GRANGE INSURANCE AUDUBON CENTER

Culminating Experience in Fire Protection Engineering

FIRE PROTECTION LIFE SAFETY REPORT

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Abstract
This technical approach narrative presents the intent and methodology of the Fire Protection and Life Safety systems for the Grange Insurance Audubon Center located at 505 W Whittier St. Columbus OH 43215. The primary goal of the structure is to provide life and property protection in a fire scenario while taking into account the costs of implementing the criterion and risks associated with the facility. This will be achieved through the appropriate application of requirements listed in the 2015 International Building Code (IBC) and the International Fire Code (IFC) as adopted by the City of Columbus, Ohio, and any reference standards and guidelines. Prescriptive requirements analyzed in the body of this report include building construction, egressing, fire alarm systems, and fire suppression systems. The effectiveness of the fire protection systems will depend on a holistic view of the design, operation, and maintenance of these systems. In addition to a prescriptive analysis of the building, a performance-based analysis is performed. The intent of the performance analysis is to demonstrate the protection of occupants not intimate with the initial fire development, and the improvement of the survivability of occupants intimate with the initial fire development.

The building is found to be fully compliant in accordance with the required codes, except for a single dead-end corridor which exceeds allowable length. A solution to this compliance issue is described in the body of the report. The performance-based analysis identifies three potential design fire scenarios: a multipurpose room table fire, a kitchen fire, and a lobby furniture fire. Fire modeling efforts finds that the existing building geometries provide adequate pooling of smoke such that occupants are not exposed to untenable conditions for at least 20 minutes after ignition, at which point they are able to escape the building.

Prescriptive Analysis
Building Description
The Audubon Center is a business development on the Scioto Audubon Metro Park nature preserve in Columbus, Ohio. The project consists of the new construction of a single-story building. The building will consist of office spaces, lecture hall classrooms, and a large multipurpose assembly space. The building is frequently rented for weddings and other private gatherings. As shown in Figure 1 below, the building consists of assembly spaces for large gatherings, and individual office and staff workspaces for business use.

The student authoring this report was only provided the Architectural Floor Plans and Revit model of this building. Any design or schematic layout of fire protection and life safety components are not available for the purpose of this project. Therefore, the work presented in this report is written under the assumption that the design is for a new construction project and not an analysis of existing systems.
Applicable Codes and Standards
Applicable codes and standards will be those adopted by the City of Columbus in accordance with Ohio Building Code. The basis of this design is the 2015 International Building Codes with Amendments as adopted by the State of Ohio. The following summarizes the codes and standards applicable to this project which are referenced throughout this document.

- IBC Ohio Amendments to the 2015 International Building Code
- IFC Ohio Amendments to the 2015 International Fire Code
- NFASCO National Fire Alarm and Signaling Code of Ohio, 2016
- NFPA 13 2013 Standard for the Installation of Sprinkler Systems
- NFPA 72 2013 National Fire Alarm and Signaling Code
- NFPA 92 2015 Standard for Smoke Control Systems
- ASHRAE Handbook of Smoke Control Engineering, 2012

Throughout this document the use of the code acronym and number (if applicable) will be used to reference the above list of codes/standards and associated edition (e.g., IBC, NFPA 72, etc.).

Occupancy Classification and Mixed-Use Analysis
Occupancy classifications are used for the basis of determining construction type requirements, allowable height and areas, egress requirements, and fire alarm and suppression system requirements. Occupancy classifications are assigned based on the definitions provided in Chapter 3 of the IBC. In accordance with IBC §508, each portion of the building is individually assigned an occupancy classification and where multiple occupancy classifications exist, the occupancies are classified as either
accessory to the main occupancy, or as mixed (separated or nonseparated) occupancies in accordance with IBC §508.1.

The Audubon Center is primarily a Group A-2 assembly space with additional Group B office spaces. Due to the area of the mixed-use spaces being greater than 10% of the overall floor area, no spaces can be considered accessory to the main occupancy. Therefore, the building is a non-separated mixed occupancy. Fire protection systems and building egress are required to comply with the A-2 requirements listed within the IBC, due to the assembly space being more restrictive (IBC §508.3.1).

The occupancy classification of each space is labeled on floor plans provided in Figure 1.

Building Separations
The Audubon Center is a single building isolated from other construction in the nature preserve. As shown in Figure 2, there is a 100-car parking lot adjacent to the east face of the building. It is assumed that the property lot lines of the building are the nearest public roads surrounding the building. The closest lot line is approximately 55 feet from the north face of the project. Given that all exterior walls have a fire separation distance greater than 30’ to the nearest public road, no fire resistance is required for exterior walls in accordance with IBC Table 602.
Fire Resistance Analysis

The prescribed fire-resistance of the building is utilized by the IBC to determine building construction type, compartmentation, and fire safety.

Construction Type

The building is assumed to be Type IIB construction, given the use of exposed steel structural members (IBC Table 602). It is assumed that the structure is entirely supported by the steel framing, and there are no load-bearing walls present. Fire-treated-wood wall and ceiling construction are present in nonbearing exterior walls and roof construction, as permitted by IBC §603.1. The following Table 1 identifies each material used in construction, as identified in Figure 3, or labeled in the Revit model material properties.

![Figure 3- Exposed steel and fire-treated wood](image)

<table>
<thead>
<tr>
<th>Component</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columns</td>
<td>Unprotected Steel Square Tube</td>
</tr>
<tr>
<td>Beams</td>
<td>Unprotected Steel I-Beams</td>
</tr>
<tr>
<td>Floor</td>
<td>Cast-In-Place Concrete</td>
</tr>
<tr>
<td>Roof</td>
<td>Fire-Treated Wood Paneling</td>
</tr>
<tr>
<td>Exterior Walls</td>
<td>Fire-Treated Wood-Panel on Metal Stud and Non-Rated Glazing</td>
</tr>
<tr>
<td>Interior Walls</td>
<td>Gypsum Wall Board</td>
</tr>
<tr>
<td>Partitions</td>
<td>8” Fire-Treated Wood</td>
</tr>
</tbody>
</table>

Door openings, joints, and penetration materials are not listed in any provided documents of the building, however in general, through penetrations and membrane penetrations of horizontal
assemblies and fire-resistance-rated wall assemblies are in accordance with IBC §714. Opening protectives for openings in fire-resistance-rated assemblies are provided in accordance with IBC §716. Fire door assemblies and shutters are installed in accordance with the requirements of the IBC and NFPA 80. Joint systems are installed in accordance with IBC §715.

The following Table 2 summarizes the fire-resistance rating of various building elements based on the Type IIB requirements in IBC Table 602.

Table 2. Fire-Resistance Rating for Building Elements

<table>
<thead>
<tr>
<th>Building Element</th>
<th>Fire-Resistance Rating (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Frame</td>
<td></td>
</tr>
<tr>
<td>Members having direct connection to</td>
<td>0</td>
</tr>
<tr>
<td>other designed to carry gravity loads</td>
<td></td>
</tr>
<tr>
<td>Columns supporting floor assemblies</td>
<td>0</td>
</tr>
<tr>
<td>Bearing Walls</td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td>0</td>
</tr>
<tr>
<td>Interior</td>
<td>0</td>
</tr>
<tr>
<td>Nonbearing Walls/Partitions</td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td>0 a</td>
</tr>
<tr>
<td>Interior</td>
<td>0</td>
</tr>
<tr>
<td>Floor Construction</td>
<td></td>
</tr>
<tr>
<td>Including supporting beams and joists</td>
<td>0</td>
</tr>
<tr>
<td>Roof Construction</td>
<td></td>
</tr>
<tr>
<td>Including supporting beams and joists</td>
<td>0</td>
</tr>
</tbody>
</table>

a. Fire-resistance rating of Exterior Non-Bearing Walls is based on FSD, as discussed below in this report.

Given that no members of the building construction are required to be rated, there are no mark ups on the attached floor plans.

Fire-Resistance Ratings and Opening Protection for Exterior Walls

Exterior wall rating requirements of the building are determined by the fire separation distance (FSD) of each exterior wall, measured from each building face to either the closest interior lot line or the centerline of the street, or public right-of-way. When applying the varying FSDs to the exterior wall requirements of IBC Table 602, the fire-resistance rating requirement will vary along the sides of the building.

Fire-resistance ratings of exterior nonbearing walls is provided in accordance with the requirements of IBC Table 602 based on Fire Separation Distance (FSD), building construction type, and the occupancy groups present within the building. As discussed above, the exterior walls along the outer perimeter of the project have varying FSDs. Table 3 below summarizes the fire resistance ratings required and the percent of unprotected openings allowed for each face of the building based on FSD.

Table 3. Fire Separation Requirements

<table>
<thead>
<tr>
<th>Building Face</th>
<th>FSD</th>
<th>Required Fire Rating (hr)</th>
<th>Percent Unprotected Openings</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>&gt;30’</td>
<td>0</td>
<td>Unlimited</td>
</tr>
<tr>
<td>South</td>
<td>&gt;30’</td>
<td>0</td>
<td>Unlimited</td>
</tr>
<tr>
<td>East</td>
<td>&gt;30’</td>
<td>0</td>
<td>Unlimited</td>
</tr>
<tr>
<td>West</td>
<td>&gt;30’</td>
<td>0</td>
<td>Unlimited</td>
</tr>
</tbody>
</table>

Interior Building Separations

The building is a non-separated mixed-use occupancy; therefore, the assembly space is not required to be separated from the Group B business space.
Incidental accessory occupancies are separated as required in IBC Table 509. The following table summarizes general fire-resistance rated separations provided for the areas and hazards that may be present within the building. Equipment lists are not available for the building, but Table 4 will cover any potential requirement.

<table>
<thead>
<tr>
<th>Area</th>
<th>Required Separation</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace room where any piece of equipment is over 400,000 Btu per hour input</td>
<td>Construction to resist the passage of smoke</td>
<td>IBC Table 509 &amp; §509.4.2</td>
</tr>
<tr>
<td>Rooms with boilers where the largest piece of equipment is over 15 psi and 10 hp</td>
<td>Construction to resist the passage of smoke</td>
<td>IBC Table 509 &amp; §509.4.2</td>
</tr>
<tr>
<td>Electrical equipment over 600V, nominal</td>
<td>1-Hour</td>
<td>NFPA 70 §110.31(A)</td>
</tr>
<tr>
<td>Individual dry-type transformers of more than 112.5 kVA</td>
<td>1-Hour</td>
<td>NFPA 70 §450.21(B)</td>
</tr>
<tr>
<td>Oil-insulated transformers installed indoors</td>
<td>1-Hour fire barrier</td>
<td>NFPA 70 §450.26 &amp; §450.42</td>
</tr>
<tr>
<td>Emergency Generator</td>
<td>2-Hour fire barrier</td>
<td>IBC §2702.1.3 &amp; NFPA 110 §7.2.1.1</td>
</tr>
</tbody>
</table>

Per IBC §406, the private garage car port is required to be separated from the other occupancies in accordance with IBC §508.1. In addition, it is required to be provided with 7’ clear height, and cannot be more than 1000 square feet. The space is provided with non-combustible and non-absorbent floor surfaces, and fuel is not dispensed within the garage.

**Allowable Height/Area Analysis**

Chapter 5 of the IBC sets a limit on building height, number of stories, and floor area. Values are determined as a function of building construction type, occupancy, and sprinkler usage. The building is single-story Type IIB construction and must comply for the most restrictive Group A-2 space. Pictures of the space from Google Maps shows that the building is fully sprinklered. Therefore, the building is required to comply with IBC §504 and §506, which limits the height and area of the Audubon Center to be less than 75 feet and 38,000 square feet, respectively.

The Audubon Center has a 17,717 square foot floor plan. The tallest section of roof of the single story is above the multipurpose room, measuring 20’-6”. Therefore, the building is compliant in accordance with Chapter 5 of the IBC.

**Means of Egress**

Means of egress for the building is provided in accordance with the provisions in Chapter 10 of the IBC. Life safety sheets are provided in the appendix of this report.

**Occupant Load**

Occupant loads are utilized for determining the basis of all egress requirements and are determined in accordance with the requirements of IBC §1004. Occupant loads factors are applied based on the functional use of the space and are independent of occupancy classification. IBC Table 1004.1.2 contains
an all-inclusive list of occupant load factors; however, the primary occupant load factors applied in these buildings are summarized in the Table 5 (detailed occupant load calculations are included on Life Safety Plans). In total, the maximum occupant load of the building consists of 570 assembly occupants and 61 business occupants (631 total).

### Table 5 - Occupant Load Factors

<table>
<thead>
<tr>
<th>Function of Space</th>
<th>Occupant Load Factor (ft²/person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessory storage areas, mechanical equipment rooms</td>
<td>300 gross</td>
</tr>
<tr>
<td>Assembly without fixed seats:</td>
<td></td>
</tr>
<tr>
<td>Concentrated (chairs only – not fixed)</td>
<td>7 net</td>
</tr>
<tr>
<td>Unconcentrated (tables and chairs)</td>
<td>15 net</td>
</tr>
<tr>
<td>Classroom</td>
<td>20 gross</td>
</tr>
<tr>
<td>Locker Rooms</td>
<td>50 gross</td>
</tr>
<tr>
<td>Business Area</td>
<td>150 gross</td>
</tr>
<tr>
<td>Mercantile</td>
<td>60 gross</td>
</tr>
<tr>
<td>Storage, stock, shipping areas</td>
<td>300 gross</td>
</tr>
</tbody>
</table>

### Number of Exits

The number and capacity of exits from each area of the building are determined based on calculated occupant loads and the requirements of IBC §1005 and §1006. No stair enclosures are required for this single-story project. Per IBC Table 1006.3.2, a minimum of three exits are required from the story. Eight exits are provided to the exterior of the building.

In addition to the total number of exits provided from a space, consideration must be given to required number of exit access components for individual spaces or areas based on occupant loads and common path of egress travel distance. Table 1006.2.1 includes maximum occupant loads and common path limits for which rooms or areas withing various occupancy groups can be served by one exit access doorway. Table 6 provides guidance where spaces or areas can be provided with a single exit access doorway. If either of these values are exceeded in any space, additional exit access is required.

### Table 6 - Spaces with One Exit or Exit Access Doorway

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Maximum Occupant Load of Space</th>
<th>Maximum Common Path of Travel Distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>49</td>
<td>75</td>
</tr>
<tr>
<td>B</td>
<td>49</td>
<td>100</td>
</tr>
</tbody>
</table>

All spaces which exceed the limits tabulated above are provided with at least two exits.

### Exit Widths

Exits must be sized to provide adequate capacity based on calculated occupant loads. Exit doors and stairs must be provided in accordance with IBC §1010 and §1011, respectively, and each of these exit components must meet the minimum width requirements based on occupant load as prescribed in IBC §1005. The capacity for a means of egress component is calculated by multiplying the occupant load served by the component by its egress capacity factor. As permitted by IBC §1005.3, stairways are subject to an egress capacity factor of 0.3 inches per occupant and doors are subject to an occupant load factor of 0.2 inches per occupant. In addition, the minimum allowable clear width of any door or
stair serving 50 occupants or greater is 32” or 44”, respectively. For the 484 occupants, 97” of door width is required. 416” are provided between the 8 exits.

In accordance with IBC §1020.2, corridors within the occupied portions of the building are typically required to be at least 44” wide. If the occupant load utilizing the corridor is less than 50, the required width is 36” minimum. Corridors which only provide access to mechanical, plumbing, or electrical systems have a minimum required width of 24”. Corridors widths must be unobstructed.

**Exit Access**

Exits and access to exits are provided so that the exits are readily accessible at all times, in accordance with IBC §1016. Where more than one exit, exit access, or exit discharge is required from a building or portion thereof, such exits, exit accesses, or exit discharges will be remotely located from each other to minimize the possibility that more than one has the potential to be blocked by any one fire or emergency condition. In areas where two exits, exit accesses, or exit discharges are required, they are located at a distance from one another not less than one-third the length of the maximum overall diagonal dimension of the building or area served as required by IBC §1007.1.1. For areas where more than two exits, exit accesses, or exit discharges are required, a minimum of two of the required exits, exit accesses, or exit discharges are configured to comply with the one-third minimum separation distance required. With this building, the eight exits are spaced appropriately to meet the one-third requirement discussed above. In addition, the multi-purpose room and lobby (which both require a minimum of two exits from the respective spaces) are provided with exits which are spaced more than one-third the diagonal distance of that space.

Doors which serve a room or area containing 50 or more occupants are required to swing in the direction of egress travel. In addition, if that space contains a Group A occupancy, the door is required to be provided with panic hardware.

Access to exits is arranged to minimize dead-end corridors, common paths of travel, and overall travel distances. Exit access travel distance, common path of travel distance, and dead-end corridor distances are limited in accordance with IBC §1017, §1006, and §1020 based on occupancy. Table 7 summarizes maximum dead-end corridor, common path of travel, and travel distance lengths for all occupancy types present within the sprinkler protected building.

<table>
<thead>
<tr>
<th>Occupancy Group</th>
<th>Exit Access Travel Distance</th>
<th>Common Path of Travel</th>
<th>Dead-End Corridor Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>250’</td>
<td>75’</td>
<td>20’</td>
</tr>
<tr>
<td>B</td>
<td>300’</td>
<td>100’</td>
<td>50’</td>
</tr>
</tbody>
</table>

Where two or more occupancies utilize portions of the same means of egress, each component is required to meet the more stringent requirements of all occupancies that are served, in accordance with IBC §1004.6.

There is one corridor in the Group A-2 space which has a 36-foot dead end, which exceeds the maximum allowable limit. As such, it is the recommendation of this report to provide an additional door at the end of the corridor to provide access to the exterior, as shown by the red door in Figure 4.
Exit Discharge

Exit discharge is provided in accordance with IBC §1028. All exits discharge to directly to the exterior of the building and provide direct path of egress travel to grade plan without reentering the building. Each exit must provide direct and unobstructed access to the public way. The main lobby exits into an egress court as shown in Figure 5, which is required to comply with IBC §1028.4. However, as shown in the figure below, the egress court is greater than 10 feet wide; therefore, fire rated exterior walls and opening protection is not required for the court.
In accordance with IBC §1028, where egress courts are less than 10’ from the building face, the exterior walls are required to have a 1-hour rating, and all openings in the building exterior wall parallel to the egress court less than 10’ above the floor are required to be protected by at least ¾-hr opening protectives in accordance with IBC §716.

Roof and Attic Access
Roof access is not required for a single-story building, per IBC §1011.12.

Emergency Lighting and Exit Signs
The means of egress serving any space must be illuminated whenever the space is occupied, at an intensity of not less than 1 footcandle at the walking surface, per IBC §1008.2. Illumination is always required at all exit discharge (including exterior egress courts) from each exit to the public way. In the event of power supply failure, an emergency electrical system must automatically illuminate the building corridors, exit access stairways and ramps, exit discharge, and electrical equipment rooms for a duration of 90 minutes, per IBC §1008.3. The emergency power system is permitted to consist of storage batteries or an on-site generator.

