FIRE PROTECTION AND LIFE SAFETY ANALYSIS

BUILDING 192 – ENGINEERING IV

DONALD JOSEPH WOOD

CALIFORNIA POLYTECHNIC STATE UNIVERSITY, SAN LUIS OBISPO

M.S. FIRE PROTECTION ENGINEERING - CULMINATING PROJECT

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STATEMENT OF DISCLAIMER

KEYWORDS

CBC - California Building Code

RSET - Required Safe Egress Time

ASET - Available Safe Egress Time

Performance Based Analysis

FDS - Fire Dynamics Simulator

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EXECUTIVE SUMMARY

A Fire Protection and Life Safety Analysis has been performed on California Polytechnic State University Building 192 – Engineering IV as part of a culminating project in the Masters of Science in Fire Protection Engineering program at California Polytechnic State University. This analysis consists of a prescriptive analysis based on current codes and standards as well as a performance-based analysis.

A prescriptive analysis evaluates compliance with modern codes and standards and consists of the following five parts:

- Egress Design and Analysis
- Structural Fire Protection
- Water-based Fire Suppression
- Fire Detection and Alarm Systems
- Smoke Control Systems

The purpose of the prescriptive analysis is to determine if Engineering IV complies with the modern codes and standards that would be applicable if the building was constructed in the present. The prescriptive analysis is performed using the 2016 California Building and Fire Codes (CBC and CFC), and well as various NFPA standards adopted by the CBC and CFC.

Engineering IV's means of egress system is evaluated using occupant load factors from the 2016 CBC as well as CPDC Technical Bulletin A/E 17-002, which contains more conservative factors than those originally used based on the 2001 CBC (1997 UBC). The resulting occupant load calculations show that areas previously considered as business use would now be considered flexible assembly space, and that based on the increased occupant loads present the exit capacity is severely non-compliant for the second and third floors of the building. Regardless, the university keeps an emergency planning and preparedness plan in accordance with Chapter 4 of the California Fire Code, and is required to keep the occupant load of the building within the exit capacity limits specified in the original design. Other means of egress requirements such as travel distance, number of exits, exit separation and common path of travel were found to be compliant based on the original design.

The building's fire detection and alarm system was evaluated based on the requirements of the 2016 CBC as well as NFPA 72. Visible appliances are provided in most public use areas, however there is a lack of coverage in the Multi-Disciplinary Dirty Lab, Room 130. Smoke detectors are provided in corridors, classrooms, laboratories and office spaces; however, smoke detectors are not located in the 1st Floor welding lab. The secondary power supply calculations confirm that the Fire Alarm Control Panel (FACP) is provided with adequate backup power for this application.

The building's automatic sprinkler system was evaluated using the 2016 CBC as well as NFPA 13 and NFPA 25. Hydraulic calculations were performed for the most remote area of the building on the 3rd floor. These calculations show that the sprinkler demand at this location exceeds the water supply provided at the site man. A fire pump has been sized to meet the demand of the sprinkler system.

A structural fire protection analysis was performed using the 2016 CBC. The building elements used in the construction of Engineering IV appear to meet or exceed the requirements set by the 2016 CBC. Additionally, the Type IB construction used for this building meets the allowable building height and

area requirements of CBC Chapter 5. All building elements and assemblies with required fire-resistance ratings are U.L. listed.

The building's smoke management features are evaluated based on the requirements of 2016 CBC. Engineering IV is provided with all smoke management features required by the 2016 CBC. The 2-hour rated curtain wall sprinklers and glass enclosure at the top of the communicating stair as well as the horizontal fire shutters serve to limit the development of a large smoke plume in the main lobby and eliminate the requirement for mechanical smoke control. Magnetic closing doors, elevator hoistway protection and combination smoke/fire dampers serve to compartmentalize the building and limit the spread of smoke in a fire event. Duct smoke detectors are provided at both air handlers to detect if smoke is being supplied into the building's HVAC system and allows the fire alarm system to shut down the HVAC system in alarm condition.

A performance based analysis was performed to determine if occupants could safety egress from the building in the event of a fire. Two fire scenarios were evaluated using Fire Dynamics Simulator (FDS) and Pathfinder. The Required Safe Egress Time (RSET) was determined by researching occupant behaviors and by using Pathfinder to model building egress. Tenability criteria were determined based on engineering judgement and used with FDS to determine if unsafe conditions were reached before the Required Safe Egress Time (RSET) was reached. Based on the results of the performance based analysis, visibility dropped below 10-meters in both Design Fire Scenarios before the RSET time was reached. As such, Engineering IV does not provide an adequate level of protection for occupants during the time needed to evacuate. To provide a tenable environment for occupants during evacuation, I would recommend providing an engineering smoke control system complying with CBC Section 909 or providing a rated separation between Levels 1 and 2. I also recommend revisiting the location of combustibles in the lobby and main corridor of the building.

INTRODUCTION

A Fire Protection and Life Safety Analysis has been performed on California Polytechnic State University Building 192 – Engineering IV as part of a culminating project in the Masters of Science in Fire Protection Engineering program at California Polytechnic State University. This analysis will consist of a prescriptive analysis based on current codes and standards as well as a performance-based analysis.

The prescriptive analysis evaluates compliance with modern codes and standards and consists of the following five parts:

- Egress Design and Analysis
- Structural Fire Protection
- Water-based Fire Suppression
- Fire Detection and Alarm Systems
- Smoke Control Systems

A performance-based analysis is included to evaluate the building's performance in two challenging fire scenarios. This goal of analysis is to determine whether a reasonably safe environment is provided for occupants such that occupants who are not intimate with fire ignition are protected. The performance-based analysis will consist of the following three parts:

- First Order Hydraulic Egress Calculations

- Pathfinder Simulation – 3D Egress Model
- Fire Dynamics Simulator (FDS) – 3D Fire Model

The following analysis is based on the requirements of the following codes and standards:

- California Building Code (CBC), 2016 Edition
- California Fire Code (CFC), 2016 Edition
- NFPA 13 Standard for the Installation of Sprinkler Systems, 2016 Edition
- NFPA 25 Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems, 2014 Edition
- NFPA 72 National Fire Alarm and Signaling Code, 2016 Edition
- NFPA 80 Standard for Fire Doors and Other Opening Protectives, 2016 Edition
- NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems, 2015 Edition
- NFPA 101 Life Safety Code (LSC), 2015 Edition

The following texts are also referenced in this report:

- NFPA Fire Protection Handbook, Twentieth Edition
- SFPE Handbook of Fire Protection Engineering, Fifth Edition

BUILDING OVERVIEW

As shown in Figure 1, Engineering IV is located off Highland Drive on the northwest edge of the Cal Poly campus, in the City of San Luis Obispo, CA. This 104,000-gross-square-foot, fully-sprinklered, Type I-B structure houses the departments of mechanical, aerospace, civil, materials, industrial and biomedical engineering, as well as Dean's offices. The building contains laboratories, lecture halls, design rooms, support spaces, and faculty offices. The building height is 56-feet and is three-stories tall. It is my understanding that the building was opened in 2007.

Figure 1. Location of Engineering IV on the Cal Poly Campus

Students and faculty enter Engineering IV through one of three exterior stairways, or through the main lobby, as shown in Figure 2. The main lobby is served by a communicating stair that connects three stories. This atrium will be the focus of the performance-based analysis discussed later in this report. A color-coded floor plan detailing different occupancy classifications, storage/equipment areas, exit access corridors and vertical exits is provided in Appendix A.

Figure 2. East entrance to Engineering IV. Stair #4 is shown as one of the three exterior exit stairways serving the building. (left) The main entrance to Engineering IV leads into a three-story atrium space with a communicating stair. (right)

The Authority Having Jurisdiction (AHJ) for this building is the California Office of the State Fire Marshal (SFM). The San Luis Obispo Fire Department is the responding fire department.

The following codes and standards were applicable to fire and life safety at the time of construction:

- California Building Code (CBC), 2001 Edition
- California Fire Code (CFC), 2001 Edition
- NFPA 13 Standard for the Installation of Sprinkler Systems, 1999 Edition
- NFPA 72 National Fire Alarm and Signaling Code, 1999 Edition

EGRESS ANALYSIS AND DESIGN

This section is intended to outline non-structural life safety requirements as well as various aspects of egress system design. This section summarizes calculated occupant loads and exit capacities, and in addition evaluates regulatory compliance for building egress systems.

CLASSIFICATION OF OCCCUPANCY

In accordance with CBC Section 508.3 the occupancy of this building is classified as a mixed-use, non-separated occupancy due to the multitude of uses throughout the space. A Group A-3, Assembly occupancy classification is given to classrooms over 50 occupants while classrooms, labs, studios and offices under 50 occupants are classified as a Group B, Business occupancy. Storage rooms and mechanical equipment rooms are classified as Group S-2, Storage occupancy. Definitions of these occupancy types can be found in Sections 303, 304 and 311 of the CBC.

MEANS OF EGRESS ANALYSIS

For this building to meet the prescriptive requirements of the CBC, the means of egress system must be sized by the code-specified method of matching the occupant load of a floor against the calculated egress capacity of the egress components serving the floor. Components of the egress system must also meet the regulatory requirements of the CBC.

OCCUPANT LOADS

The occupant load reflects the maximum number of people anticipated to occupy a space at any given time. To determine the calculated occupant load (OL) for a given space, the area of the space is divided by an occupant load factor (OLF), which has units of ft^2/person. The OLF is an occupant density factor which varies depending on the function or use of the space. These values are specified in CBC Table 1004.1.2 in both gross and net area figures. Table 1 provides the occupant load factors employed for occupant load calculations throughout Engineering IV.

Table 1. Maximum Floor Allowances per Occupant [CBC Table 1004.1.2]

Function of Space	Occupant Load Factor (ft^2/person)
Assembly Use	-
Laboratories, Educational (fixed seating)	50 net[1]
Classrooms, Computer Labs (without fixed seating)	15 net[1]
Flexible laboratory spaces - under 49 occupants	20 net[1]
Flexible laboratory spaces – 50 or more occupants	15 net[1]
Business Areas	-
Offices, restrooms, circulation spaces	100 gross
Storage Use	-
Accessory storage areas, mechanical equipment rooms	300 gross

1. Per CPDC A/E Technical Bulletin 17-002, all traditional classroom areas without fixed seating and computer labs are required to be calculated at an occupant load factor of 15 net. This is an acknowledgement of the function of university classrooms as an unconstrained assembly space with tables and chairs rather than educational classroom areas as defined in CBC Table 1004.1.2. Flexible laboratory spaces are required to be calculated at an occupant load factor of 20 net up to 49 occupants. Flexible laboratory spaces are required to be calculated at an occupant load factor of 15 net up for spaces with 50 or more occupants.

Net floor area consists of the actual occupied area of the space, not including unoccupied accessory areas such as corridors, restrooms, stairways, mechanical rooms or closets. [CBC Chapter 2] These accessory areas will be included in gross area occupant load calculations or excluded if they serve only assembly areas using net occupant load factors.

A diagram of each floor of Engineering IV, color-coded by function of the space, is provided in Appendix B. Using floor area takeoffs in Bluebeam Revu and the OLF's listed in Table 1, the occupant load of each floor was calculated. A total occupant load of 3394 occupants was calculated for the three-story

structure, with laboratory use making up most of the space. The first story contains the highest occupant load at 1224 occupants. The occupant load distribution for each floor is provided in the tables next to each floor on the diagram.

EGRESS CAPACITY

To meet the egress sizing requirements of the CBC, the egress capacity of each component in the means of egress must be calculated to determine if it exceeds the occupant load for each story. These components include door assemblies, stairs, ramps, horizontal exits, exit passageways, and areas of refuge.

The width of egress components is calculated by multiplying the occupant load for the space by an egress capacity factor, with units of inch-width per person. For non-health care or high-hazard occupancies, capacity factors of 0.3 inch-width per person are used for stairways and 0.2 inch-width per person are used for level components (i.e. doors and ramps). [CBC Section 1005.3.1, 1005.3.2] Regardless of the calculated egress width, in accordance with CBC Section 1010.1.1, door openings in the means of egress shall not be less than 32 inches in clear width.

Exit capacity calculations for the first floor are provided in Table 2. The first floor contains 1224 total occupants. Where occupants in a space have the option to egress to the exit access corridor or the public way, the occupants are split evenly. This results in 469 occupants discharging to the outside while 755 occupants egress to the main exit access corridor. These 755 occupants are split between four available exits, with a total required door width of 151-inches. This level contains three 72-inch exit doors and a main exit with three 72-inch doors, all having a clear width of 68-inches. This gives a combined provided width of 408-inches. Therefore, the egress capacity of the first floor is significantly greater than the calculated occupant load.

Table 2. 1st Floor Exit Capacity Calculations

Total Occupant Load Exiting to Corridor	755 Occupants
Total Clear Door Width Required	755 x 0.2 = 151-inches
Total Clear Door Width Provided	408-inches

Exit width calculations for the second floor are provided in Table 3. This floor has a total occupant load of 1180 persons, split evenly between three exterior egress stairways and the exit access stairway located in the center of the building. Using the 0.3 inch-width per person capacity factor for stairs, 354-inches of required stair width is calculated. This is less than the provided stair width of 198-inches. Using the 0.2 in. width/person capacity factor for doors, 236-inches of clear egress width are required. Each of the three exterior egress stairways are provided with 32-inch clear width doors, while the exit access stairway is not provided with a door.

Table 3. 2nd Floor Exit Capacity Calculations

Total Occupant Load	1180 Occupants
Stair Clear Width Required	1180 x 0.3 = 354-inches
Stair Clear Width Provided	198-inches
Door Clear Width Required	1180 x 0.2 = 236-inches
Door Clear Width Provided	173-inches

The original egress calculations for this building are based on the 2001 CBC. The code analysis plan (Sheet A-003) in the Engineering IV record drawings indicates that the original occupant load for the 2nd Floor was calculated to be 500 occupants, where a traditional laboratory OLF of 50-s.f./occupant was used for most of the building. [2001 CBC Table 1004.1.2] The occupant load calculated under the requirements of the 2016 CBC and CPDC A/E Technical Bulletin 17-002 is more than twice the original calculated occupant load of the space. The building in its current configuration would require an additional 156-inches of stair width and an additional 63-inches of door width to be compliant with the 2016 CBC.

Exit width calculations for the third floor are provided in Table 4. The total occupant load for this floor is 990 occupants, which is split evenly between two exterior exit stairways. The central communicating stair is closed during a fire event for smoke management purposes, and should not be included as part of the 3rd floor exit capacity. In its existing condition, 132-inches of stair width and 70-inches of clear door width are provided for the 3rd Floor. Based on the same calculation methods employed for the 2nd Floor, 297-inches of stair width and 198-inches of clear door width are required to meet egress capacity.

Table 4. 3rd Floor Exit Capacity Calculations

Total Occupant Load	990 Occupants
Stair Clear Width Required	990 x 0.3 = 297-inches
Stair Clear Width Provided	132-inches
Door Clear Width Required	990 x 0.2 = 198-inches
Door Clear Width Provided	70-inches

Similar to the 2nd Floor, the existing code analysis plan for this building indicates that the original occupant load for the 3rd Floor was calculated to be 367 occupants. The occupant load calculated under the requirements of the 2016 CBC and CPDC A/E Technical Bulletin 17-002 is almost three times the original calculated occupant load of the space. The building in its current configuration would require an additional 165-inches of stair width and an additional 128-inches of door width to be compliant with the 2016 CBC.

The occupant load calculated for all floors under the requirements of the 2016 CBC and CPDC A/E Technical Bulletin 17-002 is significantly greater than that provided in the original record drawings, which were calculated under the 2001 CBC. The building's original design did not account for the more conservative occupant load factors required by the SFM in 2018, so this is expected. Regardless, the university keeps an emergency planning and preparedness plan in accordance with Chapter 4 of the California Fire Code, and is required to keep the occupant load of the building within the exit capacity limits specified in the original design. Additionally, CBC Section 1004.3 requires all classrooms and spaces with more than 50 occupants used for assembly purposes to be provided with signage that states the maximum occupant load permitted for that space.

The calculated occupant loads for individual rooms, each story, and the capacity at each component along the means of egress are provided in Appendix B. The use of each space reflects its current use and not that from the original record drawings.

NUMBER OF MEANS OF EGRESS

CBC Section 1006 requires a minimum number of means of egress based on the type of occupancy and calculated occupant load.

The first floor of Engineering IV has a total occupant load of 1224 occupants. Stories with occupant loads greater than 1000 are required to have not less than four means of egress. [CBC Section 1006.2.1.1] To meet this requirement five exits have been provided on the first floor. The second and third floors have calculated occupant loads of greater than 500 occupants, and are required to be provided with three means of egress. The original code analysis plan for Engineering IV indicates that the second floor was sized for an occupant load of 500 persons, and provided with three means of egress. However, the third floor is provided with two means of egress. This number of exits on the 3rd floor would be non-compliant under the 2016 CBC. The required number of means of egress in the existing egress system is not reduced anywhere along the egress path.

For Group A-3 Assembly occupancies, where the occupant load of the space is greater than 50 persons, not less than two means of egress are required. Each classroom or lab originally designated as an assembly occupancy has been provided with two exits.

ARRANGEMENT OF MEANS OF EGRESS

CBC Section 1003.6 requires exits to be located so that exits are readily accessible at all times. Where exits are not immediately accessible from an open floor area, exits in Engineering IV are connected by a main exit access corridor leading directly to an exit. This exit access corridor connects not less than two exits by separate ways of travel, unless the provisions for a single exit or common path of travel are met. These corridors provide exit access without passing through any intervening rooms other than corridors, lobbies, or other spaces permitted to be open to the corridor.

Minimum Separation of Exits

Where two exits are required for a space or story, remoteness shall be provided in accordance with CBC Section 1007. Engineering IV is equipped with an automatic sprinkler system, so the minimum separation distance between two exits shall not be less than one-third the length of the maximum overall diagonal dimension of the building or area to be served. [CBC Section 1007.1.1 Exception 2] The maximum overall diagonal dimension is 445-ft for the first floor, 426-ft for the second floor, and 343-ft for the third floor. Means of egress for the first and second story in Engineering IV are provided at 369-ft apart and 367-ft apart, respectively, with the two exits on the third story 258-ft apart. Each assembly space that is required to have two exits also have exits spaced more than one-third the maximum diagonal dimension. Therefore, the requirement of exit separation is met. Exit separation distances are shown in Figures 3, 4, and 5 for each floor of Engineering IV.

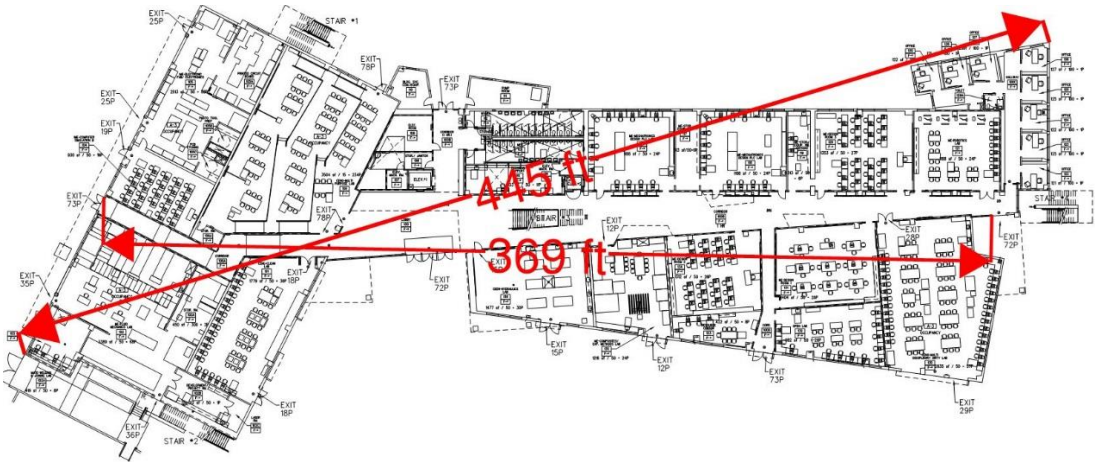

Figure 3. Exit separation distance for the first floor. The two farthest exits serving the main corridor are 369-feet apart, greater than one-third the maximum separation distance of 445-feet.

Figure 4. Exit separation distance for the second floor. The two farthest exits serving the main corridor are 367-feet apart, greater than one-third the maximum separation distance of 426-feet.

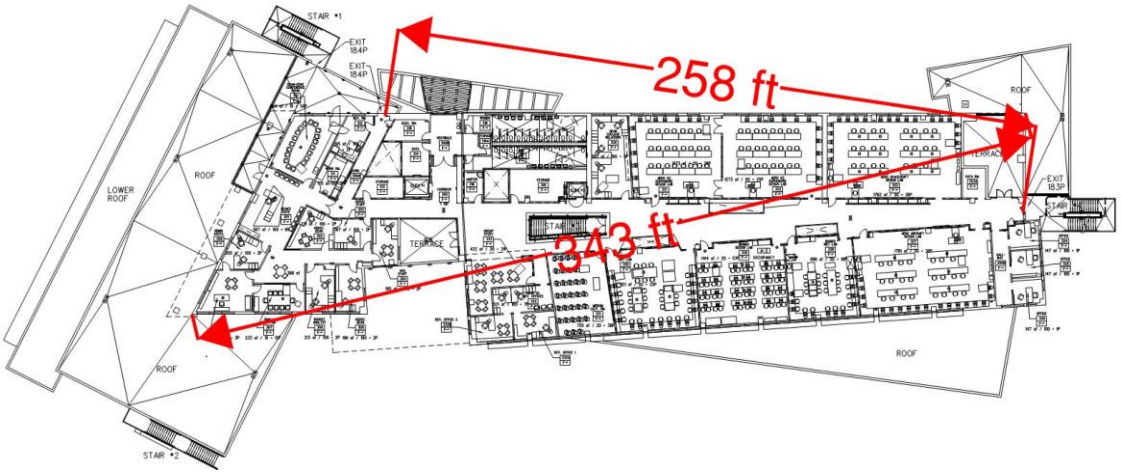

Figure 5. Exit separation distance for the third floor. The two farthest exits serving the main corridor are 258-ft apart, greater than one-third the maximum separation distance of 343-ft.

MEASUREMENT OF TRAVEL DISTANCE TO EXITS

In accordance with Section 1017, the CBC specifies the requirements regarding the maximum distance that occupants are permitted to travel from their position in a building to the nearest exit. Travel distance, common path of travel, and dead-end limitations based on occupancy are provided in Table 5.

Table 5. Common Path, Dead-End, and Travel Distance Limits by Occupancy. All measurements are applicable to a fully sprinklered building. [CBC §1006.2.1, §1017, §1020.4]

Occupant Travel Limits	Requirement
Travel Distance:	-
Group A-3	250-feet
Group B	300-feet
Group S-2	400-feet
Common Path:	-
Group A-3	20-feet/75-feet*
Group B	100-feet
Group S-2	100-feet
Dead End Corridors:	-
Group A-3	20-feet
Group B	50-feet
Group S-2	50-feet

*For common path serving >50 persons, 20-ft; for common path serving ≤50 persons, 75-ft

Travel Distance

For fully sprinklered Group A-3, B and S-2 occupancies, the travel distance limits are 250-feet, 300-feet and 400-feet, respectively. The maximum travel distance for Engineering IV is experienced by occupants on the third floor, since only two means of egress are available. As shown in Figure 6, a maximum travel distance of 227-feet is needed for an occupant in the far corner of Room 331 to travel to the nearest exit at Stair #4. This distance is less than the 250-foot requirement for Group A-3 occupancies, and therefore meets the maximum travel distance requirements of the CBC.

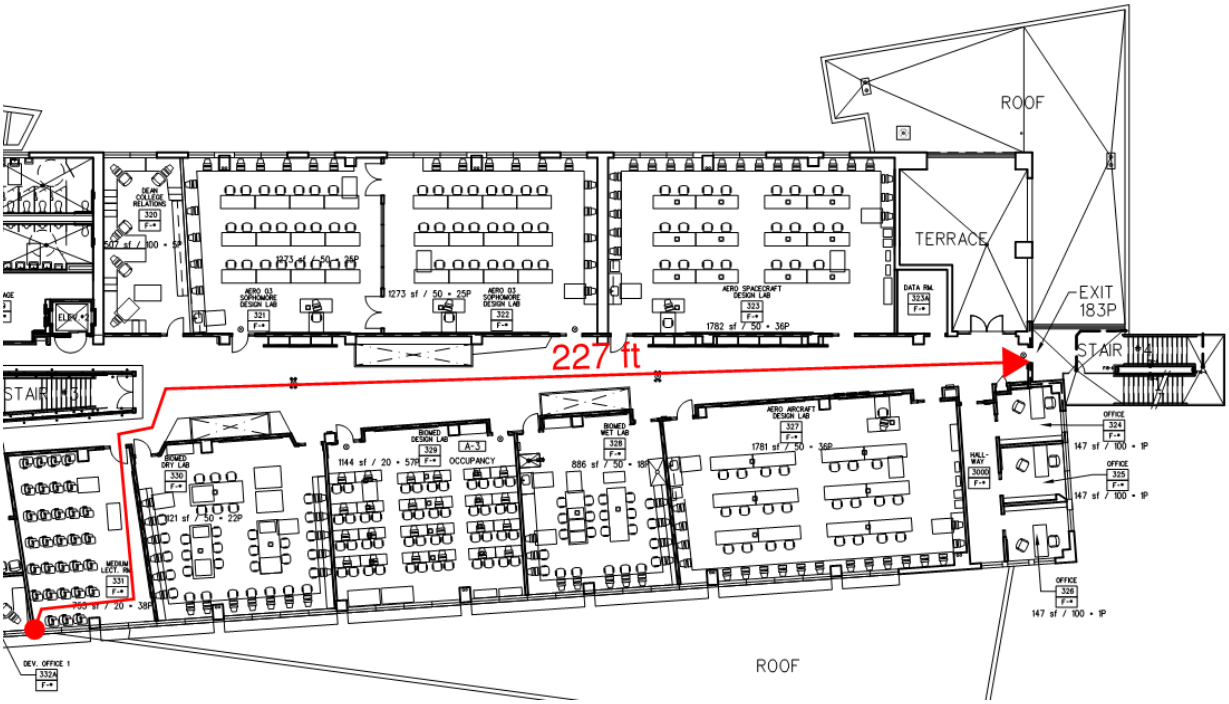

Figure 6. The maximum travel distance for Engineering IV is 225-feet, satisfying the 250-foot limit required by the CBC.

Common Path of Travel

The common path of travel is the distance an occupant must travel before they reach two distinct paths of egress. For a Group B occupancy, the common path of travel must not exceed 100-ft. [CBC Table 1006.2.1] As shown in Figure 7, the maximum common path of travel in Engineering IV is 94-ft, which occurs in the faculty office space. Therefore, Engineering IV does not exceed the common path of travel limit specified by the CBC.

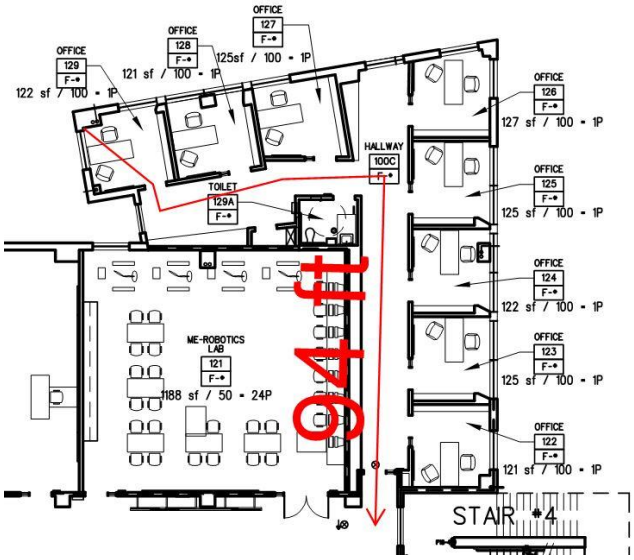

Figure 7. Common path of travel from the furthest faculty office to the main corridor.

Dead-End Limits

Dead-end limits are specified by the CBC so that occupants do not become trapped during evacuation. For Engineering IV, the dead-end limit for a Group A-3 assembly space is 20-feet. [CBC Section 1020.4] As shown in Figure 8, the vestibule serving the restrooms on the second and third floor is 34-feet long, and would normally exceed the dead-end limit. However, doors with magnetic closers have been installed that are activated when the building is in alarm. These doors close reducing the corridor length to 19-ft. Therefore, Engineering IV meets the dead-end requirements of the CBC.

Figure 8. The 20-foot dead-end limit required for Group A occupancies is not exceeded in the corridor due to the addition of magnetic closing doors.

HORIZONTAL EXITS

A horizontal exit is a fire barrier with fire door assemblies that provides passage from one fire compartment of a building to another fire compartment in the same building or in an adjoining building on approximately the same level. This building does not utilize horizontal exits.

INCIDENTAL USES

Equipment in many of the labs in Engineering IV, such as the large ovens in the composites lab, pose a special hazard to the surrounding spaces. In accordance with CBC Section 509, rooms with mechanical equipment exceeding 400,000 Btu, rooms or spaces used for the processing or use of combustible supplies deemed hazardous by the AHJ are required to be separated by a 1-hour fire barrier or provided with automatic sprinkler protection.

INTERIOR FINISH

In accordance with CBC Section 803.11, interior wall and ceiling finish materials are required to be Class C in all corridors, lobbies and other rooms and enclosed spaces. Class B interior finish materials are required in enclosed exit ramps.

FIRE-RESISTANCE RATINGS FOR CORRIDORS AND STAIRWAYS

In accordance with CBC Table 1020.1, the interior corridors and lobbies in Engineering IV are not required to be separated from adjacent spaces by fire barriers since they are protected throughout by an approved, supervised automatic sprinkler system. However, the existing corridors are constructed as 1-hour rated fire partitions based on the requirements of the 2001 CBC.

Engineering IV makes use of three exterior egress stairs which are required to be separated from the building by 1-hour exterior walls. The first two levels of the central atrium stairway are separated from the third story a glass enclosure with curtain wall sprinklers as well as by magnetized doors that close in alarm condition. This assembly provides a 2-hour rating similar to that of a shaft enclosure.

EXIT SIGNS

Means of egress are required to be marked in accordance with the requirements of CBC Section 1013. Exits are required to be marked by an approved sign that is readily visible from any direction of exit access.

Exit access areas, such as corridors, are also required to be marked by approved, readily visible signs in all cases where the exit or way to reach an exit is not readily apparent to the occupants. Signs are placed such that no point in an exit access corridor is in excess of 100-ft or the rated viewing distance, whichever is less, from the nearest sign. Directional indicators are also required in every location where the direction of travel to reach the nearest exit is not readily apparent. A proposed layout of exit signs in Engineering IV is provided in Appendix C.

SUMMARY

Based on the preceding prescriptive analysis, no specific deficiencies were discovered as part of this analysis that would not meet the requirements of the 2001 CBC. Engineering IV meets or exceeds the means of egress requirements of the 2016 CBC, including exit access travel distance, exit separation and number of exits. The exception in this analysis is exit capacity. The occupant load of 2,925 persons calculated under the requirements of the 2016 CBC and CPDC A/E Technical Bulletin 17-002 is significantly greater than the 1,530 persons calculated under the requirements of the 2001 CBC. The building's original design did not account for the more conservative occupant load factors required by the SFM in 2018, so this is expected. Regardless, the university keeps an emergency planning and preparedness plan in accordance with Chapter 4 of the California Fire Code, and is required to keep the occupant load of the building within the exit capacity limits specified in the original design. The next section will evaluate the fire detection and alarm systems used throughout Engineering IV and their compliance with the requirements of the 2016 CBC.

FIRE DETECTION AND ALARM SYSTEMS

This section is intended to outline important features of the fire alarm, detection and communication systems present in Engineering IV. This section explores the multitude of devices present throughout the building and describes how these devices are installed as well as their intended function.

The fire alarm system in Engineering IV is installed under the requirements of the 2001 California Building Code (CBC) and the 1999 Edition of NFPA 72 – National Fire Alarm Code. The following analysis is based on the requirements of the 2016 California Building Code as well as the 2016 Edition of NFPA 72 – National Fire Alarm and Signaling Code. Engineering IV fire alarm shop drawings are provided in Appendix D.

FIRE ALARM SYSTEM OVERVIEW

Engineering IV utilizes a mixed-use, non-separated occupancy approach, consisting of Group B classroom and office spaces and multiple Group A assembly spaces. In accordance with CBC Section 907.2.1, Group A buildings used for educational purposes are required to be provided with a manual or automatic fire alarm system. This system is required to be installed in accordance with NFPA 72 and provide occupant notification in accordance with Section 907.5.

The system installed in Engineering IV is an automatic and manual fire alarm system with sprinkler monitoring, elevator control interface and HVAC shutdown. The main FACP is routed to the existing campus master fire alarm control panel manufactured by Notifier, which classifies this system as a Proprietary Supervising Station Alarm System.

Under such a system, all fire alarm signals received by the supervising station are immediately transmitted to the communications center, the emergency response team, and other parties as required by the authority having jurisdiction (AHJ). Runners or technicians are dispatched to arrive at the building location within 2 hours of receipt of a signal to restore the system.

Upon receipt of supervisory signals, personnel are dispatched within 2 hours to investigate and ascertain the reason for a signal. This may also involve notifying the AHJ if required by the fire department or if the sprinkler system has been out of service for 8 hours or more.

Trouble signals are automatically indicated and recorded at the proprietary supervising station. Personnel are required to be dispatched within 4 hours to initiate maintenance, and if necessary, alert the fire department and/or AHJ.

Fire Alarm Control Panel

The fire alarm control panel (FACP) used in Engineering IV is a Notifier NFS-640. This FACP integrates a central processing unit (CPU), a 6-amp power supply, and a battery charger. The panel supports FlashScan protocol and has network capabilities.

The main FACP is located in Electrical Room 109 on the 1st Floor. The FACP is connected to four additional Fire Control Power Supplies (FCPSs), model number FCPS-24S8. Each of these FCPSs are provided with two battery backups. The main FACP is also connected to a fire alarm annunciator panel, model FDU-80. Manufacturer data sheets for the FACP and accessory devices are provided in Appendix E.

INITIATING DEVICES

This section details the initiating devices used throughout Engineering IV and whether they comply with the installation requirements of NFPA 72. Manufacturer data sheets of initiating devices are provided in Appendix E.

Smoke Detectors

The first type of initiating device used in this system is a ceiling mounted smoke detector. The smoke detector utilized in Engineering IV is a Notifier FSP851. FSP851 is a photoelectric smoke detector designed to provide open area protection.

Spot-type smoke detectors are required to be installed on the ceiling or, if on a sidewall, between the ceiling and 12-in. down from the ceiling to the top of the detector. [NFPA 72 Section 17.7.3.2.1] All smoke detectors in Engineering IV are ceiling mounted.

Smoke detector spacing throughout Engineering IV is based on a 30-foot nominal spacing with detectors placed within 15-feet of all walls and partitions that extend to ceiling height. All points on the ceiling are required to have a detector within a distance equal to or less than 0.7 times the nominal 30-foot

spacing. [NFPA 72 Section 17.7.3.2.3.1] Smoke detectors are provided in all corridors, classrooms, laboratories and office spaces. However, smoke detectors are not located in the Materials Engineering Welding & Joining Lab, Room 103A. Based on a review of the electrical power plans, all detectors are within the required spacing and are compliant with the requirements of NFPA 72.

Heat Detectors

The second type of initiating device used in this system is a ceiling mounted analog/addressable heat detector. The specific model used in Engineering IV is a Notifier FST-851 Series Intelligent Thermal Heat Detector with FlashScan. These heat detectors provide fixed-temperature heat detection with an activation temperature of 135°F.

Heat detectors are typically required to be located on the ceiling not less than 4-in. from the sidewall or on the sidewalls between 4-in. and 12-in. from the ceiling. [NFPA 72 Section 17.6.3.1.3] However, NFPA 72 Section 17.6.3.7 states that where heat detectors are used in an application other than open area protection, the manufacturer's published instructions should be followed.

These devices are used in Engineering IV for the protection of property rather than open area protection, and are installed in specific areas of high hazard, such as the pump room, data rooms, electrical rooms, elevator machine rooms and elevator shafts. The manufacturer's installation guide for this device is not available from the Notifier website, so it cannot be confirmed whether the device placement complies with manufacturer specification.

Manual Pull Stations

Notifier NBG-12LX single stage manual pull stations are provided throughout Engineering IV. These devices are designed to initiate an alarm when pulled, and once pulled remain open and cannot be reset without utilizing a key.

Manual fire alarm boxes are required to be mounted not less than 42-in. and not more than 48-in. from the finished floor measured to the lever. [NFPA 72 Section 17.14.5] All manual pull stations in Engineering IV are mounted 48-inches on center from the finished floor.

Manual fire alarm boxes are required to be located within 5-feet of each exit doorway on each floor, and provided so that the travel distance to the nearest fire alarm box does not exceed 200-feet. [NFPA 72 Section 17.14.8.4, 17.14.8.5] In Engineering IV, manual pull stations are located at each exit on every level, and every pull station is within 200-feet of travel distance. Therefore, this arrangement complies with the requirements of NFPA 72.

Duct Smoke Detectors

Engineering IV is equipped with Notifier FSD-751P duct smoke detectors. Duct smoke detectors are provided to detect if smoke is being supplied into the building's HVAC system and allows the fire alarm system to shut down the HVAC system in alarm condition. 2015 NFPA 90A requires that duct smoke detectors are located in the following locations [NFPA 90A Section 6.4.2.1]:

1. Downstream of the air filters and ahead of any branch connections in air supply systems having a capacity of greater than 2000 ft^3/min

2. At each story prior to the connection to a common return and prior to any recirculation or fresh air inlet connection in air return systems having a capacity greater than 15,000 ft^3/min and serving more than one story

Additionally, return system smoke detectors are not required where then entire space served by the air distribution system is protected by a system of area smoke detectors. [NFPA 90A Section 6.4.2.2]

Based on the mechanical drawings provided in the original record drawings, duct smoke detectors are provided at both air handling units located on the roof, downstream of supply air openings that provide 2000 ft^3/min per NFPA 90A Section 6.4.2.1 Item 1. Therefore, the placement of duct smoke detectors in Engineering IV satisfies the requirements of NFPA 90A.

Fire Sprinkler Heads

Fire sprinkler heads act as initiating devices when they trigger their associated waterflow switches to initiate an alarm. Engineering IV utilizes five types of sprinkler heads:

1. Reliable Model F1FR Series Upright quick-response sprinkler heads rated at 155°F
2. Reliable Model F1FR Series Upright quick-response sprinkler heads rated at 200°F
3. Reliable Model G4A concealed pendent sprinkler heads rated at 155°F
4. Reliable Model F1FR Series Sidewall quick-response sprinkler heads rated at 200°F
5. Tyco Model WS Vertical Pendant sprinkler heads rated at 155°F

Sprinkler heads with a temperature rating of 155° are used in classroom, circulation and office spaces, while sprinkler heads with a temperature rating of 200° are used in laboratories and other extra hazardous spaces where the ambient temperature is much higher due to the large equipment present. Tyco vertical pendant sprinkler heads are used for the glass enclosure on Level 3.

Sprinkler Waterflow Switches

Two System Sensor Model WFDTH vane-type sprinkler waterflow switches are provided at the two sprinkler risers in Engineering IV. Waterflow detectors are electro-mechanical devices designed to send an alarm to the FACP when continuous flow of water occurs through the fire sprinkler systems piping from an activated fire sprinkler head or leak in the system.

Sprinkler waterflow switches are required to activate within 90 seconds of waterflow at the alarm-initiating device when flow occurs that is equal to or greater than that from a single sprinkler of the smallest orifice size installed in the system. [NFPA 72 17.12.2]

It should be noted that the model WFDTH switches listed in the electrical drawings are intended to be installed in single-family residential dwellings, and is not listed for commercial use. These devices should be approved by the SFM prior to installation.

Sprinkler Tamper Switches

Two System Sensor OSY2 gate valve tamper switches are installed at the two sprinkler risers in Engineering IV. Tamper switches monitors what is typically the first valve between the city water line and the building sprinkler system. It is crucial that this valve is monitored by the fire alarm system to ensure the sprinkler system stays in service.

Sequence of Operations

SEQUENCE OF OPERATION

	PULL STATION	AREA SMOKE DETECTOR	ELEVATOR LOBBY SMOKE DETECTOR	HEAT DETECTOR	DUCT SMOKE DETECTOR	ELEVATION SHAFT SMOKE DETECTOR	SPRINKLE WATER FLOW SWITCH	SPRINKLE VALVE TAMPER SWITCH	SPECIAL EXTING USHING SYSTEM	LOW BATTERY	AC FAIL
ANNUNCIATE ON FACP	X	X	X	X	X		X	X		X	X
ANNUNCIATE AT REMOTE ANNUNCIATOR	X	X	X	X	X		X	X		X	X
SOUND THE GENERAL ALARM	X	X	X	X	X		X				
ACTIVATE ALL ROLL DOWN DOORS AND FIRE SHUTTERS											
RECALL ASSOCIATED ELEVATORS	X	X	X	X	X		X				
SHUT DOWN ASSOCIATED AIR (HVAC) UNIT	X	X	X	X	X						
ANNUNCIATE AT REMOTE 24 HOURS ATTENDED LOCATION	X	X					X	X		X	X

Figure 9. Sequence of operations matrix for the Engineering IV fire alarm system.

The sequence of operations is useful in determining the rationale behind how the fire alarm system is intended to function. This information is used frequently during testing and inspection to determine whether devices are sequencing correctly. It is also useful for future engineers who are tasked with making modifications to the existing building so that they can modify the existing system while making sure it works as intended.

As we can see in Figure 9, this matrix is incomplete and contains errors. The following are comments and suggested revisions to the matrix:

A. Based on the requirements for disposition of trouble and alarm signals, activation of smoke detectors and heat detectors should annunciate at the 24-hour attended location.

B. There are no special extinguishing systems present in Engineering IV and this column should be removed.

C. It is unclear from this matrix when the fire shutters should activate. The fire shutters should activate when any smoke detector is activated, except for the elevator shaft smoke detectors.

D. Elevator shaft heat detectors are not shown in this matrix.

ALARM NOTIFICATION APPLIANCES

Alarm notification appliances are required to provide stimuli for initiating emergency action and provide information to users, emergency response personnel, and occupants. This section details the alarm

notification devices used throughout Engineering IV and whether they comply with the installation requirements of NFPA 72 – Chapter 18. Manufacturer data sheets of each of these devices are in Appendix E.

Wall Mounted Strobes and Combination Horn/Strobes

Engineering IV is provided with System Sensor S1224MCW wall mounted strobes and System Sensor P1224MCW combination hornstrobes.

Location and Spacing

Engineering IV would be required to meet public mode audible requirements listed in NFPA 72 Section 18.4.3. This includes maintaining 15 dBA above the average ambient sound level or at least 5 dBA above the maximum sound level have a duration of at least one minute, whichever is greater, in every occupiable space within the building. [NFPA 72 Section 18.4.4.1] For a business occupancy such as Engineering IV, based on Table A.18.4.3, the average ambient sound level would be 55 dBA, so 70 dBA should be maintained in classroom, office and circulation spaces. In lab spaces where ambient noise levels are much higher due to the equipment present, an average ambient sound level of 85 dBA for mechanical spaces can be assumed, so a minimum of 100 dBA should be maintained.

The 24 VDC horns used throughout Engineering IV utilize a 3000 Hz interrupted signal and are rated for 81 dBA at 10 feet. Using the general rule of thumb that the output of an audible appliance is reduced by 6 dB when the distance is doubled, the sound pressure level would be 75 dBA at 20-feet and 69 dBA at 30-feet. A review of the Engineering IV fire alarm as-built drawings indicate that the minimum required sound level of 70 dBA is maintained in all public areas, except there is no horn appliance present in the Multi-disciplinary Dirty Lab, Room 130. Therefore, besides this one room, the building is in compliance with the spacing requirements of NFPA 72.

Visible appliances should be located in all public use and common use areas including classrooms, labs, office areas and corridors. Spacing for visible appliances is required to meet the room spacing requirements of Table 18.5.5.4.1(b) and Figure 18.5.5.4.1. Visible appliance in corridors less than 20-feet in width can be located not less than 15-feet from the end of the corridor with a separation not greater than 100-feet between appliances [NFPA 72 Section 18.5.5.5.5]. Where corridors are greater than 20-feet in width, visible appliances should comply with the spacing requirements of rooms in accordance with Section 18.5.5.4. [NFPA 72 Section 18.5.5.5.5]

Based on a review of the Engineering IV as-built drawings, visible appliances are located in the majority of public use areas, however there is a lack of coverage in the Multi-Disciplinary Dirty Lab, Room 130. The spacing for corridors is utilized on the far east and west areas of the building where the corridor is less than 20-feet in width. Where the corridor widens towards the lobby in the center of the building, visible appliances are spaced as required for room spacing. Visible appliances are not furnished on exterior exit stairways or in normally unoccupied spaces such as mechanical and electrical rooms. It appears that with the exception of one lab space, visible appliances in Engineering IV are in compliance with the spacing requirements of NFPA 72.

Placement

All hornstrobes and strobes are mounted at 80-inches (90-inches horn only) from the finished floor to the bottom of the lens, or 6-inches from the ceiling to the top of the lens, whichever is lower. This is in compliance with the requirements of NFPA 72 Sections 18.4.8.1 and 18.5.5.1.

Waterflow Bells

Engineering IV is equipped with two Wheelock MB-G10-24-R waterflow bells. Section 903.4.2 of the 2016 CBC requires an exterior alarm be provided on the exterior of the building in a location approved by the fire code official. The exterior alarm is typically in close proximity to the fire department connection (FDC) in somewhat open view. The primary purposes of the exterior alarm are to alert the arriving fire department of which building or sprinkler system is in operation before staging firefighting activities and to help the responding fire apparatus engineer more quickly locate the FDC.

SECONDARY BATTERY SUPPLY CALCULATIONS

Engineering IV is equipped with a main FACP and four power supplies that serve annunciating devices throughout the building. As no secondary battery calculations are provided by the contractor on the fire alarm as-built drawings, the main FACP has been chosen to estimate the secondary power supply requirements. The main FACP serves the greatest number and variety of devices throughout the building.

NFPA 72 Section 10.6.3 requires that proprietary supervisory fire alarm systems are provided with both a primary and secondary power supply. Per Section 10.6.7.2.1, the secondary power supply should have sufficient capacity to operate the system under quiescent load for 24 hours, and, at the end of that period, should be capable of operating all alarm notification appliances used for evacuation for 5 minutes.

Table 6 lists the devices serving the main FACP and their current draws in both the standby and alarm conditions. The total currents for each condition are summed and multiplied by the time factors required by Section 10.6.7.2.1. Based on the results of these calculations, one 12 amp-hour backup battery is necessary to serve the main FACP.

Table 6. Secondary Battery Supply Calculations

No.	Device	Current (A)		Total Current (A)	
		Standby	Alarm	Standby	Alarm
2	Fire Alarm Annunciator	0.0643	0.0643	0.1286	0.1286
4	Wall Mount Strobe[1]	---	0.428	---	0.428
9	Wall Mount Horn/Strobe[1]	---	1.469	---	1.469
243	Smoke Detector	0.0003	0.0065	0.0729	1.5795
9	Heat Detector	0.0003	0.0065	0.0027	0.0585
22	Manual Pull Station	0.0003	0.0003	0.0066	0.0066
12	Monitor Module	0.005	---	0.06	---
28	Relay Module	0.000375	0.000375	0.0105	0.0105

1. Wall mount strobes and horn strobes are added independently due to current ratings depending on dB or candela rating

Total Standby Current:	0.28	Amps
Time Factor: 24 Hours Standby	x 24	Hours
Standby Sub-Total:	6.75	Amp-Hours
Total Alarm Current:	3.68	Amps
Time Factor: 5 Minutes Alarm	x 0.083	Hours
Alarm Sub-Total:	0.31	Amp-Hours
System Amp-Hours:	7.06	Amp-Hours
+20% Safety Margin	x 1.2	
System Total Amp-Hours:	8.47	Amp-Hours
Battery Provided:	One 12 Amp-Hour Battery	
	Part Number: PS-12120	
Remaining Capacity:	3.53	Amp-Hours

TESTING AND MAINTENANCE

Inspection, testing and maintenance procedures are required to ensure that the fire alarm system continues to operate in accordance with the approved design documents and in accordance with the requirements of NFPA 72. Responsibility for testing, maintenance and inspection of the system, as well as any additions or alterations to the system, falls with California Polytechnic State University. The university is required to keep and maintain documentation regarding the system and system alterations, including specifications, wiring diagrams, and floor plans. This information should be provided by the university to service personnel upon request.

