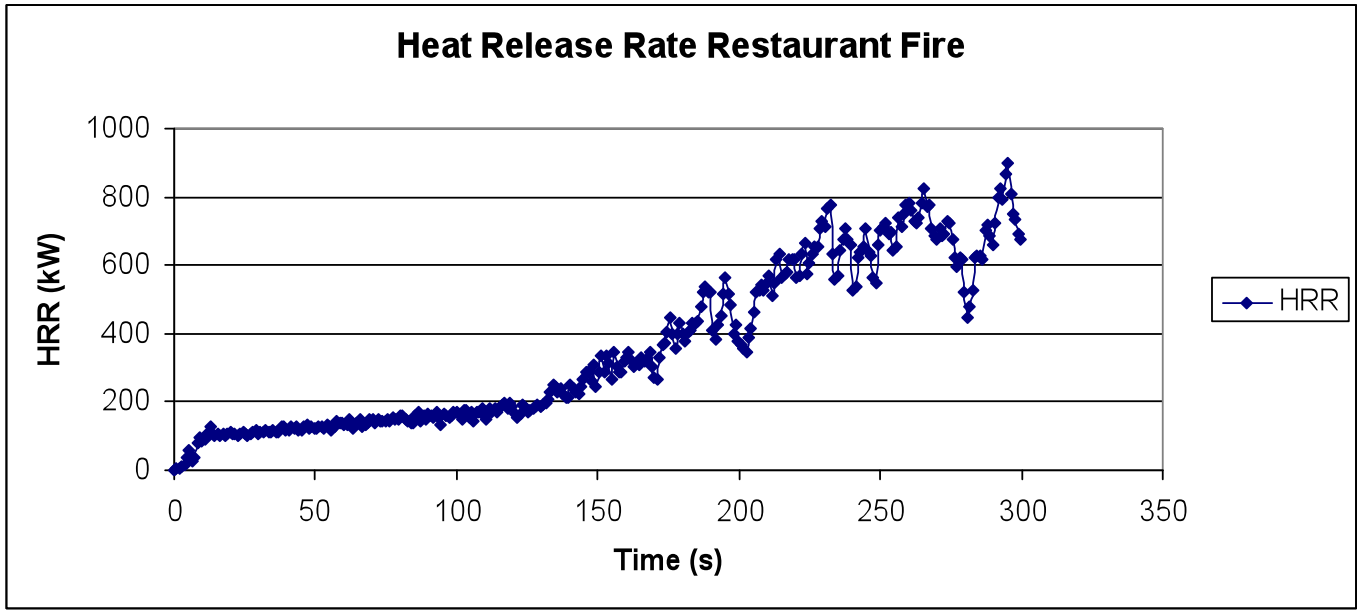


Figure 6. Simulation Heat Release Rate for Restaurant Fire

Soot yield was determined using Table 3-4.16 of the SFPE handbook. The oil was modeled as a hydrocarbon. The pallet of food packaging was modeled as corrugated paper with PET. These have soot yields of 0.059 and 0.053 respectively. Based on the size of each component contributing to the overall fire a soot yield of 0.055 was chosen for simulation.

The DETACT (Detector Actuation) method was used to analyze sprinkler response. This is in accordance with Annex B (B.6.1) of NFPA 72. This method models the heat release rate, gas temperature, and detector temperature relative to time elapsed. See Figure 7 below for a graph of these values for fire scenario 1. It was assumed that the sprinkler had an RTI of 120 $(m\text{-}s)^{1/2}$ based on information found in NFPA 13. This code states that standard response sprinklers have an RTI rating of 80 $(m\text{-}s)^{1/2}$ or more (section 3.6.1, 2013), and the sprinklers used in this calculation are standard response.

Based on the HRR graph from the SFPE Handbook, the fire for this scenario reaches 1055 kW at approximately 200 seconds. This is between a medium and fast growth rate fire. This corresponds to a t-squared fire having an alpha value of 0.0264. This value was used for DETACT calculation purposes and yielded a sprinkler activation time of 267 seconds. See Table 12 below for input parameters, and Appendix E for DETACT spreadsheet values.

Table 12. DETACT Input Parameters

Input	Value	Units	Calc. Parameters	Value
Calculation reset	1	0 or 1	R/H	0.43
Ceiling height (H)	5.75	m	dT(cj)/dT(pl)	0.52
Room width (W)		m	u(cj)/u(pl)	0.40
Radial distance (R)	2.5	m		
Ambient temperature (To)	20	C	t squared coeff.	k
Actuation temperature (Ta)	68.3	C	slow	0.003
Rate of rise rating (ROR)	N/A	C/min	medium	0.012
Response time index (RTI)	120	(m-s)1/2	fast	0.047
Fire growth power (n)	2	-	ultrafast	0.4
Fire growth coefficient (k)	0.0264	kW/s^n		
Time Step	1	s		

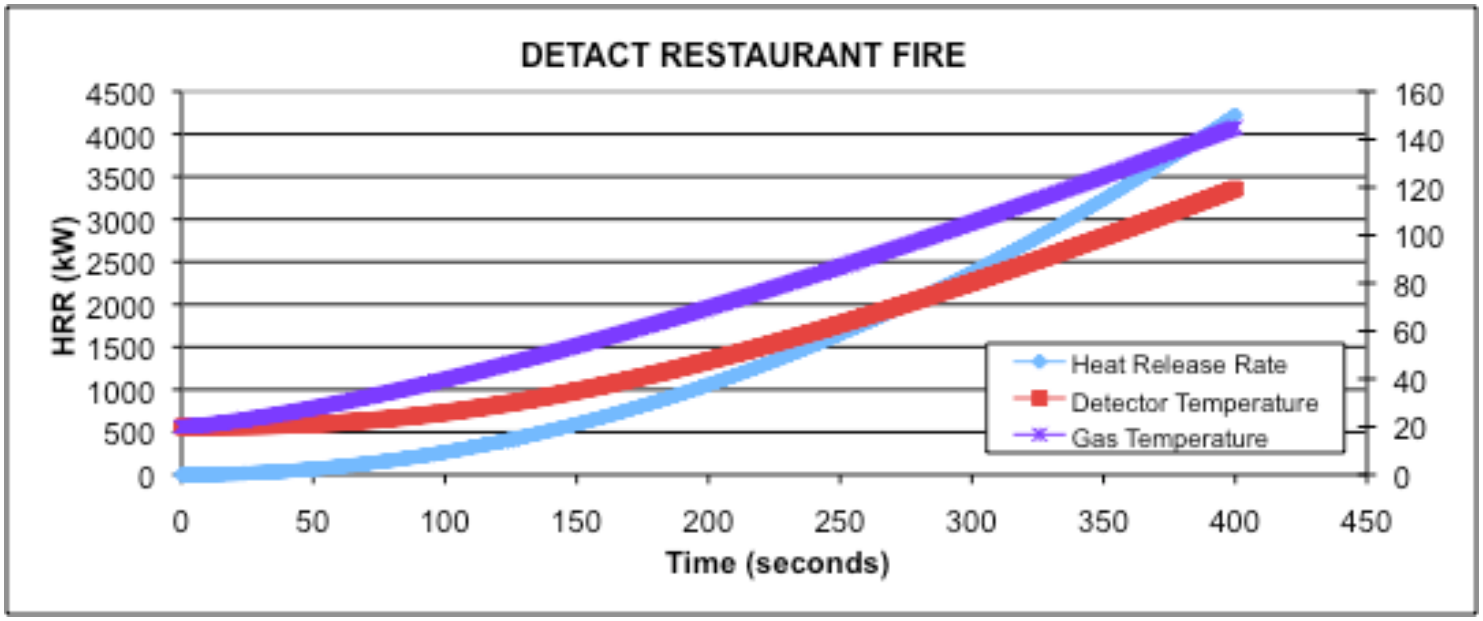


Figure 7. Restaurant Fire DETACT

According to FDS simulation results, sprinkler activation occurred at 234 seconds for this fire. This was fairly similar to the DETACT model results, which yielded a value of 267 seconds. The sprinklers were assumed to control but not suppress the fire. The HRR was then modeled as remaining at the HRR found at 234 seconds for the remainder of the simulation. Tenability limits are reached far before sprinkler activation, and the sprinklers played no part in the tenability analysis of this scenario.

Performance Based Egress

Method 2 of NFPA 101, A.5.2.2 was used to analyze this scenario. This method requires that all occupants evacuate an area before the smoke layer level of that area reaches a level 6ft above the ground or floor level. The program Pathfinder was used to simulate evacuation. Time to egress for the mezzanine in the pizza restaurant was 92s when steering mode was used and 110s when SFPE mode was used. The kitchen door was blocked by fire and all egress occurred through the other doors. See Appendix E for examples of the pathfinder model.

Hand Calculations

The loss of the kitchen door as a means of egress had no effect on the overall evacuation time of the room (see hand calculation in Apppendix E). The time to exit through doors was1.87 minutes after the removal of the door. This is still less than the exit time for the mezzanine, which was 2.27 minutes. Thus, the mezzanine exit time still controlled evacuation even with the loss of the kitchen door.

Pre-Movement Time

As discussed earlier, many factors can influence the movement time of occupants. The SPFE Handbook states in Section 3, Chapter 12, that many fire safety engineers use 15 to 30 seconds as their chosen pre-movement times for a building. This was considered an industry standard. Pre-movement time is based on recognition time and response time of occupants. As the room is open, the fire will be visible to occupants very quickly, and recognition time should be very small. Due to this, a pre-movement time of 30 seconds should be fairly accurate.

Results

Smoke layer height with respect to time was determined using a smoke layer device in FDS simulation. The tenability limit was reached on the mezzanine when the smoke layer descended to 4.84m. This occurred 103 seconds after fire ignition. Including pre-movement time, the tenability limit was reached well before occupants would have a chance to egress the mezzanine regardless of which pathfinder method is used. Steering mode yielded an RSET of 122 seconds including pre-movement time, and SFPE mode yielded an RSET of 140 seconds including pre-movement time. See Figure 8 below for an FDS image of the smoke layer height when it reached 4.84m, and the tenability limit was reached as well. See Appendix E for layer height device spreadsheet. The RSET of this scenario is greater than the ASET, and the design fails to meet the performance criterion.

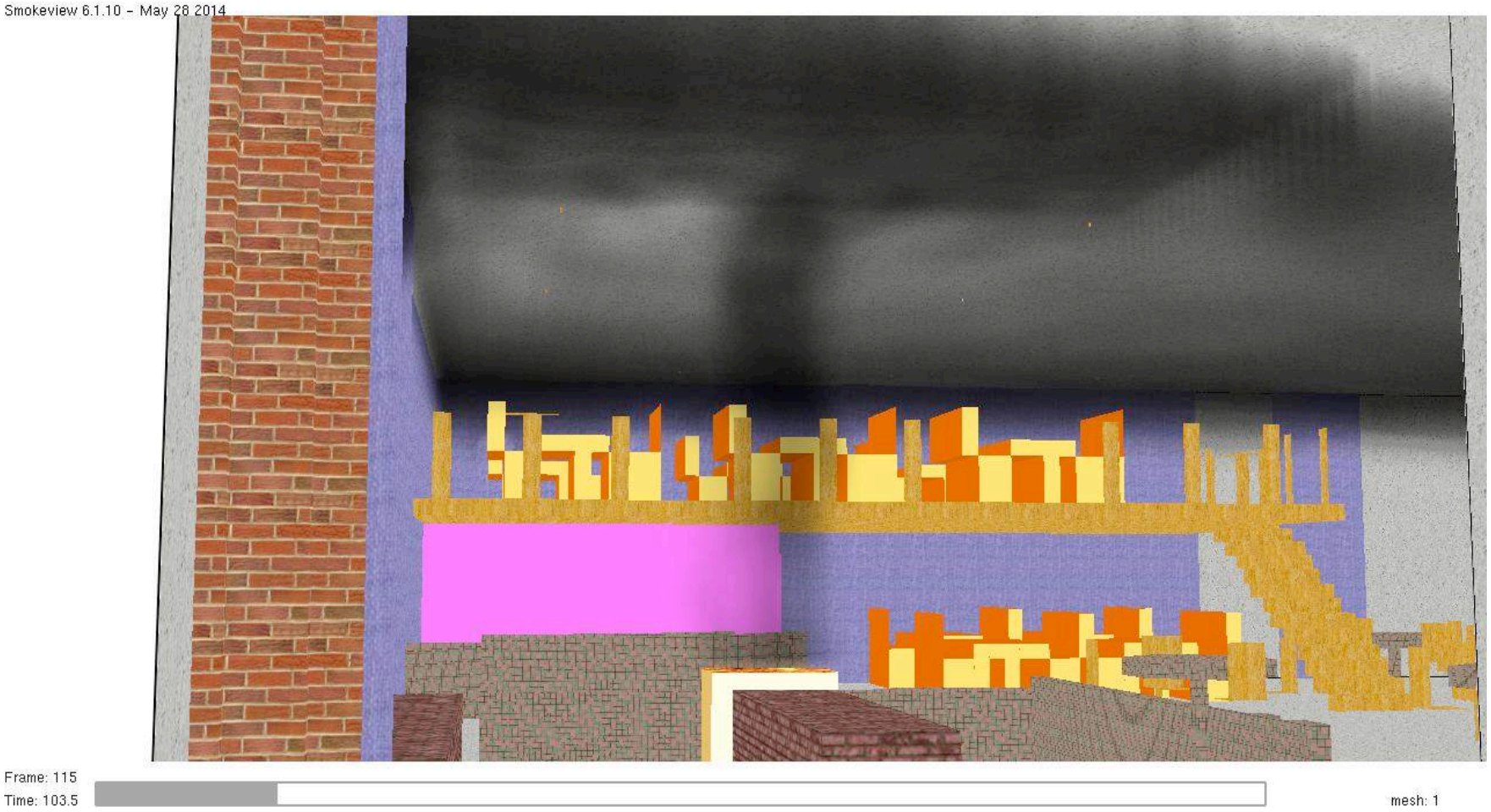


Figure 8. Smoke Filling Mezzanine as Tenability Limit is Reached

Fire Scenario 2

Office Fire

Fire scenario 2 consisted of an office fire in an insurance office. The ignition source was an electrical fire originating from a light source on a desk in the office. The fire then spread to the desk, papers, and office chairs. Electrical distribution and lighting equipment is the second largest cause of ignition in office type buildings (See Figure 9). The largest cause of ignition is cooking equipment. This office has no kitchen area, and electrical malfunctions then become the most probable cause of ignition for this scenario. An electrical ignition source was chosen for this reason.

It can be safely assumed that all occupants not in direct contact with the fire at the time of ignition would safely evacuate before conditions became untenable. There are only 9 occupants, and egress would occur quickly in this area. Due to this, the design was focused on reduction in property loss rather than life safety. Flashover was considered to be the point at which large property damage would be incurred. The goal of this scenario was to prevent flashover.

It is assumed that sprinklers, if activated, would control the fire and prevent flashover. Sprinklers were not included in analysis, and it was assumed that they failed to have any effect on the fire. Data from NFPA states that sprinkler systems fail to operate 12% of the time (see Table 13). This makes the assumption of sprinkler failure quite reasonable. It was also assumed that there was no attempt at suppression from the occupants. Instead suppression came from the fire department, and an FDS simulation was run to determine if flashover occurred in the office before the fire department arrived to extinguish the fire. The time for the Renton fire department to respond to a fire incident is available for 2012. See Figure 10 below. The graph shows the average time to respond, and the “fractal” time to respond. The fractal time corresponds to the 90^{th} percentile time of response. The fractal time was used in order to be conservative. This time is 7 minutes and 41 seconds. Additionally, some pre-movement time was assumed as well. It was assumed that sprinklers did not operate, and these are the only

automatic detection devices located in this area of the building. It was assumed that a pull station is the alarm-initiating device because of this. Estimating time to alarm initiation is very difficult as it can vary greatly on a case-by-case basis. Sections 3-11 and 3-12 of the SFPE handbook cover the concept of pre-movement time. For this scenario, it was assumed that the time to detection will be 30 seconds for the same reasons as those mentioned in the fire scenario 1 analysis. This was conservative based on the size of the fire area. Occupants should be able to initiate the fire alarms in less than 30 seconds. The overall time from ignition to the arrival of the fire department was 8 minutes and 11 seconds for the purposes of this simulation.

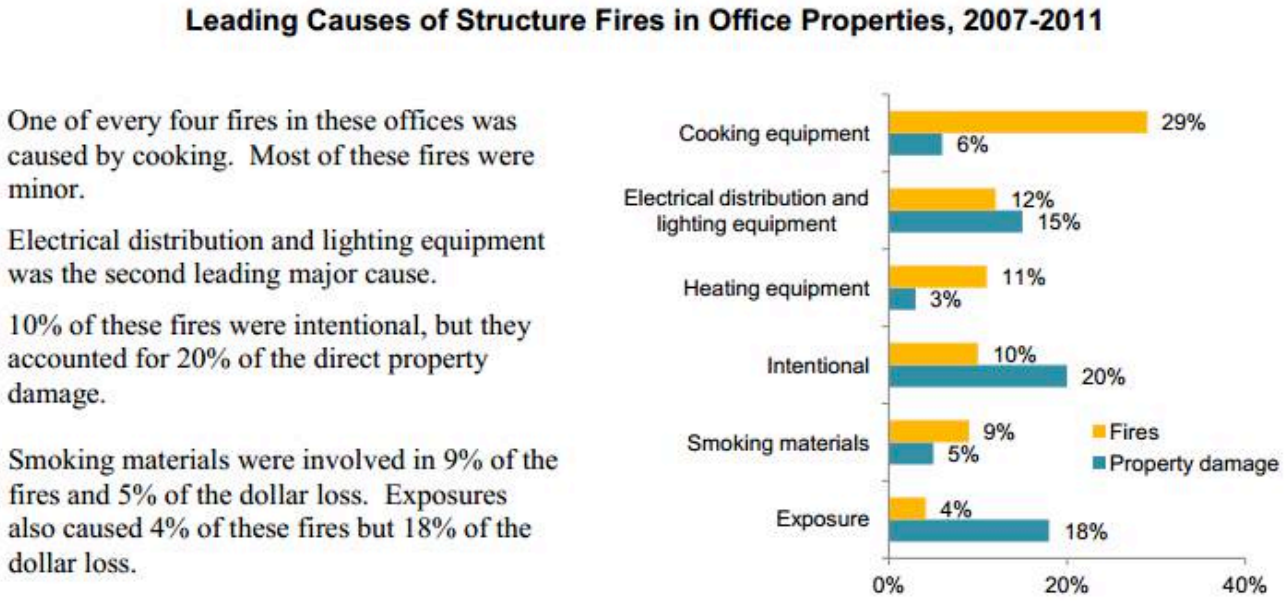


Figure 9. Causes of Office Fires

Table 13. Sprinkler System Effectiveness

Table B.
Sprinkler Systems in Office Structure Fires
2007-2011 Annual Averages*

Percent of structure fires in offices reporting some type of sprinkler present	33%
Percent of fires with wet pipe sprinklers in which sprinklers operated	90%
Percent of fires with wet pipe sprinklers present in which sprinklers operated effectively	88%
Reduction in average loss per fire when wet pipe sprinklers were present	46%

* Excludes properties under construction and fires where sprinklers were not present in the fire area.

Source: NFIRS 5.0 and NFPA survey.

Source: Campbell, Richard. *U.S. Structure Fires in Office Properties*. NFPA, 1 Aug. 2013. Web. <http://www.nfpa.org/~/media/Files/Research/NFPA reports/Occupancies/osoffices.pdf>.

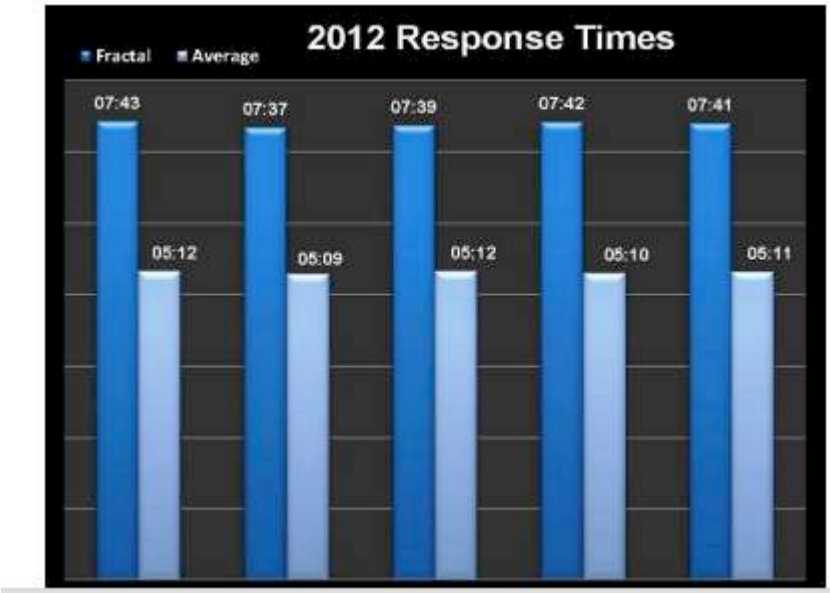


Figure 10. Fire Department Response Times

Source :"2012 Annual Report." *Renton Fire and Emergency Services* 1 Jan. 2012. City of Renton. Web. <http://rentonwa.gov/uploadedFiles/Government/FIRE/2012 Annual Report.pdf>.

Model

The heat release rate was modeled after a single office workstation fire taken from the SFPE Handbook pg 3-32(See Appendix F). A graph of the heat release rate used for the model in FDS is shown in Figure 11 below.

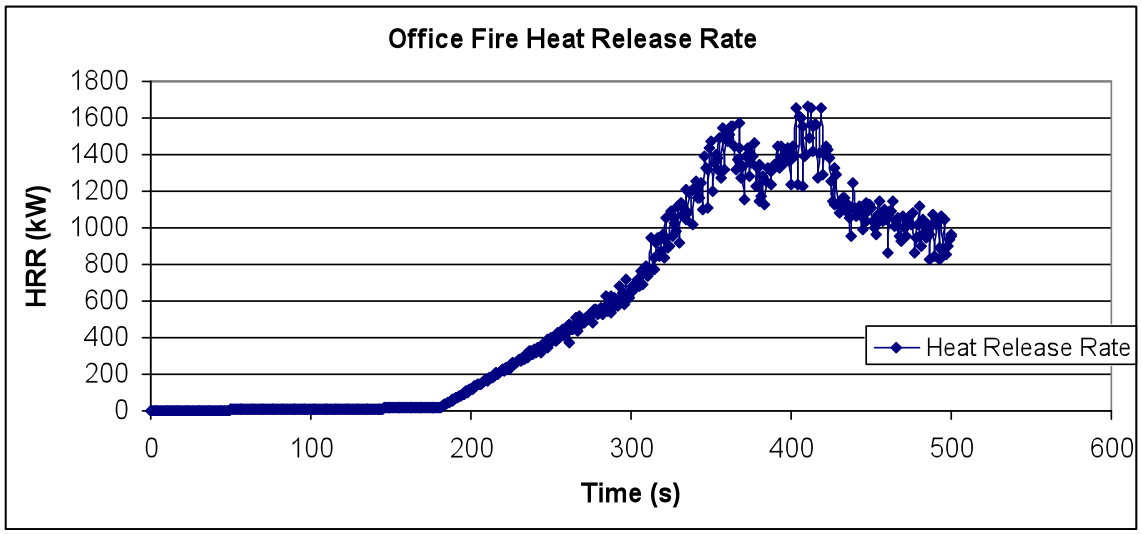


Figure 11. FDS Heat Release Rate for Office Fire

The office dimensions are 9X10X5.75 m. The mesh size used for the office was 72X80X48 cells. This resulted in cell sizes of 0.125X0.1219X0.1198. These cell sizes correspond to a mesh between a rough and moderate classification. Sensitivity analysis based on mesh size was not performed due to the length of calculation for one simulation. It was assumed that the fire blocked the rear exit and only the exit directly to the outdoors was open during the simulation.

Thermocouples with a vertical spacing of 0.5m have been placed near the center of the room in order to measure the temperature of the room with respect to time. One thermocouple was placed directly at the roof level as well. Additionally, temperature slice files have been placed in various locations throughout the room to measure temperature. One slice file was located directly across the fire and was used to measure the onset of flashover.

Gas temperature values of 500 or 600 degrees Celsius near ceiling height are associated with the onset of flashover (SFPE Handbook Pg 3-204). In order to be

conservative, a gas temperature value of 500 degrees Celsius was used as the flashover criterion for this fire scenario.

Results

Based on FDS analysis, the maximum gas temperature in the room before the arrival of the fire department was 471 degrees Celsius. This is fairly well below the 500 degree threshold and thus it can be safely assumed that flashover will not occur in this room even with the failure of the sprinkler system. See Appendix F for thermocouple device spreadsheet. See Figure 12 for a temperature slice file depicting the fire temperature at the time of firefighter arrival.

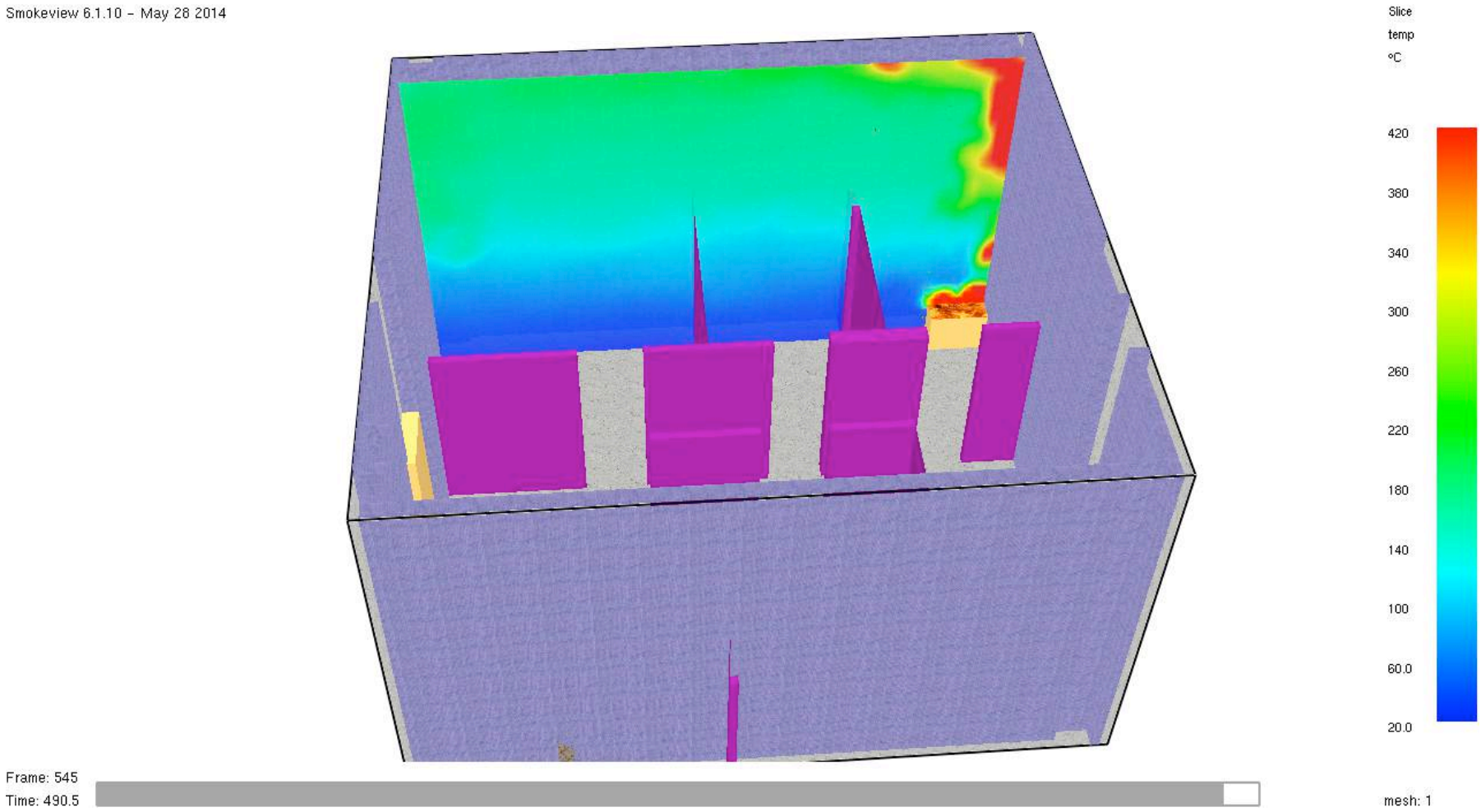
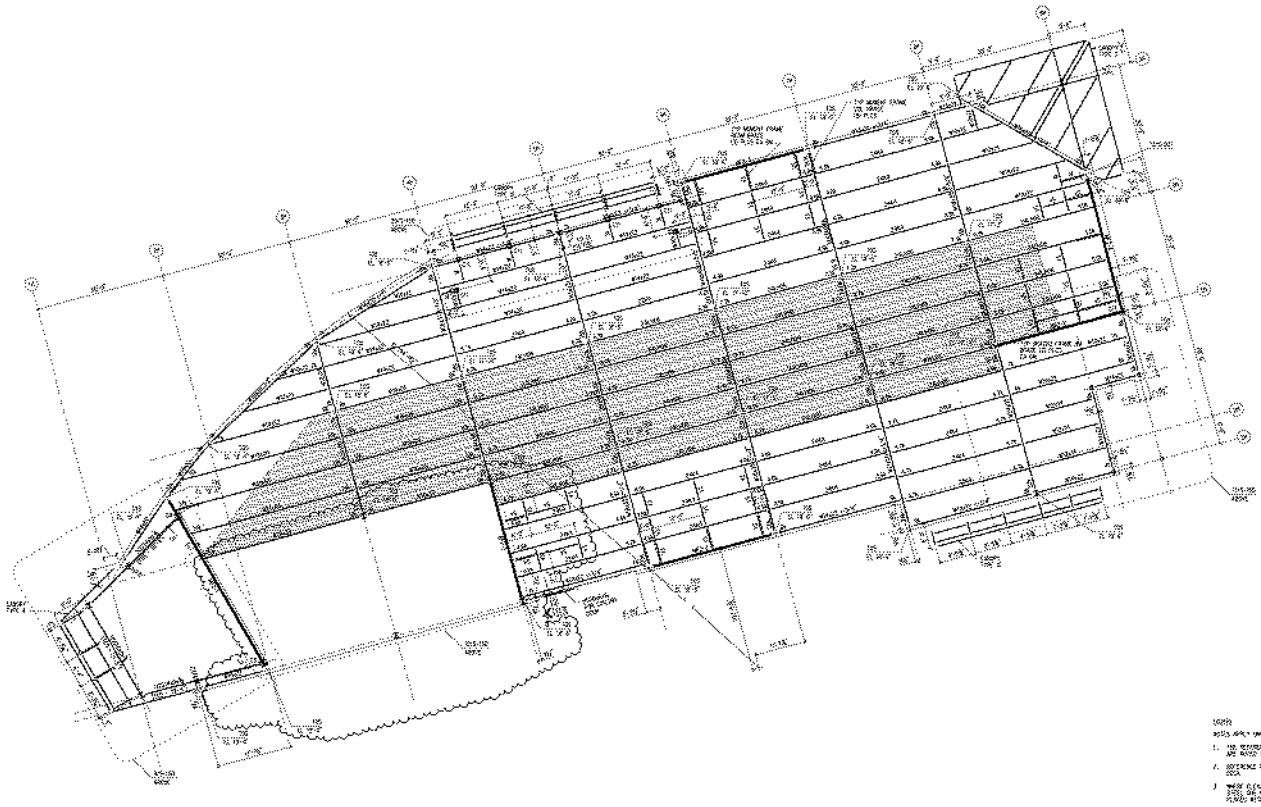


Figure 12. Temperature Slice at Time of Firefighter Arrival

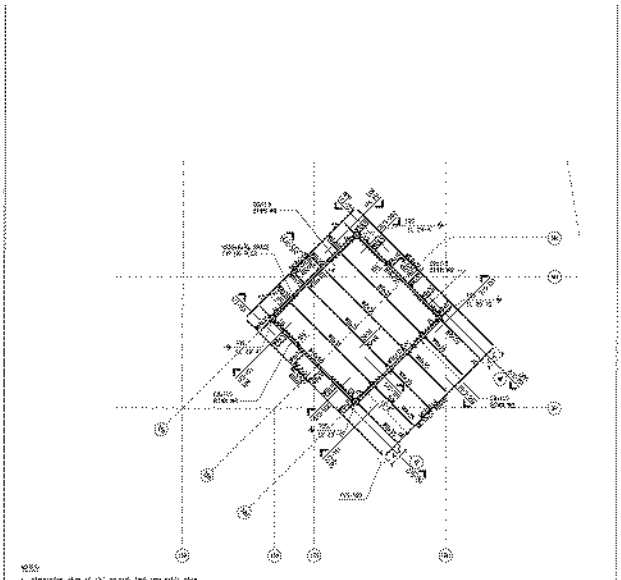
Summary and Conclusions

The building complies with all applicable codes except in one instance. The mezzanine in the pizza restaurant is in violation of code. The mezzanine should have two exits. This area does not meet the objectives of a performance based design or prescriptive requirements. Additionally, the building is overdesigned structurally. It could have been built with 1-hour rated walls, instead of 2-hour fire rated walls, due to the presence of a sprinkler system. The sprinkler system is also overdesigned, and could have been designed with at least one less branch line.