Exit signs must be readily visible from any direction of egress travel, placed within 100 feet of another exit sign in any corridor. Note that exit signs are not required in rooms or areas that require only one exit or exit access. Light emitting signs are recommended to improve visibility in a smoke-obscured environment.

Egress Conclusion
The only compliance issue identified with the buildings egress system is a dead-end corridor which exceeds allowable limits. All other life-safety features are found to be fully compliant. Next, the building fire alarm system will be reviewed.

Fire Alarm Systems
In accordance with IBC §907.2.1, the building is required to be provided with a manual fire alarm system due to the assembly space having greater than 300 occupants. Initiation will consist of manual pull stations and flow detectors. Notification will consist of audible and visual devices. Device model identification is provided in the Installation section of this report. Device layouts are provided in the Appendix of this report.

Initiation
It is assumed that flow switches are present within the sprinkler system, which will also be used as fire alarm initiating devices. Therefore, only a single manual pull stations is required in order to activate the occupant notification system in accordance with IBC §907.2.1, which will be located adjacent to the primary entrance/exit of the building. An additional pull station will be located at the exit of the assembly space as a redundancy in safety. Both manual pull stations will be mounted between 42 inches and 48 inches from the floor. Duct detectors must be provided in the main return air and exhaust air plenum of al HVAC systems with a capacity greater than 2,000 cfm. Given that the required fire alarm system is manual, smoke and heat detection is not required throughout the building. However, in accordance with NFPA §10.4.5, an automatic smoke detector will be placed in the front entrance.
vestibule, above the FACP, to provide early warning fire detection. In addition, the waterflow switches within the sprinkler system will operate under the same principle as a heat detector. Assume the space is designed for low-hazard quick response (RTI 50 ms^{-1/2}) sprinklers with 15 foot spacing and activation temperatures of 155 °F.

**Occupant Notification**

Notification appliances are required to be located and installed in accordance with NFPA 72. For cost-saving purposes, combination horn/strobe devices are used when applicable. Device placement is provided in the attached drawings. A riser diagram is not provided, given that the space is single story. Design-basis device models are discussed in the Device Installation section of this report.

**Audible**

Audible devices will be provided that are capable of emitting a distinctive sound that is not to be used for any other purpose than that of a fire alarm. The devices are required to provide a sound pressure level of 15 decibels above the average sound level in every occupiable space, while not exceeding 110 decibels at a minimum hearing distance from any device. All audible notification devices are to be wall mounted. Wall mounted appliances are required to be mounted within 6 inches of the finished ceiling.

It is assumed that the typical business space has an ambient noise level of 54 decibels, and the assembly space has an ambient noise level of 60 decibels (see NFPA 72 Table A.18.4.4). Therefore, the spaces should have audible notification of 69 dBA and 75 dBA, respectively. The devices will be required to be rated higher than these levels because the sound is lost as it travels through a room. Typically, it is assumed that 6 decibels are lost every time the distance from the emitter is doubled. The distance between devices is measured to ensure that every space within the building is exposed to at least the minimum required sound level. It is recommended that the selected audible devices have variable sound level intensities, as a large gathering or music at an event might provide ambient sound levels greater than 60 dBA. If such is the case, a sound intensity meter can be used to determine the actual ambient sound levels of the room so that the audible fire alarm devices can be adjusted accordingly.

Audible devices are not required in every room, so long as the noise of neighboring devices are at the appropriate sound level across walls. See attached drawings for device placement. Sound intensity is labeled on each device in the plans. If the device is wall mounted, it is labeled with a W.

**Visual**

Visual devices will be installed in all public use and common areas. Offices or utility rooms serving only one occupant are not required to have visual notification in accordance with IBC §907.5.2.3.1. All visual notification devices are to be wall mounted. Wall mounted appliances are required to be mounted in between 80 inches and 96 inches from the finished floor.

Strobes within corridors shall be spaced a maximum of 100 feet apart, in accordance with NFPA 72 §18.5.5.6.5. Strobes within spaces shall be spaced in accordance with NFPA 72 Table 18.5.5.5.1(a) and the size of the room. All strobes within corridors are shown with a maximum candela rating of 185 cd (per device settings). Light intensity is marked in the plans on each device in units of candela.

**Mass Notification**

The Audubon Center is not a high-rise nor have phased evacuation. The assembly space is loaded with fewer than 1000 occupants. Therefore, an emergency communication system is not required in
accordance with IBC §907.5.2.2.4. Mass notification will not be provided to save on system cost and power requirements.

**Control Unit**
The fire alarm system shall annunciate at the fire alarm control unit and shall initiate occupant notification upon activation, in accordance with IBC §907.5. The Fire Alarm Control Panel (FACP) will be located within the vestibule of the main entrance, along the south of the space. The FACP will be installed such that it monitors initiating signals from the manual pull stations and relays activation of all notification appliances. Due to the size of the building, zoned activation will not be utilized. In accordance with NFPA 72 §26.3.4, the FACP will be labeled as such for emergency response identification. In addition to a FACP identification, the building egress paths will be mapped and posted less than 3 feet from the FACP. The FACP will also include documentation of the primary contractor, maintenance schedule, inspection expiration dates, local AHJ information, and a description of the fire alarm system monitored by the panel.

Upon any device activation, the FACP shall display a supervisory signal. If power is lost or a device is not responding to signal, a trouble signal shall display.

**Device Installation**
All devices are to be installed by a certified professional. All devices are required to be UL listed for fire alarm usage. ¾” minimum diameter electrical metallic tubing (EMT) will be used as conduit throughout the building, unless adjusted by contractor. Wire will be 14 gage stranded copper.

The following Honeywell devices are used as a design basis for the fire alarm system. Datasheet of devices are placed in the appendix. When multiple devices are listed on a datasheet, the relevant devices are highlighted in yellow.

- P2RL (wall mounted speaker/strobe)
- SGRL (wall mounted strobe)
- SCRL (ceiling mounted strobe)
- HPFF12 (12-amp power source)
- NFW2-100 (Addressable FACP)

The power requirements of the devices layed-out on the fire alarm plans are calculated with Honeywell’s Hotfire software, which calculates the power loss of each device using Ohms Law (V=IR) and the gage and length of the wire. The primary power supply for the building is a dedicated circuit from the main electrical distribution. A 12-amp battery is provided for secondary power, and per voltage drop calculations, the total alarm load of all four circuits is anticipated to be 3.55 amps. At this current, over the 15-minute required alarm time, 0.89 amp-hours are required for the system. The FACP is the only item which is anticipated to have a significant standby load. According to the HPFF12 specification sheet, the FACP is required to be provided with a minimum 7 amp-hour battery system. As such, the standby power should be sufficiently provided by the battery system. If field-inspection finds that the 7 amp-hour battery is insufficient, the FACP is capable of using a maximum 26 amp-hour battery. No circuit has a voltage drop greater than 10%, so the provided 24V battery is found to sufficiently to power the system for the required amount of time, and a booster is not required. See attached specification sheets
of each device, and the voltage-drop calculations attached in the appendix. Current draw on the
initiating devices is considered negligible, and not accounted for in these calculations.

The FACP must be programmed such that different inputs will result in various types of outputs for the
system. Any activation of an initiating device (flow switch, pull station, FACP smoke detector) must
activate all notifying devices (audible and visual). There is no need for elevator recall or activation of
magnetic hold-opens for this building. The activation of any tamper switches or duct detectors must
send a supervisory signal to the FACP. Loss of power to any device in the fire alarm system must send a
addressable trouble signal.

Inspection and Maintenance
In accordance with the NFASCO, all fire alarm inspection, testing, and maintenance is required to comply
with NFPA 72 Chapter 14. Initial testing and reinspection are designed to ensure compliance with
approved design documents and to ensure installation of the fire alarm system is in accordance with
NFPA 72. Inspection, testing, and maintenance programs shall verify correct operation of the system. If a
deficiency is not corrected at the conclusion of system inspection, testing, or maintenance, the system
owner or the owner’s designated representative is required to repair the deficiency promptly. The
property owner is required to be responsible for inspection, testing, and maintenance of the system and
for alterations or additions to this system.

The test plan and results shall be documented with the testing records. Testing shall compose of visual
inspection and active testing. Visual testing will include inspection of all equipment, fire alarm control
panel LED notification, component maintenance tag compliance, location and condition of all
components listed on fire alarm plans, and any other inspection unique to the fire alarm design. Active
testing will include activation of all initiating devices to ensure they signal to the fire alarm control panel.
Notification devices will be tested to confirm they activate after initiation sequence, and they produce
the desired effects as listed in the fire alarm plans.

The frequency of all tests shall comply with NFPA 72 Tables 14.3.1 and 14.4.3.2.

Fire Alarm Conclusion
The building fire alarm system is designed to be fully compliant with NFPA 72 and the National Fire
Alarm and Signaling Code of Ohio. Next, the building sprinkler system will be reviewed.

Fire Suppression Systems
The building contains a Group A-2 assembly space with greater than 300 occupants. There is no
separation of different fire areas; therefore, an automatic sprinkler system will be provided throughout
the building in accordance with the IBC §903.2.1.3. The space is fully conditioned, so sprinklers will not
be exposed to temperatures < 40 °F. If the garage is not conditioned, dry barrel sprinklers are
recommended to avoid the potential for freezing. Therefore, the system is permitted to be wet pipe, per
NFPA 13 §16.4.4.1. Device layouts are provided in the Appendix of this report.

Water Supply
The Columbus Division of Water provided a Fire Hydrant Flow Test dated 1/26/2018 of the site
(attached as an appendix). It is the recommendation of this report that a more recent test be conducted
before the submittal of sprinkler documents to the city. The test reports the following flow information:
Static Pressure: 83 psi  
Residual Pressure: 70 psi  
Flow: 1880 gpm

As a conservative approach, a 10% reduction in the available pressure is assumed. Thus, the available pressures are assumed to be as follows:

Static Pressure: 75 psi  
Residual Pressure: 63 psi  
Flow: 1880 gpm

Sprinkler Design Criteria
The design density requirements and hose stream allowances are provided throughout the building in accordance with the design criteria provided in NFPA 13. The assembly and business spaces will be designed as Light Hazard in accordance with NFPA 13 §A.4.3.2. Mechanical spaces and low-piled storage will be designed as Ordinary Hazard Group 1. The following Table 8 demonstrates design criteria as provided in NFPA 13 §19.3.3.1.

<table>
<thead>
<tr>
<th>Uses or Functions</th>
<th>Light Hazard</th>
<th>Ordinary Hazard Group 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lobbies, Areas</td>
<td>Mechanical/Electrical, Storage Use (under 8’), Garage</td>
</tr>
<tr>
<td>Design Density (gpm/ft²)</td>
<td>0.10</td>
<td>0.15</td>
</tr>
<tr>
<td>Area of Operation (ft²)</td>
<td>1500</td>
<td>1500</td>
</tr>
<tr>
<td>Hose Demand (gpm)</td>
<td>100</td>
<td>250</td>
</tr>
<tr>
<td>Duration (min)</td>
<td>30</td>
<td>60</td>
</tr>
</tbody>
</table>

The following Figure 6 demonstrates the proposed sprinkler system design.
Figure 6 – Sprinkler Layout

The building has an area less than 52,000 sf, therefore only one sprinkler zone is require per NFPA 13 §4.5.1. Water enters the building from the north, into the mechanical room. The sprinkler riser elevates the water to roof height, and the sprinkler mains transport water down the corridors. Branch lines split off the main to each individual sprinkler. Note that the pipe diameters are determined upon hydraulic analysis further in this report.

Installation
K5.6 standard-response pendent sprinklers are spaced a maximum of 15’ apart in every space within the building. There are no concealed combustible spaces that require sprinkler protection. There are no ceiling tiles shown in any online images of the building. The ceiling / roof consists of FRT wood and exposed steel members, with exposed mechanical ducting and sprinkler pipes. The building exterior projections are all less than 4’, therefore sprinklers are not required. There is no indication that the electrical room is constructed of 2-hr rated construction, therefore sprinkler protection is required per NFPA §9.2.6.

The provided plans of the building do not show ceiling obstructions or structural layout of the truss system. Therefore, it is assumed that the sprinkler pipes shown in the image below can be supported by the building structure. Slight design changes might be required upon sprinkler contractor shop-plans. The building is not located in an earthquake zone and Ohio does not provide any additional bracing requirements; therefore, the sprinklers will be fastened via standard hangers.

The sprinkler riser is located in the mechanical room at the north of the building. Water entry must be provided with a pressure indicating valve (PIV) and a backflow preventer (BFP). The BFP must include check valves, butterfly valve, pressure gauge, and OS&Y valve. A test drain must be located in the mechanical room, and the flow switch on the system must be connected to the building FACP. One fire
department connection (FDC) is required in an approved location. The FDC is at the front entrance to the building for easy fire department access.

Hydraulic Analysis
The most hydraulically demanding area of the system will be in the multipurpose space and corridor, as shown in Figure 7. Although this space is not the most remote area, the sprinklers are installed on a sloped ceiling, so the design area requires a 30% increase without revising the density, per NFPA 13 §19.3.3.2.4. Thus, the required sprinkler design is 0.1 gpm per sf at 1950 sf, with a hose stream allowance of 100 gpm.

As demonstrated by the figure above, four remote sprinkler branches are inside the most design area. The length of the longest branch is less than 1.2 x sqrt(design area), therefore the entire branch is included in the hydraulically most demanding area. The 4 full branches do not cover the 1950 sf, so the highest flowing sprinkler on the next branch line is also included in the design area.

HASS (Hydraulic Analyzer of Sprinkler Systems) software is used to perform the calculations of this analysis. Each node input into HASS is labeled in the appendix, as well as the HASS output report. The water entry design is not available for review, therefore conservative assumptions are made in the HASS model to predict water entry diameter, length, pipe type, and use of gate and check valves from the city.
supply to the bottom of the sprinkler riser. It is also assumed that water lines are 3’ below grade to be below the frost line, as required by a Columbus Amendment to the IBC (§4125.03), and that the backflow preventer is 2’ above grade and causes a 4-psi pressure loss.

All pipe in the building is assumed to be roll-grooved thin wall steel. Pipe diameters, as shown in Table 9, are selected to best represent past experience and understanding of available product.

### Table 9 - Sprinkler System Design

<table>
<thead>
<tr>
<th>Pipe</th>
<th>Nominal Diameter (inches)</th>
<th>Color on Sprinkler Layout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riser</td>
<td>4”</td>
<td>Red</td>
</tr>
<tr>
<td>Main</td>
<td>3”</td>
<td>Pink</td>
</tr>
<tr>
<td>Branches</td>
<td>1.25”</td>
<td>Orange</td>
</tr>
</tbody>
</table>

All sprinklers are assumed to be at an elevation of 19’ to meet the top of the sloped ceiling. Branches are anticipated to connect to the main line by two T-joints. The sprinklers will drop from the branches with either a T or an Elbow (depending on if the branch continues or ends with the sprinkler). The pressure loss associated with the length of pipe between the branch and sprinkler is negligible compared to the pressure gain by the drop from the branch, therefore the node between the branch and the sprinkler is not recorded and the calculation remains conservative.

Each head will cover a maximum of 225 sf with a flow of 0.1 gpm/sf, it is anticipated that the most remote node requires 22.5 gpm.

As shown in Figure 8 (and further shown in the Appendix), the HASS analysis calculates that the estimated available water pressure is sufficient to supply the sprinkler system designed through this report. The sprinkler system is predicted to require 60 psi at 281 gpm (plus 100 gpm hose stream). 74 psi is available at that flow rate, providing a 15-psi buffer. If either the 3” pipes or 1.25” pipes is reduced further, the pressure demand exceeds what is available.
Through calculation, it is determined that the city pressure is sufficient to supply the designed sprinkler system without the need of a fire pump. As shown in the HASS analysis in the appendix, the largest pressure losses occur in the sprinkler mains. If a new flow test is conducted and the available water pressure is found to be lower than estimated, increasing to a 4” diameter main would reduce the demand even further.

Fire Flow
Appendix B of the IFC is not adopted by Ohio Fire Code. Therefore, fire flow calculations are not required for this building.

Sprinkler Inspection, Testing, and Maintenance
Inspection, testing, and maintenance is required for the sprinkler system in accordance with NFPA 25. A summary of the testing frequency is provided Table 5.1.1.2. All ITM must be performed by a qualified person. Failure to maintain a sprinkler system can result in fine or loss of occupancy certification.

When a component in the sprinkler system is adjusted, repaired, or replaced, the actions listed in Table 5.5.1. are required.

Standpipe System
The floor level of the highest story is located at grade plane therefore a standpipe system is not required, per IBC §905.3.1.

Fire Sprinkler Conclusion
The building sprinkler system is designed to be fully compliant with NFPA 13. Next, the building smoke control system will be reviewed.

Smoke Control Systems
A smoke control system designed in accordance with IBC §909 is not required for this building. Note that all HVAC is required to shut down upon fire alarm activation.

Interior Finishes
Interior finishes are provided in accordance with Chapter 8 of the IBC based on occupancy classification. Interior wall and ceiling finish materials are classified in accordance with ASTME E84 or UL 723 and are classified as either Class A (flame spread index 0-25; smoke developed index 0-450), Class B (flame spread index 26-75; smoke developed index 0-450), or Class C (flame spread index 76-200; smoke developed index 0-450). Interior floor finished are provided as required by IBC §804 and are classified as either Class I (0.45 watts/cm$^2$ or greater) or Class II (0.22 watts/cm$^2$ or greater) in accordance with NFPA 253. Table 10 below summarizes the interior finish ratings provided based on the occupancy groups present.
Table 10 - Interior Finish Requirements

<table>
<thead>
<tr>
<th>Occupancy Group</th>
<th>Exit Enclosures &amp; Exit Passageways</th>
<th>Corridors</th>
<th>Rooms &amp; Enclosed Spaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>B II</td>
<td>B II</td>
<td>C II</td>
</tr>
<tr>
<td>B</td>
<td>B II</td>
<td>C II</td>
<td>C II</td>
</tr>
</tbody>
</table>

Prescriptive Analysis Conclusion
The building is required to be provided with fully compliant egress, suppression, and alarm systems. All requirements and potential compliance issues are discussed throughout the body of the report. In addition to meeting the prescriptive requirements of the code, the building is also analyzed for performance in the following sections of this report.

Performance Based Analysis
The primary purpose of this fire protection engineering performance-based analysis (PBA) is to document the computational fluid dynamics (CFD) modeling efforts for the Audubon Center. This rational analysis will document the capability of the facility design to provide a tenable egress environment for occupants exiting from a smoke compartment of fire origin. This document will examine the available safe egress time (ASET) and the required safe egress time (RSET) within the building to validate the capability of the building to maintain a tenable environment that allows building occupants to safely exit the compartment of fire origin. As discussed earlier, the building is not required to be provided with a smoke control system designed in accordance with IBC §909. As such, the natural smoke development will be modeled without any exhaust or additional ventilation means.