After successful completion of acceptance tests approved by the AHJ, a set of reproducible as-built drawings, operation and maintenance manuals, and a written sequence of operation should be provided to the building owner or the owner's designated representative. The university will be required to maintain these records for the life of the system for examination by the AHJ.

Inspection

Visual inspection should be performed in accordance with the schedules listed in NFPA 72 Table 14.3.1 or more frequently if required by the AHJ. Equipment performance can be affected by building modifications, occupancy changes, changes in environmental conditions, device location, physical obstructions, and other obvious problems that might not be indicated through electrical supervision.

All equipment should be tested on at least an annual basis to ensure that there are no changes that affect system performance. More critical devices should be inspected on a quarterly or even monthly basis.

Testing

Systems and associated equipment should be tested in accordance with NFPA 72 Table 14.4.3.2. Anytime an initiating device, notification appliance, or control relay is added, it should be tested. Anytime an initiating device, notification appliance, or control relay is deleted, another device, appliance, or relay on the circuit should be operated. When modifications or repairs to the system are made, the control equipment should be tested.

Testing should be performed in accordance with the schedules found in NFPA 72 Table 14.4.3.2 or more often if required by the AHJ. The sensitivity of devices should be checked within one year after installation, and every alternate year thereafter unless otherwise permitted by compliance with NFPA 72 Section 14.4.4.3.3. If devices pass the second calibration test, testing frequency can extend up to 5 years. Otherwise, devices will need to be recalibrated and replaced.

Maintenance

System equipment should be maintained on a regular basis in accordance with the manufacturer's published instructions. The frequency of maintenance and/or cleaning of the system will depend on the type of equipment and the local ambient conditions.

SUMMARY

Based on the preceding analysis, the fire detection and alarm system serving Engineering IV meets the prescriptive requirements of the 2016 CBC and NFPA 72 with few exceptions. Smoke detectors provide open area protection in all common use spaces; however, smoke detectors are not located in the Materials Engineering Welding & Joining Lab, Room 103A. The model WFDTH switches listed in the electrical drawings are intended to be installed in single-family residential dwellings, and are not listed for commercial use. These devices should be approved by the SFM prior to installation. The secondary power supply calculations confirm one 12 amp-hour backup battery is necessary to serve the main FACP, and that the FACP is provided with adequate backup power for this application. The next section will analyze the water-based fire suppression systems located throughout Engineering IV to determine if it meets the prescriptive requirements of the 2016 CBC and NFPA 13.

WATER-BASED FIRE SUPPRESSION

This section is intended to outline the design criteria, installation requirements and maintenance of all water-based fire suppression systems provided in Engineering IV. This section includes a summary of

components used throughout the building's automatic sprinkler system, as well as an analysis of the adequacy of the system's water demand using manual hydraulic calculations.

The codes and standards applied to this analysis are as follows:

- California Building Code (CBC) – 2016 Edition
- California Fire Code (CFC), 2016 Edition
- NFPA 13 Standard for the Installation of Sprinkler Systems, 2016 Edition
- NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, 2014 Edition

The building information contained in this section is provided in the Engineering IV record drawings, dated July 23, 2007, as well as the fire sprinkler shop drawings dated October 18, 2005. The fire sprinkler shop drawings are provided in Appendix F.

OVERVIEW OF WATER-BASED FIRE SUPPRESSION SYSTEMS

The following section outlines the required water-based fire suppression systems in Engineering IV.

Installation of Automatic Sprinkler Protection

Automatic sprinkler protection can be required based on allowable height and area requirements of CBC Chapter 5, or if any of the requirements in CBC Section 903.2 are met.

CBC Section 903.2.1.3 requires that buildings containing Group A-3 occupancies are provided with an automatic sprinkler system if one of the following criteria is met:

1. The fire area exceeds 12,000 square feet.

2. The fire area has an occupant load of 300 or more.

3. The fire area is located on a floor other than a level of exit discharge serving such occupancies.

Engineering IV contains fire areas over 12,000 square feet and Group A occupancies on floors above the level of exit discharge, and would be required to be fully-sprinklered based on these requirements.

CBC Section 903.2.3 also requires automatic sprinkler protection for Group E occupancies where the structure is greater than 12,000 square-feet in area or is a public-school state funded construction project. Both these conditions are applicable to Engineering IV, and require the building to be fully-sprinklered.

Based on these requirements, Engineering IV is provided with automatic wet-pipe sprinkler protection installed in accordance with NFPA 13.

Installation of Standpipe Systems

CBC Section 905.3 lists where standpipe systems are required to be installed based on a building's height. CBC Section 905.3.1 requires that standpipes are provided where buildings meet any of the following conditions:

1. Where the floor level of the highest story is located more than 30-feet above the lowest level of fire department vehicle access.

2. Buildings that are four or more stories in height.

3. Building where the floor level of the lowest story is located more than 30-feet below the lowest level of fire department access.

As none of these building height criteria are applicable to Engineering IV, this building is not provided with wet standpipes.

SITE WATER SUPPLY ANALYSIS

The following section outlines site water supply information, including underground piping and fire department connections.

Underground Piping

The buildings at the northeast corner of the Cal Poly campus are fed by an 8-inch site water supply. The 8-inch site main tees off to Engineering IV with a 6-inch ductile iron pipe, and is separated from the site water supply by a control valve. The 6-inch ductile iron pipe is buried 3-feet below grade, and continues approximately 350-feet until it reaches a 6-inch double check valve assembly. The 6-inch ductile iron pipe continues to serve the building's main riser.

The following is the water supply provided by the site main. The hydrant from which this flow test data was derived is located south of the Advanced Technology Laboratory (ATL), adjacent to North Perimeter Road. This flow test data was obtained in 2005.

- Static Pressure: 80 psi
- Residual Pressure: 65 psi
- Flow: 1244 GPM

Fire Department Connection

Engineering IV contains a single fire department connection (FDC) at the southeast portion of the building, adjacent to the main riser. The location of the FDC is provided in Figure 10.

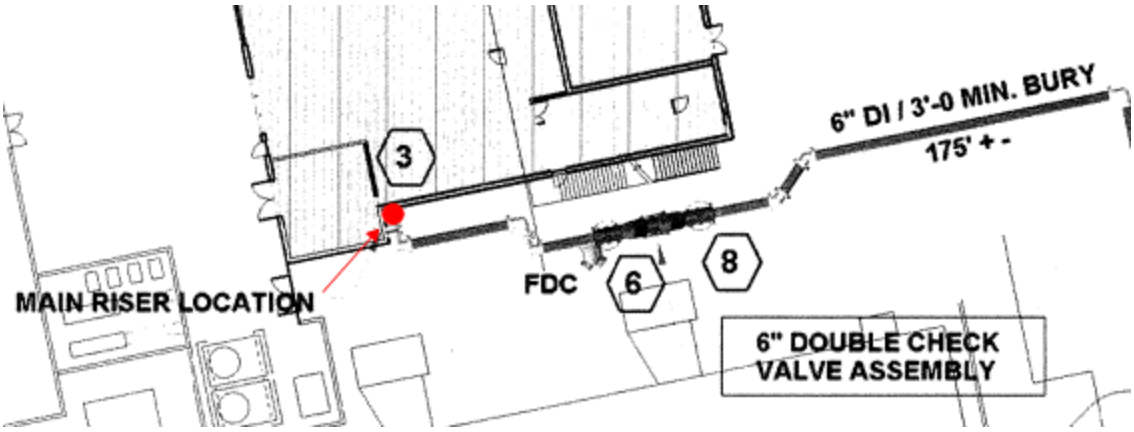

Figure 10. Location of the FDC and main riser at the southeast portion of the building site

CBC Section 912 requires that fire department connections are located so that they are fully visible and recognizable from the street or nearest point of fire department vehicle access. A fire apparatus access road to the south provides the nearest access to the FDC, which can be accessed via the adjacent plaza.

DESIGN CRITERIA FOR AUTOMATIC SPRINLKER SYSTEM

The following section details hazard occupancy classifications and sprinkler design criteria used in Engineering IV.

Classification of Occupancies

Engineering IV contains a multitude of uses, including classrooms, computer labs, faculty office space, laboratories and mechanical rooms. In accordance with NFPA 13 Chapter 5, these uses can be classified into hazard occupancy groups that determine their sprinkler design, installation, and water supply requirements. These hazard occupancy classifications are distinct from those determined within Chapter 3 of the California Building Code.

The rooms and spaces within Engineering IV are classified into the following hazard occupancies:

Light Hazard Occupancies – Occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected.

- Classrooms, faculty office space, circulation spaces, computer labs

Ordinary Hazard (Group 1) – Occupancies where the combustibility is low, quantity of combustibles is moderate, stockpiles of combustibles do not exceed 8-feet, and fires with moderate rates of heat release are expected.

- Mechanical rooms, laboratories, welding areas

Sprinkler Design Criteria

Water demand criteria for this system is based on the density/area method of NFPA 13 Section 11.2.3.2. [NFPA 13 Section 11.2.3.1.1] The water supply requirement for sprinklers is determined from the

density/area curves provided in Figure 11. Based on the curves provided, sprinklers serving Light Hazard occupancies are designed to supply 0.1-gpm/ft^2 over 1500-ft^2, or 150-gpm. Sprinklers serving Ordinary Hazard (Group 1) occupancies are designed to supply 0.15-gpm/ft^2 over 1500-ft^2, or 225-gpm.

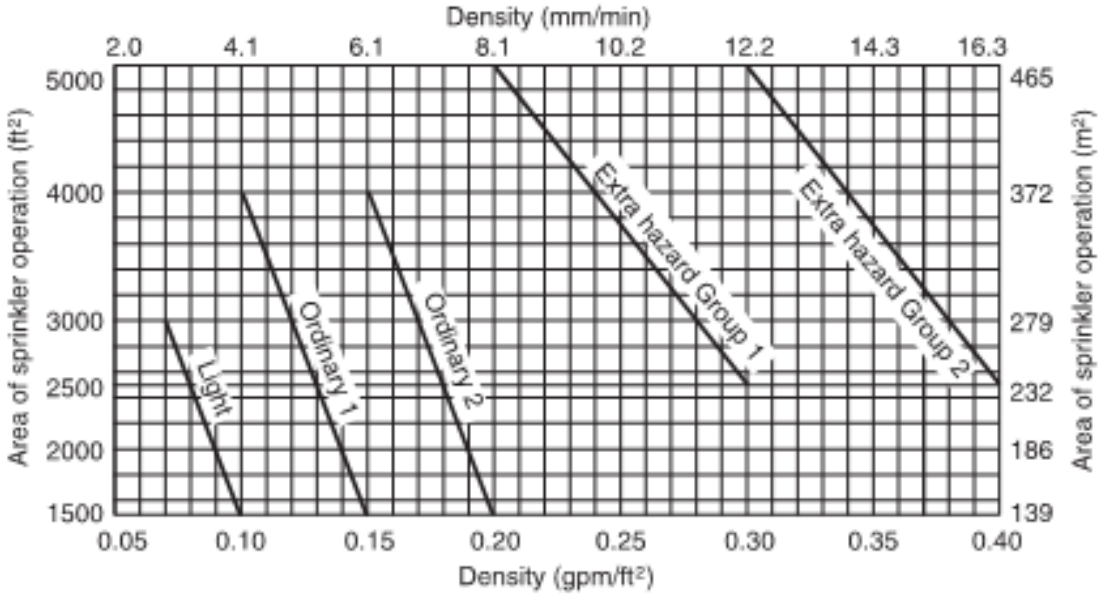

Figure 11. Density/Area Curves [NFPA 13 Figure 11.2.3.1.1]

For Light Hazard and Ordinary Hazard occupancies, NFPA 13 Section 11.2.3.2.3 allows a reduction in the sprinkler area of operation where quick-response sprinklers are used. For a ceiling height of 10-feet, a 40% reduction in design area is permitted. [Figure 11.2.3.2.3.1] For a design area of 1,500-ft^2, this reduction results in a design area of 900-ft^2. This section further requires that the number of sprinklers in the design area should never be less than five. [NFPA 13 Section 11.2.3.2.3.2]

NFPA 13 Table 11.2.3.1.2 lists the hose stream allowance and water supply duration requirements for hydraulically calculated systems. Based on the presence of ordinary hazard occupancies in Engineering IV, the total combined inside and outside hose stream allowance is 250-gpm for a duration of 60 to 90-minutes. Since this system waterflow alarm devices and supervisory devices are monitored at an approved, constantly attended location, the lower duration of 60-minutes is permitted to be used. [NFPA 13 Section 11.2.3.1.3] Light hazard occupancies are required to provide a total combined inside and outside hose stream allowance of 100-gpm for a duration of 30-minutes.

The following is a summary of the sprinkler design criteria employed for Engineering IV:

Light Hazard Occupancy
Density: 0.1 gpm/ft^2 over 900-ft^2 (+100-gpm hose stream allowance)
Minimum Number of Sprinklers: 5
Duration: 30-minutes

Ordinary Hazard (Group 1)
Density: 0.15 gpm/ft^2 over 900-ft^2 (+250-gpm hose stream allowance)
Minimum Number of Sprinklers: 5
Duration: 60-minutes

SYSTEM COMPONENTS

The following section details the types of piping, devices and other components used throughout the automatic sprinkler system. Technical datasheets for various system components are provided in Appendix G.

Main Riser

An underground 6-inch ductile iron pipe comes up through the concrete floor slab to a 4-inch Schedule 10 riser. The main riser consists of a first-floor riser that is provided with a 2-inch drain, a butterfly valve with a tamper switch, a 2-inch test and drain with a ½-inch orifice, and 300-pound pressure gages. The first-floor riser feeds the 4-inch second and third-floor riser through a flexible coupling. The second- and third-floor risers also contain their own 2-inch drain, a butterfly valve with a tamper switch, a 2-inch test and drain with a ½-inch orifice, and 300-pound pressure gages. Riser details are provided in Figure 12.

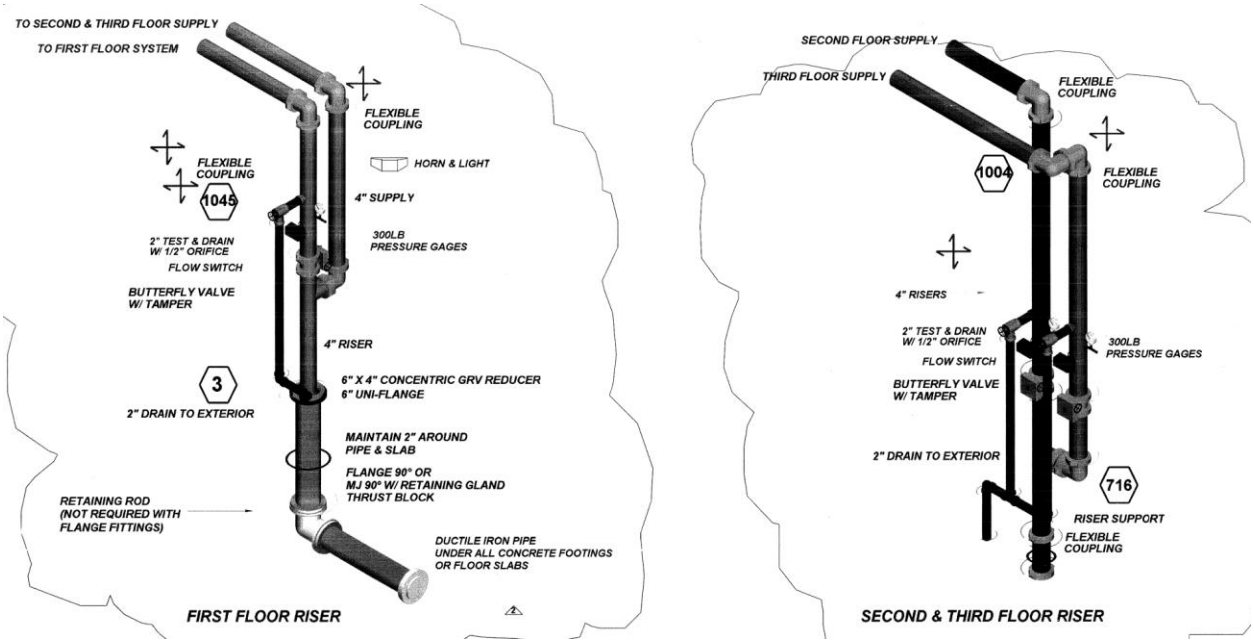

Figure 12. Riser details for the main riser serving Engineering IV

Cross Mains and Branch Lines

Per the Engineering IV fire sprinkler shop drawings, all piping 1.25-inch through 4-inch diameter used for welded mains or branch lines is Schedule 10 steel. All piping 1-inch through 2-inch used for threaded branch lines is Schedule 40 steel.

Sprinkler Heads

Fire sprinkler heads act as initiating devices when they trigger their associated waterflow switches to initiate an alarm. Engineering IV utilizes five types of sprinkler heads:

1. Reliable Model F1FR Series Upright quick-response sprinkler heads rated at 155°F

2. Reliable Model F1FR Series Upright quick-response sprinkler heads rated at 200°F
3. Reliable Model G4A concealed pendent sprinkler heads rated at 155°F
4. Reliable Model F1FR Series Sidewall quick-response sprinkler heads rated at 200°F
5. Tyco Model WS Vertical Pendant sprinkler heads rated at 155°F

Reliable sprinkler heads with a temperature rating of 155° are used in classroom, circulation and office spaces, while Reliable sprinkler heads with a temperature rating of 200° are used in laboratories and other extra hazardous spaces where the ambient temperature is much higher due to the large equipment present. Tyco Vertical Pendant sprinkler heads are used in a curtain wall configuration at the glass enclosure that separates the central communicating stair at Level 3. The K-factors for all sprinklers used in Engineering IV are 5.6.

Sprinkler Waterflow Switch

Two System Sensor Model WFDTH vane-type sprinkler waterflow switches are provided at the main riser. Waterflow detectors are electro-mechanical devices designed to send an alarm to the FACP when continuous flow of water occurs through the fire sprinkler systems piping from an activated fire sprinkler head or leak in the system.

Sprinkler waterflow switches are required to activate within 90 seconds of waterflow at the alarm-initiating device when flow occurs that is equal to or greater than that from a single sprinkler of the smallest orifice size installed in the system. [NFPA 72 17.12.2]

It should be noted that the model WFDTH switches listed in the electrical drawings are intended to be installed in single-family residential dwellings, and are not listed for commercial use. These devices should be approved by the SFM prior to installation.

Sprinkler Tamper Switches

Two System Sensor OSY2 gate valve tamper switches are installed at main riser. Tamper switches monitor what is typically the first valve between the city water line and the building sprinkler system. It is crucial that this valve is monitored by the fire alarm system to ensure the sprinkler system stays in service.

Waterflow Bell

Engineering IV is equipped with two Wheelock MB-G10-24-R waterflow bells. Section 903.4.2 of the 2016 CBC requires an exterior alarm be provided on the exterior of the building in a location approved by the fire code official. The exterior alarm is typically in close proximity to the fire department connection (FDC) in somewhat open view. The primary purposes of the exterior alarm are to alert the arriving fire department of which building or sprinkler system is in operation before staging firefighting activities and to help the responding fire apparatus engineer more quickly locate the FDC.

MANUAL HYDRAULIC CALCULATIONS

Hydraulic hand calculations are performed using the control mode density/area (CMDA) method for the most remote area on Level 3, which is the Biomed Wet Lab. This room is classified as Ordinary Hazard (Group 1), with a design density of 0.15 gpm/ft^2 over 900-ft^2 (+250-gpm hose stream allowance) for a duration of 60-minutes.

Sprinklers are spaced 10-ft by 13-ft, for a sprinkler design area of 130-ft^2. Based on a design area of 900-ft^2, we can calculate the minimum branch line length as follows:

$$L \geq 1.2\sqrt{A}$$

$$L \geq 1.2\sqrt{900\ ft^2}$$

$$L \geq 36\ ft$$

For sprinkler spacing of 10-feet, we can calculate the minimum number of sprinklers per branch line:

$$N \geq {}^{36\ ft}/_{10\ ft}$$

$$N \geq 3.6\ sprinklers$$

$$N = 4\ sprinklers$$

Taking the actual design area for 4 sprinklers per branch line results 850-ft^2, which is less than the minimum required design area of 900-ft^2. Therefore, we need to add one additional sprinkler for each branch line to exceed to minimum required design area, for a total of 10-sprinklers. The sprinklers serving this area are Reliable Model G4A concealed pendent sprinkler heads rated at 155°F, with K-factors of 5.6. The remote design area is 1,049-ft^2, which is shown in Figure 13.

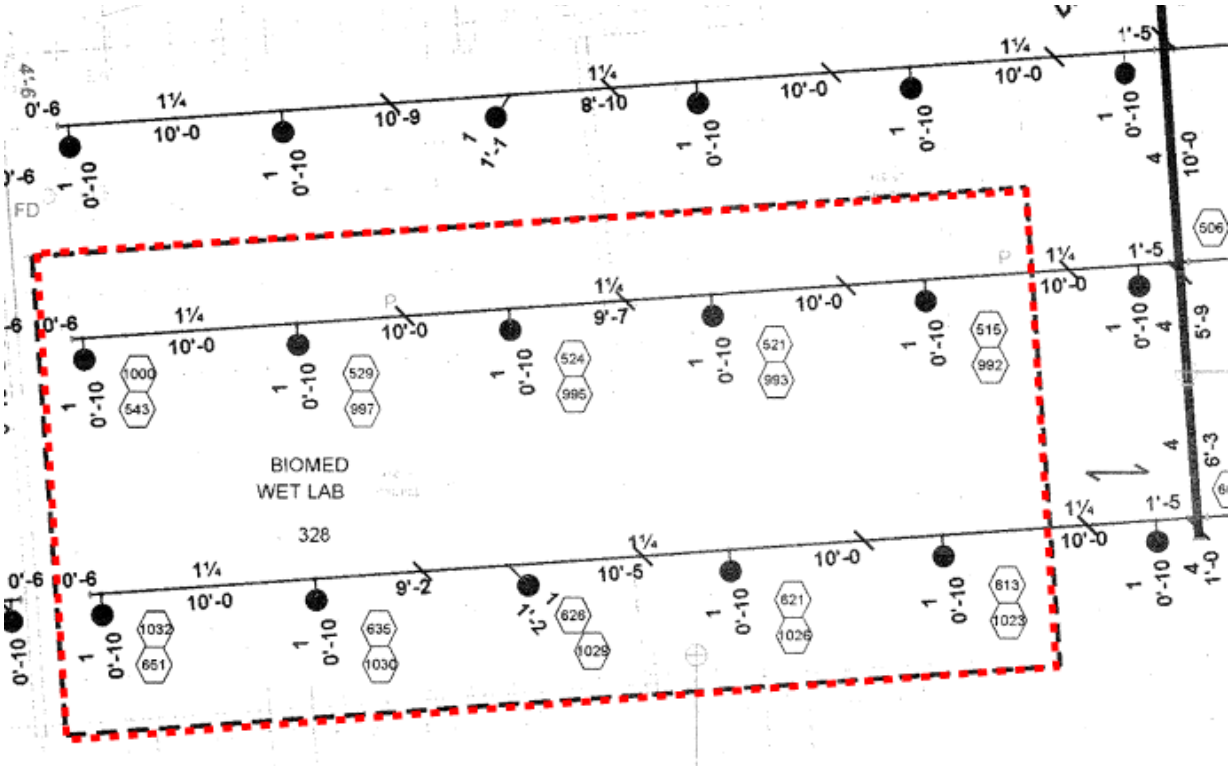

Figure 13. Design area used in hydraulic calculations for Engineering IV.

The manual hydraulic calculations for this design area are provided in Appendix H. The resulting system demand for this design area is provided below:

Manual Hydraulic Calculations:

Required Pressure: 92.7 psi

Required Flow: 227 gpm + 250 gpm HSA

Available Pressure: 77.6 psi

Safety Margin: -19.5%

Engineering IV Shop Drawings:

Required Pressure: 67.2 psi

Required Flow: 210.8 gpm

Available Pressure: 77.6 psi

Safety Margin: 13.4%

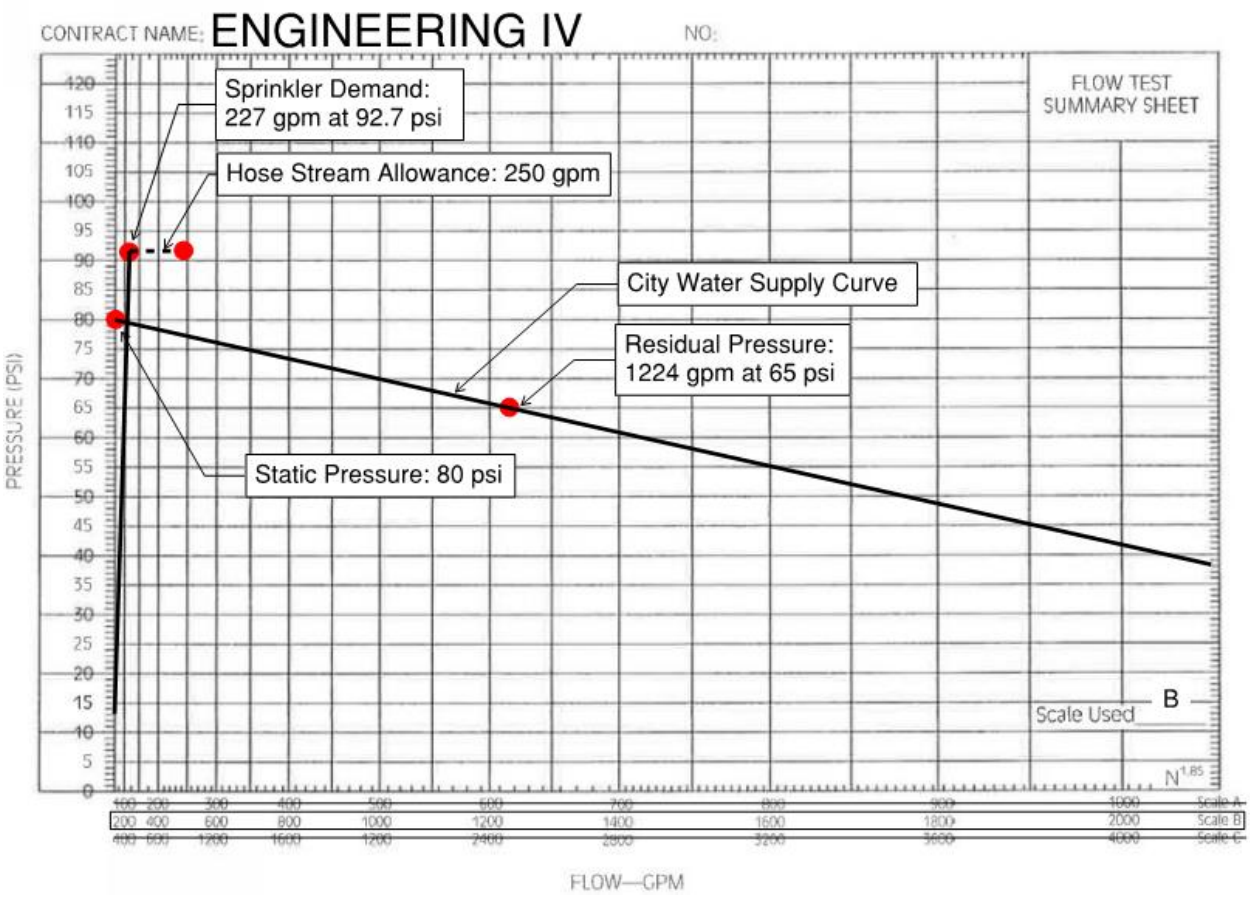

Figure 14. Supply and demand curves for Engineering IV

The supply and demand curves produced from these calculations are provided in Figure 14. Based on these calculations, the city water supply is inadequate to meet the system demand for Engineering IV and a fire pump is required.

It should be noted that the fire sprinkler shop drawings do not specifically call out which pipes are Schedule 10 and which are Schedule 40. For the purposes of these calculations, I assumed that the branch lines are Schedule 40 while the cross main and riser are Schedule 10. This could have contributed to the sprinkler demand being significantly higher than the city water supply. I would also recommend that computer-based calculations are performed to compare to the hand-calculations to determine any deviation.

Sizing a Fire Pump

NFPA 13 does not specifically recommend a safety factor for fire pumps, however most local jurisdictions require a 10% or 10 psi safety factor for fire pump sizing, whichever is higher. 10% of the required pressure is 9.3 psi, so the pump will need to boost the pressure by an additional 10 psi for a total system pressure of 102 psi. The site water main supplies approximately 76 psi at 577 gpm, so an additional 26 psi is required from the fire pump.

Based on a sprinkler and hose stream demand of 577 gpm at 92.7 psi, a fire pump should serve 150% of the rated flow at 65% of the rated head. To select the rated flow, the demand flowrate can be divided by 1.5 and then rounded up to the next highest standard size:

$$577\ gpm\ \div 1.5 = 384.7\ gpm$$

The next highest pump size is 500 gpm. The percent of overload flow is:

$$577\ gpm\ \div 500\ gpm = 115\%$$

Based on Figure 15, 115% of the rated capacity produces 90% of the rated head. [1] The rated head can be found by dividing the pressure provided at the pump at the demand flow by the percentage of the head:

$$26\ psi\ \div 0.9 = 28.9\ psi$$

The minimum pump rating is 500 gpm at 29 psi. To verify the churn pressure doesn't exceed 175 psi, the pressure provided by the pump at its rated pressure is multiplied by 120% and added to the 80 psi static pressure of the system:

$$(29\ psi \times 1.2) + 80 = 114.8\ psi\ < 175\ psi$$

Therefore, I would recommend a fire pump with a minimum rating of 500 gpm at 29 psi. The resulting supply and demand curves are provided in Figure 16.

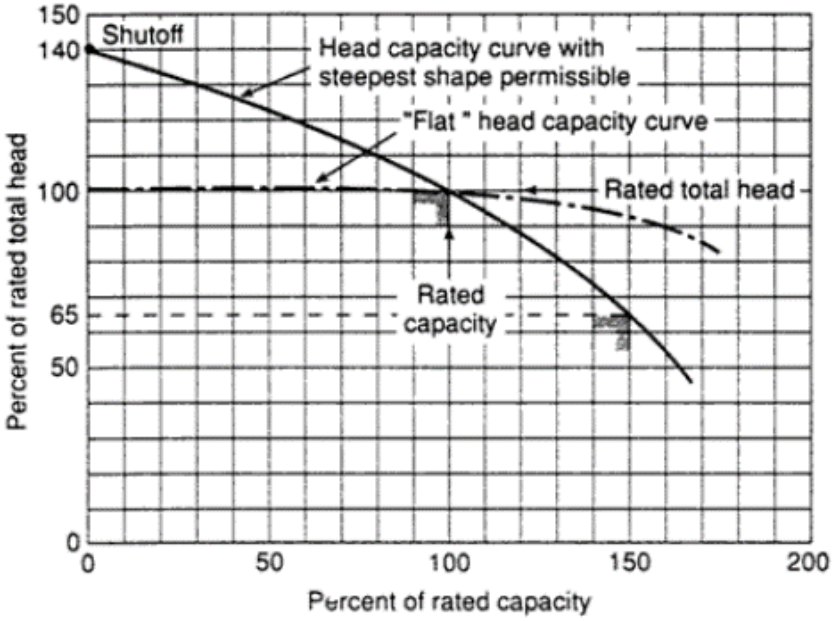

Figure 15. Fire pump curve

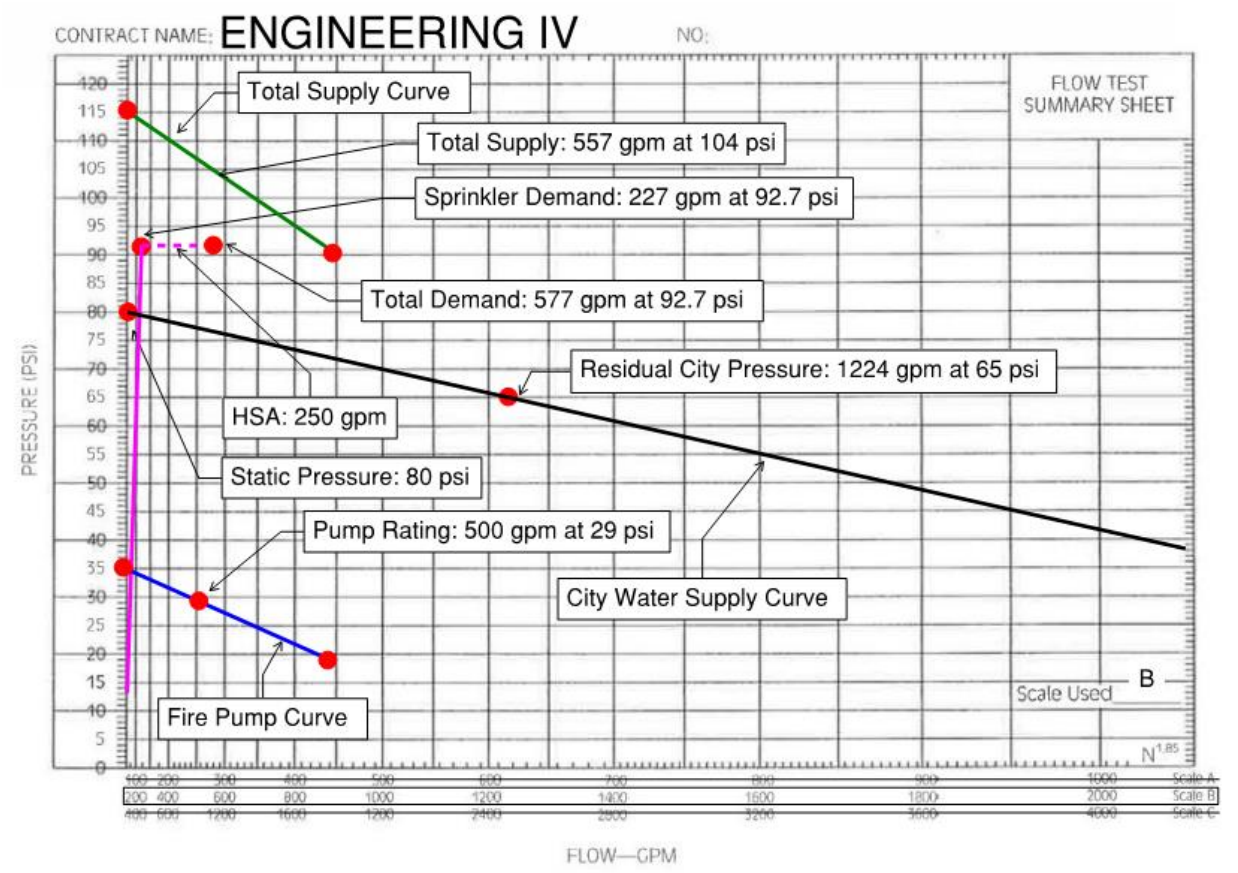

Figure 16. Supply and demand curves for Engineering IV. The addition of a fire pump supplying 500 gpm at 29 psi results in a total supply of 557 gpm at 104 psi.

INSPECTION, MAINTENANCE AND TESTING

It is the responsibility of California Polytechnic State University to maintain the integrity of the sprinkler system. The following items are an overview of the requirements of NFPA 25 for this building:

A. Inspection, testing, maintenance and impairment procedures should be implemented in accordance with NFPA 25 and in accordance with the manufacturer's instructions. [NFPA 25 Section 4.1.1.1]

B. The property owner or designated representative should not make any changes in the occupancy, the use or process, or the materials used or stored in the building without the evaluation of the fire protection systems for their capability to protect the new occupancy use, or materials. [NFPA 25 Section 4.1.6]

C. If an impairment to a water-based fire protection system occurs or is identified during inspection, testing or maintenance activities, the procedures outlined in Chapter 15 should be followed, including the attachment of a tag to the impaired system. [NFPA 25 Section 4.1.10.1]

D. Records should be made for all inspections, tests, and maintenance of the system and its components and should be made available to the AHJ upon request. The records should be maintained by the property owner. [NFPA 25 Section 4.3.1, 4.3.3]

A summary of sprinkler system inspection, testing and maintenance intervals is provided in NFPA 25 Tables 5.1.1.2 and 13.1.1.2.

SUMMARY

This section has outlined the design criteria, installation requirements and maintenance of all water-based fire suppression systems provided in Engineering IV. This section has also included a summary of components used throughout the building's automatic sprinkler system, as well as an analysis of the adequacy of the system's water demand using manual hydraulic calculations. This system meets the prescriptive requirements of the 2016 CBC and NFPA 13, except that the model WFDTH switches listed in the electrical drawings are intended to be installed in single-family residential dwellings, and are not listed for commercial use. Based on the hydraulic calculations performed herein, the consultant would recommend the addition of a fire pump supplying 500-gpm at 29-psi to meet the system's hydraulic demand. The next section will examine the structural fire protection features of Engineering IV and determine whether these features meet the prescriptive requirements of the 2016 CBC.

STRUCTURAL FIRE PROTECTION

The purpose of this section is to perform a structural fire protection analysis to determine if Engineering IV complies with the requirements of the 2016 CBC. The analysis of this building will consist of the following three items:

- Determine the required construction classification in accordance with the 2016 CBC.
- Identify the materials used to construct the columns, beams, floor assemblies, roof assembly, exterior walls and interior walls and partitions.
- Summarize the fire resistance requirements for different elements of the building.

OCCUPANCY, CONSTRUCTION TYPE, AND STRUCTURAL FIRE PROTECTION REQUIREMENTS

The original code analysis for this building is based on the 2001 California Building Code (CBC), however for this analysis we will determine if the requirements of the 2016 CBC are met. This building is equipped with an automatic sprinkler system, so the following analysis will not reflect requirements for non-sprinklered buildings.

Occupancy Classification

To determine allowable types of building construction for this building, the occupancy type(s) must first be established. The occupancy of this building is classified as a mixed-use occupancy due to the multitude of uses throughout the space. A Group A-3 classification is given to classrooms over 50 occupants while classrooms, labs, studios and offices under 50 occupants are classified as a Group B occupancy. Mechanical spaces and storage rooms are classified as a Group S-2 occupancy. The definitions of these occupancy types can be found in Sections 303, 304 and 311 of the CBC.

CBC Section 504.2 states that in a building containing mixed occupancies no individual occupancy shall exceed the number of story limits specified in this section for the applicable occupancies.

Building Height and Number of Stories

CBC Section 504 details the requirements for allowable building height and number of stories based on the type of construction, occupancy classification, and whether an automatic sprinkler system is installed throughout the building. The actual building height is 56-feet above grade plane and the highest occupied floor is 30-ft above grade. Since the highest occupied floor level is less than 75-ft above the level of fire department access, it is not considered a high-rise building per CBC Section 403. Based on CBC Table 504.3, for a 56-ft tall Group A-3, B or S-2 occupancy equipped with an automatic sprinkler system, Types I, II, III, IV and V construction are allowed.

CBC Section 504.2 states that in a building containing mixed occupancies no individual occupancy shall exceed the number of story limits specified in this section for the applicable occupancies. In accordance with CBC Section 504.4, the maximum number of stories of a building shall not exceed the limits specified in CBC Table 504.4. Types I, II, III, IV and VA construction are permitted for a three-story building with Group A-3, B, and/or S-2 occupancies. Type VB construction is not permitted, since Group A-3 occupancies are limited to 2-stories above grade plane even if the height increase is applied.

Allowable Building Area

Section 506 details how to determine the floor area of a building based on type of construction, occupancy classification, whether there is an automatic sprinkler system installed throughout the building and the amount of building frontage on public way or open space. For a mixed-occupancy, multistory building, the allowable area is calculated from CBC Equation 5-3.

$$A_a = \left[A_t + \left(NS \times I_f\right)\right] \quad \text{(Equation 5-3)}$$

The frontage allowance is calculated in CBC Equation 5-5 as shown below. Engineering IV has one side open to a public way and two sides open to an open space. The distance for each of these sides is greater than 30-ft and therefore a value of 30-ft will be used for *W*. Using an approximate building perimeter of 1120-ft and a frontage distance of 860-ft, the area factor increase based on frontage was calculated to be approximately 50%.

$$I_f = \left[{}^{F}/_{P} - 0.25\right] \times {}^{W}/_{30} \quad \text{(Equation 5-5)}$$

$$I_f = 100 \times \left[{}^{860ft}/_{1120ft} - 0.25\right] \times {}^{30}/_{30}$$

$$I_f \approx 50\%$$

The maximum allowable areas for each construction type is provided in Table 7.

Table 7. Allowable area values for Group A-3, B and S-2 occupancies per CBC Table 506.2.

	Type I		Type II		Type III		Type IV	Type V	
	A	B	A	B	A	B	HT	A	B
A-3[1]	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000
B[2]	UL	UL	112,500	69,000	85,500	57,000	108,000	54,000	27,000

	Type I		Type II		Type III		Type IV	Type V	
	A	B	A	B	A	B	HT	A	B
S-2[2]	UL	237,000	117,000	78,000	117,000	78,000	115,500	63,000	40,500

1. Values are for a sprinklered multi-story building without height increase.
2. Values are for a sprinklered multi-story building.

Allowable area calculations for each construction type are provided in Table 8 (Type VB has been previously eliminated). The allowable area for each story is calculated using Equation 5-3, considering the frontage allowance calculated previously. The actual area of each story was then divided by the allowable area for each story. Per CBC Section 506.2.4, the ratio of actual area to allowable area for each story cannot exceed 1. Since Group A-3 occupancies are present, the sum of the ratios for each story cannot exceed 2. Based on the results of these calculations, Types VA, IV, III, and II construction are eliminated from consideration based on these limits. That leaves only two construction types, Types IB and IA, that are permitted for this building.

Table 8. Allowable area calculations for Engineering IV. Area increase is applied for allowable area values unless otherwise noted. Based on the results of this calculation, Types I-B and I-A construction are permitted.

Construction Type	Story Above Grade Plane	Actual Area (feet^2)	Allowable Area[1] (feet^2)	Ratio
VA[2]	1st	44,949	17,250	2.61
	2nd	40,818	17,250	2.37
	3rd	27,954	17,250	1.62
	Total	**113,721**	**51,750**	**6.59**
IV	1st	44,949	52,500	0.86
	2nd	40,818	52,500	0.78
	3rd	27,954	52,500	0.53
	Total	**113,721**	**157,500**	**2.17**
IIIB[2]	1st	44,949	14,250	3.15
	2nd	40,818	14,250	2.86
	3rd	27,954	14,250	1.96
	Total	**113,721**	**42,750**	**7.98**
IIIA	1st	44,949	49,000	0.92
	2nd	40,818	49,000	0.83
	3rd	27,954	49,000	0.57
	Total	**113,721**	**147,000**	**2.32**
IIB[2]	1st	44,949	14,250	3.15
	2nd	40,818	14,250	2.86
	3rd	27,954	14,250	1.96
	Total	113,721	**42,750**	**7.98**
IIA	1st	44,949	23,250	1.93
	2nd	40,818	23,250	1.76
	3rd	27,954	23,250	1.20
	Total	**113,721**	**69,750**	**4.89**

Construction Type	Story Above Grade Plane	Actual Area (feet^2)	Allowable Area[1] (feet^2)	Ratio
IB	1st	44,949	276,500	0.16
	2nd	40,818	276,500	0.15
	3rd	27,954	276,500	0.10
	Total	**113,721**	**829,500**	**0.41**
IA	1st	44,949	UL	UL
	2nd	40,818	UL	UL
	3rd	27,954	UL	UL
	Total	**113,721**	**UL**	**UL**

1. Includes frontage factor of $I_f = 0.50$.
2. Allowable area values are for a sprinklered multistory building with the height increase.

At the time Engineering IV was constructed all structural work, materials and testing were required to comply with the 2001 CBC, which was based on the 1997 UBC. The original construction classification was Type II-FR, which under IBC standards is now specified as Type I-B construction. Since this building is constructed with Type I-B construction, the construction type meets the requirements of the 2016 CBC.

STRUCTURAL FIRE PROTECTION REQUIREMENTS

Fire Protection of Building Elements

The fire protection requirements for building elements are provided in CBC Table 601. For Type IB construction, the primary structural frame, as well as the interior and exterior load-bearing walls must be not less than 2-hours. The floor construction and associated secondary members shall have a 2-hour rating. Roof construction and associated secondary members shall have a 1.5-hour rating. Interior nonbearing walls and partitions are not required to have a rating unless required by other sections of the CBC. The fire-resistance ratings of primary structural frame and interior bearing walls are permitted to be reduced by 1-hour where supporting a roof only.

Rating Requirements for Exterior Walls based on Fire Separation Distance

The fire-resistance rating requirements for non-load-bearing exterior walls based on fire separation distance are provided in CBC Table 602. For Group A, B and S-2 occupancies of Type I-B construction, a 1-hour fire-resistance rating is required for fire separation distances (FSD) between 0-feet and 30-feet. However, footnote “g” of this table allows exterior walls to be non-rated if the allowable area of unprotected openings is not limited by CBC Table 705.8. This exception was recently applied as of the 2013 CBC, and did not exist during the construction of this building.

As shown in Figure 17, the south exterior walls of Engineering IV are adjacent to the Advanced Technology Laboratory (ATL) building. There is 40-feet of separation between the opposing exterior walls of these two buildings. During the original design, an imaginary property line was drawn at the midpoint between the two buildings, resulting in 20-feet of FSD for each building. Based on this placement of the imaginary property line, the exterior walls of each building were required to be 1-hour rated with unlimited area of unprotected openings.

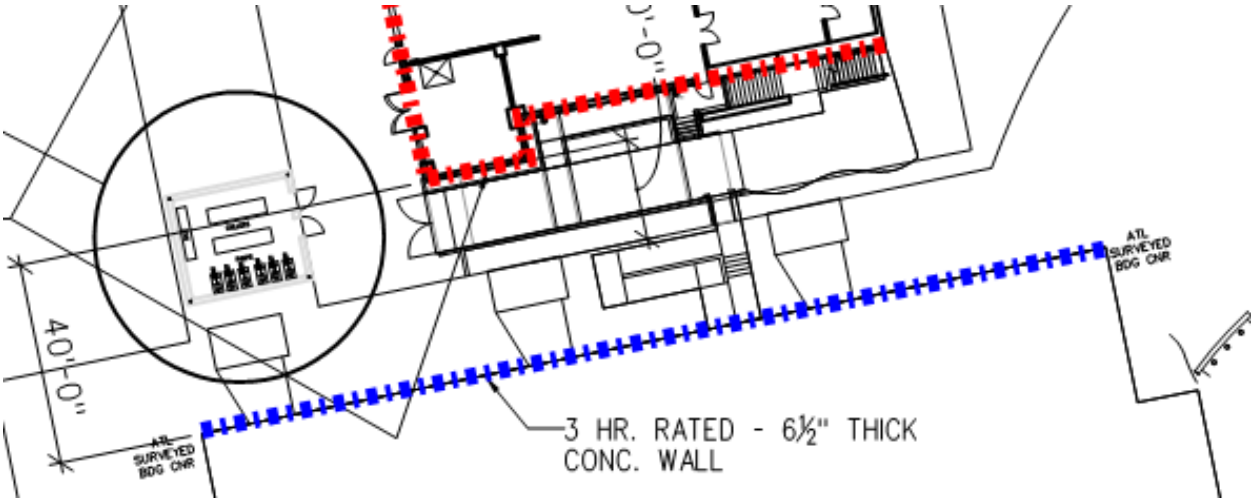

Figure 17. Fire separation distance between Engineering IV and the ATL building. The imaginary property line is located at the midpoint between the two buildings, resulting in 20-feet of FSD for each building. The exterior wall of the ATL building (bottom) is a 3-hour rated concrete wall (shown in blue), while the exterior wall of Engineering IV (top) is 1-hour rated (shown in red).