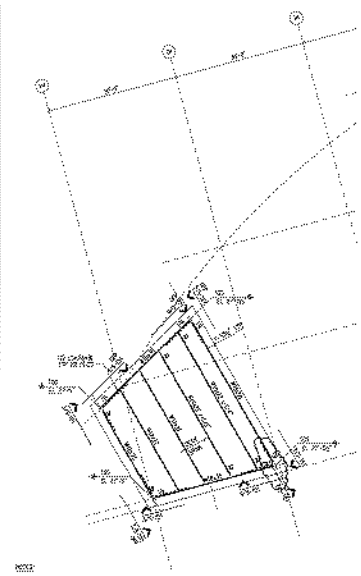
Appendix A- Prescriptive Structural Attachments



ROOF FRAMING PLAN



PARTIAL PLAN



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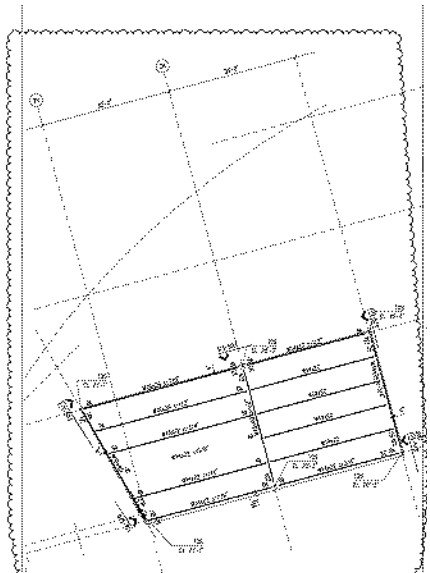

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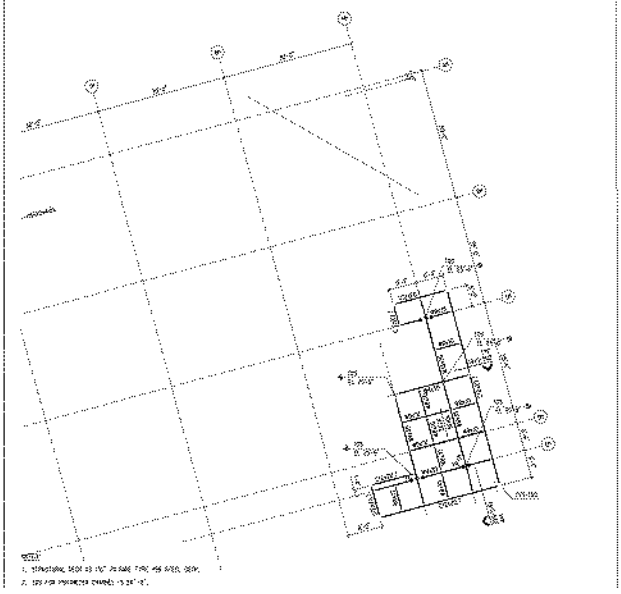
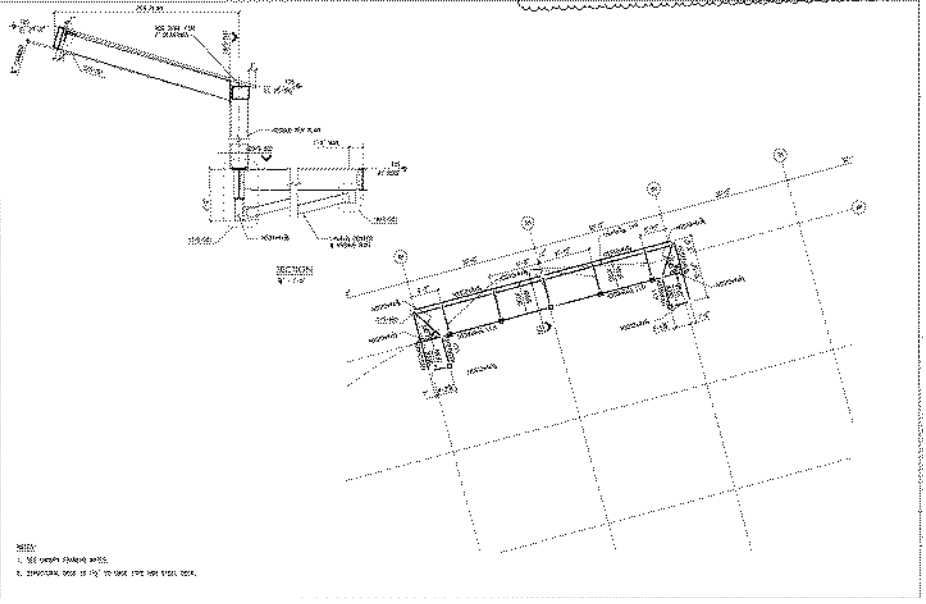




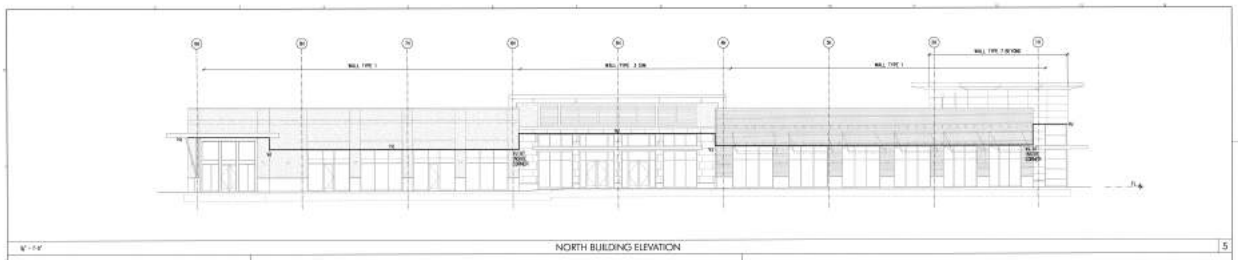
SECTION

STEEL COLUMN SCHEDULE

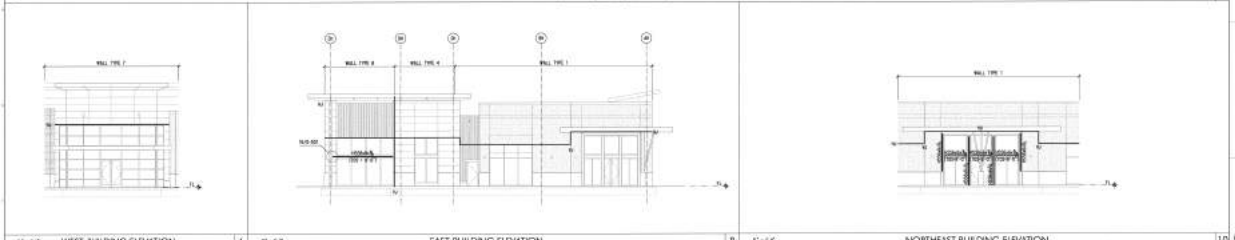
MARK / LEVEL	C1	C2, C2A	C3, C3A	C4, C4A	C5	C6	C7	C8	C9	C10	C11
HIGH ROOF											
ROOF					P12		HSS4x4x¼	W10x45			HSS8x8x⅜
	W10x33	W10x45 @ C2 W10x45	HSS8x8x⅜ @ C3 HSS6x6x½ @ C3A	HSS8x8x⅜ @ C4 HSS8x8x⅜ @ C4A	CONC PIER	W10x45			HSS6x4x½	P6 CONC PIER	
BASE PL SIZE TxWxL	PL¾x9x0'-11"	PL¾x9x0'-11"	PL¾	PL¾	PL¾	PL¾x9'x0'-11"	PL¾	PL¾	PL¾	PL¾	PL¾
BASE PL TYPE	1	1	2	2	2	1	4	3	2	2	3

NOTES:

1. SPLICE COLUMNS PER TYPICAL SPLICE DETAIL.



NORTH BUILDING ELEVATION



WEST BUILDING ELEVATION

EAST BUILDING ELEVATION

NORTHEAST BUILDING ELEVATION

SOUTH BUILDING ELEVATION

THE LANDING
PACKAGE II
RENTON, WASHINGTON

SITE KEY PLAN

BUILDING 310
EXTERIOR ELEVATIONS

S-712-H

Building area modifications

$W \Rightarrow 30$ ft (IBC 2012, 506.2)

$P = 680$ ft

$F = P$ (all sides have open space >20 ft)

$I_f = [F/P - .25] W/30$ (eq. 5-2)

$I_f = [1 - .25](30/30) = .75$

$I_s = 3$ (506.3) $\Rightarrow$ one-story $\Rightarrow$ mezzanine doesn't count as another story (505)

$A_a = (A_t + [A_t \cdot I_f] + [A_t \cdot I_s])$ (eq. 5-1)

$A_{building} = 24{,}000\ ft^2$ Group A-2

Type V-B, $A_t = 9000\ ft^2$

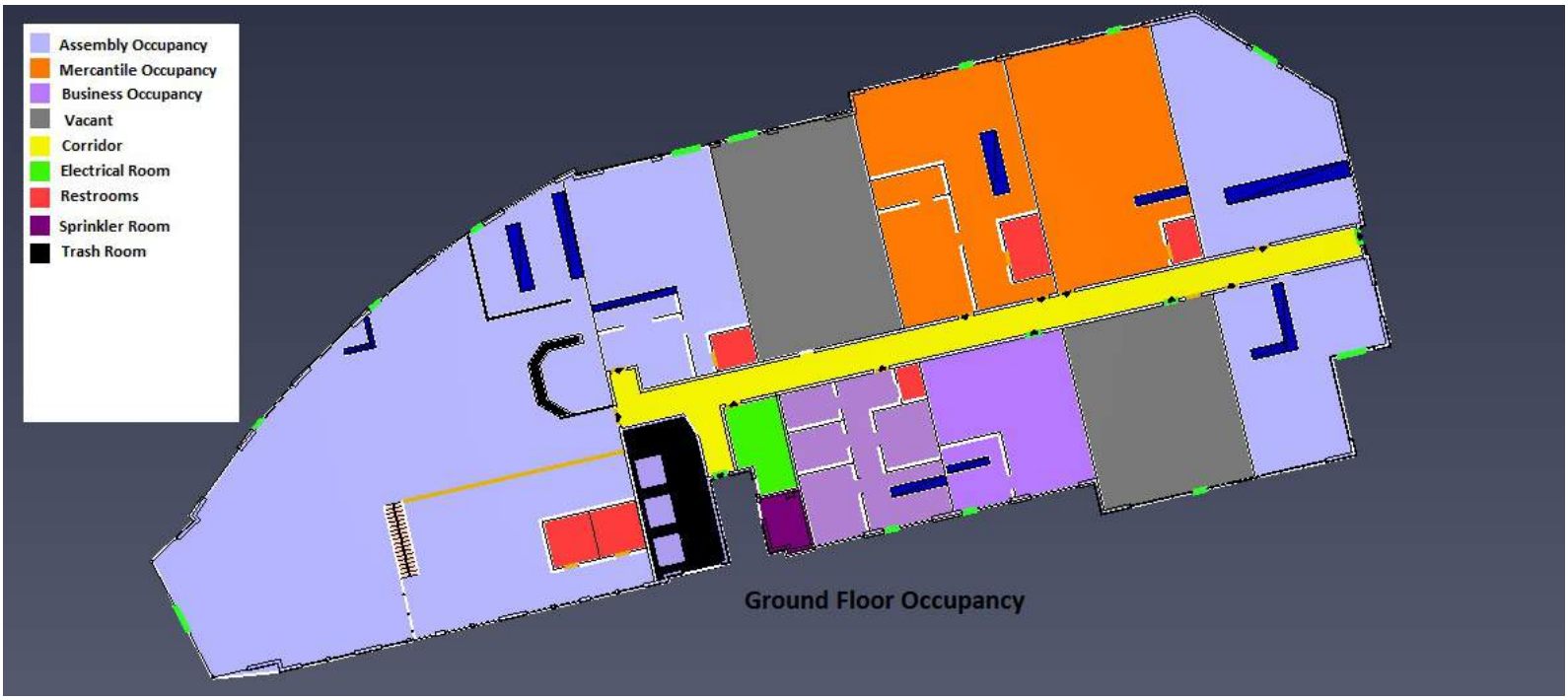
$A_a = [6000 + 6000(.75) + 6000 \cdot 3 = 28{,}500\ ft^2$

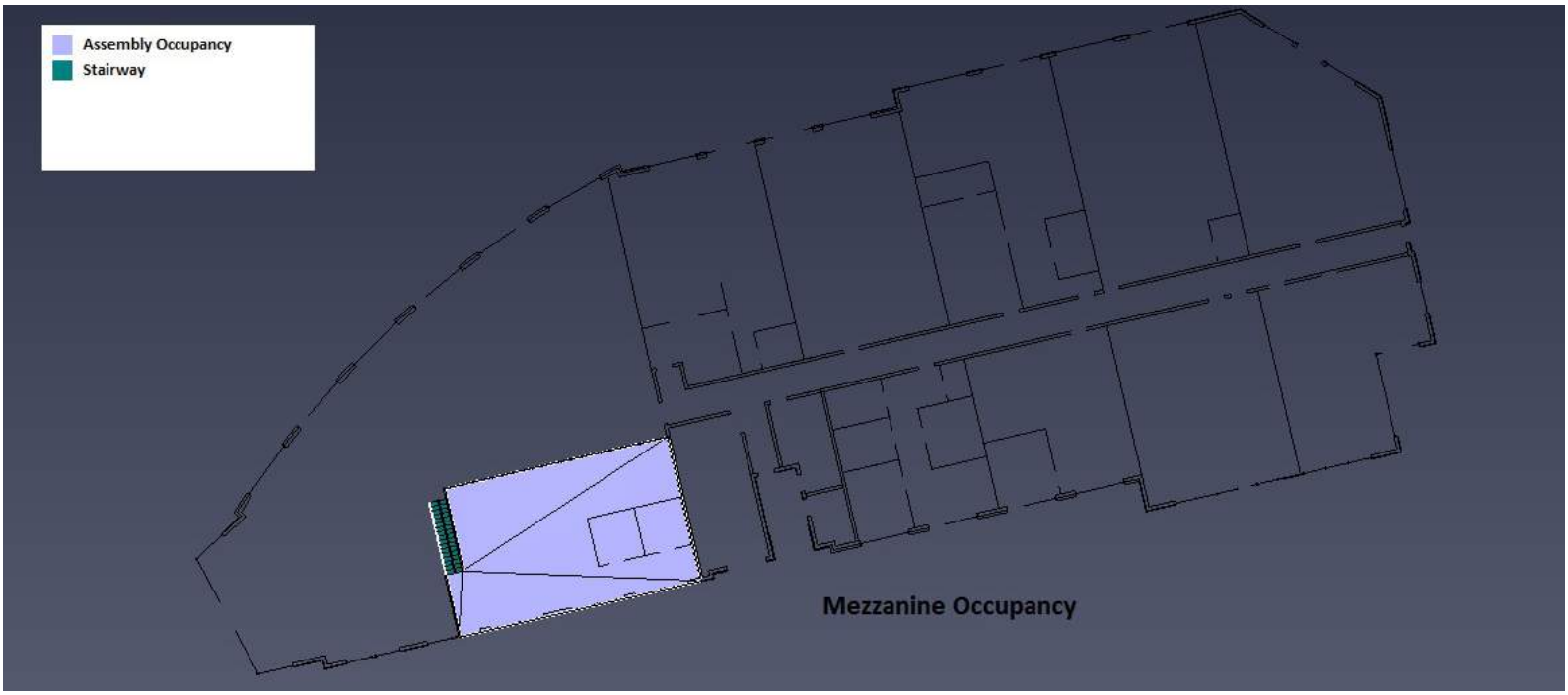
$24{,}000 < 28{,}500$ so OK

Type V-B is most stringent so other types allowable as well with sprinkler system

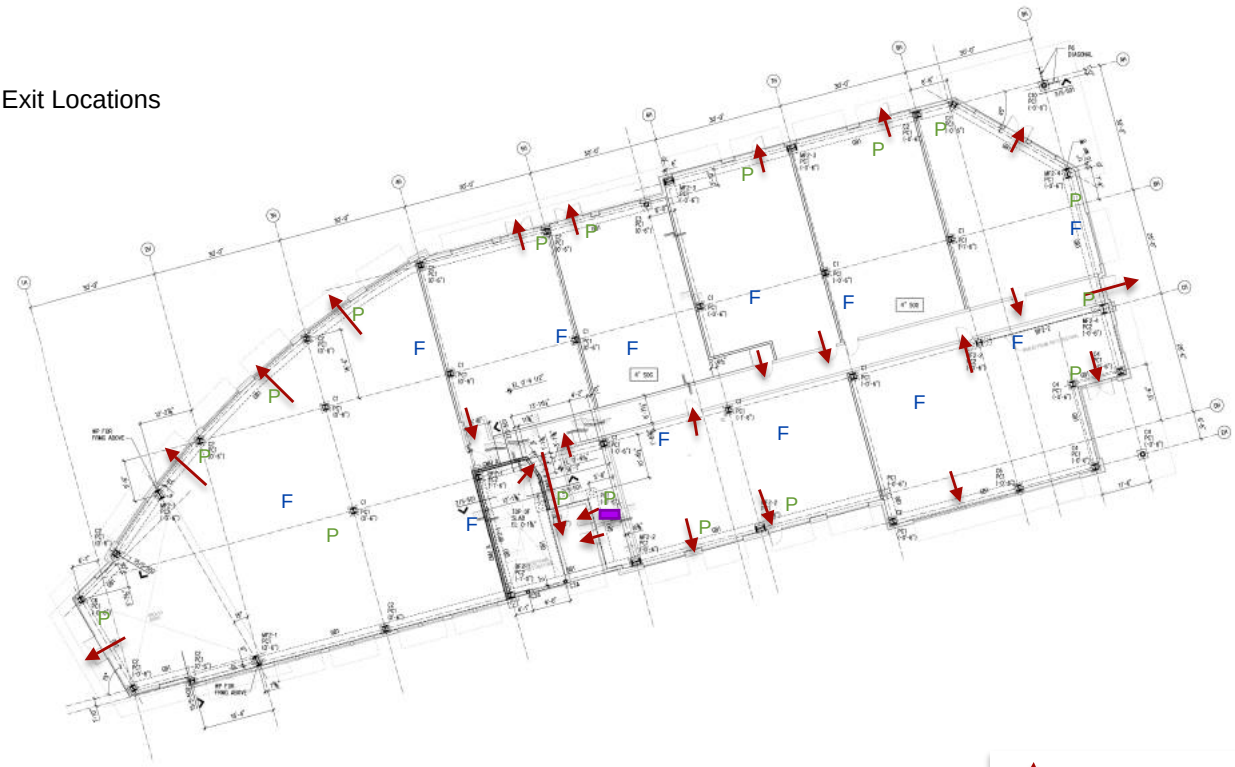
Appendix B- Prescriptive Egress Attachments

Tenant Spaces


Assembly Occupancy
Mercantile Occupancy
Business Occupancy
Vacant
Corridor
Electrical Room
Restrooms
Sprinkler Room
Trash Room
Ground Floor Occupancy


Assembly Occupancy
Stairway
Mezzanine Occupancy

Exit Locations



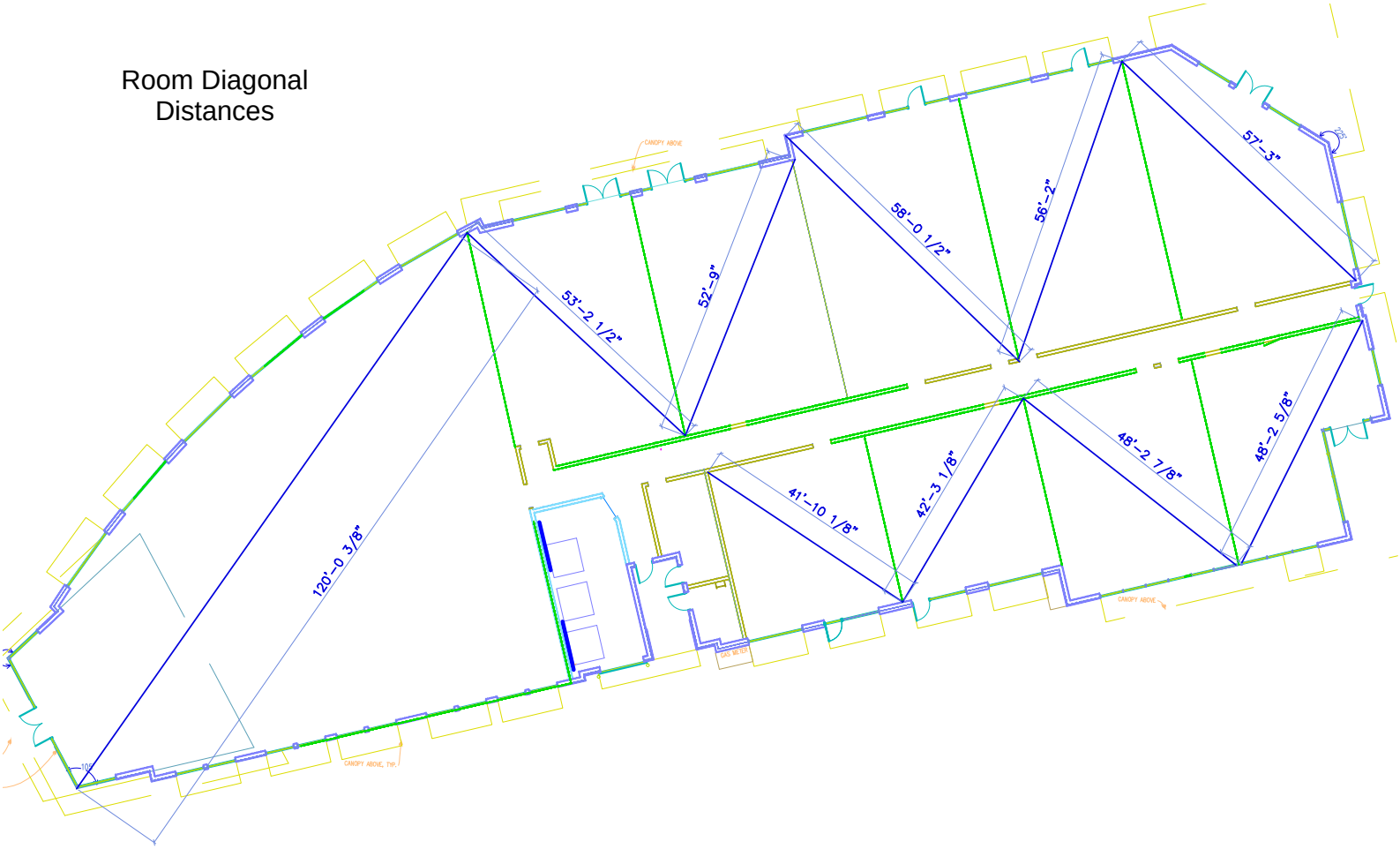
Exit

F Fire Extinguisher

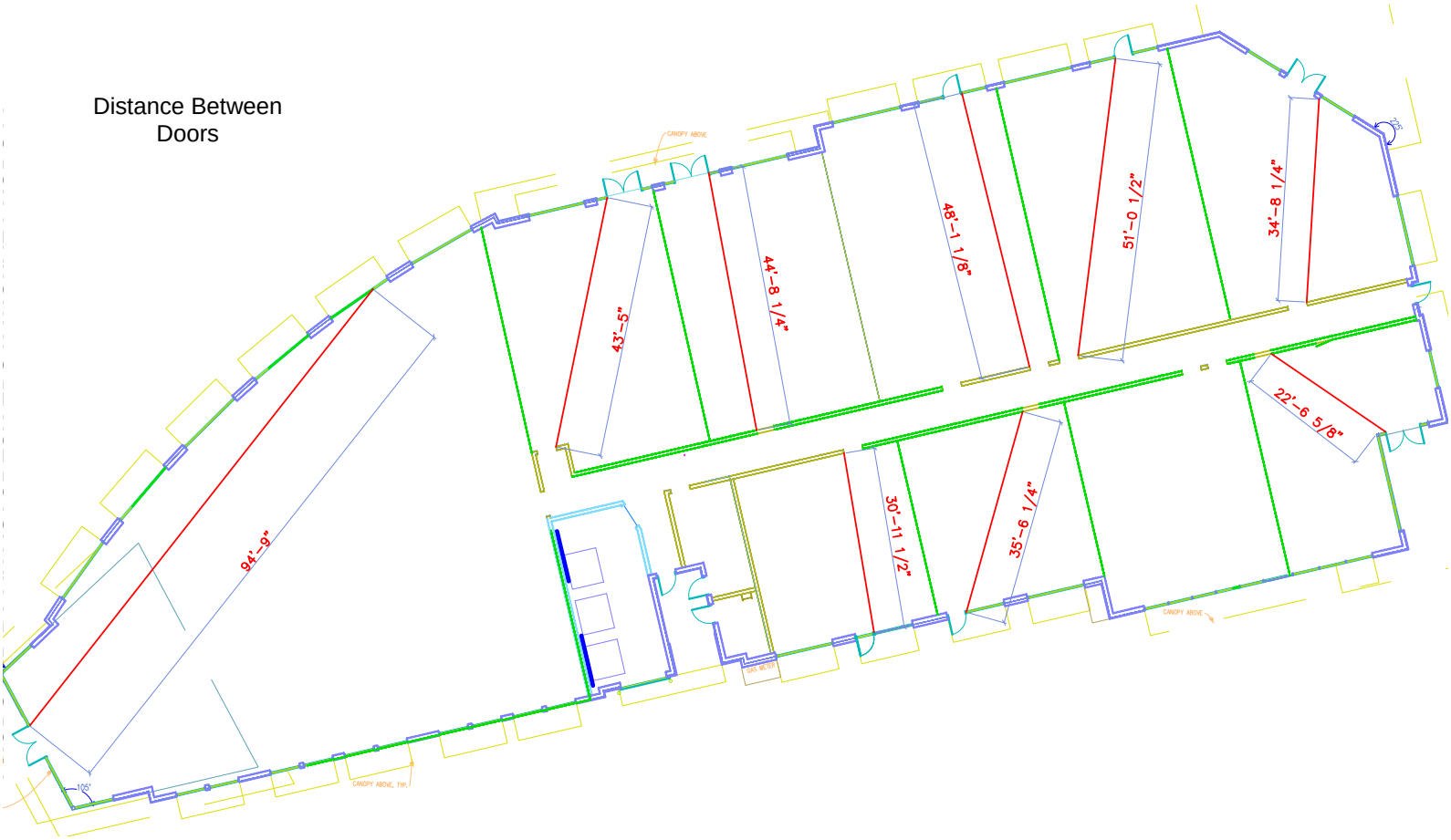
P Pull Station

Fire Alarm Control Panel

Room Diagonal Distances



Distance Between Doors



Exit Sign Locations

Sample Occupant Load Calculation

Pizza Place

gross Area = 5700 ft^2 + 1400 ft^2 (mezzanine)

Area net = 7100 - 380 = 6720 ft^2

Occupant Load Factor = 15 net

Occupant Load = 6720/15 = 448 people

Exit Capacity

Doors = 36 in.

Capacity = 36 in./.2 in/person = 180 people

(Tbl 7.3.3.1 NFPA 101 & IBC 1005.3.1)

Stairway = 44 in.

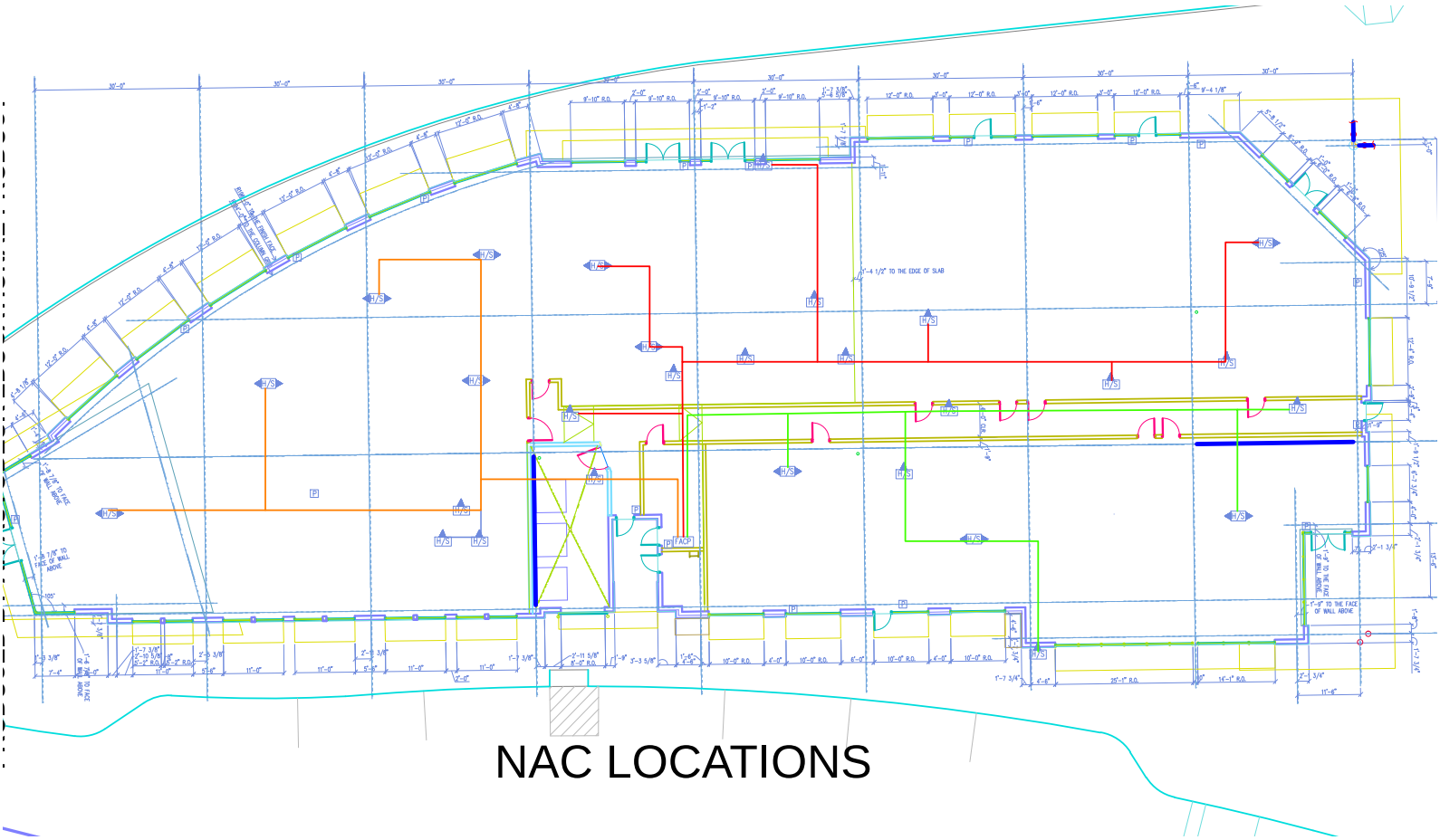
Capacity = 44 in./.3 in./person = 147 people

(Tbl 7.3.3.1 NFPA 101 & IBC 1005.3.2)

Appendix C- Prescriptive Alarm System Attachments

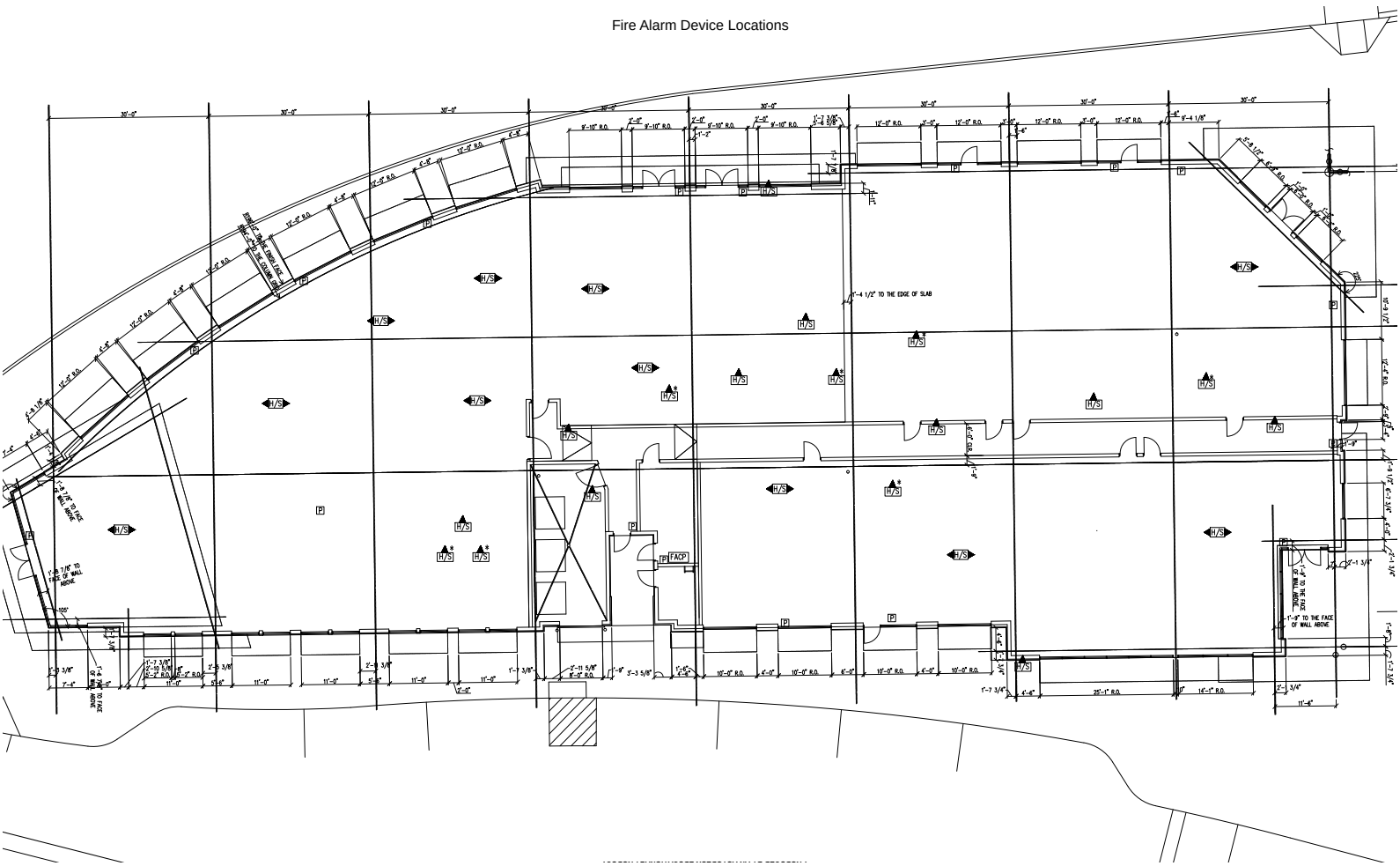
Battery Calculations

Required Battery Capacity	
Total Standby Current Required (amps)	$24 \times \frac{272.9}{1000} = 6.6$
Total Alarm Current Required (amps)	$0.083 \times \frac{5601.4}{1000} = 0.5$
Safety Factor	1.2
Required Battery Capacity (amp-hours)	$1.2 \times (6.6 + 0.5) = 8.5$



NAC LOCATIONS

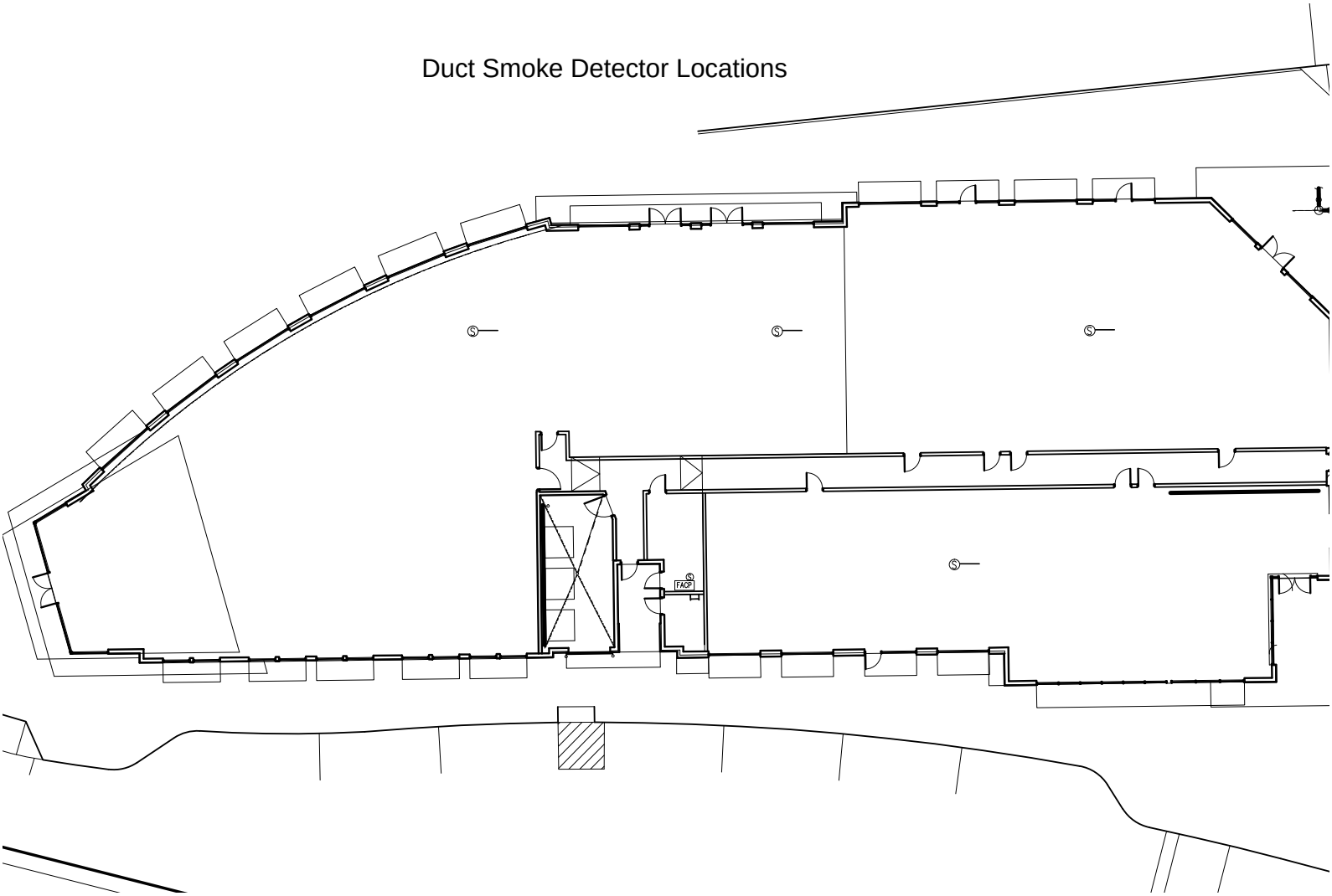
Fire Alarm Device Locations



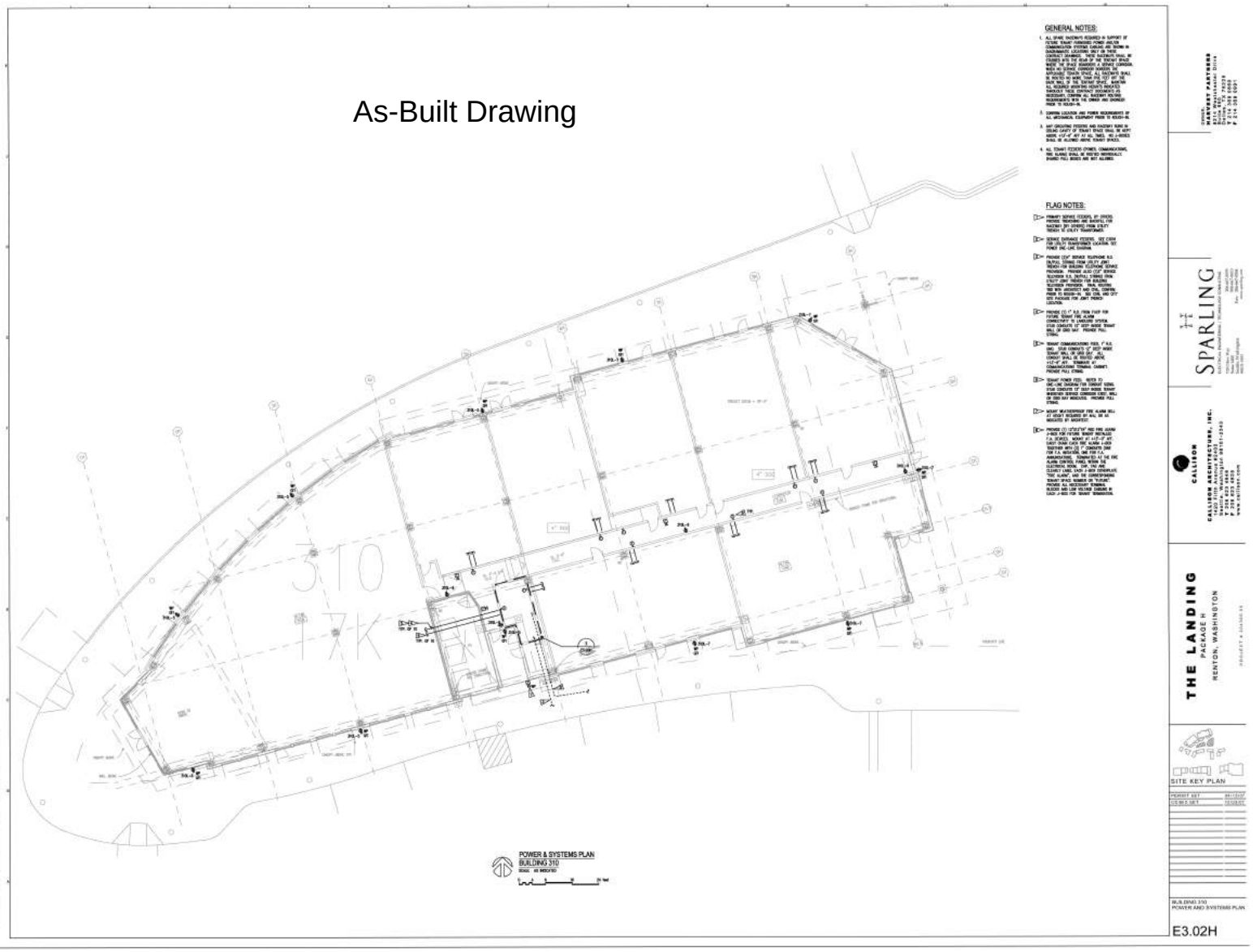
SYMBOL LEGEND

FACP	FIRE ALARM CONTROL PANEL
	REMOTE ANNUNCIATOR
P	MANUAL PULL STATION WALL MOUNT @ 48" AFF.
(S)	SMOKE DETECTOR
(S)	SINGLE STATION SMOKE DETECTOR
(S)----	HVAC DUCT SMOKE DETECTOR
(H)	135degree RATE OF RISE HEAT DETECTOR
	194degree FIXED TEMP. HEAT DETECTOR LOCATED IN INTERSTITIAL OR ATTIC SPACE
	HORN & STROBE LIGHT. WALL MOUNT @ 80" OR 6" BELOW CEILING WHICH EVER IS LOWER. (UNLESS OTHERWISE NOTED)
	(CEILING MOUNT) 115cd HORN & STROBE LIGHT.
S	STROBE LIGHT. WALL MOUNT @ 80" OR 6" BELOW CEILING WHICH EVER IS LOWER. (UNLESS OTHERWISE NOTED)
S	(CEILING MOUNT) 115cd STROBE LIGHT.
F	10" ALARM BELL WITH ADJACENT STROBE LIGHT MOUNT @ 12'-0" A.F.G.
(F)	WET SPRINKLER SYSTEM WATERFLOW SWITCH
(P)	DRY SPRINKLER SYSTEM PRESSURE SWITCH
(A)	DRY SPRINKLER SYSTEM LOW AIR SWITCH
(T)	SPRINKLER SYSTEM TAMPER SWITCH
(V)	SPRINKLER SYSTEM SUPERVISORY SWITCH
(J)	JUNCTION BOX
$(S)_R$	ELEVATOR RECALL
E	INDICATES EXISTING DEVICE
EOL	INDICATES END OF LINE DEVICE
WP	INDICATES WEATHER PROOF DEVICE

Duct Smoke Detector Locations



As-Built Drawing



SILENT KNIGHT by Honeywell

IntelliKnight® 5808 Single Loop Addressable Fire Alarm Control System

The convenience of an addressable fire alarm control panel in a cost-effective easy to use package.