Performance Objective
A smoke control system designed in accordance with IBC §909 is not required; however, the performance objectives of this building will be commensurate to that detailed in §909. IBC §909.8 includes requirements for the exhaust method of smoke control, which stipulates performance criteria to maintain a tenable environment within the compartment of origin as follows:

“909.8.1 Smoke Layer. The height of the lowest horizontal surface of the smoke layer interface shall be maintained not less than 6 feet above a walking surface that forms a portion of a required egress system within the smoke zone.”

In addition, IBC §909.4.6 requires that the duration of operation for smoke control systems shall be capable of continued operation after detection of the fire event for a period of not less than either 20 minutes of 1.5 times the calculated egress time, whichever is greater.

It is worth noting that the IBC Commentary to IBC §909.8 indicates that the exhaust method is used to maintain a tenable condition within a large-volume spaces, such as atriums, arenas, convention centers, airport terminals, and malls. Such spaces include a volume at the ceiling level that allows for the pooling of smoke to delay the descent of the smoke layer into occupied spaces and provide adequate time for detection and ventilation system activation. Application of the exhaust method to this design scenario is not practical given the low ceiling heights and the fact that this is not a large-volume space. Therefore, a
6’ smoke layer interface height may be impractical for certain areas within the spaces. Furthermore, application of the minimum 20-minute system performance duration is not appropriate for this facility given the relatively short egress times associated with this building.

**Tenability Criteria**

The intent of this fire modeling effort is to demonstrate that the proposed smoke control system design maintains a tenable environment in all areas of the building used for egress for a period of time sufficient for building occupants to exit the building safely. Since the definition of a “tenable environment” is not provided in any of the applicable code documents, quantifiable tenability criteria are established below based on information in the SFPE Guide to Human Behavior in Fire. Three parameters that are regularly analyzed when evaluating tenability are carbon monoxide concentration, gas temperature, and visibility. These parameters are analyzed thoroughly for each of the design fires of this design brief in order to demonstrate that the smoke control system satisfies all performance requirements.

**Carbon Monoxide Concentration**

Exposure to carbon monoxide (CO) can cause incapacitation of occupants at relatively low concentrations and at short exposure times. CO absorbed through the respiratory system will bond to hemoglobin proteins in the blood and reduces the amount of oxygen which can be supplied to the brain and other vital organs. Since fires produce a significant amount of CO, CO concentration can provide an indication of an untenable environment. The effects of CO exposure are dependent on the concentration of CO within the environment, the length of time that a person is exposed to that concentration and the amount of physical activity that the person is engaging in throughout the duration of exposure.

Table 7.1 in the SFPE Guide to Human Behavior in Fire states that a 70 kg human will be incapacitated upon exposure to 35,000 ppm-min of CO. Exposure to 1,750 ppm for a total of 20 minutes will result in this amount of exposure. Although it is not anticipated that occupants will egress is less than 20 minutes, a conservative tenability threshold for CO concentration is assumed to equal 1,750 ppm at any time in the simulation.

**Gas Temperature**

Heat from fire and smoke gases can negatively affect a person’s ability to breathe and evacuate a building. Table 7.6 in the SFPE Guide to Human Behavior in Fire states that 140°F (60°C) has been found to be the highest temperature at which 100 percent water-vapor saturated air can be breathed. Since all fires produce a considerable amount of water vapor from combustion, gas temperatures are an important parameter in measuring the tenability of an environment. FDS output information is used to verify that the smoke control system maintains gas temperatures below 140°F (60°C) within all areas used for evacuation by building occupants.

**Visibility**

One of the key factors affecting occupant evacuation during a fire scenario is the reduction in visibility caused by the obscuration of smoke. Reduced visibility results in reduced movement speed and longer exposure to heat and toxic gases. With sufficient, continued exposure to heat and/or toxic gases speed of movement can continue to slow occupant movement and diminish occupants’ mental capabilities. Reduced visibility also affects way finding and may increase the time taken to locate exits. If evacuation
is not completed, incapacitation may result. Section 5.2 in the SFPE Guide to Human Behavior in Fire provides recommendations of allowable values of visibility for safe fire escape proposed by a number of different researchers, ranging from 4 ft (1.2 m) to 65.6 ft (20 m). Visibility should be treated very differently than an exposure to gas concentrations or heated smoke. There are key tenets to consider when addressing visibility, including occupant familiarity with the building, occupant abilities, and types of smoke exposure present. As a conservative approach, a visibility limit of 10 meters is selected as a tenability threshold for this analysis.

Tenability Definition
The measurement of the actual interface between the upper smoke layer and the lower clear layer is not very straightforward due to the presence of a gradual ‘transition zone’ that exists between the two layers. There are multiple methods of estimating the position of the smoke layer interface within FDS, none of which being verified as a ‘correct’ method. Since the goal of this smoke control system is to maintain a tenable environment within the atrium spaces that are to be used for occupant egress, the following performance characteristics in Table 11, as established above, are measured for verification of a successful smoke control system design:

<table>
<thead>
<tr>
<th>Tenability Parameter</th>
<th>Tenability Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO Concentration</td>
<td>Maintain &lt; 1750 ppm CO Concentration</td>
</tr>
<tr>
<td>Gas Temperature</td>
<td>Maintain &lt; 140˚F (60˚C) Gas Temperatures</td>
</tr>
<tr>
<td>Visibility</td>
<td>Maintain visibility &gt; (10 m)</td>
</tr>
</tbody>
</table>

In order to evaluate whether these parameters have been maintained within the atrium areas that are to be used for egress, the ‘SLICE’ output functionality is utilized. FDS and the accompanying visualization program, Smokeview, have the capability to provide a visual output of various quantities (temperature, gas concentration, flow velocities, etc.) along a user specified plane. Since the building and fire codes require that a tenable environment be maintained 6 ft above the highest level of the atrium utilized for egress, ‘slices’ of the three tenability parameters established above. These slices are placed 6 ft above evacuation routes of the atrium and are analyzed against the established tenability criterion for the various fire scenarios established in this design brief. Additionally, the 3D Slice can be visualized in Smokeview to demonstrate the boundary layer at which any of the three-tenability criterion are exceeded, providing a more absolute depiction of the threshold of tenability within the environment.

Egress Modeling – RSET Analysis
As indicated above, the performance objective for this system is proposed to maintain tenable environments for a period equal to 1.5 times the calculated egress time. Detection time and time to alarm cue or warning, as well as an appropriate margin of safety must be included in the total calculated RSET time.

In order to validate these evacuation times and formulate the entire RSET period, this section provides background on the development of egress time models, the assumptions and applications of specific egress models, and an analysis of the model output. Significant research has been conducted to formulate models and develop methods of predicting the various phases of evacuation, with the most significant developments in the prediction of movement time. This RSET analysis will formulate estimates of detection/alarm time and premovement time based on historical data and will utilize egress modeling software to determine movement time.
Egress Time Model Elements
A performance-based assessment of evacuation time needs to address all components of the evacuation process. The following Figure 9 provides a graphic representation of all elements which make up the entire evacuation process.

From the graphic above, the components which makeup the total required safe egress time are comprised of detection/alarm time, pre-movement time, and movement time. Detection and alarm time is the interval between the first instances of ignition to the time when notification of the occupants takes place. This portion of the evacuation timeline is generally a result of the type of fire detection and alarm system provided for the space; more robust systems (e.g., aspiration smoke detection, beam detection, voice evacuation system) can be specified in order to reduce the detection/alarm phase. The pre-movement phase is the interval between the time at which notification occurs and the time at which occupants initiate movement towards an exit. This phase consists of recognition time, which is the time it takes the occupants to interpret notifications as indication of an emergency, and the response time, which the occupants decide to begin evacuation of the building. Finally, movement time is the time required for occupants to traverse through the building and reach a place of safety.

Detection/Alarm Time Determination
Water flow switches are provided for initiation of evacuation in the event of a fire. This type of system, as opposed to relying on manual fire alarm pull stations, helps to ensure that fire within the space will be detected quickly, so that delay between ignition and evacuation can be minimized.

Premovement Time Determination
Premovement time includes the time that elapses while the occupant is preparing to leave or seek refuge. This includes recognition time and response time. Premovement activities involve all of the activities in which an occupant will engage from the time when he or receives cues of the fire event and
makes a decision to evacuate until the time he or she actually starts to travel towards an exit or area of refuge. For example, office workers may take time to shut off equipment, gather belongings, or lock files. Generally, it is not possible to distinctly classify reaction and response times and therefore these two are usually considered together as premovement time.\(^a\)

Table 64.4 of the SFPE Handbook provides delay times derived from actual fires and evacuation exercise reported in various published literatures. A one-story building is found to have an average premovement time with 95 participants of 0.4 minutes during an unannounced drill. As such, a premovement time of 30 seconds is assumed for this building.

**Movement Time**

Numerous calculation methods are available for the estimation of movement/travel time. These calculation tools range from simple hand calculations to complex models which must be run on computers. Calculation of the movement times for an individual through a space is fairly straightforward and can generally be done with hand calculations utilizing travel distance and walking speeds. This calculation becomes much more complex when trying to estimate travel time of crowds of occupants. This is largely due to the phenomena related to crowd movement (density, speed, and flow), and the interactions which occur between crowds as egress paths merge. This is further complicated by exit proximity, level of familiarity with the building, and occupant queuing at egress components, which result in complex decision making by each occupant to evaluate how to most efficiently navigate through the building to reach an exit. Computer simulation models have been used to more appropriately estimate travel time for this scenario.

**Software: Thunderhead Engineering Pathfinder**

Pathfinder is an agent-based egress simulator that uses steering behaviors to model occupant motion. It consists of three modules: a graphical user interface, the simulator, and a 3D results viewer. Pathfinder uses a 3D geometry model. Within this geometric model is a navigation mesh defined as a continuous 2D triangulated surface. Occupant motion takes place on this irregular one-sided surface represented by adjacent triangles.

Since this is an agent-based model, each occupant has a behavior that is assigned to them within the user interface. A behavior dictates a sequence of goals that the occupant must achieve in the simulation. These goals generally dictate that an occupant move towards a certain exit or location within the model but can be specified with more complexity to include targeted commands. Once an occupant has a destination to seek, they then need a plan for how to reach the destination, a path to follow, and a way to follow the path while accounting for dynamic obstacles along the path, such as other occupants. In selecting a path, agents can be programmed to utilize certain predefined exits, or they can independently assess visible exit locations, queue times, and obstacles to select a destination and path.

Agents are located within the model in the user interface and specified with individual attributes regarding height, width, separation distance, walking speed, etc. Through variation in these parameters,

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it is possible to specify various genders, age groups, and physical abilities of agents within the model. These characteristics will largely determine the basic movements and decisions made within the model.

Pathfinder provides two primary options for occupant motion: an SFPE mode and a steering mode. The SFPE mode implements the concepts in the SFPE Handbook of Fire Protection Engineering [Nelson and Mowrer, 2002]. This is a flow model, where walking speeds are determined by occupant density within each room and flow speed through doors is controlled by door width. Furthermore, in SFPE mode, occupants make no attempt to avoid one another and can interpenetrate.

The steering mode is based on the idea of inverse steering behaviors. Steering behaviors were first presented in Craig Reynolds’ paper “Steering Behaviors For Autonomous Characters” [Reynolds, 1999] and later refined into inverse steering behaviors in a paper by Heni Ben Amor [Amor et. al., 2006]. Pathfinder’s steering mode allows more complex behavior to naturally emerge as a byproduct of the movement algorithms – eliminating the need for explicit door queues and density calculations.

**Model Set Up**

Steering mode is utilized as the basis of these modeling efforts due to the tendency of this mode to more accurately model real-world agent behaviors. Although SFPE mode does offer insightful output, these calculations generally only take into account walking speed and flow rate limitations through various egress components (e.g. doors and stairs), and therefore do not take into account the complex decision making for each individual agent that computer models are capable of.

AutoCAD backgrounds are exported from the current design layout of the expansion and utilized to develop the 3D navigational mesh for the egress model. All doors included in the design have a 3’ panel and have been indicated in the egress model to have a 32’’ clear width. Figure 10 below shows the building imported into the Pathfinder software, with occupants randomly distributed throughout the occupied spaces.

![Figure 10 – Pathfinder Model](image-url)
**Occupant Profile Definitions**

Two types of agent profiles have been defined within the egress model: Default and Physically Impaired. Generally, all profile parameters associated with the agents has been left to the default values recommended by the Pathfinder Software; however, Acceleration Time, Height, Speed, and Shoulder Distance have been modified from the default values for each profile type. The following Table 12 through Table 14 summarize the aforementioned parameters defined within the egress model for the various agent profiles:

<table>
<thead>
<tr>
<th>Table 12 - Default Egress Agent Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agent Profile: Default (Able-Bodied People)</strong></td>
</tr>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>Acceleration Time:</td>
</tr>
<tr>
<td>Height:</td>
</tr>
<tr>
<td>Speed:</td>
</tr>
<tr>
<td>Shoulder Distance:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 13 - Impaired Egress Agent Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agent Profile: Impaired (Physically Impaired People)</strong></td>
</tr>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>Acceleration Time:</td>
</tr>
<tr>
<td>Height:</td>
</tr>
<tr>
<td>Speed:</td>
</tr>
<tr>
<td>Shoulder Distance:</td>
</tr>
</tbody>
</table>

Physically impaired people include elderly or very young occupants within the space who require assistance for egress. The distribution of occupant profiles as stated above that have been prescribed to the population within the egress model is as follows:

<table>
<thead>
<tr>
<th>Table 14 - Egress Agent Population Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agent Profile</strong></td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Default</td>
</tr>
<tr>
<td>Impaired</td>
</tr>
</tbody>
</table>

**Egress Model Output & Results**

Given the parameters and model information defined above, the model output demonstrates that a minimum movement time of approximately 76 seconds is expected from the Audubon Center. The following Figure 11 clips a video rendering output from the egress models for each unit with indication of the time it takes all occupants to egress out of the smoke compartment.
Fire/Smoke Modeling – ASET Analysis

IBC §909.8 requires that smoke control systems which utilize the exhaust method shall be designed in accordance with NFPA 92. While NFPA 92 does include simplistic, steady-state calculations to determine smoke exhaust flow rate requirements, §5.1 allows alternative methods of analysis and design to the prescriptive algebraic equation method discussed above. One of these methods is the use of CFD based modeling software to simulate the performance and response of the smoke control system based on the specific space configuration as a means of verifying that the performance criteria as discussed in this document are met.

This approach, utilizing CFD modeling, is referred to throughout this analysis as the performance-based design (PBD) approach to the smoke control system design. The PBD approach utilizes the Fire Dynamics Simulator (FDS) modeling software developed by the National Institute of Standards and Technology (NIST). FDS is a CFD model of fire driven flow that numerically solves a form of the Navier-Stokes equations appropriate for low-speed, thermally-driven flow with an emphasis on smoke and heat transport from fires. FDS has become the standard CFD software utilized by academics, engineers, researchers to investigate and understand the development and effects of fires within three dimensional domains. The version of FDS that will be used for this analysis is Version 6.7.7 and is the most current version of the software available.

General Model Assumptions

Due to the complexity of the FDS software, there are multiple assumptions that must be made in regard to model setup and parameter input. Significant research is available regarding many aspects of these assumptions, and an in-depth analysis of each issue is provided in the following sections.

Computational Mesh Resolution

All FDS calculations must be performed within a domain that is made up of rectilinear volumes called meshes. Each mesh is divided into rectangular cells, the number of which depends on the desired
resolution of the flow dynamics. For simulations involving buoyant plumes, a measure of how well the flow field is resolved is given by the non-dimensional expression $D^*/\delta x$, where $D^*$ is a characteristic fire diameter and $\delta x$ is the nominal size of a mesh cell.

$$D^* = \left( \frac{\dot{Q}}{\rho_{\infty} c_p T_{\infty} \sqrt{g}} \right)^{2/5}$$

The U.S. Nuclear Regulatory Commission completed a comprehensive validation study of mesh resolutions and recommends utilizing $D^*/\delta x$ values ranging from 4 to 16 for areas in which combustion occurs, with values of 4 corresponding to a coarse mesh and values of 16 corresponding to a fine mesh.

In order to balance accuracy and computational performance, variable mesh sizing has been utilized so that the size of the mesh near the combustion, plume development, and interface layer regions is finer, and the mesh size is coarser throughout surrounding regions where limited smoke, combustion products, and heat transfer are taking place. This approach of increasing mesh resolution near the areas of combustion has been shown to greatly increase computation time while maintaining accurate predictions of fire behavior. This conclusion is further supported by the following references:

- From ‘Guidelines for the use of CFD simulations for fire and smoke modeling’ (Hadjisophocleous & McCatney) from the National Research Council of Canada (NRCC-47740;):
  “The results from the ‘atrium’ simulations show that high resolution modeling of the combustion volume may not be necessary for accurate prediction of the bulk plume flow at higher elevations. This can result in computational savings, although selected grid sensitivity studies should be performed to verify the model’s accuracy. As a rough guideline, mesh resolutions in the order of $10^{-1}$ m should be used for plume models. Ma and Quintiere have recently published a mesh sensitivity study applied to plume dynamics modeling [7].”

- From ‘Numerical simulation of axisymmetric fire plumes: accuracy and limitations’ (Ma & Quintiere) from the Fire Safety Journal (Volume 38, 2003):
  “Except for the first case, which the grid size of $\delta x = 4.69$ cm is not enough to capture the fire, all simulations produced a similar temperature distribution in the plume region. This shows that the thermal plume dynamics are insensitive to the grid variation.”

An analysis has been conducted to determine the most appropriate grid resolution size to utilize for this model. Multiple meshes will be defined to encapsulate the building geometry. The meshes which contain the combustion reaction, plume boundaries, and layer interfaces are specified as having a fine grid mesh with 0.1 m cell dimensions, per recommendation from NRCC-47740 (see above). In the outlying areas where the space will remain mostly clear of smoke, a coarse grid mesh of 0.2 m cell dimensions is specified. As indicated above, this configuration produces the most realistic results while still providing a simulation environment that can be run in reasonable times.

**Effects of Suppression Systems**

It is assumed that the effects and benefits of fire suppression systems will be realized within the fire model. Although it is possible to implement active water-based fire suppression systems within the FDS model, it is well understood throughout the community that this approach is not well validated and not an accurate indicator of real-world results. Furthermore, the implementation of water suppression
significantly increases model processing time. Therefore, one of the most commonly applied methods of incorporating the benefits of fire suppression systems is to modify the heat release rate curve of the fire based off of anticipated fire suppression system response. This approach utilizes a model to predict at what temperature the fire suppression system will activate. At this time, the heat release rate curve is modified to maintain a constant value for the duration of the fire. The total duration of the fire is then modified and lengthened to produce an exact total heat release as the original curve. This process is described in detail in the Handbook of Smoke Control Engineering (Klote, 2012). The following examples demonstrate how implementation of fire suppression systems will be realized within the design fire scenarios.