Similarly, the west exterior walls of Engineering IV face Engineering III, as shown in Figure 18. There is approximately 52-feet of separation between the opposing exterior walls of the two buildings. During the original design, an imaginary property line was drawn at the approximate midpoint between the two buildings, resulting in 25-feet of FSD for each building. Based on this placement of the imaginary property line, the exterior walls of each building were required to be 1-hour rated with unlimited area of unprotected openings.

Figure 18. Fire separation distance between Engineering IV and Engineering III. The imaginary property line is located at the approximate midpoint between the two buildings, resulting in 25-feet of FSD for each building. The exterior wall of Engineering III (left) is a 3-hour rated CMU wall (shown in blue), while the exterior wall of Engineering IV (right) is 1-hour rated (shown in red).

Based on 2016 CBC Tables 602 and 705.8, a FSD of over 20-feet would allow the ATL, Engineering III and Engineering IV to have non-rated exterior walls with unlimited unprotected openings.

BUILDING STRUCTURE AND CONSTRUCTION DETAILS

Columns and Primary Structure

The primary structure consists of concrete encased steel wide flange columns and pipe columns supporting steel wide-flange girders, beams and joists. The structural frame has 2-hour spray applied resistive material as was required by the design rating. Fireproofing is not required for steel supporting canopies or steel supporting exterior stairs.

The steel columns used in this construction have a 2-hour unrestrained fire-resistance rating, and are classified under U.L. X-772 for the wide flange columns and U.L. X-771 for the tube columns. The U.L. X-722 listing specifies a minimum W6x16 column size with outside dimensions of 6-1/4 by 4 in. with a flange thickness of 3/8-in., a web thickness of 1/4-in. and a cross sectional area of 4.72-sq in. To achieve a 2-hour rating, the minimum thickness of SFRM used is 1-11/16-in. The U.L. X-771 listing specifies steel circular pipe with diameter (OD) ranging from a minimum of 3-in. to a max of 32-in. with a minimum wall thickness of 3/16-in. The amount of SFRM applied is based on the A/P ratio and the hourly resistance rating.

Floor and Roof Assemblies

The floor steel deck consists of 3-inch deep, 20-gauge 36-inch wide metal decking with 3.25-inch thick light weight concrete topping reinforcement. The roof steel deck consists of 3-inch deep, 20-gauge 36" wide metal decking with 2.5-inch thick light weight concrete topping reinforcement.

The floor decks and roof decks are classified under U.L. D-925 and protected by a 2-hour rating for floor decks and a 1-hour rating for roof decks. No fireproofing is required under this listing and the decks are left exposed.

The floor and roof beams are listed under U.L. N-782 and are protected with a 2.5-hour rating for primary beams at the roof, a 1.5-hour rating for secondary beams at the roof, and a 2-hour rating for primary and secondary floor beams. According to the fireproofing schedule the floor and roof beams supporting light weight concrete were sprayed with an increase of ½ hourly rating due to the addition of insulation on top of concrete.

Exterior Walls

The exterior walls are R-19 rated and constructed of steel stud frame walls faced with fiber reinforced cementitious panel and metal panel siding. The furred walls have one layer of 5/8-in. Type 'X' gypsum wall board and 2.5-in. metal studs where noted, with a max span of 11-ft-6-in. The exterior walls are non-load bearing and are not required to be fire-resistance rated, except for walls facing the neighboring buildings as mentioned earlier. These walls are 1-hour fire-rated based on fire-separation distance.

Interior Non-Load Bearing Walls and Partitions

The interior non-load bearing walls and partitions have a 1-hour fire-resistance rating and are U.L. U-419 listed. The partition consists of either one or two layers of 5/8-in. Type 'X' gypsum wall board on each side, with either 4-in. or 6-in. x 22-gauge studs at 16-in. on center. The walls contain plenum rated fiberglass batt insulation and have a continuous acoustical sealant on both sides.

Shaft Walls

Since shafts in this building penetrate a 2-hour rated floor assembly, the shaft walls are required to be of at least 2-hour construction per CBC Section 713.4. The shaft walls have a 2-hour fire resistance rating and are U.L. U-415 listed. The shaft walls consist of one layer of 1-in. core board on the shaft side and two layers of 5/8-in. Type 'X' gypsum wall board on the opposite side. The walls are fitted with 4-in. by 20-gauge channel studs. The walls contain plenum rated fiberglass batt insulation and have a fire-rated acoustical seal.

SUMMARY

From the preceding analysis, the building elements used in the construction of Engineering IV appear to meet or exceed the requirements set by the 2016 CBC. Additionally, the Type IB construction used for this building meets the allowable building height and area requirements of CBC Chapter 5. All building elements and assemblies with required fire-resistance ratings are U.L. listed. The next section will examine the smoke control features of Engineering IV.

SMOKE CONTROL SYSTEMS

The purpose of this section is to discuss the smoke control features of Engineering IV. Although Engineering IV is not provided with a mechanical smoke control system, this building is equipped with various passive fire protection features.

ATRIUM

As shown in Figure 19 (left), the main lobby of this building is open to the level above and can be considered a two-story atrium per CBC Section 404. Adjacent to the main lobby is a three-story convenience stair, which is also shown in Figure 19 (right).

CBC Section 404.3 requires that atrium connecting more than two-stories are provided with an active smoke control system complying with CBC Section 909. CBC Section 404.6 also requires that atriums be enclosed in 1-hour fire barrier construction. To avoid providing active smoke control in this building and separating the atrium from the rest of the building, the original design incorporated a glass wall with closely spaced sprinklers to atmospherically separate the convenience stair from the 3rd Floor, in accordance with CBC Section 404.6 Exception 1. The result is that the 1st and 2nd Floors can be considered a two-story atrium and the opening between the 2nd and 3rd Floors can be considered a two-story vertical opening per CBC Section 712.1.9.

Figure 19. Main lobby of Engineering IV is a two-story atrium (left). A three-story convenience stair connects all three floors (right).

DUCT SMOKE DETECTORS

Engineering IV is equipped with Notifier FSD-751P duct smoke detectors. Duct smoke detectors are provided at both air handlers to detect if smoke is being supplied into the building's HVAC system and allows the fire alarm system to shut down the HVAC system in alarm condition. 2015 NFPA 90A requires that duct smoke detectors are located in the following locations [NFPA 90A Section 6.4.2.1]:

1. Downstream of the air filters and ahead of any branch connections in air supply systems having a capacity of greater than 2000 ft^3/min

2. At each story prior to the connection to a common return and prior to any recirculation or fresh air inlet connection in air return systems having a capacity greater than 15,000 ft^3/min and serving more than one story

Additionally, return system smoke detectors are not required where then entire space served by the air distribution system is protected by a system of area smoke detectors. [NFPA 90A Section 6.4.2.2]

Based on the mechanical drawings provided in the original record drawings, duct smoke detectors are provided at both air handling units located on the roof, downstream of supply air openings that provide 2000 ft^3/min per NFPA 90A Section 6.4.2.1 Item 1. Therefore, the placement of duct smoke detectors in Engineering IV satisfies the requirements of NFPA 90A.

FIRE DAMPERS

Engineering IV contains corridors that are constructed as 1-hour fire partitions. CBC Sections 717.5.4 and 717.5.4.1 require duct penetrations and air transfer openings in corridors to be constructed as fire partitions. They must be protected with both a fire damper and smoke damper or a combination fire/smoke damper. The fire damper and smoke damper can be omitted if the duct is constructed of steel not less than 0.019 inches in thickness and there are no openings from the duct serving the corridor.

Engineering IV also contains rated fire barriers and shaft enclosures that are penetrated by ducts and air transfer openings. Per CBC Sections 717.5.2 and 717.5.3, ducts and air transfer openings of fire barriers and shaft enclosures are required to be protected with approved fire and smoke dampers installed in accordance with their listing. Based on the mechanical drawings provided in the original record drawings, combination fire/smoke dampers are provided throughout Engineering IV where ducts and air transfer openings penetrate rated assemblies.

MAGNETIC CLOSING DOORS

Cross-corridor doors are provided near the restrooms on Levels 2 and 3 that are equipped with magnetic closing devices. These doors close in alarm condition to maintain the 20-foot dead-end limit required for Group A occupancies, and maintain corridor continuity for the one-hour rated corridors required by the UBC.

Magnetic closing doors are also provided at the 3rd floor landing of the central communicating stair. These doors close in alarm condition and maintain a 2-hour separation between the first two floors and the 3rd floor.

ELEVATOR HOISTWAY PROTECTION

In accordance with CBC Section 3006, elevator hoistway openings are required to be protected where the elevator hoistways connect more than two stories in a Group A. The purpose of this requirement is to prevent smoke spread up the elevator hoistway to adjacent levels. To meet this requirement, Elevator 1 is provided with a listed and labeled smoke containment system complying with ICC ES AC 77 per CBC Section 3006.3 Item 5. Elevator 2 is provided with additional smoke and draft control doors that close on alarm per CBC Section 3006.3 Item 3.

AUTOMATIC HORIZONTAL FIRE SHUTTERS

There are six light wells (three on the 2nd floor and three on 3rd floor) that allow light to pass from the floors above to the floors below. To maintain the integrity of the rated floor assembly and allow the main lobby to remain classified as a two-story atrium, the light wells on the 3rd floor are provided with horizontal fire shutters that achieve a 2-hour rating.

SUMMARY

This section has examined the various passive smoke protection features provided throughout Engineering IV. The 2-hour rated curtain wall sprinklers and glass enclosure at the top of the communicating stair as well as the horizontal fire shutters serve to limit the development of a large smoke plume in the main lobby and eliminate the requirement for mechanical smoke control. Magnetic closing doors, elevator hoistway protection and combination smoke/fire dampers serve to compartmentalize the building and limit the spread of smoke in a fire event. Duct smoke detectors are provided at both air handlers to detect if smoke is being supplied into the building's HVAC system and allows the fire alarm system to shut down the HVAC system in alarm condition. A performance-based analysis of Engineering IV used to evaluate the building's performance in two design fire scenarios will be discussed in the next section.

PERFORMANCED-BASED ANALYSIS

This performance based analysis consists of using a computational fluid dynamics (CFD) model to evaluate this building's performance in two design fire scenarios. These design fire scenarios reflect worst case fire scenarios that are likely to occur in Engineering IV due the geometry and intended use of the space. Pass/fail criteria derived from the SFPE Handbook are used to determine if occupants can evacuate the building before being exposed to untenable conditions.

GOALS AND OBJECTIVES

The goal of this performance based analysis is to provide an environment for occupants that is reasonably safe from fire by the following means (NFPA 101 Section 4.1.1):

1. Protection of occupants not intimate with the initial fire development
2. Improvement of the survivability of occupants intimate with the initial fire development.

To meet these goals, the objective for this analysis is to demonstrate that the building provides a level of occupant protection such that the building is designed, constructed, and maintained to protect occupants who are not intimate with the initial fire development for the time needed to evacuate. (NFPA 101 Section 4.2.1)

CALCULATION OF EVACUATION TIME

This analysis is based on the fundamental principle that the available safe egress time (ASET), or the time from ignition until the building becomes untenable, needs to be greater than the required safe egress time (RSET), which is the time needed by occupants to evacuate from the building.

RSET can be broken into discrete time intervals, the sum of which constitute the total RSET:

$$RSET = \left(t_d + t_n + t_{p-e} + t_e\right) \times S_F$$

where t_d is the detection phase, t_n is the notification phase, $t_{p\text{-}e}$ is pre-evacuation phase, and t_e is the evacuation phase. "S_F" represents the factor of safety used in these egress calculations. The elements t_d and t_n are heavily dependent on factors relating to human interaction with the fire and notification equipment. Appropriate pre-evacuation times ($t_{p\text{-}e}$) and evacuation times (t_e) are based on occupant behavior as well as fire and egress modeling.

The following analysis employs a first-order hydraulic model as well as a computer evacuation model enabling the evacuation time t_e to be calculated. A discussion of characteristics of occupants related to pre-evacuation activities and times is also included.

CHARACTERISTICS OF OCCUPANTS

It is important to summarize the characteristics of occupants within a building that will influence their egress times, including pre-movement and movement times. Delay times, also referred to as pre-movement times, are influenced by several factors, including the effectiveness of different cues, training of occupants or staff, time of day and so on. Travel times, or movement times, can be influenced by occupant characteristics and how familiar occupants are with the space.

Factors Related to Delay Times

Occupants in Engineering IV are mostly college students between the ages of 18 and 23, lecturers and support staff. Many of these occupants visit this building multiple times a week for lectures and lab instruction and are familiar with the layout of the building.

In the event of an emergency, students will look to professors for guidance on whether to follow or ignore the signal produced by the fire alarm system. Lecturers will have the attention of their students and will be able to give them instructions in the event of an emergency. Professors are likely to fulfill the role of fire wardens in an office building, assuming leadership and directing occupants to safety.

Once the students recognize that the threat is credible, it is assumed that students will engage in pre-movement activities such as gathering their school supplies, backpacks and other belongings. If an exam is taking place, students might wait to hand off their exam to the instructor before collecting their things.

Factors Related to Movement Times

Most occupants in Engineering IV are college-aged students, that are considered able-bodied adults without mobility impairments. They are familiar with the space, however may not be familiar with all available exits.

Students typically use the central stairway (Stair #3) near the main entrance to move between levels. However, Stair #3 is a three-story atrium and is not intended to be used for egress in the event of an emergency. This means students will need to use one of the three egress stairways located on opposite sides of the building. Faculty should also be trained to direct occupants to the closest available exit.

Engineering IV is also used by K-12 students during the summer months for educational programs. These students may not be as familiar with the building as college age students that use the building on a regular basis. This knowledge should be used when making assumptions on occupant familiarity with the building.

HYDRAULIC MODEL

A first-order hydraulic model is employed to enable the occupant escape time to be calculated. The methods, equations and assumptions described herein are derived from Chapters 56 through 59 of The SFPE Handbook, 5th Edition as well as Engineering IV Record Drawings.

Model Limitations

It should be noted that the first-order hydraulic model is limited in the factors it can represent. These aspects should be noted as follows:

- Behaviors of occupants that detract from movement are not explicitly considered, such as disabilities.
- The numbers of people in a structural component are considered rather than their identity and their individual attributes.
- Movement between egress components is considered rather than within them.
- The results are deterministic and will remain the same unless changes are made to the scenario of the assumptions employed.
- The results of this model are only able to represent only a small subset of behavioral factors, and should be combined with other simulation methods (e.g., a computer simulation model) to have a stronger basis for the results.

Assumptions

The equations employed in this model are based on the relationship between the speed of movement and the population density of the evacuating population stream. These equations are based on the following assumptions:

- All persons start to evacuate at the same time.
- The population will use all facilities in the optimum balance.
- Occupant flow does not involve interruptions caused by evacuee decisions.
- The evacuees are free of impairments/disabilities that impede their movement.

The following assumptions were made based on the features of Engineering IV:

- This building consists of three floors.
- Floor-to-floor height is 15-ft.
- Three egress stairways are provided for the second floor, and two stairways are located at the ends of the building on the third floor. The building's central stair will not be used for egress.
- All three stairs are 66-in. wide with handrails protruding 2.5-in.
- Stair risers are 7-in. wide and treads are 11-in. high.
- Stair #1 and Stair #4 have 13-ft x 7-ft landings. Stair #2 has a single 10-ft x 5.7-ft landing.
- There is one 36-in. nominal width door at the entrance to each stair on the second level. The third level contains 40-in. nominal width doors at the entrance to stairs. All stairs discharge directly to the public way and are not mechanically held open.
- The first floor does not exit through the stairways.
- There is a population of 586 occupants on the second floor and 530 occupants on the third floor.

- The prime controlling factor will be either the stairways at either end of the floor or the doors serving those stairwells. Because queuing is likely to occur, the specific flow, F_s, will be set to the maximum specific flow, F_{sm}.

First-Order Approximation

From Table 59.1, the effective width of each stairway is:

$$66\ in. - 12\ in. = 54\ in.$$

Table 59.5 specifies that the maximum specific flow, F_{sm}, for the stairway is 18.5 persons/min/ft of effective width. Therefore, using Equation 59.8, the flow from each stairway is limited to:

$$F_c = F_{sm} \times W_e = 18.5\ \frac{persons}{min/ft} \times \left(54\ in. \div \frac{12\ in}{ft}\right) = 83.3\ {}^{persons}/_{min}$$

From Table 59.5, the maximum specific flow through a doorway is 24 persons/min/ft of effective width. To obtain the effective width of the doors serving the stairs, the actual width is reduced by 6-in. on each side to account for boundary layer conditions. Therefore, the effective width, W_e, of a 36-in. door and 41-in. door is 24-in. and 27-in., respectively.

Using Equation 59.8, the flow through a 36-in. door is limited to:

$$F_c = F_{sm} \times W_e = 24\ \frac{persons}{min/ft} \times \left(24\ in. \div \frac{12\ in}{ft}\right) = 48\ {}^{persons}/_{min}$$

Using the same equation for a 40-in. door:

$$F_c = F_{sm} \times W_e = 24\ \frac{persons}{min/ft} \times \left(28\ in. \div \frac{12\ in}{ft}\right) = 56\ {}^{persons}/_{min}$$

The maximum flow rate through an exit that is not mechanically held open is 50 persons/min. Because the flow capacity for the 40-in. door is higher, the flow capacity for these doors will be reduced to 50 persons/min. The flow capacity of the doors is less than the flow capacity of the stairway served, so the flow is controlled by the stairway entrance doors.

Assuming a maximum population density D of 0.175 persons/ft^2 at the queue, the speed of movement down the stairs is:

$$S = k - akD = 212 - \left(2.86 \times 212 \times 0.175\ \frac{persons}{ft^2}\right) = 105.9\ \frac{ft}{min}$$

where k and a are constants for speed in ft/min and density in persons/ft^2. The travel distance on the stair slope between floors is:

$$15\ ft \times 1.85 = 27.8\ ft$$

where 1.85 is the conversion factor from Table 59.3. Assuming 13-ft of travel on each of the two landings, the total floor-to-floor travel distance is:

$$27.8\ ft + (2 \times 13\ ft) = 53.8\ ft$$

The travel time for a person moving with the flow is:

$$\frac{53.8\ ft}{105.9\ {}^{ft}/_{min}} = 0.51\ min/floor$$

This means occupants on the second floor will need 0.51 min to travel down one floor to reach the exit discharge. Occupants on the third floor will need 1.02 minutes to reach the exit discharge.

If all the occupants in the building start evacuation at the same time, the second floor can discharge 48 persons/min while the third floor can discharge 50 persons/minute. Solving for the time required to evacuate the second floor:

$$586\ Persons\ \div \left(48\ {}^{Persons}/_{min} \times 3\ Stairways\right) = 4.1\ minutes$$

Solving for the time required to evacuate the third floor:

$$530\ Persons\ \div \left(50\ {}^{Persons}/_{min} \times 2\ Stairways\right) = 3.6\ minutes$$

This results in a total of 7.7 minutes required for the 1116 occupants above the first floor to pass through the exits. An additional 0.51-min travel time is required for the movement from the second floor to the exit. The total minimum evacuation time for the 1116 occupants located on the second and third floors is estimated at 8.2 minutes. This time is a minimum evacuation time, and does not include safety factors to account for the limitations of the model discussed above.

COMPUTER BASED EVACUATION MODEL

Pathfinder is an agent based egress and human movement simulator developed by Thunderhead Engineering. It provides a graphical user interface for simulation design and execution as well as 2D and 3D visualization tools for results analysis. The model uses a 3D triangulated mesh to match the real dimensions of the building model. The simulation mode used for this analysis is the SFPE mode, where occupants make no attempt to avoid one another and can interpenetrate, but doors impose a flow limit and velocity is controlled by density. [2]

This model is classified as a movement model, which focuses on the movement of occupants and does not have a behavioral component. This model is used to demonstrate congestion areas, queuing, or bottlenecks within the simulated building. It does not consider occupant behaviors or decision-making.

A model has been developed for Engineering IV based on the geometry of occupied spaces, doors, stairs, and other egress components. Occupants are placed in a random distribution in each room based on the occupant load calculations in Appendix B. Figure 20 shows a screenshot of the Pathfinder model when the building is fully occupied.

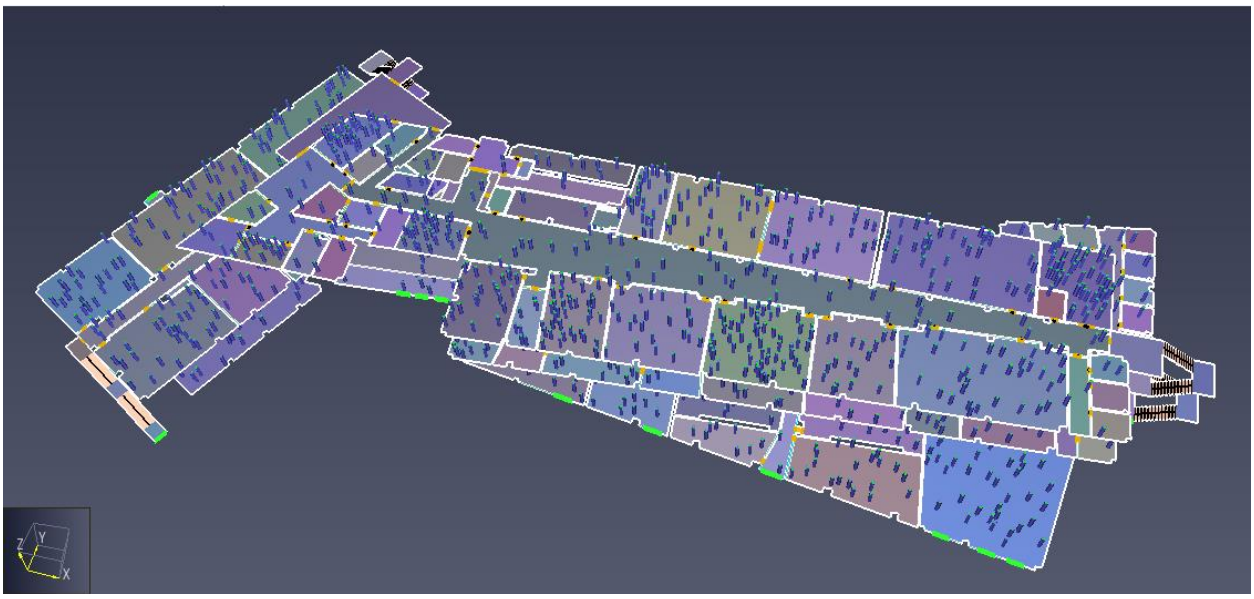

Figure 20. Pathfinder model of Engineering IV. The building occupants are represented by blue cylinders.

Evacuation Model Results

Based on the results of the simulation, the time for the last occupant to exit the second and third floors, or the escape time, is 300 seconds (5 minutes). This is 3.2 minutes faster than the 8.2 minutes calculated from the first order hydraulic model. It was expected that the hand calculations would be more conservative than the computer simulation. Figure 21 shows the Pathfinder simulation at approximately 210 seconds. As was expected, Stairs 1 and 4 are severely impacted on Level 3 since this level has a large occupant load and only has access to two exit stairs.

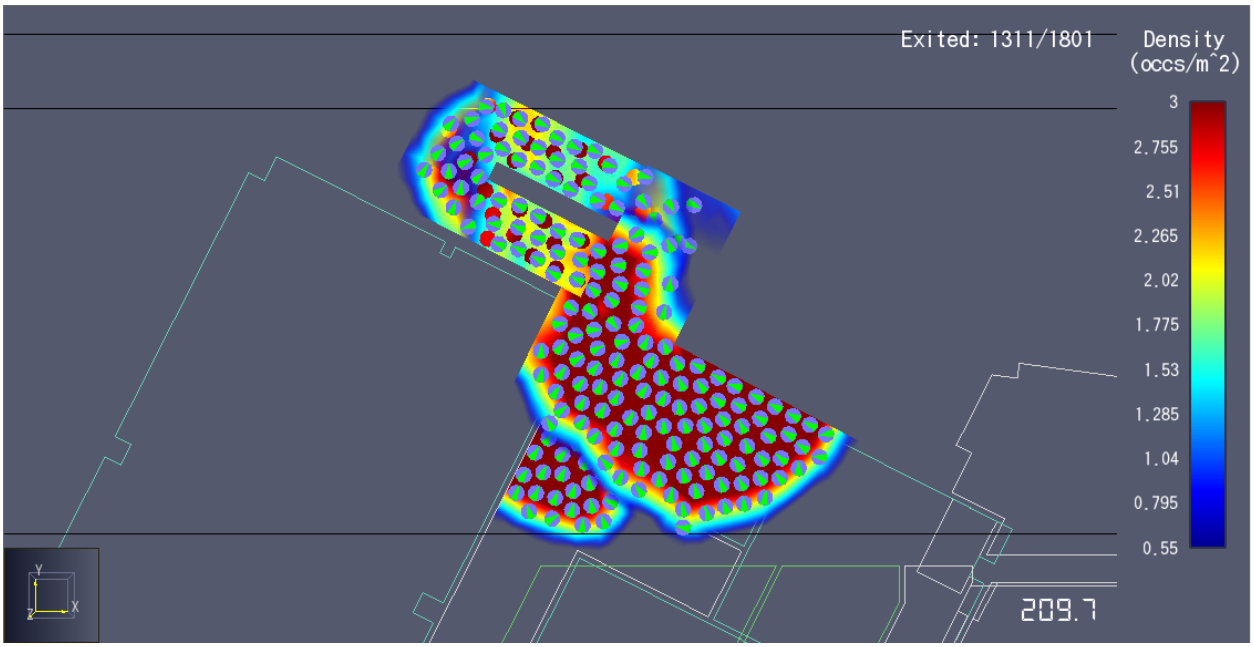

Figure 21. Pathfinder model at 210 seconds. Stair 1 is significantly impacted from the large occupant load on Level 3.

Evacuation Time Results

Each of the individual factors that make up the RSET value need to be quantified to determine the total RSET. The detection time is determined by using a smoke detector in Fire Dynamics Simulator. Photoelectric smoke detectors are input into the model based on their actual location in the building, and their activation time is determined from running the simulation for each design fire scenario. A screen capture of a smoke detector on Level 2 activating at approximately 20 seconds for Design Fire Scenario 1 is provided in Figure 22. Figure 23 shows and a smoke detector on the 3rd floor activating at approximately 45 seconds for Design Fire Scenario 2.

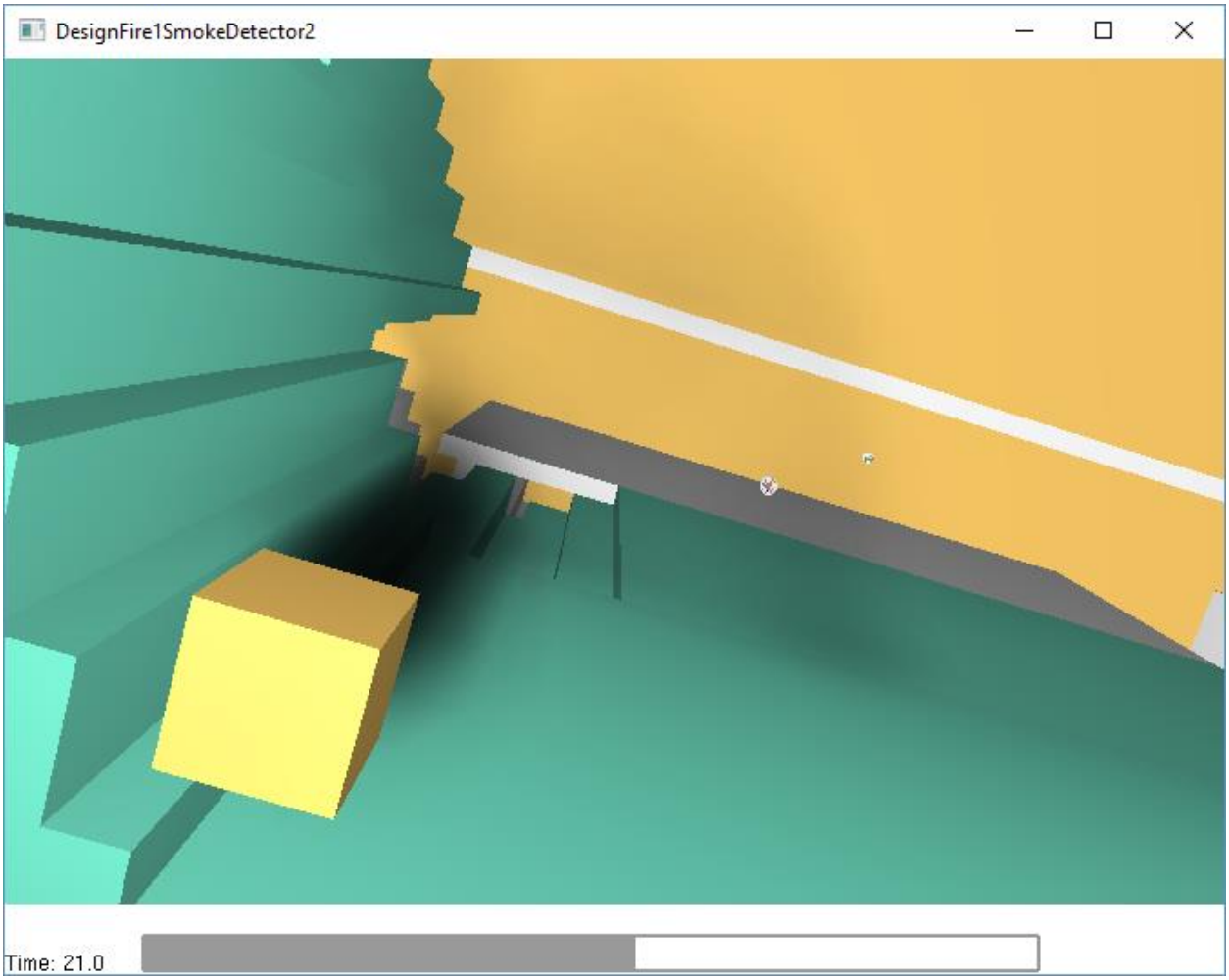

Figure 22. A photoelectric smoke detector under the Level 2 balcony activates at approximately 20 seconds for Design Fire Scenario 1.

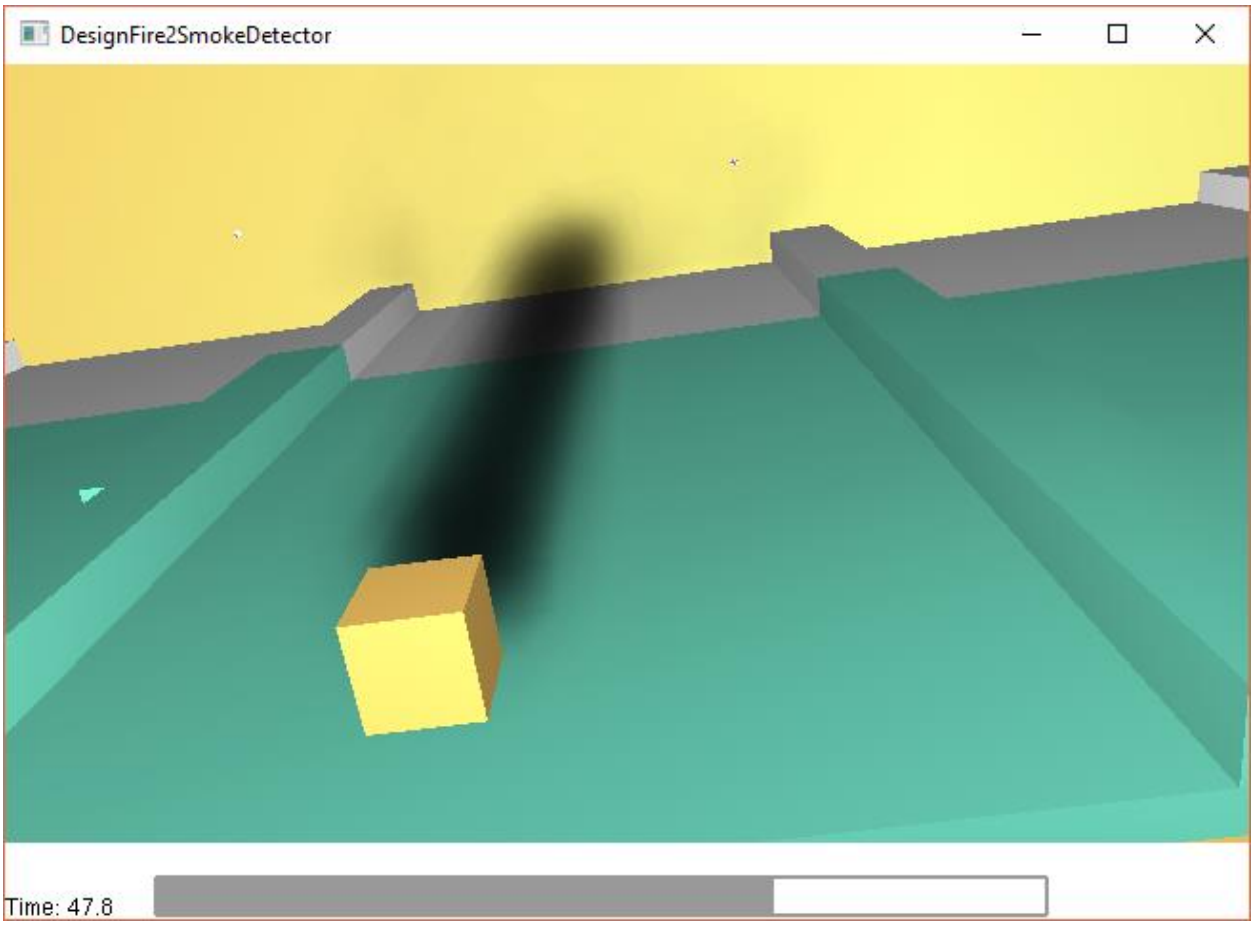

Figure 23. A photoelectric smoke detector in the Level 3 corridor activates at approximately 45 seconds for Design Fire Scenario 2.

The National Fire Alarm Code specifies a maximum time of 10-seconds for fire alarm systems to actuate alarm notification appliances or voice communication after a detection device activates. [3] From this requirement we can assume a notification time of 10-seconds.

Pre-movement time is largely based on our understanding of human behavior and understanding the activities occupants take before evacuating. It is assumed that students will engage in pre-movement activities such as gathering their school supplies, backpacks and other belongings. If an exam is taking place, students might wait to hand off their exam to the instructor before collecting their things.

Some delay times to start evacuation found in the published literature are summarized in a paper by Fahy and Proulx [4]. Table 3-12.2 in the SFPE Handbook, 2008 Edition presents premovement times found in different studies at the time of publication in 2001. Based on these assumptions, a pre-movement time of 66-seconds will be assumed for occupants to pack up their things and begin moving towards an exit. This time is based on the average premovement time of an unannounced drill for a mid-rise office building with good alarm performance and fire wardens.

The evacuation or escape time calculated in the Pathfinder simulation is 300 seconds, or 5 minutes. CBC Section 909.4.6 requires that an engineered smoke control system operate for a period not less 1.5 times the calculated egress time, so a factor of safety of 1.5 is used in these calculations.

The Required Safe Egress Time (RSET) is calculated as follows:

Design Fire Scenario 1:

$$RSET = \left(t_d + t_n + t_{p-e} + t_e\right) \times S_F$$

$$t_d = 20\ seconds$$

$$t_n = 10\ seconds$$

$$t_{p-e} = 66\ seconds$$

$$t_e = 300\ seconds$$

$$RSET = (20 + 10 + 66 + 300) \times 1.5$$

$$RSET = 594\ seconds\ (9.9\ minutes)$$

Design Fire Scenario 2:

$$RSET = \left(t_d + t_n + t_{p-e} + t_e\right) \times S_F$$

$$t_d = 45\ seconds$$

$$t_n = 10\ seconds$$

$$t_{p-e} = 66\ seconds$$

$$t_e = 300\ seconds$$

$$RSET = (45 + 10 + 66 + 300) \times 1.5$$

$$RSET = 632\ seconds\ (10.5\ minutes)$$

Therefore, the RSET values used for this analysis are 594 seconds for Design Fire Scenario 1, and 632 seconds for Design Fire Scenario 2.

TENABILITY CRITERIA

Section 5.2 of the Life Safety Code details performance criteria for a performance-based alternative to prescriptive provisions. The methods used to develop the ASET portion of the occupant evacuation analysis allow the designer to prove that any occupant who is not intimate with ignition shall not be exposed to instantaneous or cumulative untenable conditions.

Of the four methods specified in this section, Method 2 will be used for this analysis. Method 2 involves demonstrating that each room or area will be fully evacuated before the smoke and toxic gas layer in that room descends to a level lower than 6-ft above the floor. This method allows occupants to egress while maintaining the ability to stand, walk, or run normally to an exit. This assures that occupants are not exposed to fire effects.

To maintain a tenable environment for occupant egress, design criteria are developed to provide quantifiable thresholds to evaluate performance. In accordance with Method 2 described above, temperature effects, toxicity, and visibility are evaluated at 6-feet above the walking surface. These criteria and the engineering basis for their selection are detailed in the following sections.

Temperature

For building occupants escaping from a fire, the most important sources of heat exposure are radiation from hot areas and convection from hot gases. Radiation effects are most likely to affect those occupants most intimate with the fire event. Since the purpose of this performance based analysis is to protect those not intimate with the fire, the tenability effects of convection from hot gases should be considered.

Based on data provided in the SFPE Handbook, pain and the likelihood of skin burns occurs at air temperatures above approximately 120°C. [5] Under this temperature, tolerance is limited by hypothermia, and above this temperature, pain followed by burns becomes important. This concept is illustrated in Figure 22, which contains data regarding the tolerance of humans to exposure to convected heat over time. [5]

Based on an RSET of 20 minutes and the data shown in Figure 24, for this analysis the smoke layer temperature at 6-feet above the walking surface should not exceed 110°C.

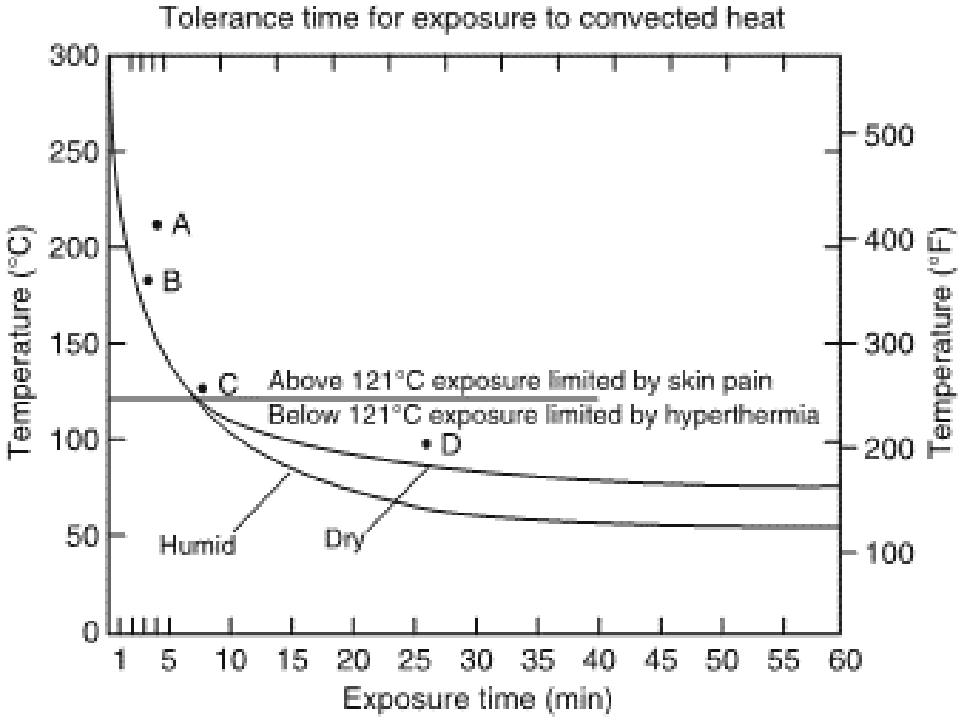

Figure 24. Thermal tolerance for humans at rest, naked skin exposed, with low air movement (less than 30 m/min) [5]

Visibility

Based on data provided in the SFPE Handbook chapter, “Visibility and Behavior in Fire Smoke”, allowable visibility for safe fire escape can vary based on occupant’s familiarity with the building geometry as well

as their emotional state. Numerous studies have been performed by fire researchers, with values ranging from 1.2-meters to 20-meters. [6] Based on SFPE Handbook Table 61.3, unfamiliar occupants need 13-meters of visibility for safe escape, while familiar occupants need only 4-meters of visibility.

Most of the occupants in Engineering IV are students that are very familiar with the building since they attend classes multiple times a week, or at the least once a week. However, there are situations where tours are provided to prospective students who may not be as familiar with their surroundings. Since there exists some number of occupants who are unfamiliar with the building, the visibility criteria should reflect this fact. Consequently, an allowable visibility limit of 10-meters will be used in this analysis. [7]

Additionally, Table 2-1.10 of the SFPE Guide to Human Behavior in Fire lists similar criterion for the effects of smoke on visibility and behavior. This table suggests that for large enclosures and travel distances, such as those present in Engineering IV, an optical density of 0.08/m should be used. [8]

Toxicity

Although it is not the most toxic of fire gases, extensive research has shown that carbon monoxide (CO) is the major threat in most fire atmospheres. CO is also usually the most abundant toxic gas.

CO inhalation can cause tissue hypoxia, which is caused by the inability of the blood to carry sufficient oxygen to critical body organs. The affinity of hemoglobin for carbon monoxide is 300 times greater than that for oxygen. This results in CO tying up the hemoglobin to produce the carboxyhemoglobin (COHb). Studies have shown that CO has been detected in lethal concentrations (greater than 50% COHb) in 54% of fire fatalities, while some 70% of victims had COHb concentrations capable of causing incapacitation (greater than 50% COHb). [9]

According to Kaplan et al., the threshold of COHb content in blood for escape impairment of human individuals appears to be in the range of 30 to 40%. [9] Figure 25 provides concentration time curves for a man with a respiratory minute volume (RMV) of 20 liters/minute (light physical activity) for different COHb concentrations in blood. From these curves, Kaplan draws the conclusion that a COHb concentration in the range of 30-40% corresponds to an accumulated Ct dose of CO of approximately 35,000 – 45,000 ppm·min, the dose which can cause incapacitation in humans.

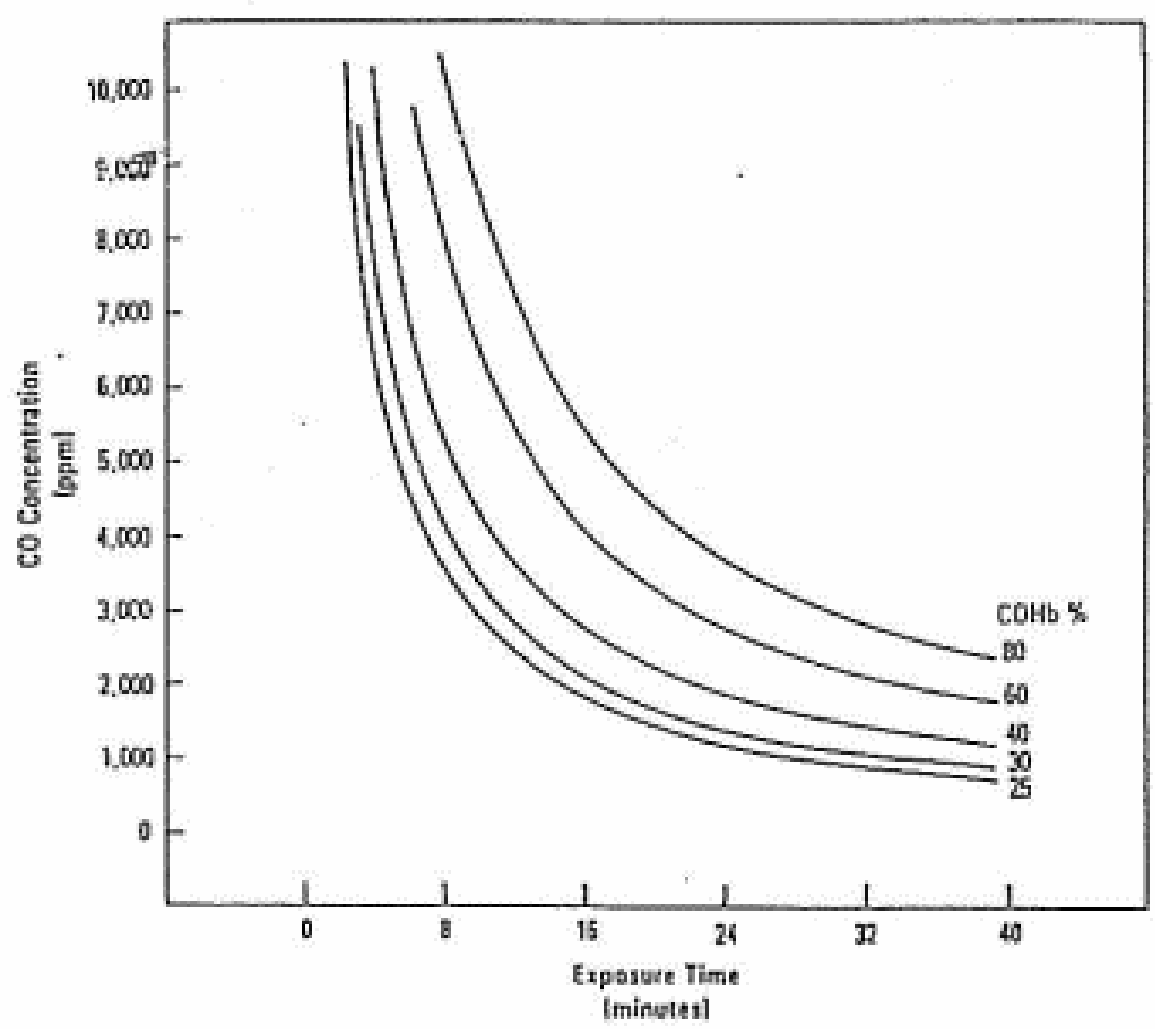

Figure 25. Percent of COHb as a function of ambient CO concentration and exposure time for humans with a RMV of 20 liters/min. [9]

Based on the curves provided in Figure 25, a time a certain dose can be tolerated by a human undergoing light activity can be estimated, such as an occupant walking towards an exit in a fire event. Based on an estimated RSET of approximately 10 minutes, a CO concentration of 3,000 ppm will cause incapacitation. Therefore, a CO concentration limit of 3,000 ppm will be established at 6-feet above the walking surface.

Summary of Tenability Criteria

Table 9 summarizes each of the tenability limits that will be employed in this performance based analysis:

Table 9. Tenability criteria to be evaluated at 6-feet above the walking surface for the performance based analysis.

Toxicity	Visibility	Temperature
3,000 ppm	10 meters	110°C

DESIGN FIRE 1

Sheet A-211W of the Engineering IV record drawings details the furniture plan for the west portion of the first floor. When the building was originally constructed in 2007, there were no plans to furnish the first-floor lobby. However, in the years following the original construction of Engineering IV, a lounge area with a sofa arrangement was added as shown in Figure 26. The location of the furniture arrangement in plan view is shown in Figure 27. Since the original design of the fire protection systems did not account for a lounge area in this space, this is an ideal candidate for a design fire scenario. The following sections will attempt to address the requirements for Design Fire Scenario 1 specified in NFPA 101. (NFPA 101 Section 5.5.3.1)

Figure 26. Sofa arrangement in the first-floor lobby area. Two spot-type photoelectric smoke detectors can be seen under the balcony at the top-right.