IntelliKnight Model 5808 is a 127 point class leading single loop addressable fire alarm control/communicator system. 5808 provides you with the revolutionary value and performance of addressable sensing technology combined with exclusive, built-in digital communication, distributed intelligent power, easy to use interface. Powerful features such as drift compensation and maintenance alert are delivered in this powerful FACP from Silent Knight.

For more information about the IntelliKnight system, or to locate your nearest source, please call 1-800-328-0103.

Description

The basic 5808 system can be enhanced by adding modules such as 5860 remote annunciator, 5824 serial/parallel printer interface module (for printing system reports), and 5496 intelligent power module. 5808 supports SD or SK protocol devices. 5808 also features a powerful built-in dual line fire communicator that allows for reporting of all system activity to a remote monitoring location.

Features

- Built-in support for up to 99 SK detectors *and* 99 SK modules.
- Built in support for 127 SD devices.
- Up to 125 zones and 125 output groups.
- Uses standard wire—no shielded or twisted pair required
- Built-in digital communicator.
- Central station reporting by point or by zone
- Supports Class B (Style 4) and Class A (Style 6 or 7) configuration for SLC.
- Distributed, intelligent power.
- Drift compensation.
- 13 pre-programmed output cadences, (including ANSI-3.41), and 4 programmable outputs.
- Notification circuits can be configured as 2 Class A (Style Z) or 4 Class B (Style Y), or auxiliary power for resettable, constant, or door holder power.
- Built-in annunciator with 80-character LCD display.
- RS-485 bus provides communication to system accessories.
- Built-in RS-232 and USB interface for programming via a PC.
- Upload or download programming, event history, or detector status via remote or direct connection.
- Improvements in SKSS deliver five times faster upload/downloads.
- Built-in synchronization for appliances from AMSECO, Gentex®, Faraday, System Sensor®, and Wheelock®.
- One Form C trouble relay rated at 2.5A at 27.4 VDC and two Form C programmable relays rated at 2.5A at 27.4 VDC.

Model 5808

- Plex-2 door option combines a dead front cabinet door with a clear window, limiting access to the panel while providing single button operation of the reset and silence functions.
- Integrated dead front panel protects operator from exposure to electrical components.
- The FACP enclosure features a Plexiglass® viewing window to protect annunciator.
- Acknowledge function allows operator to keep track of event status.

Installation

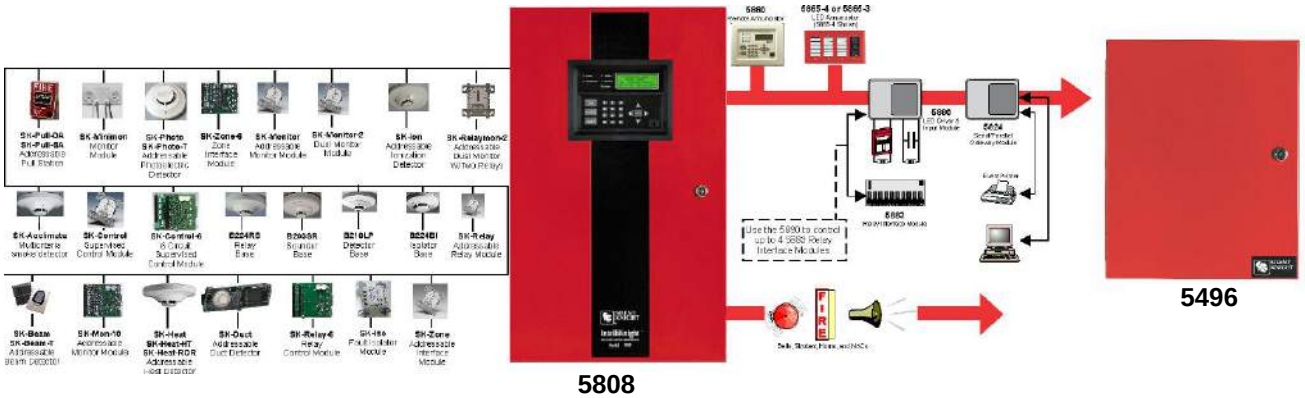
The 5800 can be surface or flush mounted.

Compatibility

The 5808 signal line circuit (SLC) supports multiple device types of the *same* protocol:

- SK
- SD

You cannot mix SD and SK SLC devices on a FACP.



Specifications

Electrical

Primary AC: 120 VRMS at 50/60 Hz, 2.75A

Total Accessory Load: 6A @ 27.4 VDC

Notification Power: 6A @ 27.4 VDC, power-limited

Standby Current: 170 mA

Alarm Current: 365 mA

Notification & Auxiliary Circuits: 3A @ 27.4 VDC per circuit,power-limited

Battery Charging Capacity: 7.0-35 AH

Battery Size: 18 AH max. allowed in FACP. Larger capacity batteries can be housed in an RBB accessory cabinet

Physical

Flush Mount Dimensions: 14.5” W x 24.75” H x 3.5” D (36.8 W x 62.9 H x 8.73 D cm)

Overall Dimensions: 16" W x 26.4" H x 4.65" D (40.6 W x 67 H x 11.8 D cm)

Weight: 28 lbs. (12.8 kg)

Color: Red

Telephone Requirements: FCC Part 15 and Part 68 approved Type of Jack: RJ31X (two required)

Approvals

NFPA 13, NFPA 15, NFPA 16, NFPA 70, & NFPA 72: Central Station; Remote Signalling; Local Protective Signalling Systems; Auxiliary Protected Premises Unit; & Water Deluge Releasing Service. Suitable for automatic, manual, waterflow, sprinkler supervisory (DACT non-coded) signalling services.
UL Listed
CSFM 7165-0559:0142;
MEA 429-92-E Vol. XIV
OSHPD (CA) OSP-0065-10

S-BUS Accessories

5860/R Remote Fire Annunciator
Features the same 80 character backlit LCD display keypad and firefighter's key switch as the 5808. 5860 is gray and 5860R is red.

5496 Intelligent Power Module
A 6 amp notification power expander that provides four additional power-limited notification appliance circuit outputs.

5880 LED/IO Module
Features 40 LED outputs, 8 normally open dry contact inputs and one piezo output.

5865-3 and 5865-4 Remote LED Annunciator
Features 30 programmable LED (15 red and 15 yellow) outputs and a piezo sounder. The 5865-4 adds a silence and reset switch to the package.

5824 Serial/Parallel Printer Interface Module
Provides one parallel and one RS-232 serial port for connecting a printer to 5808. Use to print a real-time log of system events, detector status reports, and event history.

5883 Relay Board
Features 10 general purpose Form C relays. Used with 5880 module.

Miscellaneous Accessories

5660 Silent Knight Software Suite
PC-base software for FACP programming. Upload and view panel account information, event history, and detector status.

5670 Silent Knight Software Suite
End-user facility management software allows viewing of detector status and event history via modem or direct connection.

Plex-2 Door
Dead front cabinet door with clear window to limit access to the FACP.

RBB
Remote Battery Box Accessory Cabinet. Use if backup batteries are too large to fit into FACP cabinet. Dimensions: 16” W x 10” H x 6” D (406 mm W x 254 mm H x 152 mm D)

SK-SCK
Seismic Compliance Kit

SD and SK Devices

See the specification sheets listed below for a complete listing of the SD and SK devices.

53624 SD Devices data sheet

53623 SK Devices data sheet

SILENT KNIGHT by Honeywell

MADE IN AMERICA

350386 Rev. L

SILENT KNIGHT by Honeywell

5496 Intelligent Power Module

A dynamic combination of power and intelligence for your notification expansion needs.

The Model 5496 Intelligent Power Module by Silent Knight is the most-powerful and cost-effective power supply available today. It delivers 6 amps of notification appliance circuit power and built-in synchronization for appliances from System Sensor®, Gentex®, Faraday, AMSECO and Wheelock® — what you need to drive power-hungry components like ADA notification appliances. The 5496's advanced microprocessor design is years ahead of the competition. Its switch mode power supply design is up to 50% more efficient than competitive linear mode power supplies.

For the most sophisticated and cost-effective notification power supply available, you need Model 5496. Call Silent Knight today for more information at 1-800-328-0103.

Model 5496 Intelligent Power Module

The model 5496 is a 6 amp notification power expander that provides its own AC power connection, battery charging circuit, and backup battery for use with fire and security controls such as the IntelliKnight Model 5808 Fire Control /Communicator. The 5496 is the cost-effective solution for powering notification appliances required by the Americans with Disabilities Act (ADA). The 5496 has built-in ANSI cadence pattern, which can upgrade older control panels that lack cadence capability. The Output circuits can be programmed as Notification Appliance Circuits, or as Auxiliary Power (configurable for, constant, resettable, or door holder power).

Features

- UL Listed for 6 amps of notification power
- Power supply's advanced switch mode design reduces damaging heat and manages power up to 50% more efficiently than other systems
- Built-in synchronization for appliances from AMSECO, Gentex®, Faraday, System Sensor®, and Wheelock®
- 24 VDC filtered output voltage
- Four power-limited notification outputs; 2 Class A or 4 Class B, or 1 Class A and 2 Class B
- NACs are programmable as Notification Appliance Circuits, or as auxiliary power to be used as constant, resettable, or door holder power
- 3 amps per output circuit
- Ground fault detector
- Communicates to the FACP via 4-wire SBUS (wire runs up to 6000 ft)
- AC loss delay option shuts off power to non-essential high-current accessories like magnetic door holders
- Lightweight design adds to ease of installation and reduces shipping costs
- UL 864,1481 & 1971 listed
- ANSI Cadence pattern output capability built-in

Specifications

AC Input: 120 VAC at 2.7 A

Output: 24 VDC at 6 amps

Current:
Standby 40 mA
Alarm 160 mA

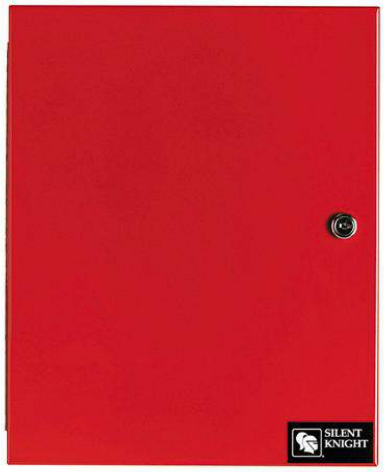
Notification/Aux.Power circuits: 4

Output configuration:
- 2 Class A (Style Z)
- 4 Class B (Style Y) (1 Class A & 2 Class B)

Amps per output circuit:
3.0 (6.0 amps total)

Notification circuit output:
20.4 to 27.3 VDC, 3.0 amps each, 4.7k EOL resistor required on each Class B circuit

Battery charging capacity: 35.0 AH



5496 Intelligent Power Module

Ambient Temp.:
32° to 120° F (0° to 49° C)

Dimensions:
12.25" W x 16" H x3" D
(30.88 Wx 40.64 H x7.62 D cm)

Listings:
UL
CSFM
MEA 429-92-E vol. XIV

Compatible FACPs

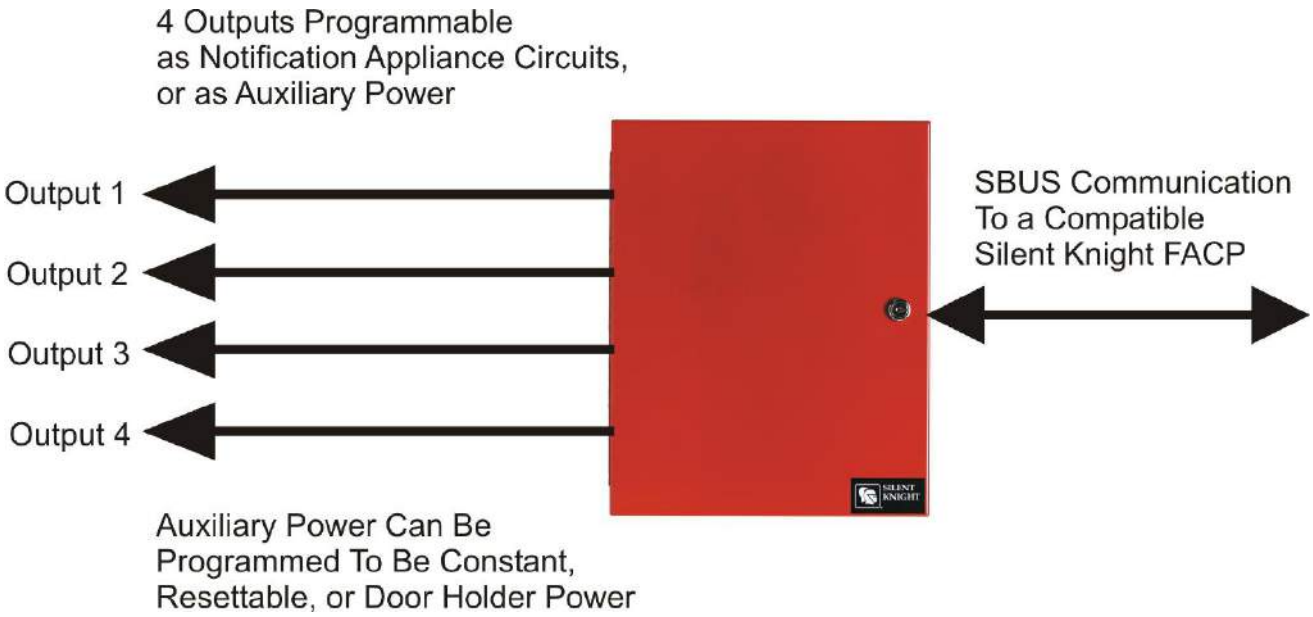
- IntelliKnight 5700
- IntelliKnight 5808
- IntelliKnight 5820XL
- IntelliKnight 5820XL-EVS

Firepower 5496
Distributed Power Module

Engineering Specifications

The contractor shall supply a power module compatible with the Silent Knight FACP. The power module must have 6.0 amps of output power. The power module shall connect to the main FACP via an RS 485 system bus (SBUS). The Outputs shall be programmable as Notification Appliance Circuits, or as Auxiliary Power (configurable for, constant, resettable, or door holder power). The power module shall have four separate outputs.

The power module RS 485 bus shall be optically isolated providing ground loop isolation and transient protection.



SILENT KNIGHT by Honeywell

7750F

AES CORPORATION | IntelliNet For Alarm Monitoring

RF Subscriber Unit

UL Fire and AA Burglary Listed

NFPA-72 Compliant

UL Listed

UL Listed Central station

Remote Station

864,827,1610,365,681

CSFM

- UL LIsted (Fire & AA Burglary)
- NFPA-72 Compliant
- 864, 827,1610,365, 681
- Options for Full Data for Fire and Burglary
- Available in 4 & 8 Zone Configurations
- Built-in Power Supply and Battery Charger

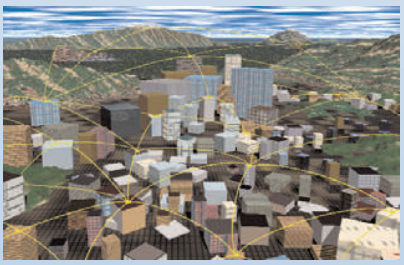
Advanced Wireless Alarm Monitoring

The 7750-F smart subscriber unit links an alarm panel to an alarm monitoring central station. This 2-way transceiver and repeater in one is housed in a full size locking steel cabinet for superior performance. The 7750-F supports a wide range of inputs such as NO/NC/EOL and direct voltage. It automatically senses phone line cuts and antenna cuts, and monitors battery and AC power status. Advanced status reporting, self-diagnostics and a built-in power supply make the 7750-F the first choice for all wireless alarm communication needs.

Full Data for Fire and Burglary

Use with the optional Firetap for full fire data or the IntelliTap for full burglary data.

Available Configurations	Available Options
7750 F 4x4 – 4 reversing polarity inputs plus 4 programmable EOL inputs **7750 F 8** – 8 programmable EOL inputs	FireTap 7768 IntelliTap 7067 NEMA 4 Enclosure High Gain Antenna Back Up Battery Available in Burglary Beige or Fire Red



Wireless mesh networking is an innovative technology adopted by many industries with applications that need to communicate data over a large geographic area with a high level of reliability at a low total cost of ownership.

The advanced design and 2-way communications capability provides easy installation, expansion, and management when compared to alternative communication methods, both wired and wireless.

7750F
RF Subscriber Unit

Technical Specifications

Radio
Standard CSAA frequency ranges: 450-470 MHz and 130-174 MHz, VHF and UHF. Others available

Standard Output Power
2 watts (requires FCC license)

Power Input
16.5 VAC, 40VA UL listed
Class II transformer required

Voltage
12 VDC nominal

Current
175mA standby; 800mA transmit

Alarm Signal Inputs
- 4 individually programmable Zones: NO/NC/EOL, trouble restore
- RS-232

Operating Temperature Range
0° to 50°C, 32° to 122°F

Storage Temperature Range
-10° to 60°C, 14° to 140°F

Relative Humidity Range
0-85% RHC non-condensing

Back up Battery
12V, 7 AH option

Low Battery Reporting
22.5-minute test cycle

AC Status
Reports to central station after approximately 4 minutes without AC power, reports power restored after approximately 4 minutes of restored power

Antenna Cut (local reporting)
12 VDC signal output at outputJ4, 200 mA max load

Open Collector Output
200mA maximum load

Size
13.25"H x 8.5"W x 4.3"D
34cm x 21.5cm x 11cm

Weight
6.4 lbs, 2.9 Kilograms
(excluding battery)

Colors
Available in standard
Burglary Beige or Fire Red
Please specify when ordering

Available Options
- 7750F-8 RF subscriber unit with 8 EOL inputs
- 7750F-4x4 RF subscriber unit with 4 EOL inputs and 4 reverse polarity inputs
- 7768 - FireTap
- 7067 - IntelliTap

Please specify when ordering

AES-*IntelliNet*™ is the industry leader in delivering high quality wireless mesh networks to the fire and security industry in commercial, corporate, government, and educational applications with its broad line of products and advanced network management tools. Users of AES-*IntelliNet* networks have gained significant revenue, communications, and cost advantages while meeting the high standards of reliability required for the fire and security industry. AES-*IntelliNet* alarm monitoring systems are deployed at hundreds of thousands of locations in over 130 countries.

AES CORPORATION | *IntelliNet*® For Alarm Monitoring

For more information
Call 800-AES-NETS (800-237-6387)

AES Corporation | 285 Newbury Street | Peabody, MA 01960 USA
Tel. +1 978-535-7310 | Fax +1 978-535-7313 | Email info@aes-intellinet.com
Web www.aes-intellinet.com

Available configurations

- 4 EOL Inputs
- 8 EOL inputs
- 4 EOL inputs w/4 reverse polarity inputs
- NEMA 4 Enclosure

7750F/12/04/R1

BOSCH
Invented for life

D285 Series Photoelectric Smoke Detector Heads (12/24 VDC)

- **Commercial or residential applications**
- **Two-wire or four-wire application, depending on base**
- **Chamber Check rapid-flash LED sends contaminated chamber reports**
- **Flashing LED power indicator**
- **Steady-On LED alarm indicator**
- **Modular design**

The D285 and D285TH detector heads detect the large smoke particles which typically result from wood, paper, and fabric combustion. The D285TH smoke detector also has a +135°F (+57°C) fixed temperature heat sensor. Use in areas where the ambient temperature does not exceed +100°F (+38°C). These detectors are compatible with two-wire or four-wire, 12 VDC or 24 VDC circuits. Also available are addressable bases for use on the POPEX bus.

These detectors have two components: the detector base and the detector head. The base is permanently attached and wired to a back box. The interchangeable heads quickly detach for replacement and cleaning without affecting circuit wiring. The D285 and D285TH detector heads attach to the following detector bases:

- D278S 12 V Four-wire Addressable (POPIT) Detector Base (6 in. [15.2 cm] diameter)
- D287 Two-wire Detector Base (5.5 in. [14 cm] diameter)
- D288 Two-wire Detector Base ([6 in. [15.2 cm] diameter)
- D292 Four-wire Detector Base (6 in. [15.2 cm] diameter)
- D293A Four-wire Detector Base (6 in. [15.2 cm] diameter) with Form C Relay
- D293E Power Supervision Detector Base (6 in. [15.2 cm] diameter) with Auxiliary Form A Relay
- D293S Four-wire Detector Base (6 in. [15.2 cm] diameter) with Sounder
- D298M 24 V Four-wire Addressable (POPIT) Master Detector Base (6 in. [15.2 cm] diameter)
- D298S 24 V Four-wire Addressable (POPIT) Slave Detector Base (6 in. [15.2 cm] diameter)

Functions

Detection chamber operation

The D285 and D285TH smoke detectors use an infrared (IR) LED light source and a silicon photodiode to measure light in a chamber. In normal conditions the light is absorbed in the chamber. The presence of a significant number of particulates allows the light to reflect to the photodiode. After three consecutive measurements exceeding the threshold level, the unit signals an alarm condition. The detector can be reset from the control panel, after an alarm condition is cleared, by interrupting power.

The detection chamber, designed for reliable smoke entry characteristics, is protected by a micro-fine insect screen to reduce dust accumulation and insect penetration and minimize nuisance alarms.

Chamber Check Feature

To further reduce nuisance alarms, the D285 and D285TH heads check their calibration. This Chamber Check feature is automatic. If the head is out of calibration for a period exceeding 24 hours, the Trouble-Alarm LED flashes once per second, three times the normal rate.

Testing

Internal diagnostic test

These heads have moisture-proof reed switches that react to an external magnet for testing. The magnet test simulates a 4% to 6% smoke obscuration that places the detector in an alarm condition. This test results in specific LED and alarm circuit responses to indicate:

- Detector within calibration standards
- Detector settings outside sensitivity standards
- Detector not operational

This test is especially useful in environmentally unstable or unclean areas.

Sensitivity voltage test

These detector heads have a socket that accepts the D1005 Test Cable. The D1005 connects to the detector head and allows a voltmeter to read the sensitivity of the device.

LEDs

The D285 and D285TH have a built-in LED that flashes to indicate the device is powered. The LED latches on steady in an alarm condition.

Certifications and Approvals

Region	Certification	
USA	UL	UROX: Smoke - Automatic Fire Detectors (UL268 and A), UROX7: Smoke - Automatic Fire Detectors Certified for Canada (cULus)
	CSFM	7272-1615:0134 SMOKE DETECTOR-SYSTEM TYPE-PHOTOELECTRIC
	NYC-MEA	274-93-E, Vol. VII
	MSFM	
Hong Kong	HKFSD	

Installation/Configuration Notes

Note Smoke detectors are intended for detection circuits that protect people. Heat detectors are appropriate for circuits that protect property.

Mounting

The D285 smoke detector head and D285TH smoke and heat detector head are parts of a compound device. The detector base installs over a back box and contains all the wiring. The detector head attaches to the base by aligning the head with the base and turning it clockwise. No tools are required for installation other than the hex key used to tighten the optional tamper screw.

Wiring

The terminal block accepts up to 12 AWG (2.3 mm) wire.

Technical Specifications

Environmental Considerations

Radio Frequency Interference (RFI) Immunity:	No alarm or setup on critical frequencies in the range from 26 MHz to 950 MHz at field strengths less than 50 V/m
Relative Humidity:	Up to 93%, non-condensing
Temperature (operating):	+32°F to +100°F (0°C to +38°C)

Mechanical Properties

Color:	Bone white
Dimensions (diameter x D):	4 in. x 1.25 in. (10.2 cm x 3.2 cm)

Power Requirements

Current (alarm):	Two-wire: depends on control panel that must limit the alarm current to 100 mA maximum Four-wire: depends on detector base; refer to pertinent base specifications
Current (standby):	Two-wire: 0.08 mA at 12 VDC; 0.09 mA at 24 VDC Four-wire (D293E): 4 mA at 12 VDC or 24 VDC
RMS Ripple (maximum):	25% of DC input
Voltage (input):	Two-wire: 8.5 VDC to 33 VDC Four-wire: 10 VDC to 30 VDC

AIR PRODUCTS AND CONTROLS

You in Control

SL-2000 SERIES

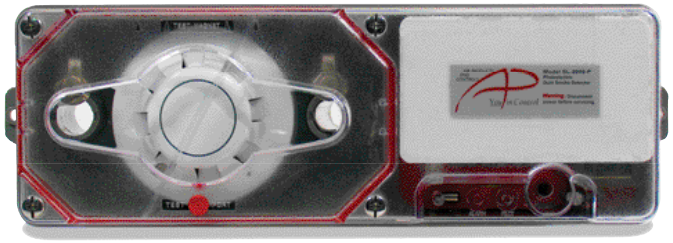
DUCT SMOKE DETECTORS

Hi-Temp, Low-Flow & No-Tools

PRODUCT APPLICATION

The SL-2000 Series Conventional Duct Detector is the latest innovation for early detection of smoke and products of combustion present in air moving through HVAC ducts in Commercial, Industrial, and Residential applications. The unit is designed to prevent the recirculation or spread of smoke by air handling systems, fans and blowers. Complete systems may be shut down in the event of smoke detection. The SL-2000 is designed and built to meet all local code requirements, as well as the NFPA and ICC standards regarding HVAC supply and return duct smoke detectors. Output terminals are provided for a wide range of remote accessories such as horns, strobes, remote status indicators, and test/reset key switches or push buttons.

PRODUCT DESCRIPTION



The SL-2000 includes many features that represent true innovations from current generation duct smoke detectors. Our traditional installer/servicer-friendly approach has been closely followed and expanded throughout the SL-2000. This philosophy provides a new level of efficiency in after-purchase value to both the installer/servicer and end-user. Our attention to detail has yielded a host of "No-Tools Required" features, as well as a multi-application performance level as yet unmatched in the industry. Innovative product combined with unsurpassed customer service equals the right combination for all of your projects. The key features below detail many of the customer-driven innovations incorporated in the SL-2000 Series.

SIGNALING c UL us LISTED

CSFM LISTED **MEA** ACCEPTED

FEATURES

- Low-Flow Technology: Both Ionization and Photoelectric models listed for velocities between 100-4000 ft./min
- Both models listed for high-temperature applications
- Operating voltages: 230VAC, 115VAC, 24VAC, 24VDC
- Interconnect up to 30 units for common functions
- Patented "No-Tools Required" front *or* rear loading and removing sampling/exhaust tubes
- Patented "Test Port Valve" allows for aerosol smoke testing without cover removal
- Clear cover fitted with four captive "No-Tools Required" thumbscrews
- Instantaneous cover removal trouble indication
- Staggered terminal blocks for easier wiring
- Flashing LED on detector head indicates normal operation
- Magnet test capability (magnet included)
- More wiring space than competitive models
- Footprint allows easy retrofit in many applications without additional drilling
- Over 15 remote accessories available
- Duct wall gaskets on back of enclosure are pre-installed
- Compatible with the WP-2000 weatherproof enclosure
- Reset switch is also an alarm test switch - competitive models require a magnet or cover removal to test at unit
- Unit includes green pilot and red alarm visual indicators
- External mounting tabs do not require cover removal to install
- Colored cover gasket indicates proper cover seal
- UL, CUL, CSFM, and MEA Listed
- Compact, lightweight size means easy handling, lower shipping costs
- Two sets of 10A form "C" alarm contacts
- One set of 2A form "A" alarm contacts
- One set of 10A form "C" trouble contacts
- Large terminal connection screws
- Standard interchangeable "plug-in" UL268 photoelectric or ionization heads
- Advanced detector head design yields internal dust filtering
- No additional screens or filters to clean
- Compatible with building automation and fire alarm systems
- Ionization and Photoelectric versions available
- Complete wiring details permanently attached to unit

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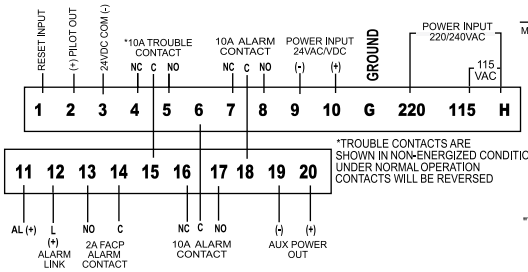
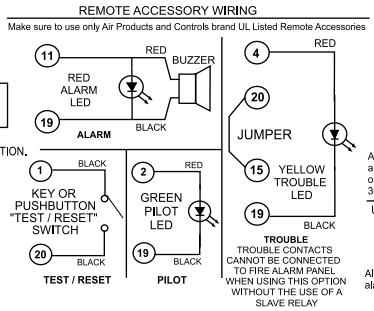
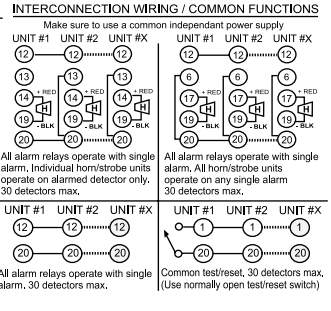
WIRING







PRODUCT SPECIFICATIONS

MODEL NUMBER:	**SL-2000-N**	Ionization: 230VAC, 115VAC, 24VAC, 24VDC
	SL-2000-P	Photoelectric: 230VAC, 115VAC, 24VAC, 24VDC
DETECTOR MODEL NUMBER:	**SL-2000-N**	55000-225APO
	SL-2000-P	55000-328APO
SAMPLING TUBES:	**FAST Tube**	Sectional sampling tube, kit fits up to 90" duct width
	STN-1.0	Sampling tube for 12" or less duct width
	STN-2.5	Sampling tube for 6" to 2.5' duct width
	STN-5.0	Sampling tube for 2.5' to 5.0' duct width
	STN-10.0	Sampling tube for 5.0' to 10.0' duct width
ACCESSORIES:	MS- and MSR-Series remote accessories, WP-2000 weatherproof enclosure, TG-2000 aerosol test gas, and T-PB power supplies (All available from Apollo America)	
POWER REQUIREMENTS: (without accessories)	230VAC	12 mA
Standby:	115VAC	22 mA
	24VAC	55 mA
	24VDC	14 mA
Alarm:	230VAC	18 mA
	115VAC	32 mA
	24VAC	190 mA
	24VDC	68 mA
RELAY CONTACT RATING:		
Alarm Contacts:	Resistive load: 2 sets form "C" rated at 10 Amps @ 115VAC Resistive load: 1 set form "A" rated at 2 Amps	
Trouble Contacts:	Resistive load: 1 set form "C" rated at 10 Amps @ 115VAC	
AIR VELOCITY:	100 to 4,000 ft./min.	
AMBIENT TEMPERATURE:	**SL-2000-N**	32ºF to 158ºF (0ºC to 70ºC)
	SL-2000-P	32ºF to 140ºF (0ºC to 60ºC)
HUMIDITY:	85 ±5 % RH (@32 ±2°C; 86 ±3.6°F) Non-Condensing / Non-Freezing	
WIRING:	Solid or stranded: #12 to #22 AWG terminals	
APPROVALS:	UL & CUL Listed (UL268A, UROX, UROX7) File # S2829 CSFM Listed (3240-1004:105) MEA Accepted (73-92-E; VOL. 27)	
MATERIAL:	Grey plastic backbox, clear plastic cover (Makrolon 94V-0)	
DIMENSIONS:	13 ½" L x 4 ½" W x 2 ¼" H	
MAX. NET WT.:	2 ½ lbs.	
RADIOACTIVE ELEMENT:	For **SL-2000-N** (Ionization) Americium 241; 0.9 Micro-Curie Do not expose to corrosive atmospheres	
HARDWARE:	7" exhaust tube, sampling tube end cap, mounting template, test magnet, and mounting hardware included	

ENGINEERS & ARCHITECTS SPECIFICATIONS

- Air duct smoke detectors shall be Air Products and Controls SL-2000 Series. For ionization detectors the model number is **SL-2000-N**.
- For photoelectric detectors the model number is **SL-2000-P**. The detectors shall be listed by Underwriters Laboratories per UL 268A.
- The detectors shall operate at air velocities from 100 feet per minute to 4,000 feet per minute and at temperatures of no greater than 140°F (60°C).
- Visual indication of alarm and power must be provided on the detector front.
- A manual reset switch shall be located on front of the device.
- Detector head shall not require additional filters or screens which must be maintained, and shall include both a standby and alarm visual indication.
- The housing shall contain a detector base which will accept photoelectric or ionization detector heads.
- Terminal connections shall be of the screw type, a minimum of #6 screw (#12 to #22 AWG compatible). Terminals shall be provided for remote pilot, remote alarm indications, strobe/horn, and remote test/reset switch. All wiring must comply with local codes and regulations.
- A method of testing the alarm function with a magnet must be provided.
- A method of smoke testing the detector without removing the cover must be provided.
- All unit, remote accessory, and common function connection designations must be permanently affixed to the unit.
- Cover and sampling/exhaust tube installation or removal must not require the use of tools.
- Capability for interconnection of up to 30 units shall be provided for common functions.
- Sample and exhaust tubes shall be capable of removal/installation from the front and/or rear of the detector for inspection/maintenance.

Indoor Selectable-Output Strobes and Horn Strobes for Ceiling Applications

SpectrAlert® Advance audible visible notification products are rich with features guaranteed to cut installation times and maximize profits.

SPECTRAlert ADVANCE from System Sensor

Features

- Plug-in design with minimal intrusion into the back box
- Tamper-resistant construction
- Automatic selection of 12- or 24-volt operation at 15 and 15/75 candela
- Field-selectable candela settings on ceiling units: 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, and 185
- Horn rated at 88+ dBA at 16 volts
- Rotary switch for horn tone and three volume selections
- Universal mounting plate for ceiling units
- Mounting plate shorting spring checks wiring continuity before device installation
- Electrically Compatible with legacy SpectrAlert devices
- Compatible with MDL sync module
- Listed for ceiling or wall mounting

The SpectrAlert Advance series offers the most versatile and easy-to-use line of horns, strobes, and horn strobes in the industry. With white and red plastic housings, wall and ceiling mounting options, and plain and FIRE-printed devices, SpectrAlert Advance can meet virtually any application requirement.

Like the entire SpectrAlert Advance product line, ceiling-mount 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, SpectrAlert Advance utilizes a universal mounting plate with an onboard shorting spring, so installers can test wiring continuity before the device is installed.

Installers can also easily adapt devices to a 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 three volume selections.

Agency Listings

SIGNALING UL LISTED
S4011 (chimes, horn strobes, horns)
S5512 (strobes)

FM APPROVED
3023572

MEA approved
MEA452-05-E

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

SpectrAlert Advance Specifications

Architect/Engineer Specifications

General

SpectrAlert Advance strobes and horn strobes shall mount to a standard 4 × 4 × 1½-inch back box, 4-inch octagon back box, or double-gang back box. Two-wire products shall also mount to a single-gang 2 × 4 × 17/8-inch back box. A universal mounting plate shall be used for mounting ceiling and wall products. The notification appliance circuit wiring shall terminate at the universal mounting plate. Also, SpectrAlert Advance products, when used with the Sync•Circuit™ Module accessory, shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts. When used with the Sync•Circuit Module, 12-volt-rated notification appliance circuit outputs shall operate between 9 and 17.5 volts; 24-volt-rated notification appliance circuit outputs shall operate between 17 and 33 volts. Indoor SpectrAlert Advance products shall operate between 32 and 120 degrees Fahrenheit from a regulated DC or full-wave rectified unfiltered power supply. Strobes and horn strobes shall have field-selectable candela settings including 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, and 185.