**Automatic Sprinkler Systems**

Sprinkler heads with user specified operating temperatures and RTIs can be included in the FDS model. A DETACT model, along with the EULER approximation method (Excel spreadsheet) has been utilized to approximate the resulting temperature of a sprinkler head located on the ceiling of the atrium in addition to FDS. The DETACT Model utilizes the following Euler approximation:

$$T_{e^t + \Delta t} = T_e^t + \left( \frac{u_g^t}{RTI} \left( T_{g^t} - T_e^t \right) \right) \times \Delta t$$

In the preceding equation the ceiling jet gas temperature ($T_{e^t}$) and the ceiling jet gas velocity ($u_g^t$) are calculated from the following formulae:

$$u_g^t = \left[ 0.95 \left( \frac{Q_f}{H} \right)^{1/3} \right] \times \left[ \frac{0.20}{(R/H)^{5/6}} \right]$$

$$T_g^t = \left[ 16.9 \left( \frac{Q_f^{2/3}}{H^{5/3}} \right) \right] \times \left[ \frac{0.32}{(R/H)^{2/3}} \right]$$

For these equations $Q_f$ is equal to the maximum heat release rate of the fire, $R$ is the maximum radial distance from the center of the plume to the nearest sprinkler head based on 15’x15’ head spacing (10.6’ (3.23 m)), and $H$ is equal to the height of the ceiling (10’ (3.048 m)). These equations have been calculated at time increments of 0.5 seconds for the duration of the fire to calculate the resulting gas temperature ($T_g$) and sprinkler element temperature ($T_e$) assuming that a sprinkler head with an activation temperature ($T_{act}$) of 135˚F (57.2˚C) and a quick response time index (RTI) equal to 144.8 $(ft.s)^{1/2}$ ($80 (m.s)^{1/2}$). This is a widely accepted method of estimating sprinkler head and heat detector activation times as detailed in the Handbook of Smoke Control Engineering (Klote, 2012).

This topic is further discussed under the various design fire scenario section of this report.

**Ambient Conditions**

Based on weather data from the 2012 ASHRAE Handbook of Smoke Control Engineering collected at a Columbus Ohio State University, the model assumes the following ambient conditions:

- Latitude: 40.07N degrees
- Longitude: 83.07W degrees
- Elevation: 928 ft
- Standard Barometric Pressure: 14.21 psi
- Winter Temp: 6.9 °F
- Summer Temp: 90.4 °F

Because makeup air is not provided for any components in the building, it is predicted that the ambient conditions of the building will have a negligible effect on the smoke development.

**Fire Scenarios**

A fire scenario includes more than just the design fire curve. The word *scenario* means an outline of events that are critical to determining the outcome of an alternative design. In addition to the heat release rate and fire location, a scenario could include the type of materials burned, airborne toxicants produced, and soot produced. As required by IBC §909.9, the design fire shall be based on a rational analysis performed by the registered design professional and approved by the fire code official. As indicated in the proceeding sections of the IBC, these design fires should consider type of fuel, fuel spacing/configuration, heat release rate assumptions based on data from approved sources, and an engineering analysis shall be provided for conditions that assume fire growth is halted at the time of sprinkler activation.

The design fire scenarios developed for this performance-based design analysis have been decided upon based on the most significant fire hazards envisioned for the building and the most damaging fuel loads that could be anticipated within these spaces. Although numerous other hazards were evaluated as part of this approach, only the design fire scenarios which present the most significant threat to the safety of life have been evaluated as part of this document. Since data regarding chemical composition, reaction product/yield, and heat release rate is not available for almost all materials, reference data from various industry approved documents is utilized to characterize heat release rate and product yield values utilized for each design scenario.

The following descriptions detail the important factors associated with each design fire. In addition, hand-calculations of sprinkler activation are compared to FDS-modeled sprinklers.

**Scenario 1**

A fire within the Multipurpose Space presents the longest time for smoke travel due to the tall ceilings. Furthermore, the sloped ceilings will result in delayed sprinkler activation, therefore the smoke temperature will be greatest in this design fire.

The most significant fuel source in the room will be chairs assembled for a presentation. Attached to the Multipurpose Space is a chair storage space, so it is inferred that these chairs are stackable/collapsible and not fixed. Ignition is assumed to occur due to a poorly-placed magnifying glass near the window on a sunny day. For the intents of this assignment, assume that the peak heat release rate is high enough that a t-squared fire ramps continuously at a fast \((0.044444 \text{ kW/s}^2)\) speed until sprinkler activation. This assumption is justified by the large openings to the exterior which provide ample oxygen for the combustion reaction to maintain. These chairs are stored in a storage closet when not in use, so denser storage scenario was considered as a Design Fire. However, ultimately it was determined that the chair being used in the multipurpose room are a more significant fire for two reasons. First, the ceiling and sprinklers are closer to the fuel in the storage closet, which will result in sooner activation. Secondly, the
storage closet has only one opening to the space, so oxygen consumption will be the limiting factor to the combustion reaction. This design fire is allowed to continue ramping, assuming that each table and chair are spaced such that the flames will spread without any delay. As such, this design fire is more conservative than a storage closet fire.

A sprinkler could be a maximum of 10.7 feet from the fuel source given the 15-foot spacing hypotenuse. The ceiling height is 20’6” at the tallest part of the ceiling. Using Alpert correlations, it is calculated that the sprinkler will activate 169 seconds after ignition. At this time, the fire will have ramped to 1273 kW. The FSD sprinkler had a slightly later activation time of 195 seconds, at which the fire HRR was approximately 1600 kW, as shown in Figure 12 and Figure 13.

![Figure 12- DF 1 Sprinkler Activation](image)
The byproduct yield ratios of this design fire are extracted from SFPE Handbook Table A.39 data for polyethylene and used as product yields produced by this design fuel source. Table 15 summarizes the model input parameters utilized to define this fuel load.

Table 15 - Design Fire 1 Fuel Composition

<table>
<thead>
<tr>
<th>Fuel Component</th>
<th>Yield</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO&lt;sub&gt;2&lt;/sub&gt; Yield</td>
<td>CO&lt;sub&gt;2&lt;/sub&gt; Generated / Spent Fuel Mass</td>
<td>0.024</td>
</tr>
<tr>
<td>CO Yield</td>
<td>CO Generated / Spent Fuel Mass</td>
<td>0.007</td>
</tr>
<tr>
<td>Soot Yield</td>
<td>Soot Generated / Spent Fuel Mass</td>
<td>0.060</td>
</tr>
</tbody>
</table>

**Scenario 2**

The most likely source of ignition would come from the catering kitchen area (12’ ceiling height). The space is not a commercial kitchen and does not appear to be equipped with a wet-chemical system because no major gas-burning appliances are installed within the space. Assume that an electric microwave malfunctions and ignites, which spreads to wooden cabinetry above the countertops. This fire scenario is noteworthy because the fuel source is closer to the ceiling, so less cold air will be entrained within smoke.

Recently, the National Fire Research Laboratory released the Fire Calorimeter Database (FCD), which provides data for different cone and furniture calorimeter fire tests. From the available tests, a Kitchen Room Fire<sup>b</sup> was reported which represents similar fuel loading and orientation to the Audubon Kitchen.

<sup>b</sup> https://www.nist.gov/el/fcd/kitchen-room-fire/kitchen-room-fire
The following Figure 14 demonstrates the test scenario provided by NIST with the HRR curve overlayed over the image.

![Figure 14- DF 2 HRR Plot from NIST](image)

This HRR data is input into FDS (and Alpert Correlation calculations) to estimate sprinkler activation times, as shown in Figure 15.

![Figure 15- DF 2 Sprinkler Activation](image)

At the time that the FDS sprinklers activate, the fire has ramped to 160 kW. The byproduct yield ratios of this design fire are extracted from a combination of the FCD and the SFPE Handbook Table A.39 data for
polyethylene and used as product yields produced by this design fuel source. Table 16 summarizes the model input parameters utilized to define this fuel load.

<table>
<thead>
<tr>
<th>Table 16 - Design Fire 2 Fuel Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 Yield = CO2 Generated / Spent Fuel Mass</td>
</tr>
<tr>
<td>CO Yield = CO Generated / Spent Fuel Mass</td>
</tr>
<tr>
<td>Soot Yield = Soot Generated / Spent Fuel Mass</td>
</tr>
</tbody>
</table>

**Scenario 3**

A fire within the lobby of the Audubon Center (12’ ceiling height) will potentially block egressing through the main lobby exits. The lobby will have furniture for occupant comfort. Assume a polyethylene and polyester filled chair is ignited due to a lithium-ion phone battery malfunction. The NIST Fire Calorimeter Database provides a detailed description of an upholstered chair mockup fire scenario (test name CO-2). Figure 16 below represents the HRR curve overlayed on a video of the chair burning.

![Figure 16- DF 3 HRR Plot from NIST](https://www.nist.gov/el/fcd/fire-barriers-full-scale-chair-mock-ups/c0-2)

This HRR data is input into FDS (and Alpert Correlation calculations) to estimate sprinkler activation times, as shown in Figure 17.
It is calculated that the sprinkler will activate 170 seconds after ignition. At this time, the fire will have ramped to 1510 kW. The byproduct yield ratios of this design fire are extracted from a combination of the FCD and the SFPE Handbook Table A.39 data for polyethylene and used as product yields produced by this design fuel source. Table 17 summarizes the model input parameters utilized to define this fuel load.

| CO2 Yield | CO2 Generated / Spent Fuel Mass | 0.024 | kg/kg |
| CO Yield  | CO Generated / Spent Fuel Mass  | 0.021 | kg/kg |
| Soot Yield| Soot Generated / Spent Fuel Mass| 0.083 | kg/kg |

Performance Evaluation

The following sections provide screenshots and documentation of the FDS and Smokeview-generated output of the fire models. Specifically, multiple screenshots showing the previously described ‘slice’ output visualizations are provided. For each design fire and each of the tenability criteria established in this document, a slice visualization is shown along a horizontal plane located 6 feet above walking surfaces. The screenshots provided have selective building geometry features turned off for a clearer view of the results (e.g. ceiling assemblies, floor slabs, exterior walls, etc.).

The proceeding sections demonstrate the capability of the passive ventilation features to maintain tenable environments along all walking given the design fire scenarios established in the previous section. For each design fire, screenshots of the visual Smokeview output are provided to document the gas temperature, carbon monoxide concentration, and visibility with respect to the tenability criteria thresholds established in earlier in this document. The tenability criteria for which the performance of the smoke control system will be evaluated for the selected design fire scenarios is as described earlier in this report and summarized below in Table 18.
Table 18 - Tenability Criteria

<table>
<thead>
<tr>
<th>Tenability Parameter</th>
<th>Tenability Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO Concentration</td>
<td>Maintain &lt; 1750 ppm CO Concentration</td>
</tr>
<tr>
<td>Gas Temperature</td>
<td>Maintain &lt; 140°F (60°C) Gas Temperatures</td>
</tr>
<tr>
<td>Visibility</td>
<td>Maintain visibility &gt; 10 m</td>
</tr>
</tbody>
</table>

**Design Fire 1**

As depicted in the following paragraphs, the building is able to maintain a tenable environment throughout all occupied spaces for the required safe egress time. Figure 18 through Figure 21 show results of the fire model.

**CO Concentration**

The following slice shows the worst-case scenario for the accumulation of CO at a point 6 ft. above finished floor as a result of Design Fire 1, which occurs at approximately 19 minutes after ignition.

As can be seen from the figure above, the carbon monoxide concentration for all areas at a height 6 feet above the floor does not come close to reaching the tenability threshold values. At this point in time, the worst-case concentration within the space is 100 ppm, which is considerably less than the threshold of 1750 ppm. Furthermore, this maximum worst-case condition occurs 19 minutes after ignition, when the entirety of the building is already evacuated.

**Gas Temperature**

The following slice shows the worst-case scenario for gas temperature within the lobby at a point 6 ft. above finished floor as a result of Design Fire 1, which also occurs at approximately 19 minutes after ignition.
As can be seen from the figure above, gas temperatures at a height 6 feet above the floor within the multipurpose room remains entirely below the tenability criteria established within this report. The only space to exceed temperatures above 60 °C is directly above the fuel source, which is expected and not considered a loss of tenability.

**Visibility**

The following slice shows the time at which the calculated reduction of visibility exceeds the tenability limit of 10 meters as a result of Design Fire 1, which occurs at approximately 3 minutes after ignition.
As can be seen from the figure above, visibility is reduced to less than 10 meters in the lobby. By approximately 5 minutes, the reduction in visibility is constant throughout the building. Further discussion of the reduced visibility is provided in the RSET vs ASET analysis of this report.

Design Fire 2
As depicted in the following paragraphs, the building is able to maintain a tenable environment throughout all occupied spaces for the required safe egress time. Figure 22 through Figure 24 show results of the fire model.

**CO Concentration**
The following slice shows the worst-case scenario for the accumulation of CO at a point 6 ft. above finished floor as a result of Design Fire 2, which occurs at approximately 18 minutes after ignition.
As can be seen from the figure above, the carbon monoxide concentration for all areas at a height 6 feet above the floor does not come close to reaching the tenability threshold values. At this point in time, the average concentration within the space is 600 ppm, which is considerably less than the threshold of 1750 ppm. Furthermore, this maximum worst-case condition occurs 18 minutes after ignition, when the entirety of the building is already evacuated.

*Gas Temperature*

The following slice shows the worst-case scenario for gas temperature within the building at a point 6 ft. above finished floor as a result of Design Fire 2, which also occurs at approximately 18 minutes after ignition.
As can be seen from the figure above, gas temperatures at a height 6 feet above the floor within the kitchen remains mostly below the tenability criteria established within this report. Temperatures outside of the kitchen remain ambient at walking level. At the southeast corner of the kitchen, the temperature reaches up to approximately 70 °C. This can be explained by the plume source and where the ceiling jet of smoke hits a wall and deflects downwards due to conservation of momentum. However, the floor area with temperatures exceeding 60 °C is very small and remote, thus tenability is considered to be maintained throughout all occupiable space.

**Visibility**

The following slice shows the time at which the calculated reduction of visibility exceeds the tenability limit of 10 meters as a result of Design Fire 2, which occurs at approximately 10 minutes after ignition.
As can be seen from the figure above, visibility exceeds 10 meters in the southeast corner of the lobby. At this point in time, the average visibility within the remainder of the building is unaffected by smoke. Note that the kitchen loses visibility earlier, at approximately 4 minutes after ignition. However, egress through the kitchen is not required, therefore it is assumed that the low kitchen visibility will not negatively affect the ASET of the building.

**Design Fire 3**
As depicted in the following paragraphs, the building is able to maintain a tenable environment throughout all occupied spaces for the required safe egress time. Figure 25 through Figure 28 show results of the fire modeling.

**CO Concentration**
The following slice shows the worst-case scenario for the accumulation of CO at a point 6 ft. above finished floor as a result of Design Fire 3, which occurs at approximately 14 minutes after ignition.
As can be seen from the figure above, the carbon monoxide concentration for all areas at a height 6 feet above the floor does not come close to reaching the tenability threshold values. At this point in time, the worst-case concentration within the space is 200 ppm, which is considerably less than the threshold of 1750 ppm. Furthermore, this maximum worst-case condition occurs 14 minutes after ignition, when the entirety of the building is already evacuated.

**Gas Temperature**
The following slice shows the worst-case scenario for gas temperature within the lobby at a point 6 ft. above finished floor as a result of Design Fire 3, which also occurs at approximately 14 minutes after ignition.

As can be seen from the figure above, gas temperatures at a height 6 feet above the floor within the lobby remains entirely below the tenability criteria established within this report. The only space to exceed temperatures above 60 °C is directly above the fuel source, which is expected and not considered a loss of tenability.
Visibility

The following slice shows the time at which the calculated reduction of visibility exceeds the tenability limit of 10 meters as a result of Design Fire 3, which occurs at approximately 2.5 minutes after ignition.

![Figure 27 - Design Fire 3 Visibility Slice – 2.5 minutes](image1)

![Figure 28 - Design Fire 3 Visibility Slice – 5 minutes](image2)

As can be seen from the figure above, visibility is reduced to less than 10 meters in the lobby. By approximately 5 minutes, the reduction in visibility is constant throughout the building. Further discussion of the reduced visibility is provided in the RSET vs ASET analysis of this report.

RSET vs ASET

As indicated above, the total calculated RSET time is the period of time that encompasses the initiation of ignition until the last occupant safely evacuates the space. Broken down into component phases, this includes detection/alarm time, premovement time, movement time, and some margin of safety. In accordance with the requirements of IBC, §909.4.6, a margin of safety is incorporated by multiplying the calculated egress time by a factor of 1.5. Utilization of the time values determined in this section, the total RSET for the facility is as follows:
\[ \text{RSET} = (\text{Detection Time} + \text{Premovement Time} + \text{Movement Time}) \times 1.5 \]

The detection times, premovement times, and movement times of each design fire are tabulated below in Table 19. Detection time and movement time varies between design fires due to ceiling height and sprinkler location, and availability of exits.

\[
\begin{array}{|c|c|c|}
\hline
\text{RSET} & \text{DF1} & \text{DF2} & \text{DF3} \\
\hline
\text{Detection (sec)} & 193 & 260 & 172 \\
\hline
\text{Premovement (sec)} & 30 & 30 & 30 \\
\hline
\text{Movement (sec)} & 75.8 & 75.8 & 108.8^a \\
\hline
\text{Total (x1.5 SF)} & 7.5 mins & 9.1 mins & 7.8 mins \\
\hline
\end{array}
\]

\[ a. \text{ DF3 has a longer movement time due to the anticipated loss of an exit in the main lobby, which leads to more significant queuing at other exits.} \]

In order for the building to succeed in the RSET vs ASET comparison, tenability must be maintained in the building for the egress durations listed above. For the three design fire scenarios modeled in analysis, temperature and carbon monoxide levels are found to remain tenable for all occupants for a period of at least 20 minutes – more than double the required egress time. In evaluation of the fire modeling results, the only tenability criteria found to exceed the thresholds established in this report is visibility. However, given that low visibility will not cause bodily harm to the occupants, and upon ignition the occupants are expected to immediately move towards the exit, the loss of visibility is not considered to be exceedingly dangerous.