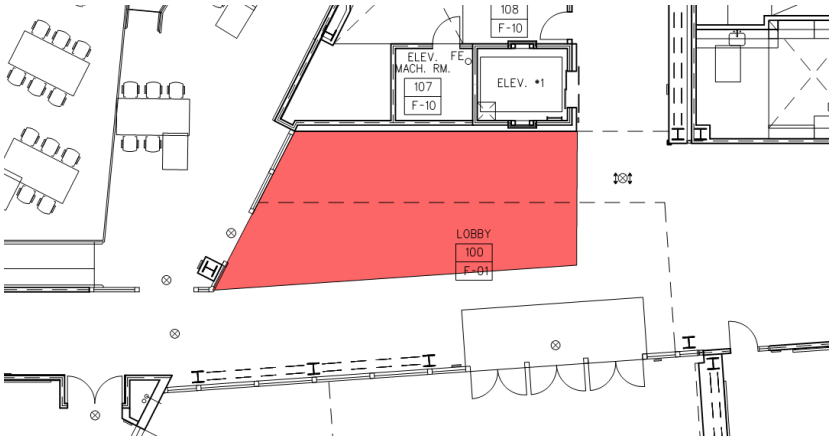

Figure 27. Plan view of the location of the lounge in the main lobby.

Occupant Activities, Number of Occupants and Location

The main lobby Engineering IV can contain a large assembly occupant load consisting of students waiting for class to start or students studying for upcoming exams. There is a large classroom directly adjacent to the lounge area where one of the two means of egress lead directly into the main lobby. A fire on the ground level can also expose occupants walking on the balcony above.

Ignition Potential

The lounge area in the main lobby of the building does not contain waste baskets or other sources for ignition, and the plant shown near the sofas is fake. However, there are certain times throughout the

year when senior project expositions are held in the lobby, so there is a possibility that a student's senior project could malfunction and catch one of the sofas on fire. A student smoking in the lobby could also potentially ignite one of the sofas.

Fuel Packages

The sofas located in the lounge area are most likely made of a wood frame with flexible polyurethane foam fabric for the filling material.

After March 1, 1992, all seating furniture sold to be used in public occupancies in California is required to meet California Technical Bulletin (TB) 133 standards for combustion. This standard requires that furniture is tested using the TB 133 test procedure, which involves subjecting the seating system to a large open flame in a specially designed test room.

Seating furniture fails to meet the requirements of TB 133 if the test sample creates a maximum heat release rate of 80 kW or greater. Therefore, to create the worst-case scenario for the fire curve, a maximum heat release rate of 80 kW is specified for my fuel package. Based on categories of t^2 fires shown in the SFPE Handbook Table 38.2, modern upholstered furniture can be classified as having a fast growth rate, which reaches a heat release rate of 1055 kW at approximately 150 seconds. [10] Therefore, a fast growth fire has been specified with a fire growth coefficient of $\alpha = 0.0469$ kW/sec^2.

Ventilation

There are six light wells (three on the 2nd floor and three on 3rd floor) that allow light to pass from the floors above to the floors below. To maintain the integrity of the rated floor assembly and allow the main lobby to remain classified as a two-story atrium, the light wells on the 3rd floor are provided with horizontal fire shutters that achieve a 2-hour rating.

NFPA 80, 2016 Edition provides the requirements for fire doors and other opening protectives. NFPA 80 Section 8.4.1.2 states that the average closing speed of a horizontal fire shutter shall not be less than 6 inches/second. The largest horizontal fire shutter used in Engineering IV is 261-inches long. Based on a minimum closing speed of 6-inches/second, the shutter will close in 44 seconds. As such, the horizontal fire shutters are modeled as movable boundaries in FDS and will close in 44 seconds after the detection time is reached.

As the fuel package in this situation is in a large volume space, the heat release rate curve would not be impacted by enclosure fire dynamics.

Geometry

The lounge is located under the second-floor balcony. Since there are sofas positioned away from the balcony area, this would create a dangerous condition where smoke in a fire plume would have to travel up from the first floor, past the smoke detectors on the balcony, and reach the second-floor smoke detectors before the building's fire alarm system could detect the presence of a fire event.

For this scenario, the first sofa to ignite will be the farthest from the balcony to extend the time for the smoke to reach the smoke detectors on Level 2. As the simulation progresses, additional sofas will ignite under the balcony to model the flame spread between sofas.

Flame Spread Potential

The arrangement of the sofas in the lounge has each sofa positioned about one to two feet away from each other. To model the impact of flame spread from one sofa to another, I've considered the radiative heat transfer from a sofa that has reached its peak heat release rate.

Assuming a fire area of approximately 5-feet by 2-feet (0.93-m^2), the heat release rate per unit area can be calculated as:

$$\dot{Q}^{"} = \frac{80\ kW}{0.93\ m^2} = 86\ \frac{kW}{m^2}$$

Using Equation 6.32 from Drysdale's Introduction to Fire Dynamics, in which $\dot{Q}''$ is constant and heat losses are ignored, we can calculate the time to ignition for a thermally thick solid:

$$t_{ig} = \frac{\pi}{4} k\rho c \frac{\left(T_{ig} - T_o\right)^2}{\dot{Q}''^{\,2}}$$

As a means of assessing the ignition resistance of materials, Tewarson and Ogdon developed the Thermal Response Parameter (TRP) (kW-$s^{1/2}/m^2$) given by the following expression [11]:

$$TRP = \left(T_{ig} - T_o\right)\sqrt{k\rho c}$$

The Thermal Response Parameter is the resistance of a material to generate a combustible mixture. A second parameter used by Tewarson is the Critical Heat Flux (CHF) (kW/m^2) which is the minimum heat flux at or below which a material cannot generate a combustible mixture for ignition to occur.

Tewarson introduced a variation of Equation 6.32 that uses these two parameters, the TRP and CHF of a material, to estimate the time to ignition [12]:

$$t_{ig} = \frac{\pi}{4}\left(\frac{TRP}{\dot{Q}_e'' - CHF}\right)^2$$

Based on SFPE Handbook Table A.35, the TRP for flexible polyurethane foam is in the range of 55 to 221 KW·$s^{1/2}/m^2$, with a Critical Heat Flux (CHF) of 13 to 40 kW/m^2. Using an average value of 138 KW·$s^{1/2}/m^2$ for the TRP and 26 kW/m^2 for the CHF, the TRP and CHF can be substituted into Equation 6.32 to find the approximate time to ignition for polyurethane foam:

$$t_{ig} = \frac{\pi}{4}\left(\frac{TRP}{\dot{Q}_e'' - CHF}\right)^2 = \frac{\pi}{4}\left(\frac{138}{86 - 26}\right)^2 = 4.2\ seconds$$

The ignition time of 4.2 seconds assumes that the ignition source is at a constant external heat flux for the duration of the ignition time, which is unlikely to occur in real fires. For a t^2 growth fire, the time to ignition at its maximum heat flux is approximately 3.2 times the ignition time if the heat flux is held constant at this maximum. Therefore, the ignition time for a t^2 growth fire is:

$$t_{ig} = 4.2\ seconds \times 3.2$$

$$t_{ig} = 13.5\ seconds$$

Therefore, to incorporate the effect of flame propagation into my fire curve, I will model a second sofa igniting 13.5 seconds after the first sofa reaches its maximum heat release rate, which will bring the total heat release rate for the fuel package to 160 kW. Since there are eight sofas located in the main lobby, and based on recommendations from Dr. Mowrer, I will assume that at any one time up to three sofas will be burning simultaneously, bringing my total heat release rate to 240 kW.

Design Fire Heat Release Rate Curve

A fast growth fire has been specified with a fire growth coefficient of $\alpha = 0.0469$ kW/sec. The fire will ramp up to 80 kW, with two subsequent sofas igniting 13.5 seconds after the previous sofa reaches its peak HRR, bringing the maximum HRR of the fuel package to 240 kW.

Once the ramp is completed, the steady burning phase will commence. To determine the duration of the steady burning phase, a computer based egress model, Pathfinder, was employed to enable occupant evacuation time to be calculated, based on methods, equations and assumptions derived from the SFPE Handbook, 5th Edition. The steady burning phase of the fire curve will have a conservative duration of 10.5 minutes, based on the RSET time calculated previously.

The peak heat release rate will stay constant until the start of the decay phase. The SFPE Handbook states that decay phase of a fire commences when about 70% to 80% of the design fire load has been consumed. However, the since the sofas are made up of many different materials, it can be difficult to determine when this phase will be reached. For modeling purposes, we can take a conservative approach and state that the steady burning phase will last through the RSET calculated from egress modeling in Pathfinder.

The complete design fire heat release rate curve is shown in Figure 28.

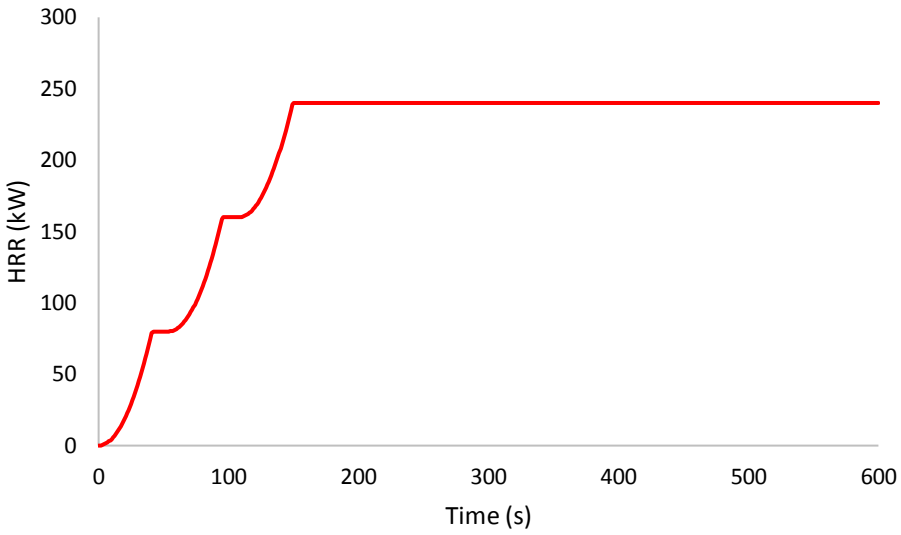

Figure 28. Heat release rate curve for a series of three sofa fires in the main lobby of Engineering IV.

DESIGN FIRE 2

For Design Fire 2, a fire in the main corridor on Level 1 is considered. This scenario is based on Design Fire Scenario 8 as specified in NFPA 101. This scenario is described as a fire originating in ordinary combustibles in a room or area with each active or passive fire protection system independently rendered ineffective. It addresses concerns regarding the unreliability or unavailability of each fire protection system or fire protection feature, considered individually. (NFPA 101 Section 5.5.3.8)

Occupant Activities, Number of Occupants and Location

The main corridor on Level 1 is heavily occupied throughout the day by students walking to class or waiting for their class to start. Based on occupant load calculations, a total of 755 occupants exit into the main corridor before traveling to one of five exits on Level 1. The fuel package used in this scenario is located at the east portion of the main corridor.

Ignition Potential

Sources of ignition could include a cigarette dropped into an adjacent trash can, or a student project on exhibition that malfunctions and starts a fire.

Fuel Packages

For this scenario the fuel load will consist of a notice board located in the main corridor on Level 1. The notice board is used by students to post information about upcoming club events and presentations. It consists of paper products pinned to a cloth and foam backing. Multiple notice boards are located on metal tracks, with four to five notice boards making up one assembly, as shown in Figure 29.

Although there is no heat release rate data from the SFPE Handbook specific to notice boards, there are many fire tests for curtains of similar size and materials. The fuel package for this scenario is a

cotton/polyester curtain with a polystyrene foam backing in the closed configuration, with a heat release rate of 385 kW. [13] Since there are five notice boards in one assembly, the total peak HRR for this fuel package will be approximately 2 MW. Based on heat release rate data from fire tests performed on non-fire-retardant treated cotton curtains by Yamada T., Yanai, E., and Naba, H., the curtain heat release rate will be modeled as an ultrafast growth fire with a fire growth coefficient of $\alpha = 0.118$ kW/sec. [14]

Located approximately 4-feet from the notice board is a trash bin. This trash bin is typically used to discard paper materials. On occasion, the trash bin is full and students leave trash bags next to the trash bin. For this simulation the notice board will be ignited by a trash bag containing paper waste, which reaches a peak heat release rate of 175 kW in 275 seconds. [15] Based on this data obtained from the SFPE Handbook, the heat release rate curve of this ignition source will be modeled as a slow growth fire with a fire growth coefficient of $\alpha = 0.0029$ kW/sec.

Figure 29. Poster board used as the fuel package for Design Fire 2

Ventilation

The main corridor is located off the main lobby which is classified as a two-story atrium. As discussed earlier, the two-story atrium is not provided with an active mechanical smoke control system. Instead, passive smoke control features are provided to separate Levels 1 and 2 from Level 3, one of which are horizontal fire shutters located in light wells.

There are three light wells that allow light to pass through the Level 3 floor assembly down to Level 2. To maintain the integrity of the rated floor assembly and allow the main lobby to remain classified as a two-story atrium, the light wells are provided with horizontal fire shutters that achieve a 2-hour rating.

As the purpose of this design fire scenario is to explore the effects of rendering a fire protection system ineffective, the horizontal fire shutters will be modeled as nonfunctional for this scenario.

Geometry

The main corridor on Level 1 extends the length of the building, and was constructed to achieve a 1-hour rating per the requirements of the 2001 CBC. As the corridor and its respective openings are constructed to limit the transfer of smoke, only the corridor volume on Levels 1 through 3 will be modeled in FDS. As the fuel package in this situation is in a large volume space similar to Design Fire 1, the heat release rate curve would not be impacted by enclosure fire dynamics.

Flame Spread Potential

The notice board in the main corridor is approximately 4-feet from the nearest trash bin. As such, the flame spread from the trash bin to the notice board is considered.

Assuming a fire area of approximately 4-feet by 2-feet (0.74-m^2), the heat release rate per unit area can be calculated as:

$$\dot{Q}'' = \frac{175\ kW}{0.74\ m^2} = 236\ \frac{kW}{m^2}$$

Based on SFPE Handbook Table A.35, the TRP for PVC fabric is 217 $KW \cdot s^{1/2}/m^2$, with a CHF of 26 kW/m^2. The TRP and CHF can be substituted into Equation 6.32 to find the approximate time to ignition for PVC fabric:

$$t_{ig} = \frac{\pi}{4}\left(\frac{TRP}{\dot{Q}_e'' - CHF}\right)^2 = \frac{\pi}{4}\left(\frac{217}{236 - 26}\right)^2 = 18.5\ seconds$$

$$t_{ig} = 4.2\ seconds \times 3.2$$

$$t_{ig} = 60\ seconds$$

Based on this calculation, the notice board will ignite approximately 60 seconds after the trash bag ignites.

Design Fire Heat Release Rate Curve

The design fire heat release rate curve will have a peak heat release rate of 2 MW that is modeled as a ultrafast growth fire with a fire growth coefficient of α = 0.188 kW/sec. To incorporate flame spread from the ignition source to the fuel package, the heat release rate will rise at a slow growth rate with a fire growth coefficient of α = 0.0029 kW/sec for 60 seconds, after which the curve will be modeled as a fast growth fire up to the peak HRR of 2 MW. Based on heat release rate data from fire tests performed on non-fire-retardant treated cotton curtains by Yamada T., Yanai, E., and Naba, H., the fuel from the curtains will quickly be consumed as the same ultrafast rate as the initial growth phase. Therefore, to model the decay phase, the heat release will decrease at an ultrafast rate until it reaches the maximum

175 kW heat release rate of the trash bags. From that point, the trash bag fire will decay at a slow growth rate until the heat release rate reaches zero, which is based on heat release rate curves of trash bag fire provided in the SFPE Handbook. [14]

The complete design fire heat release rate curve is shown in Figure 30.

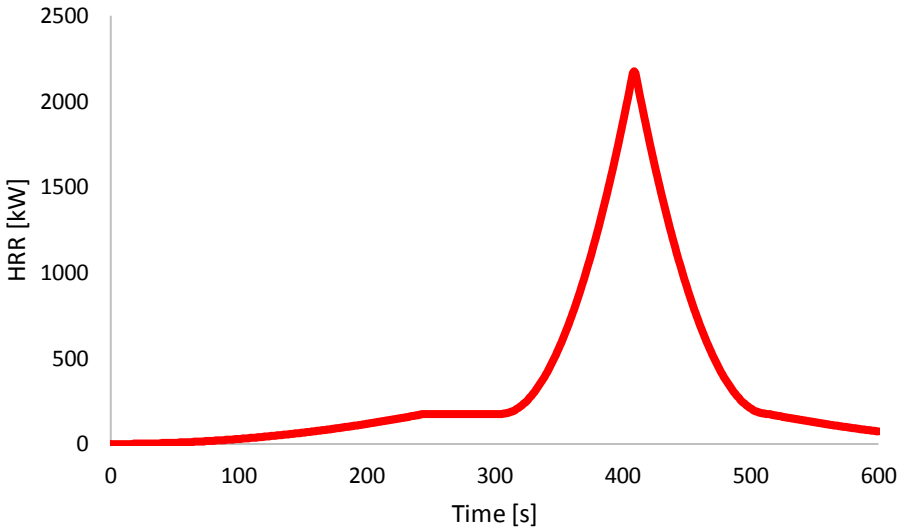

Figure 30. Heat release rate curve for a notice board fire in the Level 1 corridor of Engineering IV.

DESIGN FIRE 1 RESULTS

The tenability criteria of visibility, temperature and toxicity are modeled in FDS as slice files placed 6-feet above the walking surface. If at any time before the RSET of 594 seconds, the temperature increases above 110°C or the toxicity rises above 3,000 ppm of CO at 6-feet above the walking surface, the simulation is considered failing. Any decrease below the visibility criteria of 10-meters at 6-feet above the walking surface before RSET is reached is considered failing.

As discussed earlier in this section, the horizontal fire shutters in the Level 3 light wells are modeled to close at 44-seconds after the fire alarm has activated, which is 64-seconds after the start of the simulation if the time for a smoke detector to activate is considered. Based on the results of the simulation, the ceiling jet does not reach the fire shutters at 64-seconds, so Level 3 is considered completely separated from the levels below. As such, this section evaluates tenability above the Level 1 and Level 2 walking surfaces. A screenshot of the smoke spread at 64 seconds into the simulation is provided in Figure 31.

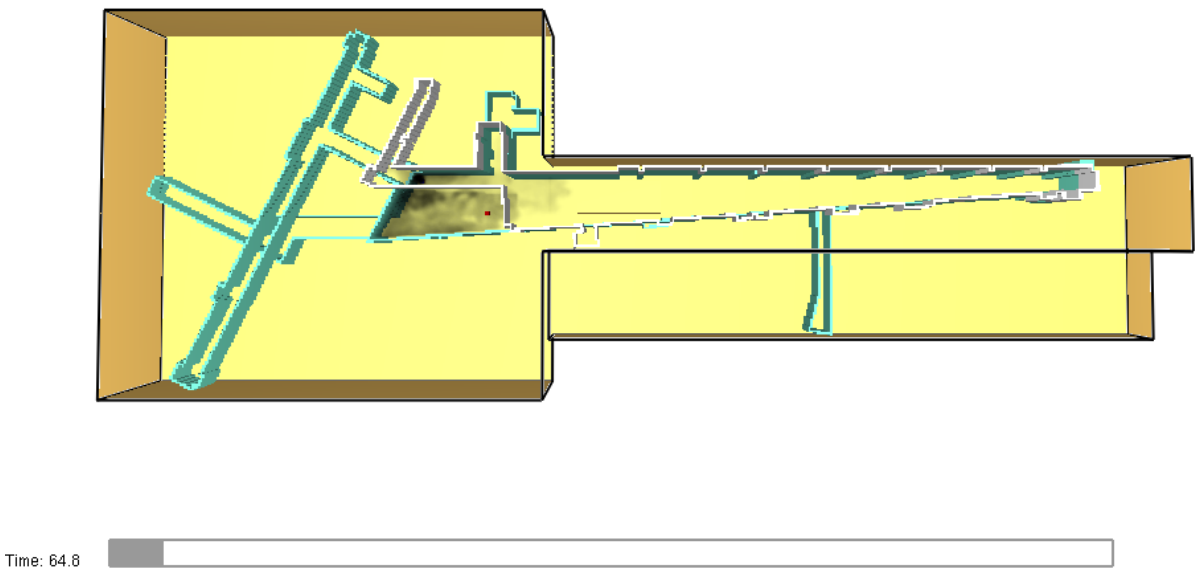

Figure 31. Smoke spread at 64 seconds after the start of the simulation. The ceiling jet is still localized to the main lobby and hasn't spread to the horizontal fire shutters at the Level 3 floor slab. Level 3 is thereby considered completely separated from smoke spread and tenability is not evaluated at this level.

Visibility

Visibility drops below the tenability limit above the Level 2 balcony corridor at 121 seconds, as shown in Figure 32. Visibility on Level 1 drops below the tenability criteria at 347 seconds, as shown in Figure 33.

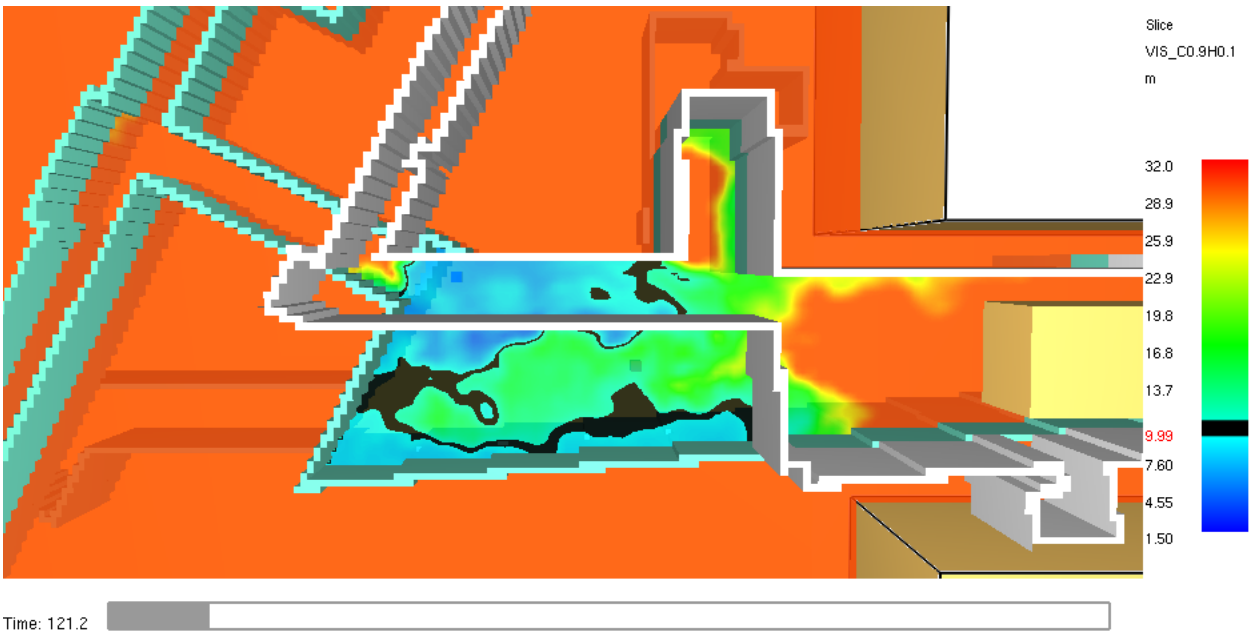

Figure 32. Visibility drops below 10m above the Level 2 balcony corridor at 121 seconds.

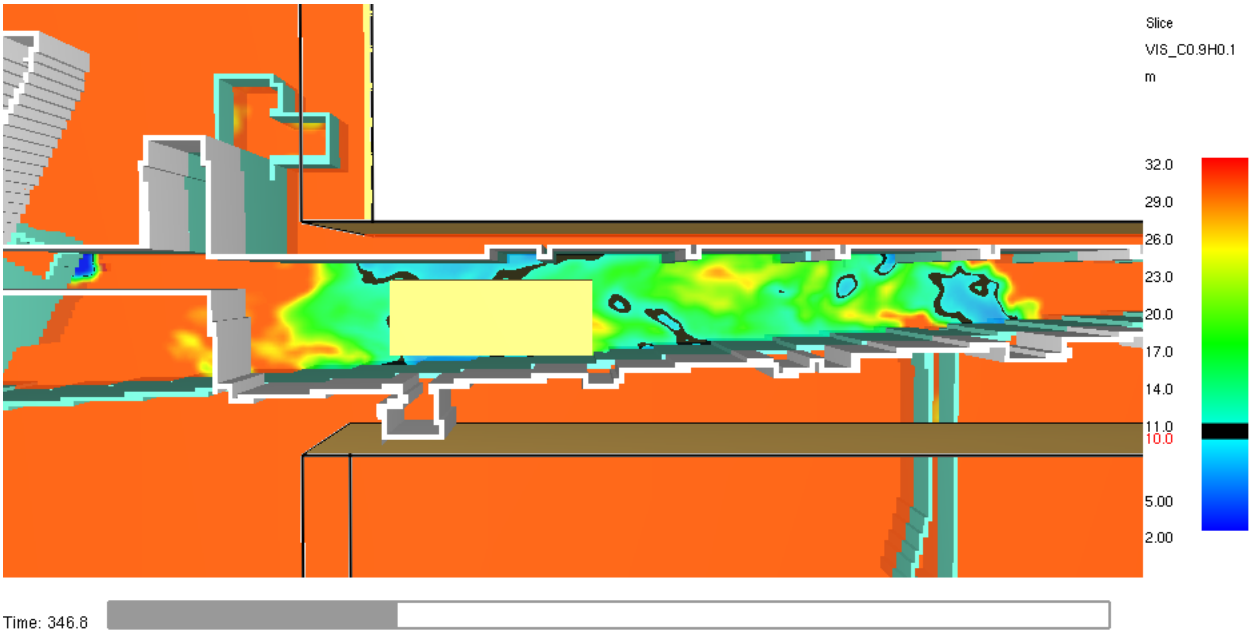

Figure 33. Visibility drops below 10m above the Level 1 corridor at approximately 347 seconds.

Temperature

Temperature does not drop below 110°C at 6-feet above the walking surface at any point before RSET is reached. Figures 34 and 35 show the temperature at 6-feet above the walking surface at approximately 600-seconds into the simulation.

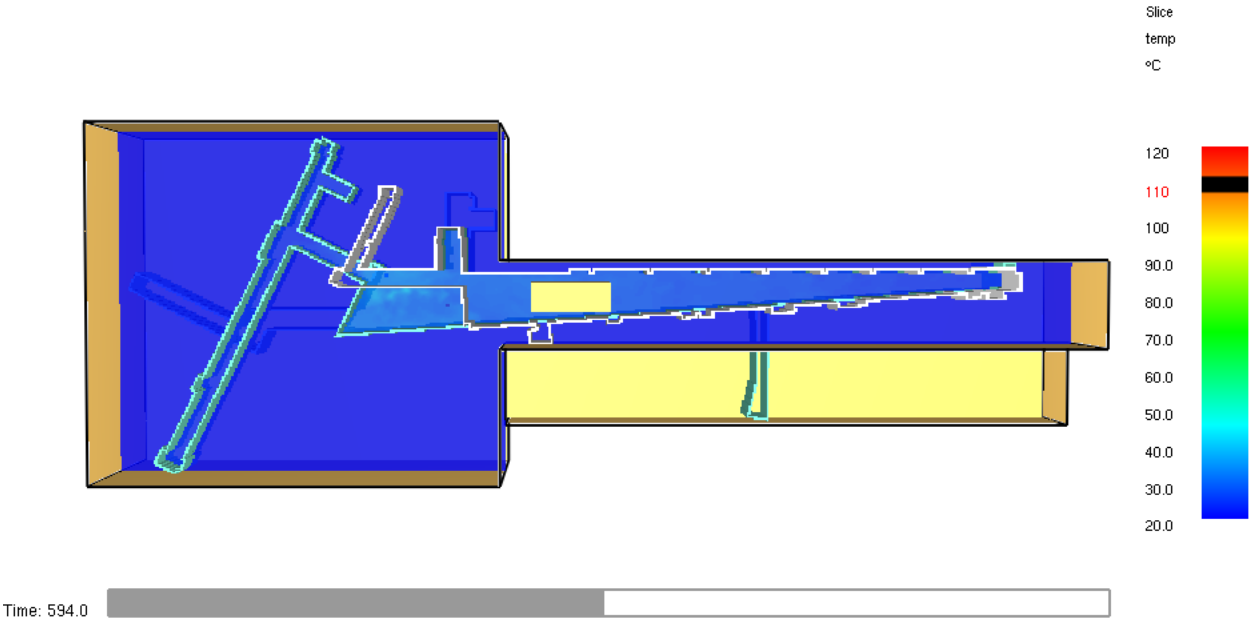

Figure 34. At 6-feet above the Level 2 walking surface, temperature does not reach 110°C at any point during the simulation.

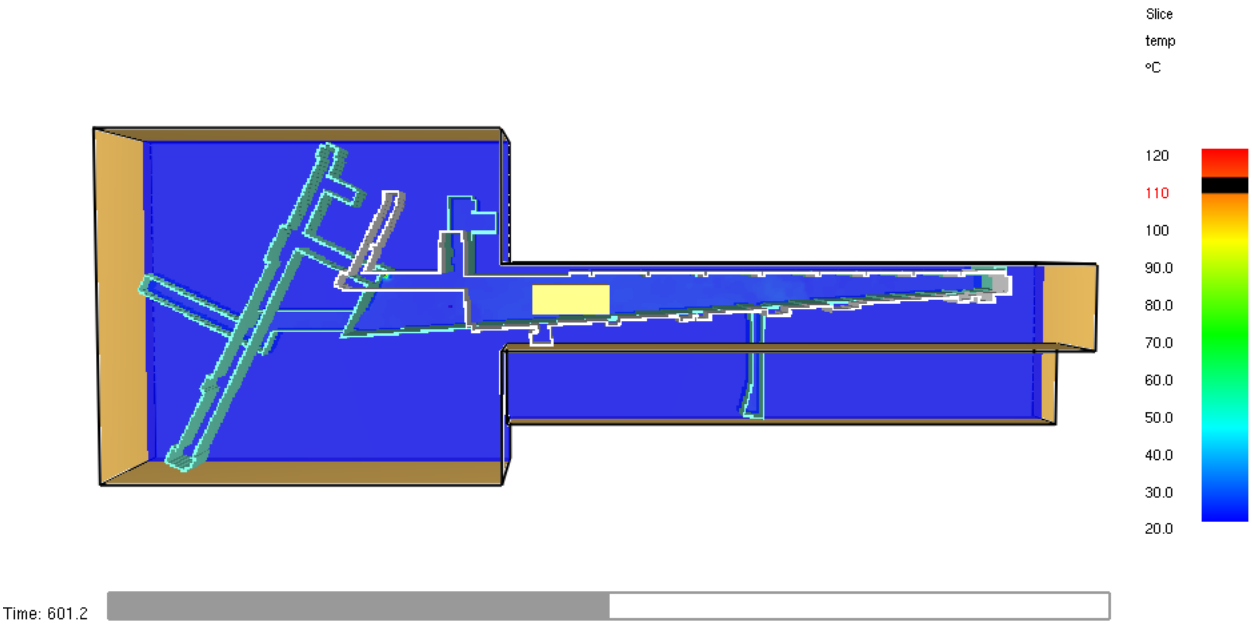

Figure 35. At 6-feet above the Level 1 walking surface, temperature does not reach 110°C at any point during the simulation.

Toxicity

Toxicity does not increase above 3,000 ppm of CO at 6-feet above the walking surface at any point before RSET is reached. Figures 36 and 37 show the toxicity at 6-feet above the walking surface at approximately 600-seconds into the simulation.

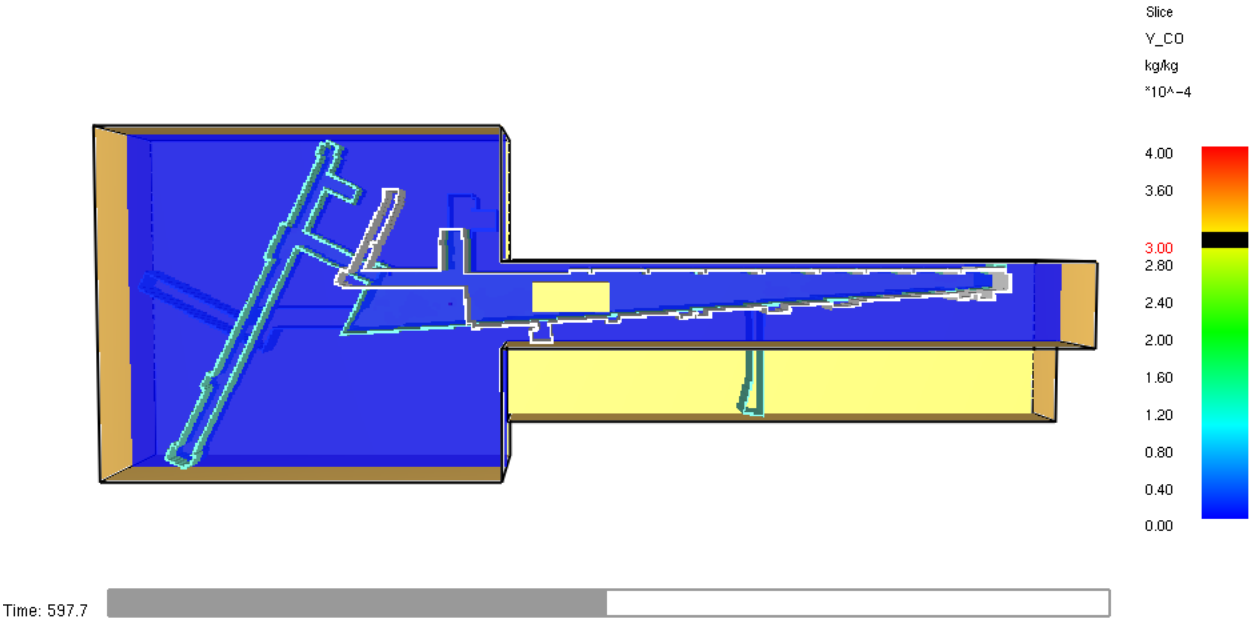

Figure 36. At 6-feet above the Level 2 walking surface, toxicity does not reach 3,000 ppm of CO at any point during the simulation.

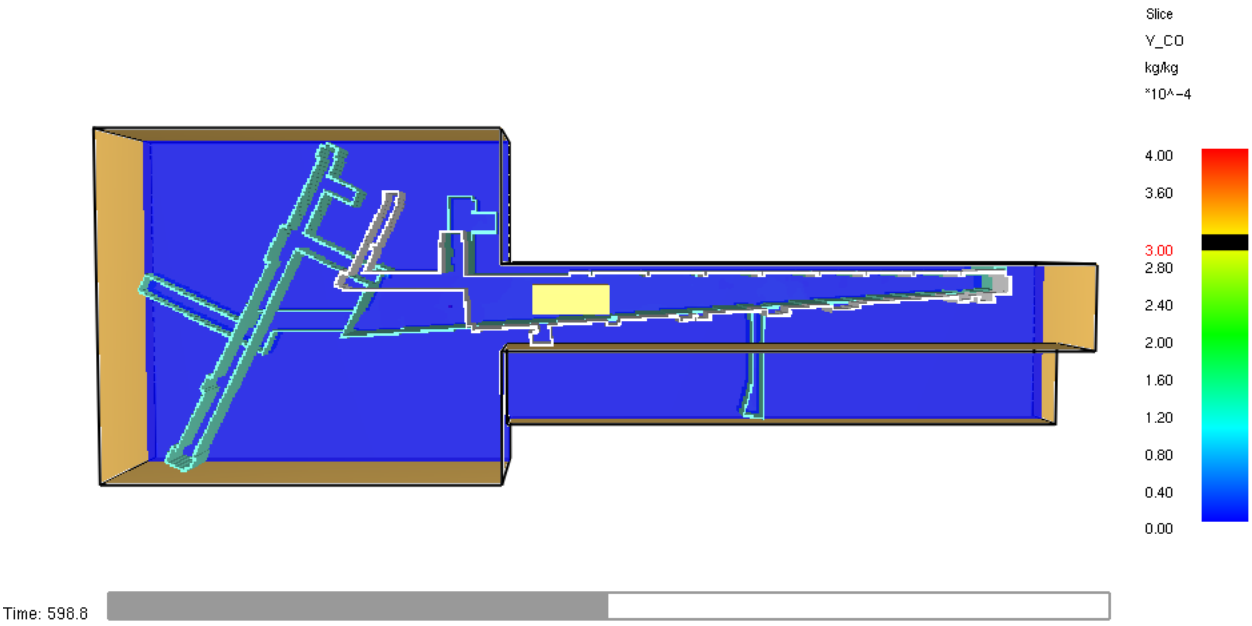

Figure 37. At 6-feet above the Level 1 walking surface, toxicity does not reach 3,000 ppm of CO at any point during the simulation.

DESIGN FIRE 2 RESULTS

The tenability criteria of visibility, temperature and toxicity are modeled in FDS as slice files placed 6-feet above the walking surface. If at any time before the RSET of 632 seconds, the temperature increases above 110°C or the toxicity rises above 3,000 ppm of CO at 6-feet above the walking surface, the simulation is considered failing. Any decrease below the visibility criteria of 10-meters at 6-feet above the walking surface before RSET is reached is considered failing. As discussed previously, the horizontal fire shutters do not close during this design fire scenario, so tenability is evaluated at all three levels.

Visibility

Based on the results of the simulation, visibility drops below 10m at all three levels before the RSET time is reached. Visibility drops below the tenability limit in the Level 3 corridor at 260 seconds, as shown in Figure 38. Visibility drops below the tenability limit in the Level 2 corridor at 347 seconds, as shown in Figure 39. Visibility drops below the tenability limit in the Level 1 corridor at 373 seconds, as shown in Figure 40.

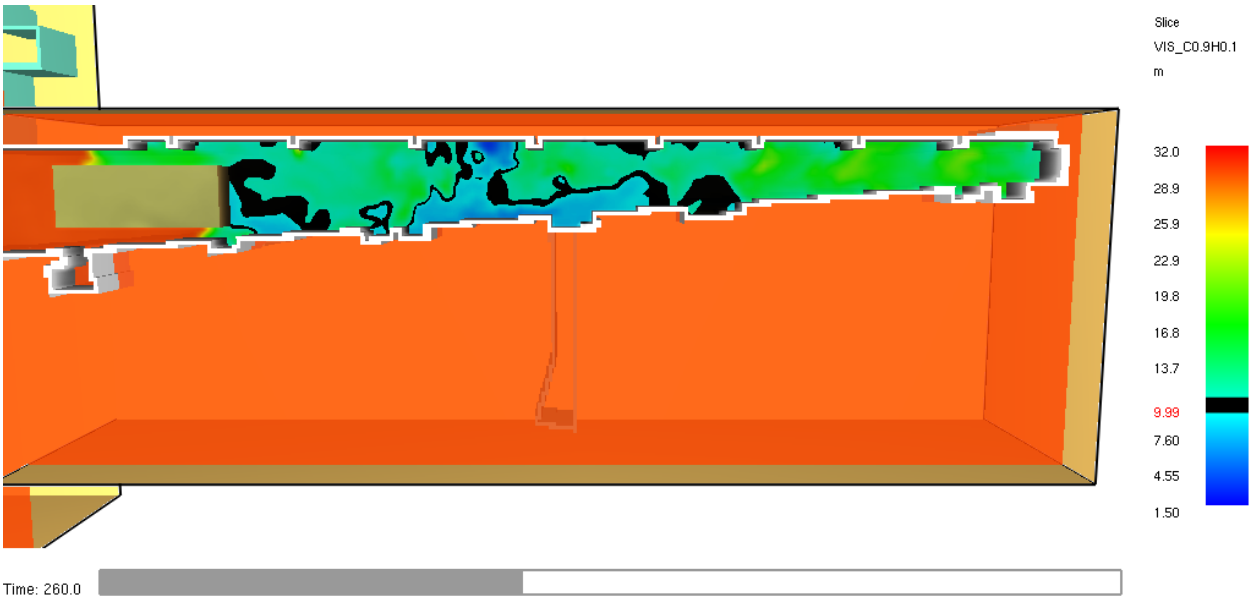

Figure 38. At 6-feet above the Level 3 walking surface, visibility drops below 10-meters at 260 seconds.

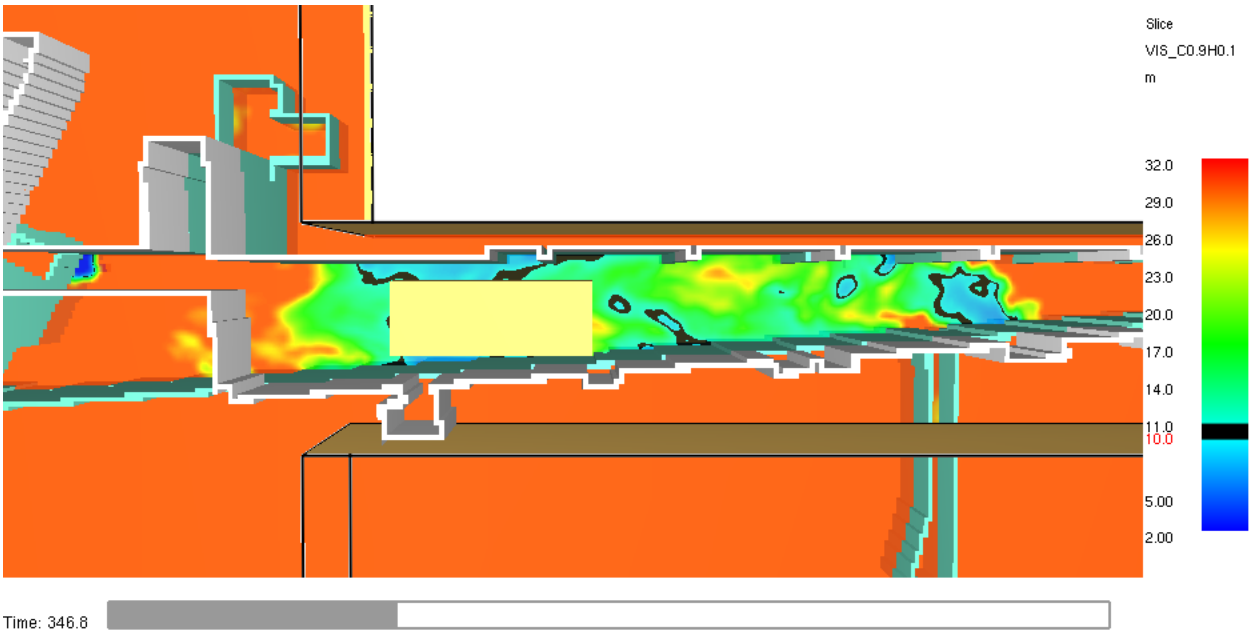

Figure 39. At 6-feet above the Level 2 walking surface, visibility drops below 10-meters at 347 seconds.

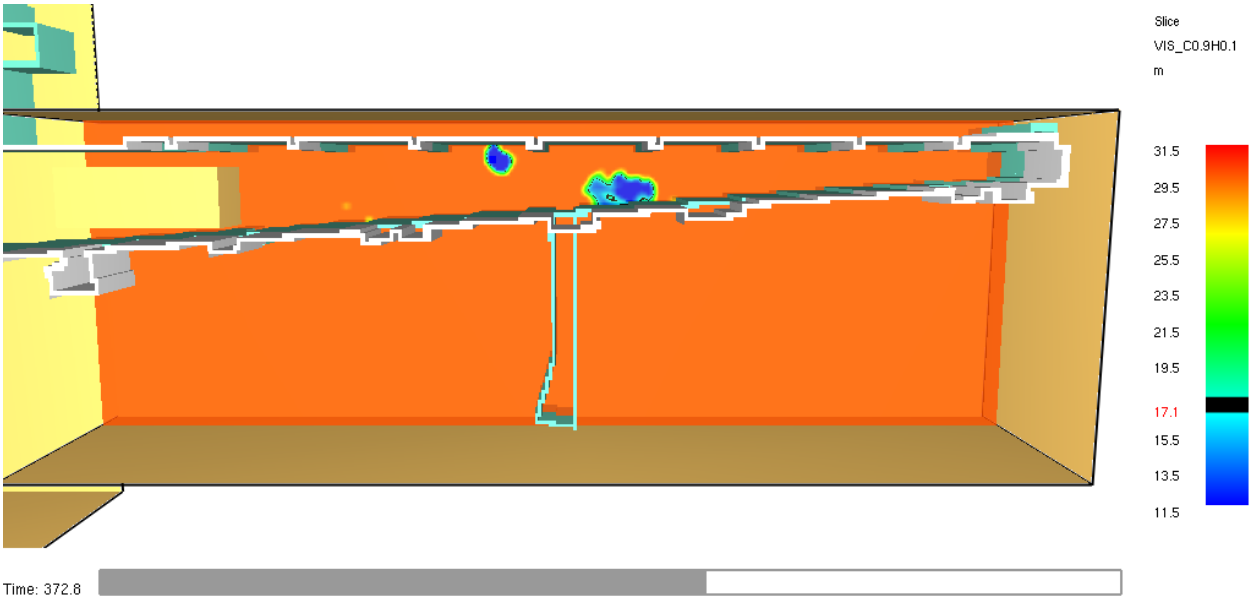

Figure 40. At 6-feet above the Level 1 walking surface, visibility drops below 10-meters at 373 seconds.

Temperature

Temperature does not drop below 110°C at 6-feet above the walking surface at any point before RSET is reached. Figures 41 through 43 show the highest temperatures experienced at each level during the simulation.

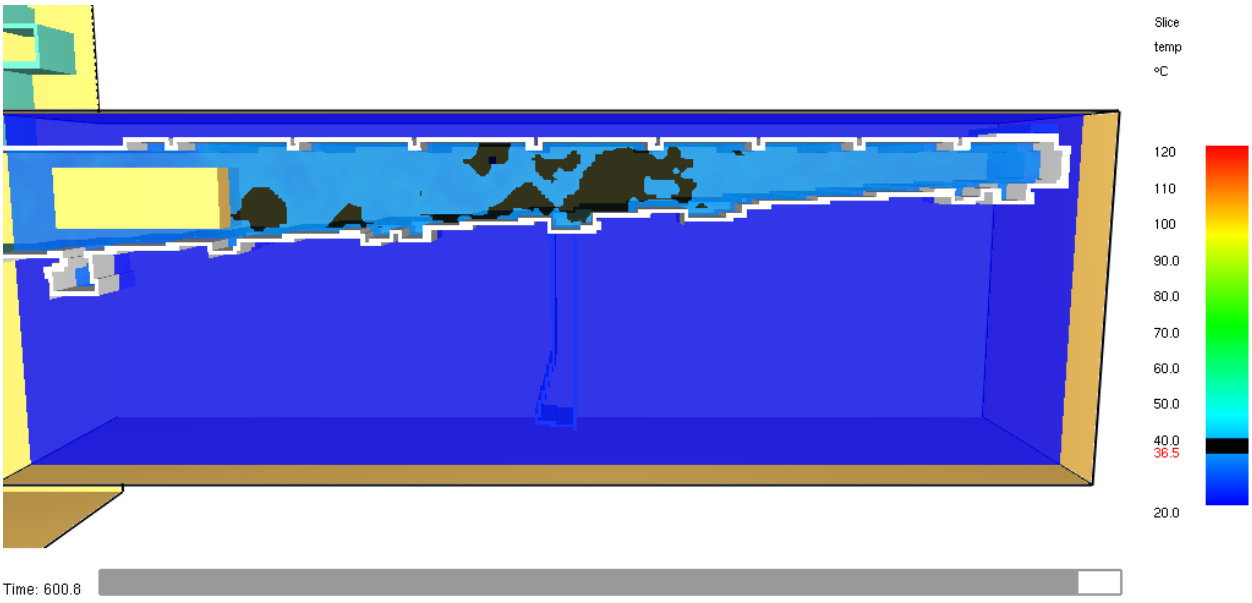

Figure 41. At 6-feet above the Level 3 walking surface, temperature does not reach 110°C at any point during the simulation. The highest temperature reached during the simulation at this height is approximately 36.5°C.