Strobe

The strobe shall be a System Sensor SpectrAlert Advance Model _____ listed to UL 1971 and shall be approved for fire protective service. The strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 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 System Sensor SpectrAlert Advance Model _____ listed to UL 1971 and UL 464 and shall be approved for fire protective service. The horn strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 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 three audibility options and an option to switch between a temporal three pattern and a non-temporal (continuous) pattern. These options are set by a multiple position switch. On four-wire products, the strobe shall be powered independently of the sounder. The horn on horn strobe models shall operate on a coded or non-coded power supply.

Synchronization Module

The module shall be a System Sensor Sync•Circuit model MDL listed to UL 464 and shall be approved for fire protective service. The module shall synchronize SpectrAlert strobes at 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 × 411/16 × 21/8-inch back box. The module shall also control two Style Y (class B) circuits or one Style Z (class A) circuit. The module shall synchronize multiple zones. Daisy chaining two or more synchronization modules together will synchronize all the zones they control. The module shall not operate on a coded power supply.

Physical/Electrical Specifications

Standard Operating Temperature	32°F to 120°F (0°C to 49°C)
Humidity Range	10 to 93% non-condensing
Strobe Flash Rate	1 flash per second
Nominal Voltage	Regulated 12 DC/FWR or regulated 24 DC/FWR[1]
Operating Voltage Range[2]	8 to 17.5 V (12 V nominal) or 16 to 33 V (24 V nominal)
Input Terminal Wire Gauge	12 to 18 AWG
Ceiling-Mount Dimensions (including lens)	6.8″ diameter × 2.5″ high (173 mm diameter × 64 mm high)
Ceiling-Mount Back Box Skirt Dimensions (BBSC-2, BBSCW-2)	7.1″ diameter × 2.2″ high (180 mm diameter × 57 mm high)
Ceiling-Mount Trim Ring Dimensions (sold as a 5 pack) (TRC-HS, TRCW-HS)	6.9″ diameter × 0.35″ high (175 mm diameter × 9 mm high)

Notes:

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

UL Current Draw Data

UL Max. Strobe Current Draw (mA RMS)

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

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

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

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

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

Horn Strobe Tones and Sound Output Data

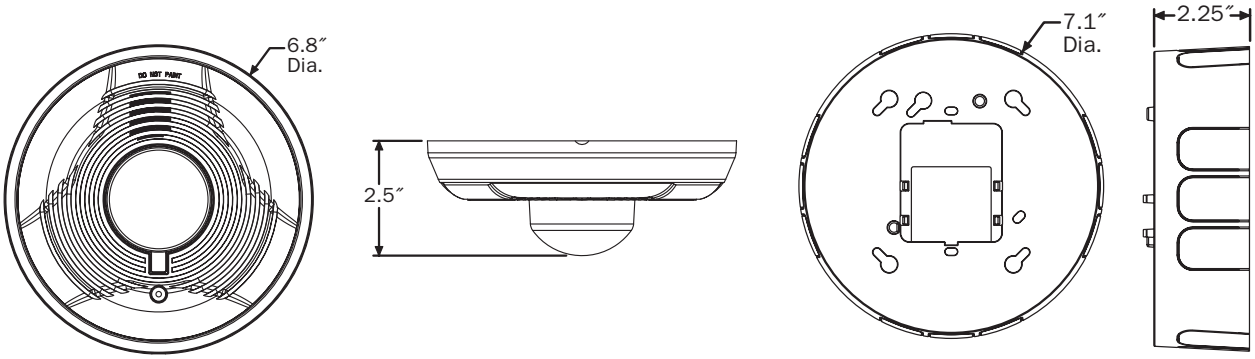
Horn Strobe Output (dBA)

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

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

AVDS00501

SpectrAlert Advance Dimensions



Ceiling-mount horn strobes

Ceiling back box skirt

SpectrAlert Advance Ordering Information

Model	Description
Ceiling Horn Strobes	
PC2R*	2-Wire Horn Strobe, Standard cd, Red
PC2RH	2-Wire Horn Strobe, High cd, Red
PC2W*†	2-Wire Horn Strobe, Standard cd, White
PC2WH*	2-Wire Horn Strobe, High cd, White
PC4R	4-Wire Horn Strobe, Standard cd, Red
PC4RH	4-Wire Horn Strobe, High cd, Red
PC4W	4-Wire Horn Strobe, Standard cd, White

Model	Description
Ceiling Strobes	
SCR	Strobe, Standard cd, Red
SCRH	Strobe, High cd, Red
SCW*	Strobe, Standard cd, White
SCWH	Strobe, High cd, White
Accessories	
BBSC-2	Back Box Skirt, Ceiling, Red
	Back Box Skirt, Ceiling, White
TRC-HS	Trim Ring, Ceiling, Red
TRCW-HS	Trim Ring, Ceiling, White

Notes:

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

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

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

SYSTEM SENSOR®

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

AVDS00501 • 3/12

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

SpectrAlert® Advance audible visible notification products are rich with features guaranteed to cut installation times and maximize profits.

Features

- Plug-in design with minimal intrusion into the back box
- Tamper-resistant construction
- Automatic selection of 12- or 24-volt operation at 15 and 15/75 candela
- Field-selectable candela settings on wall units: 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, and 185
- Horn rated at 88+ dBA at 16 volts
- Rotary switch for horn tone and three volume selections
- Universal mounting plate for wall units
- Mounting plate shorting spring checks wiring continuity before device installation
- Electrically Compatible with legacy SpectrAlert devices
- Compatible with MDL3 sync module
- Listed for ceiling or wall mounting

The SpectrAlert Advance series offers the most versatile and easy-to-use line of horns, strobes, and horn strobes in the industry. With white and red plastic housings, wall and ceiling mounting options, and plain and FIRE-printed devices, SpectrAlert Advance can meet virtually any application requirement.

Like the entire SpectrAlert Advance product line, 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, SpectrAlert Advance utilizes a universal mounting plate with an onboard shorting spring, so installers can test wiring continuity before the device is installed.

Installers can also easily adapt devices to a 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 three volume selections.

Agency Listings

SIGNALING UL LISTED
S4011 (chimes, horn strobes, horns)
S5512 (strobes)

FM APPROVED
3023572

MEA approved
MEA452-05-E

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

SpectrAlert Advance Specifications

Architect/Engineer Specifications

General

SpectrAlert Advance horns, strobes, and horn strobes shall mount to a standard 4 × 4 × 1½-inch back box, 4-inch octagon back box, or double-gang back box. Two-wire products shall also mount to a single-gang 2 × 4 × 17/8-inch back box. A universal mounting plate shall be used for mounting ceiling and wall products. The notification appliance circuit wiring shall terminate at the universal mounting plate. Also, SpectrAlert Advance products, when used with the Sync•Circuit™ Module accessory, shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts. When used with the Sync•Circuit Module, 12-volt-rated notification appliance circuit outputs shall operate between 8.5 and 17.5 volts; 24-volt-rated notification appliance circuit outputs shall operate between 16.5 and 33 volts. Indoor SpectrAlert Advance products shall operate between 32 and 120 degrees Fahrenheit from a regulated DC or full-wave rectified unfiltered power supply. Strobes and horn strobes shall have field-selectable candela settings including 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, and 185.

Strobe

The strobe shall be a System Sensor SpectrAlert Advance Model _____ listed to UL 1971 and shall be approved for fire protective service. The strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 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 System Sensor SpectrAlert Advance Model _____ listed to UL 1971 and UL 464 and shall be approved for fire protective service. The horn strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 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 three audibility options and an option to switch between a temporal three pattern and a non-temporal (continuous) pattern. These options are set by a multiple position switch. On four-wire products, the strobe shall be powered independently of the sounder. The horn on horn strobe models shall operate on a coded or non-coded power supply.

Synchronization Module

The module shall be a System Sensor 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 × 411/16 × 21/8-inch back box. The module shall also control two Style Y (class B) circuits or one Style Z (class A) circuit. The module shall synchronize multiple zones. Daisy chaining two or more synchronization modules together will synchronize all the zones they control. The module shall not operate on a coded power supply.

Physical/Electrical Specifications

Standard Operating Temperature	32°F to 120°F (0°C to 49°C)
Humidity Range	10 to 93% non-condensing
Strobe Flash Rate	1 flash per second
Nominal Voltage	Regulated 12 DC/FWR or regulated 24 DC/FWR[1]
Operating Voltage Range[2]	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 × 4.7˝W × 2.5˝D (142 mm L × 119 mm W × 64 mm D)
Horn Dimensions	5.6˝L × 4.7˝W × 1.3˝D (142 mm L × 119 mm W × 33 mm D)
Wall-Mount Trim Ring Dimensions (sold as a 5 pack) (TR-HS)	5.7˝L × 4.8˝W × 0.35˝D (145 mm L × 122 mm W × 9 mm D)

Notes:

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

UL Current Draw Data

UL Max. Strobe Current Draw (mA RMS)

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

UL Max. Horn Current Draw (mA RMS)

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

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

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

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

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

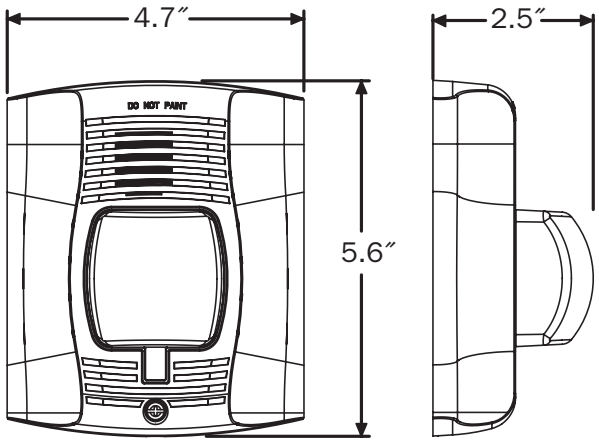
Horn Tones and Sound Output Data

Horn and Horn Strobe Output (dBA)

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

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

SpectrAlert Advance Dimensions



Wall-mount horn strobes

SpectrAlert Advance Ordering Information

Model	Description
Wall Horn Strobes	
P2R	2-Wire Horn Strobe, Standard cd, Red
P2R-P	2-Wire Horn Strobe, Standard cd, Red, Plain
P2R-SP	2-Wire Horn Strobe, Standard cd, Red, “FUEGO”
P2RH	2-Wire Horn Strobe, High cd, Red
P2RH-P	2-Wire Horn Strobe, High cd, Red, Plain
P2W	2-Wire Horn Strobe, Standard cd, White
P2W-P	2-Wire Horn Strobe, Standard cd, White, Plain
P2WH	2-Wire Horn Strobe, High cd, White
P2WH-P	2-Wire Horn Strobe, High cd, White, Plain
P4R	4-Wire Horn Strobe, Standard cd, Red
P4R-P	4-Wire Horn Strobe, Standard cd, Red, Plain
P4RH	4-Wire Horn Strobe, High cd, Red
P4W	4-Wire Horn Strobe, Standard cd, White
Wall Strobes	
SR	Strobe, Standard cd, Red
SR-P	Strobe, Standard cd, Red, Plain
SR-SP	Strobe, Standard cd, Red, “FUEGO”

Model	Description
Wall Strobes (cont.)	
SRH	Strobe, High cd, Red
SRH-P	Strobe, High cd, Red, Plain
SRH-SP	Strobe, High cd, Red, “FUEGO”
SW	Strobe, Standard cd, White
SW-P	Strobe, Standard cd, White, Plain
SWH	Strobe, High cd, White
SWH-P	Strobe, High cd, White, Plain
Horns	
HR	Horn, Red
HW	Horn, White
Accessories	
TR-HS	Trim Ring, Wall, Red
SBBR	Indoor Surface Mount Back Box, Red
SBBW	Indoor Surface Mount Back Box, White

Notes:
All -P models have a plain housing (no “FIRE” marking on cover)
All -SP models have “FUEGO” marking on cover
“Standard cd” refers to strobes that include 15, 15/75, 30, 75, 95, 110, and 115 candela settings.
“High cd” refers to strobes that include 135, 150, 177, and 185 candela settings.

SYSTEM SENSOR®
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Outdoor Selectable-Output Horns, Strobes, and Horn Strobes for Wall Applications

SPECTRAlert ADVANCE from System Sensor

SpectrAlert® Advance outdoor audible visible products are rich with features that cut installation times and maximize profits.

Features

- Weatherproof per NEMA 4X, IP56
- Listed to UL 1638 (strobe) and UL 464 (horn)
- Compatible with System Sensor synchronization protocol and legacy SpectrAlert products
- Field-selectable candela settings: 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, and 185
- Automatic selection of 12- or 24-volt operation at 15 and 15/75 candela
- Rotary switch for horn tone and three volume selections
- Horn rated at 88+ dBA at 16 volts
- Rated from –40°F to 151°F
- Universal mounting plate with an onboard shorting spring that tests wiring continuity before devices are installed
- Plug-in design with minimal intrusion into the back box
- Tamper-resistant construction
- Listed for ceiling or wall mounting

Agency Listings

SIGNALING UL LISTED
S4011 (chimes, horn strobes, horns)
S3593 (outdoor and alert strobes)

FM APPROVED
3023572

MEA approved
MEA452-05-E

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

SpectrAlert Advance offers the broadest line of outdoor horns, strobes, and horn strobes in the industry. With white or red plastic housings, wall or ceiling mounting options, and plain or FIRE-printed devices, SpectrAlert Advance can meet virtually any application requirement, including indoor, outdoor, wet, and dry applications in temperatures from –40°F to 151°F.

Like the entire SpectrAlert Advance line, outdoor horns, strobes, and horn strobes for wall applications include a variety of features that increase application flexibility and simplify installation. First, field-selectable settings, including candela, automatic selection of 12- or 24-volt operation, horn tones, and three volume options enable installers to easily adapt devices to meet requirements.

Next, SpectrAlert Advance devices use a universal mounting plate for both wall and ceiling applications. This mounting plate includes an onboard shorting spring that ensures wiring continuity before devices are installed, so installers can verify proper wiring without mounting the devices and exposing them to potential construction damage. Once the plates are mounted, all SpectrAlert Advance devices utilize a plug-in design with a single captured screw to speed installation and virtually eliminate costly ground faults.

Outdoor devices ship with weatherproof plastic back boxes (metal back boxes are available separately) that accommodate in-and-out wiring for daisy chaining devices. Plastic back boxes feature removable side flanges and improved resistance to saltwater corrosion. Knock-outs located on the back eliminate the need to drill holes for screw-in mounting. Plastic and metal weatherproof back boxes come with ¾-inch top and bottom conduit entries and ¾-inch knock-outs at the back. A screw-in NPT plug with an O-ring gasket for a watertight seal is included with each back box.

SpectrAlert Advance Outdoor Horn, Strobe, and Horn Strobe Specifications

Architect/Engineer Specifications

General

SpectrAlert Advance outdoor horns, strobes, and horn strobes shall mount to a weatherproof back box. A universal mounting plate shall be used for mounting ceiling and wall products. The notification appliance circuit wiring shall terminate at the universal mounting plate. Also, SpectrAlert Advance products, when used with the Sync•Circuit™ Module accessory, shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts. When used with the Sync•Circuit Module, 12-volt-rated notification appliance circuit outputs shall operate between 9 and 17.5 volts; 24-volt-rated notification appliance circuit outputs shall operate between 17 and 33 volts. Outdoor SpectrAlert Advance products shall operate between –40 and 151 degrees Fahrenheit from a regulated DC or full-wave rectified unfiltered power supply. Strobes and horn strobes shall have field-selectable candela settings including 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, and 185.

Strobe

The strobe shall be a System Sensor SpectrAlert Advance Model _____ listed to UL 1971 and shall be approved for fire protective service. The strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 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 strobe must be installed with its weatherproof back box in order to remain outdoor approved per UL. The strobe shall be suitable for use in wet environments.

Horn Strobe Combination

The horn strobe shall be a System Sensor SpectrAlert Advance Model _____ listed to UL 1971 and UL 464 and shall be approved for fire protective service. The horn strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 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 three audibility options and an option to switch between a temporal three pattern and a non-temporal (continuous) pattern. These options shall be set by a multiple position switch. On four-wire products, the strobe shall be powered independently of the sounder. The horn or horn strobe models shall operate on a coded or non-coded power supply. The horn strobe must be installed with its weatherproof back box in order to remain outdoor approved per UL. The horn strobe shall be suitable for use in wet environments.

Physical/Electrical Specifications

Operating Temperature	–40°F to 151°F (–40°C to 66°C)
Strobe Flash Rate	1 flash per second
Nominal Voltage	Regulated 12 DC/FWR or regulated 24 DC/FWR[1]
Operating Voltage Range[2]	8 to 17.5 V (12 V nominal) or 16 to 33 V (24 V nominal)
Input Terminal Wire Gauge	12 to 18 AWG
Wall-Mount Dimensions (including lens)	5.6˝L × 4.7˝W × 2.5˝D (142 mm L × 119 mm W × 64 mm D)
Horn Dimensions	5.6˝L × 4.7˝W × 1.3˝D (142 mm L × 119 mm W × 33 mm D)
Wall-Mount Weatherproof Back Box Dimensions (SA-WBB)	5.7˝L × 5.1˝W × 2.0˝D (145 mm L × 130 mm W × 51 mm D)

Notes:

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

UL Current Draw Data

UL Max. Strobe Current Draw (mA RMS)

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

UL Max. Horn Current Draw (mA RMS)

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

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

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

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

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

Candela Derating

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

Strobe Output (cd)

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

Horn Tones and Sound Output Data

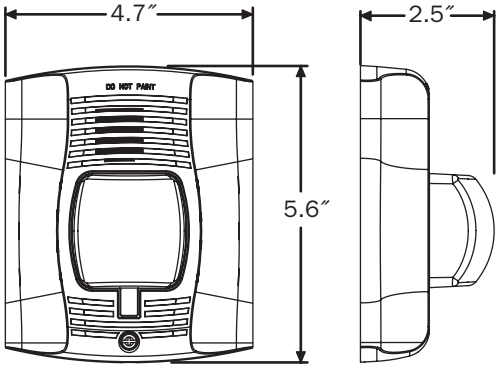
Horn and Horn Strobe Output (dBA)

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

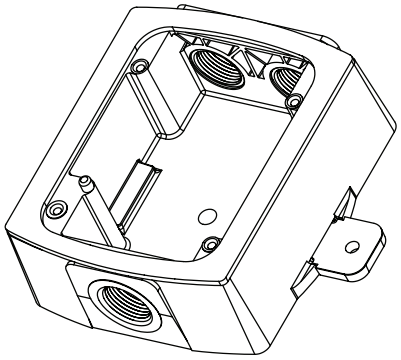
†Settings 7, 8, and 9 are not available on 2-wire horn strobe.

AVDS01201

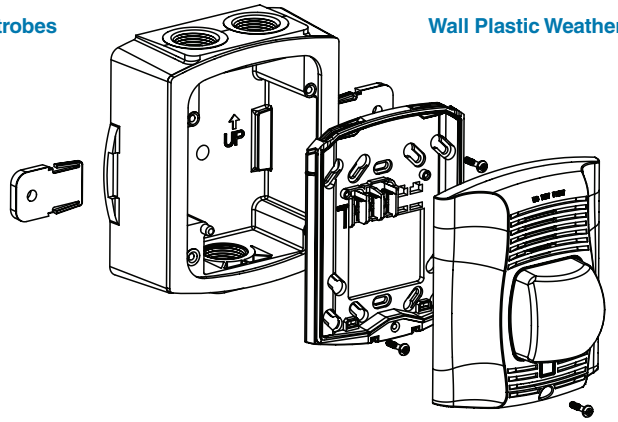
SpectrAlert Advance Diagrams



Wall-Mount Horn Strobes



Wall Plastic Weatherproof Back Box



Wall-Mount Horn Strobe with Plastic Weatherproof Back Box

SpectrAlert Advance Ordering Information

Model	Description
Wall Horn Strobes	
P2RK*†	2-Wire Horn Strobe, Standard cd, Red, Outdoor (includes plastic weatherproof back box)
P2RHK*†	2-Wire Horn Strobe, High cd, Red, Outdoor (includes plastic weatherproof back box)
P2WK*†	2-Wire Horn Strobe, Standard cd, White, Outdoor (includes plastic weatherproof back box)
P2WHK*†	2-Wire Horn Strobe, High cd, White, Outdoor (includes plastic weatherproof back box)
P4RK†	4-Wire Horn Strobe, Standard cd, Red, Outdoor (includes plastic weatherproof back box)
P4WK	4-Wire Horn Strobe, Standard cd, White, Outdoor (includes plastic weatherproof back box)
P2RHK-120	2-Wire Horn Strobe, High cd, Red, Outdoor, 120 V (includes plastic weatherproof back box)
Wall Strobes	
SRK*†	Strobe, Standard cd, Red, Outdoor (includes plastic weatherproof back box)
SRHK*†	Strobe, High cd, Red, Outdoor (includes plastic weatherproof back box)
SWK*†	Strobe, Standard cd, White, Outdoor (includes plastic weatherproof back box)
SWHK*†	Strobe, High cd, White, Outdoor (includes plastic weatherproof back box)
Horns	
HRK†	Horn, Red, Outdoor (includes plastic weatherproof back box)
Accessories	
SA-WBB	Red, Metal Weatherproof Back Box
SA-WBBW	White, Metal Weatherproof Back Box

Notes:
* Add "-P" to model number for plain housing (no "FIRE" marking on cover), e.g., P2RK-P.
† Add "-R" to model number for weatherproof replacement device (no back box included), only for use with weatherproof outdoor flush mounting plate, WTP and WTPW.
"Standard cd" refers to strobes that include 15, 15/75, 30, 75, 95, 110, and 115 candela settings. "High cd" refers to strobes that include 135, 150, 177, and 185 candela settings. **When replacing standard outdoor units both the device and back box must be replaced.**

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

AVDS01201 • 3/12

Intelligent Manual Pull Stations

E-270, E-278

Overview

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

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

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

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

Standard Features

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

Operation

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

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

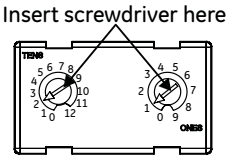
The pull station is configured for alarm latching operation. When the pull lever is activated, an alarm signal is sent to the control panel and the alarm condition is latched at the pull station.

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

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

Device Addressing

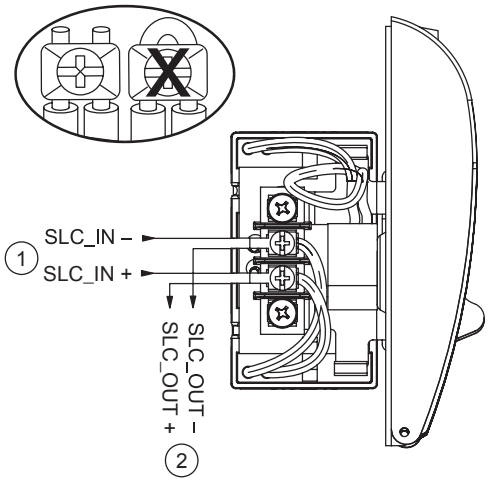
Use a screwdriver to adjust the two rotary switches on the front of the module. Set the TENS rotary switch (0 through 12) for the 10s digit and the ONES rotary switch for the 0 through 9 digit.



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

Refer to the Specifications Table for available address numbers.

Wiring

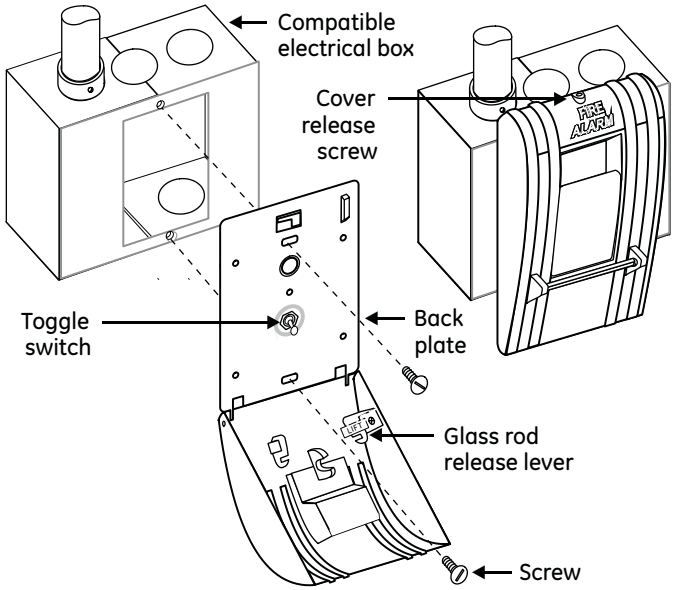


1. From previous device or control panel
2. To next device or EOL resistor

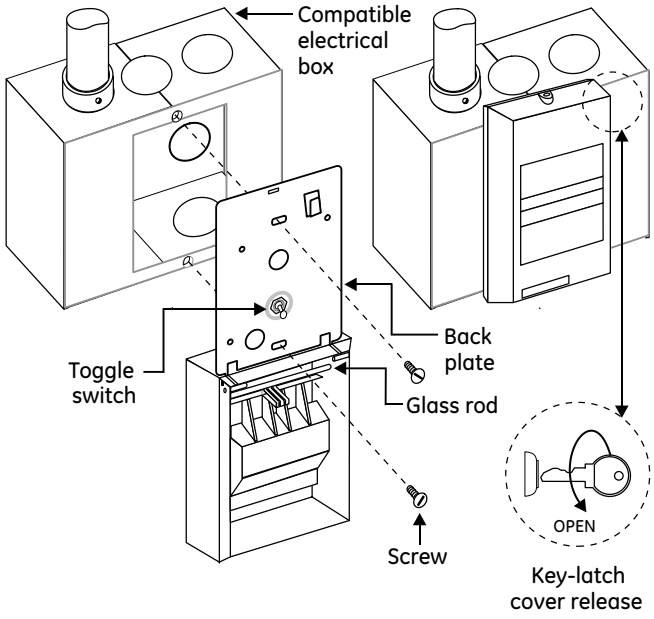
Installation

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

E-270 Single Action Pull Station



E-278 Double Action Pull Station



Specifications

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

Ordering Information

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

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

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

Accuflow™ Series Solid State Waterflow Detectors

SYSTEM SENSOR®

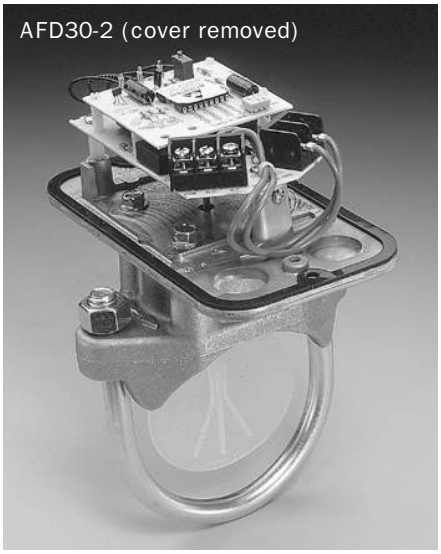
Models Available

AFD20
AFD25
AFD30-2
AFD35
AFD40
AFD50
AFD60
AFD80

Replacement Parts

WFDW	Cover wrench
546-9000	Cover tamper switch kit
WFDN4	Gasket kit
AFDPCBRK	Retard PCB kit


AFD30-2


AFD30-2 (cover removed)

Product Overview

Solid state retard assures precise timing accuracy

DIP Switch selections simplify retard settings

Non-polarized, two-wire design allows connection to a local bell and conventional or addressable systems

Compatible with a wide range of pipe schedules, including 5 through 40

Models are equipped with a NEMA 4 gasket

Synchronized switches activate both the alarm panel and local bell simultaneously

Field-replaceable retard assembly

System Sensor's Accuflow™ series is a new line of solid state waterflow detectors compatible with a wide range of pipe schedules, including 2″ schedule 5. Accuflow detectors can be mounted in a vertical or horizontal position.

Robust Construction. The Accuflow series consists of a rugged enclosure for indoor and outdoor use. Like all System Sensor waterflow detectors, Accuflow models operate across a wide temperature range, from 32°F to 120°F (0°C to 49°C).

Reliable Performance. Accuflow detectors incorporate a solid state retard to ensure consistently accurate timing. Designed for use within conventional and addressable fire alarm systems, Accuflow detectors include connections for both the panel or addressable module, as well as a local bell or notification device.

False Alarm Immunity. The solid state circuitry of the Accuflow series provides greater timing accuracy over traditional mechanical retard designs. This accuracy minimizes the risk of false alarms created by pressure surges or air trapped within the sprinkler system.

Simplified Operation. Accuflow detectors are designed to simplify installation. Wired like traditional waterflow detectors, the Accuflow series does not require the installer to run an additional third wire. Two conduit openings permit easy attachment to the local alarm system.

UL LISTED

Engineering Specification

Vane-type waterflow detector with a solid state retard shall be an Accuflow™ Series model number _____ manufactured by System Sensor, and 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 on a vertical upflow or horizontal run, at least 6″ from any fittings which may change water direction, flow rate, or pipe diameter, or no closer than 24″ from a valve or drain. Detectors shall be compatible with schedule 5 through 40 for 2″ diameter pipe, schedule 7 through 40 for 2½″ – 6″ diameter pipe and schedule 10 through 40 for 8″ diameter pipe. 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″ – 8″ diameter pipes. The detector shall respond to water flow in the specified direction after a preset time delay. The delay mechanism shall be a solid state unit which is field-adjustable via a dipswitch. The detector's actuation mechanism shall include a polyethylene vane inserted through a hole in the pipe and connected by a mechanical linkage to the delay mechanism. Outputs shall consist of one SPDT switch (Form C contact) and one SPST switch (normally open contact) for wiring to an alarm panel or addressable control module and local bell and/or notification device. Two conduit entrances (one knockout type) for standard fittings of commonly used electrical conduit shall be provided on the detectors. A grounding provision shall be provided. Unless noted, enclosures shall be NEMA 4 listed by Underwriters Laboratories, Inc. for indoor or outdoor use.

Standard Specifications

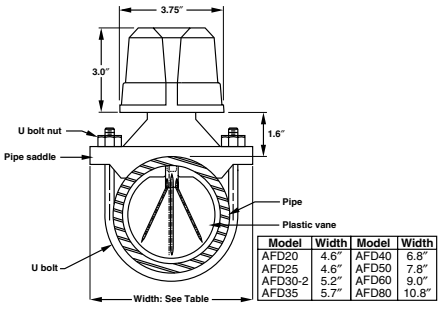
Static Pressure Rating
450 PSI

Triggering Threshold Bandwidth (Flow Rate)
4 – 10 GPM

Maximum Surge
18 Feet Per Second (FPS)

Compatible Pipe
Steel water pipe,
2″: schedule 5 through 40
2½″ – 6″: schedule 7 through 40
8″: schedule 10 through 40

Overall Dimensions Installed



Model	Width	Model	Width
AFD20	4.6″	AFD40	6.8″
AFD25	4.6″	AFD50	7.8″
AFD30-2	5.2″	AFD60	9.0″
AFD35	5.7″	AFD80	10.8″

Contact Ratings
One SPDT (Form C)
One SPST (normally open)
0.6 A @ 125 VAC
2.0 A @ 30 VDC

Voltage Range
8.4 – 35 V (DC-FWR)
108 – 132 VAC

Current Draw
300 microamps @ 12/24 VDC or FWR
400 microamps @ 120 VAC

Compatibility
The Accuflow and Accuflow Low Flow detectors may receive power and operate on a two-wire initiating zone of a fire alarm control panel. When determining compatibility of these devices, the standby operating voltage of the control panel must be between 8.5 and 35 volts. In the standby mode, each Accuflow and Accuflow Low Flow detector acts as a shot across the initiating zone. **For two wire conventional fire alarm control panels, not more than 5 waterflow detectors may be connected to a single initiating zone.** The maximum retard/reset time of the waterflow detector plus the initiating zone shall not exceed 90 seconds.

For two wire addressable control panels, the number of waterflow detectors connected to the panel's signaling line circuit shall be limited by the circuit's current capacity.

Conduit Entrances
Two openings for ½″ conduit, one open, one knock-out type

Operating Temperature Range
32°F – 120°F (0°C to 49°C)

Enclosure Rating
NEMA 4 – suitable for indoor/outdoor use

Cover Tamper Switch
Optional, part no. 546-9000

Shipping Weight
AFD20: 4.1 lbs. (1.8 kg)
AFD25: 4.2 lbs. (1.9 kg)
AFD30-2: 4.4 lbs. (2.0 kg)
AFD35: 4.6 lbs. (2.1 kg)
AFD40: 5.1 lbs. (2.3 kg)
AFD50: 6.2 lbs. (2.8 kg)
AFD60: 6.7 lbs. (3.0 kg)
AFD80: 7.4 lbs. (3.4 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

Retard Settings
0 – 90 seconds, in increments of 15 seconds

Warranty
3 years

Ordering Information

Model Numbers	Pipe Size
AFD20	2″
AFD25	2½″
AFD30-2	3″
AFD35	3½″
AFD40	4″
AFD50	5″
AFD60	6″
AFD80	8″

Replacement Part Number	Description
546-9000	Cover tamper switch kit
WFDW	Tamper proof wrench for cover
WFDN4	Gasket kit
AFDPCBRK	Retard PCB kit

System Sensor Sales and Service

System Sensor Headquarters
3825 Ohio Avenue
St. Charles, IL 60174
Ph: 800-SENSOR2
Fx: 630/377-6495
Documents On Demand:
1-800-736-7672 x3
Web: www.systemsensor.com

System Sensor in Canada
Ph: 905.812.0767
Fx: 905.812.0771

System Sensor in Europe
Ph: + 44.1403.276500
Fx: + 44.1403.276501

System Sensor in China
Ph: + 86.29.524.6253
Fx: + 86.29.524.6259

System Sensor in Singapore
Ph: + 65.273.2230
Fx: + 65.273.2610

System Sensor in the Far East
Ph: + 852.21919003
Fx: + 852.27366580

System Sensor in Australia
Ph: + 613.54.281.142
Fx: + 613.54.281.172

System Sensor in India
Ph: + 91.11.558.2119
Fx: + 91.11.567.6815

A05-0277-002•6/03•#1119

Fire Protection, Inc.

Acct. #: [redacted]

The items on this checklist have been inspected and tested. This list does not constitute all of the required inspecting and testing of the fire and life safety system. Refer to Fire Department Fire Codes for inspecting and testing requirements.

Alarm System Functionality

1. Trouble signal with AC power off?		☑ Yes	☐ No
2. System operates properly on battery backup?		☑ Yes	☐ No
3. Battery voltage (no load) 26.56 volts			
4. Battery voltage (full load) 25.5 volts (signals operating)			
5. Charge circuit voltage 27.5 volts			
6. System operates properly on standby power?		☑ Yes	☐ No
7. All signals operate on AC power?		☑ Yes	☐ No
8. Number of initiating circuits SLC			
9. Number of signal circuits 8			
10. Does alarm system meet audibility standards as accepted?		☐ Yes	☐ No
11. All circuits checked for electrical supervision?		☑ Yes	☐ No
12. All auxiliary equipment operates (elevators, fans, dampers)?	☑ N/A	☐ Yes	☐ No
13. Ventilation controls operate?	☑ N/A	☐ Yes	☐ No
14. Key to panel available?		☑ Yes	☐ No
15. Operating instructions at panel?		☐ Yes	☑ No
16. Trouble indicators function properly?		☑ Yes	☐ No
17. Remote Annunciator Panels function properly?	☑ N/A	☐ Yes	☐ No
18. Elevator Call Down functions properly?	☑ N/A	☐ Yes	☐ No
19. Test record posted at panel?		☐ Yes	☐ No
20. General alarm automatic time delay _____ (minutes)	☑ N/A		
21. Was a signal received at the Central Station monitoring company?	☐ N/A	☐ Yes	☐ No
22. Other Devices (specify)		☐ Yes	☐ No

System Devices	Total Number of Units in Building	Total Number Units Tested	Test Results Acceptable		
23. Bells, Horns, Chimes	20	20	☐ N/A	☑ Yes	☐ No
24. Voice Speakers (Voice Clarity)			☑ N/A	☐ Yes	☐ No
25. Smoke Detectors	1	1	☐ N/A	☑ Yes	☐ No
26. Heat Detectors	1	1	☑ N/A	☐ Yes	☐ No
27. Duct Detectors	4	4	☐ N/A	☑ Yes	☐ No
28. Sprinkler Flow Switches	1	1	☐ N/A	☑ Yes	☐ No
29. Sprinkler Supervisory Switches	2	2	☐ N/A	☑ Yes	☐ No
30. Visual Alarm Devices	14	14	☐ N/A	☑ Yes	☐ No
31. Manual Pull Stations	14	14	☐ N/A	☑ Yes	☐ No
32. Annunciator(s)			☑ N/A	☐ Yes	☐ No
33. Beam Detectors			☑ N/A	☐ Yes	☐ No
34. Automatic Door Unlocks			☐ N/A	☐ Yes	☐ No
35. Automatic Door Release			☑ N/A	☐ Yes	☐ No
36. Fire Dampers			☑ N/A	☐ Yes	☐ No

Communications Equipment	Total Number of Units in Building	Total Number Units Tested	Test Results Acceptable		
37. Phone Sets			☐ N/A	☐ Yes	☐ No
38. Phone Jacks			☐ N/A	☐ Yes	☐ No
39. Call-in Signal			☐ N/A	☐ Yes	☐ No

574261

Fire Protection, Inc.