Design Fire 3 is the only circumstance where visibility reaches a level where occupant safety might be compromised. As shown in the table and figures above, visibility in the lobby is below 10 meters after approximately 2.5 minutes. Five minutes after ignition, the FDS model estimates that visibility will be approximately three meters – far below the ten-meter target. Fortunately, the building egressing system is well designed, such that every assembly space within the building is provided an exit directly to the exterior, without requiring occupants to intervene through the lobby space. This is especially valuable in DF3, where travel through the main lobby is untenable. All assembly occupants who are unfamiliar with the space have direct access to the exterior. Some business occupants will be required to travel through the smoke-filled corridors to exit their offices. However, it is assumed that the business occupants are familiar with the building and will not experience wayfaring issues. These business occupants can use the exit at the end of the corridor and avoid the lobby space entirely. Furthermore, the egress model is exceedingly conservative by predicting that the building requires 7.8 minutes to egress. In a circumstance where smoke is very visible, occupant evacuation is expected to occur immediately. The three-minute Detection Time is not accurate in a worst-case fire scenario where visibility falls below 10 minutes before the fire alarm system activates.

Given that occupants who encounter a fire similar to what is predicted in Design Fire 3 will have immediate exterior exit availability, and they are anticipated to be able to exit in far less time than the RSET model calculates, the provided building design can adequately support the lobby arrangement and potential fire scenarios that occur in that space.
In all models for this project, there is no scenario when occupants who are not intimate with the fire are exposed to untenable conditions. As such, the building geometry provides an inherent level of safety for the occupants to be able to exit the building before experiencing harmful fire exposure.

Conclusion

The preceding analysis documents all fire protection and life safety features provided for the Grange Insurance Audubon Center in Columbus, Ohio. The building is designed to meet all requirements of the 2015 Ohio Building Code. Egress from the building is found to be fully compliant with the exception of one dead-end corridor which exceeds the allowable limit. As such, an additional door to the exterior is recommended. A manual fire alarm designed in accordance with NFPA 72 is installed to provide visual and audible occupant notification upon water flow switch or manual pull station initiation. A sprinkler system designed in accordance with NFPA 13 is installed to provide control or suppression of a fire. Most of the building is designed for a light-hazard, and a fire pump is not required.

In addition to meeting prescriptive requirements of the local codes and standards, a performance based in maintaining a tenable environment for egress from these controlled areas. This analysis validates that the building design is capable of maintaining a tenable environment at least 6 ft above all occupied walking surfaces in required means of egress for a period equal to 1.5 times the calculated egress time. Three design fires (a multipurpose room chair fire, a kitchen fire, and a lobby furniture fire) are quantified with heat release rate curves and combustion byproduct yields. Computational Fluid Dynamics and Agent-Based Egress modeling of the design fires provide appropriate smoke control system design for the specific building geometry, and more precise evacuation times are developed. Through modeling, it is determined that all occupants will exit the building within 10 minutes after ignition; meanwhile, the fire is estimated to not impact building tenability until after 20 minutes, giving at least a 10-minute buffer after occupants have fully exited. This analysis documents the modeling efforts, summarizes the output data, and demonstrates that a tenable environment is provided within the building for a time period equal greater than the calculated required egress time for all occupants to safely exit building in the fire scenarios envisioned.
Appendix 1: Life Safety Egress Drawings
632 occupants total -> 3 exits required
0.2 in/occ -> 127" of exit width required
8 exits provided with 320"

Egress Component Limits
Travel Distance = 250'
Common Path of Travel 75'
Dead-End Corridor = 20'

Unconcentrated Tables and Chairs
8,551 sf @ 15 net sf/occ
570 occupants

Business Areas
9155 sf @ 150 gross sf/occ
62 occupants

1. TRASH: To be handled as described in the trash room. The trash room should be located in a convenient location and be well ventilated to prevent odor. It should be equipped with a lock for security purposes.
2. ANIMAL CARE ROOM: Must have adequate ventilation and be equipped with a sink and running water.
3. WORK ROOM: Needs to be equipped with counters, storage, and tools.
4. COMMUNITY ACTION CENTER DIRECTOR: Should have a private office with a locking door.
5. CENTER DIRECTOR:也需要一个私人办公室.
6. MKTG. & DEVELOP.: Needs a large conference room.
7. EDUC DIRECTOR: Needs a private office with a locking door.
8. OFFICE MAINT.: Needs a private office with a locking door.
9. EXHIBIT STORAGE: Needs a large room with shelves and locks.
10. RECEIVING/STORAGE: Needs a large room with shelves and locks.
11. VIEWING AREA: Needs a large room with viewing equipment.
12. CATERING KITCHEN: Needs a large kitchen with cooking equipment.
13. AV/ TECH.: Needs a large room with AV equipment.
14. SERVER/SECURITY: Needs a large room with security equipment.
15. VOLUNTEER OFFICE/BREAKOUT/Locker: Needs a large room with storage.
16. VOLUNTEER SUITE STORAGE: Needs a large room with storage.
17. JAN. CLOSET: Needs a small room for cleaning supplies.
18. MECHANICAL: Needs a large room with mechanical equipment.
19. CORR.: Needs a large room with cells.
20. CORR.: Needs a large room with cells.
21. CORR.: Needs a large room with cells.
22. CORR.: Needs a large room with cells.
23. CORR.: Needs a large room with cells.
24. CORR.: Needs a large room with cells.
25. CORR.: Needs a large room with cells.
26. CORR.: Needs a large room with cells.
27. CORR.: Needs a large room with cells.
28. CORR.: Needs a large room with cells.
29. CORR.: Needs a large room with cells.
30. CORR.: Needs a large room with cells.
31. CORR.: Needs a large room with cells.
32. VOLUNTEER OFFICE/BREAKOUT/Locker: Needs a large room with storage.
33. MECHANICAL: Needs a large room with mechanical equipment.
34. CORR.: Needs a large room with cells.
35. CORR.: Needs a large room with cells.
36. CORR.: Needs a large room with cells.
37. CORR.: Needs a large room with cells.
38. VOLUNTEER OFFICE/BREAKOUT/Locker: Needs a large room with storage.
39. MECHANICAL: Needs a large room with mechanical equipment.
40. CORR.: Needs a large room with cells.
41. CORR.: Needs a large room with cells.
42. CORR.: Needs a large room with cells.
43. CORR.: Needs a large room with cells.
44. VOLUNTEER OFFICE/BREAKOUT/Locker: Needs a large room with storage.
45. MECHANICAL: Needs a large room with mechanical equipment.
46. CORR.: Needs a large room with cells.
47. CORR.: Needs a large room with cells.
48. CORR.: Needs a large room with cells.
Appendix 2: Fire Alarm Layout
Appendix 3: Fire Alarm Voltage Calculations
## Voltage Drop Calculations

**POWER SOURCE**: 12 amp  
**MODEL NUMBER**: HPFF12  
**BRAND**: HPP  
**CLASS B**: 20.4 VOLTS  
**DC POWER**

**CIRCUIT**: NAC Circuit 1  
3 Amps  
14 AWG  
7 DEVICES  
40.3 % (1.209) AMPS USED  
6.83 % (1.393) VOLTAGE DROP

<table>
<thead>
<tr>
<th>#</th>
<th>MODEL</th>
<th>CANDELA</th>
<th>PATTERN</th>
<th>VOLUME</th>
<th>TONE</th>
<th>CURRENT (amps)</th>
<th>DISTANCE FROM PREVIOUS DEVICE (Ft)</th>
<th>12 AWG</th>
<th>14 AWG</th>
<th>16 AWG</th>
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<td>High</td>
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**Voltage Drop**: 0.877  
1.393  
2.221  
3.531

**POWER SOURCE**: 12 amp  
**MODEL NUMBER**: HPFF12  
**BRAND**: HPP  
**CLASS B**: 20.4 VOLTS  
**DC POWER**

**CIRCUIT**: NAC Circuit 2  
3 Amps  
14 AWG  
7 DEVICES  
33.5 % (1.005) AMPS USED  
3.02 % (0.617) VOLTAGE DROP

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**Voltage Drop**: 0.389  
0.617  
0.983  
1.562
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Voltage Drop: 0.777 1.234 1.965 3.129

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<th>12 AWG</th>
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Voltage Drop: 0.330 0.523 0.833 1.325
Indoor Selectable-Output Low Frequency Sounders and Low Frequency Sounder Strobes

System Sensor L-Series audible visible notification products are rich with features guaranteed to maximize profits with lower current draw and modern aesthetics.

Features

• 520 Hz ± 10% square wave tone, NFPA compliance
• Full candela range plus High/Low tone options to optimize current draw for a wide variety of applications
• Compact, standard, and round ceiling options
• Field-selectable candela settings. Wall units: 15, 30, 75, 95, 110, 135, and 185. Ceiling units: 15, 30, 75, 95, 115, 150, and 177
• Rotary switch for High/Low, Temp3, Temp4, and Continuous settings. Sounder-only models also offer a Coded setting.
• Plug-in design with minimal intrusion into the back box
• Mounting plate shorting spring checks wiring continuity before device installation
• Electrically compatible with legacy SpectrAlert and SpectrAlert Advance devices (Direct replacement for HW/R-LF and P2R/WH-LF)
• Compatible with MDL3 sync module
• Sounders listed for ceiling and wall
• Round Sounder Strobes listed for ceiling and wall
• Updated modern aesthetics

The L-Series offers the most versatile and easy-to-use line of low frequency sounder and low frequency sounder strobes in the industry. With white and red plastic housings, listed for wall and ceiling mounting, L-Series Low Frequency can meet virtually any application requirement.

The low frequency sounder and low frequency sounder strobes were designed to address the NFPA 72 sleeping space requirements that require a low frequency notification appliance that operates within frequency range of 520 Hz ± 10% and is of a square wave tone. Like the entire L-Series product line they include a variety of features that increase their application versatility while simplifying installation. All devices feature plug-in designs with minimal intrusion into the back box, making installations fast and foolproof while virtually eliminating costly and time-consuming ground faults.

To further simplify installation and protect devices from construction damage, L-Series uses 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, 24-volt operation, and a rotary switch for 520 Hz low frequency sounder tones.

Agency Listings

UL Listed
FM Approved

System Sensor

Indoor Selectable-Output Low Frequency Sounders and Low Frequency Sounder Strobes
L-Series Specifications

Architect/Engineer Specifications

General
L-Series low frequency sounder and low frequency sounder strobes shall mount to a standard 4 x 4 x 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 x 4 x 1½-inch back box. A universal mounting plate shall be used for mounting products. The notification appliance circuit wiring shall terminate at the universal mounting plate. Also, L-Series products, when used with the Sync•Circuit™ Module accessory, shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts. When used with the Sync•Circuit Module, 24-volt-rated notification appliance circuit outputs shall operate between 16.5 and 33 volts. Indoor L-Series products shall operate between 32 and 120 degrees Fahrenheit (0°C to 49°C) from a regulated DC or full-wave rectified unfiltered power supply. Low Frequency Sounder strobes shall have field-selectable candela settings. Wall units: 15, 30, 75, 95, 110, 135, and 185. Ceiling units: 15, 30, 75, 95, 115, 150, and 177. The field selectable tones will sound within the frequency range of 520 Hz ±10% square wave tone and have a permanent marking on the housing that reads “520 Hz”.

Low Frequency Sounder
The low frequency sounder shall be a System Sensor L-Series Model _______ listed to UL 464 and shall be approved for fire protective service. The low frequency sounder and the Sync•Circuit™ MDL3 Module accessory, if used, shall be powered from a notification appliance circuit output and shall operate on a nominal 24 volts (includes fire alarm panels with built-in sync). When used with the Sync•Circuit Module MDL3, 24-volt rated notification appliance circuit outputs shall operate between 16.5 to 33 volts. If the notification appliances are not UL 9th edition listed with the corresponding panel or power supply being used, then refer to the compatibility listing of the panel to determine maximum devices on a circuit. The low frequency sounder has an option to switch between temporal three or temporal four pattern, non-temporal (continuous) pattern and coded supply within the frequency range of 520 Hz ±10% square wave tone. The low frequency sounder shall operate on a coded or non-coded power supply with high and low volume settings.

Low Frequency Sounder Strobe Combination
The low frequency sounder strobe shall be a System Sensor L-Series Model _______ listed to UL 1971 and UL 464 and shall be approved for fire protective service. The low frequency sounder strobe models shall operate on a non-coded power supply with high and low volume settings. The field selectable tones will sound within the frequency range of 520 Hz ±10% square wave tone.

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 low frequency sounder at temporal three. Also, while operating the strobes, the module shall silence the low frequency sounder on low frequency sounder strobe models over a single pair of wires. The module shall mount to a 41⅛ x 4⅞ x 2⅝-inch back box. The module shall also control two Class B circuits or one 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

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<th>Unit of Measurement</th>
<th>Value</th>
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<tr>
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<td>°F to °C</td>
<td>32°F to 120°F</td>
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<tr>
<td>Humidity Range</td>
<td></td>
<td>10 to 93% non-condensing</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>Hz ±%</td>
<td>520 Hz ± 10%</td>
</tr>
<tr>
<td>Strobe Flash Rate</td>
<td>Flash/second</td>
<td>1 flash per second</td>
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<tr>
<td>Nominal Voltage Low Frequency Sounder</td>
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<td>Regulated 24 DC/FWR¹</td>
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<td>Nominal Voltage Range Low Frequency Sounder Strobe</td>
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<td>Regulated 24 VDC/FWR¹</td>
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<tr>
<td>Operating Voltage Range</td>
<td>Volt</td>
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<td>Operating Voltage Range MDL3 Sync Module</td>
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<td>Input Terminal Wire Gauge</td>
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Dimensions

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<td>L × W × D</td>
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<td>Ceiling Sounder Strobe (including lens)</td>
<td>diameter × height</td>
<td>6.8&quot; diameter x 2.47&quot; high (173mm diameter x 62.7 mm D)</td>
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<td>Standard Wall Sounder</td>
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<td>5.6&quot; × 4.7&quot; × 1.5&quot; (142 mm L x 119 mm W x 38 mm D)</td>
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<td>Compact Wall Sounder</td>
<td>L × W × D</td>
<td>5.25&quot; L × 3.46&quot; W × 1.5&quot; D (133mm L x 88mm W x 38mm D)</td>
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<td>Ceiling Sounder</td>
<td>diameter × height</td>
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<tr>
<td>Standard Wall Sounder with SBBRL/SBBWL Surface Mount Back Box</td>
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<td>5.70&quot; L × 4.8&quot; W × 3.3&quot; D (145 mm L x 120 mm W x 87 mm D)</td>
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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.
### UL Current Draw and Sound Output Data

#### Low Frequency Sounder Strobe Current Draw (mA) and Sound Output (dBA)

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<td>98</td>
</tr>
<tr>
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<td>120</td>
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</table>

#### UL Max. Low Frequency Sounder Current Draw (mA RMS)

<table>
<thead>
<tr>
<th>Wall and Ceiling Sounder</th>
<th>Volume Setting</th>
<th>Current Draw (mA)</th>
<th>Sound Output (dBA) Reverberant</th>
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<tbody>
<tr>
<td></td>
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<td>16–33 Volts</td>
<td>16–33 Volts</td>
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<tr>
<td>Pos</td>
<td>Tone</td>
<td>Volume Setting</td>
<td>DC</td>
</tr>
<tr>
<td>-----</td>
<td>------</td>
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</tr>
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<td>1</td>
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<td>5</td>
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<td>6</td>
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<td>Low</td>
<td>80</td>
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<tr>
<td>7</td>
<td>Coded</td>
<td>High</td>
<td>111</td>
</tr>
<tr>
<td>8</td>
<td>Coded</td>
<td>Low</td>
<td>80</td>
</tr>
</tbody>
</table>

*NOTE: For coded tones, temporal coding must be provided by the NAC. If the NAC voltage is held constant, the sounder output will remain constantly on. Coded ratings provided are for continuous voltage.*
## L-Series Dimensions

### Part No. Description

<table>
<thead>
<tr>
<th>Red</th>
<th>White</th>
</tr>
</thead>
</table>

#### Low Frequency Sounder Strobes

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2RL-LF</td>
<td>P2WL-LF</td>
</tr>
<tr>
<td>PC2RL-LF</td>
<td>PC2WL-LF</td>
</tr>
<tr>
<td></td>
<td>LF Sounder Strobe, Wall</td>
</tr>
<tr>
<td></td>
<td>LF Sounder Strobe, Ceiling</td>
</tr>
</tbody>
</table>

#### Low Frequency Sounders

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRL-LF</td>
<td>HWL-LF</td>
</tr>
<tr>
<td>HGRL-LF</td>
<td>HGWL-LF</td>
</tr>
<tr>
<td>HCRL-LF</td>
<td>HCWL-LF</td>
</tr>
<tr>
<td></td>
<td>LF Sounder, Wall</td>
</tr>
<tr>
<td></td>
<td>Compact LF Sounder, Wall</td>
</tr>
<tr>
<td></td>
<td>LF Sounder, Ceiling</td>
</tr>
</tbody>
</table>

#### Accessories

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>MDL3R</td>
<td>MDL3W</td>
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<tr>
<td>SBBRL</td>
<td>SBBWL</td>
</tr>
<tr>
<td>SBBCRL</td>
<td>SBBCWL</td>
</tr>
<tr>
<td>SBBGRL</td>
<td>SBBGWL</td>
</tr>
<tr>
<td></td>
<td>Sync•Circuit™ Module, UL-listed</td>
</tr>
<tr>
<td></td>
<td>Surface Mount Back Box, Wall</td>
</tr>
<tr>
<td></td>
<td>Surface Mount Back Box, Ceiling</td>
</tr>
<tr>
<td></td>
<td>Surface Mount Back Box, Wall, Compact</td>
</tr>
</tbody>
</table>

System Sensor® is a registered trademark and Sync•Circuit™ is a trademark of Honeywell International, Inc.
Indoor Selectable-Output Horns, Strobes, and Horn Strobes for Wall Applications

System Sensor L-Series audible visible notification products are rich with features guaranteed to cut installation times and maximize profits with lower current draw and modern aesthetics.

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

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

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

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

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

**Architect/Engineer Specifications**

**General**
L-Series standard horns, strobes, and horn strobes shall mount to a standard 2 x 4 x 1⅛-inch back box, 4 x 4 x 1½-inch back box, 4-inch octagon back box, or double-gang back box. L-Series compact products shall mount to a single-gang 2 x 4 x 1⅛-inch back box. A universal mounting plate shall be used for mounting ceiling and wall products for all standard models and a separate universal mounting plate shall be used for mounting wall compact models. The notification appliance circuit wiring shall terminate at the universal mounting plate. Also, L-Series products, when used with the Sync•Circuit™ Module accessory, shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 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 L-Series 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, 30, 75, 95, 110, 135, and 185.

**Strobe**
The strobe shall be a System Sensor L-Series Model _______ listed to UL 1971 and shall be approved for fire protective service. The strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1 Hz over the strobe’s entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflecter system.

**Horn Strobe Combination**
The horn strobe shall be a System Sensor L-Series Model _______ listed to UL 1971 and UL 464 and shall be approved for fire protective service. The horn strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1 Hz over the strobe’s entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflecter system. The horn shall have two audibility options and an option to switch between a temporal three pattern and a non-temporal (continuous) pattern. These options are set by a multiple position switch. The horn on horn strobe models shall operate on a coded or non-coded power supply.