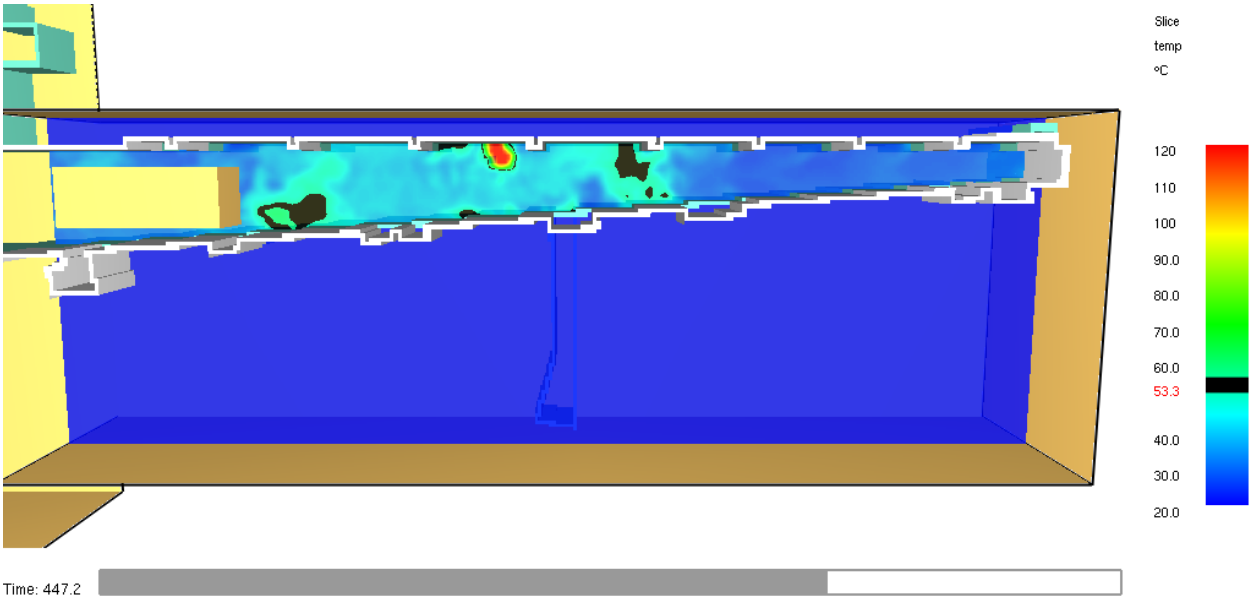

Figure 42. At 6-feet above the Level 2 walking surface, temperature does not reach 110°C at any point during the simulation. The highest temperature reached during the simulation at this height is approximately 53.3°C.

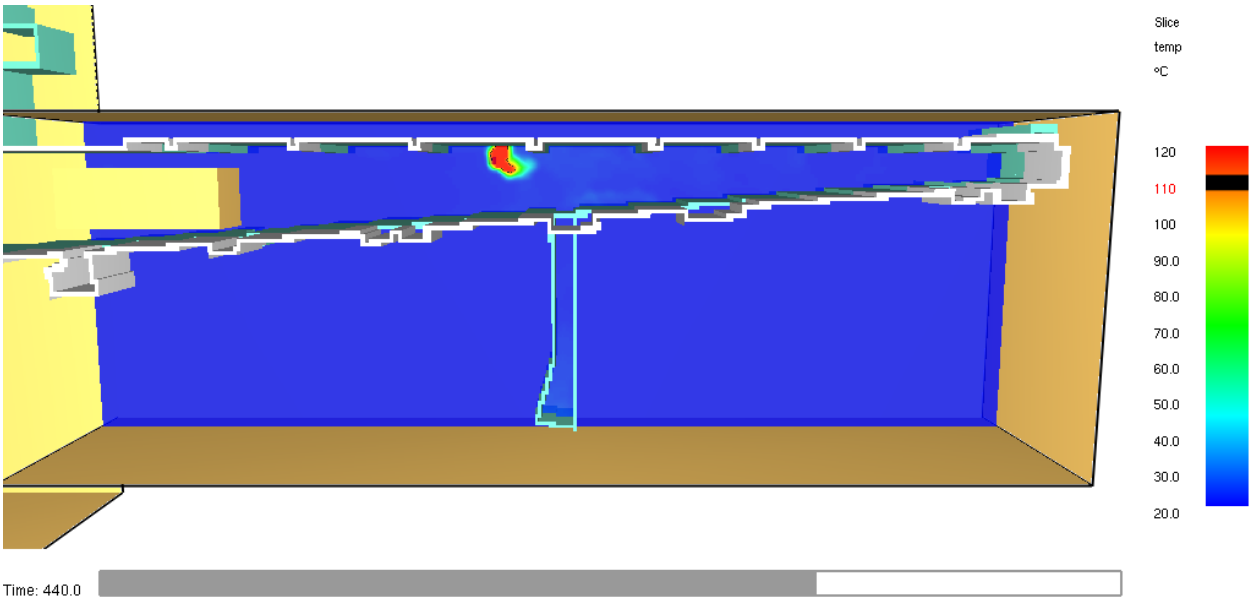

Figure 43. At 6-feet above the Level 1 walking surface, temperature does not reach 110°C at any point during the simulation.

Toxicity

Toxicity does not increase above 3,000 ppm of CO at 6-feet above the walking surface at any point before RSET is reached. Figures 44 through 46 show the highest toxicity levels experienced at 6-feet above the walking surface during the simulation.

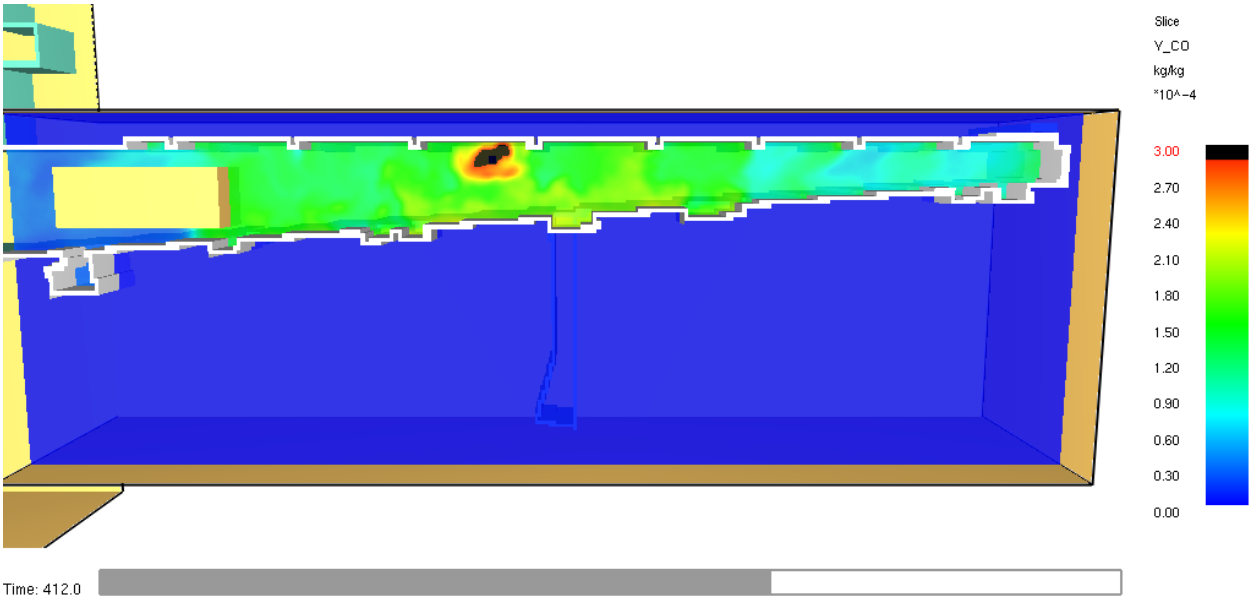

Figure 44. At 6-feet above the Level 3 walking surface, toxicity does not exceed 3,000 ppm of CO for the duration of the RSET. The highest toxicity levels experienced at this level are approximately 2,000 ppm of CO.

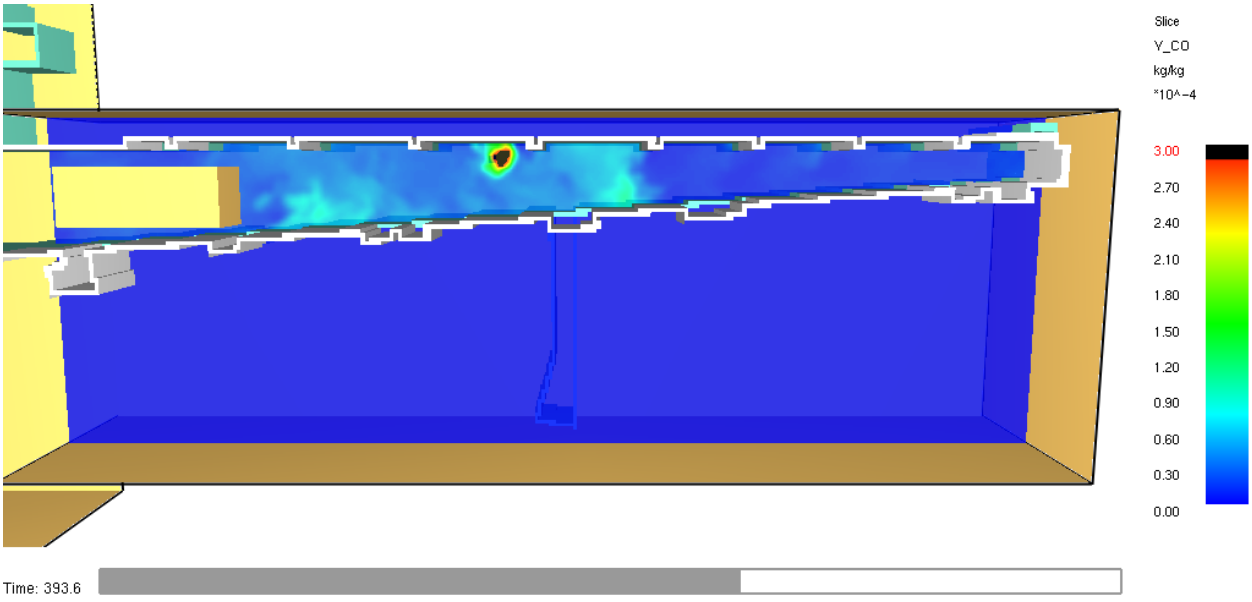

Figure 45. At 6-feet above the Level 2 walking surface, toxicity does not exceed 3,000 ppm of CO for the duration of the RSET. The highest toxicity levels experienced at this level do not exceed approximately 1,000 ppm of CO.

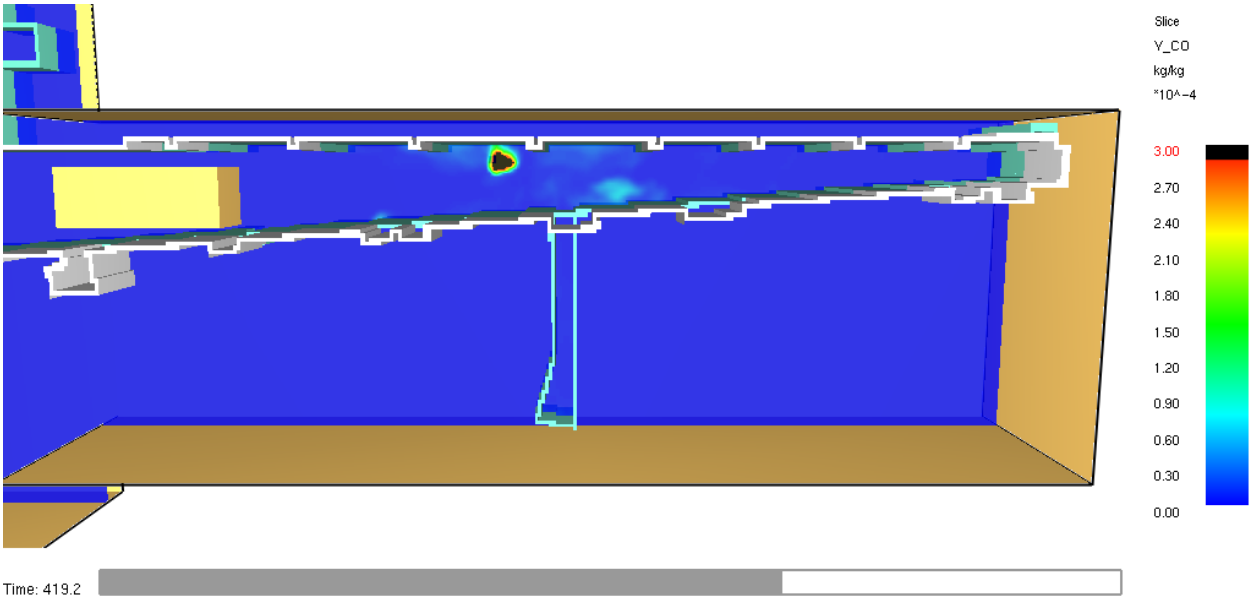

Figure 46. At 6-feet above the Level 1 walking surface, toxicity does not exceed 3,000 ppm of CO for the duration of the RSET. The highest toxicity levels experienced at this level do not exceed approximately 1,000 ppm of CO.

SUMMARY

Tenability results are summarized for Design Fire Scenarios 1 and 2 in Tables 10 and 11, respectively. The green colored cells green show that the tenability limit was not exceeded during the simulation. The red colored cells show where the tenability limit was exceeded and at what time during the simulation.

Table 10. Summary of Tenability Results for Design Fire Scenario 1

Level	RSET Time	Visibility	Temperature	Toxicity
2	594 seconds	FAIL at 121 seconds	Pass	Pass
1		FAIL at 347 seconds	Pass	Pass

Table 11. Summary of Tenability Results for Design Fire Scenario 2

Level	RSET Time	Visibility	Temperature	Toxicity
3	632 seconds	FAIL at 260 seconds	Pass	Pass
2		FAIL at 347 seconds	Pass	Pass
1		FAIL at 373 seconds	Pass	Pass

Visibility dropped below the tenability limit on Level 2 at 121 seconds during Design Fire Scenario 1. Visibility also dropped below the tenability limit on Level 3 at 260 seconds during Design Fire Scenario 2. Since the duration of the Available Safe Egress Time (ASET) is less than the duration of the Required Safe Egress Time (RSET), both design fire scenarios are considered to have failed. Based on the results of this

performance based analysis, Engineering IV does not provide an adequate level of protection for occupants during the time needed to evacuate.

CONCLUSION

No specific deficiencies in the means of egress system were discovered as part of this analysis that would not meet the requirements of the 2001 CBC. Engineering IV meets or exceeds the means of egress requirements of the 2016 CBC, including exit access travel distance, exit separation and number of exits. The exception in this analysis is exit capacity. The occupant load of 2,925 persons calculated under the requirements of the 2016 CBC and CPDC A/E Technical Bulletin 17-002 is significantly greater than the 1,530 persons calculated under the requirements of the 2001 CBC. The building's original design did not account for the more conservative occupant load factors required by the SFM in 2018, so this is expected. Regardless, the university keeps an emergency planning and preparedness plan in accordance with Chapter 4 of the California Fire Code, and is required to keep the occupant load of the building within the exit capacity limits specified in the original design. The fire detection and alarm system serving Engineering IV meets the prescriptive requirements of the 2016 CBC and NFPA 72 with few exceptions. Smoke detectors provide open area protection in all common use spaces; however, smoke detectors are not located in the Materials Engineering Welding & Joining Lab, Room 103A. The model WFDTH switches listed in the electrical drawings are intended to be installed in single-family residential dwellings, and is not listed for commercial use. These devices should be approved by the SFM prior to installation. The secondary power supply calculations confirm one 12 amp-hour backup battery is necessary to serve the main FACP, and that the FACP is provided with adequate backup power for this application. Engineering IV's automatic sprinkler system meets the prescriptive requirements of the 2016 CBC and NFPA 13. Based on the hydraulic calculations performed herein, a fire pump supplying 500-gpm at 29 psi should be provided to meet the system's hydraulic demand. The building elements used in the construction of Engineering IV appear to meet or exceed the requirements set by the 2016 CBC. Additionally, the Type IB construction used for this building meets the allowable building height and area requirements of CBC Chapter 5, and all building elements and assemblies with required fire-resistance ratings are U.L. listed. Engineering IV is provided with all smoke management features required by the 2016 CBC. The 2-hour rated curtain wall sprinklers and glass enclosure at the top of the communicating stair as well as the horizontal fire shutters serve to limit the development of a large smoke plume in the main lobby and eliminate the requirement for mechanical smoke control. Magnetic closing doors, elevator hoistway protection and combination smoke/fire dampers serve to compartmentalize the building and limit the spread of smoke in a fire event. Duct smoke detectors are provided at both air handlers to detect if smoke is being supplied into the building's HVAC system and allows the fire alarm system to shut down the HVAC system in alarm condition. Two fire scenarios were evaluated using Fire Dynamics Simulator (FDS) and Pathfinder. An RSET time of approximately 10 minutes was calculated using Pathfinder modeling as well as engineering assumptions based on occupant behavior. Design Fire Scenario 1 consisted of a furniture fire in the main lobby atrium and explored the effects of a typical fire for the building's occupancy. Design Fire Scenario 2 consisted of a notice board fire in the main corridor which rendered the building's horizontal fire shutters nonoperational and explored the effects of rapid smoke spread to the Level 3 egress path. Based on the results of the performance based analysis, visibility dropped below 10-meters in both Design Fire Scenarios before the RSET time was reached. As such, Engineering IV does not provide an adequate level of protection for occupants during the time needed to evacuate.

RECOMMENDATIONS

The building's means of egress system is compliant based on the codes and standards used during construction, however based on the present-day requirements set by the California State Fire Marshal, the building's egress system would be non-compliant. Regardless, the university keeps an emergency planning and preparedness plan in accordance with Chapter 4 of the California Fire Code, and is required to keep the occupant load of the building within the exit capacity limits specified in the original design. I would recommend that as the function of spaces are changed through time, the occupant load of redesigned spaces should be revisited to match their current use. The means of egress system should be revaluated as spaces are renovated based on current code and standards to ensure that exits are sized accordingly. If occupant loads for any given space exceed 50 occupants, a minimum of two egress doors should be provided that swing in the direction of egress, in accordance with CBC Table 1006.2.1. Visible appliances should be provided in the Multi-Disciplinary Dirty Lab, Room 130. Heat detectors should be provided in the Materials Engineering Welding and Joining Lab, Room 103A. The model WFDTH waterflow switches listed in the electrical drawings are not listed for commercial use, and should be approved by the SFM prior to installation. Based on the manual hydraulic calculations provided herein, the water supply for the sprinkler system is insufficient. A fire pump supplying 500-gpm at 29 psi should be provided to meet the system's hydraulic demand. There are no recommendations regarding the building's structural fire protection or smoke management features.

Based on the results of this performance based analysis, Engineering IV does not provide an adequate level of protection for occupants during the time needed to evacuate. Two available options to increase the level of protection for occupants are to provide a mechanical smoke control system complying with CBC Section 909 or to provide a rated separation at the openings between Level 1 and 2. This could consist of providing additional horizontal fire shutters in the Level 2 light wells, enclosing the main lobby atrium with glass walls and curtain wall sprinklers at Level 2 and/or providing special purpose horizontal sliding doors (i.e. Won-Door or McKeon) to separate the two-story atrium from the remainder of the building. I would recommend revising the location of combustibles in the main lobby as well as in the main corridors of the building. Combustibles should not be placed directly under light wells if possible so that large smoke plumes do not form.

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APPENDICIES

Appendix A – Engineering IV Occupancy Analysis

Appendix B – Engineering IV Occupant Load Calculations

Appendix C – Engineering IV Horizontal Exits and Exit Signs

Appendix D – Engineering IV Fire Alarm Drawings

Appendix E – Engineering IV Fire Alarm Cut Sheets

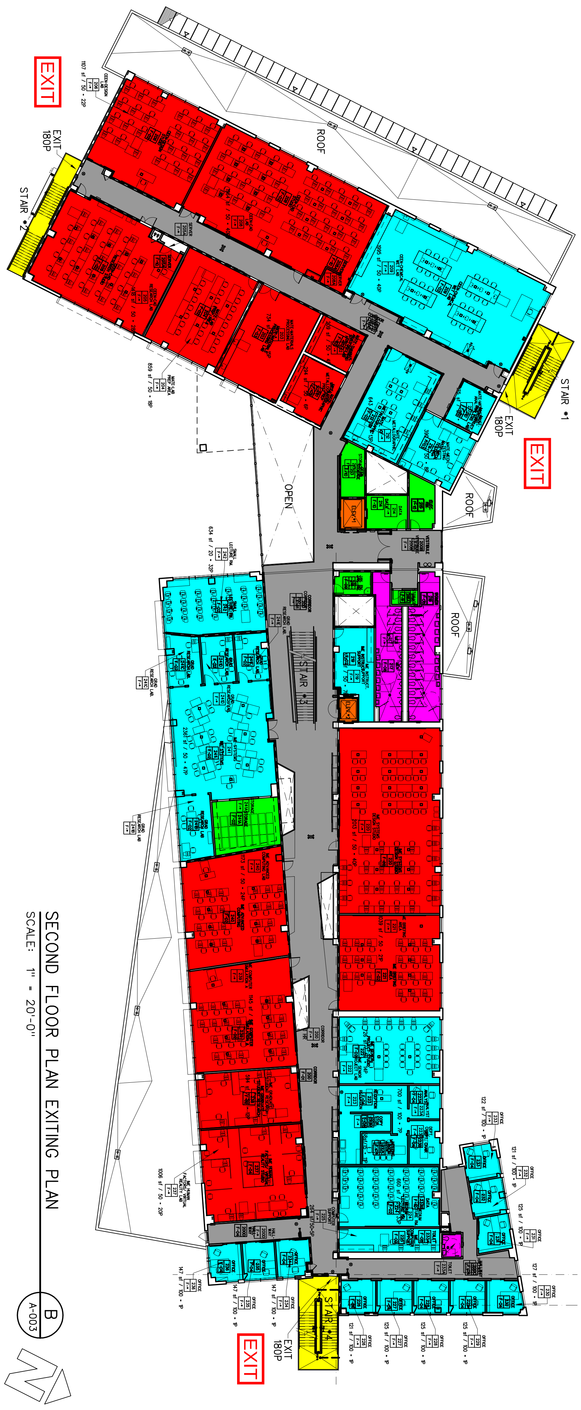
Appendix F – Engineering IV Fire Sprinkler Shop Drawings

Appendix G – Engineering IV Fire Sprinkler Cut Sheets

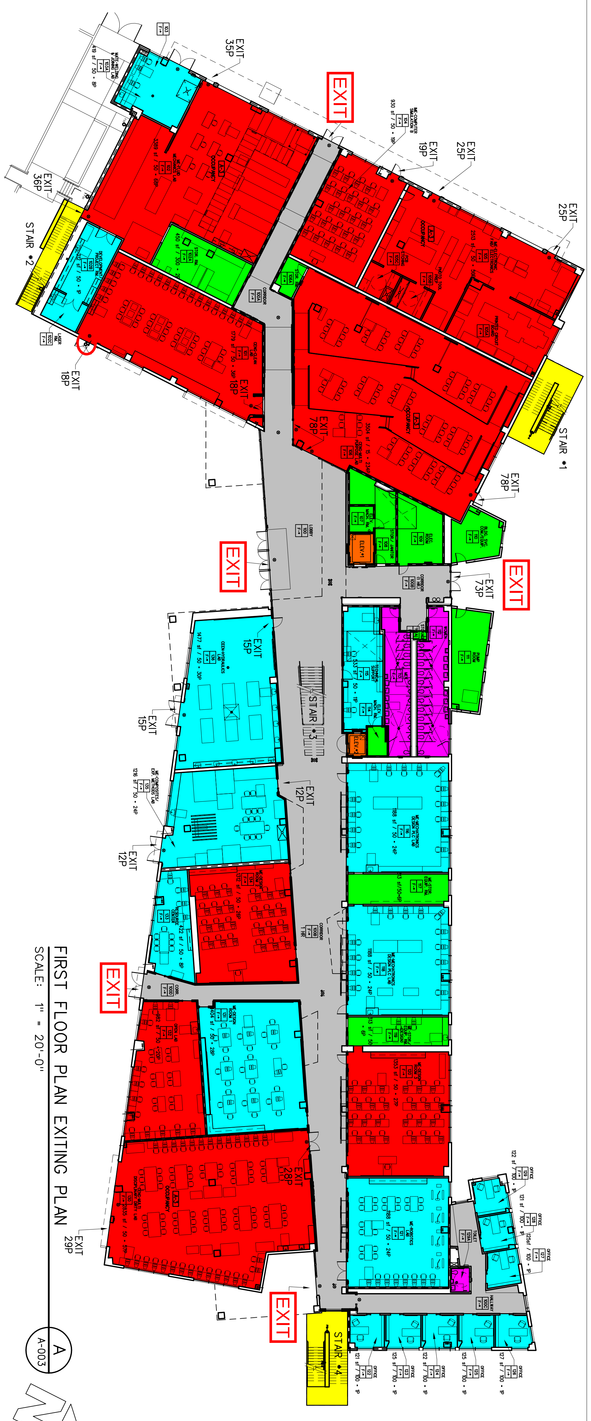
Appendix H – Engineering IV Fire Sprinkler Hydraulic Calculations

APPENDIX A

THIRD FLOOR PLAN EXITING PLAN
SCALE: 1" = 20'-0"
A-003 C



SECOND FLOOR PLAN EXITING PLAN
SCALE: 1" = 20'-0"
A-003 B



FIRST FLOOR PLAN EXITING PLAN
SCALE: 1" = 20'-0"
A-003 A

LEGEND

- CORRIDOR
- GROUP B BUSINESS
- GROUP A-3 ASSEMBLY
- GROUP S-2 EQUIPMENT / STORAGE
- EXIT STAIR
- ELEVATOR
- RESTROOMS
- EXIT DOORS (EXIT)

ac martin partners, inc
PLANNING ARCHITECTURE ENGINEERING

444 SOUTH FLOWER STREET
SUITE 1200
LOS ANGELES, CA 90071
213/683-1900

18401 VON KARMAN AVE
SUITE 130
IRVINE, CA 92612
949/474-0101

2485 NATOMAS PARK DRIVE
SUITE 360
SACRAMENTO, CA 95833
916/646-2890

consultant

plot date: 7/23/2007

sheet number: A-003

project: **Engineering IV Building**
California Polytechnic State University, San Luis Obispo

RECORD DRAWINGS

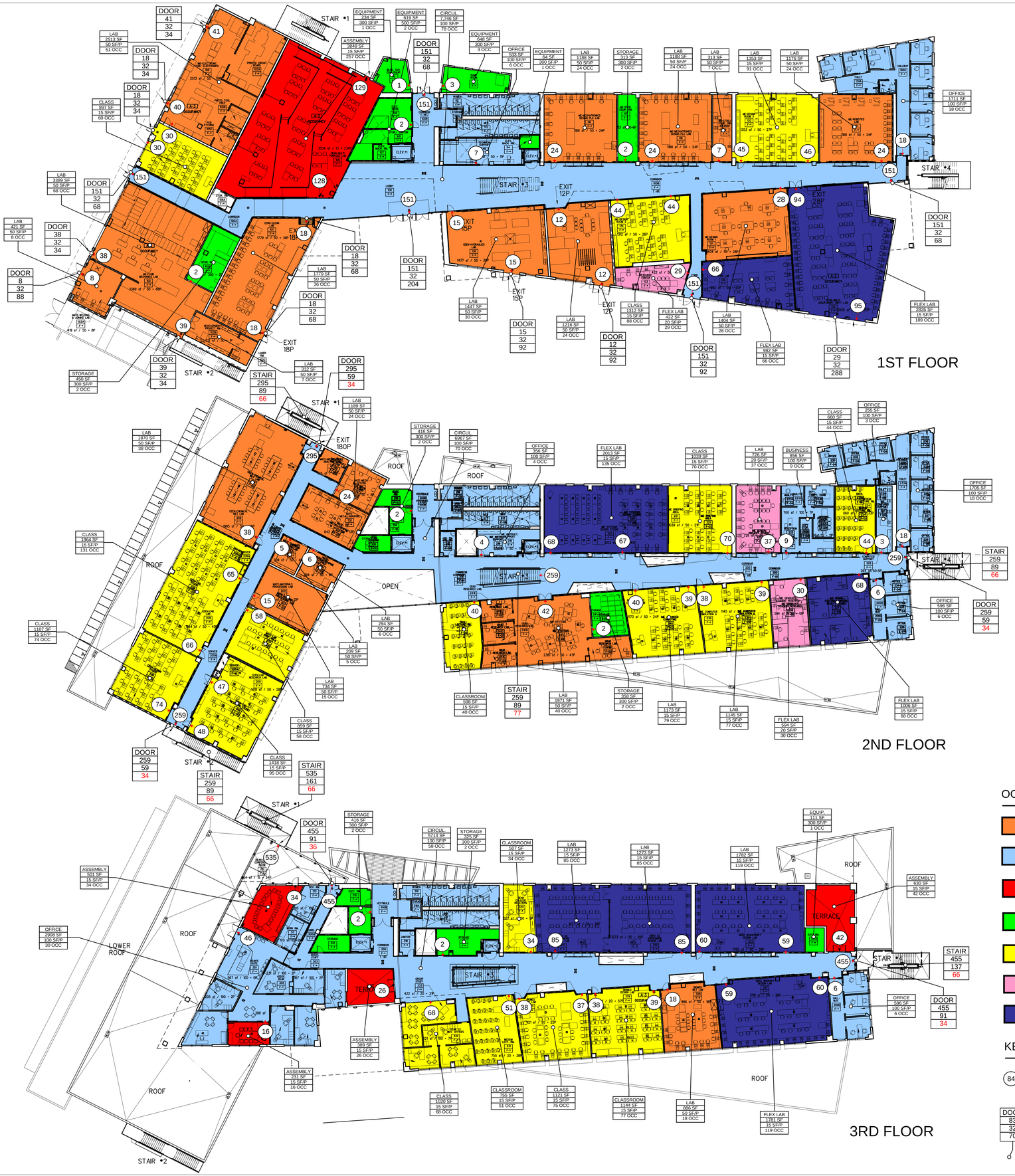
sheet title: **CODE ANALYSIS**

project information
- job number: 2003317
- project director: R. Halfon
- project designer: G. Bouvrie
- project architect: W. Charoenrath
- plan check submittal date:
- drawn by:
- checked by:
- construction issue date:

revision information

no.	date	revision	by	no.	date	revision	by

APPENDIX B



1ST FLOOR - OCCUPANT LOAD DISTRIBUTION

USE	OLF	OCC. LOAD
LABORATORY, EDUCATIONAL	50 NET	331
BUSINESS / CIRCULATION	100 GROSS	102
ASSEMBLY, UNCONCENTRATED	15 NET	257
CLASSROOMS, COMPUTER LABS	15 NET	239
EQUIPMENT / STORAGE	300 GROSS	11
FLEXIBLE LABORATORIES, UNDER 49 OCC.	20 NET	29
FLEXIBLE LABORATORIES, 50 OR MORE OCC.	15 NET	255

TOTAL: 1224 OCCUPANTS

1st Floor Exit Width Calculations	
Occupant Load Exiting Into Corridor	755 Occupants
Door Clear Width Required	755 x 0.2 = 151-inches
Door Clear Width Provided	408-inches

2ND FLOOR - OCCUPANT LOAD DISTRIBUTION

USE	OLF	OCC. LOAD
LABORATORY, EDUCATIONAL	50 NET	128
BUSINESS / CIRCULATION	100 GROSS	110
ASSEMBLY, UNCONCENTRATED	15 NET	0
CLASSROOMS, COMPUTER LABS	15 NET	668
EQUIPMENT / STORAGE	300 GROSS	4
FLEXIBLE LABORATORIES, UNDER 49 OCC.	20 NET	67
FLEXIBLE LABORATORIES, 50 OR MORE OCC.	15 NET	203

TOTAL: 1180 OCCUPANTS

2nd Floor Exit Width Calculations	
Total Occupant Load	1180 Occupants
Stair Clear Width Required	1180 x 0.3 = 354-inches
Stair Clear Width Provided	198-inches
Door Clear Width Required	1180 x 0.2 = 236-inches
Door Clear Width Provided	173-inches

3RD FLOOR - OCCUPANT LOAD DISTRIBUTION

USE	OLF	OCC. LOAD
LABORATORY, EDUCATIONAL	50 NET	18
BUSINESS / CIRCULATION	100 GROSS	94
ASSEMBLY, UNCONCENTRATED	15 NET	160
CLASSROOMS, COMPUTER LABS	15 NET	305
EQUIPMENT / STORAGE	300 GROSS	5
FLEXIBLE LABORATORIES, UNDER 49 OCC.	20 NET	0
FLEXIBLE LABORATORIES, 50 OR MORE OCC.	15 NET	408

TOTAL: 990 OCCUPANTS

3rd Floor Exit Width Calculations	
Total Occupant Load	990 Occupants
Stair Clear Width Required	990 x 0.3 = 297-inches
Stair Clear Width Provided	132-inches
Door Clear Width Required	990 x 0.2 = 198-inches
Door Clear Width Provided	70-inches

OCCUPANT LOAD LEGEND [CBC TABLE 1004.1.2]

- LABORATORY, EDUCATIONAL (50 NET)
- BUSINESS (100 GROSS)
- UNCONCENTRATED ASSEMBLY (15 NET)
- EQUIPMENT / STORAGE (300 GROSS)
- CLASSROOMS, COMPUTER LABS (15 NET)
- FLEXIBLE LABORATORIES, UNDER 49 OCC. (20 NET)
- FLEXIBLE LABORATORIES, 50 OR MORE OCC. (15 NET)

KEY

84 → OCCUPANT DISTRIBUTION

DOOR 83 32 70 → EGRESS COMPONENT / OCCUPANTS SERVED / REQUIRED CLEAR WIDTH / PROVIDED CLEAR WIDTH

LAB 1506 SF 50 SF/P 21 OCC → EGRESS COMPONENT / OCCUPANTS SERVED / REQUIRED CLEAR WIDTH / PROVIDED CLEAR WIDTH

revision information

consultant

project information

sheet title: OCCUPANT EXITING ANALYSIS

project: Engineering IV Building
California Polytechnic State University,
San Luis Obispo

sheet number: A-003

plot date: 7/23/2007

APPENDIX C

ac martin partners, inc
PLANNING ARCHITECTURE ENGINEERING

444 SOUTH FLOWER STREET
SUITE 1200
LOS ANGELES, CA 90071
213/683-1900

18401 VON KARMAN AVE
SUITE 130
IRVINE, CA 92612
949/474-0101

2485 NATOMAS PARK DRIVE
SUITE 360
SACRAMENTO, CA 95833
916/646-2890

consultant

sheet number
A-004

project
Engineering IV Building
California Polytechnic State University, San Luis Obispo

sheet title
EXIT SIGNS

project information

revision information

APPENIDX D

ENGINEERING IV BUILDING
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO CA

PROJECT DATA:

CONSTRUCTION TYPE: ***TYPE II - N***
OCCUPANCY GROUP: ***B/F***
SPRINKLERED: ***FULLY SPRINKLERED***

TYPE OF SYSTEM:
AUTOMATIC AND MANUAL FIRE ALARM SYSTEM WITH SPRINKLER MONITORING, ELEVATOR CONTROL INTERFACE AND HVAC SHUTDOWN.

APPLICABLE CODES

CALIFORNIA BUILDING CODE 2001 - EDITION
CALIFORNIA FIRE CODE- 2001 EDITION
NFPA 70 NATIONAL ELECTRIC CODE - 1999 EDITION
NFPA 72 FIRE ALARM CODE - 1999 EDITION

FIRE ALARM DESIGNER

ALPHA FIRE ALARM CORPORATION
650 SWEENEY LANE
SAN LUIS OBISPO, CA (805) 541-2527
LIC. # C-10, C-16, #761360

ARCHITECT

AC MARTIN PARTNERS INC.
444 S. FLOWER STREET STE. 1200
LOS ANGELES CA 90071
(213) 683 1900

FIRE ALARM INSTALLING CONTRACTOR

ALPHA FIRE ALARM CORPORATION
650 SWEENEY LANE
SAN LUIS OBISPO, CA (805) 541-2527
LIC. # C-10, C-16, #761360

CONSTRUCTION MANAGER

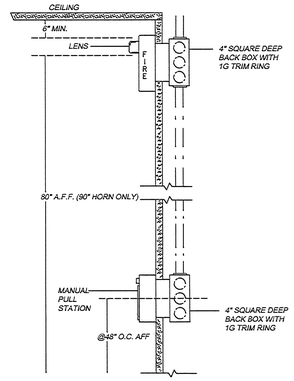
GILBANE CO.
4370 LA JOLLA VILLAGE DR. STE. 400
SAN DIEGO CA 92122
(858) 646 3055

ELECTRICAL CONTRACTOR

THOMA ELECTRIC CO.
3562 EMPLEO DR
SAN LUIS OBISPO CA 93401
(805) 543 3850

MECHANICAL AND ELECTRICAL ENGINEER

INNOVATIVE ENGINEERING GROUP INC.
2501 DAVIDSON DR. STE 200
MOHNTEREY PARK CA 91754
(323) 262 9199



MOUNTING NOTES

1. *All Hornstrobes and Strobes shall be mounted at 80" (90" Horn only) from the finished floor to the bottom of the lens, or 6" from the ceiling to the top of the lens, whichever is lower.*

2. *All Manual Pull Stations shall be mounted at 48" on center.*

MOUNTING DETAIL

NO SCALE

1. *PRIMARY POWER SOURCE (120VAC) MUST BE ON A DEDICATED BRANCH CIRCUIT. FIRE ALARM CIRCUIT BREAKER MUST BE CLEARLY MARKED AND MECHANICALLY SECURED TO PREVENT ANY UNAUTHORIZED TAMPERING.*

2. *THE FIRE ALARM SYSTEM SHALL CONFORM TO ARTICLE 760 OF THE NATIONAL ELECTRIC CODE, AND ALL APPLICABLE SECTIONS OF THE CALIFORNIA BUILDING CODE AND NFPA STANDARDS.*

3. *ALL EQUIPMENT SHALL BE U.L. AND CALIFORNIA STATE FIRE MARSHALL LISTED.*

4. *ALL TESTING SHALL BE PERFORMED IN ACCORDANCE WITH SECTION 7-1.6 OF 1999 NFPA 72.* △2

GENERAL NOTES

NO SCALE

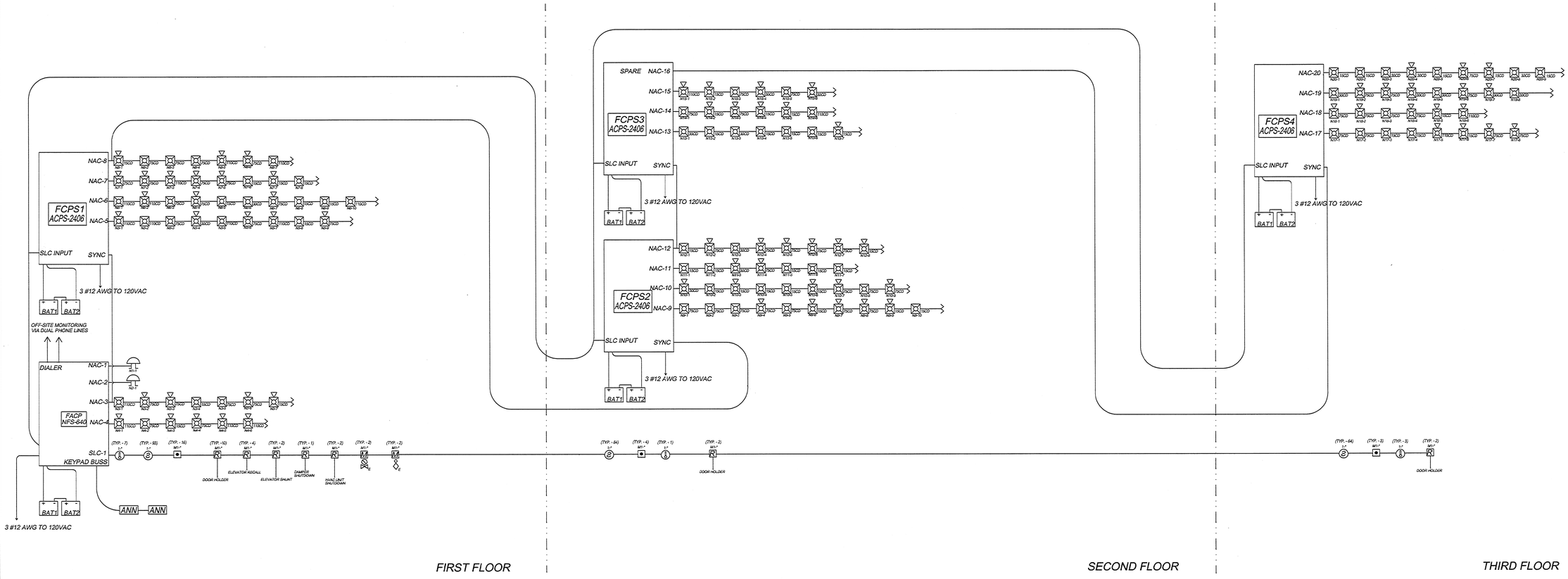
SYMBOL	*QTY*	*DESCRIPTION*	*PART NUMBER*	*CSFM LISTING NUMBER*
FACP	1	FIRE ALARM CONTROL PANEL	NOTIFIER NFS-640	7170-0028:216
FCPS#	4	FIRE ALARM POWER SUPPLY	NOTIFIER FCPS-24S8	7315-0028:225
ANN	2	FIRE ALARM ANNUNCIATOR	NOTIFIER FDU-80	7120-0028:209
	9	HEAT DETECTOR	NOTIFIER FST-851	7270-0028:196
	243	SMOKE DETECTOR	NOTIFIER FSP-851	7272-0028:206
	22	MANUAL PULL STATION	NOTIFIER NBG-12LX	7150-0028:199
M	12	MONITOR MODULE	NOTIFIER FMM-101	7300-0028:202
R	28	RELAY MODULE	NOTIFIER FRM-101	7300-0028:202
	2	DUCT SMOKE DETECTOR	NOTIFIER FSD-751P	3240-0028-205
CD	61	WALL MOUNT STROBE	SYSTEM SENSOR S1224MCW	7125-1653:162
HCD	69	WALL MOUNT HORN STROBE	SYSTEM SENSOR P1224MCW	7135-1653:163
	2	WATERFLOW BELL	WHEELOCK MB-G10-24-R	7135-0785:113
	2	FIRE SPRINKLER RISER	PROVIDED BY OTHERS	BY OTHERS
	2	WATERFLOW SWITCH	PROVIDED BY OTHERS	BY OTHERS
	2	CONTROL VALVE TAMPER SWITCH	PROVIDED BY OTHERS	BY OTHERS
OSSY	2	OS&Y SWITCH	PROVIDED BY OTHERS	BY OTHERS

XX - DENOTES STROBE CANDELA RATING

WIRE DESIGNATION	*DESCRIPTION*
A	16/2 FPL SIGNALING LINE CIRCUIT (SLC) CABLE
B	14/2 FPL NOTIFICATION APPLIANCE CIRCUIT (NAC) CABLE
C	3 - 16/2 FPL ANNUNCIATOR CABLES
D	16/2 FPL INITIATING CIRCUIT CABLE
E	14/2 FPL 24VDC RESETTABLE POWER CABLE
F	14/2 FPL 24VDC NON-RESETTABLE POWER CABLE
G	14/2 FPL SPEAKER CIRCUIT CABLE

PARTS AND WIRING LEGENDS

NO SCALE



RISER DIAGRAM

NO SCALE

ISSUED FOR:

REV#	DATE	
△1	4/18/2005	A.H.J. APPROVAL
△2	08/12/2005	A.H.J. APPROVAL
△3	09/20/2005	

DRAWN BY: WALLACE SIMS

ALPHA FIRE
ALARM CORPORATION
LIC # C-10, C-16 THRU, ADM #886
650 Sweeney Lane
San Luis Obispo, CA 93401
(805) 541-2527 • FAX: 781-8886

ENGINEERING IV BUILDING
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA

AS-BUILT

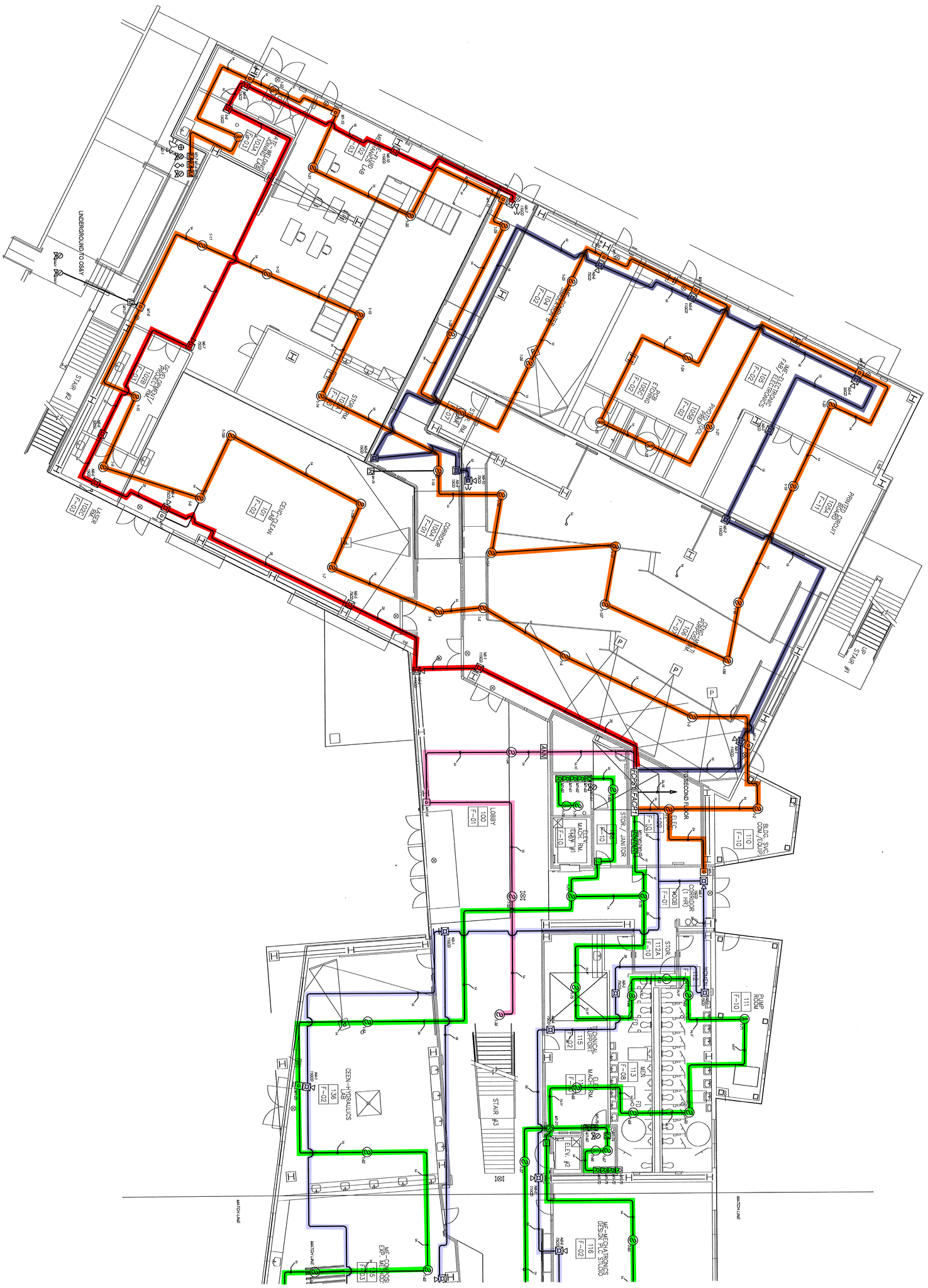
JOB	521-05
START DATE	6/24/2005

SHEET

FA-1

FIRST FLOOR WEST FIRE ALARM PLAN

1/8" = 1'0"