CONTRACTOR #FIREPI*021ML
Fire and Security Alarm Installations
24 Hour Local UL Monitoring

Date: 1-6-14
Acct. #:
Work Order #:

(425) 290-9600 • (800) 681-1125
Fax: (425) 353-4546

FIRE ALARM SYSTEM

(One System per Report)

☒ CONFIDENCE TEST ☐ REPAIRS

Certification Given ☐ YELLOW ☐ WHITE

Occupancy Address: 830 N. 10th St
Renton, WA

Testers Name: Anthony Z 196
Mike K

Time In: 755 am Time Out:

Central station monitoring? ☒ Yes ☐ No

System Make: Silent Knight

System Location: Fantom Elec Rm

Occupancy Name: Landing Bldg 810

Phone Number:

Responsible Party
E-mail Address:

Inspection Frequency/Type:
☐ Monthly
☐ Quarterly
☐ Semi-Annual
☒ Annual

Certification Number: 29577

Monitoring Company Name: **Fire Protection, Inc.**

System Model: 5208

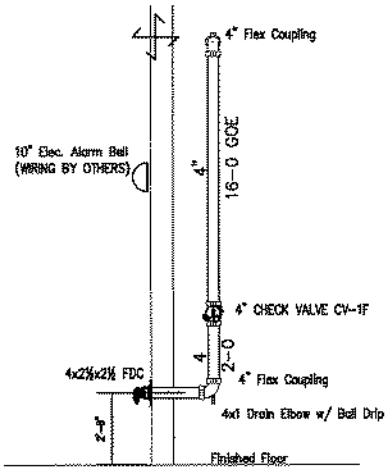
CORRECTIONS NEEDED:

* Silence cut failed 3 units under construction
* Open circuit on main bell

CORRECTIONS MADE: Date Corrected: Corrected By:

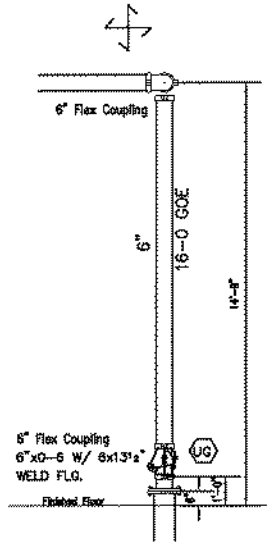
Replaced 2 12v 7ah batteries in fact

Appendix D- Prescriptive Suppression System Attachments



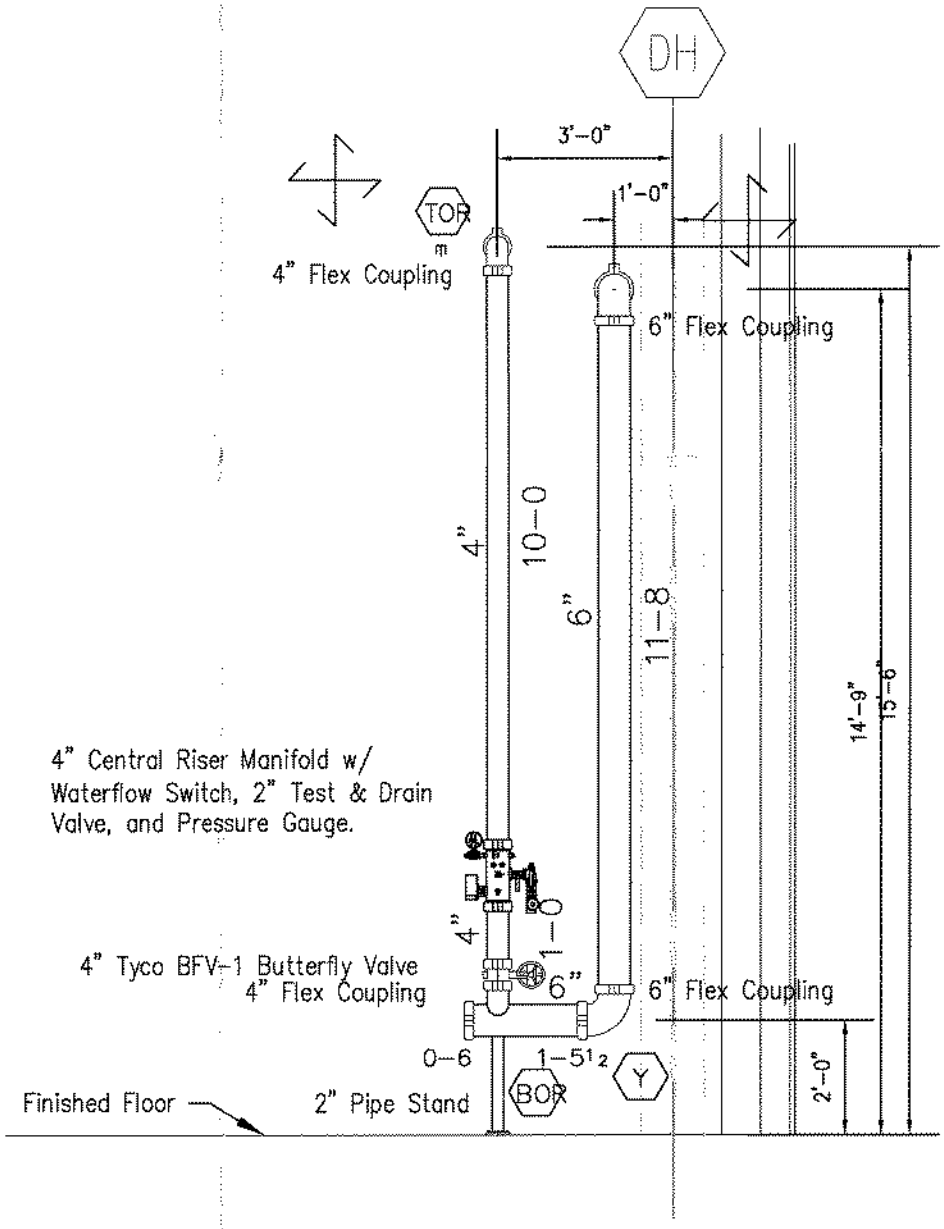
FDC SECTION

SCALE 1/4" = 1-0



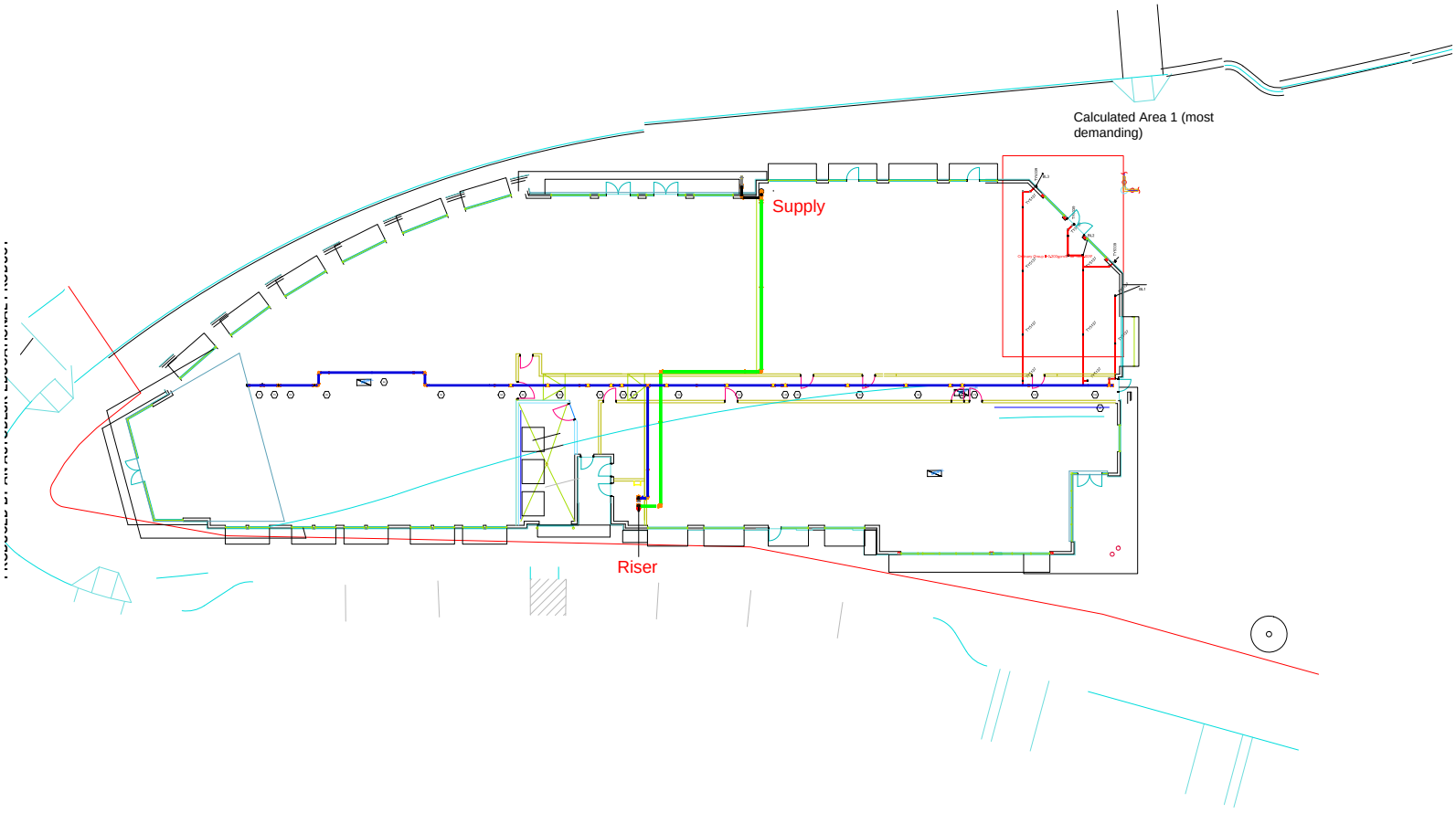
UG / SUPPLY SECTION

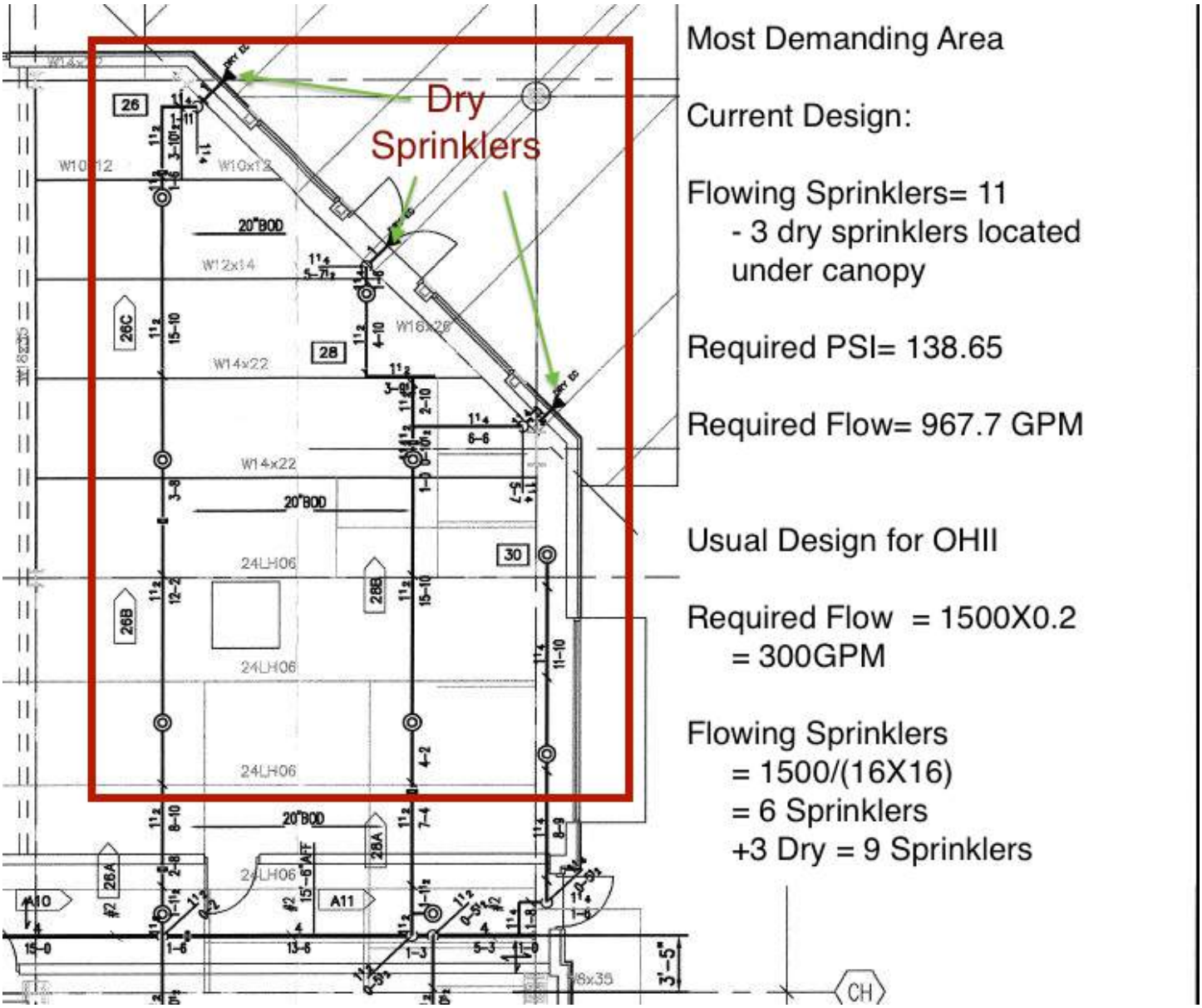
SCALE 1/4" = 1-0

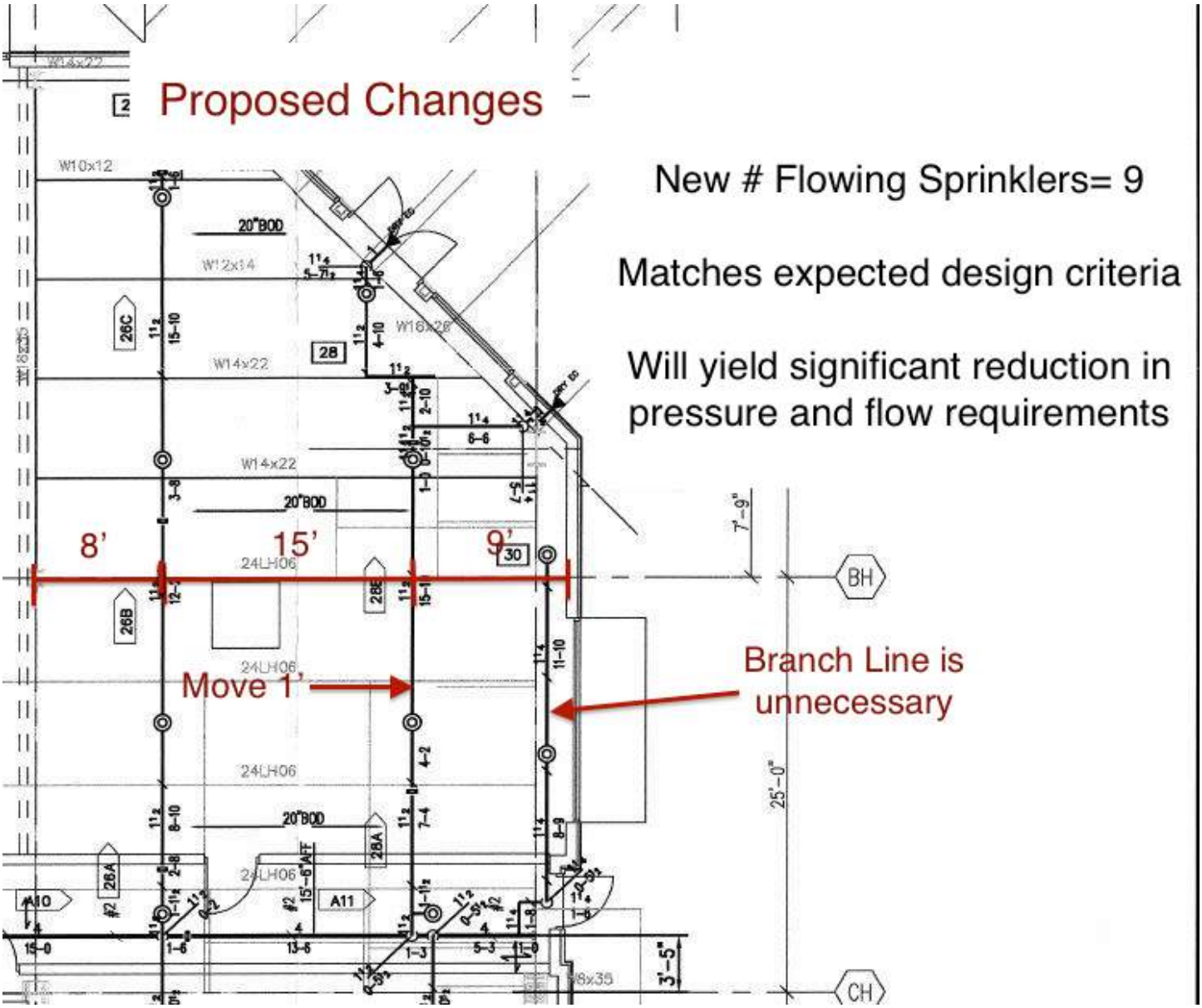


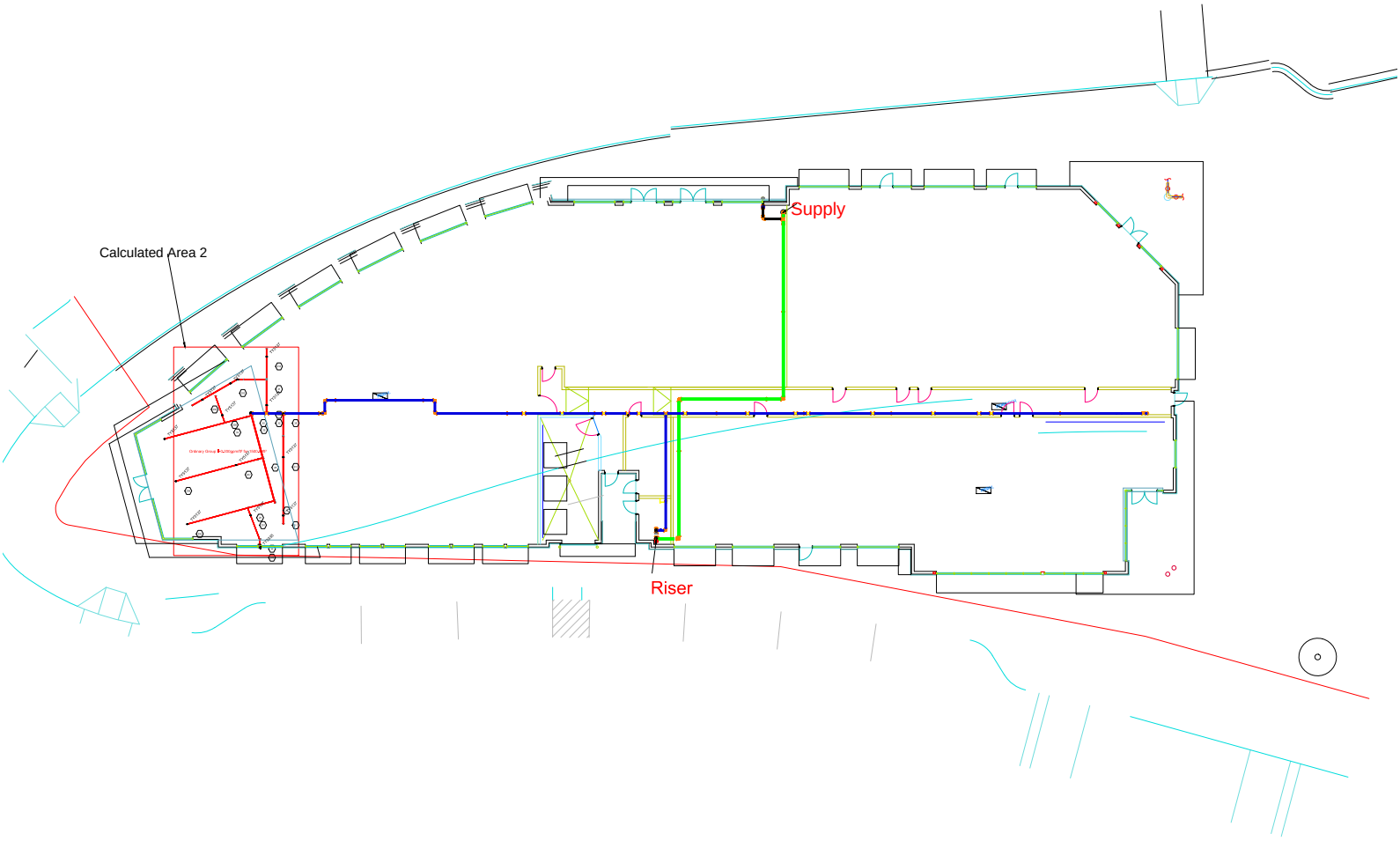
RISER SECTION

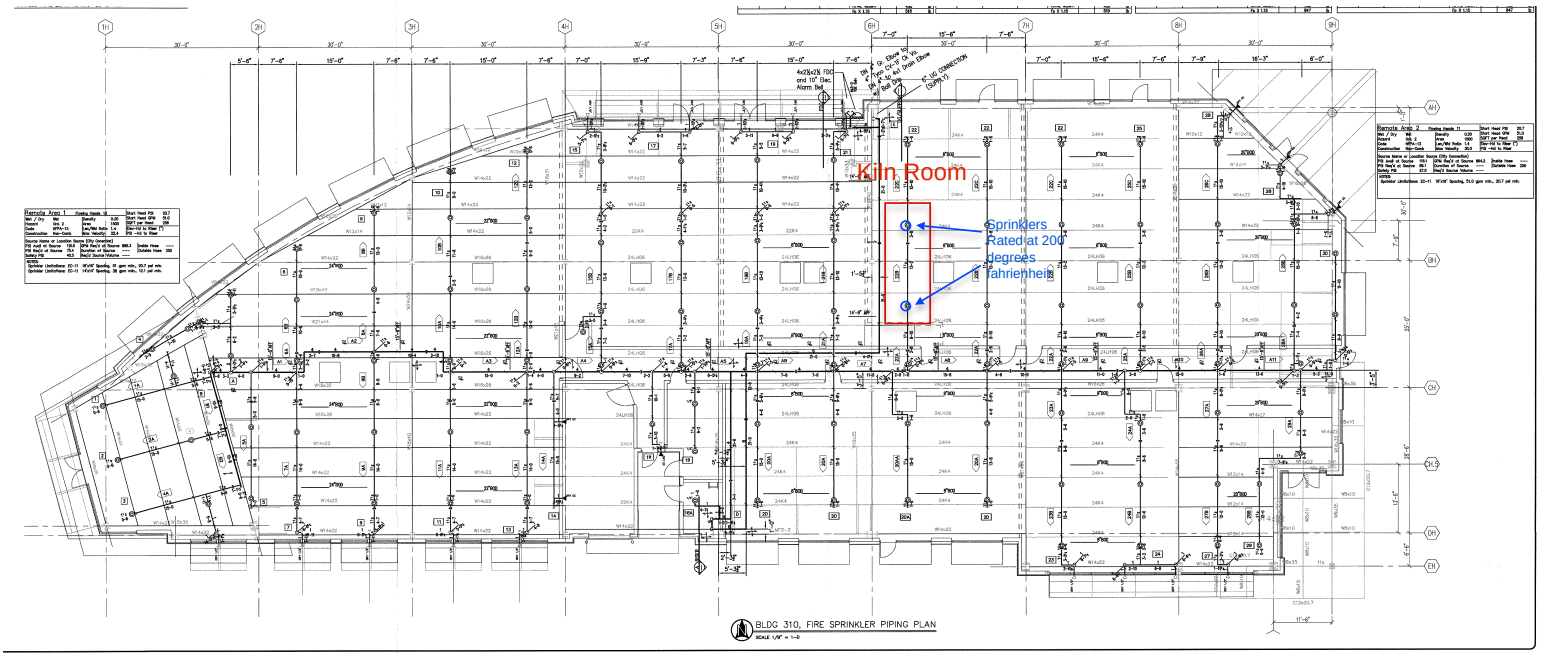
SCALE 1/2" = 1-0


Calculated Area 1 (most demanding)
Supply
Riser


Dry Sprinklers
Most Demanding Area
Current Design:
Flowing Sprinklers= 11
- 3 dry sprinklers located under canopy
Required PSI= 138.65
Required Flow= 967.7 GPM
Usual Design for OHII
Required Flow = 1500X0.2
= 300GPM
Flowing Sprinklers
= 1500/(16X16)
= 6 Sprinklers
+3 Dry = 9 Sprinklers


Proposed Changes
New # Flowing Sprinklers= 9
Matches expected design criteria
Will yield significant reduction in pressure and flow requirements
8'
15'
9'
Move 1'
Branch Line is unnecessary
BH
CH
7'-9"
25'-0"
3'-5"
W10x12
W12x14
W14x22
W16x26
W8x35
20"BOD
24LH06
26A
26B
26C
28
28A
28E
30
A10
A11


Calculated Area 2
Supply
Riser


Kiln Room
Sprinklers Rated at 200 degrees Fahrenheit
BLDG 310, FIRE SPRINKLER PIPING PLAN

HYDRAULIC CALCULATIONS

for most demanding sprinkler

CONTRACT NAME OH II 1500 ft² Wet System - steel

SHEET 1 OF 2

NOZZLE IDENT. AND LOCATION		FLOW IN GPM	PIPE SIZE	PIPE FITTINGS AND DEVICES	EQUIV. PIPE LENGTH	FRICTION LOSS PSI/FT	PRESSURE SUMMARY	NORMAL PRESSURE	NOTES
									D = .2 gpm/ft² K = 11.2
1	BL1	q	Dyna flow 1¼ (1.536)		L 11.83'	C=120	Pt 20.9	Pt	Q = 256 · (.2)
					F		Pe	Pv	P = (51.2/11.2)²
		Q 57.2			T 11.83	.116	Pf 1.4	Pn	
2	to CM	q 52.9	1¼ (1.536)	Elbow x3	L 11.92		Pt 22.3	Pt	
					F 15		Pe .2	Pv	q = 11.2√22.3
		Q 104.1		T x1	T 26.9	.430	Pf 11.6	Pn	5.5" = 2
	CM to BL2	q	4 (4.31)		L 6.5	C=100	Pt 34.1	Pt	K = 104.1/√34.1
					F		Pe	Pv	= 17.83
		Q 104.1			T 6.5	.004	Pf .03	Pn	
	to node 142	q	4 (4.31)		L 36.5		Pt 34.4	Pt	P = 34.6
					F	.004	Pe	Pv	Q = 104.1
		Q 104.1			T 36.5		Pf .15	Pn	
1	BL2	q	Dyna thread 1 (1.08)	Elbow x1	L 2	C=120	Pt 20.9	Pt	
					F 7		Pe	Pv	
		Q 51.2			T 4	.64	Pf 2.6	Pn	
	Size change	q	Dyna flow 1¼ (1.536)	Elbow x1	L 7.13		Pt ~~23.5~~	Pt	ele -5' 7"
					F 3		Pe 2.4	Pv	
		Q 51.2			T 10.13	.116	Pf 1.2	Pn	
2	to elbow	q 52.9	1½ (1.73)	Elbow x2	L 11.41		Pt 22.3	Pt	q = 11.2√22.3
					F 8		Pe	Pv	
		Q 104.1			T 19.4	.241	Pf 4.7	Pn	
3	to elbow	q	Dyna thread 1 (1.08)	elbow	L 2		Pt 27	Pt	q = 11.2√27
					F 2		Pe	Pv	
		Q 58.2			T 4	.815	Pf 3.3	Pn	
	to T	q	Dyna flow 1¼ (1.536)	elbow x1	L 12.1		Pt 30.3	Pt	ele -5' 7"
					F 9		Pe 2.4	Pv	
		Q 58.2		T	T 21.1		Pf 3.1	Pn	
	T to 4	q	1½ (1.73)		L .875		Pt 31	Pt	
					F	.546	Pe	Pv	
		Q 162.3			T .875		Pf .48	Pn	
4		q 65.9	1½ (1.73)		L 16		Pt 31.5	Pt	q = 11.2√31.48
					F		Pe	Pv	
		Q 233.7			T 16	1	Pf 16	Pn	
							Pt		

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HYDRAULIC CALCULATIONS

CONTRACT NAME _____ SHEET 2 OF 2

NOZZLE IDENT. AND LOCATION		FLOW IN GPM	PIPE SIZE	PIPE FITTINGS AND DEVICES	EQUIV. PIPE LENGTH	FRICTION LOSS PSI/FT	PRESSURE SUMMARY	NORMAL PRESSURE	NOTES
5	DN to CM	q 77.2	1 ½	elbow	L 8.92	1.73	Pt 47.5	Pt	ele 5 ½"
		Q 302.3	(1.73)		F 12		Pe .2	Pv	$q = 11.2\sqrt{47.5}$
				T	T 20.92		Pf 39.1	Pn	
	to node 142	q	4		L 30	C=100	Pt 83.9	Pt	P = 84.8
		Q 302.3	(4.31)		F		Pe	Pv	Q = 302.3
					T 30	.03	Pf .92	Pn	
1	BL3	q	Dyna Thread 1	elbow	L 2	C=120	Pt 20.9	Pt	
		Q 57.2	(1.09)		F 2		Pe	Pv	
					T 4	.64	Pf 2.6	Pn	
	to elbow	q	1 ¼	elbow	L 7.2	.116	Pt 23.5	Pt	ele -5' 3½"
		Q 57.2	(1.53)	x2	F 6		Pe -2.3	Pv	size change
					T 13.2		Pf 1.53	Pn	
	to 2	q	1 ½		L 3.88	.065	Pt 22.7	Pt	size change
		Q 57.2	(1.73)		F		Pe	Pv	
					T 3.88		Pf .25	Pn	
2		q 53.7	1 ½		L 15.83	.244	Pt 23	Pt	$q = 11.2\sqrt{23}$
		Q 104.9	(1.73)		F		Pe	Pv	
					T 15.83		Pf 3.9	Pn	
3		q 58.1	1 ½		L 15.83	.552	Pt 26.9	Pt	$q = 11.2\sqrt{26.9}$
		Q 163	(1.73)		F		Pe	Pv	
					T 15.83		Pf 8.7	Pn	
4	DN to CM	q 66.8	1 ½	T x2	L 12.8	1.04	Pt 35.6	Pt	ele 2"
		Q 229.8	(1.73)		F 16		Pe .07	Pv	$q = 11.2\sqrt{35.6}$
					T 28.8		Pf 30	Pn	
	to node 142	q	4		L 15.5	C=100	Pt 65.7	Pt	P = 66
		Q 229.8	(4.31)		F		Pe	Pv	Q = 230
					T	.017	Pf .3	Pn	
		q			L		Pt	Pt	Sprinkler 1 on BL-2 is most demanding
		Q			F		Pe	Pv	
					T		Pf	Pn	
		q			L		Pt	Pt	
		Q			F		Pe	Pv	
					T		Pf	Pn	
							Pt		

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HYDRAULIC CALCULATIONS

CONTRACT NAME OHII 1500 ft² Wet system SHEET 1 OF 2

NOZZLE IDENT. AND LOCATION		FLOW IN GPM	PIPE SIZE	PIPE FITTINGS AND DEVICES	EQUIV. PIPE LENGTH	FRICTION LOSS PSI/FT	PRESSURE SUMMARY	NORMAL PRESSURE	NOTES
1	BL2	q	Dyna Thread 1" (1.08)	E·2	L 2	C=120	Pt 20.9	Pt	D=.2 gpm/ft² k=11.2 Q=256·(.2) P=(51.2/11.2)
		Q 51.2			F 2		Pe	Pv	
					T 4	.64	Pf 2.6	Pn	
	5.2C change	q	Dyna Flow 1¼ (1.536)		L 7.13		Pt 23.5	Pt	ele -5" 7"
		Q 57.2		E·3	F 3		Pe -2.4	Pv	
					T 10.13	.116	Pf 1.2	Pn	
2	to elbow	q 52.9	1½ (1.73)	2E·4	L 11.41		Pt 22.3	Pt	q=11.2√22.3
		Q 104.1			F 8		Pe	Pv	
					T 19.4	.241	Pf 4.7	Pn	
3	to elbow	q	Dyna Thread 1" (1.08)	E·2	L 2		Pt 27	Pt	q=11.2√27
		Q 58.2			F 2		Pe	Pv	
					T 4	.815	Pf 3.3	Pn	
	to T	q	Dyna Flow 1¼ (1.536)	E·3	L 12.1		Pt 30.3	Pt	ele -5" 7"
		Q 58.2		T·6	F 9		Pe -2.4	Pv	
					T 21.1	.147	Pf 3.1	Pn	
	T to 4	q	1½ (1.73)		L .875		Pt 31	Pt	
		Q 162.3			F		Pe	Pv	
					T .875	.546	Pf .48	Pn	
4		q 62.8	1½ (1.73)		L 16		Pt 31.5	Pt	q=11.2√31.48
		Q 225.1			F		Pe	Pv	
					T 16	1	Pf 16	Pn	
5	DN to CM	q 77.2	1½ (1.73)	E·4	L 8.92		Pt 47.5	Pt	ele 5½" q=11.2√47.5
		Q 302.3		T·8	F 12		Pe .2	Pv	
					T 20.92	1.73	Pf 36.2	Pn	
	CM to BL1	q	4 (4.31)		L 6.5	C=100	Pt 83.9	Pt	See ees sheet attached
		Q 158.2			F		Pe	Pv	
					T		Pf	Pn	
	CM to BL3	q	4 (4.31)		L 15	C=100	Pt 83.9	Pt	
		Q 460.5			F		Pe	Pv	
					T 15	.062	Pf .9	Pn	
	BL3	q			L		Pt 84.8	Pt	Sees sheet attached
		Q 262.5			F		Pe	Pv	
					T		Pf	Pn	
							Pt		

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HYDRAULIC CALCULATIONS

CONTRACT NAME OH II 1500 ft² Wet system SHEET 2 OF 2

NOZZLE IDENT. AND LOCATION	FLOW IN GPM	PIPE SIZE	PIPE FITTINGS AND DEVICES	EQUIV. PIPE LENGTH	FRICTION LOSS PSI/FT	PRESSURE SUMMARY	NORMAL PRESSURE	NOTES
CM	q	Dyna flow	2T·20 1SV·12	L 135	C=100	Pt 84.8	Pt	ele 13'
to		4"	CV·22	F 67		Pe 5.6	Pv	multiply f
BOR	Q 723	(4.31)	2E·10	T 202	.143	Pf 28.9	Pn	by .713
BOR	q	Sch.10	6E·14	L 135.7		Pt 119.3	Pt	
to		6"		F 60		Pe 1.1	Pv	ele -2.6
Supply	Q 723	(6.36)		T 196	.021	Pf 4.1	Pn	multiply f by .713
	q			L		Pt 124.5	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
	q			L		Pt	Pt	
				F		Pe	Pv	
	Q			T		Pf	Pn	
						Pt		

AFSA
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File Edit Search Options Calculate Tables Plots Windows Help Examples

Variables For Sprinkler 1, BL1

$d1 = 1.536$ [in]

$C1 = 120$

$K = 11.2$ [gpm/psi$^{.5}$]

$L1 = \left[11 + \frac{10}{12}\right] \cdot 1$ [ft]

Equations Sprinkler 1

$Q1 = K \cdot Pt1^{0.5}$

$FL1 = 4.52 \cdot \frac{Q1^{1.85}}{C1^{1.85} \cdot d1^{4.87}}$

$Pf1 = L1 \cdot FL1$

Equations Sprinkler 2

$Q2 = Q1 + K \cdot Pt2^{0.5}$

$Pe = \frac{5.5}{12} \cdot 0.433$

$L2 = 19.58 + 3 \cdot 3 + 6$ [ft] 3 elbows, 1 Tee

$FL2 = 4.52 \cdot \frac{Q2^{1.85}}{C1^{1.85} \cdot d1^{4.87}}$

$Pf2 = L2 \cdot FL2$

$Pt2 = Pt1 + Pf1$

Equations Cross Main to BL2

$C2 = 100$ [-]

$d2 = 4.31$

$L3 = 6.5$ [ft]

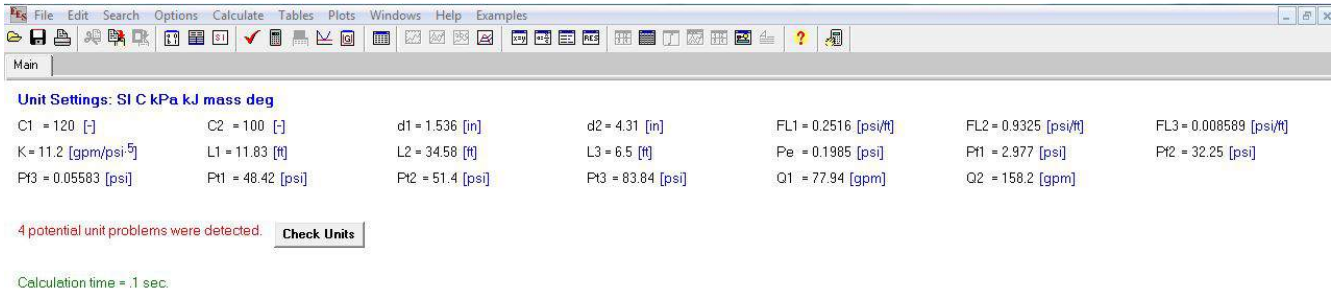
$$L3 = 6.5 \quad [ft]$$

$$FL3 = 4.52 \cdot \frac{Q2^{1.85}}{C2^{1.85} \cdot d2^{4.87}}$$

$$Pf3 = L3 \cdot FL3$$

$$Pt3 = Pf2 + Pe + Pt2$$

$$Pt3 + Pf3 = 83.9 \quad [psi]$$


File Edit Search Options Calculate Tables Plots Windows Help Examples
Main
Unit Settings: SI C kPa kJ mass deg
C1 = 120 [-]
C2 = 100 [-]
d1 = 1.536 [in]
d2 = 4.31 [in]
FL1 = 0.2516 [psi/ft]
FL2 = 0.9325 [psi/ft]
FL3 = 0.008589 [psi/ft]
K = 11.2 [gpm/psi^.5]
L1 = 11.83 [ft]
L2 = 34.58 [ft]
L3 = 6.5 [ft]
Pe = 0.1985 [psi]
Pf1 = 2.977 [psi]
Pf2 = 32.25 [psi]
Pf3 = 0.05583 [psi]
Pt1 = 48.42 [psi]
Pt2 = 51.4 [psi]
Pt3 = 83.84 [psi]
Q1 = 77.94 [gpm]
Q2 = 158.2 [gpm]
4 potential unit problems were detected.
Check Units
Calculation time = .1 sec.