**Synchronization Module**
The module shall be a System Sensor Sync•Circuit model MDL3 listed to UL 464 and shall be approved for fire protective service. The module shall synchronize 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 4⅞ x 4⅞ x 2⅝-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 or regulated 24 DC/FWR¹

**Operating Voltage Range²**
8 to 17.5 V (12 V nominal) or 16 to 33 V (24 V nominal)

**Operating Voltage Range MDL3 Sync Module**
8.5 to 17.5 V (12 V nominal) or 16.5 to 33 V (24 V nominal)

**Input Terminal Wire Gauge**
12 to 18 AWG

**Wall-Mount Dimensions (including lens)**
5.6” L x 4.7” W x 1.91” D (143 mm L x 119 mm W x 49 mm D)

**Compact Wall-Mount Dimensions (including lens)**
5.26” L x 3.46” W x 1.91” D (133 mm L x 88 mm W x 49 mm D)

**Horn Dimensions**
5.6” L x 4.7” W x 1.25” D (143 mm L x 119 mm W x 32 mm D)

**Compact Horn Dimensions**
5.25” L x 3.45” W x 1.25” D (133 mm L x 88 mm W x 32 mm D)

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. Strobe products will operate at 12 V nominal only for 15 cd and 30 cd.
### UL Current Draw Data

#### UL Max. Strobe Current Draw (mA RMS)

<table>
<thead>
<tr>
<th>Horn and Horn Strobe Output (dBA)</th>
<th>Sound Pattern</th>
<th>dB</th>
<th>8–17.5 Volts</th>
<th>16–33 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch Position</td>
<td></td>
<td></td>
<td>DC</td>
<td>DC</td>
</tr>
<tr>
<td>1</td>
<td>Temporal</td>
<td>84</td>
<td>89</td>
<td>89</td>
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<tr>
<td>2</td>
<td>Temporal</td>
<td>75</td>
<td>83</td>
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<td>3</td>
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<td>4</td>
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<td>5</td>
<td>3.1 KHz Temporal</td>
<td>83</td>
<td>88</td>
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<td>76</td>
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<td>7</td>
<td>3.1 KHz Non-Temporal</td>
<td>84</td>
<td>89</td>
<td>89</td>
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<tr>
<td>8</td>
<td>3.1 KHz Non-Temporal</td>
<td>77</td>
<td>83</td>
<td>83</td>
</tr>
<tr>
<td>9</td>
<td>Coded</td>
<td>85</td>
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<td>10</td>
<td>3.1 KHz Coded</td>
<td>84</td>
<td>89</td>
<td>89</td>
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</tbody>
</table>

* Settings 9 and 10 are not available on 2-wire horn strobes. Temporal coding must be provided by the NAC. If the NAC voltage is held constant, the horn output remains constantly on.

### UL Max. Horn Current Draw (mA RMS)

<table>
<thead>
<tr>
<th>Sound Pattern</th>
<th>8–17.5 Volts</th>
<th>16–33 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DC</td>
<td>DC</td>
</tr>
<tr>
<td>Temporal</td>
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<tr>
<td>Temporal</td>
<td>28</td>
<td>32</td>
</tr>
<tr>
<td>Non-Temporal</td>
<td>43</td>
<td>47</td>
</tr>
<tr>
<td>Non-Temporal</td>
<td>29</td>
<td>32</td>
</tr>
<tr>
<td>3.1 KHz Temporal</td>
<td>39</td>
<td>41</td>
</tr>
<tr>
<td>3.1 KHz Temporal</td>
<td>29</td>
<td>32</td>
</tr>
<tr>
<td>3.1 KHz Non-Temporal</td>
<td>42</td>
<td>43</td>
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<tr>
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<td>43</td>
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<tr>
<td>3.1 KHz Coded</td>
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### UL Max. Current Draw (mA RMS), Wall Horn Strobe, Candela Range (15–185 cd)

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<th>Candela Range</th>
<th>8–17.5 Volts</th>
<th>16–33 Volts</th>
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<tr>
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<tr>
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<td>154</td>
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<tr>
<td>Non-Temporal</td>
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<td>166</td>
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<tr>
<td>Non-Temporal</td>
<td>93</td>
<td>156</td>
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<tr>
<td>3.1 KHz Temporal</td>
<td>93</td>
<td>156</td>
</tr>
<tr>
<td>3.1 KHz Temporal</td>
<td>91</td>
<td>154</td>
</tr>
<tr>
<td>3.1 KHz Non-Temporal</td>
<td>99</td>
<td>162</td>
</tr>
<tr>
<td>3.1 KHz Non-Temporal</td>
<td>93</td>
<td>156</td>
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<td>FWR Input</td>
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<td>Temporal</td>
<td>68</td>
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<td>Non-Temporal</td>
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<td>Non-Temporal</td>
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<td>3.1 KHz Temporal</td>
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<td>105</td>
</tr>
<tr>
<td>3.1 KHz Temporal</td>
<td>68</td>
<td>90</td>
</tr>
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<td>3.1 KHz Non-Temporal</td>
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<td>3.1 KHz Non-Temporal</td>
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<td>102</td>
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### Horn Tones and Sound Output Data

#### Sound Pattern

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<th>Sound Pattern</th>
<th>dB</th>
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<tr>
<td>1</td>
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<td>84</td>
</tr>
<tr>
<td>2</td>
<td>Temporal</td>
<td>75</td>
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<tr>
<td>3</td>
<td>Non-Temporal</td>
<td>85</td>
</tr>
<tr>
<td>4</td>
<td>Non-Temporal</td>
<td>76</td>
</tr>
<tr>
<td>5</td>
<td>3.1 KHz Temporal</td>
<td>83</td>
</tr>
<tr>
<td>6</td>
<td>3.1 KHz Temporal</td>
<td>76</td>
</tr>
<tr>
<td>7</td>
<td>3.1 KHz Non-Temporal</td>
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<td>8</td>
<td>3.1 KHz Non-Temporal</td>
<td>77</td>
</tr>
<tr>
<td>9</td>
<td>Coded</td>
<td>85</td>
</tr>
<tr>
<td>10</td>
<td>3.1 KHz Coded</td>
<td>84</td>
</tr>
</tbody>
</table>
**L-Series Dimensions**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2RL</td>
<td>2-Wire, Horn Strobe, Red</td>
</tr>
<tr>
<td>P2WL</td>
<td>2-Wire, Horn Strobe, White</td>
</tr>
<tr>
<td>P2GRL</td>
<td>2-Wire, Compact Horn Strobe, Red</td>
</tr>
<tr>
<td>P2GWLL</td>
<td>2-Wire, Compact 2 fils act Horn Strobe, White</td>
</tr>
<tr>
<td>P2RL-P</td>
<td>2-Wire, Horn Strobe, Red, Plain</td>
</tr>
<tr>
<td>P2WL-P</td>
<td>2-Wire, Horn Strobe, White, Plain</td>
</tr>
<tr>
<td>P2RL-SP</td>
<td>2-Wire, Horn Strobe, Red, FUEGO</td>
</tr>
<tr>
<td>P2WL-SP</td>
<td>2-Wire, Horn Strobe, White, FUEGO</td>
</tr>
<tr>
<td>P4RL</td>
<td>4-Wire, Horn Strobe, Red</td>
</tr>
<tr>
<td>P4WL</td>
<td>4-Wire, Horn Strobe, White</td>
</tr>
<tr>
<td>SRL</td>
<td>Strobe, Red</td>
</tr>
<tr>
<td>SWL</td>
<td>Strobe, White</td>
</tr>
<tr>
<td>SGRL</td>
<td>Compact Strobe, Red</td>
</tr>
<tr>
<td>SGWL</td>
<td>Compact Strobe, White</td>
</tr>
<tr>
<td>SRL-P</td>
<td>Strobe, Red, Plain</td>
</tr>
<tr>
<td>SWL-P</td>
<td>Strobe, White, Plain</td>
</tr>
<tr>
<td>SRL-SP</td>
<td>Strobe, Red, FUEGO</td>
</tr>
<tr>
<td>SWL-CLR-ALERT</td>
<td>Strobe, White, ALERT</td>
</tr>
</tbody>
</table>

**L-Series Ordering Information**

<table>
<thead>
<tr>
<th>Description</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horn Strobes</td>
<td></td>
</tr>
<tr>
<td>2-Wire, Horn Strobe, Red</td>
<td>P2RL</td>
</tr>
<tr>
<td>2-Wire, Horn Strobe, White</td>
<td>P2WL</td>
</tr>
<tr>
<td>2-Wire, Compact Horn Strobe, Red</td>
<td>P2GRL</td>
</tr>
<tr>
<td>2-Wire, Compact 2 fils act Horn Strobe, White</td>
<td>P2GWLL</td>
</tr>
<tr>
<td>2-Wire, Horn Strobe, Red, Plain</td>
<td>P2RL-P</td>
</tr>
<tr>
<td>2-Wire, Horn Strobe, White, Plain</td>
<td>P2WL-P</td>
</tr>
<tr>
<td>2-Wire, Horn Strobe, Red, FUEGO</td>
<td>P2RL-SP</td>
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<tr>
<td>2-Wire, Horn Strobe, White, FUEGO</td>
<td>P2WL-SP</td>
</tr>
<tr>
<td>4-Wire, Horn Strobe, Red</td>
<td>P4RL</td>
</tr>
<tr>
<td>4-Wire, Horn Strobe, White</td>
<td>P4WL</td>
</tr>
<tr>
<td>Strobe, Red</td>
<td>SRL</td>
</tr>
<tr>
<td>Strobe, White</td>
<td>SWL</td>
</tr>
<tr>
<td>Compact Strobe, Red</td>
<td>SGRL</td>
</tr>
<tr>
<td>Compact Strobe, White</td>
<td>SGWL</td>
</tr>
<tr>
<td>Strobe, Red, Plain</td>
<td>SRL-P</td>
</tr>
<tr>
<td>Strobe, White, Plain</td>
<td>SWL-P</td>
</tr>
<tr>
<td>Strobe, Red, FUEGO</td>
<td>SRL-SP</td>
</tr>
<tr>
<td>Strobe, White, ALERT</td>
<td>SWL-CLR-ALERT</td>
</tr>
</tbody>
</table>

**Horns**
- HRL*: Horn, Red
- HWL*: Horn, White
- HGRL*: Compact Horn, Red
- HGWL*: Compact Horn, White

**Accessories**
- TR-2: Universal Wall Trim Ring Red
- TR-2W: Universal Wall Trim Ring White
- SBBRL: Wall Surface Mount Back Box, Red
- SBBWL: Wall Surface Mount Back Box, White
- SBBGRL: Compact Wall Surface Mount Back Box, Red
- SBBGWL: Compact Wall 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.
- All -ALERT models have “ALERT” marking on cover.
- *Horn-only models are listed for wall or ceiling use.
Indoor Selectable-Output Strobes and Horn Strobes for Ceiling Applications

System Sensor L-Series audible visible notification products are rich with features guaranteed to cut installation times and maximize profits with lower current draw and modern aesthetics.

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 30 candela
- Field-selectable candela settings on ceiling units: 15, 30, 75, 95, 115, 150, and 177
- Horn rated at 88+ dBA at 16 volts
- Rotary switch for horn tone and two volume selections
- Universal mounting plate for ceiling units
- Mounting plate shorting spring feature checks wiring continuity before device installation
- Electrically Compatible with legacy SpectrAlert and SpectrAlert Advance devices
- Compatible with MDL3 sync module
- Listed for ceiling mounting only

The System Sensor L-Series offers the most versatile and easy-to-use line of horns, strobes, and horn strobes in the industry with lower current draws and modern aesthetics. With white and red plastic housings, wall and ceiling mounting options, System Sensor L-Series can meet virtually any application requirement.

The entire L-Series product line of ceiling-mount strobes and horn strobes include a variety of features that increase their application versatility while simplifying installation. All devices feature a plug-in design 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, the L-Series utilizes a universal mounting plate so installers can mount them to a wide array of back boxes. With an onboard shorting spring, 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 two volume selections.

Agency Listings

[S5512 54011] FM approved except for ALERT models 35071863
7125-1858-0504 7125-1853-0503
L-Series Specifications

Architect/Engineer Specifications

General
L-Series ceiling-mount 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, L-Series products, when used with the Sync•Circuit™ Module accessory, shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 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 L-Series products shall operate between 32 and 120 degrees Fahrenheit from a regulated DC or full-wave rectified unfiltered power supply. Ceiling strobes and horn strobes shall have field-selectable candela settings including 15, 30, 75, 95, 115, 150, and 177.

Strobe
The strobe shall be a System Sensor L-Series Model ______ listed to UL 1971 and shall be approved for fire protective service. The strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1 Hz over the strobe’s entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflector system.

Horn Strobe Combination
The horn strobe shall be a System Sensor L-Series Model ______ listed to UL 1971 and UL 464 and shall be approved for fire protective service. The horn strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1 Hz over the strobe’s entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. The horn shall have two audibility options and an option to switch between a temporal three pattern and a non-temporal (continuous) pattern. These options are set by a multiple position switch. The horn on horn strobe models shall operate on a coded or non-coded power supply.

Synchronization Module
The module shall be a System Sensor Sync•Circuit model MDL3 listed to UL 464 and shall be approved for fire protective service. The module shall synchronize L-Series 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 4 11/16 × 4 11/16 × 2 1/8-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

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Operating Temperature</td>
<td>32°F to 120°F (0°C to 49°C)</td>
</tr>
<tr>
<td>Humidity Range</td>
<td>10 to 93% non-condensing</td>
</tr>
<tr>
<td>Strobe Flash Rate</td>
<td>1 flash per second</td>
</tr>
<tr>
<td>Nominal Voltage</td>
<td>Regulated 12 VDC or regulated 24 DC/FWR</td>
</tr>
<tr>
<td>Operating Voltage Range&lt;sup&gt;1&lt;/sup&gt;</td>
<td>8 to 17.5 V (12 V nominal) or 16 to 33 V (24 V nominal)</td>
</tr>
<tr>
<td>Operating Voltage Range (MDL3)</td>
<td>8.5 to 17.5V (12 V nominal) or 16.5 to 33 V (24V nominal)</td>
</tr>
<tr>
<td>Input Terminal Wire Gauge</td>
<td>12 to 18 AWG</td>
</tr>
<tr>
<td>Ceiling-Mount Dimensions (including lens)</td>
<td>6.8” diameter x 2.5” high (173 mm diameter x 64 mm high)</td>
</tr>
<tr>
<td>Ceiling-Mount Surface Mount Back Box Skirt Dimensions (SBBCRL, SBBCL)</td>
<td>6.9” diameter x 3.4” high (175 mm diameter x 86 mm high)</td>
</tr>
</tbody>
</table>

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 30 cd.
### UL Current Draw Data

#### UL Max. Strobe Current Draw (mA RMS)

<table>
<thead>
<tr>
<th>Candela Range</th>
<th>8–17.5 Volts</th>
<th>16–33 Volts</th>
<th>DC</th>
<th>DC</th>
<th>FWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>87</td>
<td>41</td>
<td>60</td>
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<tr>
<td>30</td>
<td>153</td>
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<td>86</td>
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<tr>
<td>75</td>
<td>N/A</td>
<td>111</td>
<td>142</td>
<td></td>
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<tr>
<td>95</td>
<td>N/A</td>
<td>134</td>
<td>164</td>
<td></td>
<td></td>
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<tr>
<td>115</td>
<td>N/A</td>
<td>158</td>
<td>191</td>
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</tr>
<tr>
<td>150</td>
<td>N/A</td>
<td>189</td>
<td>228</td>
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<tr>
<td>177</td>
<td>N/A</td>
<td>226</td>
<td>264</td>
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#### UL Max. Horn Current Draw (mA RMS)

<table>
<thead>
<tr>
<th>Sound Pattern</th>
<th>8–17.5 Volts</th>
<th>16–33 Volts</th>
<th>DC</th>
<th>DC</th>
<th>FWR</th>
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<tbody>
<tr>
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<td>44</td>
<td>54</td>
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<tr>
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<tr>
<td>Non-Temporal High</td>
<td>43</td>
<td>47</td>
<td>54</td>
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<tr>
<td>Non-Temporal Low</td>
<td>29</td>
<td>32</td>
<td>54</td>
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<tr>
<td>3.1 KHz Temporal High</td>
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<td>41</td>
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</tr>
<tr>
<td>3.1 KHz Temporal Low</td>
<td>29</td>
<td>32</td>
<td>54</td>
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<tr>
<td>3.1 KHz Non-Temporal High</td>
<td>42</td>
<td>43</td>
<td>54</td>
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<tr>
<td>3.1 KHz Non-Temporal Low</td>
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<tr>
<td>Coded High</td>
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<tr>
<td>3.1 KHz Coded High</td>
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### UL Max. Current Draw (mA RMS), Ceiling Horn Strobe, Candela Range (15–177 cd)

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<tr>
<th>DC Input</th>
<th>8–17.5 Volts</th>
<th>16–33 Volts</th>
<th>15cd</th>
<th>30cd</th>
<th>15cd</th>
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<td>54</td>
<td>71</td>
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### Horn Strobe Tones and Sound Output Data

<table>
<thead>
<tr>
<th>Horn Strobe Output (dBA)</th>
<th>8–17.5 Volts</th>
<th>16–33 Volts</th>
<th>DC</th>
<th>DC</th>
<th>FWR</th>
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</thead>
<tbody>
<tr>
<td>1 Temporal High</td>
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<td>2 Temporal Low</td>
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<td>3 Non-Temporal High</td>
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<td>4 Non-Temporal Low</td>
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<td>84</td>
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<tr>
<td>5 3.1 KHz Temporal High</td>
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<td>88</td>
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<td>6 3.1 KHz Temporal Low</td>
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<td>82</td>
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<td>7 3.1 KHz Non-Temporal High</td>
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<td>8 3.1 KHz Non-Temporal Low</td>
<td>77</td>
<td>83</td>
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</table>
L-Series Dimensions

**L-Series Ordering Information**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>PC2RL</td>
<td>2-Wire, Horn Strobe, Red</td>
</tr>
<tr>
<td>PC2WL</td>
<td>2-Wire, Horn Strobe, White</td>
</tr>
<tr>
<td>PC4RL</td>
<td>4-Wire, Horn Strobe, Red</td>
</tr>
<tr>
<td>PC4WL</td>
<td>4-Wire, Horn Strobe, White</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
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<tbody>
<tr>
<td>SCRL</td>
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<tr>
<td>SCWL</td>
<td>Strobe, White</td>
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<tr>
<td>SCWL-CLR-ALERT</td>
<td>Strobe, White, ALERT</td>
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**Accessories**

<table>
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<tr>
<th>Model</th>
<th>Description</th>
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<tbody>
<tr>
<td>TRC-2</td>
<td>Universal Ceiling Trim Ring Red</td>
</tr>
<tr>
<td>TRC-2W</td>
<td>Universal Ceiling Trim Ring White</td>
</tr>
<tr>
<td>SBBCL</td>
<td>Ceiling Surface Mount Back Box, Red</td>
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<tr>
<td>SBBCL-W</td>
<td>Ceiling Surface Mount Back Box, White</td>
</tr>
</tbody>
</table>

For a ceiling-listed horn-only device, see AVDS865 “Indoor Selectable-Output Horns, Strobes, and Horn Strobes for Wall Applications”.