FA-2	JOB	2211-04	**AS-BUILT**
SHEET	START DATE	6/24/2005	

ENGINEERING IV BUILDING
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA

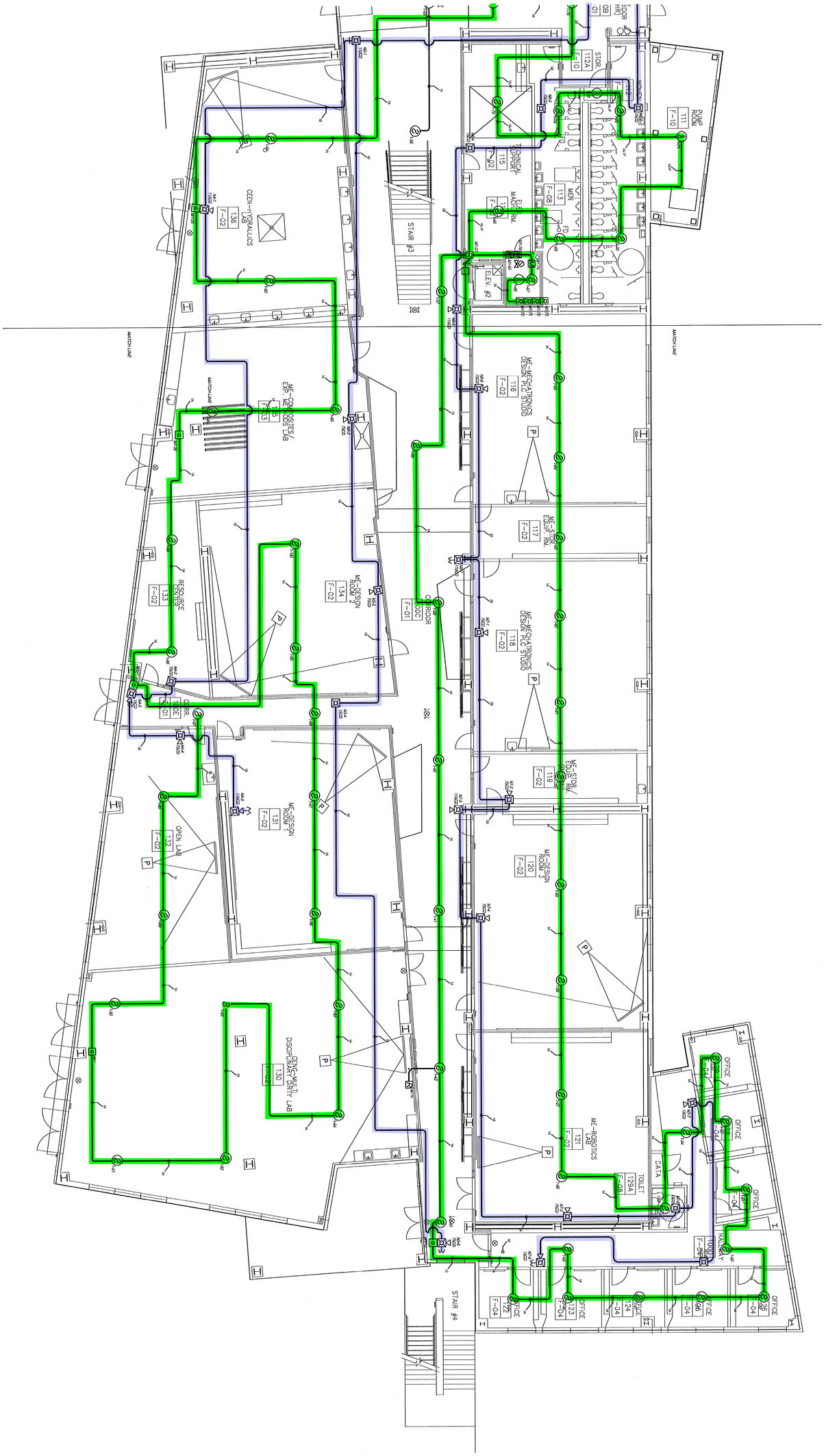
ALPHA FIRE
ALARM CORPORATION
LIC C-10, C-16 761560, ACO# 6366
650 Suzanne Lane
San Luis Obispo, CA. 93401
(805) 541-2527 FAX: 784-5656

DRAWN BY:
WALLACE SIMS

REV#	DATE	ISSUED FOR:
1	4/18/2005	A.H.J. APPROVAL
2	09/12/2005	A.H.J. APPROVAL
3	09/20/2005	

FIRST FLOOR EAST FIRE ALARM PLAN

1/8" = 1'0"



AS-BUILT

ENGINEERING IV BUILDING

CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA

ALPHA FIRE
ALARM CORPORATION
LIC C-10, C-16 761363, ACO# 5365
650 Sweeney Lane
San Luis Obispo, CA 93401
(805) 541-2027 FAX: 784-0868

DRAWN BY:
WALLACE SIMS

REV#	DATE	ISSUED FOR:
1	4/18/2005	A.H.J. APPROVAL
2	08/12/2005	A.H.J. APPROVAL
3	09/20/2005	

SHEET FA-3

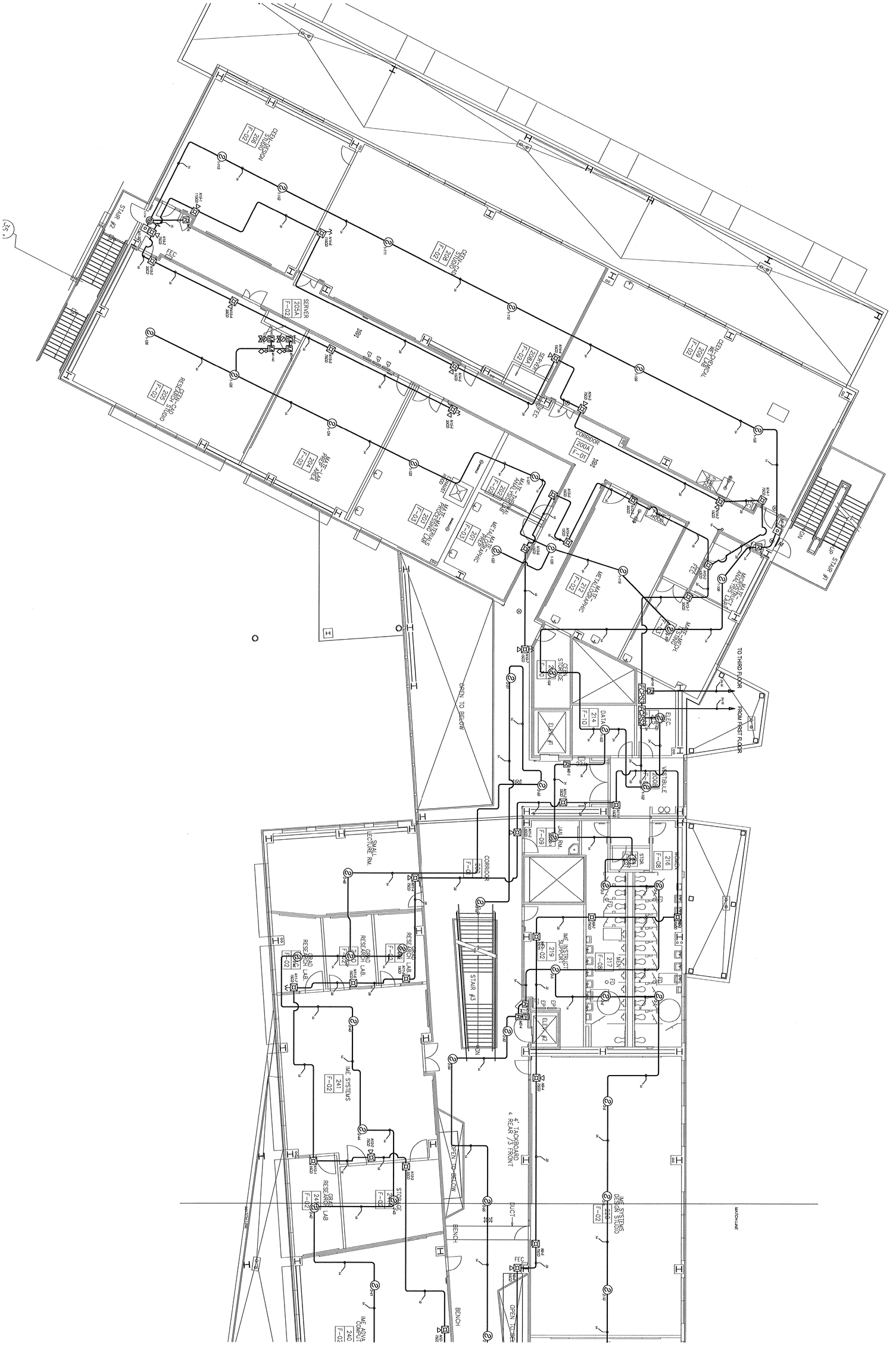
JOB

START DATE 6/24/2005

EST+04

SECOND FLOOR WEST FIRE ALARM PLAN

1/8" = 1'0"



AS-BUILT

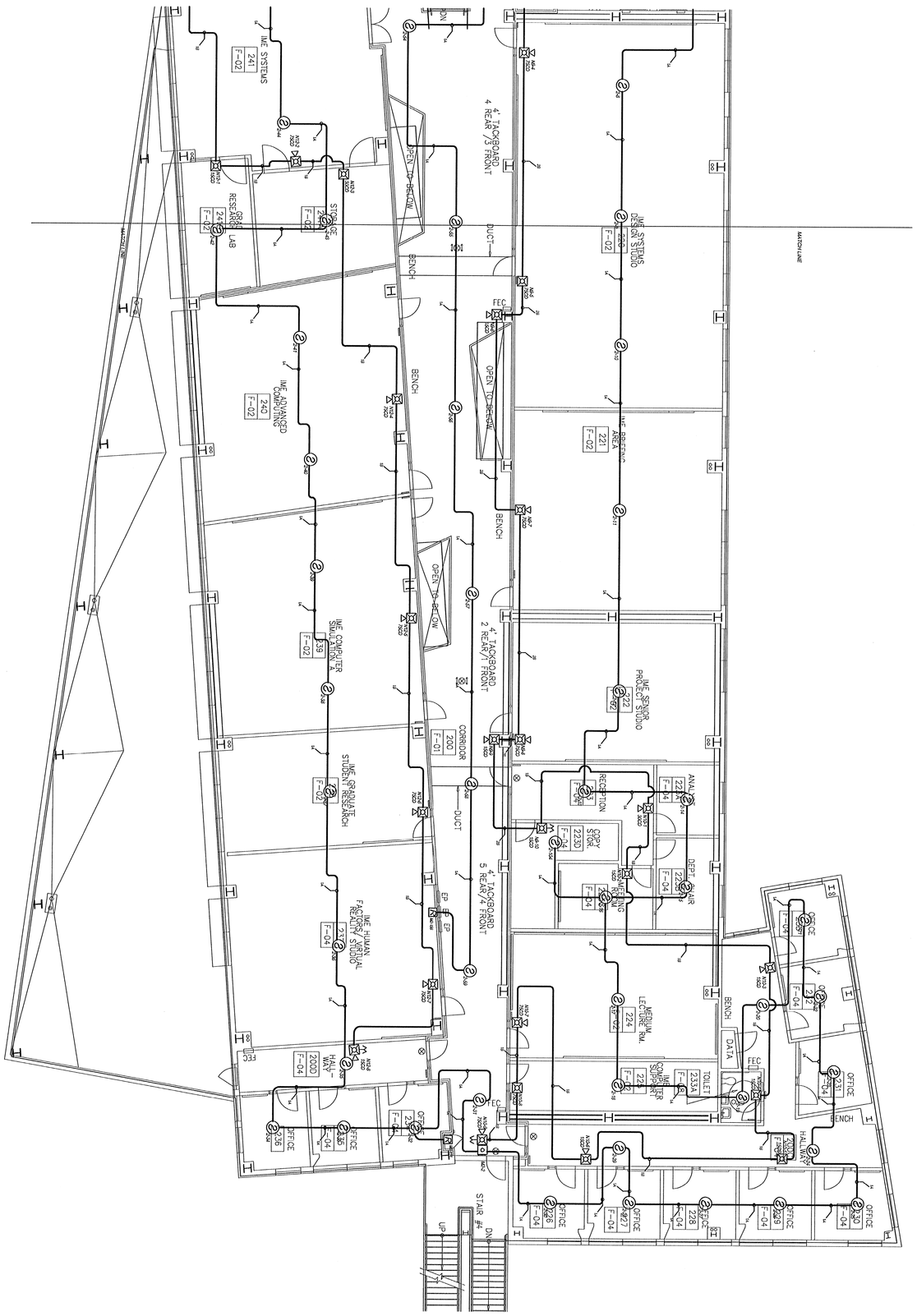
ENGINEERING IV BUILDING
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA

ALPHA FIRE
ALARM CORPORATION
LIC C-10, C-16 761502, ACO# 5365
650 Swanay Lane
San Luis Obispo, CA. 93401
(805) 541-3537 FAX 784-0868

DRAWN BY:
WALLACE SIMS

REV#	DATE	ISSUED FOR:
1	4/18/2005	A.H.J. APPROVAL
2	09/12/2005	A.H.J. APPROVAL
3	09/20/2005	

JOB
START DATE 6/04/2005
SHEET FA-4



SECOND FLOOR EAST FIRE ALARM PLAN

1/8" = 1'0"

FA-5

SHEET

JOB	
STARTDATE	03-05
05/4/2005	

AS-BUILT

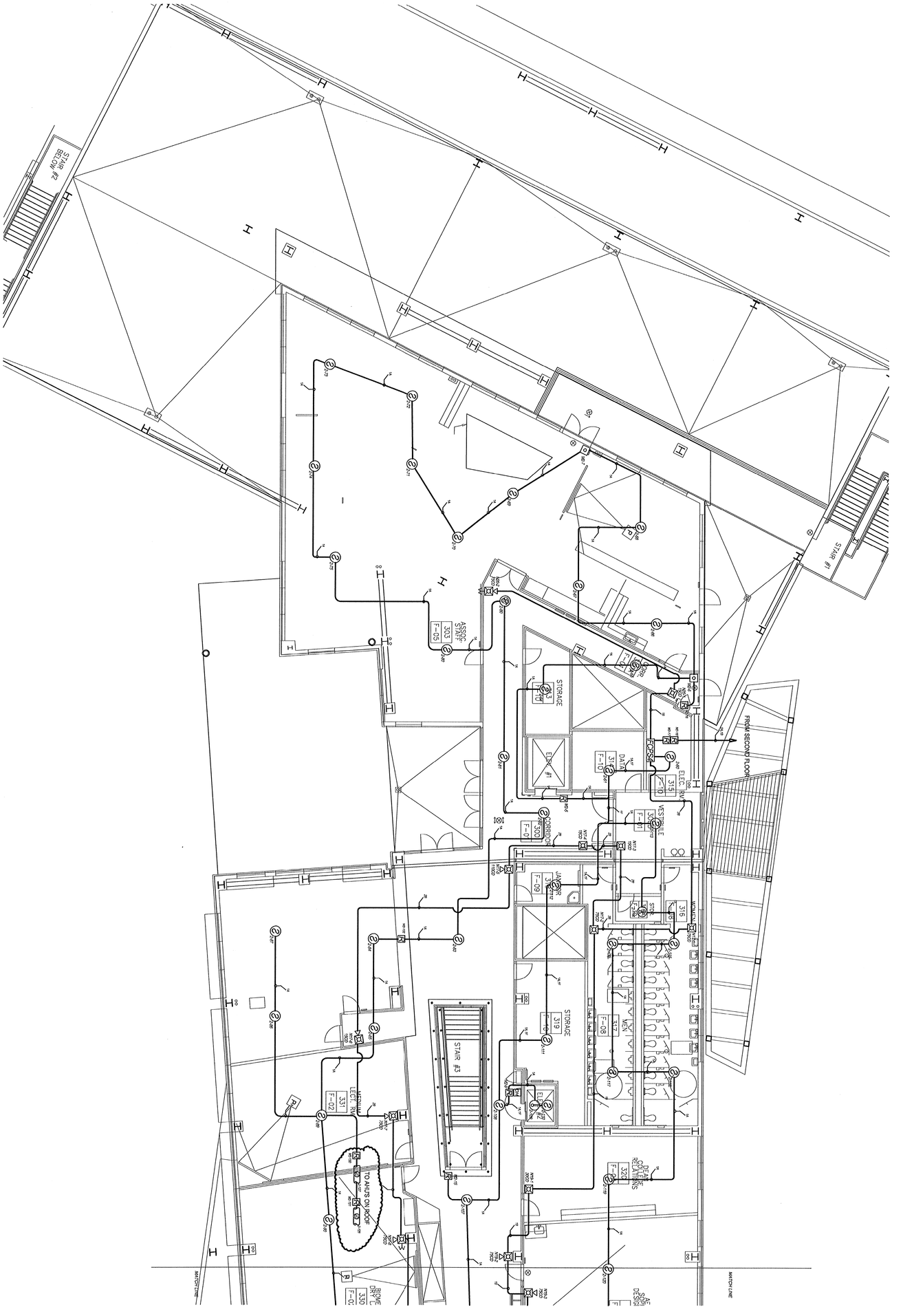
ENGINEERING IV BUILDING

CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA

ALPHA FIRE
ALARM CORPORATION
I/C C-10, C-16 761360, ACOR 5565
650 Suncrest Lane
San Luis Obispo, CA. 93401
(805) 541-2537 FAX: 784-0868

DRAWN BY:
WALLACE SIMS

REV#	DATE	ISSUED FOR:
1	4/18/2005	A.H.J. APPROVAL
2	09/12/2005	A.H.J. APPROVAL
3	09/20/2005	



THIRD FLOOR WEST FIRE ALARM PLAN

1/8" = 1'-0"

FA-6

SHEET

JOB	
START DATE	05/12/05

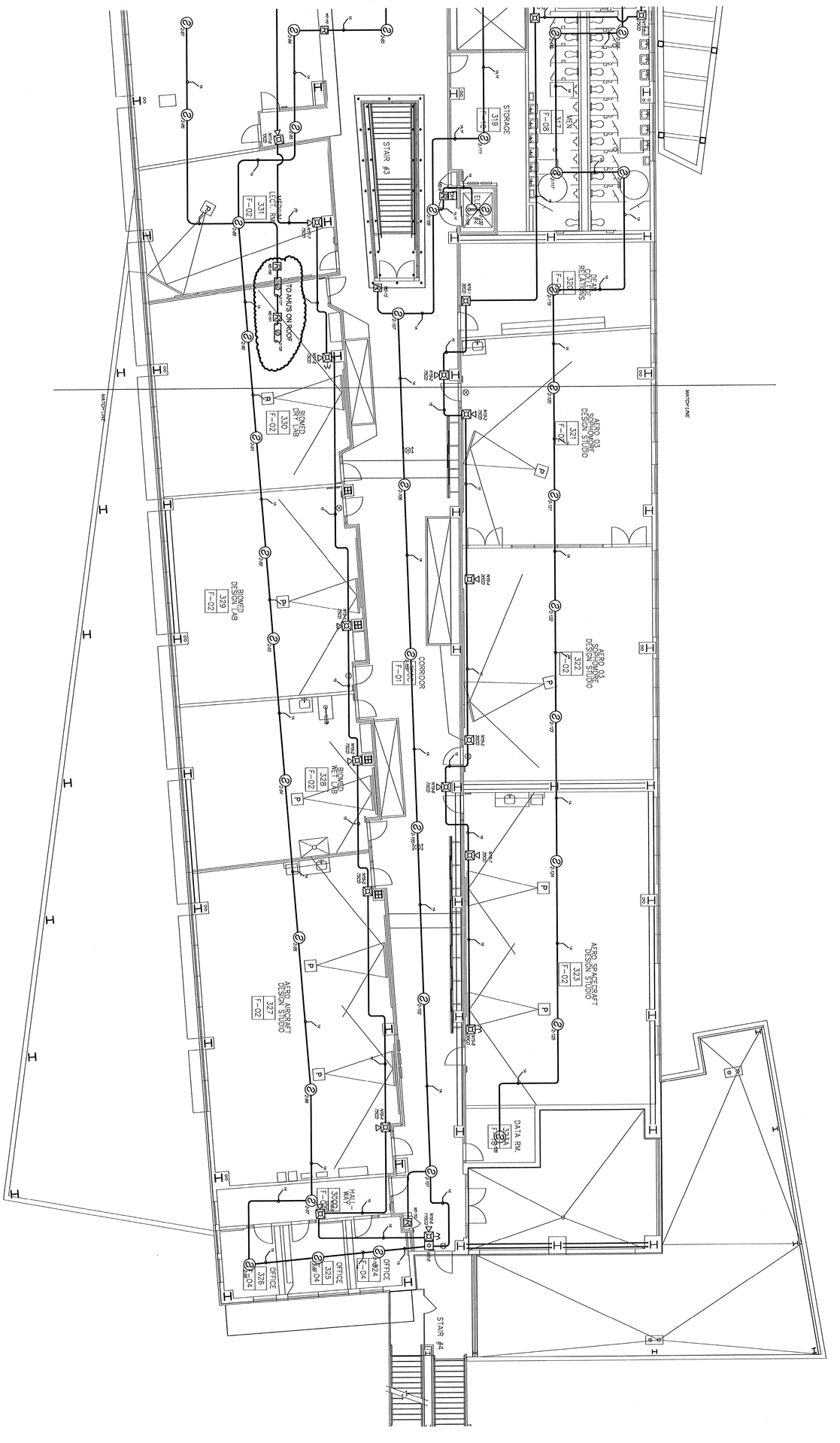
AS-BUILT

ENGINEERING IV BUILDING
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA

ALPHA FIRE
ALARM CORPORATION
LIC C-10, C-16 761200, ACO# 5308
650 Sweeney Lane
San Luis Obispo, CA. 93401
(805) 541-2527 FAX: 781-0868

DRAWN BY:
WALLACE SIMS

REV#	DATE	ISSUED FOR:
1	4/18/2005	A.H.J. APPROVAL
2	09/12/2005	A.H.J. APPROVAL
3	09/20/2005	



THIRD FLOOR EAST FIRE ALARM PLAN

1/8" = 1'0"

FA-7

SHEET

JOB

START DATE 6/24/2005

S21-05

AS-BUILT

ENGINEERING IV BUILDING

CALIFORNIA POLYTECHNIC STATE UNIVERSITY

SAN LUIS OBISPO, CA

ALPHA FIRE

ALARM CORPORATION

LIC C-10, C-16 761099, ACO# 5369

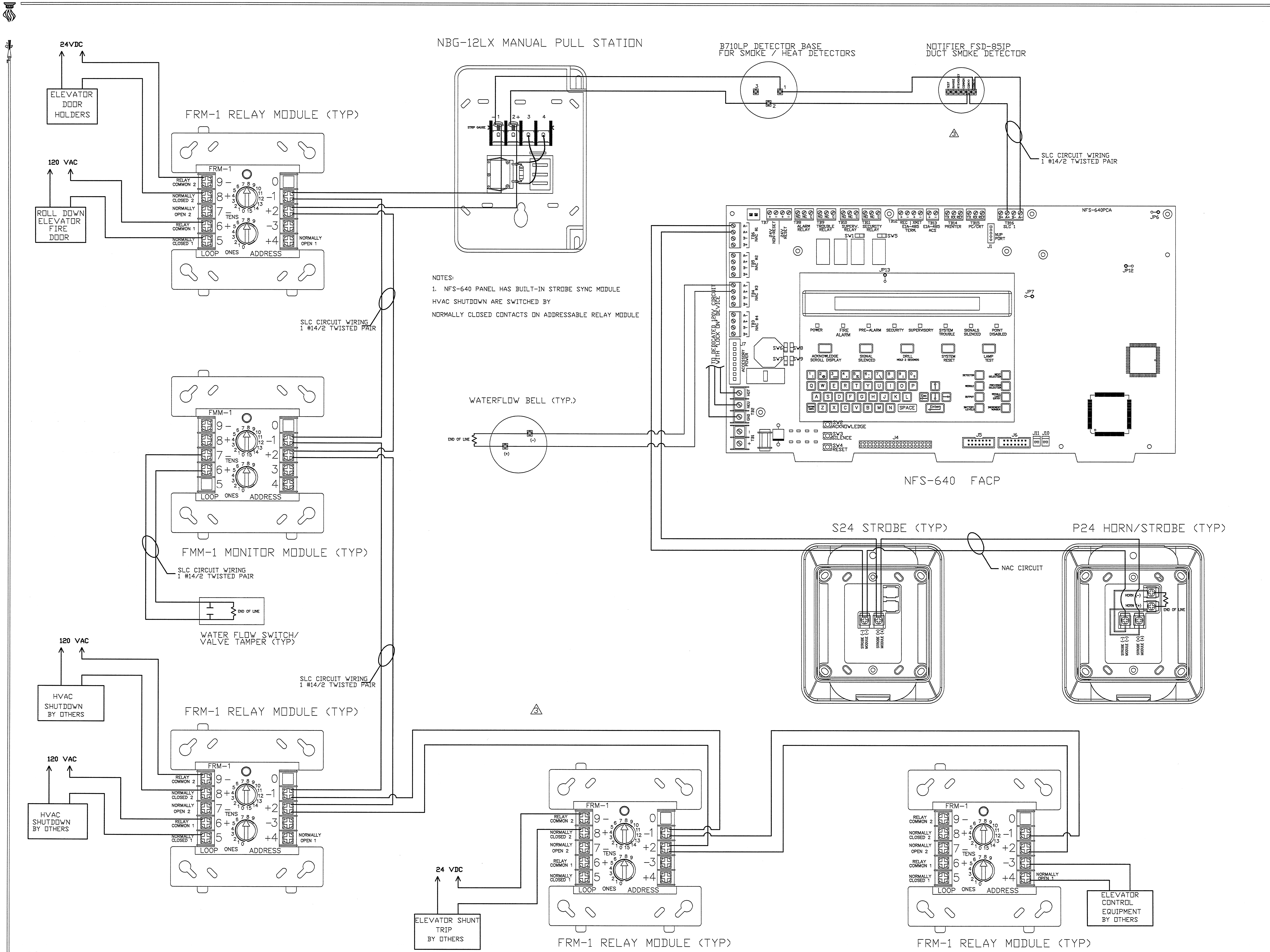
650 Sweeney Lane

San Luis Obispo, CA 93401

(805) 541-2527 FAX: 784-0868

DRAWN BY:
WALLACE SIMS

REV#	DATE	ISSUED FOR:
1	4/18/2005	A.H.J. APPROVAL
2	08/12/2005	A.H.J. APPROVAL
3	09/20/2005	



POINT TO POINT
NO SCALE

ISSUED FOR:
A.H.J. APPROVAL
A.H.J. APPROVAL

REV#	DATE
	4/18/2005
	09/12/2005
	09/20/2005

DRAWN BY:
WALLACE SIMS

ALPHA FIRE

ENGINEERING IV BUILDING
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CA

AS-BUILT

JOB	521-05
START DATE	6/24/2005
SHEET	FA-8

NFS2-640(E)

Intelligent Addressable Fire Alarm System

NOTIFIER® by Honeywell

Intelligent Fire Alarm Control Panels

General

The NFS2-640 intelligent Fire Alarm Control Panel is part of the ONYX® Series of Fire Alarm Controls from NOTIFIER.

In stand-alone or network configurations, ONYX Series products meet virtually every application requirement.

The NFS2-640's modular design makes system planning easier. The panel can be configured with just a few devices for small building applications, or networked with many devices to protect a large campus or a high-rise office block. Simply add additional peripheral equipment to suit the application.

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

NOTE: *Unless called out with a version-specific "E" at the end of the part number, "NFS2-640" refers to models NFS2-640 and NFS2-640E; similarly, "CPU2-640" refers to models CPU2-640 and CPU2-640E.*

NFS2-640

Features

- Certified for seismic applications when used with the appropriate seismic mounting kit.
- Approved for Marine applications when used with listed compatible equipment. *See DN-60688.*
- One, expandable to two, isolated intelligent Signaling Line Circuit (SLC) Style 4, 6 or 7.
- Wireless fire protection using SWIFT Smart Wireless Integrated Fire Technology. See DN-60820.
- Up to 159 detectors and 159 modules per SLC; 318 devices per loop/636 per FACP or network node.
  - Detectors can be any mix of ion, photo, thermal, or multi-sensor; wireless detectors are available for use with the FWSG.
  - Modules include addressable pull stations, normally open contact devices, two-wire smoke detectors, notification, or relay; wireless modules are available for use with the FWSG.
- Standard 80-character display, 640-character large display (NCA-2), or display-less (a node on a network).
- Network options:
  - High-speed network for up to 200 nodes (NFS2-3030, NFS2-640, NFS-320(C), NFS-320SYS, NCA-2, DVC-EM, ONYXWorks, NFS-3030, NFS-640, and NCA).
  - Standard network for up to 103 nodes (NFS2-3030, NFS2-640, NFS-320(C), NFS-320SYS, NCA-2, DVC-EM, ONYXWorks, NCS, NFS-3030, NFS-640, NCA, AFP-200, AFP-300/400, AFP-1010, and AM2020). Up to 54 nodes when DVC-EM is used in network paging.
- 6.0 A switch mode power supply with four Class A/B built-in Notification Appliance Circuits (NAC). Selectable System Sensor, Wheelock, or Gentex strobe synchronization.
- Built-in Alarm, Trouble, Security, and Supervisory relays.
- VeriFire® Tools online or offline programming utility. Upload/Download, save, store, check, compare, and simulate panel databases. Upgrade panel firmware.
- Autoprogramming and Walk Test reports.
- Multiple central station communication options:
  - Standard UDACT
  - Internet
  - Internet/GSM
- 80-character remote annunciators (up to 32).
- EIA-485 annunciators, including custom graphics.
- Printer interface (80-column and 40-column printers).
- History file with 800-event capacity in nonvolatile memory, plus separate 200-event alarm-only file.
- Alarm Verification selection per point, with automatic counter.
- Presignal/Positive Alarm Sequence (PAS).
- Silence inhibit and Auto Silence timer options.
- March time/temporal/California two-stage coding/strobe synchronization.
- Field-programmable on panel or on PC, with VeriFire Tools program check, compare, simulate.
- Full QWERTY keypad.
- Battery charger supports 18 – 200 AH batteries.
- Non-alarm points for lower priority functions.
- Remote ACK/Signal Silence/System Reset/Drill via monitor modules.
- Automatic time control functions, with holiday exceptions.
- Surface Mount Technology (SMT) electronics.
- Extensive, built-in transient protection.
- Powerful Boolean logic equations.
- Support for SCS Series smoke control system in HVAC mode.

FCPS-24FS8

8-Amp, 24-Volt Power Supply

FIRE·LITE ALARMS by Honeywell

Power Supplies/Accessories

General

The **Fire•Lite FCPS-24FS8(C/E)** is a compact, cost-effective, 8-amp remote power supplies with battery charger. The FCPS-24FS8C/E) may be connected to any 12 or 24 volt fire alarm control panel (FACP) or may stand-alone. Primary applications include notification appliance (bell) circuit (NAC) expansion (to support ADA requirements and NAC synchronization) or auxiliary power to support 24 volt system accessories. The FCPS provides *regulated and filtered* 24 VDC power to four notification appliance circuits configured as either two Class B (Style Y) and Class A (Style Z, with ZNAC-4 option module) or four class B only. Alternately, the four outputs may be configured as any combination of resettable/non-resettable power outputs (optimal for powering four-wire smoke detectors. The FFCPS-24FS8(C/E) also contains a battery charger capable of charging up to 18.0 Amp hour batteries. FCPS-24FS8C/E) is ULC-listed.

NOTE: *Unless otherwise specified, the term FCPS-24FS8 used in this document refers to the standard FCPS-24FS8, FCPS-24FS8C, FCPS-24FS8E*

Features

- UL-Listed Notification Appliance Circuit (NAC) synchronization using System Sensor, Wheelock, or Gentex "Commander^2" appliances.
- Operates as a "sync-follower" or as a "sync-generator" (default). *See note on page 2.*
- Contains two fully-isolated input/control circuits - triggered from FACP NAC (NAC expander mode) or jumped permanently "ON" (stand-alone mode).
- Two Class B (Style Y) or Class A (Style Z, with ZNAC-4 module) NACs (circuits 1 & 3)
- 8-amp full load output, with 3 amps maximum/circuit, in NAC expander mode (UL 864).
- 6-amp continuous output in stand-alone mode (UL 1481).
- Compatible with coded inputs; signals passed through.
- Optional power-supervision relay (EOLR-1).
- In stand-alone mode, output power circuits may be configured as: resettable, (reset line from FACP required), non-resettable, or a mix of two and two.
- Fully regulated and filtered power output - optimal for powering four-wire smoke detectors, annunciators, and other system peripherals requiring regulated/filtered power.
- Power-limiting technology meets UL power-limiting requirements.
- Form-C normally-closed trouble relay.
- Fully supervised power supply, battery, and NACs.
- Selectable earth fault detection.
- AC trouble report selectable for immediate 2-hour delay.
- Works with virtually any UL 864 fire alarm control which utilizes an industry-standard reverse-polarity notification circuit (including unfiltered and unregulated bell power).
- Requires input trigger voltage of 9 - 32 VDC.
- Self-contained in compact, locking cabinet - 15"H x 14.5"W x 2.75"D (cm: 38.1H x 36.83W x 6.985D).

- Includes integral battery charger capable of charging up to 18 AH batteries. Cabinet capable of housing 7.0 AH batteries.
- Battery charger may be disabled via DIP switch for applications requiring larger batteries.
- Fixed, clamp-type terminal blocks accommodate up to 12 AWG (3.1mm^2) wire.

Specifications

Primary (AC) Power:

- FCPS-24FS8: 120 VAC, 60 Hz, 3.2A maximum.
- FCPS-24FS8/E: 240 VAC, 50 Hz, 1.6A maximum.
- Wire Size: minimum #14 AWG (2.0mm^2) with 600 V insulation.

Control Input Circuit:

- **Trigger Input Voltage:** 9 to 32 VDC.
- **Trigger Current:** 2.0 mA (16 - 32 V); Per Input: 1.0 mA (9 - 16 V).

Trouble Contact Rating: 5 A at 24 VDC.

Auxiliary Power Output: Specific application power 500 mA maximum.

Output Circuits:

- +24 VDC filtered, regulated.
- 3.0 A maximum for any one circuit.
- Total continuous current for all outputs (stand-alone mode):
  – FCPS-24FS8: 6.0 A maximum.
- Total short-term current for all outputs (NAC expander mode):
  – FCPS-24FS8: 8.0 A maximum.

FDU-80

80 Character Liquid Crystal Display

NOTIFIER® by Honeywell

Annunciators

General

The FDU-80 is a compact, cost-effective, 80-character, backlit LCD remote Fire Annunciator for use with the NOTIFIER Fire-Warden-100-2, NFS2-640, and NFS-320 Fire Alarm Control Panels (FACPs). The FDU-80 mimics the display of the control panel and displays complete system point status information.

Up to 32 FDU-80s may be connected onto the EIA-485 terminal port of each FACP. The FDU-80 requires no programming, which saves time during system commissioning.

Features

- 80-character Liquid Crystal Display.
- Mimics all display information from the host panel.
- Control switches for System Acknowledge, Signal Silence, Drill and Reset with enable key.
- System status LEDs for Power, Alarm, Trouble, Supervisory and Alarm Silenced.
- No programming necessary — FDU-80 connects to the terminal porton the FACP.
- Displays device type identifiers, individual point alarm, trouble or supervisory, zone and custom alpha labels.
- Time-and-date display field.
- Aesthetically pleasing design.
- May be powered from the host FACP or by remote power supply (requires 24 VDC).
- Up to 32 FDU-80 annunciators per FACP.
- Plug-in terminal blocks for ease of installation and service.
- Can be remotely located up to 6,000 feet (1828.8 m) from the FACP.
- Local piezo sounder with alarm and trouble resound.
- Semi-flush mounts to 2.188" (5.556 cm) minimum deep, three-gang electrical box (NOTIFIER PN **10103**) or three-gangable electrical switchbox.
- Surface-mounts to NOTIFIER PN **SBB-3** surface backbox.

Operation

The FDU-80 annunciator provides the FACP with point annunciation with full display text on an 80-character LCD display. The FDU-80 also provides an array of LEDs to indicate system status, and includes control switches for remote control of critical system functions.

The FDU-80 provides the FACP with up to 32 remote serially connected annunciators. All field-wiring terminations on the FDU-80 use removable, compression-type terminal blocks for ease of wiring and circuit testing.

Communication between the FACP and the annunciators is accomplished over an EIA-485 serial interface, which greatly reduces wire and installation cost over traditional systems.

Installation

The FDU-80 can be semi-flush mounted to a 2.188" (5.556 cm) minimum deep, three-gang electrical box or three-gangable electrical switchboxes. Alternately, an SBB-3 surface backbox is available for surface-mount applications.

6820fdu8.jpg

Ordering Information

FDU-80: 80 character, backlit, LCD Fire Annunciator with control switches for remote control of system functions, and key-switch lock.

FDU-80C: ULC-listed version; see DN-60573 for details.

10103: Three-gang electrical box, minimum 2.188" (5.556 cm) deep, for semi-flush mount applications.

SBB-3: Three-gang surface backbox for surface-mount applications.

Agency Listings And Approvals

These listings and approvals apply to the modules specified in this document. In some cases, certain modules or applications may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL Listed:** S635
- **MEA Listed:** 245-00-E
- **FDNY:** COA#6038
- **CSFM: 7120-0028:209**
- **FM Approved**

NOTE: For ULC-listed version, see DN-60573.

FSP-851, FSP-851T and FAPT-851 Intelligent Photoelectric Smoke Sensors
Installation and Maintenance Instructions

This sensor must be installed in compliance with the control panel system installation manual. The installation must meet the requirements of the Authority Having Jurisdiction (AHJ). Sensors offer maximum performance when installed in compliance with the National Fire Protection Association (NFPA); see NFPA 72.

GENERAL DESCRIPTION

Models FSP-851, FSP-851T and FAPT-851 are plug-in type smoke sensors that combine a photoelectronic sensing chamber with addressable-analog communications. The sensors transmit an analog representation of smoke density over a communication line to a control panel. Rotary decade switches are provided for setting the sensor's address.

Two LEDs on the sensor are controlled by the panel to indicate sensor status. An output is provided for connection to an optional remote LED annunciator (P/N RA400Z). Models FAPT-851 and FSP-851T combines a photoelectronic sensing chamber and 135°F (57.2°C) fixed temperature heat detector.

Notifier panels offer different features sets across different models. As a result, certain features of the FSP-851, FSP-851T and FAPT-851 may be available on some control panels, but not on others. The possible features available in the FSP-851, FSP-851T and FAPT-851, if supported by the control unit are:

1. The panel controls the LED operation on the sensor. Operational modes are RED blink, RED continuous, GREEN blink, and off.

2. The remote output may be synchronized to the LED operation or controlled independent of the LEDs.

Please refer to the operation manual for the UL listed control unit for specific operation of the FSP-851, FSP-851T and FAPT-851.

The FSP-851, FSP-851T and FAPT-851 require compatible addressable communications to function properly. Connect these sensors to listed-compatible control panels only.

SPECIFICATIONS

Operating Voltage Range:	15 to 32 VDC
Standby Current:	300µA @ 24 VDC (one communication every 5 seconds with LED blink enabled)
Max. Alarm Current (LED on):	6.5 mA @ 24 VDC
Operating Humidity Range:	10% to 93% Relative Humidity, noncondensing
Operating Temperature Range:	0° to 49°C (32° to 120°F); FSP-851 0° to 38°C (32° to 100°F); FSP-851T, FAPT-851
Height:	2.1 inches (51 mm) installed in B710LP Base
Diameter:	6.1 inches (155 mm) installed in B710LP Base 4.1 inches (104 mm) installed in B501 Base
Weight:	5.2 oz. (147 g)

SPACING

Notifier recommends spacing sensors in compliance with NFPA 72. In low air flow applications with smooth ceilings, space sensors 30 feet apart. For specific information regarding sensor spacing, placement, and special applications, refer to NFPA 72 or the *System Smoke Detector Application Guide*, available from Notifier.

Duct Applications: FSP-851 and FSP-851T are listed for use in ducts.
See Duct Applications Guide A05-1004 for details on pendant mount applications.
NOTE: These products are not listed for use inside duct smoke detectors.

WIRING GUIDE

All wiring must be installed in compliance with the National Electrical Code, applicable local codes, and any special requirements of the Authority Having Jurisdiction. Proper wire gauges should be used. The installation wires should be color-coded to limit wiring mistakes and ease system troubleshooting. Improper connections will prevent a system from responding properly in the event of a fire.

Remove power from the communication line before installing sensors.

1. Wire the sensor base (supplied separately) per the wiring diagram, see Figure 1.
2. Set the desired address on the sensor address switches, see Figure 2.
   NOTE: Some panels support extended addressing. In order to set the sensor above address 99 on compatible systems, carefully remove the stop on the upper rotary switch with thumb as shown in Figure 2.
3. Install the sensor into the sensor base. Push the sensor into the base while turning it clockwise to secure it in place.
4. After all sensors have been installed, apply power to the control unit and activate the communication line.
5. Test the sensor(s) as described in the **TESTING** section of this manual.

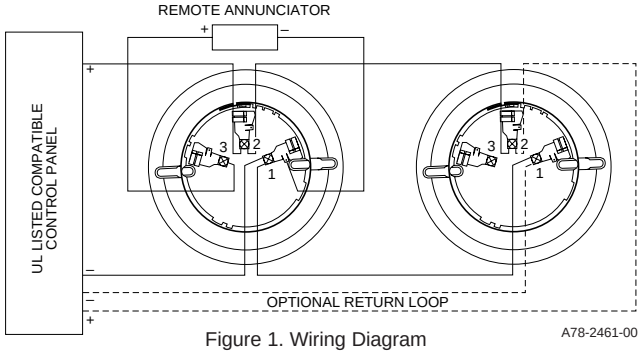


Figure 1. Wiring Diagram

Caution: Do Not Loop Wire Under Terminal 1 or 2.
Break Wire Run To Provide Supervision of Connections.

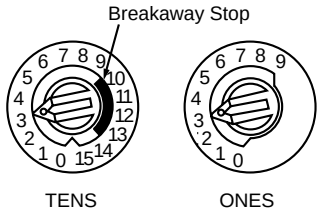


Figure 2. Rotary Address Switches

⚠CAUTION

Dust covers provide limited protection against airborne dust particles during shipping. Dust covers must be removed before the sensors can sense smoke. Remove sensors prior to heavy remodeling or construction.

TAMPER-RESISTANCE

Models FSP-851, FSP-851T and FAPT-851 include a tamper-resistant capability that prevents their removal from the bracket without the use of a tool. Refer to the base manual for details on making use of this capability.

TESTING

Before testing, notify the proper authorities that the system is undergoing maintenance, and will temporarily be out of service. Disable the system to prevent unwanted alarms.

All sensors must be tested after installation and periodically thereafter. Testing methods must satisfy the Authority Having Jurisdiction (AHJ). Sensors offer maximum performance when tested and maintained in compliance with NFPA 72.

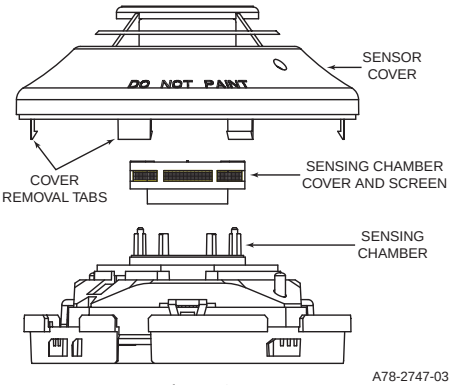


Figure 3.

Notifier, 12 Clintonville Rd, Northford, CT 06472, (203) 484-7161

The sensor can be tested in the following ways:

A. Functional: Magnet Test (P/N M02-04-01 or M02-09-00)
This sensor can be functionally tested with a test magnet. The test magnet electronically simulates smoke in the sensing chamber, testing the sensor electronics and connections to the control panel.
1. Hold the test magnet in the magnet test area as shown in Figure 3.
2. The sensor should alarm the panel.

Two LEDs on the sensor are controlled by the panel to indicate sensor status. Coded signals, transmitted from the panel, can cause the LEDs to blink, latch on, or latch off. Refer to the control panel technical documentation for sensor LED status operation and expected delay to alarm.

B. Smoke Entry: Aerosol Generator (Gemini 501)
The GEMINI model 501 aerosol generator can be used for smoke entry testing. Set the generator to represent 4%/ft to 5%/ft obscuration as described in the GEMINI 501 manual. Using the bowl shaped applicator, apply aerosol until the panel alarms.
For FAPT-851, smoke entry testing should be performed immediately following the magnet test. Magnet test initiates an approximately 10 minute period when the detector's signal processing software routines are not active. Failure to first perform the magnet test will introduce a time delay before the detector alarms.

C. Direct Heat Method (Hair dryer of 1000-1500 watts). FSP-851T and FAPT-851 only.
A hair dryer of 1000-1500 watts should be used to test the thermistors. Direct the heat toward either of the two thermistors, holding the heat source approximately 12 inches from the detector in order to avoid damaging the plastic housing. The detector will reset only after it has had sufficient time to cool. Make sure both thermistors are tested individually.

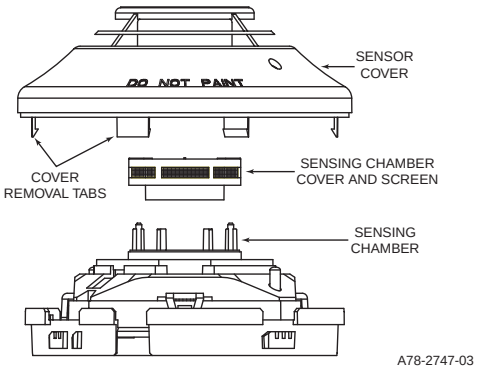
A sensor that fails any of these tests should be cleaned as described under **CLEANING**, and retested. If the sensor fails after cleaning, it must be replaced and returned for repair.

When testing is complete, restore the system to normal operation and notify the proper authorities that the system is back in operation.

HIGH SENSITIVITY SETTING

The use of the 0.2% to 0.5% per foot sensitivity setting requires a 90-day test period to ensure that the detector's environment is suitable for this setting. The following steps must be followed to meet Notifier and UL requirements for this high sensitivity application:

1. Each detector intended for 0.2% to 0.5% per foot alarm application shall have its initial alarm setting set for 0.5% obscuration per foot alarm level. The initial prealarm setting for the detector shall be set to the intended alarm setting of the system. Prealarm shall be set for nonlatching operation.
2. Detectors set at 0.2% to 0.5% per foot are intended for use in smoke-free, environmentally controlled applications, such as computer rooms and clean rooms. In order to determine if an environment is suitable for installation, the detectors shall be operated continuously for 90 days with all environmental factors, including temperature, humidity, air flow, occupancy, etc., similar to the intended application for these detectors. An electronic history file or printer shall be used to record all events associated with the detectors under testing.
3. At the end of 90 days, the results of the test shall be inspected by an authorized Notifier representative or the end user, if trained by an authorized Notifier representative. If no alarms or prealarms are recorded for the detectors under testing, the system may be set to the tested prealarm level in the 0.2% to 0.5% per foot range.