Variables For Sprinkler 1, BL3

$d1 = 1.08$ [in]

$C1 = 120$

$K = 11.2$ [gpm/psi$^{.5}$]

$L1 = 2 + 2$ [ft] 1 elbow

Equations Sprinkler 1

$$Q1 = K \cdot Pt1^{0.5}$$

$$FL1 = 4.52 \cdot \frac{Q1^{1.85}}{C1^{1.85} \cdot d1^{4.87}}$$

$$Pf1 = L1 \cdot FL1$$

Pipe Size Change

1in to 1 1/4in

$d2 = 1.536$ [in]

$L2 = 7.2 + 6$ 2 elbow

$$FLP1 = 4.52 \cdot \frac{Q1^{1.85}}{C1^{1.85} \cdot d2^{4.87}}$$

$$PFp1 = L2 \cdot FLP1$$

$$Pe = -\left[5 + \frac{3.5}{12}\right] \cdot 0.433 \text{ [psi]}$$ 5ft 3.5in. elevation drop

Pipe Size Change

$d3 = 1.73$

$L3 = 3.88$

$$FLP2 = 4.52 \cdot \frac{Q1^{1.85}}{C1^{1.85} \cdot d3^{4.87}}$$

$$PFp2 = L3 \cdot FLP2$$

File Edit Search Options Calculate Tables Plots Windows Help Examples

$PFp2 = L3 \cdot FLP2$

Equations Sprinkler 2

$Q2 = Q1 + K \cdot Pt2^{0.5}$

$L4 = 15.83$ [ft]

$$FL2 = 4.52 \cdot \frac{Q2^{1.85}}{C1^{1.85} \cdot d3^{4.87}}$$

$Pf2 = L4 \cdot FL2$

$Pt2 = Pt1 + Pf1 + Pe + PFp1 + PFp2$

Equations Sprinkler 3

$L5 = 15.83$ [ft]

$Q3 = Q2 + K \cdot Pt3^{0.5}$

$$FL3 = 4.52 \cdot \frac{Q3^{1.85}}{C1^{1.85} \cdot d3^{4.87}}$$

$Pf3 = L5 \cdot FL3$

$Pt3 = Pf2 + Pt2$

Equations Sprinkler 4

$L6 = 12.8 + 16$ 2 Tee

$Pe2 = \frac{2}{12} \cdot 0.433$ [psi] 2in. change in elevation

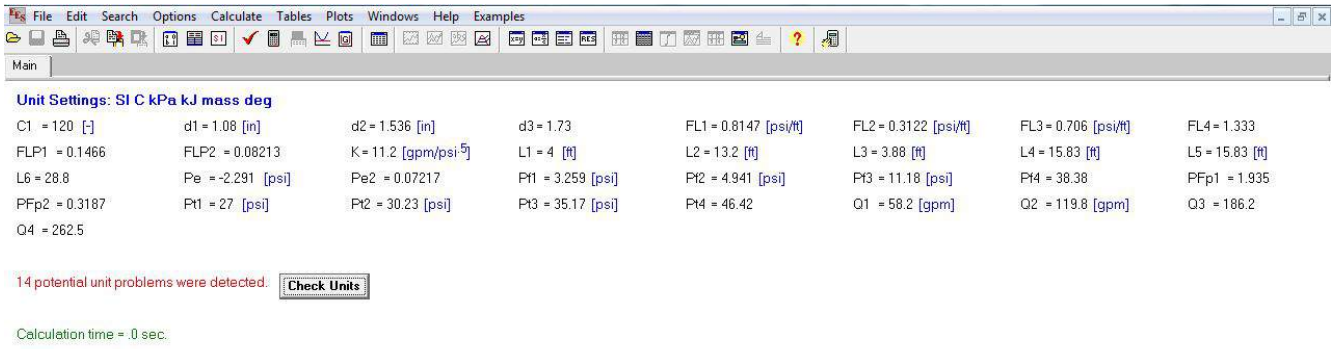
$Q4 = Q3 + K \cdot Pt4^{0.5}$

$$FL4 = 4.52 \cdot \frac{Q4^{1.85}}{C1^{1.85} \cdot d3^{4.87}}$$

$Pf4 = L6 \cdot FL4$

$Pt4 = Pf3 + Pe2 + Pt3$

$Pt4 + Pf4 = 84.8$ [psi]


File Edit Search Options Calculate Tables Plots Windows Help Examples
Main
Unit Settings: SI C kPa kJ mass deg
C1 = 120 [-]
d1 = 1.08 [in]
d2 = 1.536 [in]
d3 = 1.73
FL1 = 0.8147 [psi/ft]
FL2 = 0.3122 [psi/ft]
FL3 = 0.706 [psi/ft]
FL4 = 1.333
FLP1 = 0.1466
FLP2 = 0.08213
K = 11.2 [gpm/psi^.5]
L1 = 4 [ft]
L2 = 13.2 [ft]
L3 = 3.88 [ft]
L4 = 15.83 [ft]
L5 = 15.83 [ft]
L6 = 28.8
Pe = -2.291 [psi]
Pe2 = 0.07217
Pf1 = 3.259 [psi]
Pf2 = 4.941 [psi]
Pf3 = 11.18 [psi]
Pf4 = 38.38
PFp1 = 1.935
PFp2 = 0.3187
Pt1 = 27 [psi]
Pt2 = 30.23 [psi]
Pt3 = 35.17 [psi]
Pt4 = 46.42
Q1 = 58.2 [gpm]
Q2 = 119.8 [gpm]
Q3 = 186.2
Q4 = 262.5
14 potential unit problems were detected.
Check Units
Calculation time = .0 sec.

Hydraulic Overview

Job

Job Number: 1	Design Engineer:
Job Name: Drawing1	Phone: / FAX:
Address 1:	State Certification/License Number:
Address 2:	AHJ:
Address 3:	Job Site/Building:

System

Density: 0.200gpm/ft²	Area of Application: 1500.00ft² (Actual 1100.00ft²)
Most Demanding Sprinkler Data: 11.2 K-Factor 50.96 at 20.700	Hose Streams: 250.00
Coverage Per Sprinkler: 100.00ft²	Number Of Sprinklers Calculated: 11
System Pressure Demand: 138.650	System Flow Demand: 717.70
Total Demand: 967.70 @ 138.650	Pressure Result: +11.152 (7.4%)

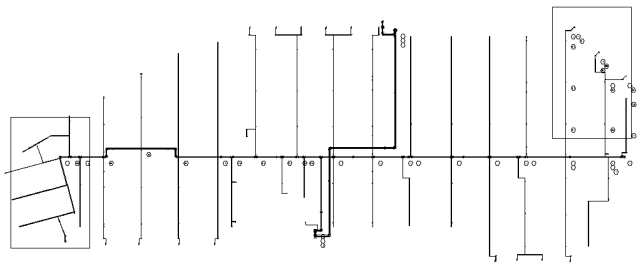
Supplies

Node	Name	Flow(gpm)	Hose Flow(gpm)	Static(psi)	Residual(psi)
19	Water Supply	5000.00	250.00	151.000	126.000

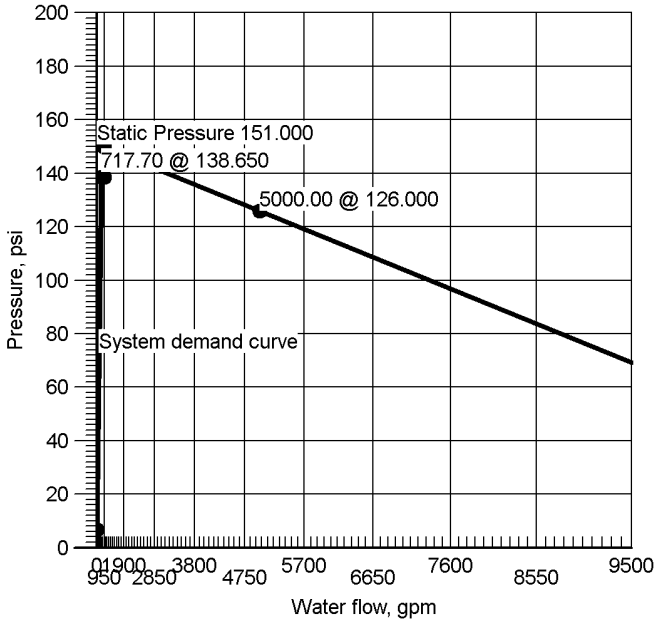
Check Point Gauges

Identifier	Pressure(psi)	K-Factor(K)	Flow(gpm)
BOR	0.000	0	0.00
BOR	0.000	0	0.00

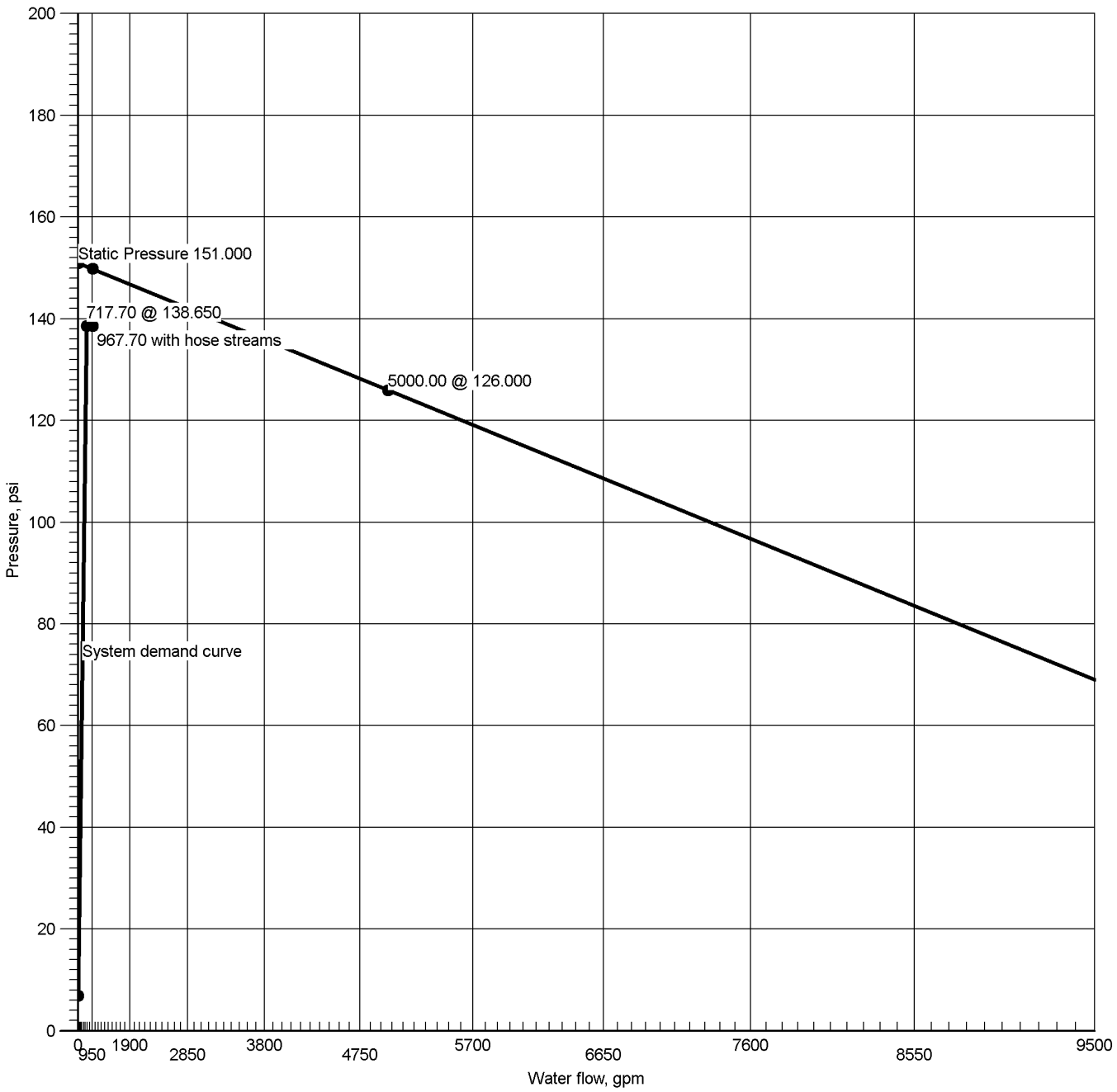
Drawing1-1



Water Supply at Node 19 (5000.00, 250.00, 151.000, 126.000)

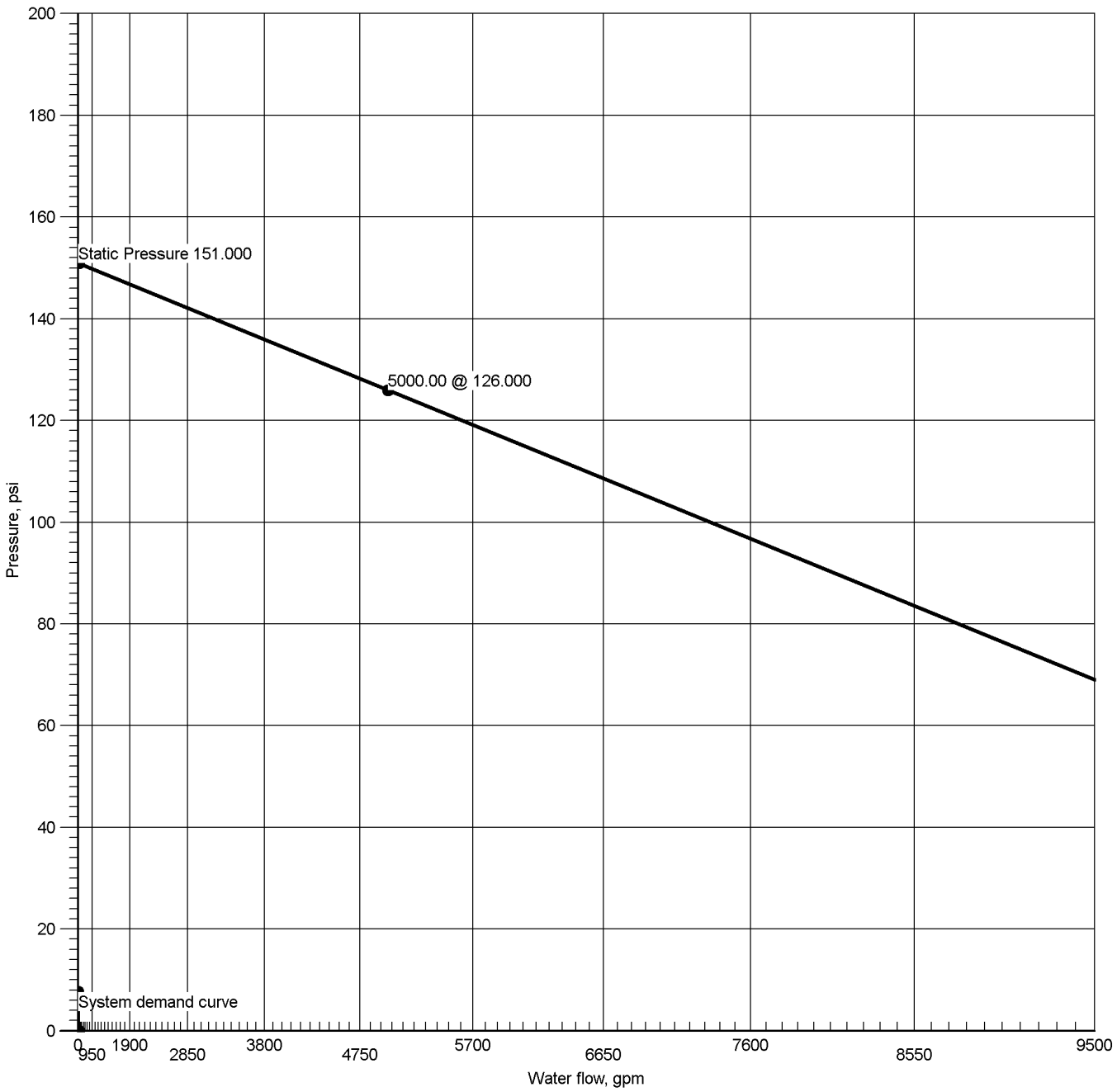


Water Supply at Node 19



Hydraulic Graph	Water Supply at Node 19
Static: Pressure	151.000
Residual: Pressure	126.000 @ 5000.00
Available Pressure at Time of Test	149.802 @ 967.70
System Demand	138.650 @ 717.70
System Demand (Including Hose Allowance at Source)	138.650 @ 967.70

BOR



Hydraulic Graph	BOR
Static: Pressure	N/A
Residual: Pressure	N/A
Available Pressure at Time of Test	N/A
System Demand	0.000 @ 0.00
System Demand (Including Hose Allowance at Source)	0.000 @ N/A

Summary Of Outflowing Devices

Job Number: 1
Report Description: Ordinary Group II

Device		Actual Flow (gpm)	Minimum Flow (gpm)	K-Factor (K)	Pressure (psi)		
Sprinkler	**102**	**50.96**	**50.96**	**11.2**	**20.700**		
Sprinkler	104	53.01	50.96	11.2	22.400		
Sprinkler	106	59.63	50.96	11.2	28.346		
Sprinkler	107	73.92	50.96	11.2	43.565		
Sprinkler	108	54.49	50.96	11.2	23.667		
Sprinkler	110	57.50	50.96	11.2	26.361		
Sprinkler	112	61.64	50.96	11.2	30.292		
Sprinkler	113	66.46	50.96	11.2	35.214		
Sprinkler	115	76.28	50.96	11.2	46.391		
Sprinkler	116	80.68	50.96	11.2	51.897		
Sprinkler	118	83.12	50.96	11.2	55.071		

Most Demanding Sprinkler Data

Node	Elevation(Foot)	Fittings	Pressure(psi)	Discharge(gpm)	
19	0'-0	S	138.650	717.70	
102	10'-4	Spr(-20.700)	20.700	50.96	
104	15'-11½	Spr(-22.400)	22.400	53.01	
106	15'-11½	Spr(-28.346)	28.346	59.63	
107	15'-11½	Spr(-43.565)	43.565	73.92	
108	10'-4½	Spr(-23.667)	23.667	54.49	
110	10'-4½	Spr(-26.361)	26.361	57.50	
112	15'-8	Spr(-30.292)	30.292	61.64	
113	15'-8	Spr(-35.214)	35.214	66.46	
115	15'-8	Spr(-46.391)	46.391	76.28	
116	15'-11½	Spr(-51.897)	51.897	80.68	
118	15'-11½	Spr(-55.071)	55.071	83.12	
1	10'-4	E(2'-3¾)	23.443		
2	15'-11½	T(10'-1¼)	27.885		
3	15'-11½	E(5'-7¾)	73.386		
4	15'-6	T(11'-4¼)	92.750		
5	15'-6	T(11'-4¼)	93.662		
6	15'-6	T(11'-4¼)	95.775		
7	15'-6	T(11'-4¼)	96.198		
8	15'-6	T(11'-4¼)	97.747		
9	15'-6	T(11'-4¼)	99.789		
10	15'-6	T(11'-4¼)	101.972		
11	15'-6	T(11'-4¼)	102.395		
12	15'-6	T(11'-4¼)	104.014		
13	15'-6	T(11'-4¼)	106.127		
14	15'-6	T(19'-10½), LtE(6'-0)	118.336		
15	2'-6	T(20'-0)	133.251		
16	14'-9	T(26'-10¾), LtE(8'-0¾)	129.098		
17	14'-9	T(28'-4½)	131.864		
18	14'-9	LtE(12'-9¼)	132.057		
20	10'-4½	E(2'-3¾)	26.771		
21	10'-4½	E(2'-3¾)	29.791		
22	15'-8	E(5'-0¾)	29.979		
23	15'-8	T(11'-3½)	78.307		
24	15'-6	T(10'-1¼)	92.691		
25	15'-6	T(11'-4¼)	92.739		
89	15'-6	T(11'-4¼)	109.582		
98	15'-6	E(4'-3¼)	109.582		
101	15'-6	T(14'-2¼)	109.582		
103	15'-6	T(11'-4¼)	109.582		
105	15'-6	T(11'-4¼)	109.582		
109	15'-6	T(11'-4¼)	109.582		
111	15'-6	T(11'-4¼)	109.582		
114	15'-6	T(11'-4¼), C(11'-4¼)	109.582		
117	15'-6	T(11'-4¼)	109.582		
120	15'-6	T(11'-4¼)	109.582		
122	15'-6	T(11'-4¼)	109.582		
124	15'-6	T(11'-4¼)	109.582		

Pipe Type / Downstream / Upstream	Diameter / Elevation	Flow / Discharge	Velocity / K-Factor	HWC / Pt	Pn	Friction Loss / Fittings	Length / Eq. Length / Total Length	Pressure Summary
• • • • • Route 1 • • • • •								
BL	1.0800	50.96	17.85	120		0.637097	2'-0	Pf 2.743
102	10'-4	50.96	11.2	20.700		Sprinkler,	2'-3¾	Pe
1	10'-4			23.443		E(2'-3¾)	4'-3¾	Pv
BL	1.5360	50.96	8.82	120		0.114618	7'-1½	Pf 1.396
1	10'-4			23.443			5'-0¾	Pe -2.439
104	15'-11½			22.400		E(5'-0¾)	12'-2¼	Pv
BL	1.7280	103.96	14.22	120		0.241577	11'-5	Pf 5.485
104	15'-11½	53.01	11.2	22.400		Sprinkler,	11'-3½	Pe
2	15'-11½			27.885		2E(5'-7¾)	22'-8½	Pv
BL	1.7280	158.45	21.68	120		0.526771	0'-10½	Pf 0.461
2	15'-11½	54.49		27.885		Flow (q) from Route 2		Pe
106	15'-11½			28.346			0'-10½	Pv
BL	1.7280	218.08	29.83	120		0.951172	16'-0	Pf 15.219
106	15'-11½	59.63	11.2	28.346		Sprinkler		Pe
107	15'-11½			43.565			16'-0	Pv
BL	1.7280	292.01	39.95	120		1.632257	12'-7½	Pf 29.821
107	15'-11½	73.92	11.2	43.565		Sprinkler,	5'-7¾	Pe
3	15'-11½			73.386		E(5'-7¾)	18'-3¼	Pv
RN	1.6100	292.01	46.02	145		1.623076	0'-5½	Pf 19.166
3	15'-11½			73.386			11'-4¼	Pe 0.199
4	15'-6			92.750		T(11'-4¼)	11'-9¾	Pv
CM	4.3100	455.81	10.02	100		0.060810	15'-0	Pf 0.912
4	15'-6	163.80		92.750		Flow (q) from Route 4		Pe
5	15'-6			93.662			15'-0	Pv
CM	4.3100	717.70	15.78	100		0.140840	15'-0	Pf 2.113
5	15'-6	261.89		93.662		Flow (q) from Route 3		Pe
6	15'-6			95.775			15'-0	Pv
CM	4.3100	717.70	15.78	100		0.140840	3'-0	Pf 0.423
6	15'-6			95.775				Pe
7	15'-6			96.198			3'-0	Pv
CM	4.3100	717.70	15.78	100		0.140840	11'-0	Pf 1.549
7	15'-6			96.198				Pe
8	15'-6			97.747			11'-0	Pv
CM	4.3100	717.70	15.78	100		0.140840	14'-6	Pf 2.042
8	15'-6			97.747				Pe
9	15'-6			99.789			14'-6	Pv
CM	4.3100	717.70	15.78	100		0.140840	15'-6	Pf 2.183
9	15'-6			99.789				Pe
10	15'-6			101.972			15'-6	Pv
CM	4.3100	717.70	15.78	100		0.140840	3'-0	Pf 0.423
10	15'-6			101.972				Pe
11	15'-6			102.395			3'-0	Pv
CM	4.3100	717.70	15.78	100		0.140840	11'-6	Pf 1.620
11	15'-6			102.395				Pe
12	15'-6			104.014			11'-6	Pv
CM	4.3100	717.70	15.78	100		0.140840	15'-0	Pf 2.113
12	15'-6			104.014				Pe
13	15'-6			106.127			15'-0	Pv
CM	4.3100	717.70	15.78	100		0.140840	35'-0¼	Pf 12.209
13	15'-6			106.127			51'-8	Pe
14	15'-6			118.336		2T(19'-10½), LtE(5'-11½), LtE(6'-0)	86'-8¼	Pv
FR	4.0260	717.70	18.09	120		0.140091	12'-3¼	Pf 9.283
14	15'-6			118.336			54'-0	Pe 5.632
15	2'-6			133.251		CV(22'-0), BV(12'-0), T(20'-0)	66'-3¼	Pv
FR	6.0650	717.70	7.97	120		0.019044	12'-7½	Pf 1.155
15	2'-6			133.251			48'-0	Pe -5.307
16	14'-9			129.098		LtE(9'-0), f, T(30'-0), LtE(8'-0¾)	60'-7½	Pv
CM	6.3570	717.70	7.25	100		0.021222	106'-1½	Pf 2.766
16	14'-9			129.098			24'-2½	Pe
17	14'-9			131.864		3LtE(8'-0¾)	130'-4	Pv
FM	6.0650	717.70	7.97	145		0.013419	1'-7½	Pf 0.193
17	14'-9			131.864			12'-9¼	Pe
18	14'-9			132.057		LtE(12'-9¼)	14'-4¾	Pv
FR	6.0650	717.70	7.97	145		0.013419	14'-9	Pf 0.198
18	14'-9			132.057				Pe 6.395
19	0'-0			138.650		Water Supply	14'-9	Pv
		250.00				Hose Allowance At Source		
19		967.70						
• • • • • Route 2 • • • • •								

Pipe Type / Downstream / Upstream	Diameter / Elevation	Flow / Discharge	Velocity / K-Factor	HWC / Pt	Pn	Friction Loss / Fittings	Length / Eq. Length / Total Length	Pressure Summary
BL	1.0800	54.49	19.08	120		0.721127	2'-0	Pf 3.104
108	10'-4½	54.49	11.2	23.667		Sprinkler,	2'-3¾	Pe
20	10'-4½			26.771		E(2'-3¾)	4'-3¾	Pv
BL	1.5360	54.49	9.43	120		0.129736	12'-1	Pf 3.535
20	10'-4½			26.771			15'-2	Pe -2.421
2	15'-11½			27.885		E(5'-0¾), T(10'-1¼)	27'-3	Pv
• • • • • Route 3 • • • • •								
BL	1.0800	57.50	20.14	120		0.796758	2'-0	Pf 3.430
110	10'-4½	57.50	11.2	26.361		Sprinkler,	2'-3¾	Pe
21	10'-4½			29.791		E(2'-3¾)	4'-3¾	Pv
BL	1.5360	57.50	9.96	120		0.143343	7'-2½	Pf 2.482
21	10'-4½			29.791			10'-1¼	Pe -2.294
22	15'-8			29.979		2E(5'-0¾)	17'-3¾	Pv
BL	1.7280	57.50	7.87	120		0.080772	3'-10½	Pf 0.313
22	15'-8			29.979				Pe
112	15'-8			30.292			3'-10½	Pv
BL	1.7280	119.15	16.30	120		0.310865	15'-10	Pf 4.922
112	15'-8	61.64	11.2	30.292		Sprinkler		Pe
113	15'-8			35.214			15'-10	Pv
BL	1.7280	185.61	25.39	120		0.705874	15'-10	Pf 11.176
113	15'-8	66.46	11.2	35.214		Sprinkler		Pe
115	15'-8			46.391			15'-10	Pv
BL	1.7280	261.89	35.83	120		1.334587	12'-7½	Pf 31.916
115	15'-8	76.28	11.2	46.391		Sprinkler,	11'-3½	Pe
23	15'-8			78.307		T(11'-3½)	23'-11	Pv
RN	1.6100	261.89	41.27	145		1.327081	0'-2	Pf 15.283
23	15'-8			78.307			11'-4¼	Pe 0.072
5	15'-6			93.662		T(11'-4¼)	11'-6¼	Pv
• • • • • Route 4 • • • • •								
BL	1.5360	80.68	13.97	120		0.268219	11'-10	Pf 3.174
116	15'-11½	80.68	11.2	51.897		Sprinkler		Pe
118	15'-11½			55.071			11'-10	Pv
BL	1.5360	163.80	28.36	120		0.994047	12'-4½	Pf 37.421
118	15'-11½	83.12	11.2	55.071		Sprinkler,	25'-3¼	Pe 0.199
24	15'-6			92.691		3E(5'-0¾), T(10'-1¼)	37'-7¾	Pv
CM	4.3100	163.80	3.60	100		0.009156	5'-3	Pf 0.048
24	15'-6			92.691				Pe
25	15'-6			92.739			5'-3	Pv
CM	4.3100	163.80	3.60	100		0.009156	1'-3	Pf 0.011
25	15'-6			92.739				Pe
4	15'-6			92.750			1'-3	Pv

Equivalent Pipe Lengths of Valves and Fittings (C=120 only)

$$\left(\frac{\text{Actual Inside Diameter}}{\text{Schedule 40 Steel Pipe Inside Diameter}}\right)^{4.87} = \text{Factor}$$

C Value Multiplier

Value Of C	100	130	140	150
Multiplying Factor	0.713	1.16	1.33	1.51

Pipe Type	Diameter	Flow	Velocity	HWC		Friction Loss	Length	Pressure
Downstream	Elevation	Discharge	K-Factor	Pt	Pn	Fittings	Eq. Length	Summary
Upstream							Total Length	

Pipe Type Legend

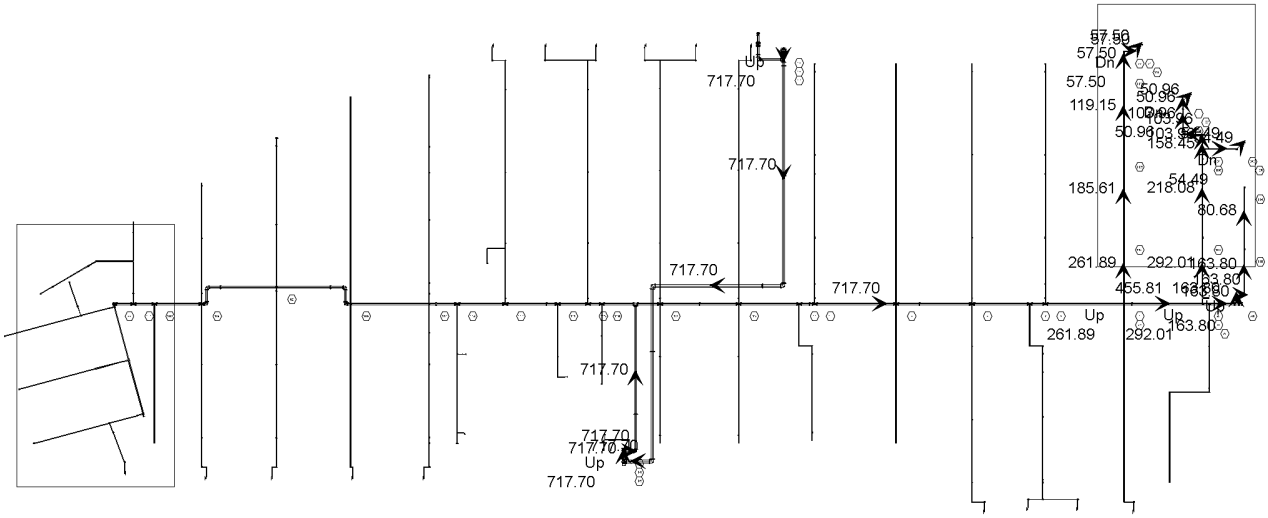
AO	Arm-Over
BL	Branch Line
CM	Cross Main
DN	Drain
DR	Drop
DY	Dynamic
FM	Feed Main
FR	Feed Riser
MS	Miscellaneous
OR	Outrigger
RN	Riser Nipple
SP	Sprig
ST	Stand Pipe
UG	Underground

Units Legend

Diameter	Inch
Elevation	Foot
Flow	gpm
Discharge	gpm
Velocity	fps
Pressure	psi
Length	Foot
Friction Loss	psi/Foot
HWC	Hazen-Williams Constant
Pt	Total pressure at a point in a pipe
Pn	Normal pressure at a point in a pipe
Pf	Pressure loss due to friction between points
Pe	Pressure due to elevation difference between indicated points
Pv	Velocity pressure at a point in a pipe

Fittings Legend

ALV	Alarm Valve
AngV	Angle Valve
b	Bushing
BalV	Ball Valve
BFP	Backflow Preventer
BV	Butterfly Valve
C	Cross Flow Turn 90°
cplg	Coupling
Cr	Cross Run
CV	Check Valve
DelV	Deluge Valve
DPV	Dry Pipe Valve
E	90° Elbow
EE	45° Elbow
Ee1	11¼° Elbow
Ee2	22½° Elbow
f	Flow Device
fd	Flex Drop
FDC	Fire Department Connection
fE	90° FireLock(TM) Elbow
fEE	45° FireLock(TM) Elbow
flg	Flange
FN	Floating Node
fT	FireLock(TM) Tee
g	Gauge
GloV	Globe Valve
GV	Gate Valve
Ho	Hose
Hose	Hose
HV	Hose Valve
Hyd	Hydrant
LtE	Long Turn Elbow
mecT	Mechanical Tee
Noz	Nozzle
P1	Pump In
P2	Pump Out
PIV	Post Indicating Valve
PO	Pipe Outlet
PRV	Pressure Reducing Valve
PrV	Pressure Relief Valve
red	Reducer/Adapter
S	Supply
sCV	Swing Check Valve
Spr	Sprinkler
St	Strainer
T	Tee Flow Turn 90°
Tr	Tee Run
U	Union
WirF	Wirsbo
WMV	Water Meter Valve
Z	Cap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163.80
455.81
Up
261.89
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163.80

Hydraulic Overview

Job

Job Number: 1	Design Engineer:
Job Name: Drawing1	Phone: / FAX:
Address 1:	State Certification/License Number:
Address 2:	AHJ:
Address 3:	Job Site/Building:

System

Density: 0.200gpm/ft²	Area of Application: 1500.00ft² (Actual 1200.00ft²)
Most Demanding Sprinkler Data: 11.2 K-Factor 50.96 at 20.700	Hose Streams: 250.00
Coverage Per Sprinkler: 100.00ft²	Number Of Sprinklers Calculated: 12
System Pressure Demand: 89.363	System Flow Demand: 670.87
Total Demand: 920.87 @ 89.363	Pressure Result: +60.544 (40.4%)

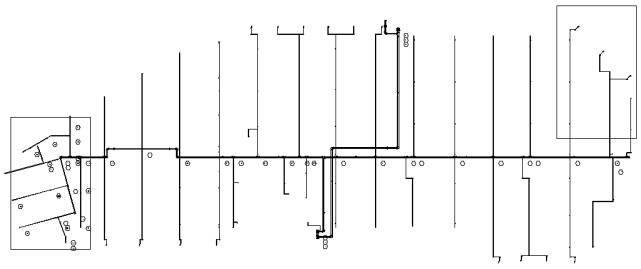
Supplies

Node	Name	Flow(gpm)	Hose Flow(gpm)	Static(psi)	Residual(psi)
19	Water Supply	5000.00	250.00	151.000	126.000