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AVDS868E-00 • 120116617
HPFF12(E) and HPFF12CM(E)
12 Amp and 24-Volt Power Supplies

Description

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

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

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

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

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

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

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

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

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

Features

- Four (4) power limited supervised notification application circuits (NAC's) capable of supplying +24VDC at 3.0 amp maximum each.
- NAC output circuits may be configured as any of the following:
  - Four Class B (Style Y).
  - Two Class B & one Class A.
  - Two Class A (Style Z).
- Four field-programmable operational modes:
  - Pass-through.
  - Temporal generator.
  - Sync generator.
  - Pass-through Filtered.
- Temporal coding and sync protocols compatible with the following notification appliance brands:
  - System Sensor.
  - Faraday.
  - Amseco.
  - Cooper-Wheelock.
  - Gentex.
- Protocol pass-through for synchronizing large systems.
- Two fully independent supervised input/output control circuits.
- Redundant activation operation for survivability.
- 2.0 amp auxiliary continuously supplied output.
- Eight status LEDs.
- Supervised AC input, battery voltage, auxiliary output, charger, and earth ground faults.
- Trouble indication for supervision of the following:
  - NAC circuits.
  - Auxiliary output.
  - AC input.
  - Battery charger voltage.
  - Earth ground faults.
- Optional two-hour delay for AC loss.
- Separate Trouble and AC Fail Form-C relay contacts.
• The Trouble Form-C relay contacts selectable for immediate or a 2 hour delay with AC failure.
• 26 AH battery charger capability:
  – HPFF12(E) supports two 12V 18AH batteries
  – HPFF12CM(E) supports two 12V 12AH batteries per unit.
• NAC Overload protection and indication.
• Provision for mounting single or 6 circuit addressable control or relay modules inside the enclosure. (Use mounting kit PN 90475.)
• Standard Honeywell key and lock can be replaced with the NOTIFIER key and lock.

**Specifications**

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

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

**Battery Charging Capacity:** Up to 26 AH batteries.

**HPFF12 Cabinet:** Holds up to two 18AH batteries.

**HPFF12CM:** Holds up to two 12AH batteries.

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

**Auxiliary Power Output:** 2.0A under all conditions.

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

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

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

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

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

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

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

**Cabinet Dimensions:**

• **HPFF12 Cabinet:** 16.65" W x 19.0" H x 5.2" D (42.29 cm W x 48.26 cm H x 13.23 cm D).

• **Large equipment enclosure:**
  – EQBB-B4: 24" W x 28.5" H x 5.16" D (60.96 cm W x 72.39 cm H x 13.1 cm D).
  – EQBB-C4: 24" W x 37.13" H x 5.16" D (60.96 cm W x 94.23 cm H x 13.1 cm D).
  – EQBB-D4: 24" W x 45.75" H x 5.16" D (60.96 cm W x 116.21 cm H x 13.1 cm D).

**Product Line Information**

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

**HPFF12E:** 240VAC/50Hz version of HPFF12.

**HPFF12CM:** 12.0A fire rated power supply (chassis mounted). Unit includes mounting hardware, battery cable and instructions for installation in large equipment enclosure. 120VAC/60Hz.

**HPFF12CME:** 240VAC/50Hz version of HPFF12CM.

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

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

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

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

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

See DN-6857. See DN-6875 for details.

**EQ Series Enclosures:**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQBB-B4</td>
<td>Backbox for mounting one HPFF12CM. Requires EQDR-B4 door.</td>
</tr>
<tr>
<td>EQBB-C4</td>
<td>Backbox for mounting one HPFF12CM. Requires EQDR-C4 door.</td>
</tr>
<tr>
<td>EQBB-D4</td>
<td>Backbox for mounting one HPFF12CM. Requires EQDR-D4 door.</td>
</tr>
</tbody>
</table>

**17045KIT:** Notifier key and lock set.

**Listings and Approvals**

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

• **UL Listed:** S24562

• **Seismic Certification of Non-Structural Electrical Components and Systems**

• **FM Approved**

• **CSFM:** 7315-1637:0102

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FireWarden-100-2(E) Rev 3
Intelligent Addressable FACP

General
The Notifier FireWarden-100-2 Rev 3 (NFW2-100) with Version 5.0 firmware is a combination FACP (Fire Alarm Control Panel) and DACT (Digital Alarm Communicator/Transmitter) all on one circuit board. This compact intelligent addressable control panel has an extensive list of powerful features.

The SLC (Signaling Line Circuit) of the FireWarden-100-2 Rev 3 operates using a Rapid Group Polling communication protocol technology that polls multiple devices simultaneously for a quicker device response time. This patented technology allows a fully-loaded panel with up to 198 devices to report an incident and activate the notification circuits in under 10 seconds. With this improved polling, devices can be wired on standard twisted, unshielded wire up to a distance of 10,000 feet.

The quick-remove chassis protects the electronics during construction. The backbox can be installed allowing field wiring to be pulled. When construction is completed, the electronics can be quickly installed with just two bolts.

New features for Rev 3 with Version 5.0 firmware include removable terminal blocks, improved transient protection, additional secondary ANN-BUS, and increased power for the resettable and remote sync outputs.

Available accessories include ANN-BUS devices as well as ACS LED, graphic and LCD annunciators, and reverse polarity/city box transmitter.

The integral DACT transmits system status (alarms, supervisions, troubles, AC loss, etc.) to a Central Station via the public switched telephone network. It also allows remote and local programming of the control panel using the PS-Tools Upload/Download utility. In addition, the control panel may be programmed or interrogated off-site via the public switched telephone network. Any personal computer with Windows® XP or greater, a compatible modem, and PS-Tools—the Upload/Download software kit—may serve as a Service Terminal. This allows download of the entire program or upload of the entire program, history file, walktest data, current status and system voltages. The panel can also be programmed through the FACP’s keypad or via a standard PS-2 computer keyboard, which can be plugged directly into the printed circuit board. This permits easy typing of address labels and other programming information.

Version 5.0 firmware supports the following: Primary and Secondary ANN-bus devices, NP-A100, USB port, NAC circuit diagnostics, a new report has been added to the walk-test that lists untested devices, new device types added: audio telephone type code for NFV-25/50ZST, Photo Supervisory and auto-resettable Drill (non-latching).

The FireWatch Series internet monitoring modules IPDACT-2 and IPDACT-2UD permit monitoring of alarm signals over the Internet saving the monthly cost of two dedicated business telephone lines. Although not required, the secondary telephone line may be retained providing backup communication over the public switched telephone line.

NOTE: Unless otherwise specified, the term “FireWarden-100-2” is used in this document to refer to both the FireWarden-100-2 and the FireWarden-100-2E FACP’s (Fire Alarm Control Panels). Likewise, “NFW2-100” refers to NFW2-100E as well.

Features
• Listed to UL standard 864, 9th edition.
• On-board DACT.
• Remote site or local USB port upload/download, using PS-Tools.
• Four (4) Style Y (Class B) NAC circuits, which can be converted to four (4) Style Z (Class A) circuits with optional ZNAC-92 converter module. (Up to 6.0 amps total NAC power when using optional XRM-24B.)
• Selectable strobe synchronization for System Sensor, Wheelock, and Gentex devices.
• Remote Acknowledge, Silence, Reset and Drill via addressable monitor modules or FDU-80, N-ANN-80 or Legacy ACS Annunciators.
• ANN-BUS for connection to following optional modules (cannot be used if ACS annunciators are used):
  – N-ANN-80(-W) Remote LCD Annunciator
  – N-ANN-I/O LED Driver
  – N-ANN-S/PG Printer Module
  – N-ANN-RLY Relay Module
  – N-ANN-LED Annunciator Module
  – N-ANN-RLED Annunciator Module alarms only
  – ROME Relay Option Module Enclosure
• ACS & Terminal-mode Annunciators:
  – ACS Annunciators: Up to 32 Legacy ACM Series annunciators (ACM-16AT or ACM-32 series). Cannot be used if ANN-BUS devices are used.
  – Terminal-mode Annunciators: Up to 32 Legacy FDU-80 annunciators.
• EIA-232 printer/PC interface (variable baud rate) on main circuit board, for use with optional UL-listed printer PRN-6.
• Integral 80-character LCD display with backlighting.
• Real-time clock/calendar with automatic daylight savings control.
• Detector sensitivity test capability (NFPA 72 compliant).
• History file with 1,000-event capacity.
• Maintenance alert warns when smoke detector dust accumulation is excessive.
• Automatic device type-code verification.
• One person audible or silent walk test with walk-test log and printout.
• Point trouble identification.
• Waterflow (nonsilenceable) selection per monitor point.
• System alarm verification selection per detector point.
• PAS (Positive Alarm Sequence) and presignal delay per point (NFPA 72 compliant).

**NOTE:** Only detectors may participate in PAS.

**SLC LOOP:**
• SLC can be configured for NFPA Style 4, 6, or 7 operation.
• SLC supports up to 198 addressable devices per loop (99 detectors and 99 monitor, control, or relay modules).
• SLC loop maximum length 10,000 ft. (3,000 m.).
 See installation manual for wire tables.

**NOTIFICATION APPLIANCE CIRCUITS (NACS):**
• Four onboard NACs with additional NAC capability using output control modules (NC-100). The four Class B NACs can be converted to four Class A NACs with optional ZNAC-92 converter module.
• Silence Inhibit and Auto Silence timer options.
• Continuous, March Time, Temporal or California code for main circuit board NACs with two-stage capability.
• Selectable strobe synchronization per NAC.
• 2.5 amps maximum per each NAC circuit.

**NOTE:** Maximum 24VDC system power output is shared among all NAC circuits and 24VDC special-application auxiliary power outputs. Total available output is 3.0 amps. Using the optional XRM-24B transformer increases 24VDC output to 6.0 amps.

**PROGRAMMING AND SOFTWARE:**
• Autoprogram (learn mode) reduces installation time.
• Custom English labels (per point) may be manually entered or selected from an internal library file.
• Three Form-C relay outputs (two programmable).
• 99 software zones.
• Continuous fire protection during online programming at the front panel.
• Program Check automatically catches common errors not linked to any zone or input point.

**OFFLINE PROGRAMMING:** Create the entire program in your office using a Windows®-based software package (NFW2-100 requires PS-Tools Programming software, available on www.magni-fire.com). Upload/download system programming and updating panel firmware.

**User Interface**

**LED INDICATORS**
• AC Power (green)
• Fire Alarm (red)
• Supervisory (yellow)
• Alarm Silenced (yellow)
• System Trouble (yellow)
• Maintenance/Presignal (yellow)
• Disabled (yellow)
• Battery Fault (yellow)
• Ground Fault (yellow)

**KEYPAD CONTROLS**
• Acknowledge/Step
• Alarm Silence
• Drill
• System Reset (lamp test)
• 16-key alpha-numeric pad (similar to telephone keypad)
• 4 cursor keys
• Enter

**Product Line Information**

**NFW2-100:** FireWarden-100-2 Rev 3 198-point addressable Fire Alarm Control Panel, one SLC loop. Includes 80-character LCD display, single printed circuit board mounted on chassis, and cabinet. 120 VAC operation.

**NFW2-100R:** Same as NFW2-100, except in a red backbox.

**NFW2-100E:** Same as NFW2-100, except with 240 VAC operation.

**4XTM Reverse Polarity Transmitter Module:** Provides supervised output for local energy municipal box transmitter, alarm, and trouble.

**ZNAC-92:** Optional converter module which converts four (4) Style Y (Class B) NAC circuits to four (4) Style Z (Class A) circuits.

**PS Tools:** Programming software for Windows®-based PC computer (cable not included), available on www.firelite.com.

**DP-9692B:** Optional dress panel for FireWarden-100-2 Rev 3.

**TR-CE-B:** Optional trim Ring for semi-flush mounting.

**BB-26:** Battery backbox, holds up to two 26 AH batteries and CHG-75.

**NFS-LBB:** Battery box, houses two 55 AH batteries.

**CHG-75:** Battery charger for lead-acid batteries with a rating of 25 to 75 AH.

**CHG-120:** Remote battery charging system for lead-acid batteries with a rating of 55 to 120 AH. Requires additional NFS-LBB for mounting.

**NOTE:** CHG-120 or CHG-75 required for batteries larger than 18AH.

**BAT Series:** Batteries, see data sheet DN-6933.


**PRT/PK-CABLE:** Cable printer/personal computer interface cable; required for printer or for local upload/download programming and updating panel firmware.

**PRN-6:** UL listed compatible event printer. Uses tractor-fed paper.

**IPDACT-2/2UD,** **IPDuct Internet Monitoring Module:** Mounts in bottom of enclosure with optional mounting kit (PN IPBRKT). Connects to primary and secondary DACT telephone output ports for internet communications over customer provided ethernet internet connection. Requires compatible Teldat VisorALARM Central Station Receiver. Can use DHCP or static IP. (See data sheet DN-60408 for more information.)

**IPBRKT:** Mounting kit for IPDACT-2/2UD in common enclosure.

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

**COMPATIBLE ANNUNCIATORS**

**N-ANN-80(W):** LCD Annunciator is a remote LCD annunciator that mimics the information displayed on the FACP LCD display. Recommended wire type is un-shielded. (Basic model is black; order -W version for white; see DN-7114.)
N-ANN-LED: Annunciator Module provides three LEDs for each zone: Alarm, Trouble and Supervisory. Ships with red or black enclosure (see DN-60242).

N-ANN-RLED: Provides alarm (red) indicators for up to 30 input zones or addressable points. (See DN-60242).

N-ANN-RLY: Relay Module, which can be mounted inside the cabinet, provides 10 programmable Form-C relays. (See DN-7107.)

ROME-B: Relay Option Module Enclosure (order ROME-B for black or ROME for red). Provides one N-ANN-RLY Relay Module already installed. The ROME Series provides mounting space for one additional Relay Module or one addressable Multi-module. (See Installation Sheet PN 53530.)

N-ANN-S/PG: Serial/Parallel Printer Gateway module provides a connection for a serial or parallel printer. (See DN-7103.)

N-ANN-I/O: LED Driver Module provides connections to a user supplied graphic annunciator. (See DN-7105.)

ACM-8R: Relay module provides 8 Form-C 5.0 amp relays.

ACM Annunciator Series: LED-type fire annunciators capable of providing up to 99 software zones of annunciation. Available in increments of 16 or 32 points to meet a variety of applications.

LDM Graphic Series: Lamp Driver Module series for use with custom graphic annunciators.

FDU-80 (Liquid Crystal Display) point annunciator: 80-character, backlit LCD-type fire annunciators capable of displaying English-language text.

NOTE: For more information on Compatible Annunciators for use with the FireWarden-100-2 Rev 3, see the following data sheets (document numbers): ACM-8R (DN-3559), ACS/ACM Series (DN-0524), LDM Series (DN-0551), FDU-80 (DN-6820).

COMPATIBLE ADDRESSABLE DEVICES
All feature a polling LED and rotary switches for addressing.

NI-100: Addressable low-profile ionization smoke detector.

NP-100: Addressable low-profile photoelectric smoke detector.

NP-100T: Addressable low-profile photoelectric smoke detector with thermal sensor.

NP-100R: Addressable remote test capable detector for use with DNR(W) duct smoke detector housings.


NH-100R: Fast-response, low-profile heat detector with rate-of-rise option.

NH-100H: Fixed high-temperature detector that activates at 190°F/88°C.

NP-A100: Addressable low-profile multi-sensor detector.

DNR: Innovair Flex low-flow non-relay duct-detector housing. Order NP-100R separately.

DNRW: Innovair Flex low-flow non-relay duct-detector housing, with NEMA-4 rating. Watertight. (Order NP-100R separately.)

NMM-100: Addressable Monitor Module for one zone of normally-open dry-contact initiating devices. Mounts in standard 4.0” (10.16 cm.) box. Includes plastic cover plate and end-of-line resistor. Module may be configured for either a Style B (Class B) or Style D (Class A) IDC.

NDM-100: Dual Monitor Module. Same as NMM-100 except it provides two Style B (Class B) only IDCs.

NMM-100P: Miniature version of NMM-100. Excludes LED and Style D option. Connects with wire pigtales. May mount in device backbox.

NZM-100: Similar to NMM-100, but may monitor up to 20 conventional two-wire detectors. Requires resettable 24 VDC power. Consult factory for compatible smoke detectors.

NC-100: Addressable Control Module for one Style Y/Z (Class B/A) zone of supervised polarized Notification Appliances. Mounts directly to a 4.0” (10.16 cm.) electrical box. Notification Appliance Circuit option requires external 24 VDC to power notification appliances.

NC-100R: Addressable relay module containing two isolated sets of Form-C contacts, which operate as a DPDT switch. Mounts directly to a 4.0” (10.16 cm.) box, surface mount using the SMB500.

NOT-BG12LX: Addressable manual pull station with interface module mounted inside.

N100-ISO: Fault Isolator Module. This module isolates the SLC loop from short circuit conditions (required for Style 6 or 7 operation).

SMB500: Used to mount all modules except the NMM-100P.

NMM-100-10: Ten-input monitor module. Mount one or two modules in a BB-XP cabinet (optional). Mount up to six modules on a CHS-6 chassis in a BB-25.

NZM-100-6: Six-zone interface module for compatible conventional two-wire detectors. Mount one or two modules in a BB-XP cabinet (optional). Mount up to six modules on a CHS-6 chassis in a BB-25.

NOTE: For more information on Compatible Addressable Devices for use with the FireWarden-100-2 Rev 3, see the following data sheets (document numbers): N100-ISO (DN-6994), NP-100 series (DN-6995), NI-100 (DN-6996), NH-100 series (DN-6997), ND-100 series (DN-7006), NP-A100 (DN-6998), NMM-100/NMM-100P/NNDM-100/NMZ-100 (DN-6999), NC-100/NC-100R (DN-7000), NOT-BG12LX (DN-7001), NMM-100-10 (DN-6990), and NZM-100-6 (DN-60150).