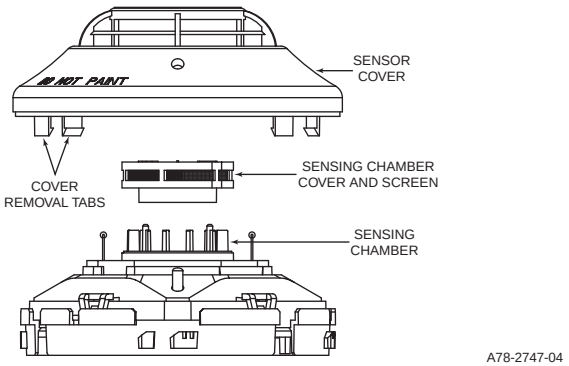


FSP-851

CLEANING

Before removing the detector, notify the proper authorities that the smoke detector system is undergoing maintenance and will be temporarily out of service.
Disable the zone or system undergoing maintenance to prevent unwanted alarms.

1. Remove the sensor to be cleaned from the system.
2. Remove the sensor cover by pressing firmly on each of the four removal tabs that hold the cover in place.
3. Vacuum the screen carefully without removing it. If further cleaning is required continue with Step 4, otherwise skip to Step 7.
4. Remove the chamber cover/screen assembly by pulling it straight out.
5. Use a vacuum cleaner or compressed air to remove dust and debris from the sensing chamber.
6. Reinstall the chamber cover/screen assembly by sliding the edge over the sensing chamber. Turn until it is firmly inplace.
7. Replace the cover using the LEDs to align the cover and then gently pushing it until it locks into place. Make sure that the thermistors do not become bent under the cover on the FSP-851T and FAPT-851 models.
8. Reinstall the detector.
9. Test the detector as described in TESTING.
10. Reconnect disabled circuits.
11. Notify the proper authorities that the system is back on line.



FSP-851T and FAPT-851

Figure 4.

Please refer to insert for the Limitations of Fire Alarm Systems

FCC Statement

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

– Reorient or relocate the receiving antenna.
– Increase the separation between the equipment and receiver.
– Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
– Consult the dealer or an experienced radio/TV technician for help.

FST-851-WP & FST-851R-WP
Weatherproof Intelligent Heat Sensors

NOTIFIER® by Honeywell

Intelligent/Addressable Devices

General

Models FST-851-WP and FST-851R-WP are intelligent addressable heat sensors that utilise a state-of-the-art thermistor sensing circuit for fast response.

Available in Fixed Temperature and Rate-of-Rise sensors are sealed against the entry of moisture to a rating of IP67. The LED will latch on when the detector is in alarm.

The sensor address can be set from 1 to 159 before installing.

Model FST-851-WP is a Type A2 fixed temperature heat sensor with 63°C fixed temperature alarm setting.

Model FST-851R-WP is a Type A2R rate-of-rise heat sensor with 63°C fixed temperature alarm setting.

Features

- IP67 rating.
- Dual LED's for 360˚ visibility.
- Fitted with flying leads.
- Easy mount base.
- Sleek, low-profile design.
- Addressable-analog communication.
- Stable communication technique with noise immunity.
- Low standby current.
- Fitted with tamper resistant feature.
- Base may be surface mounted or to a 50mm or 60mm junction box.
- Remote test feature from the panel.
- Optional relay, isolator, and sounder bases.

- Walk test with unique address display.
- Built-in functional test switch activated by external magnet.

Approvals:

Approved to AS 7240:5-2007
Listed by SAI Global
Certificate No: SMKH25312

Specifications:

Fixed Temperature Rating:	63°C
Sensitivity Rate-of-Rise:	63°C or an increase of greater than 8.3°C/min.
Operating Voltage Range:	15 VDC to 32 VDC Peak
Standby Current:	300 µA @ 24 VDC (one communication every 5 seconds with LED blink enabled).
Maximum Alarm Current (LED On):	6.5 mA @ 24 VDC.
Operating Humidity Range:	10% to 90% Relative humidity (Non-condensing).
Installation Temperature Range:	-20° C to 50° C.
IP Rating:	IP67
Height:	51 mm installed in B501 base.
Diameter:	104 mm installed in B501A base.

Ordering Information

FG-03-009	FST-851-WP Weatherproof FlashScan Thermal Fixed Sensor
FG-03-010	FST-851R-WP Weatherproof FlashScan Thermal Rate-of-Rise Sensor
FG-01-077	CP500 Hand Held Programmer

NOTIFIER®

NBG-12LX Addressable Pull Station

Document 51093 Revision A2 ECN: 01-293 09/14/01

Description

The NBG-12LX Addressable pull station is a non-coded, dual-action manual pull station with a key-lock reset feature. It provides NOTIFIER intelligent control panels with one addressable alarm initiating input. The addressable module is housed inside the pull station. The NBG-12LX is compatible with all Notifier intelligent panels and will automatically operate in either FlashScan™ or CLIP (Classic Loop Interface Protocol) mode. FlashScan™ is a patented (U.S. Pat. No. 5,539,389) High Speed Communications Protocol. Refer to the FACP Installation Manual to determine if FlashScan™ protocol is supported. FlashScan™ or CLIP operating mode must be selected in the FACP. (This selection is not available or required in FACPs that do not support FlashScan™, therefore CLIP mode is enabled by default.) No selection is required in the Pull Station. The NBG-12LX meets the ADA requirement for a 5-lb. maximum pull force to activate the pull station. Operating instructions are molded into the pull station handle along with Braille text. Molded Terminal numbers are also present.

Installation

The NBG-12LX Addressable pull station can be surface mounted to a NOTIFIER SB-10 surface backbox or semi-flush mounted on a standard single-gang, double-gang or 4" (10.16 cm) square electrical box. The optional BG-TR trim ring can be used if the NBG-12LX is to be semi-flush mounted.

Ratings

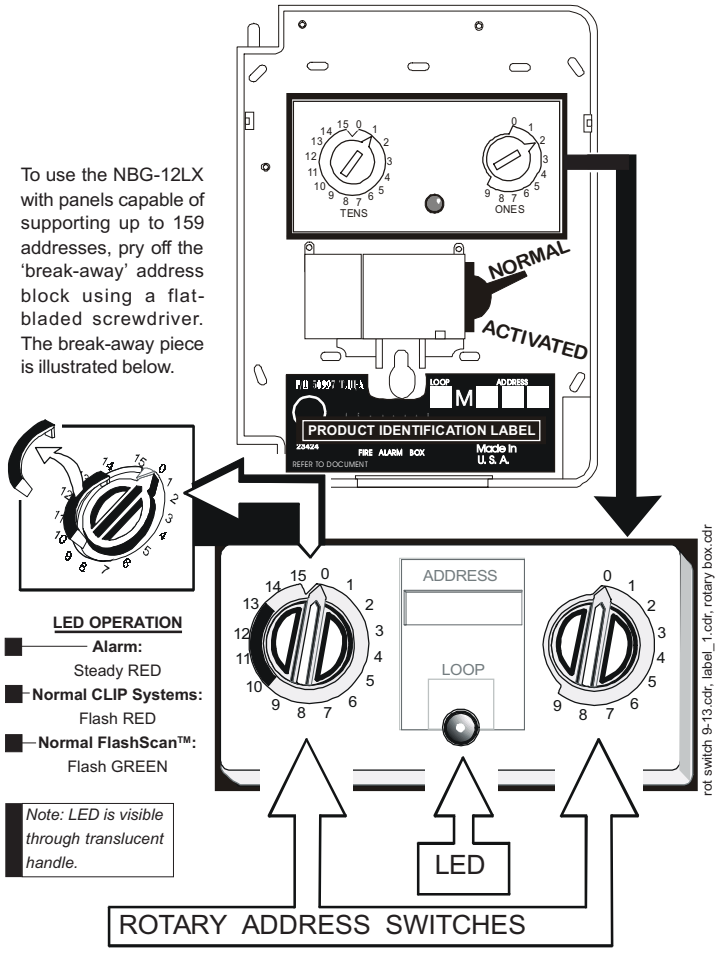
Normal Operating Voltage: 24 VDC.
Average Operating Current (LED Flash): 300 µA.
Temperature Range: 32º F - 120º F (0º C - 49º C).
Relative Humidity Range: 10% - 93% non-condensing.

Software Note for AM2020/AFP1010 Programming

The NBG-12LX is an Alarm Initiating Module of software type 'mpul'. If you have an older system that does not support the 'mpul' software type, the software type 'mon' may be used.

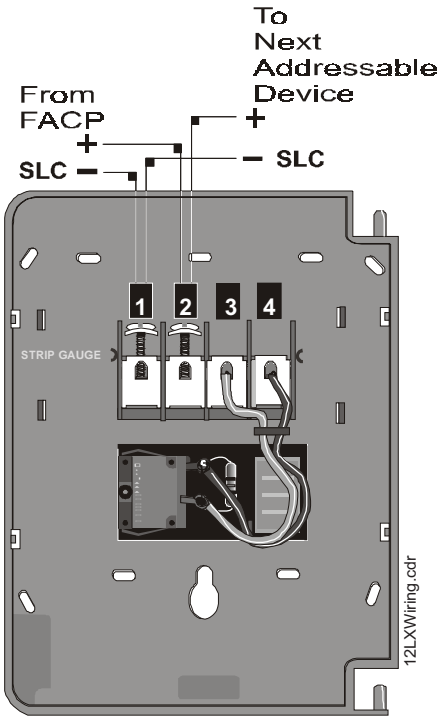
Setting the NBG-12LX Address

The NBG-12LX Addressable pull station is factory preset with address '00.' Set the address for the pull station by turning the rotary address switches on the addressable module mounted inside the pull station. Only one device per address is allowed. Multiple modules may not be set to the same address on the Signaling Line Circuit. Once the address is set, record it in the space provided on the product ID label located inside the pull station.



If, during mounting of the pull station, the door becomes detached, complete the following steps to reattach the door to the backplate. The door cannot be connected to the pull station if the unit is mounted to the backbox.

1) Position the door and backplate side by side in the full open position. (i.e. 180-degrees with respect to each other.)
2) With the backplate position fixed, move the door behind the backplate, as shown in the illustration, part A.
3) Align the hinge posts and holes by bringing the door up to meet the backplate, paying particular attention to the 'keying' that occurs when the door's post hole is aligned to the backplate's hinge post. Refer to the illustration, part B.
4) With the two pieces aligned and 'keyed' together, slide the holes down onto the posts. Refer to the illustration, part C.
5) Holding the backplate, close the door slightly to lock the door and backplate together.



Wiring

1) If semi-flush mounting, proceed to step 4.
2) Mount the backbox *before* wiring to the pull station.
3) Before mounting the station, pull all necessary wiring through the backbox and optional trim ring.
4) Remove the correct amount of wire insulation. The pull station backplate is molded with a strip gauge to measure the amount of insulation to be removed.
5) Connect the wiring from the addressable fire alarm control panel's Signaling Line Circuit (SLC) to Terminals 1(-) and 2(+) on the NBG-12LX addressable pull station. SLC polarity is critical for this connection.
6) Connect the wiring going to the next device on the SLC to Terminals 1 and 2, again being certain to observe polarity.
7) If using a single-gang or SB-10 box for mounting, open the pull station door; align the mounting holes of the pull station backplate to the backbox and screw into place. Tighten both top and bottom screws.
8) Set the address as described in 'Setting the NBG-12LX Address' and write the address in the space provided on the label.
9) Close and lock the pull station door.

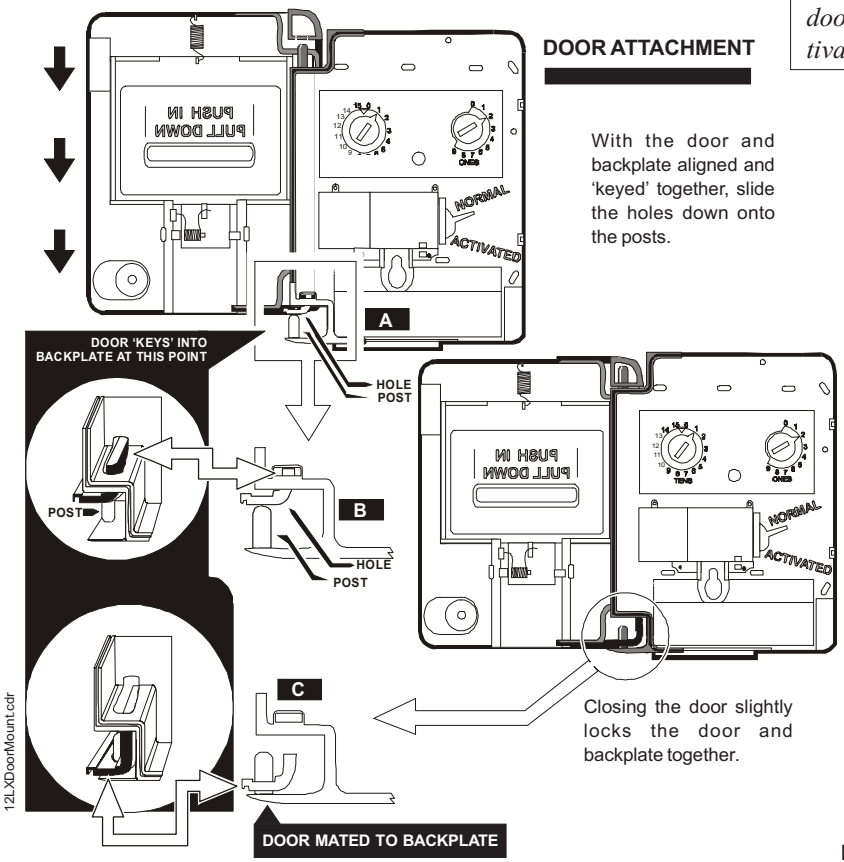
Operation

Push in and pull down the handle where indicated to activate the station. The NBG-12LX manual fire alarm pull station includes one SPST (Single Pole, Single Throw) N/O (normally-open) switch and the addressable module located inside the station. Pushing in and pulling down the dual action handle causes the N/O alarm switch to close. The word 'ACTIVATED' is displayed on the top of the handle when the pull station handle is pushed in and pulled down. The activated handle can not be reset without employing the key-lock reset. To reset the NBG-12LX pull station: 1) Insert the key and turn counterclockwise, 2) Open the door until the handle moves back into the 'NORMAL' position, 3) Close the door and lock it. Closing the door automatically resets the switch to the 'NORMAL' position.

ACTIVATED NBG-12LX PULL STATION

Note - Opening the pull station door will not activate or deactivate the alarm switch.

DOOR ATTACHMENT



With the door and backplate aligned and 'keyed' together, slide the holes down onto the posts.

Closing the door slightly locks the door and backplate together.

DOOR MATED TO BACKPLATE

CAUTION!

Install the Notifier NBG-12LX manual pull station in accordance with these instructions, applicable NFPA standards, national and local Fire and Electrical codes and the requirements of the AHJ (Authority Having Jurisdiction). Regular testing of the devices should be conducted in accordance with the appropriate NFPA standards. Failure to follow these directions may result in failure of the device to report an alarm condition. Notifier is not responsible for devices that have been improperly installed, tested or maintained.

For ADA compliance, if the clear floor space only allows forward approach to an object, the maximum forward reach height allowed is 48 in. (1,220 mm). If the clear floor space allows parallel approach by a person in a wheelchair, the maximum side reach height allowed is 54 in. (1,370 mm).

[10] Board Replacement

[10.1] Sensor Board Replacement

1. Remove the two sensor board mounting screws.
2. Pull gently on the board to remove it.
3. To replace the board, align the board mounting features, holes, and the interconnect terminals. Push the board into place.
4. Secure board with the two mounting screws.

[10.2] Power Board Replacement

1. Disconnect wiring from the terminal block.
2. Remove the two power board mounting screws.
3. Pull gently on the board to remove it.
4. To replace the board, align the board mounting features, holes, and the interconnect terminals. Push the board into place.
5. Secure board with the two mounting screws.
6. Re-connect wiring to terminal block.

[12] Model FSD-751RP Air Duct Smoke Detector Specifications

Operating Temperature	+32° to +131°F (0° to +55°C)
Storage Temperature	–22° to +158°F (–30° to +70°C)
Humidity Range	10% to 93% (non-condensing)
Air Velocity	500 to 4000 ft/min (2.54 to 20.32 m/sec.)
Dimensions	$14\frac{3}{8}$″ L x $5\frac{1}{2}$″ W x $2\frac{3}{4}$″ D (37 cm L x 14 cm W x 7 cm D)

Current Requirements (using no accessories)

Power supply voltage:	20-30 VDC	24 VAC, 50-60 Hz	120 VAC, 50-60Hz	220/240 VAC, 50-60Hz
Max. standby current:	26 mA	65 mA RMS	44 mA RMS	25 mA RMS
Max. alarm current:	87 mA	182 mA RMS	52 mA RMS	30 mA RMS
Alarm resonse time:	3 to 10 Sec.	3 to 10 Sec.	3 to 10 Sec.	3 to 10 Sec.
Power up time:	2 Sec.	2 Sec.	2 Sec.	2 Sec.

Contact Ratings

Alarm auxiliary contacts* (DPDT)	10 A @ 30 VDC
	10 A @ 277 VAC (.75 power factor)
	240 VA @ 249 VAC (0.4 power factor)
	1/8 HP @ 120 VAC
	1/4 HP @ 240 VAC
Supervisory contact (SPST)	2.0 A @ 30 VDC (resistive)

*Minimum switching current for auxiliary contact must be 100 mA DC minimum @ 5 VDC.

Accessory Current Loads at 24 VDC

Device	Standby	Alarm
PA400	0 mA	15 mA Max.
RA400Z	0 mA	12 mA Max.
RTS451/RTS451KEY	0 mA	10 mA Max.

NOTE: When a unit is powered at the 120VAC or 220/240VAC input, any combination of accessories may be used such that the given accessory loads are:
60 mA or less in the standby state,
110 mA or less in the alarm state.

Programming Specifications/Requirements for Intelligent System Control Panels

There are a limited number of devices that can have their LEDs programmed to illuminate. The actual number of devices is determined by the control panel and its ability to supply LED current. Refer to the Control Panel Installation Manual for details.

Accessories	Part No.
Remote LED	RA400Z
Magnetic Remote Test	RTS451
Key-Activated Remote Test	RTS451KEY
Replacement Filters	F36-09-11
Replacement Test Magnet	M02-04-00

Accessories	Part No.
Replacement Photo Insect Screen	S08-39-01
Replacement End Cap for Plastic Sampling Tube	P48-61-00
Replacement End Cap for Metal Sampling Tubes	P48-21-00
Replacement Photoelectric Sensor Board	A5053FS
Replacement Power Board (w/relay)	A5060

Please refer to insert for the Limitations of Fire Alarm Systems

To keep your equipment in excellent working order, ongoing maintenance is required per the manufacturer's recommendations and UL and NFPA standards. At a minimum, the requirements of Chapter 7 of NFPA 72, the National Fire Alarm Code, shall be followed. A preventative maintenance agreement should be arranged through the local manufacturer's representative. Though smoke detectors are designed for long life, they may fail at any time. Any smoke detector, fire alarm equipment, or any component of that system which fails shall be repaired or replaced as soon as possible.

FCC Statement

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

NOTIFIER®

FSD-751RP INTELLIGENT PHOTOELECTRONIC DUCT SMOKE DETECTOR INSTALLATION AND MAINTENANCE INSTRUCTIONS

Before installing detectors, please thoroughly read the NEMA Guide for Proper Use of Smoke Detectors in Duct Applications, which provides detailed information on detector spacing, placement, zoning, wiring, and special applications. Copies of this manual are available from NEMA (National Electrical Manufacturers Association, 2101 L Street NW, Washington, DC 20037). NFPA Standards 72 and 90A should also be referenced for detailed information.

NOTICE: This manual shall be left with the owner/user of this equipment.

IMPORTANT: This detector must be tested and maintained regularly following NFPA 72 requirements. The detector should be cleaned at least once a year.

GENERAL DESCRIPTION

An HVAC system supplies conditioned air to virtually every area of a building. Smoke introduced into this air duct system is distributed to the entire building. Smoke detectors designed for use in air duct systems are used to sense the presence of smoke in the duct.

The FSD-751RP air duct smoke detector is a photoelectric detector. This smoke detection method combines with an efficient housing design that samples air passing through a duct and allows detection of a developing hazardous condition. When sufficient smoke is sensed, an alarm signal is initiated at the fire control panel monitoring the detector, and appropriate action can be taken to shut off fans, blowers and change over air handling systems, etc. This can prevent the distribution or it can isolate toxic smoke and fire gases throughout the areas served by the duct system.

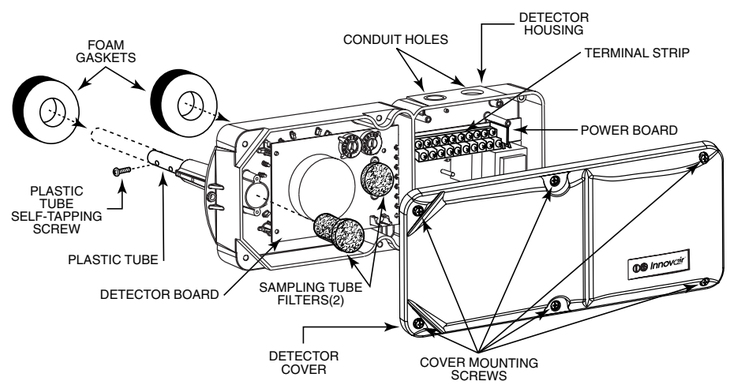
Two LEDs on each detector may illuminate, if programmed by the system control panel, to provide a local alarm indication. There is also a remote alarm output for use with auxiliary devices. The FSD-751RP has remote test capability with the RTS451/RTS451KEY Remote Test Station.

The FSD751RP incorporates a cover tamper feature. When the cover is removed for more than 20 minutes, the unit loses communication at the panel, a trouble is indicated at the panel and the alarm relay switches states thereby shutting down fans, dampers and blowers. In the case when the sensor is removed or when there is no power to the unit, only a trouble is indicated at the panel (alarm relay does not work any longer).

Figure 1. Exploded view of duct smoke detector components:

CONTENTS OF THE DUCT SMOKE DETECTOR HOUSING KIT

The FSD-751RP Duct Smoke Detector consists of the following items (See Figure 1.):



Contents Of The Duct Smoke Detector

1. Complete duct smoke detector assembly with sensor
2. Two #10 x $1\frac{1}{4}$″ sheet metal screws for mounting
3. Two sampling tube filters
4. One test magnet
5. Drilling template
6. Two foam gaskets
7. Four #6-self tapping mounting screws for the sampling tube and optional exhaust tube extension
8. One sampling tube end cap
9. One plastic sampling tube
10. One #8 self-tapping screw for plastic sampling tube

NOTE: A detector sensor board DOES NOT need to be ordered separately.

NOTE: For ducts over $1\frac{1}{2}$ feet, longer sampling tubes must be ordered to complete the installation. They must be the correct length for the width of the duct where they will be installed. See Table 1 on page 3 to determine the sampling tube required for different duct widths.

Notifier, 12 Clintonville Road, Northford, CT 06472, (203) 484-7161

Bulletin 014 Rev. P

Model F1FR Series Quick Response Glass Bulb Sprinklers

Model F1FR56 Sprinkler Types
Standard Spray Upright
Standard Spray Pendent
Conventional Upright/Pendent
Vertical Sidewall
Horizontal Sidewall

Model F1FR56 Recessed Sprinkler Types
Standard Spray Pendent
Horizontal Sidewall

Model F1FR56 Concealed Sprinkler Types
Standard Spray Pendent

Model F1FR42, F1FRXLH & F1FR28 Sprinkler Types
Standard Spray Upright
Standard Spray Pendent

Model F1FR40 Sprinkler Types
Standard Spray Pendent

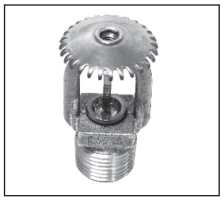
Model F1FR42, F1FR40, F1FRXLH & F1FR28 Recessed Sprinkler Types
Standard Spray Pendent

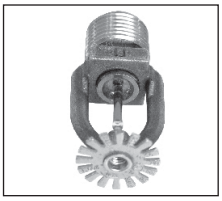
Model F1FR56LL & F1FR42LL Low Lead Sprinkler Types
Standard Spray Pendent with less than 0.25% Lead Content

Listing & Approvals
The following organizations provide Listings or Approvals for various Model F1FR series sprinklers. See the Design and Installation table in this Bulletin for information on specific listings and approvals applicable to each sprinkler.

1. Underwriters Laboratories Inc. and Certified for Canada (cULus) in accordance with ANSI/UL199.
2. FM Approvals (FM)
3. Loss Prevention Certification Board (LPCB)
4. VdS Schadenverhütung GmbH (VdS)
5. Underwriters Laboratories Inc. and Underwriters Laboratories of Canada Certified for Health Effects to NSF/ANSI Standard 61 Annex G (ULH)
6. EC Certificate: 0786-CPD-40239 (RA1414), 0786-CPD-40251 (RA1425), 0786-CPD-40252 (RA1475) (EC)

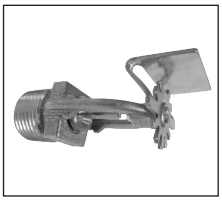
UL Listing Category
Sprinklers, Automatic & Open (VNIV)
Quick Response Sprinkler


Upright

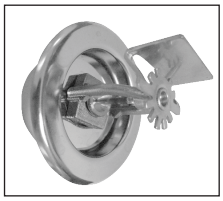

Pendent


Conventional

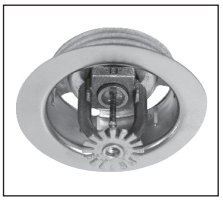

Vertical Sidewall

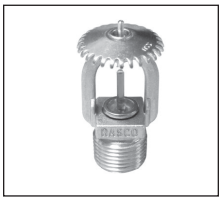

Horizontal Sidewall


Recessed Pendent/F1/F2


Recessed Horizontal Sidewall


Concealed Pendent

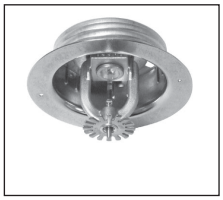

Recessed Pendent/FP


XLH Upright


XLH Pendent


XLH Recessed Pendent F1/F2

Product Description


XLH Recessed Pendent FP

Reliable Model F1FR series sprinklers are quick-response automatic sprinklers with a glass bulb thermal element. Model F1FR series sprinklers are Standard Spray sprinklers, with the exception of the Model F1FR56 Conventional sprinkler which is an Old-style/Conventional sprinkler.

The Model F1FR Series automatic sprinklers utilize a 3.0 mm frangible glass bulb. These sprinklers have demonstrated response times in laboratory tests which are five to ten times faster than standard response sprinklers. This quick response enables the Model F1FR Series sprinklers to apply water to a fire faster than standard-response sprinklers of the same temperature rating.

The glass bulb consists of an accurately controlled amount of special fluid hermetically sealed inside a precisely manufactured glass capsule. This glass bulb is specially constructed to provide fast thermal response.

WFDTH
Waterflow Detector

The System Sensor WFDTH Retard T-Tap Waterflow Detector is designed for primary signaling in residential systems and fits within 2×4 stud wall construction.

Features

- Residential sprinkler systems
- Sealed retard mechanism
- Visual switch activation
- Rugged, dual SPDT switches enclosed in a durable terminal block
- Easy to install and maintain design
- Vertical or horizontal mount
- Field replaceable retard mechanism and switch assembly
- Twelve different flexible paddles
- Durable, tamper resistant enclosure
- Two conduit openings
- Handy depth gauge
- Accommodates up to 12 AWG wire
- 100% synchronization fires alarm panel and local bell simultaneously

The WFDTH fits any tee that has a 1˝ NPT branch, including: 1˝, 1¼˝, 1½˝, and 2˝ NPT threaded ferrous and brass tees; 1˝, 1¼˝, 1½˝ and 2˝ copper sweat tees; Central, Spears®, and Victaulic® brand 1˝ CPVC tees; and 1½˝ polybutylene tees.

Design. The design of the WFDTH makes it easy to install and simple to maintain. It can be mounted in the vertical or horizontal position. Two conduit openings permit easy attachment to the local alarm system. The retard mechanism and switch assembly are field-replaceable.

Features. Twelve different flexible paddles fit 1˝, 1¼˝, 1½˝, and 2˝ tees. Sizes are marked clearly on the paddle for ease of installation. Plastic paddles slip over the actuating lever and are securely fastened with one screw. The handy depth gauge insures the proper installation depth and clearance of the detector to the tee.

Construction. The WFDTH includes a durable and tamper resistant enclosure. Its sealed retard assures that the delay mechanism is not contaminated by dust and dirt when the cover is removed. The long lasting cover completely encloses the electrical components to further keep out dust and dirt. Improved self-guiding security screws and removal tools make detectors resistant to tampering and simplify field maintenance.

Agency Listings

UL LISTED	ULC	VdS	MEA approved	FM APPROVED
S739	CS169	7770-1653:114	167-93-E	3033305

WFDTH Specifications

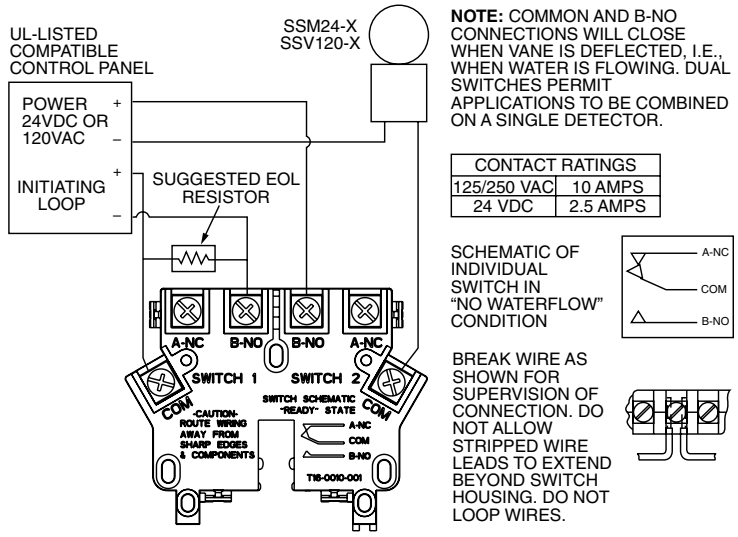
Architectural/Engineering Specifications

Model shall be a WFDTH as manufactured by System Sensor. T-tap waterflow detectors shall be installed on a tee that has a 1˝ NPT branch including: 1˝, 1¼˝, 1½˝, or 2˝ threaded ferrous or brass tee; 1–2˝ copper sweat tees; Central, Spears®, and Victaulic® brand 1˝ CPVC tees; or 1½˝ polybutylene tee as designated on the drawings and/or as specified herein. Detectors shall mount on any clear pipe span of the appropriate size, either a vertical or horizontal run at least 6˝ from any fittings or valves which may change water direction, flow rate, or pipe diameter or no closer than 24˝ from a valve or drain. Detectors shall have a sensitivity in the range of 4 to 10 gallons per minute and a static pressure rating of 250 psi. The retard t-tap detector shall be a sealed mechanical pneumatic unit with visual indication of actuation. The actuation mechanism shall include a polyethylene vane inserted through the tee fitting and connected by a mechanical linkage to the delay mechanism. Outputs shall consist of dual SPDT switches (Form C contacts). Two conduit entrances (one of which is a knockout type) for standard fittings of commonly used electrical conduit shall be provided on the detectors. A grounding provision is provided. WFDTH is listed by Underwriters Laboratories for indoor use.

Physical/Operating Specifications

Static Pressure Rating	250 PSI (max.)	**Operating Temperature Range**	32°F to 120°F (0°C to 49°C)
Maximum Surge	18 FPS	**Enclosure Rating**	UL listed for indoor use
Triggering Threshold Bandwidth (Flow Rate)	4–10 GPM	**Cover Tamper Switch**	Canadian models only, factory installed
Overall Dimensions, Installed	4.5˝ H × 3.55˝ W × 6.7˝ L (11.4cm H × 9cm W × 17cm L)	**Service Use**	Automatic Sprinkler: NFPA 13 One or Two Family Dwelling: NFPA 13D Residential Occupancies up to 4 Stories: NFPA 13R National Fire Alarm Code: NFPA 72
Contact Ratings	Two sets of SPDT (Form C) 10.0 A @ 125/250 VAC 2.5 A @ 24 VDC	**Shipping Weight**	2.6 lbs. (1.2 kg.)
Compatible Tee Fittings	Threaded ferrous and brass tees, copper sweat tees, CPVC tees, and polybutylene tees	**Warranty**	3 years
Conduit Entrances	Two openings for ½˝ conduit.	**U.S. Patent Numbers**	3,845,259; 4,782,333; 5,213,205

Electrical Connections



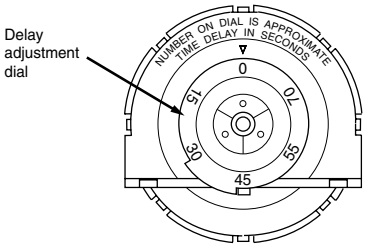
NOTE: COMMON AND B-NO CONNECTIONS WILL CLOSE WHEN VANE IS DEFLECTED, I.E., WHEN WATER IS FLOWING. DUAL SWITCHES PERMIT APPLICATIONS TO BE COMBINED ON A SINGLE DETECTOR.

CONTACT RATINGS	
125/250 VAC	10 AMPS
24 VDC	2.5 AMPS

SCHEMATIC OF INDIVIDUAL SWITCH IN "NO WATERFLOW" CONDITION

BREAK WIRE AS SHOWN FOR SUPERVISION OF CONNECTION. DO NOT ALLOW STRIPPED WIRE LEADS TO EXTEND BEYOND SWITCH HOUSING. DO NOT LOOP WIRES.

Delay Adjustment Dial



NOTE: Retard time may exceed 90 seconds.
Adjust and verify that time does not exceed 90 seconds.

Ordering Information

UL Model No.	ULC/Canadian Model No.	Description
WFDTH	WFDTHA	Waterflow Detector, Fits 1˝, 1¼˝, 1½˝, 2˝ ferrous and brass threaded tees; 1˝, 1¼˝, 1½˝, 2˝ copper sweat tees; 1˝ CPVC tees; and 1½˝ polybutylene tees

Accessories

A77-01-02	Replacement terminal block for WFDTH	S07-66002	Replacement tamper screws for covers of WFDTH
PRK9	Replacement paddle kit – 12 paddles for WFDTH (see WFDTH for sizes included)	WFDW	Replacement tamper proof wrench for cover of WFDTH
A3008-00	Replacement retard mechanism	C58-0009-000	Replacement metal cover

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A05-0941-008 • 7/10 • #2451

OSY2
Supervisory Switch

The System Sensor OSY2 is used to monitor the open position of an Outside Screw and Yoke (OS&Y) type gate valve.

Features

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

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

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

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

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

Agency Listings

S739 CS169 OW6A8.AY 167–93–E 7770-1653:118

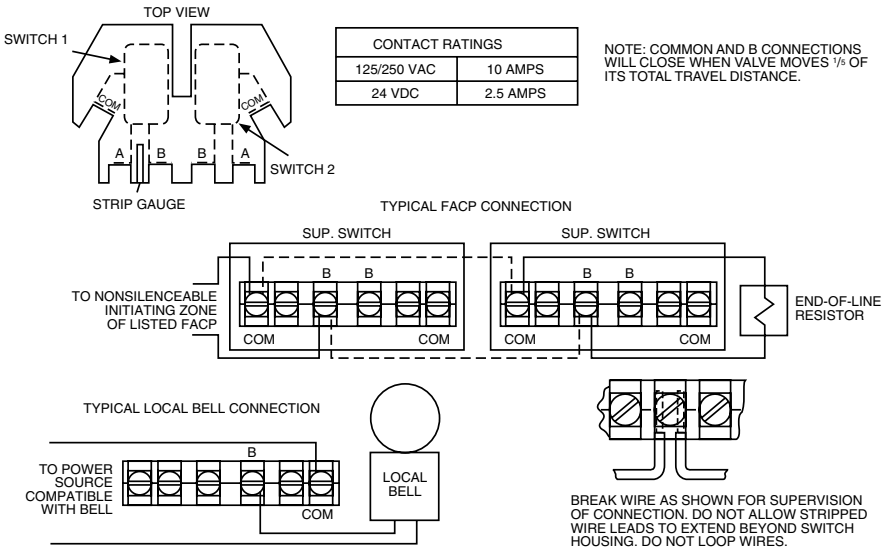
OSY2 Specifications

Architectural/Engineering Specifications

Model shall be model number OSY2 supervisory switch as manufactured by System Sensor. OSY2 shall be installed on each valve as designated on the drawings and/or as specified herein. Switches shall be mounted so as not to interfere with the normal operation of the valve and shall be adjusted to operate within two revolutions of the valve control or when the stem has moved no more than one-fifth of the distance from its normal position. The mechanism shall be contained in a weatherproof die cast metal housing that provides a side entrance for ½˝ conduit and incorporates the necessary facilities for attachment to the valve. A grounding provision is provided. The switch assembly shall include two switches each with a rated capacity of 10 Amp @ 125/250VAC and 2.5 Amp @ 24VDC. The cover shall contain tamper-resistant screws for which a security wrench will be provided with each switch. The OSY2 shall be Underwriters Laboratories listed for indoor or outdoor use. The OSY2 shall be Factory Mutual, CSFM, and MEA approved.

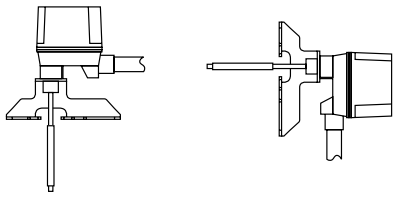
Physical Specifications		Operating Specifications	
Overall Switch Dimensions	5¾˝H x 3½˝W x 3¼˝D (14.6cm x 8.9cm x 8.2cm)	**Contact Ratings**	Two sets of SPDT (Form C) 10.0 A @ 125/250VAC; 2.5 @ 6/12/24VDC
Shipping Weight	2.8 lbs. (1.3 kg)	**Enclosure Rating**	UL indoor/outdoor NEMA 3R when mounted with the actuator vertical
Operating Temperature Range	32°F to 120°F (0°C to 49°C) NOTE: The OSY2 will operate from –40°F to 120°F (–40°C to 49°C); however UL does not test control valve supervisory switches below 32°F (0°C).	**Cover Tamper Switch**	Standard with ULC model Optional for UL model, part no. 546-7000
Maximum Stem Extension	2⅝˝ (6.7cm)	**Service Use**	Automatic Sprinkler: NFPA 13 One or Two Family Dwelling: NFPA 13D Residential Occupancies up to 4 stories: NFPA 13R National Fire Alarm code: NFPA 72
Bracket Span	¼˝H x 6¾˝W x 1˝D (5.7cm x 17.1cm x 2.5cm)	**Warranty**	3 years
Conduit Entrances	One single side open for ½˝ conduit	**U.S. Patent Nos.**	5,478,038; 5,213,205

Electrical Connections for OSY2



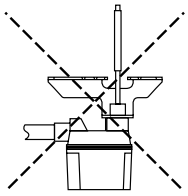
OSY2 Mounting

The following are examples of acceptable mounting positions:



Actuator Vertical (Down) Actuator Horizontal

The following mounting position is <u>not acceptable:</u>



Actuator Vertical (Pointing Up)

Ordering Information

Part No.	Description
OSY2	Outside Screw and Yoke valve supervisory switch
OSY2A	Outside Screw and Yoke valve supervisory switch (ULC model)

Accessories

OSYRK	Replacement hardware kit (wrenches, screw pack and J–hooks)	WFDW	Replacement tamper-proof wrench for cover
546-7000	Cover tamper switch kit	HEXW	Replacement hex wrench
S07-66-XX	Tamper screws for cover		

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A05-0196-010 • 1/09 • #1960

SPECTRAlert®

Selectable Output Strobe and Horn/Strobes

SYSTEM SENSOR®

Models Available

Strobes

Red	White
S1224MC	S1224MCW
S1224MCP	S1224MCPW
S1224MCK	
S1224MCSP	

Horn/Strobes

Red	White
P1224MC	P1224MCW
P1224MCP	P1224MCPW
P1224MCK	
P1224MCSP	

Horns

Red	White
H12/24	H12/24W
H12/24K	

Product Overview

Operates on either 12V or 24V

Widest range of candela options:
12V: 15 and 15/75 candela
24V: 15, 15/75, 30, 75, 110 candela

Easy candela selection

Lower current draw

Easy DIP switch selection for horn options

Easy mounting with QuickClick™

Synchronizable with MDL Sync•Circuit™ module

Meets UL1971, NFPA72, and ADA signaling requirements

All strobe and horn/strobe models incorporate a new patented voltage booster design that has a more consistent flash bulb voltage over the range of candela selections. The benefit to the customer is a high quality strobe device.

7125-1209:222
7135-1209:223

LISTED
S5512
S4011

FM APPROVED
3014150

MEA approved
122-02-E
126-02-E

SpectrAlert® Selectable Output Horns, Strobes, and Horn/Strobes offer enhanced features that include the widest range of candela options available and the capability to recognize and self-adjust for either 12 or 24 volt operation. With an overall feature set that combines performance, installation ease, flexibility, and a consistent, aesthetically pleasing appearance, the SpectrAlert Selectable Output devices provide both the innovation and efficiency synonymous with the SpectrAlert name.

Performance. SpectrAlert selectable output wall-mount horns, strobes, and horn/strobes offer key performance features long associated with the SpectrAlert name. The selectable candela strobes and horn/strobes offer average current draws that are not only lower than conventional fixed-candela SpectrAlert products, but also lower than similar selectable candela products. By consuming less current, the ability to connect even more devices per loop is possible, resulting in a lower installed cost.

Installation. SpectrAlert selectable output horns, strobes, and horn/strobes offer the same installation-friendly features synonymous with the SpectrAlert name, such as the option of 2- and 4-wire operation; the ability to use standard size backboxes with no encroachment into the box; and universal mounting incorporating the labor-saving QuickClick™ feature. Such labor-savings features make wire connections simple and fast, further reducing installed cost.

Flexibility. SpectrAlert selectable output strobes and horn/strobes offer the broadest range of candela options. In addition, the selectable output strobes and horn/strobes can operate on either 12V or 24V, with no setting required; the device recognizes and self-adjusts to the correct current automatically. Temporal 3 or Continuous tone options continue to be available, in either an Electromechanical or 3kHz pattern.

Aesthetics. SpectrAlert selectable output horns, strobes, and horn/strobes incorporate the same stylish, low profile design of the conventional SpectrAlert products, for a consistent and aesthetically pleasing appearance across the entire product line.

Engineering Specifications

General

SpectrAlert horns, strobes and horn/strobes shall be capable of mounting to a standard 4″ × 4″ × 1 1/2″ back box or a single gang 2″ × 4″ × 1 7/8″ back box using the universal mounting plate included with each SpectrAlert product. Also, SpectrAlert products, when used in conjunction with the accessory Sync•Circuit Module, shall be powered from a non-coded power supply and shall operate on 12 or 24 volts. 12 volt rated devices shall have an operating voltage range of 9–17.5 volts. 24-volt rated devices shall have an operating voltage range or 17–33 volts. SpectrAlert products shall have an operating temperature of 32° to 120°F and operate from a regulated DC or full wave rectified, unfiltered power supply.

Strobe

Strobe shall be a System Sensor SpectrAlert Model _____ listed to UL 1971 and 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 1Hz 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

Horn/Strobe shall be a System Sensor SpectrAlert Model _____ listed to UL 1971 and UL 464 and shall be approved for fire protective service. 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 1Hz 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 tone options, two audibility options (at 24 volts) and the option to switch between a temporal 3 pattern and a non-temporal continuous pattern. Strobes shall be powered independently of the sounder with the removal of factory installed jumper wires. The horn on horn/strobe models shall operate on a coded or non-coded power supply (the strobe must be powered continuously).

Synchronization Module

Module shall be a System Sensor Sync•Circuit _____ listed to UL 464 and shall be approved for fire protective service. The module shall synchronize SpectrAlert strobes at 1Hz and horns at temporal 3. Also, the module shall silence the horns on horn/strobe models, while operating the strobes, over a single pair of wires. The module shall be capable of mounting to a 4 11/16″ × 4 11/16″ × 2 1/8″ back box and shall control two Style Y (class B) or one Style Z (class A) circuit. Module shall be capable of multiple zone synchronization by daisy chaining multiple modules together and re-synchronizing each other along the chain. The module shall not operate on a coded power supply.

Specifications

Walk Test
SpectrAlert horn/strobe and horn only work on "walk tests" with time durations of 4 seconds or greater

Input Terminals
12 to 18 AWG

Dimensions
Strobe and horn/strobe with universal plate
5″ × 5 5/8″ × 2 15/16″

Strobe and horn/strobe with small footprint plate
3 3/8″ × 5 5/8″ × 2 5/16″

Horn with universal mounting plate
5″ × 5 5/8″ × 1 5/16″

Horn without mounting plate
2 15/16″ × 5 5/16″ × 1 5/16″

Weight, horn only
7.2 oz.

Weight, strobe and horn/strobe
8.8 oz.

Mounting
4″ × 4″ × 1 1/2″ or 2″ × 4″ × 1 7/8″ standard boxes

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

Maximum humidity (Indoor)
95% as tested per UL464

Outdoor (K Series) Operating Temperature
–40°F to 151°F
(–40°C to 66°C)

Outdoor rating
NEMA 3R (per UL 50)

Voltages
12 or 24VDC and FWR[1] unfiltered

Operating voltage range
12V: 8–17.5V; 24V: 16–33V

Operating voltage range (with Sync•Circuit module, MDL)[2]
12V: 9–17.5V; 24V: 17–33V

U.S. Patent Numbers
5,593,569
5,914,665
6,049,446

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. The MDL causes a one-volt voltage drop in the notification appliance circuit.

Table 1-A: SpectrAlert Strobe UL Max. Current Draw

Candela Setting	FWR Operating Current–Strobe (mA RMS)		DC Operating Current–Strobe (mA RMS)	
	8-17.5V	16-33V	8-17.5V	16-33V
15	112	64	127	59
15/75	135	74	127	69
30		93		90
75		158		160
110		208		209

Table 1-B: Horn UL Max. Current Draw Measurements (mA RMS)

Selectable Horn Tones			DC		FWR	
			8-17.5V	16-33V	8-17.5V	16-33V
Temporal	Low Volume	Electromechanical	15	23	13	23
		3000 Hz Interrupted	15	33	13	23
	High Volume	Electromechanical	36	53	20	44
		3000 Hz Interrupted	43	57	21	40
Non-Temporal	Low Volume	Electromechanical	16	37	19	29
		3000 Hz Interrupted	16	32	18	33
	High Volume	Electromechanical	38	49	46	49
		3000 Hz Interrupted	44	56	42	58

Table 1-C: 12VDC Horn/Strobe UL Max. Current Draw Measurements (mA RMS)

	Temporal			
	Low Volume		High Volume	
Candela Setting	Electromechanical	3000 Hz	Electromechanical	3000 Hz
15	111	111	112	112
15/75	127	127	126	129
	Non-Temporal			
15	113	112	114	115
15/75	128	128	130	134

Table 1-D: 24VDC Horn/Strobe UL Max. Current Draw Measurements (mA RMS)

	Temporal			
	Low Volume		High Volume	
Candela Setting	Electromechanical	3000 Hz	Electromechanical	3000 Hz
15	71	70	73	75
15/75	86	85	87	88
30	99	98	100	100
75	166	166	167	170
110	209	209	210	213
	Non-Temporal			
15	74	74	79	82
15/75	86	88	93	96
30	101	101	107	110
75	167	167	173	176
110	213	213	218	222

Explanation of Published Voltage, Current, and SPL Specifications

In May 2004 Underwriters Laboratories changed standard UL 1971 to require that operating current measuremments are made using RMS (root mean square) instead of peak or average values. RMS measurements more accurately predict the power consumption of a device since they take into account the entire current draw profile including surge, repetitive surge, and peak values. The published RMS current is the maximum operating current of that device within its operating voltage range. This current maximum may or may not occur at the endpoints of the voltage range.