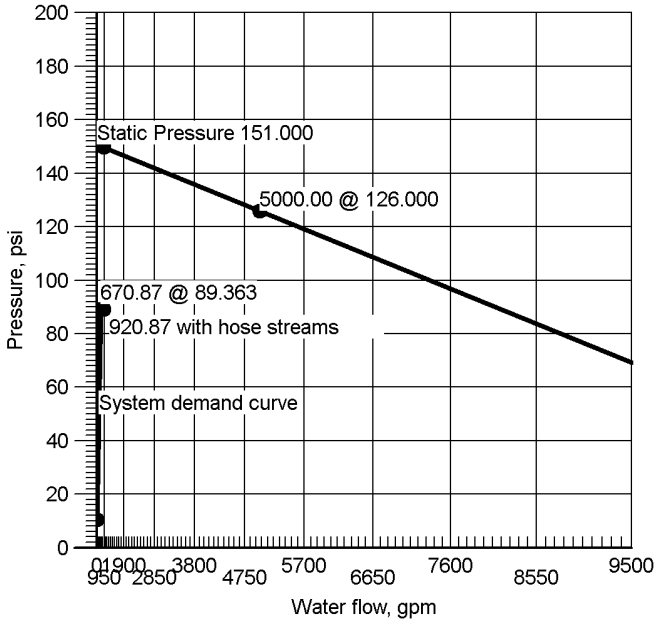
Check Point Gauges

Identifier	Pressure(psi)	K-Factor(K)	Flow(gpm)
BOR	0.000	0	0.00
BOR	0.000	0	0.00

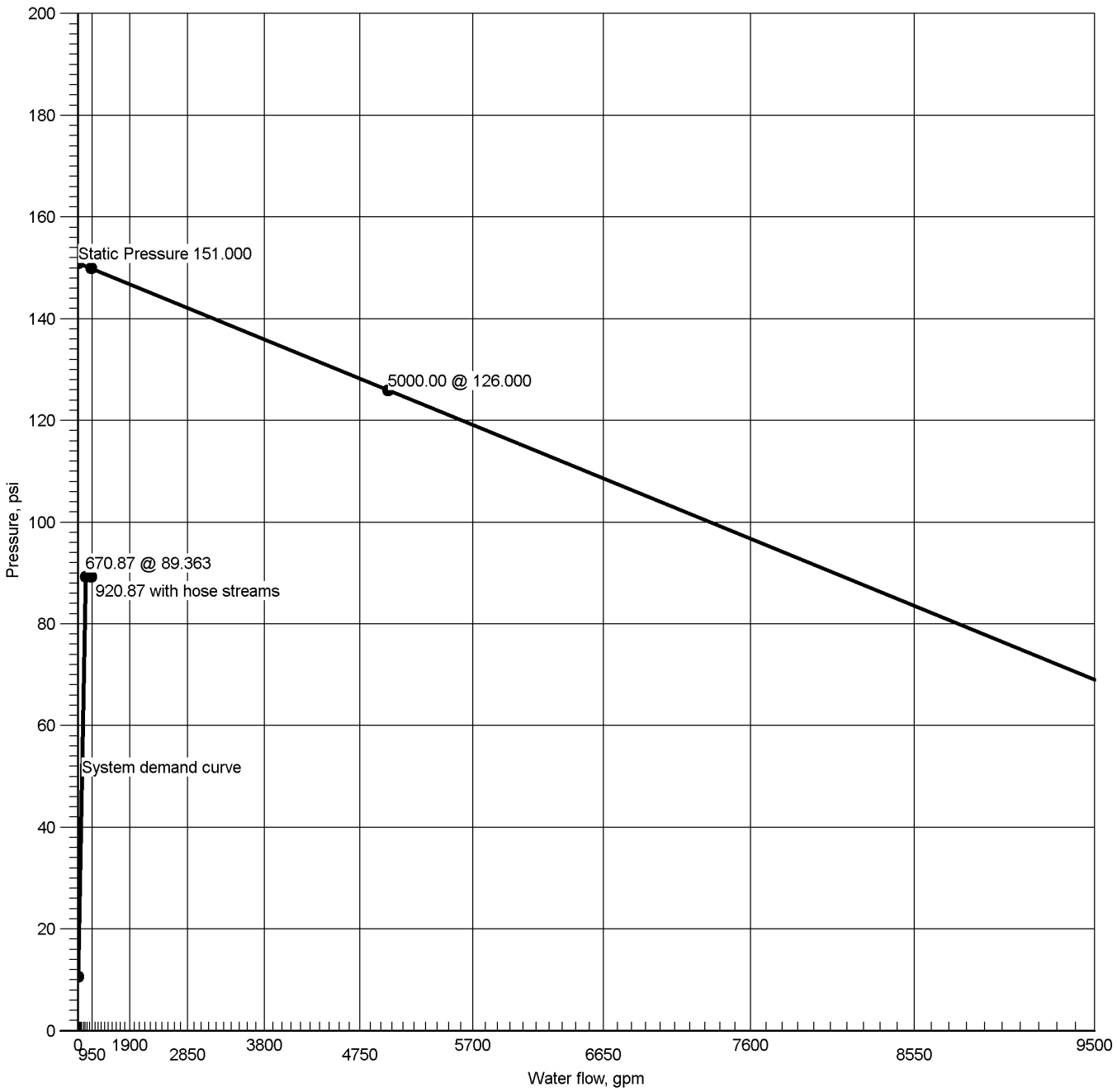
Drawing1-1



Water Supply at Node 19 (5000.00, 250.00, 151.000, 126.000)



Water Supply at Node 19



Hydraulic Graph	Water Supply at Node 19
Static: Pressure	151.000
Residual: Pressure	126.000 @ 5000.00
Available Pressure at Time of Test	149.907 @ 920.87
System Demand	89.363 @ 670.87
System Demand (Including Hose Allowance at Source)	89.363 @ 920.87

Summary Of Outflowing Devices

Device		Actual Flow (gpm)	Minimum Flow (gpm)	K-Factor (K)	Pressure (psi)		
Sprinkler	**201**	**50.96**	**50.96**	**11.2**	**20.700**		
Sprinkler	202	53.05	50.96	11.2	22.438		
Sprinkler	203	53.69	50.96	11.2	22.983		
Sprinkler	204	67.02	50.96	11.2	35.805		
Sprinkler	205	53.30	50.96	11.2	22.651		
Sprinkler	206	26.67	25.48	5.6	22.682		
Sprinkler	207	55.76	50.96	11.2	24.785		
Sprinkler	208	57.03	50.96	11.2	25.929		
Sprinkler	209	60.73	50.96	11.2	29.399		
Sprinkler	210	62.58	50.96	11.2	31.218		
Sprinkler	211	64.37	50.96	11.2	33.029		
Sprinkler	212	65.71	50.96	11.2	34.422		

Most Demanding Sprinkler Data

Node	Elevation(Foot)	Fittings	Pressure(psi)	Discharge(gpm)	
19	0'-0	S	89.363	670.87	
201	24'-9½	Spr(-20.700)	20.700	50.96	
202	18'-6	Spr(-22.438)	22.438	53.05	
203	18'-6	Spr(-22.983)	22.983	53.69	
204	16'-10½	Spr(-35.805)	35.805	67.02	
205	24'-9½	Spr(-22.651)	22.651	53.30	
206	10'-4	Spr(-22.682)	22.682	26.67	
207	24'-9½	Spr(-24.785)	24.785	55.76	
208	24'-9½	Spr(-25.929)	25.929	57.03	
209	24'-9½	Spr(-29.399)	29.399	60.73	
210	16'-10½	Spr(-31.218)	31.218	62.58	
211	16'-6½	Spr(-33.029)	33.029	64.37	
212	16'-6½	Spr(-34.422)	34.422	65.71	
4	15'-6	T(11'-4¼)	62.918		
5	15'-6	T(11'-4¼)	62.918		
6	15'-6	T(11'-4¼)	62.918		
7	15'-6	T(11'-4¼)	62.918		
8	15'-6	T(11'-4¼)	62.918		
9	15'-6	T(11'-4¼)	62.918		
10	15'-6	T(11'-4¼)	62.918		
11	15'-6	T(11'-4¼)	62.918		
12	15'-6	T(11'-4¼)	62.918		
13	15'-6	T(11'-4¼)	62.918		
14	15'-6	T(19'-10½), LtE(6'-0)	70.645		
15	2'-6	T(20'-0)	84.470		
16	14'-9	T(26'-10¾), LtE(8'-0¾)	80.182		
17	14'-9	T(28'-4½)	82.624		
18	14'-9	LtE(12'-9¼)	82.794		
25	15'-6	T(11'-4¼)	62.918		
26	24'-9½	T(10'-1¼)	23.704		
27	24'-9½	T(11'-3½)	30.335		
28	24'-9½	T(11'-3½)	30.961		
29	24'-9½	T(11'-3½)	32.906		
30	24'-9½	E(6'-7¾)	34.917		
31	16'-10½	T(11'-3½)	32.132		
32	16'-10½	E(3'-10¾)	39.295		
33	24'-9½	E(2'-3¾)	20.490		
34	24'-9½	T(10'-1¼)	31.306		
35	16'-6½	E(5'-7¾)	40.326		
89	15'-6	T(11'-4¼)	50.050		
98	15'-6	E(4'-3¼)	44.842		
101	15'-6	T(14'-2¼)	44.950		
103	15'-6	T(11'-4¼)	45.284		
105	15'-6	T(11'-4¼)	46.403		
109	15'-6	T(11'-4¼)	53.687		
111	15'-6	T(11'-4¼)	55.552		
114	15'-6	T(11'-4¼), C(11'-4¼)	56.215		
117	15'-6	T(11'-4¼)	57.355		
120	15'-6	T(11'-4¼)	58.599		
122	15'-6	T(11'-4¼)	59.314		
124	15'-6	T(11'-4¼)	59.646		

Pipe Type / Downstream / Upstream	Diameter / Elevation	Flow / Discharge	Velocity / K-Factor	HWC / Pt	Pn	Friction Loss / Fittings	Length / Eq. Length / Total Length	Pressure Summary
• • • • • Route 1 • • • • •								
BL	1.5360	77.63	13.44	120		0.249721	1'-11	Pf 3.004
201	24'-9½	26.67	11.2	20.700		Sprinkler,, Flow (q) from Route 4	10'-1¼	Pe
26	24'-9½			23.704		T(10'-1¼)	12'-0¼	Pv
BL	1.7280	130.93	17.91	120		0.370125	6'-7½	Pf 6.631
26	24'-9½	53.30		23.704		Flow (q) from Route 3	11'-3½	Pe
27	24'-9½			30.335		T(11'-3½)	17'-11	Pv
BL	2.7030	130.93	7.32	100		0.058692	10'-8	Pf 0.626
27	24'-9½			30.335				Pe
28	24'-9½			30.961			10'-8	Pv
BL	2.7030	243.72	13.63	100		0.185268	10'-6	Pf 1.945
28	24'-9½	112.79		30.961		Flow (q) from Route 5		Pe
29	24'-9½			32.906			10'-6	Pv
BL	2.7030	304.45	17.02	100		0.279607	0'-6½	Pf 2.011
29	24'-9½	60.73		32.906		Flow (q) from Route 6	6'-7¾	Pe
30	24'-9½			34.917		E(6'-7¾)	7'-2¼	Pv
RN	2.4690	304.45	20.40	100		0.434571	9'-3½	Pf 5.897
30	24'-9½			34.917			4'-3¼	Pe 4.028
98	15'-6			44.842		E(4'-3¼)	13'-6¾	Pv
CM	4.3100	304.45	6.69	100		0.028823	3'-9	Pf 0.108
98	15'-6			44.842				Pe
101	15'-6			44.950			3'-9	Pv
CM	4.3100	540.79	11.89	100		0.083433	4'-0	Pf 0.334
101	15'-6	236.34		44.950		Flow (q) from Route 2		Pe
103	15'-6			45.284			4'-0	Pv
CM	4.3100	670.87	14.75	100		0.124312	9'-0	Pf 1.119
103	15'-6	130.08		45.284		Flow (q) from Route 8		Pe
105	15'-6			46.403			9'-0	Pv
CM	4.3100	670.87	14.75	100		0.124312	17'-5	Pf 3.647
105	15'-6			46.403			11'-11	Pe -0.000
89	15'-6			50.050		2LtE(5'-11½)	29'-4	Pv
CM	4.3100	670.87	14.75	100		0.124312	17'-4	Pf 3.637
89	15'-6			50.050			11'-11	Pe 0.000
109	15'-6			53.687		2LtE(5'-11½)	29'-3	Pv
CM	4.3100	670.87	14.75	100		0.124312	15'-0	Pf 1.865
109	15'-6			53.687				Pe
111	15'-6			55.552			15'-0	Pv
CM	4.3100	670.87	14.75	100		0.124312	5'-4	Pf 0.663
111	15'-6			55.552				Pe
114	15'-6			56.215			5'-4	Pv
CM	4.3100	670.87	14.75	100		0.124312	9'-2	Pf 1.140
114	15'-6			56.215				Pe
117	15'-6			57.355			9'-2	Pv
CM	4.3100	670.87	14.75	100		0.124312	10'-0¼	Pf 1.244
117	15'-6			57.355				Pe
120	15'-6			58.599			10'-0¼	Pv
CM	4.3100	670.87	14.75	100		0.124312	5'-9	Pf 0.715
120	15'-6			58.599				Pe
122	15'-6			59.314			5'-9	Pv
CM	4.3100	670.87	14.75	100		0.124312	2'-8	Pf 0.332
122	15'-6			59.314				Pe
124	15'-6			59.646			2'-8	Pv
CM	4.3100	670.87	14.75	100		0.124312	36'-9¾	Pf 10.999
124	15'-6			59.646			51'-8	Pe
14	15'-6			70.645		2T(19'-10½), LtE(5'-11½), LtE(6'-0)	88'-5¾	Pv
FR	4.0260	670.87	16.91	120		0.123651	12'-3¼	Pf 8.193
14	15'-6			70.645			54'-0	Pe 5.632
15	2'-6			84.470		CV(22'-0), BV(12'-0), T(20'-0)	66'-3¼	Pv
FR	6.0650	670.87	7.45	120		0.016809	12'-7½	Pf 1.019
15	2'-6			84.470			48'-0	Pe -5.307
16	14'-9			80.182		LtE(9'-0), f, T(30'-0), LtE(8'-0¾)	60'-7½	Pv
CM	6.3570	670.87	6.78	100		0.018732	106'-1½	Pf 2.441
16	14'-9			80.182			24'-2½	Pe
17	14'-9			82.624		3LtE(8'-0¾)	130'-4	Pv
FM	6.0650	670.87	7.45	145		0.011844	1'-7½	Pf 0.170
17	14'-9			82.624			12'-9¼	Pe
18	14'-9			82.794		LtE(12'-9¼)	14'-4¾	Pv
FR	6.0650	670.87	7.45	145		0.011844	14'-9	Pf 0.175
18	14'-9			82.794				Pe 6.395
19	0'-0			89.363		Water Supply	14'-9	Pv

Pipe Type / Downstream / Upstream	Diameter / Elevation	Flow / Discharge	Velocity / K-Factor	HWC / Pt	Pn	Friction Loss / Fittings	Length / Eq. Length / Total Length	Pressure Summary
		250.00				Hose Allowance At Source		
19		920.87						
• • • • • Route 2 • • • • •								
BL	1.7280	53.05	7.26	120		0.069587	7'-10	Pf 0.545
202	18'-6	53.05	11.2	22.438		Sprinkler		Pe
203	18'-6			22.983			7'-10	Pv
BL	1.7280	106.75	14.60	120		0.253672	10'-8½	Pf 8.445
203	18'-6	53.69	11.2	22.983		Sprinkler,	22'-7	Pe 0.704
31	16'-10½			32.132		2E(5'-7¾), T(11'-3½)	33'-3½	Pv
BL	1.7280	169.32	23.16	120		0.595588	6'-2	Pf 3.673
31	16'-10½	62.58		32.132		Flow (q) from Route 7		Pe
204	16'-10½			35.805			6'-2	Pv
BL	2.1040	236.34	21.81	100		0.592867	2'-0	Pf 3.490
204	16'-10½	67.02	11.2	35.805		Sprinkler,	3'-10¾	Pe
32	16'-10½			39.295		E(3'-10¾)	5'-10¾	Pv
RN	2.0670	236.34	22.60	145		0.325051	1'-4½	Pf 5.059
32	16'-10½			39.295			14'-2¼	Pe 0.596
101	15'-6			44.950		T(14'-2¼)	15'-6¾	Pv
• • • • • Route 3 • • • • •								
BL	1.7280	53.30	7.29	120		0.070198	15'-0	Pf 1.053
205	24'-9½	53.30	11.2	22.651		Sprinkler		Pe
26	24'-9½			23.704			15'-0	Pv
• • • • • Route 4 • • • • •								
BL	1.0800	26.67	9.34	120		0.192325	16'-7	Pf 4.076
206	10'-4	26.67	5.6	22.682		Sprinkler,	4'-7¼	Pe -6.268
33	24'-9½			20.490		2E(2'-3¾)	21'-2¼	Pv
BL	1.5360	26.67	4.62	120		0.034601	6'-0¾	Pf 0.210
33	24'-9½			20.490				Pe
201	24'-9½			20.700			6'-0¾	Pv
• • • • • Route 5 • • • • •								
BL	1.7280	55.76	7.63	120		0.076293	15'-0	Pf 1.144
207	24'-9½	55.76	11.2	24.785		Sprinkler		Pe
208	24'-9½			25.929			15'-0	Pv
BL	1.7280	112.79	15.43	120		0.280874	6'-7½	Pf 5.032
208	24'-9½	57.03	11.2	25.929		Sprinkler,	11'-3½	Pe
28	24'-9½			30.961		T(11'-3½)	17'-11	Pv
• • • • • Route 6 • • • • •								
BL	1.5360	60.73	10.51	120		0.158558	1'-11	Pf 1.906
209	24'-9½	60.73	11.2	29.399		Sprinkler,	10'-1¼	Pe
34	24'-9½			31.306		T(10'-1¼)	12'-0¼	Pv
BL	1.7280	60.73	8.31	120		0.089346	6'-7½	Pf 1.601
34	24'-9½			31.306			11'-3½	Pe
29	24'-9½			32.906		T(11'-3½)	17'-11	Pv
• • • • • Route 7 • • • • •								
BL	1.5360	62.58	10.83	120		0.167610	5'-5½	Pf 0.915
210	16'-10½	62.58	11.2	31.218		Sprinkler		Pe
31	16'-10½			32.132			5'-5½	Pv
• • • • • Route 8 • • • • •								
BL	1.7280	64.37	8.81	120		0.099507	14'-0	Pf 1.393
211	16'-6½	64.37	11.2	33.029		Sprinkler		Pe
212	16'-6½			34.422			14'-0	Pv
BL	1.7280	130.08	17.80	120		0.365677	10'-6	Pf 5.904
212	16'-6½	65.71	11.2	34.422		Sprinkler,	5'-7¾	Pe
35	16'-6½			40.326		E(5'-7¾)	16'-1¾	Pv
RN	1.6100	130.08	20.50	145		0.363621	1'-0½	Pf 4.506
35	16'-6½			40.326			11'-4¼	Pe 0.452
103	15'-6			45.284		T(11'-4¼)	12'-4¾	Pv

Equivalent Pipe Lengths of Valves and Fittings (C=120 only)

$$\left(\frac{\text{Actual Inside Diameter}}{\text{Schedule 40 Steel Pipe Inside Diameter}}\right)^{4.87} = \text{Factor}$$

C Value Multiplier

Value Of C	100	130	140	150
Multiplying Factor	0.713	1.16	1.33	1.51

Pipe Type	Diameter	Flow	Velocity	HWC		Friction Loss	Length	Pressure
Downstream	Elevation	Discharge	K-Factor	Pt	Pn	Fittings	Eq. Length	Summary
Upstream							Total Length	

Pipe Type Legend

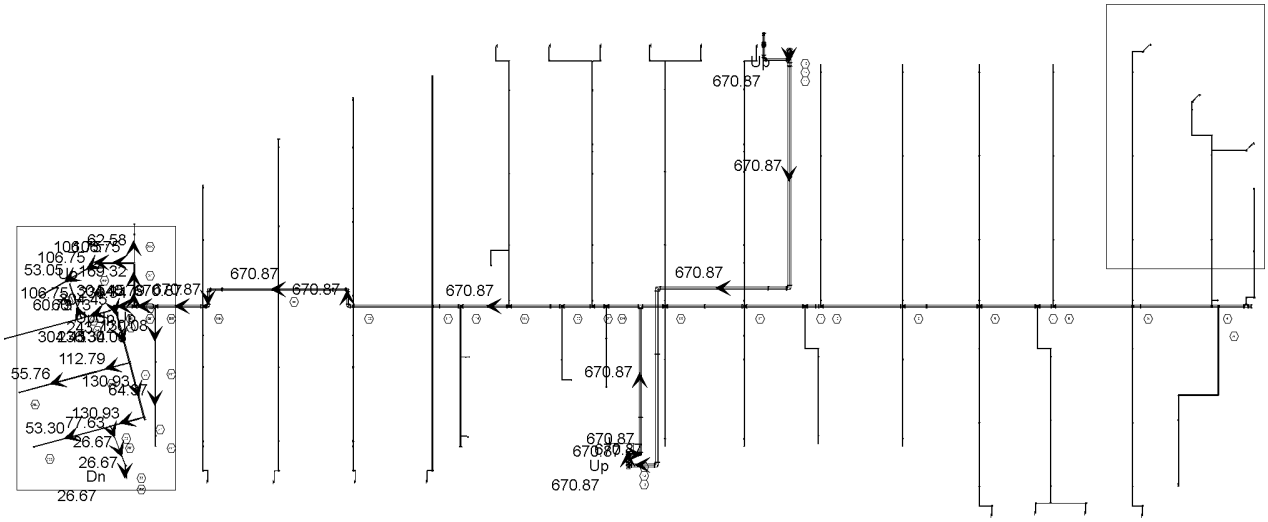
AO	Arm-Over
BL	Branch Line
CM	Cross Main
DN	Drain
DR	Drop
DY	Dynamic
FM	Feed Main
FR	Feed Riser
MS	Miscellaneous
OR	Outrigger
RN	Riser Nipple
SP	Sprig
ST	Stand Pipe
UG	Underground

Units Legend

Diameter	Inch
Elevation	Foot
Flow	gpm
Discharge	gpm
Velocity	fps
Pressure	psi
Length	Foot
Friction Loss	psi/Foot
HWC	Hazen-Williams Constant
Pt	Total pressure at a point in a pipe
Pn	Normal pressure at a point in a pipe
Pf	Pressure loss due to friction between points
Pe	Pressure due to elevation difference between indicated points
Pv	Velocity pressure at a point in a pipe

Fittings Legend

ALV	Alarm Valve
AngV	Angle Valve
b	Bushing
BalV	Ball Valve
BFP	Backflow Preventer
BV	Butterfly Valve
C	Cross Flow Turn 90°
cplg	Coupling
Cr	Cross Run
CV	Check Valve
DelV	Deluge Valve
DPV	Dry Pipe Valve
E	90° Elbow
EE	45° Elbow
Ee1	11¼° Elbow
Ee2	22½° Elbow
f	Flow Device
fd	Flex Drop
FDC	Fire Department Connection
fE	90° FireLock(TM) Elbow
fEE	45° FireLock(TM) Elbow
flg	Flange
FN	Floating Node
fT	FireLock(TM) Tee
g	Gauge
GloV	Globe Valve
GV	Gate Valve
Ho	Hose
Hose	Hose
HV	Hose Valve
Hyd	Hydrant
LtE	Long Turn Elbow
mecT	Mechanical Tee
Noz	Nozzle
P1	Pump In
P2	Pump Out
PIV	Post Indicating Valve
PO	Pipe Outlet
PRV	Pressure Reducing Valve
PrV	Pressure Relief Valve
red	Reducer/Adapter
S	Supply
sCV	Swing Check Valve
Spr	Sprinkler
St	Strainer
T	Tee Flow Turn 90°
Tr	Tee Run
U	Union
WirF	Wirsbo
WMV	Water Meter Valve
Z	Cap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670.87
670.87
670.87
670.87
670.87
Up
670.87
62.58
106.75
53.05
106.75
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55.76
130.93
64.97
130.93
53.30
77.63
26.67
26.67
Dn
26.67
670.87
670.87
Up
670.87

5.1 General

5.1.1 Minimum Requirements.

5.1.1.1 This chapter shall provide the minimum requirements for the routine inspection, testing, and maintenance of sprinkler systems.

5.1.1.2 Table 5.1.1.2 shall be used to determine the minimum required frequencies for inspection, testing, and maintenance.

TABLE 5.1.1.2 *Summary of Sprinkler System Inspection, Testing, and Maintenance*

Item	*Frequency*	*Reference*
Inspection		
Gauges (dry, preaction, and deluge systems)	Weekly/quarterly	5.2.4.2, 5.2.4.3, 5.2.4.4
Control valves		Table 13.1.1.2
Waterflow alarm devices	Quarterly	5.2.5
Valve supervisory signal devices	Quarterly	5.2.5
Supervisory signal devices (except valve supervisory switches)	Quarterly	5.2.5
Gauges (wet pipe systems)	Quarterly	5.2.4.1
Hydraulic nameplate	Quarterly	5.2.6
Buildings	Annually (prior to freezing weather)	4.1.1.1
Hanger/seismic bracing	Annually	5.2.3
Pipe and fittings	Annually	5.2.2

(continues)

TABLE 5.1.1.2 Continued

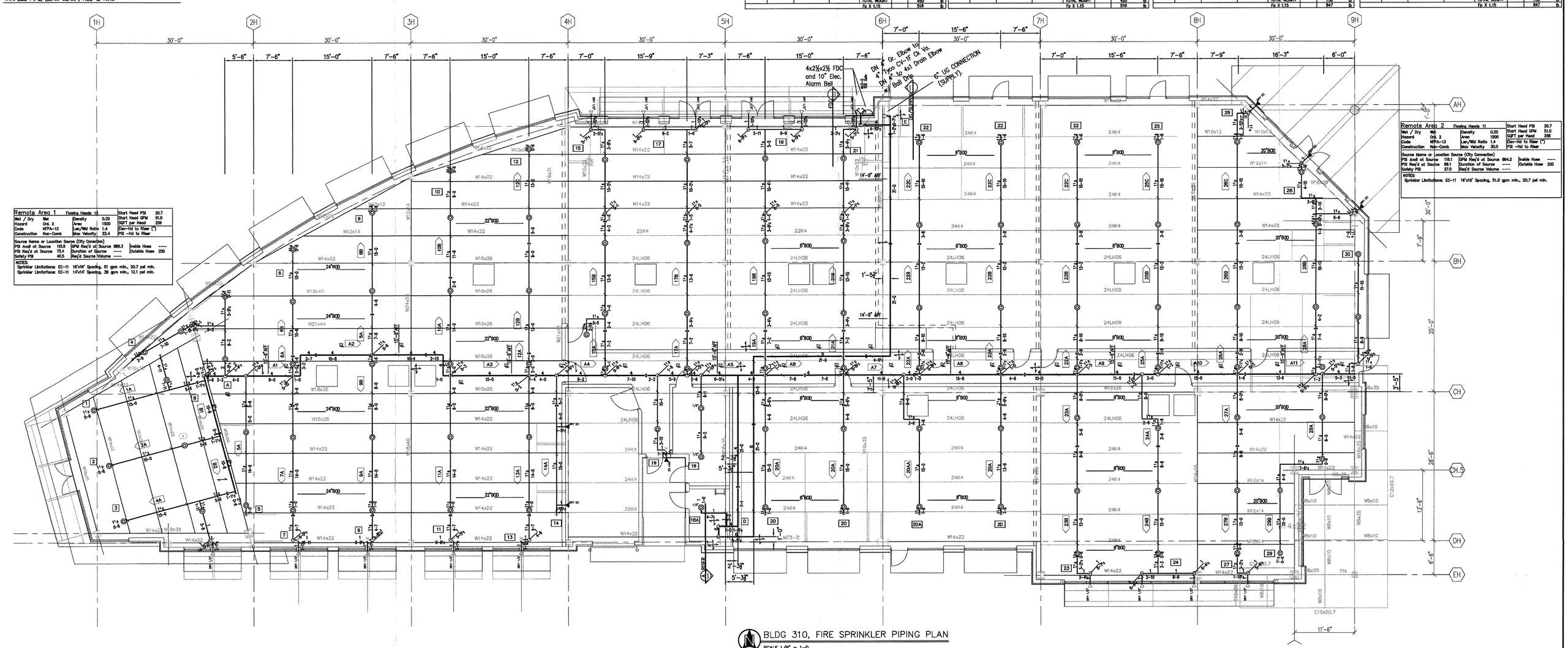
Item	*Frequency*	*Reference*
Sprinklers	Annually	5.2.1
Spare sprinklers	Annually	5.2.1.4
Information sign	Annually	5.2.8
Fire department connections		Table 13.1.1.2
Valves (all types)		Table 13.1.1.2
Obstruction, internal inspection of piping	5 years	14.2
Heat trace	Per manufacturer's requirements	5.2.7
Test		
Waterflow alarm devices		
Mechanical devices	Quarterly	5.3.3.1
Vane and pressure switch–type devices	Semiannually	5.3.3.2
Valve supervisory signal devices		Table 13.1.1.2
Supervisory signal devices (except valve supervisory switches)		Table 13.1.1.2
Main drain		Table 13.1.1.2
Antifreeze solution	Annually	5.3.4
Gauges	5 years	5.3.2
Sprinklers (extra-high or greater temperature solder type)	5 years	5.3.1.1.1.4
Sprinklers (fast-response)	At 20 years and every 10 years thereafter	5.3.1.1.1.3
Sprinklers	At 50 years and every 10 years thereafter	5.3.1.1.1
Sprinklers	At 75 years and every 5 years thereafter	5.3.1.1.1.5
Sprinklers (dry)	At 10 years and every 10 years thereafter	5.3.1.1.1.6
Sprinklers (in harsh environments)	5 years	5.3.1.1.2
Valves (all types)		Table 13.1.1.2
Valve status test		13.3.1.2.1
Maintenance		
Valves (all types)		Table 13.1.1.2
Low-point drains (dry pipe system)		13.4.4.3.2
Sprinklers and automatic spray nozzles protecting commercial cooking equipment and ventilation systems	Annually	5.4.1.9
Investigation		
Obstruction		14.3

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

Item	*Frequency*	*Reference*
Inspection		
Control Valves		
Sealed	Weekly	13.3.2.1
Locked or electrically supervised	Monthly	13.3.2.1.1
Valve Supervisory Signal Initiating Device	Quarterly	13.3.2.1.2
Alarm Valves		
Exterior	Monthly	13.4.1.1
Interior	5 years	13.4.1.2
Strainers, filters, orifices	5 years	13.4.1.2
Check Valves		
Interior	5 years	13.4.2.1
Preaction/Deluge Valves		
Enclosure (during cold weather)	Daily/weekly	13.4.3.1
Exterior	Monthly	13.4.3.1.6
Interior	Annually/5 years	13.4.3.1.7
Strainers, filters, orifices	5 years	13.4.3.1.8
Dry Pipe Valves/Quick-Opening Devices		
Gauges	Weekly/monthly	13.4.4.1.2.4, 13.4.4.1.2.5
Enclosure (during cold weather)	Daily/weekly	13.4.4.1.1
Exterior	Monthly	13.4.4.1.4
Interior	Annually	13.4.4.1.5
Strainers, filters, orifices	5 years	13.4.4.1.6
Pressure-Reducing and Relief Valves		
Sprinkler systems	Quarterly	13.5.1.1
Hose connections	Annually	13.5.2.1
Hose racks	Annually	13.5.3.1
Fire pumps		
Casing relief valves	Weekly	13.5.7.1, 13.5.7.1.1
Pressure-relief valves	Weekly	13.5.7.2,

Pressure-relief valves	Weekly	13.5.7.2, 13.5.7.2.1
Backflow Prevention Assemblies		
Reduced pressure	Weekly/monthly	13.6.1
Reduced-pressure detectors	Weekly/monthly	13.6.1
Fire Department Connections	Quarterly	13.7.1
Testing		
Main Drains	Annually/quarterly	13.2.5, 13.2.5.1, 13.3.3.4
Gauges	5 years	13.2.7.2
Waterflow Alarms	Quarterly/semiannually	13.2.6
Control Valves		
Position	Annually	13.3.3.1
Operation	Annually	13.3.3.1
Supervisory	Semiannually	13.3.3.5

(continues)



BLDG 310, FIRE SPRINKLER PIPING PLAN

SCALE 1/8" = 1-0

SYMBOLS

- Hydraulic Reference Point
- Line Designation
- A — Main Designation
- *13" ℄ of Pipe Below Bottom of Deck
- +12'-4" ℄ of Pipe Above Ref. Plane
- (LOW) C (HIGH) — Elevation Change in Pipe (not thru floor)
- Flow Switch (FS)
- Monitor Switch
- Earthquake Bracing
- Hanger
- Union
- Screwed Cap
- Grooved Cap
- Screwed Plug
- Grooved Coupling
- Flanged Connection
- System Riser
- Gate Valve – N.R.S. (GV)
- OS&Y Gate Valve (OS&Y)
- Butterfly Valve
- Alarm Valve (ALV)
- Electric Bell
- Water Motor Gong (WMG)
- Wafer Check Valve
- Swing Check Valve
- Fire Dept.Conn.(Standard)(FDC)
- Fire Dept.Conn.(Flush) (FDC)
- Fire Dept.Conn.(FDC)
- Post Indicator Valve (PIV)
- Fire Hydrant (3 Way)
- Thrust Block
- Key Gate Sectional Valve with Roadway Box
- Fire Hose Assembly
- Inspectors Test
- Globe Valve
- Angle Valve
- Dry Pipe Valve

SPRINKLERS

MAKE	TYPE	MODEL	SIN	NPT / K-FACTOR	TEMP.	FINISH	ESCUTCHEON	NOTES	SYMBOL	QTY.
TYCO	UPRIGHT	EC-11	TY5137	3/4" / K=11.2	155	BRASS	------	WRENCH: W-TYPE 3	◎	99
TYCO	UPRIGHT	TY-FRB	TY3131	1/2" / K=5.6	155	BRASS	------	WRENCH: W-TYPE 7	1/2 ◎	3
TYCO	ORY SW EC	OS-3	TY5339	1" / K=11.2	155	BRASS	------	WRENCH: W-TYPE B	DRY EC	6
TYCO	DRY SW	OS-1	TY3335	1" / K=5.6	155	BRASS	------	WRENCH: W-TYPE 7	DRY 1/2"	15

– TOTAL THIS SHEET – 123

HYDRAULIC DESIGN DATA

REM. AREA NAME/NO.	HAZARD CLASSIFICATION	DENSITY GPM/SQ.FT.	AREA OF APPLIC.	HOSE ALLOW.	SQ. FT. /HD.	TOTAL SYSTEM REQUIREMENTS GPM	PSI	AT
	SEE ABOVE							

WATER SUPPLY INFORMATION: STATIC PRESSURE 120 PSI — RESIDUAL PRESSURE 20 PSI. WITH 5000 GPM FLOWING

TEST LOCATION: _____ TEST DATE: _____

BY: _____

ABBREVIATIONS

AC – Above Finished Ceiling
AFF – Above Finished Floor
BC – Below Finished Ceiling
BOB – Bottom of Beam
BOD – Bottom of Deck
BOJ – Bottom of Joist
BOP – Bottom of Purlin
HV – Hose Valve
NIC – Not In Contract
NTS – Not to Scale
OBJ – Open Bar Joist
SP – Standpipe
TOB – Top of Beam
TOP – Top of Purlin
TOS – Top of Steel
UON – Unless Otherwise Noted

SYSTEM TYPE

WET ☐ DELUGE ☐
DRY ☐ PREACTION ☐

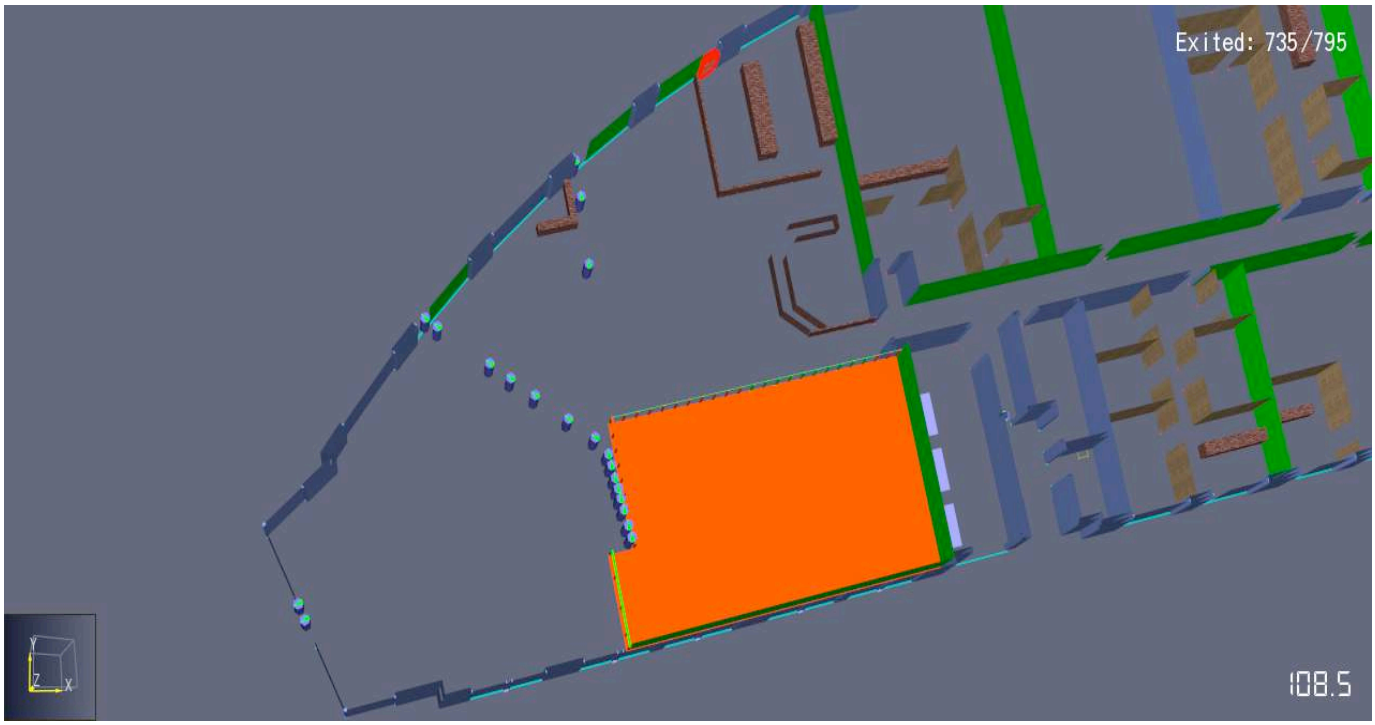
APPROVALS

☐ QTY OUT IN
☐ CNTY OUT IN
☐ FM OUT IN
☐ OUT IN

SPECIAL REQUIREMENTS

- ☐ DOMESTIC PIPE
- ☐ SCHEDULE 40
- ☐ SCHEDULE 80
- ☐ GALVANIZED PIPE
- ☐ GALVANIZED FITTINGS
- ☐ GALVANIZED MATERIALS
- ☐ SPECIAL FITTINGS
- ☐ F.M. MATERIAL
- ☐ OTHER _____