Wiring Requirements
While shielded wire is not required, it is recommended that all SLC wiring be twisted-pair to minimize the effects of electrical interference. Wire size should be no smaller than 18 AWG (0.78 mm²) and no larger than 12 AWG (3.1 mm²). The wire size depends on the length of the SLC circuit. Refer to the panel manual for wiring details.
**ANNUNCIATORS**

ACS/ACM, LDM

**ANN-BUS DEVICES**

N-ANN-80, N-ANN-LED, N-ANN-S/PG, N-ANN-I/O

**ANN-BUS or EIA-485**

in ACS mode (two wires)

24 VDC

**NOTE:** System can use either ANN-BUS devices OR ACS-mode annunciators. They cannot be used simultaneously.

**8 FORM-C, 5-AMP RELAYS**

(optional, order ACM-8R)

NACs (Notification Appliance Circuits)

Bells, Signals, Strobes

**EIA-232 INTERFACE**

(PIM-24) built into the motherboard

**EIA-485 INTERFACE**

(four wires)

FDU-80

Up to 6,000 ft. (1825.8 m) between each FDU-80 in the EIA-485 loop, and between each FDU-80 and the FACP.

**Optional REVERSE POLARITY/CITY BOX OUTPUT**

(4XTM)

**NOTE:** System can use either the printer OR the FDU-80. They cannot be used simultaneously.

24 VDC

**SMOKE DETECTORS**

NP-100, NP-100T, NI-100, NP-A100

**HEAT DETECTORS**

NH-100, NH-100R, NH-100H

**DUCT DETECTORS**

ND-100, ND-100R, DNR

**MONITOR/CONTROL**

NMM-100, NZM-100, NDM-100, NI100-ISO, NC-100, NC-100R

**ADDRESSABLE MULTI-MODULE**

NZM-100-6, NMM-100-10

**MINI-MONITOR**

NMM-100P

**PULL STATION**

NOT-BG12LX

24 VDC

**PRIINTER**

FireWarden-100-2 Rev 3

Fire Alarm Control/Communicator

FireWarden-100-2 Rev 3

Fire Alarm Control/Communicator
SYSTEM SPECIFICATIONS

System Capacity

- Intelligent Signalling Line Circuits: 1
- Addressable device capacity: 198
- Programmable software zones: 99
- ACS Annunciators: 32
- ANN-bus devices: 16

Electrical Specifications

AC Power: FireWarden-100-2 Rev 3: 120 VAC, 60 Hz, 3.0 amps. FireWarden-100-2 Rev 3(E): 240 VAC, 50 Hz, 1.5 amps. Wire size: minimum 14 AWG (2.00 mm²) with 600 V insulation.

Battery charger capacity: 7 AH - 18 AH batteries. Up to two 18 AH batteries can be housed in the FACP cabinet. Larger batteries require an external battery charger such as the CHG-75 or CHG-120, and a separate battery cabinet such as the BB-26 or NFS-LBB.

Communication Loop: Supervised and power-limited.

Notification Appliance Circuits: Each terminal block provides connections for two Style Y (Class B) for a total of four Style Y (Class B) or with an optional ZNAC-92 module converts to four Style Z (Class A) NACs. Maximum signaling current per circuit: (Class B) or with an optional ZNAC-92 module converts to four connections for two Style Y (Class B) for a total of four Style Y (Class B) NACs. Maximum signaling current per circuit: 2.5 amps. End-of-Line Resistor: 4.7K ohm, 1/2 watt (P/N 71252)

Special Application Non-resettable Power (24 VDC Nominal): Jumper selectable (JP4) for conversion to resettable power output. Up to 1.0 amp total DC current available from each output. Power-limited.

Special Application Resettable Power (24 VDC nominal): Jumper selectable (JP6) for conversion to non-resettable power output. Up to 1.0 amp total DC current available from each output. Power-limited.


Telephone Interface: Unless used with Teldat VISORALARM, requires dedicated business telephone number with a minimum of 5 volts DC (off-hook voltage). Obtain dedicated phone line directly from your local phone company. Do not use shared phone lines or PBX (digital) type phone line extensions.

Cabinet Specifications

Door: 19.26" (48.92 cm.) high x 16.82" (42.73 cm.) wide x 0.12" (.30 cm.) deep. Backbox: 19.00" (48.26 cm.) high x 16.85" (42.29 cm.) wide x 5.20" (13.34 cm.) deep. Trim Ring (TR-CE-B): 22.00" (55.88 cm.) high x 19.65" (49.91 cm.) wide.

Shipping Specifications

Weight: 26.9 lbs. (12.20 kg.) Dimensions: 20.00" (50.80 cm.) high x 22.5" (57.15 cm.) wide x 8.5" (21.59 cm.) deep.

Temperature and Humidity Ranges

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

NFPA Standards

The FireWarden-100-2 Rev 3 complies with the following NFPA 72 Fire Alarm Systems requirements:

- REMOTE STATION (Automatic, Manual, Waterflow and Sprinkler Supervisory) (Where a DACT is not accepted, the alarm, trouble and supervisory relays may be connected to UL 864 listed transmitters. For reverse polarity signaling of alarm and trouble, 4XTM is required.)
- OT, PSDN (Other Technologies, Packet-switched Data Network)

Agency Listings and Approvals

The listings and approvals below apply to the basic FireWarden-100-2 Rev 3 control panel. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- UL Listed: S635
- FM approved
- CSFM: 7165-0028:0235
- MEA: 120-06-E, Volume 2

For ULC-listed version, see DN-60600.

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Appendix 4: Fire Suppression Layout
1. REFER TO THE COVER SHEET FOR ADDITIONAL GENERAL NOTES.
2. CONTRACTOR TO PROVIDE BLOCKING IN PARTITIONS FOR PARTITION MOUNTED ITEMS AS INDICATED. CONTRACTOR ALSO TO COORDINATE QUANTITY AND LOCATIONS WITH THE OWNER FOR OWNER FURNISHED / CONTRACTOR INSTALLED ITEMS.
3. PARTITIONS ARE TYPE P1 UNLESS NOTES OTHERWISE.
4. PARTITION TYPES ARE INDICATED BY P2, P3, ETC. AS SHOWN ON THE DIMENSION PLANS. SEE A1-4 FOR PARTITION TYPES AND DETAILS.
5. TOILET ACCESSORY TYPES ARE INDICATED BY T-(#) AS SHOWN ON THE CALLOUT PLAN, AND/OR ON ENLARGED PLANS, AND/OR ON THE INTERIOR ELEVATIONS. REFER TO SPECIFICATION SECTION 10 28 13 FOR SCHEDULE.
6. SEE A1-CO SERIES DRAWINGS FOR CALL OUTS AND REFERENCES. SEE A1-DIMS SERIES DRAWINGS FOR DIMENSIONS.
7. SEE A2 SERIES DRAWINGS FOR CEILING FINISHES, CEILING HEIGHTS, AND OTHER CEILING INFORMATION.
8. REFER TO SHEET A8-2 FOR INTERIOR BORROWED LITE ELEVATIONS.
9. SEE BC SERIES DRAWINGS FOR SMOKE AND FIRE RATED PARTITION LOCATIONS.
10. SEE INTERIOR ELEVATIONS FOR EXTENT OF INTERIOR GLAZING.
11. ALL WOOD BLOCKING TO BE FIRE TREATED, TYP.
Appendix 5: Fire Flow Test
### Columbus Division of Water Fire Flow Test

<table>
<thead>
<tr>
<th>FLOW TEST ID</th>
<th>2651</th>
<th>NO. OF TEST RUN</th>
<th>1</th>
<th>ATLAS PAGE</th>
<th>6</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLOW HYDRANT 1</td>
<td>IW OF MAIER PL ON W WHITTIER ST</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLOW HYDRANT 2</td>
<td>NONE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRESSURE HYDRANT</td>
<td>2W OF MAIER PL ON W WHITTIER ST</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>PRESSURE HYDRANT ID</td>
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<td></td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>DATE</th>
<th>1/26/2018</th>
<th>TIME</th>
<th>2:15:00 PM</th>
<th>PIPE SIZE</th>
<th>6&quot; &amp; 12&quot;</th>
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</thead>
<tbody>
<tr>
<td>STATIC PRESSURE</td>
<td>83 psi</td>
<td>RESIDUAL PRESSURE</td>
<td>70 psi</td>
<td>HYDRANT OWNER</td>
<td>COLUMBUS</td>
</tr>
<tr>
<td>PITOT 1</td>
<td>20 psi</td>
<td>PITOT 2</td>
<td>NONE psi</td>
<td>COEFFICIENT</td>
<td>0.88</td>
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<tr>
<td>OUTLET</td>
<td>4&quot; DIFF</td>
<td>FLOW (GPM)</td>
<td>1880</td>
<td>WATER DISTRICT</td>
<td>CENTRAL</td>
</tr>
<tr>
<td>FLOW@20 PSI</td>
<td>4390</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>WATER DISTRICT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please remember when reviewing the results of the flow test that varying factors could change the results, i.e., hourly fluctuations in water levels at the City of Columbus water tanks, changes in consumer demands in the area of the flow test, and seasonal changes in water plant discharge pressures. The net effect of these changes will normally shift static pressures by no more than five (5) to fifteen (15) psi.
Appendix 6: Hydraulic Calculations
WATER SUPPLY ANALYSIS

Static: 75.00 psi Resid: 63.00 psi Flow: 1880.0 gpm

LEGEND

1 Available pressure
   74.37 psi @ 381.4 gpm

2 Required pressure
   60.35 psi @ 381.4 gpm

Avail. OnSite Demand Press.
   74.37 psi @ 281.4 gpm

Req. OnSite Demand Press.
   60.35 psi @ 281.4 gpm

A. Source Supply Curve
B. System Demand Curve
C. Available at Source

Note: (1) Dashed Lines indicate extrapolated values from Test Results
(2) On Site pressures are based on hose stream deduction at the source
**NFPA WATER SUPPLY DATA**

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>STATIC PRESS. (PSI)</th>
<th>RESID. PRESS. (PSI)</th>
<th>FLOW @ (GPM)</th>
<th>AVAIL. PRESS. @ DEMAND (PSI)</th>
<th>TOTAL PRESS. (PSI)</th>
<th>REQ'D PRESS. (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOURCE</td>
<td>75.0</td>
<td>63.0</td>
<td>1880.0</td>
<td>74.4</td>
<td>381.4</td>
<td>60.3</td>
</tr>
</tbody>
</table>

**AGGREGATE FLOW ANALYSIS:**

- **TOTAL FLOW AT SOURCE:** 381.4 GPM
- **TOTAL HOSE STREAM ALLOWANCE AT SOURCE:** 100.0 GPM
- **OTHER HOSE STREAM ALLOWANCES:** 0.0 GPM
- **TOTAL DISCHARGE FROM ACTIVE SPRINKLERS:** 281.4 GPM

**NODE ANALYSIS DATA**

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<th>DISCHARGE (GPM)</th>
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### NFPA5 PIPE DATA

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<td>Eq.Ln.</td>
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<td>(Pe)</td>
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<td>Disch</td>
<td>Act ID</td>
<td>(ft.)</td>
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- 60.3
- 281.4
- DC1 E6.000 T:46.0
- 56.00
- -0.0

#### Pipe: 2 Ext -3.0
- 60.0
- 281.4
- 6.080 2G:10.0
- 156.00
- 0.002

#### Pipe: 3 DC1
- 2.0
- 57.6
- 281.4
- ENTRY
- 4.0 psi, 281.4 gpm

#### Pipe: 4 DC2
- 2.0
- 53.6
- 281.4
- BOR E6.000
- 2E:44.0
- 44.00

#### Pipe: 5 Entry
- 0.0
- 54.3
- 281.4
- ENTRY
- 54.00

#### Pipe: 6 BOR
- 2.0
- 53.4
- 281.4
- TOR
- 2F:22.0
- 22.00

#### Pipe: 7 Tor
- 11.0
- 47.9
- 281.4
- 1A
- 4.000
- C:29.0
- 71.00

#### Pipe: 8 1A
- 11.0
- 45.0
- 281.4
- 1B
- 3.000
- T:20.0
- 20.00

#### Pipe: 9 1B
- 11.0
- 40.7
- 281.4
- 2A
- 3.000
- ----
- 0.00

#### Pipe: 10 2A
- 11.0
- 37.3
- 281.4
- 2B
- 3.000
- ----
- 0.00

#### Pipe: 11 2B
- 19.0
- 31.9
- 281.4
- 3.000
- 2E:20.0
- 20.00

#### Pipe: 12 3
- 19.0
- 30.8
- 251.4
- 4
- 3.000
- ----
- 0.00

#### Pipe: 13 4
- 19.0
- 30.0
- 251.4
- 5
- 3.000
- ----
- 0.00

#### Pipe: 14 5
- 19.0
- 30.0
- 251.4
- 6
- 3.000
- ----
- 0.00

#### Pipe: 15 6
- 19.0
- 30.0
- 251.4
- 7
- 3.000
- ----
- 0.00

#### Pipe: 16 7
- 19.0
- 30.0
- 251.4
- 8
- 3.000
- ----
- 0.00

#### Pipe: 17 8
- 19.0
- 30.0
- 251.4
- 9
- 3.000
- ----
- 0.00

#### Pipe: 18 9
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- 30.0
- 251.4
- 10
- 3.000
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- 0.00

#### Pipe: 19 10
- 19.0
- 30.0
- 251.4
- 11
- 3.000
- ----
- 0.00

#### Pipe: 20 11
- 19.0
- 30.0
- 251.4
- 12
- 3.000
- ----
- 0.00

#### Pipe: 21 12
- 19.0
- 30.0
- 251.4
- 13
- 3.000
- ----
- 0.00
**Pipe Tag** | **K-fac** | **Add Fl** | **Add Fl To** | **Fit:** | **L** | **C** | **(Pt)** |
--- | --- | --- | --- | --- | --- | --- | --- |
**Frm Node** | **El (ft)** | **PT** | **Node/ Nom ID** | **Eq.Ln.** | **F** | **(Pe)** |
**To Node** | **El (ft)** | **PT** | **Tot.(Q) Disch Act ID** | **(ft.)** | **T** | **Pf/ft.** |

Pipe: 13 | 0.0 | 55.6 | 14 | ---- | 15.00 | 120 | 0.2 |
4 | 19.0 | 30.0 | 69.8 | 11 | 3.000 | ---- | 0.00 | -0.0 |
5 | 19.0 | 29.7 | 125.5 | 3.260 | 15.00 | 0.016 | 0.2 |

Pipe: 14 | 5.60 | 30.0 | Disch | ---- | 14.00 | 120 | 2.2 |
3 | 19.0 | 30.8 | 0.0 | 1.250 | 3T:24.0 | 24.00 | -0.0 |
16 | 19.0 | 28.6 | 30.0 | 1.442 | 38.00 | 0.058 | 2.2 |

Pipe: 15 | 5.60 | 24.6 | Disch | ---- | 14.00 | 120 | 10.7 |
4 | 19.0 | 30.0 | 45.5 | 7 | 1.250 | 3T:24.0 | 24.00 | -0.0 |
6 | 19.0 | 19.3 | 70.1 | 1.442 | 38.00 | 0.281 | 10.7 |

Pipe: 16 | 5.60 | 22.9 | Disch | ---- | 12.00 | 120 | 2.5 |
6 | 19.0 | 19.3 | 22.6 | 8 | 1.250 | T: 8.0 | 8.00 | -0.0 |
7 | 19.0 | 16.8 | 45.5 | 1.442 | 20.00 | 0.126 | 2.5 |

Pipe: 17 | 5.60 | 22.6 | Disch | ---- | 10.00 | 120 | 0.5 |
7 | 19.0 | 16.8 | 0.0 | 1.250 | E: 4.0 | 4.00 | -0.0 |
8 | 19.0 | 16.3 | 22.6 | 1.442 | 14.00 | 0.035 | 0.5 |

Pipe: 18 | 5.60 | 28.2 | Disch | ---- | 1.00 | 120 | 4.6 |
4 | 19.0 | 30.0 | 27.7 | 10 | 1.250 | 3T:24.0 | 24.00 | -0.0 |
9 | 19.0 | 25.4 | 55.9 | 1.442 | 25.00 | 0.185 | 4.6 |

Pipe: 19 | 5.60 | 27.7 | Disch | ---- | 15.00 | 120 | 1.0 |
9 | 19.0 | 25.4 | 0.0 | 1.250 | E: 4.0 | 4.00 | -0.0 |
10 | 19.0 | 24.4 | 27.7 | 1.442 | 19.00 | 0.050 | 1.0 |

Pipe: 20 | 5.60 | 24.5 | Disch | ---- | 14.00 | 120 | 10.6 |
5 | 19.0 | 29.7 | 45.3 | 12 | 1.250 | 3T:24.0 | 24.00 | -0.0 |
11 | 19.0 | 19.1 | 69.8 | 1.442 | 38.00 | 0.279 | 10.6 |

Pipe: 21 | 5.60 | 22.8 | Disch | ---- | 12.00 | 120 | 2.5 |
11 | 19.0 | 19.1 | 22.5 | 13 | 1.250 | T: 8.0 | 8.00 | -0.0 |
12 | 19.0 | 16.6 | 45.3 | 1.442 | 20.00 | 0.126 | 2.5 |

Pipe: 22 | 5.60 | 22.5 | Disch | ---- | 10.00 | 120 | 0.5 |
12 | 19.0 | 16.6 | 0.0 | 1.250 | E: 4.0 | 4.00 | -0.0 |
13 | 19.0 | 16.1 | 22.5 | 1.442 | 14.00 | 0.034 | 0.5 |

Pipe: 23 | 5.60 | 28.1 | Disch | ---- | 1.00 | 120 | 4.6 |
5 | 19.0 | 29.7 | 27.6 | 15 | 1.250 | 3T:24.0 | 24.00 | -0.0 |
14 | 19.0 | 25.2 | 55.6 | 1.442 | 25.00 | 0.183 | 4.6 |

Pipe: 24 | 5.60 | 27.6 | Disch | ---- | 15.00 | 120 | 0.9 |
14 | 19.0 | 25.2 | 0.0 | 1.250 | E: 4.0 | 4.00 | -0.0 |
15 | 19.0 | 24.2 | 27.6 | 1.442 | 19.00 | 0.050 | 0.9 |
NOTES (HASS):

(1) Calculations were performed by the HASS 2021 D computer program in accordance with NFPA13 (2020) under license no. 64618207 granted by HRS Systems, Inc.
208 Southside Square
Petersburg, TN 37144
(931) 659-9760

(2) The system has been calculated to provide an average imbalance at each node of 0.007 gpm and a maximum imbalance at any node of 0.169 gpm.

(3) Total pressure at each node is used in balancing the system. Maximum water velocity is 13.8 ft/sec at pipe 15.

(4) Items listed in bold print on the cover sheet are automatically transferred from the calculation report.

(5) Available pressure at source node SOURCE under full flow conditions is 74.24 psi with a flow of 422.21 gpm.

(6) PIPE FITTINGS TABLE

HASS Pipe Table Name: standard

PAGE: B  MATERIAL: THNWL  HWC: 120
Diameter (in) Equivalent Fitting Lengths in Feet

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PAGE: E  MATERIAL: PVC150  HWC: 150
Diameter (in) Equivalent Fitting Lengths in Feet

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