Appendix E- Fire Scenario 1 Attachments



SFPE Mode Pathfinder 108.5 Seconds

Steering Mode 92 Seconds

Device Output Fire Scenario 1

s	kg/m3	C	C	C	C	m	C	C	C
Time	ASAMP	SPRK01	SPRK02	SPRK04	SPRK05	LAYER	THCP01	THCP02	THCP03
0.00E+00	0.00E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
9.16E-01	0.00E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
1.83E+00	0.00E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
2.75E+00	0.00E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
3.66E+00	0.00E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
4.52E+00	0.00E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
5.43E+00	0.00E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
6.31E+00	0.00E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
7.21E+00	0.00E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
8.10E+00	0.00E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
9.00E+00	0.00E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
9.90E+00	0.00E+00	2.01E+01	2.00E+01	2.01E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
1.08E+01	0.00E+00	2.01E+01	2.00E+01	2.01E+01	2.00E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
1.17E+01	0.00E+00	2.01E+01	2.01E+01	2.01E+01	2.01E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
1.26E+01	0.00E+00	2.01E+01	2.02E+01	2.01E+01	2.02E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
1.35E+01	0.00E+00	2.15E+01	2.29E+01	2.01E+01	2.23E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
1.44E+01	0.00E+00	2.20E+01	2.28E+01	2.01E+01	2.26E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
1.53E+01	0.00E+00	2.09E+01	2.16E+01	2.01E+01	2.17E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
1.62E+01	0.00E+00	2.04E+01	2.09E+01	2.02E+01	2.10E+01	5.75E+00	2.00E+01	2.00E+01	2.00E+01
1.71E+01	0.00E+00	2.02E+01	2.06E+01	2.02E+01	2.05E+01	5.39E+00	2.00E+01	2.00E+01	2.00E+01
1.80E+01	0.00E+00	2.02E+01	2.06E+01	2.02E+01	2.04E+01	5.21E+00	2.00E+01	2.00E+01	2.00E+01
1.89E+01	0.00E+00	2.03E+01	2.07E+01	2.02E+01	2.05E+01	5.27E+00	2.00E+01	2.00E+01	2.00E+01
1.98E+01	0.00E+00	2.03E+01	2.08E+01	2.02E+01	2.05E+01	5.75E+00	2.00E+01	2.00E+01	2.01E+01
2.07E+01	0.00E+00	2.04E+01	2.10E+01	2.02E+01	2.07E+01	5.75E+00	2.01E+01	2.00E+01	2.01E+01
2.16E+01	0.00E+00	2.12E+01	2.14E+01	2.02E+01	2.08E+01	5.48E+00	2.01E+01	2.01E+01	2.01E+01
2.25E+01	0.00E+00	2.38E+01	2.30E+01	2.03E+01	2.08E+01	5.32E+00	2.01E+01	2.01E+01	2.01E+01
2.34E+01	0.00E+00	2.53E+01	2.57E+01	2.03E+01	2.09E+01	5.31E+00	2.01E+01	2.01E+01	2.01E+01
2.43E+01	0.00E+00	2.44E+01	2.71E+01	2.03E+01	2.09E+01	5.33E+00	2.01E+01	2.01E+01	2.01E+01
2.52E+01	2.23E-37	2.32E+01	2.50E+01	2.03E+01	2.09E+01	5.57E+00	2.01E+01	2.01E+01	2.01E+01
2.61E+01	7.73E-33	2.24E+01	2.27E+01	2.03E+01	2.10E+01	5.43E+00	2.01E+01	2.01E+01	2.01E+01
2.70E+01	8.05E-29	2.18E+01	2.21E+01	2.04E+01	2.10E+01	5.32E+00	2.01E+01	2.01E+01	2.01E+01

2.79E+01	3.08E-25	2.14E+01	2.23E+01	2.04E+01	2.10E+01	5.31E+00	2.01E+01	2.01E+01	2.01E+01
2.88E+01	2.33E-22	2.14E+01	2.25E+01	2.04E+01	2.10E+01	5.31E+00	2.01E+01	2.01E+01	2.01E+01
2.97E+01	2.84E-20	2.16E+01	2.23E+01	2.05E+01	2.11E+01	5.32E+00	2.02E+01	2.01E+01	2.01E+01
3.06E+01	7.48E-17	2.18E+01	2.21E+01	2.12E+01	2.12E+01	5.33E+00	2.05E+01	2.01E+01	2.01E+01
3.15E+01	5.02E-14	2.21E+01	2.22E+01	2.45E+01	2.13E+01	5.32E+00	2.10E+01	2.01E+01	2.01E+01
3.24E+01	7.76E-12	2.22E+01	2.24E+01	2.48E+01	2.14E+01	5.29E+00	2.15E+01	2.01E+01	2.01E+01
3.33E+01	3.13E-10	2.23E+01	2.27E+01	2.42E+01	2.14E+01	5.29E+00	2.20E+01	2.01E+01	2.01E+01
3.42E+01	2.19E-08	2.24E+01	2.27E+01	2.32E+01	2.14E+01	5.31E+00	2.25E+01	2.01E+01	2.01E+01
3.51E+01	2.36E-06	2.31E+01	2.26E+01	2.31E+01	2.15E+01	5.32E+00	2.29E+01	2.02E+01	2.01E+01
3.60E+01	8.41E-06	2.41E+01	2.30E+01	2.30E+01	2.17E+01	5.29E+00	2.32E+01	2.04E+01	2.01E+01
3.69E+01	1.06E-05	2.50E+01	2.31E+01	2.35E+01	2.19E+01	5.28E+00	2.36E+01	2.10E+01	2.01E+01
3.78E+01	1.20E-05	2.56E+01	2.24E+01	2.52E+01	2.20E+01	5.28E+00	2.39E+01	2.16E+01	2.01E+01
3.87E+01	2.02E-05	2.67E+01	2.21E+01	2.61E+01	2.20E+01	5.29E+00	2.41E+01	2.21E+01	2.02E+01
3.96E+01	2.21E-05	2.71E+01	2.26E+01	2.69E+01	2.22E+01	5.29E+00	2.42E+01	2.25E+01	2.02E+01
4.05E+01	2.11E-05	2.64E+01	2.41E+01	2.85E+01	2.25E+01	5.28E+00	2.42E+01	2.26E+01	2.03E+01
4.14E+01	1.99E-05	2.54E+01	2.47E+01	2.80E+01	2.27E+01	5.25E+00	2.41E+01	2.26E+01	2.05E+01
4.23E+01	1.85E-05	2.51E+01	2.42E+01	2.63E+01	2.25E+01	5.24E+00	2.40E+01	2.26E+01	2.08E+01
4.32E+01	1.84E-05	2.54E+01	2.40E+01	2.54E+01	2.26E+01	5.25E+00	2.38E+01	2.26E+01	2.11E+01
4.41E+01	1.86E-05	2.49E+01	2.41E+01	2.46E+01	2.29E+01	5.28E+00	2.38E+01	2.28E+01	2.14E+01
4.50E+01	1.81E-05	2.43E+01	2.46E+01	2.36E+01	2.29E+01	5.26E+00	2.38E+01	2.30E+01	2.16E+01
4.59E+01	1.77E-05	2.38E+01	2.49E+01	2.30E+01	2.30E+01	5.27E+00	2.41E+01	2.31E+01	2.19E+01
4.68E+01	2.08E-05	2.35E+01	2.44E+01	2.29E+01	2.38E+01	5.28E+00	2.44E+01	2.33E+01	2.21E+01
4.77E+01	2.46E-05	2.33E+01	2.39E+01	2.32E+01	2.48E+01	5.23E+00	2.46E+01	2.34E+01	2.22E+01
4.86E+01	2.49E-05	2.37E+01	2.38E+01	2.37E+01	2.52E+01	5.19E+00	2.47E+01	2.34E+01	2.23E+01
4.95E+01	2.34E-05	2.39E+01	2.37E+01	2.37E+01	2.49E+01	5.19E+00	2.49E+01	2.35E+01	2.23E+01
5.04E+01	2.12E-05	2.48E+01	2.40E+01	2.38E+01	2.45E+01	5.21E+00	2.52E+01	2.35E+01	2.22E+01
5.13E+01	2.22E-05	2.55E+01	2.52E+01	2.41E+01	2.39E+01	5.17E+00	2.53E+01	2.35E+01	2.22E+01
5.22E+01	2.85E-05	2.58E+01	2.68E+01	2.39E+01	2.33E+01	5.15E+00	2.54E+01	2.36E+01	2.22E+01
5.31E+01	2.84E-05	2.58E+01	2.76E+01	2.38E+01	2.30E+01	5.17E+00	2.54E+01	2.37E+01	2.22E+01
5.40E+01	2.63E-05	2.48E+01	2.65E+01	2.34E+01	2.28E+01	5.16E+00	2.55E+01	2.40E+01	2.24E+01
5.49E+01	2.74E-05	2.45E+01	2.47E+01	2.32E+01	2.26E+01	5.14E+00	2.57E+01	2.43E+01	2.25E+01
5.58E+01	2.89E-05	2.30E+01	2.44E+01	2.29E+01	2.25E+01	5.17E+00	2.59E+01	2.46E+01	2.26E+01
5.67E+01	2.83E-05	2.29E+01	2.42E+01	2.28E+01	2.25E+01	5.14E+00	2.61E+01	2.47E+01	2.27E+01
5.76E+01	2.99E-05	2.27E+01	2.31E+01	2.25E+01	2.25E+01	5.12E+00	2.62E+01	2.48E+01	2.27E+01
5.85E+01	3.11E-05	2.24E+01	2.26E+01	2.25E+01	2.27E+01	5.11E+00	2.62E+01	2.48E+01	2.28E+01
5.94E+01	2.95E-05	2.25E+01	2.29E+01	2.24E+01	2.28E+01	5.13E+00	2.62E+01	2.49E+01	2.28E+01

6.03E+01	2.99E-05	2.39E+01	2.36E+01	2.22E+01	2.27E+01	5.12E+00	2.61E+01	2.50E+01	2.29E+01
6.12E+01	3.07E-05	2.54E+01	2.39E+01	2.25E+01	2.24E+01	5.10E+00	2.61E+01	2.51E+01	2.31E+01
6.21E+01	3.07E-05	2.69E+01	2.41E+01	2.27E+01	2.22E+01	5.14E+00	2.62E+01	2.52E+01	2.33E+01
6.30E+01	3.13E-05	2.77E+01	2.37E+01	2.25E+01	2.22E+01	5.17E+00	2.63E+01	2.52E+01	2.35E+01
6.39E+01	3.33E-05	2.82E+01	2.31E+01	2.28E+01	2.24E+01	5.17E+00	2.65E+01	2.52E+01	2.38E+01
6.48E+01	3.29E-05	2.67E+01	2.40E+01	2.31E+01	2.34E+01	5.14E+00	2.67E+01	2.52E+01	2.41E+01
6.57E+01	3.15E-05	2.48E+01	2.42E+01	2.30E+01	2.40E+01	5.14E+00	2.68E+01	2.53E+01	2.43E+01
6.66E+01	3.25E-05	2.25E+01	2.36E+01	2.32E+01	2.33E+01	5.09E+00	2.69E+01	2.54E+01	2.44E+01
6.75E+01	3.36E-05	2.20E+01	2.34E+01	2.35E+01	2.29E+01	5.08E+00	2.70E+01	2.55E+01	2.45E+01
6.84E+01	3.38E-05	2.24E+01	2.35E+01	2.40E+01	2.29E+01	5.12E+00	2.70E+01	2.56E+01	2.46E+01
6.93E+01	3.39E-05	2.33E+01	2.38E+01	2.43E+01	2.32E+01	5.05E+00	2.71E+01	2.59E+01	2.46E+01
7.02E+01	3.35E-05	2.49E+01	2.34E+01	2.47E+01	2.37E+01	5.02E+00	2.72E+01	2.61E+01	2.47E+01
7.11E+01	3.27E-05	2.52E+01	2.31E+01	2.50E+01	2.37E+01	5.07E+00	2.72E+01	2.63E+01	2.48E+01
7.20E+01	3.12E-05	2.46E+01	2.32E+01	2.56E+01	2.38E+01	5.09E+00	2.71E+01	2.63E+01	2.49E+01
7.29E+01	2.88E-05	2.30E+01	2.32E+01	2.65E+01	2.35E+01	5.13E+00	2.70E+01	2.64E+01	2.51E+01
7.38E+01	2.77E-05	2.24E+01	2.30E+01	2.57E+01	2.31E+01	5.16E+00	2.70E+01	2.65E+01	2.52E+01
7.47E+01	2.90E-05	2.23E+01	2.34E+01	2.43E+01	2.29E+01	5.13E+00	2.70E+01	2.67E+01	2.54E+01
7.56E+01	3.23E-05	2.27E+01	2.46E+01	2.40E+01	2.28E+01	5.12E+00	2.70E+01	2.68E+01	2.56E+01
7.65E+01	3.27E-05	2.31E+01	2.51E+01	2.38E+01	2.30E+01	5.15E+00	2.73E+01	2.69E+01	2.58E+01
7.74E+01	3.06E-05	2.33E+01	2.46E+01	2.39E+01	2.41E+01	5.13E+00	2.76E+01	2.70E+01	2.60E+01
7.83E+01	3.01E-05	2.31E+01	2.35E+01	2.50E+01	2.46E+01	5.08E+00	2.78E+01	2.70E+01	2.62E+01
7.92E+01	3.03E-05	2.30E+01	2.32E+01	2.46E+01	2.39E+01	5.08E+00	2.80E+01	2.70E+01	2.64E+01
8.01E+01	3.15E-05	2.35E+01	2.30E+01	2.37E+01	2.32E+01	5.07E+00	2.81E+01	2.70E+01	2.67E+01
8.10E+01	3.36E-05	2.34E+01	2.28E+01	2.38E+01	2.31E+01	5.08E+00	2.81E+01	2.72E+01	2.69E+01
8.19E+01	3.48E-05	2.36E+01	2.33E+01	2.36E+01	2.37E+01	5.09E+00	2.81E+01	2.74E+01	2.71E+01
8.28E+01	3.38E-05	2.37E+01	2.43E+01	2.38E+01	2.39E+01	5.13E+00	2.80E+01	2.76E+01	2.73E+01
8.37E+01	2.99E-05	2.54E+01	2.49E+01	2.43E+01	2.38E+01	5.13E+00	2.80E+01	2.77E+01	2.73E+01
8.46E+01	2.90E-05	2.71E+01	2.43E+01	2.38E+01	2.33E+01	5.12E+00	2.80E+01	2.78E+01	2.74E+01
8.55E+01	3.00E-05	2.70E+01	2.35E+01	2.39E+01	2.27E+01	5.13E+00	2.81E+01	2.78E+01	2.76E+01
8.64E+01	3.11E-05	2.81E+01	2.36E+01	2.50E+01	2.27E+01	5.10E+00	2.81E+01	2.78E+01	2.77E+01
8.73E+01	3.28E-05	2.77E+01	2.36E+01	2.45E+01	2.30E+01	5.10E+00	2.82E+01	2.78E+01	2.77E+01
8.82E+01	3.41E-05	2.54E+01	2.35E+01	2.56E+01	2.39E+01	5.10E+00	2.83E+01	2.79E+01	2.77E+01
8.91E+01	3.38E-05	2.39E+01	2.42E+01	2.56E+01	2.46E+01	5.07E+00	2.84E+01	2.81E+01	2.76E+01
9.00E+01	3.33E-05	2.41E+01	2.41E+01	2.53E+01	2.52E+01	5.05E+00	2.85E+01	2.82E+01	2.75E+01
9.09E+01	3.30E-05	2.34E+01	2.32E+01	2.48E+01	2.57E+01	5.03E+00	2.86E+01	2.83E+01	2.75E+01
9.18E+01	3.24E-05	2.35E+01	2.31E+01	2.45E+01	2.47E+01	5.01E+00	2.88E+01	2.85E+01	2.75E+01

9.27E+01	3.22E-05	2.37E+01	2.47E+01	2.43E+01	2.35E+01	4.96E+00	2.89E+01	2.86E+01	2.75E+01
9.36E+01	3.27E-05	2.38E+01	2.76E+01	2.39E+01	2.29E+01	4.98E+00	2.89E+01	2.87E+01	2.77E+01
9.45E+01	3.43E-05	2.33E+01	2.77E+01	2.39E+01	2.27E+01	5.09E+00	2.90E+01	2.87E+01	2.79E+01
9.54E+01	3.45E-05	2.34E+01	2.61E+01	2.36E+01	2.28E+01	5.00E+00	2.90E+01	2.87E+01	2.81E+01
9.63E+01	3.40E-05	2.33E+01	2.42E+01	2.42E+01	2.32E+01	4.95E+00	2.91E+01	2.87E+01	2.82E+01
9.72E+01	3.23E-05	2.33E+01	2.39E+01	2.43E+01	2.33E+01	4.98E+00	2.92E+01	2.87E+01	2.83E+01
9.81E+01	3.06E-05	2.32E+01	2.52E+01	2.37E+01	2.32E+01	5.03E+00	2.94E+01	2.87E+01	2.84E+01
9.90E+01	3.01E-05	2.32E+01	2.57E+01	2.37E+01	2.34E+01	4.93E+00	2.94E+01	2.87E+01	2.85E+01
9.99E+01	3.10E-05	2.34E+01	2.57E+01	2.40E+01	2.34E+01	4.90E+00	2.94E+01	2.87E+01	2.86E+01
1.01E+02	3.33E-05	2.45E+01	2.60E+01	2.42E+01	2.33E+01	4.93E+00	2.94E+01	2.87E+01	2.87E+01
1.02E+02	3.34E-05	2.53E+01	2.48E+01	2.45E+01	2.36E+01	4.89E+00	2.94E+01	2.87E+01	2.87E+01
1.03E+02	3.29E-05	2.55E+01	2.34E+01	2.40E+01	2.35E+01	4.79E+00	2.96E+01	2.88E+01	2.88E+01

DETACT

t (s)	HRR (kW)	Td (Celsius)	(delta)Td	Ug	Tg (Celsius)	(delta)Tg
258	1757.2896	65.53766645	0.33534869	2.696880421	89.70688376	69.70688376
259	1770.9384	65.87379214	0.336125697	2.70384461	90.06735857	70.06735857
260	1784.64	66.21069033	0.336898185	2.710799842	90.4282976	70.4282976
261	1798.3944	66.54835652	0.337666188	2.717746163	90.78969968	70.78969968
262	1812.2016	66.88678625	0.338429737	2.724683618	91.15156362	71.15156362
263	1826.0616	67.22597512	0.339188867	2.731612253	91.51388824	71.51388824
264	1839.9744	67.56591873	0.339943609	2.738532111	91.87667236	71.87667236
265	1853.94	67.90661273	0.340693996	2.745443238	92.23991484	72.23991484
266	1867.9584	68.24805279	0.341440062	2.752345676	92.60361452	72.60361452
267	1882.0296	68.59023462	0.342181837	2.759239471	92.96777025	72.96777025
268	1896.1536	68.93315398	0.342919355	2.766124664	93.33238089	73.33238089
269	1910.3304	69.27680663	0.343652648	2.773001299	93.6974453	73.6974453
270	1924.56	69.62118837	0.344381748	2.779869418	94.06296237	74.06296237
271	1938.8424	69.96629506	0.345106687	2.786729063	94.42893098	74.42893098
272	1953.1776	70.31212256	0.345827497	2.793580276	94.79535001	74.79535001
273	1967.5656	70.65866677	0.34654421	2.800423098	95.16221836	75.16221836
274	1982.0064	71.00592363	0.347256857	2.80725757	95.52953493	75.52953493
275	1996.5	71.3538891	0.34796547	2.814083732	95.89729863	75.89729863
276	2011.0464	71.70255918	0.348670081	2.820901626	96.26550837	76.26550837
277	2025.6456	72.0519299	0.34937072	2.82771129	96.63416308	76.63416308
278	2040.2976	72.40199732	0.35006742	2.834512764	97.00326169	77.00326169
279	2055.0024	72.75275753	0.350760211	2.841306088	97.37280313	77.37280313
280	2069.76	73.10420665	0.351449123	2.848091301	97.74278634	77.74278634

Heat Release Rate Test Data for Fire Scenario 1

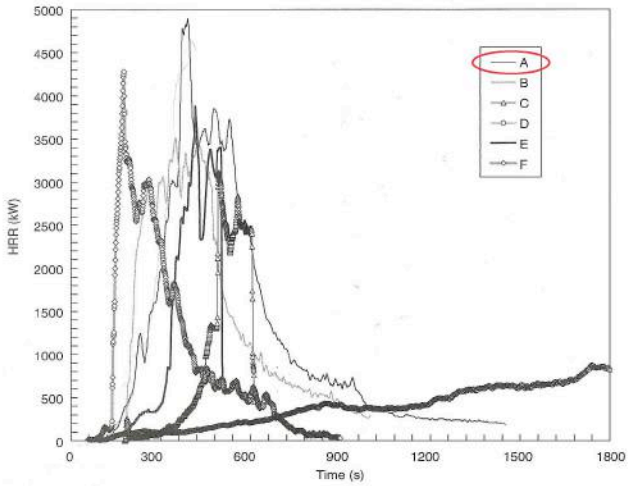


Figure 3-1.16. ***HRR of single-pallet loads of packaged fruit/berry baskets.***

exacerbates burning. Exfoliation occurs when paper folders are placed parallel rather than perpendicular to the front of the shelf. When fire attacks the front, folders progressively fall out and burn in the aisle. Although well known, this effect has not been documented with HRR testing.

Boxes and Packaging

Full-scale tests were run at Western Fire Center[74] to measure the HRR of fruit/berry baskets (i.e., small plastic containers), packaged in cardboard shipping cartons, and assembled into pallet loads. In each case, no fruit goods were actually included, the boxing material being packaged as would be delivered from the manufacturer. For all tests, only a single pallet was used. Identificati materials is given in Table 3-1.2, whereas HRR re are given in Figure 3-1.16. Southwest Research Insti tested pallets similar to Sample A but assembled as a × 2 array of pallets. This test gave a peak HRR of Sec and the results are shown in Figure 3-1.17.

Table 3-1.2 ***Packaged Fruit Cartons Tested in Shipping Pallets***

Sample	Overall Dimensions of Pallet Load (m)	Mass Before Test (kg)	Mass After Test (kg)	Peak HRR (kW)	Effective Heat of Combustion (MJ/kg)
A	0.75 × 1.14 × 1.83	393	307	4923	17.3
B	1.02 × 1.26 × 1.83	308	222	3553	14.0
C	0.99 × 1.19 × 1.87	421	393	3044	12.1
D	1.33 × 0.80 × 1.17	430	344	896	11.9
E	1.18 × 1.07 × 2.29	461	319	3894	11.0
F	1.00 × 1.22 × 2.00	254	192	4280	13.9

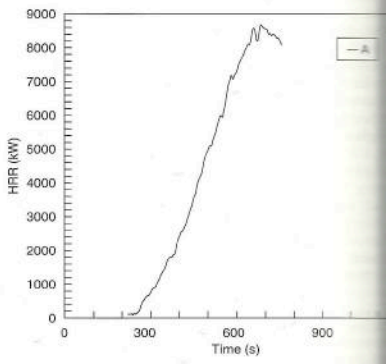


Figure 3-1.17. ***HRR of a 2 × 2 × 2 pallet array of aged fruit/berry baskets.***

Total Evacuation Time Hand calculation

Effective width:

$We_{stairs} = 44'' - 12'' = 32$ in. (Tbl 3-13.1 SFPE HndBk)

$We_{doors} = 36'' - 12'' = 24$ in.

$F_s = F_{sm}$

F_{sm} stairs = 18.5 Persons/min/ft of We (Tbl 3-13.5 SFPE HndBk)

riser = 7" Tread = 11"

F_{sm} Doors = 24 persons/min/ft of We

Flow

Stairs = $18.5 \cdot 32 \text{ in.} / 12 \text{ in/ft} = 49.3$ people/min

Door = $24 \cdot 24/12 = 48$ people/min

movement speed

$S = k - a k D$ (eq. 5 SFPE pg 3-379)

$k = 212$ Tbl (3-13.2)

$a = 2.86$

$D = .175$ (SFPE pg 3-380)

$S = 212 - (2.86)(212)(.175) = 105$ ft/min

Travel Distance from mezzanine

$\Rightarrow 33' + 10'(1.85) = 51.5'$

↑ nearest Door

↑ conversion T61 3-13.3 SFPE

Time from mezzanine to door:

$\Rightarrow$ 88 people / 49.3 people/min + 51.5 ft / 105 ft/min

$= \boxed{2.27 \text{ mins}}$

Time to exit through doors

$\Rightarrow 448/(48.6) = \underline{1.56 \text{ mins}}$

$2.27 > 1.56$, so mezzanine stair will control egress time.

Time to exit doors in Pizza Restaurant without the use of the kitchen door:

$$\frac{448}{(48 \times 5)} = 1.87\,\text{min}$$

Still less than 2.27, so mezzanine will control.

Appendix F- Fire Scenario 2 Attachments

FDS Device Output for Fire Scenario 2

s	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Time	SPRK06	THCP04	THCP05	THCP06	THCP07	THCP08	THCP09	THCP10	THCP11	THCP12	THCP13	THCP14	THCP15	THCP16
0.00E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
9.67E-01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
1.85E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
2.74E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
3.63E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
4.51E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
5.48E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
6.37E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
7.25E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
8.14E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
9.02E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
9.91E+00	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
1.09E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
1.18E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
1.27E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
1.35E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
1.44E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
1.53E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
1.63E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
1.72E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01

1.81E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
1.90E+01	2.00E+01	2.00E+01	2.01E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
1.98E+01	2.00E+01	2.00E+01	2.01E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
2.07E+01	2.00E+01	2.00E+01	2.01E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
2.16E+01	2.00E+01	2.00E+01	2.01E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
2.26E+01	2.00E+01	2.00E+01	2.01E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
2.34E+01	2.00E+01	2.00E+01	2.01E+01	2.01E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.01E+01	2.01E+01
2.44E+01	2.00E+01	2.00E+01	2.01E+01	2.01E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.01E+01	2.05E+01	2.05E+01
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4.84E+02	2.38E+02	4.54E+01	5.69E+01	8.83E+01	1.14E+02	1.35E+02	1.56E+02	1.66E+02	1.71E+02	1.74E+02	1.79E+02	2.68E+02	3.57E+02	3.57E+02
4.85E+02	2.52E+02	4.50E+01	5.75E+01	8.89E+01	1.15E+02	1.34E+02	1.56E+02	1.66E+02	1.71E+02	1.74E+02	1.78E+02	2.67E+02	3.36E+02	3.36E+02
4.86E+02	2.55E+02	4.46E+01	5.77E+01	8.94E+01	1.15E+02	1.33E+02	1.55E+02	1.65E+02	1.70E+02	1.73E+02	1.77E+02	2.64E+02	3.43E+02	3.43E+02
4.87E+02	2.12E+02	4.44E+01	5.79E+01	9.00E+01	1.14E+02	1.33E+02	1.55E+02	1.65E+02	1.70E+02	1.72E+02	1.76E+02	2.62E+02	3.38E+02	3.38E+02
4.88E+02	2.58E+02	4.42E+01	5.80E+01	9.03E+01	1.14E+02	1.33E+02	1.54E+02	1.65E+02	1.69E+02	1.71E+02	1.76E+02	2.62E+02	3.31E+02	3.31E+02
4.89E+02	2.77E+02	4.43E+01	5.83E+01	9.04E+01	1.13E+02	1.34E+02	1.54E+02	1.65E+02	1.69E+02	1.71E+02	1.78E+02	2.56E+02	3.27E+02	3.27E+02
4.90E+02	2.37E+02	4.43E+01	5.87E+01	8.98E+01	1.13E+02	1.34E+02	1.54E+02	1.65E+02	1.68E+02	1.71E+02	1.78E+02	2.58E+02	3.51E+02	3.51E+02
4.91E+02	2.30E+02	4.42E+01	5.97E+01	8.96E+01	1.12E+02	1.34E+02	1.54E+02	1.65E+02	1.68E+02	1.71E+02	1.77E+02	2.51E+02	3.40E+02	3.40E+02
4.91E+02	2.55E+02	4.43E+01	6.06E+01	8.96E+01	1.12E+02	1.34E+02	1.53E+02	1.65E+02	1.68E+02	1.71E+02	1.77E+02	2.56E+02	3.40E+02	3.40E+02
4.92E+02	2.17E+02	4.43E+01	6.10E+01	8.96E+01	1.12E+02	1.33E+02	1.52E+02	1.65E+02	1.68E+02	1.70E+02	1.77E+02	2.62E+02	3.47E+02	3.47E+02
4.93E+02	2.12E+02	4.43E+01	6.10E+01	8.98E+01	1.13E+02	1.33E+02	1.52E+02	1.64E+02	1.67E+02	1.70E+02	1.76E+02	2.55E+02	3.32E+02	3.32E+02

4.94E+02	2.04E+02	4.44E+01	6.09E+01	8.99E+01	1.13E+02	1.33E+02	1.52E+02	1.64E+02	1.67E+02	1.69E+02	1.78E+02	2.49E+02	3.19E+02	3.19E+02
4.95E+02	2.24E+02	4.44E+01	6.02E+01	8.92E+01	1.13E+02	1.33E+02	1.52E+02	1.63E+02	1.66E+02	1.70E+02	1.77E+02	2.55E+02	3.26E+02	3.26E+02
4.96E+02	2.04E+02	4.45E+01	5.99E+01	8.86E+01	1.14E+02	1.34E+02	1.53E+02	1.62E+02	1.66E+02	1.70E+02	1.77E+02	2.50E+02	3.18E+02	3.18E+02
4.97E+02	1.95E+02	4.43E+01	5.92E+01	8.81E+01	1.14E+02	1.34E+02	1.53E+02	1.62E+02	1.66E+02	1.69E+02	1.76E+02	2.51E+02	3.19E+02	3.19E+02
4.98E+02	1.95E+02	4.39E+01	5.83E+01	8.74E+01	1.14E+02	1.34E+02	1.52E+02	1.61E+02	1.66E+02	1.69E+02	1.75E+02	2.50E+02	3.19E+02	3.19E+02
4.99E+02	2.23E+02	4.37E+01	5.78E+01	8.77E+01	1.14E+02	1.34E+02	1.52E+02	1.61E+02	1.65E+02	1.68E+02	1.75E+02	2.51E+02	3.25E+02	3.25E+02
5.00E+02	2.38E+02	4.32E+01	5.78E+01	8.82E+01	1.15E+02	1.35E+02	1.52E+02	1.61E+02	1.65E+02	1.68E+02	1.75E+02	2.49E+02	3.15E+02	3.15E+02
5.00E+02	1.92E+02	4.29E+01	5.86E+01	8.88E+01	1.15E+02	1.35E+02	1.53E+02	1.61E+02	1.64E+02	1.67E+02	1.75E+02	2.46E+02	3.12E+02	3.12E+02
5.01E+02	2.34E+02	4.28E+01	5.99E+01	8.95E+01	1.15E+02	1.36E+02	1.53E+02	1.61E+02	1.64E+02	1.67E+02	1.74E+02	2.50E+02	3.12E+02	3.12E+02
5.02E+02	2.34E+02	4.30E+01	6.04E+01	8.98E+01	1.15E+02	1.36E+02	1.54E+02	1.60E+02	1.64E+02	1.67E+02	1.73E+02	2.55E+02	3.18E+02	3.18E+02
5.03E+02	2.08E+02	4.33E+01	6.02E+01	8.97E+01	1.14E+02	1.37E+02	1.54E+02	1.59E+02	1.64E+02	1.66E+02	1.72E+02	2.55E+02	3.14E+02	3.14E+02
5.04E+02	1.82E+02	4.37E+01	5.92E+01	8.94E+01	1.14E+02	1.37E+02	1.54E+02	1.59E+02	1.64E+02	1.67E+02	1.72E+02	2.63E+02	3.28E+02	3.28E+02
5.05E+02	2.60E+02	4.38E+01	5.80E+01	8.88E+01	1.14E+02	1.36E+02	1.54E+02	1.58E+02	1.64E+02	1.66E+02	1.72E+02	2.65E+02	3.37E+02	3.37E+02
5.06E+02	2.17E+02	4.40E+01	5.67E+01	8.88E+01	1.15E+02	1.35E+02	1.53E+02	1.58E+02	1.63E+02	1.66E+02	1.73E+02	2.63E+02	3.38E+02	3.38E+02

MAX TEMP	4.71E+02

Heat Release Rate Test Data for Fire Scenario 2

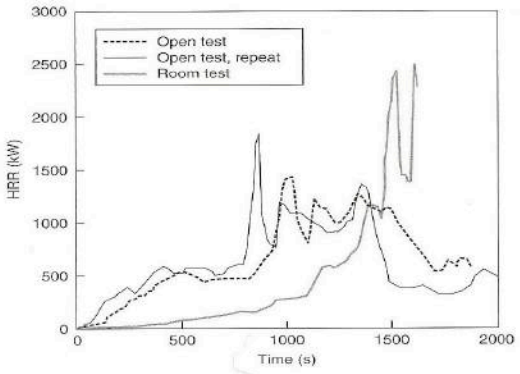

Figure 3-1.60. ***HRR of identical workstations with old-style wood furniture tested under open burning and under room fire conditions.***

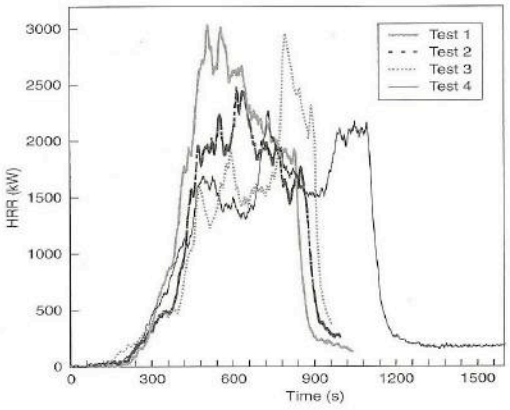

Figure 3-1.61. ***HRR of four unit workstations tested at NRIFD.***

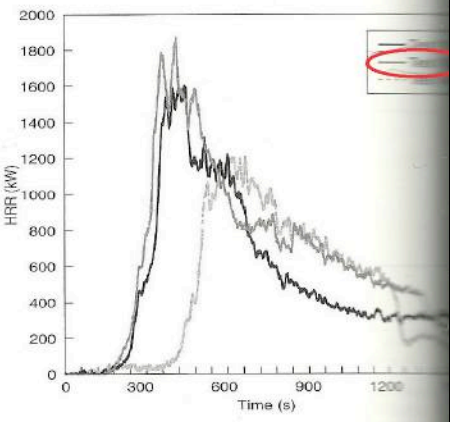

Figure 3-1.62. ***HRR of one unit workstations tested at NRIFD.***

to a more protected arrangement of the fuel, plus the fact that only short (0.45-m-high) partition panels were

Pallets

Conceptually, a wood pallet is a similar array to a wood crib. The geometry, however, is different in that instead of being composed of identical rows of square sticks, pallets are made up of rectangular elements in a traditionally dimensioned configuration (Figure The fire safety concern with pallets arises when they are idle and stacked many units high. Krasner[146] has reported on a number of tests in which the burning rate was measured. A typical experimental heat release curve is shown in Figure 3-1.64. This curve shows much like for a wood crib, a substantially constant plateau burning can be seen if the stack is reasonably high. The results for a standard pallet size of 1.22 m can be given as the following general heat release expression:

$$\dot{q} = 1368(1 + 2.14h_p)(1 - 0.03M)$$

Table 3-1.19 ***Workstations Tested by NRIFD***

Test	Combustible Mass (kg)	Type of Workstation	Number of Desk Units	Partition Panels	Peak HRR (kW)	Time to Peak (s)
1	570	Clerical	4	No	3035	508
2	597	Clerical	4	Yes	2476	616
3	1054	Engineering	4	No	2957	793
4	1086	Engineering	4	Yes	2271	732
11	272	Engineering	1	Yes	1602	441
12	264	Engineering	1	No	1870	412
14	263	Engineering	1	No	1219	601

Appendix G- References

[1]Kim, Hyeong-Jin, and David Lilley. "Heat Release Rates of Burning Items in Fires." (2000). American Institute of Aeronautics and Astronautics. Web. <http://ncfs.ucf.edu/burn_db/Thermal_Properties/docs/Kim_HRR_of_Burning_Items_in_Fires.pdf>.

[2]Pantelis, Andrew. "IMPACT OF ALCOHOL CONSUMPTION ON FIRE EGRESS." *Fema.gov*. Prince George's County Fire and Emergency Medical Services Department, 1 Jan. 2008. Web. <http://www.usfa.fema.gov/pdf/efop/efo42811.pdf>.