Similarly, UL tests the audibility of devices in accordance with UL 464 by measuring them across the operating voltage range to determine the minimum sound pressure level produced at any particular setting.

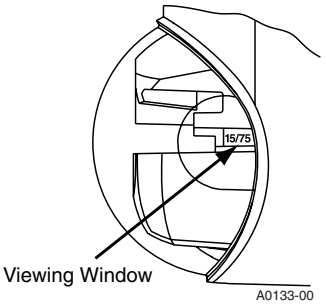
During May 2004, UL also changed the way they list the voltage range of a device. All 12V products will be listed between 8 – 17.5V and all 24V products will be listed between 16 – 33V. Those devices are considered “regulated”. Any product that does not operate within these ranges will be listed as a “special application” with its operating voltage specified on the device.

Notes

1. Current draw for strobe-only products is shown in Table 1-A.
2. Current draw for horn-only products is shown in Table 1-B.
3. 12VDC 2-wire horn/strobe current is shown in Table 1-C.
4. 24VDC 2-wire horn/strobe current draw is shown in Table 1-D.
5. Current draw for other horn/strobe power supplies can be calculated by adding the strobe current in Table 1-A to the horn current in Table 1-B from the chosen settings.

SpectrAlert Strobe Candela Selections

For strobe candela selection, adjust slide switch located on the rear of the product while watching the viewing window on the side of the reflector.



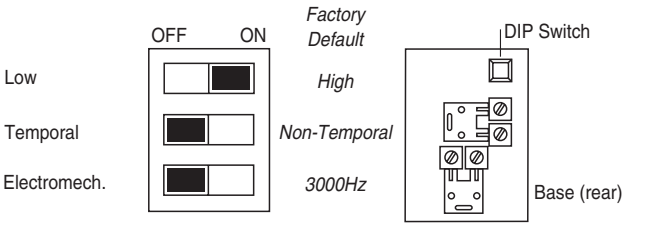
Permissible Candela Settings

Candela Setting	Operating Voltage	
	12V	24V
15	OK	OK
15/75	OK	OK
30		OK
75		OK
110		OK

SpectrAlert Horn Sound Measurements (dBA)

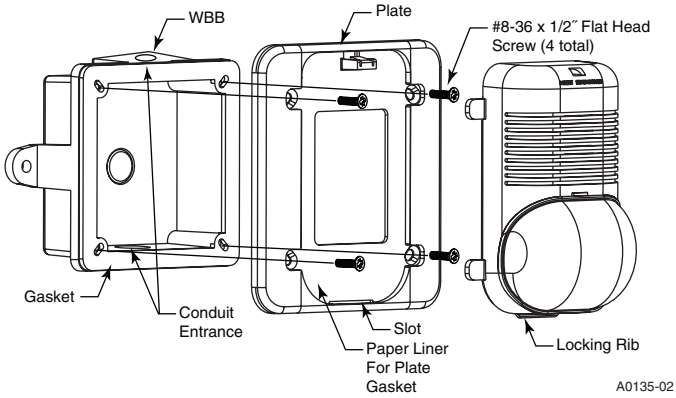
Selectable Horn Tones			8-17.5V	16-33V
Temporal	Low Volume	Electromechanical	67	75
		3000 Hz Interrupted	68	75
	High Volume	Electromechanical	71	80
		3000 Hz Interrupted	72	81
Non-Temporal	Low Volume	Electromechanical	71	79
		3000 Hz Interrupted	72	79
	High Volume	Electromechanical	76	84
		3000 Hz Interrupted	77	86

DIP Switch Operation on P1224MC



A0110-00

Typical weatherproof mounting with universal plate



A0135-02

SpectrAlert Ordering Information

Model	Description
P1224MC	Selectable Output Horn/Strobe, 12/24 volt, red
P1224MCW	Selectable Output Horn/Strobe, 12/24 volt, white
P1224MCP	Selectable Output Horn/Strobe, 12/24 volt, red, plain housing
P1224MCPW	Selectable Output Horn/Strobe, 12/24 volt, white, plain housing
P1224MCK	Selectable Output Horn/Strobe, 12/24 volt, red, outdoor
P1224MCSP	Selectable Output Horn/Strobe, 12/24 volt, red, "FUEGO" housing
S1224MC	Selectable Output Strobe, 12/24 volt, red
S1224MCW	Selectable Output Strobe, 12/24 volt, white
S1224MCP	Selectable Output Strobe, 12/24 volt, red, plain housing
S1224MCPW	Selectable Output Strobe, 12/24 volt, white, plain housing
S1224MCK	Selectable Output Strobe, 12/24 volt, red, outdoor
S1224MCSP	Selectable Output Strobe, 12/24 volt, red, "FUEGO" housing

Model	Description
H12/24	Horn, 12/24 volt, red
H12/24W	Horn, 12/24 volt, white
H12/24K	Horn, 12/24 volt, red, outdoor
Accessories	
MDL	Sync•Circuit Module, red
MDLW	Sync•Circuit Module, white
MDLWA	Sync•Circuit Module, white, Canadian model
S-MP	Small Footprint Mounting Plate, red, for single-gang back box
S-MPW	Small Footprint Mounting Plate, white, for single-gang back box
BBS	Surface Mount Back Box Skirt, red
BBSW	Surface Mount Back Box Skirt, white
D-MP	Universal Mounting Plate (replacement), red
D-MPW	Universal Mounting Plate (replacement), white
WBB	Weatherproof Back Box

Notes

All of these SpectrAlert products are designed for wall mount only. All outdoor models must use weatherproof back box model WBB. Installation of less than 75 candela strobes may be permissible under the equivalent facilitation clause of the ADAAG (Sec. 2.2). However, it is the responsibility of the person or entity designing the fire alarm system to determine the acceptability of less than 75 candela strobes. All 15/75 candela strobes or horn/strobes are recommended for 20′ × 20′ rooms or less.

System Sensor Sales and Service

System Sensor Headquarters
3825 Ohio Avenue
St. Charles, IL 60174
Ph: 800/SENSOR2
Fx: 630/377-6495
www.systemsensor.com

System Sensor Canada
Ph: 905.812.0767
Fx: 905.812.0771

System Sensor Europe
Ph: 44.1403.276500
Fx: 44.1403.276501

System Sensor in China
Ph: 86.29.8832.0119
Fx: 86.29.8832.5119

System Sensor in Singapore
Ph: 65.6273.2230
Fx: 65.6273.2610

System Sensor – Far East
Ph: 85.22.191.9003
Fx: 85.22.736.6580

System Sensor – Australia
Ph: 613.54.281.142
Fx: 613.54.281.172

System Sensor – India
Ph: 91.124.237.1770 x.2700
Fx: 91.124.237.3118

System Sensor – Russia
Ph: 70.95.937.7982
Fx: 70.95.937.7983

A05-0325-006•9/05•#1526

Motor bells

10" BELL

6" BELL

RSSP REMOTE PLATE

Description

The Wheelock MB motor bells provide a specifically designed motor bell for fire and life safety alarm systems. The Wheelock MB bells include higher dBA, low current draw, built-in trimplate for semi-flush mounting, low frequency aluminum shells, and low RFI noise. The motor for MB bells is a durable, high-torque permanent magnet motor selected for its high performance and long life.

These DC vibrating MB motor bells are offered in 6" and 10" shell sizes in both 12 and 24 VDC models.

The RSSP Sync/Non-Sync retrofit plates are used in conjunction with the MB motor bell when combination appliances are required. The RSSP retrofit plates are available with either multi-candela or single candela strobes and easily mount to a 4" square or Wheelock SBL-2 backbox. All RSSP strobe appliances meet or exceed the requirements of NFPA 72 (National Fire Alarm Code), ANSI 117.1 (American National Standard for Accessible and Usable Buildings and Facilities), ADA (Americans with Disabilities Act) and UL Standard 1971 (Signaling Devices for the Hearing Impaired).

The RSSP retrofit plates may be synchronized when installed with the Wheelock Series DSM, Sync Modules or Wheelock Power Supplies with Wheelock patented sync protocol. Wheelock synchronized strobes offer an easy way to comply with ADA requirements concerning photo-sensitive epilepsy.

Powering Business Worldwide

Features & benefits

- Meets OSHA 29 Part 1910.165
- High sound output with low current draw
- Low frequency aluminum shells for better audibility through walls, doors and other structures
- 6" and 10" shell sizes in 12 or 24 VDC models
- Integral RFI suppression to minimize included noise on the NAC circuit
- Mounting options for surface, semi-flush, outdoor, and concealed conduit installation
- Built-in trimplate makes semi-flush mounting simpler and less expensive
- Screw terminals permit fast in-out field wiring of #12 to #18 AWG wire
- Polarized for DC supervision of NAC circuits
- Operates on filtered or unfiltered DC
- For combined audible (bell) and visual signaling, convenient retrofit plate assemblies are available with Multi-Candela or Single candela strobes (Refer to Fire Alarm Products Catalog for Series RSSP Sync/Non-Sync Strobes specifications and technical information)

Note: All CAUTIONS and WARNINGS are identified by the symbol ⚠. All warnings are printed in bold capital letters.

⚠ WARNING

PLEASE READ THESE SPECIFICATIONS AND ASSOCIATED INSTALLATION INSTRUCTIONS CAREFULLY BEFORE USING, SPECIFYING OR APPLYING THIS PRODUCT. FAILURE TO COMPLY WITH ANY OF THESE INSTRUCTIONS, CAUTIONS OR WARNINGS COULD RESULT IN IMPROPER APPLICATION, INSTALLATION AND/OR OPERATION OF THESE PRODUCTS IN AN EMERGENCY SITUATION, WHICH COULD RESULT IN PROPERTY DAMAGE, AND SERIOUS INJURY OR DEATH TO YOU AND/OR OTHERS.

Approvals & compliances

- Approvals include: UL Standard 464, Factory Mutual (FM), California State Fire Marshal (CSFM), New York (MEA) and Chicago (BFP)
- Meets OSHA 29 Part 1910.165

Drawings

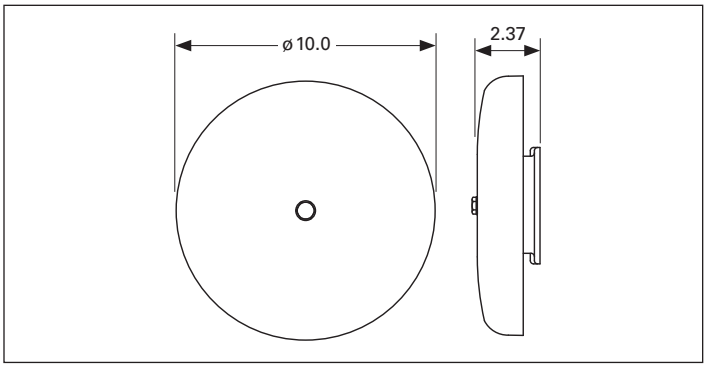


Figure 1. MB-G10 front and side views

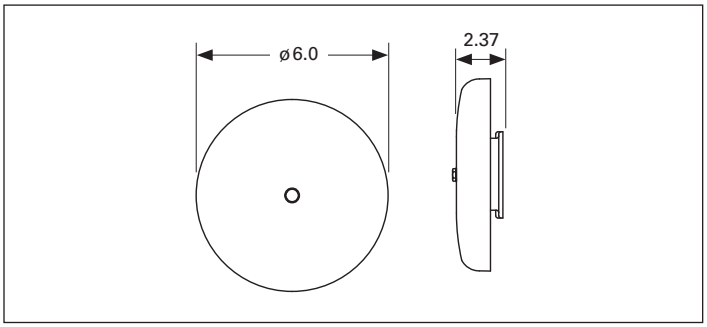


Figure 2. MB-G6 front and side views

Table 1. Specifications and ordering information: MB models

Model Number	Order Code	Shell Size	Input Voltage (VDC)	Average RMS Current	UL Max ①	dBA @ 10 ft.	Mounting Options
MB-G6-12-R	3942	6"	12	0.060	0.090	92	D, E, J, K, N, O, P, R, S
MB-G6-12-S	4221	6"	12	0.060	0.090		
MB-G6-24-R	3941	6"	24	0.030	0.040		
MB-G6-24-S	4222	6"	24	0.030	0.040		
MB-G10-12-R	3944	10"	12	0.060	0.090		
MB-G10-12-S	4223	10"	12	0.060	0.090		
MB-G10-24-R	3943	10"	24	0.030	0.040		
MB-G10-24-S	4224	10"	24	0.030	0.040		

① RMS current ratings are per UL average RMS method. UL max current rating is the maximum RMS current within the listed voltage range (16-33v for 24v units). For strobes the UL max current is usually at the minimum listed voltage (16v for 24v units). For audibles the max current is usually at the maximum listed voltage (33v for 24v units). For unfiltered FWR ratings, see installation instructions.

Notes: 1. Typical dBA at 10 feet is measured in an anechoic chamber.

Notes: 2. For bells all 12 VDC models are UL rated for 9.0 to 15.6 VDC and all 24 VDC models for 18.0 to 31.0 VDC.

Table 2. Specifications and ordering information: RSSP models

Model Number	Order Code	Nominal Voltage (VDC)	Strobe Candela	Average Current (AMPS) at Listed VDC	UL Max ①	Mounting Options ②
RSSP-24MCW-FR	9402	24	15/30/75/110	0.041/0.063/0.109/0.140	0.060/0.092/0.165/0.220	D, E, Z
RSSP-241575W-FR	7793	24	15 (75 on-axis)	0.060	0.090	D, E, Z
RSSP-121575W-FR	7798	12	15 (75 on-axis)	0.152	0.255	D, E, Z

① RMS current ratings are per UL average RMS method. UL max current rating is the maximum RMS current within the listed voltage range (16-33v for 24v units). For strobes the UL max current is usually at the minimum listed voltage (16v for 24v units). For audibles the max current is usually at the maximum listed voltage (33v for 24v units). For unfiltered FWR ratings, see installation instructions.

② Refer to data sheet TD450028EN for mounting options.

Wheelock products must be used within their published specifications and must be PROPERLY specified, applied, installed, operated, maintained and operationally tested in accordance with their installation instructions at the time of installation and at least twice a year or more often and in accordance with local, state and federal codes, regulations and laws. Specification, application, installation, operation, maintenance and testing must be performed by qualified personnel for proper operation in accordance with all of the latest National Fire Protection Association (NFPA), Underwriters' Laboratories (UL), National Electrical Code (NEC), Occupational Safety and Health Administration (OSHA), local, state, county, province, district, federal and other applicable building and fire standards, guidelines, regulations, laws and codes including, but not limited to, all appendices and amendments and the requirements of the local authority having jurisdiction (AHJ).

Architects and engineers specifications

The alarm appliances shall be Wheelock MB vibrating motor bells or approved equal. They shall be UL Standard 464 Listed for Fire Protective Service. Shells shall be aluminum in 6" or 10" diameter. Sound output at 10 feet shall be 92 dBA. The bells shall incorporate a permanent magnet motor and suppression circuitry to minimize RFI. They shall include a built-in trimplate for semi-flush mounting to a standard 4" square backbox or surface mounting to Wheelock's indoor BB backbox or outdoor WBB backbox.

For bell strobe applications, retrofit plates Wheelock RSSP with multi-candela or single candela strobes shall be used. All bell models shall be polarized for line supervision and shall have screw terminals for in/out field wiring of #12 to #18 AWG wire. Operating voltage shall be nominal 24 VDC or 12 VDC. Finish on all models shall be textured enamel.

Note: Due to continuous development of our products, specifications and offerings are subject to change without notice in accordance with Cooper Wheelock, Inc., dba Eaton, standard terms and conditions.

NEMA Member

WE ENCOURAGE AND SUPPORT NICET CERTIFICATION
3-YEAR WARRANTY

Eaton
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Cleveland, OH 44122
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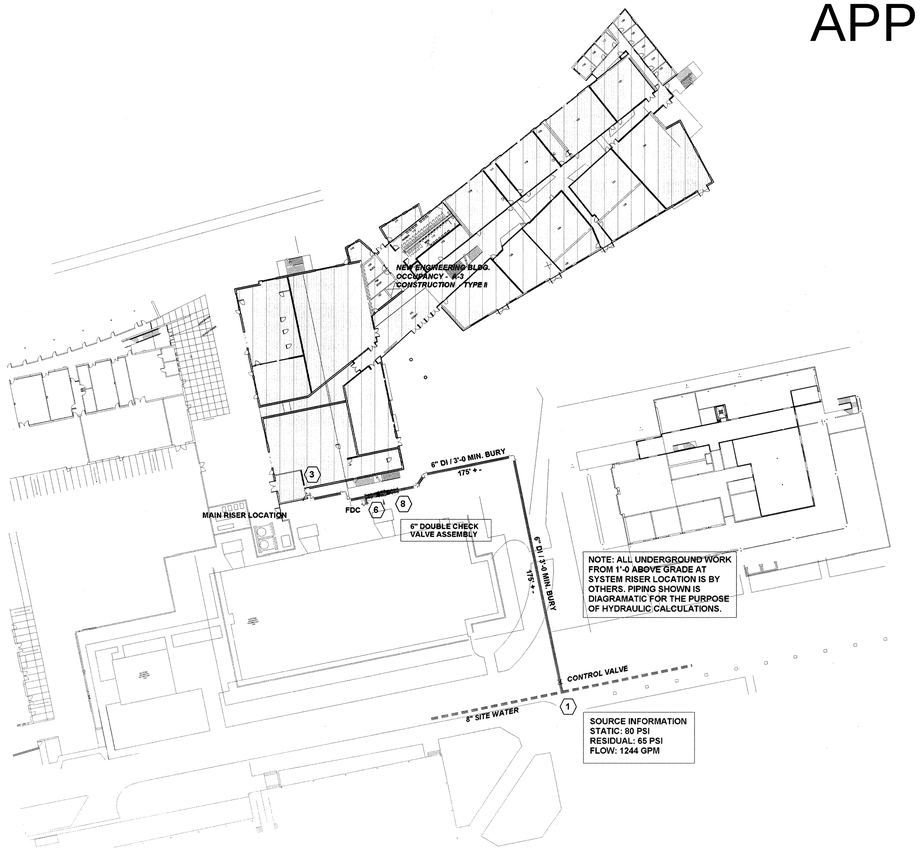
www.eaton.com/massnotification

Printed in USA
Publication No. TD450055EN
September 2016

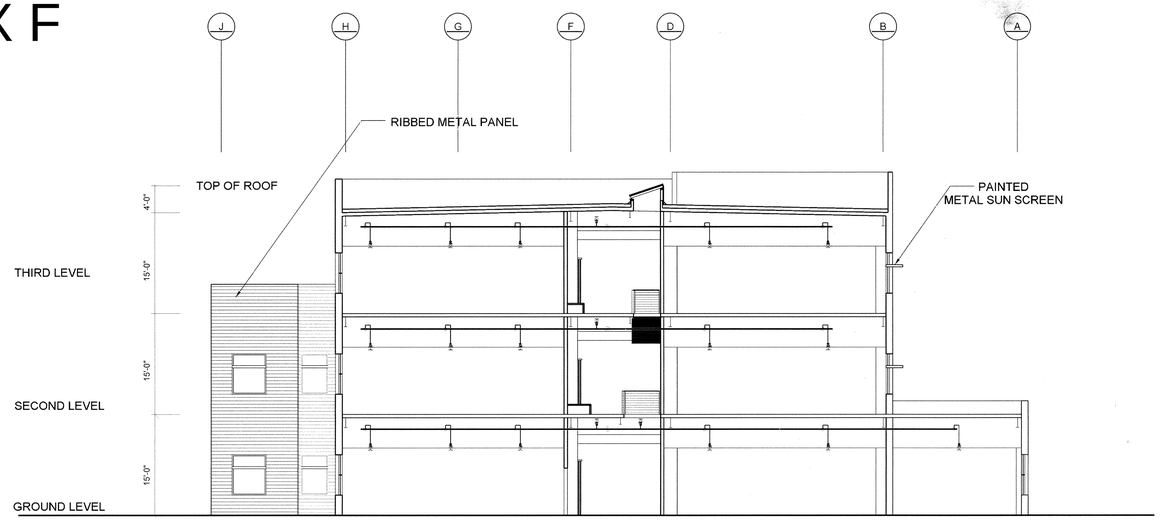
EATON
Powering Business Worldwide

APPENDIX F



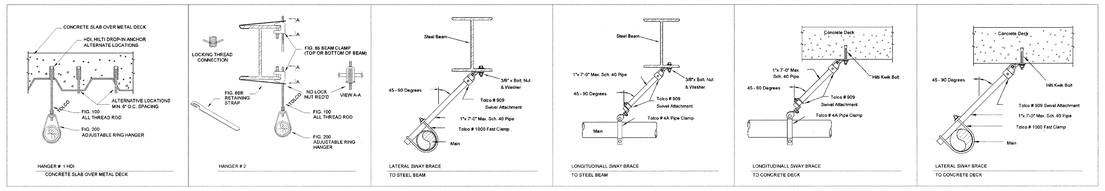
SITE PLAN

SCALE: NONE



SECTION

SCALE: 1/8" = 1'-0



PIPE SIZE	BRACE SIZE	BRACE SPACING LAT	BRACE SPACING LONG	ASSIGNED LOAD (lbs.) MULTIPLYING FACTOR = .5	NFPA #13 TABLE 4-14.4.3.5.6 BRACE TYPE	TYPE W/ MAX LOAD VALUE (lbs.) ATTACHMENT
6"	1" SCH 40	40'	80'	903	TYPE "B"	1/2" X 3" BOLT IN CONCRETE = 1782 1/2" X 3" BOLT TO STEEL = 2050
4"	1" SCH 40	40'	80'	1001	TYPE "B"	
2½"	1" SCH 40	40'	80'	750	TYPE "B"	

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MAR 16 2007
INNOVATIVE ENGINEERING GROUP, INC.

GENERAL NOTES

1. IT IS THE RESPONSIBILITY OF THE OWNER TO MAINTAIN THE INTEGRITY OF THE SPRINKLER SYSTEM.

2. ALL THE MATERIALS AND INSTALLATION OF THIS FIRE SPRINKLER SYSTEM SHALL CONFORM TO THE REQUIREMENTS OF THE NATIONAL FIRE PROTECTION ASSOCIATION PAMPHLET NUMBER 13. (NFPA 13 1999)

3. THE UNDERGROUND PORTION OF THIS FIRE SPRINKLER SYSTEM SHALL CONFORM TO THE NATIONAL FIRE PROTECTION ASSOCIATION PAMPHLET NUMBER 24 (NFPA 24). MINIMUM DEPTH OF BURY SHALL BE 3'-0". ALL CHANGES IN DIRECTION OF ANY UNDERGROUND MAINS SHALL BE RESTRAINED WITH THRUST BLOCKS OR U.L. RESTRAINING DEVICES.

4. THE SYSTEM SHALL ONLY EMPLOY THE USE OF NEW AND U.L. APPROVED MATERIALS AND DEVICES.

5. ALL UNDERGROUND MAINS AND LEAD-IN CONNECTIONS SHALL BE FLUSHED AS INDICATED IN TABLE 10-2.1 (NFPA 13 1999). PRIOR TO CONNECTION TO THE OVERHEAD PIPING, FLUSHING SHALL CONTINUE UNTIL THE WATER IS CLEAR. FLUSHING SHALL BE PERFORMED AT THE TIME OF THE HYDROSTATIC TEST.

6. ALL PIPING 1¼" THROUGH 4" DIA. USED FOR WELDED MAINS OR BRANCHLINES SHALL BE SCHEDULE 10.

7. ALL PIPING 1" THROUGH 2" DIA. USED FOR THREADED BRANCHLINES SHALL BE SCHEDULE 40.

8. A STOCK OF SPARE SPRINKLERS OF EACH STYLE, TYPE AND TEMPERATURE RATING ALONG WITH A SPRINKLER WRENCH SHALL BE LOCATED IN AN ACCESSIBLE LOCATION.

9. ALL HANDLES AND WHEELS OF CONTROL VALVES SHALL BE WITHIN 5'-0" ABOVE THE FINISH FLOOR AND BE LOCKED OR MONITORED IN THE OPEN POSTITON.

10. THIS FIRE SPRINKLER SYSTEM SHALL HAVE 24 HR MONITORING TO AN APPROVED CENTRAL STATION LOCATION. ALL WORK PERFORMED ON THE MONITORING SYSTEM SHALL BE BY OTHERS.

11. ALL WELDING SHALL CONFORM TO SECTION 3-6.2 OF (NFPA 13 1999) AND SHALL BE PERFORMED BY CERTIFIED WELDERS.

12. ALL WIRING, ELECTRICAL LINE & LOW VOLTAGE, OR FIRE EXTINGUISHERS ARE BY OTHERS.

13. ALL LOW POINTS OF THE SYSTEM SHALL HAVE PROVISIONS FOR DRAINAGE IN ACCORDANCE WITH (NFPA 13 1999).

14. ALL OVERHEAD AND UNDERGROUND PIPING SHALL BE HYDROSTATICALLY TESTED AT 200 PSI FOR A MINIMUM DURATION OF 2 HOURS.

15. AN APPOINTMENT SHALL BE MADE A MINIMUM 48 HOURS IN ADVANCE WITH THE APPROPRIATE FIRE PREVENTION OFFICE FOR ALL INSPECTIONS AND TESTS.

16. SPRINKLER PLANS SHALL BE APPROVED PRIOR TO THE INSTALLATION OF ANY PIPE. A SET OF APPROVED PLANS SHALL BE MAINTAINED AT ALL TIMES ON THE JOB SITE.

17. THE SPRINKLER CONTRACTOR WILL PROVIDE THE OWNER WITH THE NECESSARY MANUALS FOR THE UP KEEP OF THE SYSTEM AS WELL AS A COPY OF (NFPA 25 1999).

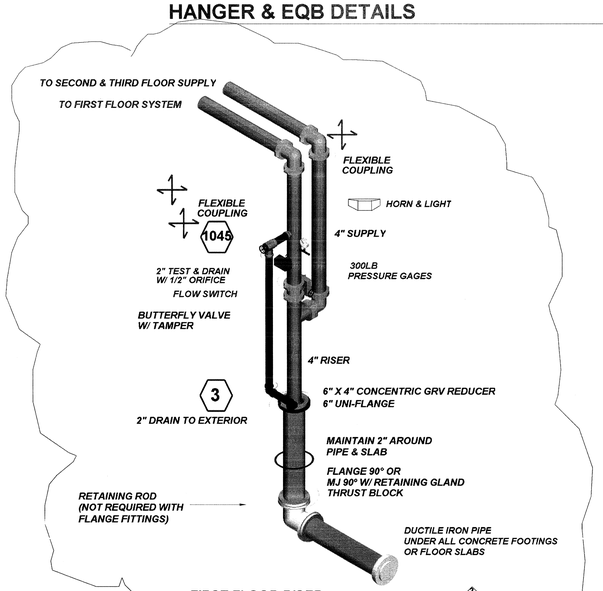
18. ALL VALVES SHALL HAVE PERMANENTLY AFFIXED SIGNS INDICATING ITS FUNCTION.

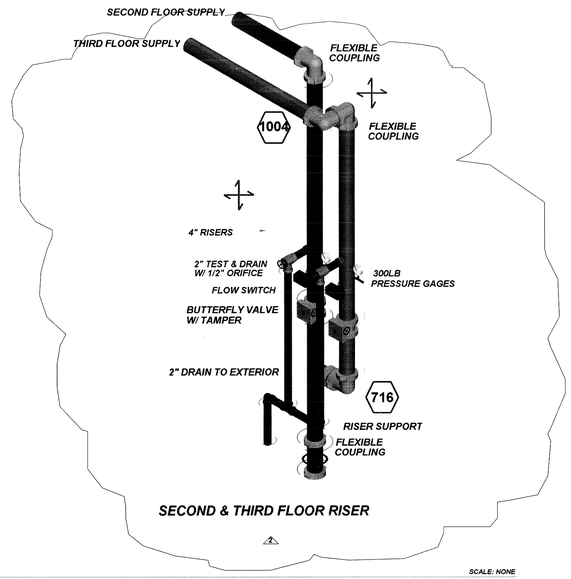
19. LOCATE AND COORDINATE EXISTING UTILITIES PRIOR TO AND DURING THE UNDERGROUND PIPING AND FITTING INSTALLATION PROCESS.

20. DISINFECT ALL NEW UNDERGROUND PIPING PER AWWA - C651 STANDARDS.

HANGER & EQB DETAILS

SCALE: NONE





RISER DETAILS

SCALE: NONE

INNOVATIVE ENGINEERING GROUP, INC.
MEP CONSULTING ENGINEERS
1005 Silverlake Drive, Suite 200, Roseville, CA 95747
☒ REVIEWED ☐ REVISE AND RESUBMIT
☐ REJECTED ☐ FURNISH AS CORRECTED
Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general compliance with the information given in the contract documents. The contractor is responsible for confirming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating his work with that of all other trades, and performing his work in a safe and satisfactory manner.
Date 03.29.2007 By J.K. | W.L.

AS BUILT DRWG.

IDENTIFICATION STAMP
CALIFORNIA STATE FIRE MARSHAL
NO. 16-40-03-0001
RECEIVED BY
DATE

HANGER LEGEND	HANGER LEGEND	STANDARD SYMBOLS	STANDARD SYMBOLS
#1 EXPANSION SHEILD, ROD AND RING	#9 ALL THREAD ROD AND RING	POST INDICATOR VALVE	ALARM CHECK VALVE
#2 C-CLAMP, ROD AND RING	#10 U-HOOK	KEY VALVE	RISER W/ ALARM CHECK VALVE
#3 POWDER DRIVEN STUD, ROD AND RING	#10A WRAP AROUND U-HOOK	FIRE HYDRANT	RISER W/ DELUGE VALVE
#4 ANGLE CLIP ROD AND RING	#11 PIPE STRAP (SHORT)	FIRE DEPARTMENT CONNECTION	RISER W/ DRY PIPE VALVE
#5 L-ROD AND RING	#12 PIPE STRAP (LONG)	OSY GATE VALVE	RISER W/ ELECT FLOW SWITCH
#6 EYE ROD AND RING	#13 HILTI KWIK BOLT, ROD, RING	SWING CHECK VALVE	WATER MOTOR ALARM GONG
#7 COACH SCREW ROD AND RING	#14 RISER CLAMP (LONG EAR)	NEW UNDERGROUND	ELECTRIC ALARM BELL
#8 CEILING FLANGE, ROD AND RING	#15 PIPE STAND	EXISTING UNDERGROUND	FLUSH FIRE DEPT CONNECTION

SPRINKLER HEAD LEGEND :	SYMBOL	ORIFICE	K-FACTOR	HEAD FINISH	PLATE FINISH	TEMP.	QUAN.
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625		*1/2"*	*5.6*	*BRASS*	*N/A*	*155°*	*242*
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625		*1/2"*	*5.6*	*BRASS*	*N/A*	*200°*	*28*
RELIABLE MODEL G4A CONCEALED PENDENT SIN # 5415		*1/2"*	*5.6*	*BRASS*	*WHITE*	*155°*	*618*
RELIABLE MODEL F1FR HORIZONTAL SIDEWALL SIN # 3635		*1/2"*	*5.6*	*BRASS*	*N/A*	*200°*	*2*
TYCO MODEL WS VERTICAL PENDENT SIN # TY3488		*1/2"*	*5.6*	*BRASS*	*N/A*	*155°*	*30*
						TOTAL SPRINKLERS =	*920*

HEAD COUNTS REFLECT ENTIRE FLOOR

MK	DATE	BY	COORD.	REVISIONS - LOCATE BY GRID COORDINATES
				FOR APPROVAL - 10-18-05
1				REVISED 12-12-05 CALIFORNIA STATE FIRE MARSHAL
2				AS-BUILT CONDITIONS 3-2-07

APPROVALS BY:

FIELD INSPECTED BY:	CONTRACT WITH:
1.	
2.	ADDRESS:
3.	CITY:
4.	PHONE:
WATER DEPT:	ARCHITECT:
ADDRESS:	ADDRESS:
CITY:	CITY:
PHONE:	PHONE:

LICENSED FIRE PROTECTION CONTRACTOR · COSCO FIRE PROTECTION INC. · CLASSIFICATION C-16 · LICENSE NO. 577621 · FRESNO · STATE OF CALIFORNIA

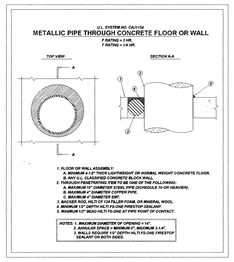
SCALE: 1/8" = 1'-0"

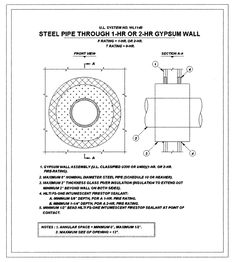
PROJECT: *ENGINEERING IV BUILDING*
ADDRESS: *CALIFORNIA POLYTECHNIC STATE UNIVERSITY*
CITY: *SAN LUIS OBISPO, CALIFORNIA*
TITLE:

COSCO FIRE PROTECTION INC.

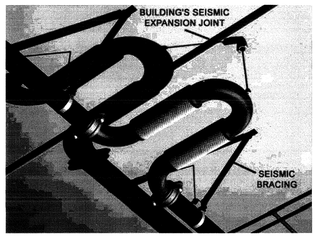
4233 W. SIERRA MADRE #108
FRESNO, CA 93722
559-275-3795 FAX: 559-275-8606
LICENSE NO. C-16-577621

SURVEYED:	DATE: *10-18-05*
DRAWN: *KDT*	DRAWING NO:
CONTRACT:	FP-1 of 7





FIRE STOPPING PENETRATION DETAILS



EXPANSION JOINT DETAIL

FIRE SPRINKLER PLAN
FIRST FLOOR - WEST

SCALE: 1/8" = 1'-0"

AS BUILT DRWG.

NOTES:
1. SEE FP-1 FOR RISER DETAIL AND CONTINUATION OF UG.
2.SEE FP-1 FOR HANGER AND EQB DETAILS.

1. ALL MANUAL WET STANDPIPES AND DEVICES WERE OMITTED

IDENTIFICATION STAMP
CALIFORNIA STATE FIRE MARSHAL
NO. 18-40-03-0001
RECEIVED BY:
DATE:

HANGER LEGEND	HANGER LEGEND	STANDARD SYMBOLS	STANDARD SYMBOLS
#1 EXPANSION SHELL, ROD AND RING	#9 ALL THREAD ROD AND RING	POST INDICATOR VALVE	ALARM CHECK VALVE
#2 C-CLAMP, ROD AND RING	#10 U-HOOK	KEY VALVE	RISER W/ ALARM CHECK VALVE
#3 POWDER DRIVEN STUD, ROD AND RING	#10A WRAP AROUND U-HOOK	FIRE HYDRANT	RISER W/ DELUGE VALVE
#4 ANGLE CLIP, ROD AND RING	#11 PIPE STRAP (SHORT)	FIRE DEPARTMENT CONNECTION	RISER W/ DRY PIPE VALVE
#5 L-ROD AND RING	#12 PIPE STRAP (LONG)	OSY GATE VALVE	RISER W/ ELECT FLOW SWITCH
#6 EYE ROD AND RING	#13 HILTI KWIK BOLT, ROD, RING	SWING CHECK VALVE	WATER MOTOR ALARM GONG
#7 COACH SCREW ROD AND RING	#14 RISER CLAMP (LONG EAR)	NEW UNDERGROUND	ELECTRIC ALARM BELL
#8 CEILING FLANGE, ROD AND RING	#15 PIPE STAND	EXISTING UNDERGROUND	FLUSH FIRE DEPT CONNECTION

SPRINKLER HEAD LEGEND :	SYMBOL	ORIFICE	K-FACTOR	HEAD FINISH	PLATE FINISH	TEMP.	QUAN.
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625		***1/2"***	***5.6***	***BRASS***	***N/A***	***155°***	***153***
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625		***1/2"***	***5.6***	***BRASS***	***N/A***	***200°***	***18***
RELIABLE MODEL G4A CONCEALED PENDENT SIN # 5415		***1/2"***	***5.6***	***BRASS***	***WHITE***	***155°***	***199***
RELIABLE MODEL F1FR HORIZONTAL SIDEWALL SIN # 3635		***1/2"***	***5.6***	***BRASS***	***N/A***	***200°***	***2***

APPROVALS BY:

TOTAL SPRINKLERS = ***372***
HEAD COUNTS REFLECT ENTIRE FLOOR

MK	DATE	BY	COORD	REVISIONS - LOCATE BY GRID COORDINATES
				FOR APPROVAL - 10-18-05
1				REVISED 12-12-05 CALIFORNIA STATE FIRE MARSHAL
2				AS-BUILT CONDITIONS 2-3-07

FIELD INSPECTED BY:
1.
2.
3.
4.
WATER DEPT:
ADDRESS:
CITY:
PHONE:

CONTRACT WITH:
ADDRESS:
CITY:
PHONE:
ARCHITECT:
ADDRESS:
CITY:
PHONE:

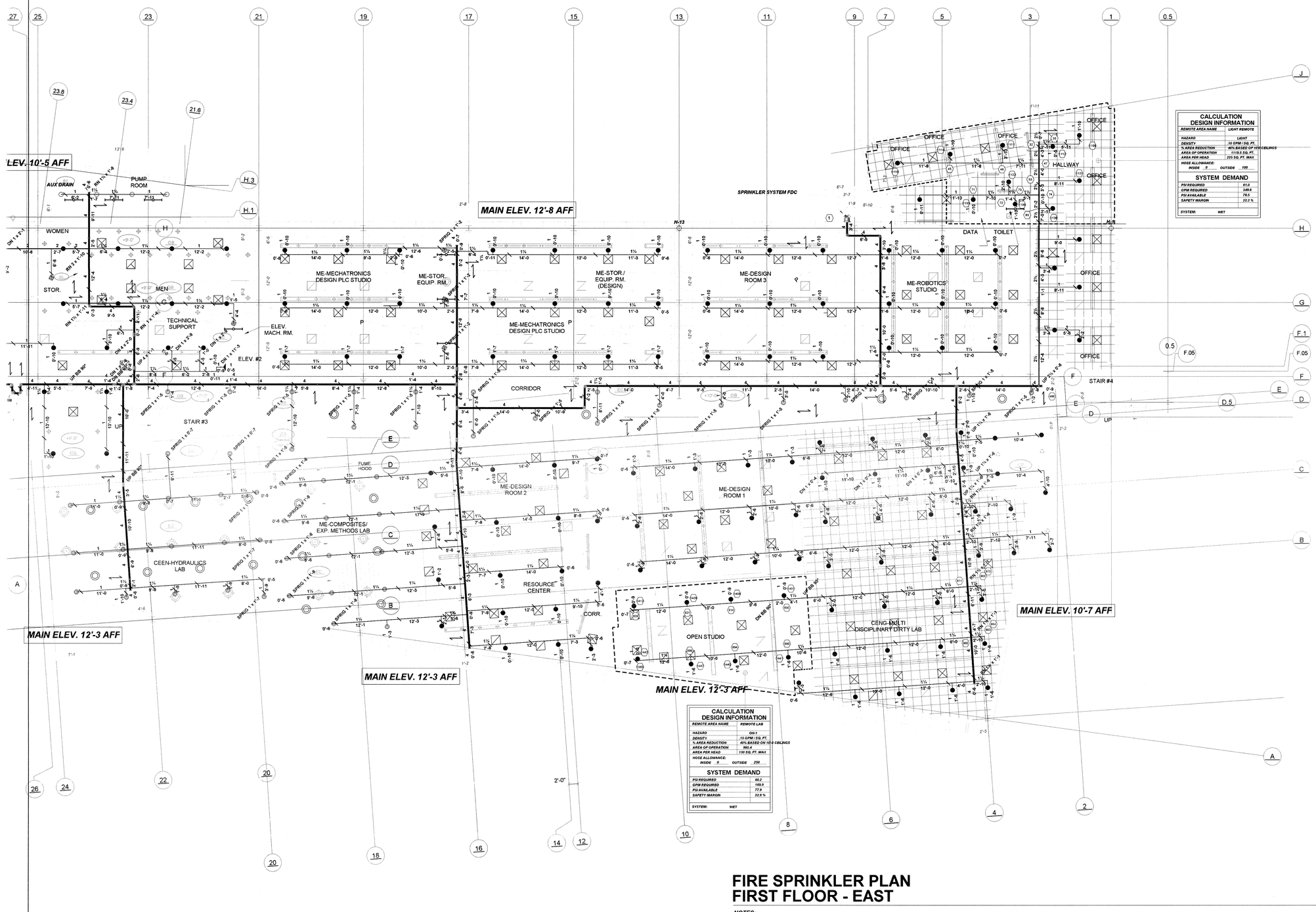
LICENSED FIRE PROTECTION CONTRACTOR — COSCO FIRE PROTECTION INC. — CLASSIFICATION C-16 LICENSE NO. 577621 — FRESNO — STATE OF CALIFORNIA

SCALE: 1/8" = 1'-0"

PROJECT: ***ENGINEERING IV BUILDING***
ADDRESS: ***CALIFORNIA POLYTECHNIC STATE UNIVERSITY***
CITY: ***SAN LUIS OBISPO, CALIFORNIA***
TITLE:

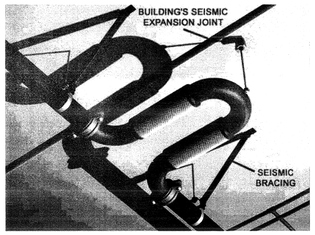
COSCO FIRE PROTECTION INC.
4233 W. SIERRA MADRE #108
FRESNO, CA 93722
559-275-3795 FAX: 559-275-9606
LICENSE NO. C-16-577621

SURVEYED:	DATE: ***10-18-05***
DRAWN: ***KDT***	DRAWING NO:
CONTRACT:	FP-3 of 7

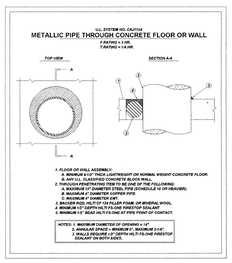


CALCULATION DESIGN INFORMATION	
REMOTE AREA NAME	REMOTE LAB
HAZARD	ON-1
DENSITY	.15 GPM / SQ. FT.
% AREA REDUCTION	40% BASED ON 10'-0 CEILINGS
AREA OF OPERATION	960.4
AREA PER HEAD	130 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0 OUTSIDE 250	
SYSTEM DEMAND	
PSI REQUIRED	60.2
GPM REQUIRED	189.3
PSI AVAILABLE	77.9
SAFETY MARGIN	32.8 %
SYSTEM:	WET

CALCULATION DESIGN INFORMATION	
REMOTE AREA NAME	LIGHT REMOTE
HAZARD	LIGHT
DENSITY	.10 GPM / SQ. FT.
% AREA REDUCTION	40% BASED OF 10'0 CEILINGS
AREA OF OPERATION	1119.5 SQ. FT.
AREA PER HEAD	225 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0 OUTSIDE 100	
SYSTEM DEMAND	
PSI REQUIRED	61.0
GPM REQUIRED	349.9
PSI AVAILABLE	78.5
SAFETY MARGIN	22.2 %
SYSTEM:	WET



EXPANSION JOINT DETAIL



FIRE STOPPING PENETRATION DETAILS

FIRE SPRINKLER PLAN
FIRST FLOOR - EAST

SCALE: 1/8" = 1'-0

AS BUILT DRWG.

NOTES:
1. SEE FP-1 FOR RISER DETAIL AND CONTINUATION OF UG.
2.SEE FP-1 FOR HANGER AND EQB DETAILS.

2. ALL MANUAL WET STANDPIPES AND DEVICES WERE OMITTED

SPRINKLER HEAD LEGEND :	SYMBOL	ORIFICE	K-FACTOR	HEAD FINISH	PLATE FINISH	TEMP.	QUAN.
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625	○	***1/2"***	***5.6***	***BRASS***	***N/A***	***155°***	***153***
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625	⊕	***1/2"***	***5.6***	***BRASS***	***N/A***	***200°***	***18***
RELIABLE MODEL G4A CONCEALED PENDENT SIN # 5415	●	***1/2"***	***5.6***	***BRASS***	***WHITE***	***155°***	***199***
RELIABLE MODEL F1FR HORIZONTAL SIDEWALL SIN # 3635	◖	***1/2"***	***5.6***	***BRASS***	***N/A***	***200°***	***2***

APPROVALS BY:

TOTAL SPRINKLERS * 372
HEAD COUNTS REFLECT ENTIRE FLOOR

MK	DATE	BY	COORD	REVISIONS - LOCATE BY GRID COORDINATES
				FOR APPROVAL - 10-18-05
1				REVISED 12-12-05 CALIFORNIA STATE FIRE MARSHAL
2				AS-BUILT CONDITIONS 2-3-07

HANGER LEGEND	HANGER LEGEND
#1 EXPANSION SHELL, ROD AND RING	#9 ALL THREAD ROD AND RING
#2 C-CLAMP, ROD AND RING	#10 U-HOOK
#3 POWDER DRIVEN STUD, ROD AND RING	#10A WRAP AROUND U-HOOK
#4 ANGLE CLIP ROD AND RING	#11 PIPE STRAP (SHORT)
#5 L-ROD AND RING	#12 PIPE STRAP (LONG)
#6 EYE ROD AND RING	#13 HILTI KWIK BOLT, ROD, RING
#7 COACH SCREW ROD AND RING	#14 RISER CLAMP (LONG EAR)
#8 CEILING FLANGE, ROD AND RING	#15 PIPE STAND

STANDARD SYMBOLS	STANDARD SYMBOLS
POST INDICATOR VALVE	ALARM CHECK VALVE
KEY VALVE	RISER W/ ALARM CHECK VALVE
FIRE HYDRANT	RISER W/ DELUGE VALVE
FIRE DEPARTMENT CONNECTION	RISER W/ DRY PIPE VALVE
OSY GATE VALVE	RISER W/ ELECT FLOW SWITCH
SWING CHECK VALVE	WATER MOTOR ALARM GONG
NEW UNDERGROUND	ELECTRIC ALARM BELL
EXISTING UNDERGROUND	FLUSH FIRE DEPT CONNECTION

FIELD INSPECTED BY:
1.
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3.
4.
WATER DEPT:
ADDRESS:
CITY:
PHONE:

CONTRACT WITH
ADDRESS:
CITY:
PHONE:
ARCHITECT:
ADDRESS:
CITY:
PHONE:

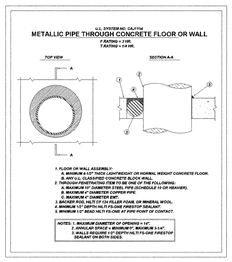
LICENSED FIRE PROTECTION CONTRACTOR — COSCO FIRE PROTECTION INC. — CLASSIFICATION C-16 LICENSE NO. 577621 — FRESNO — STATE OF CALIFORNIA

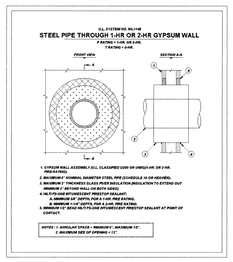
SCALE: 1/8" = 1'-0"

PROJECT: ***ENGINEERING IV BUILDING***
ADDRESS: ***CALIFORNIA POLYTECHNIC STATE UNIVERSITY***
CITY: ***SAN LUIS OBISPO, CALIFORNIA***
TITLE:

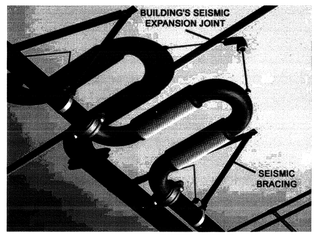
COSCO FIRE PROTECTION INC.
4233 W. SIERRA MADRE #108
FRESNO, CA 93722
559-275-3795 FAX: 559-275-9006
LICENSE NO. C-16-577621

SURVEYED: DATE: ***10-18-05***
DRAWN: ***KDT***
CONTRACT:
DRAWING NO.
FP-3 of 7

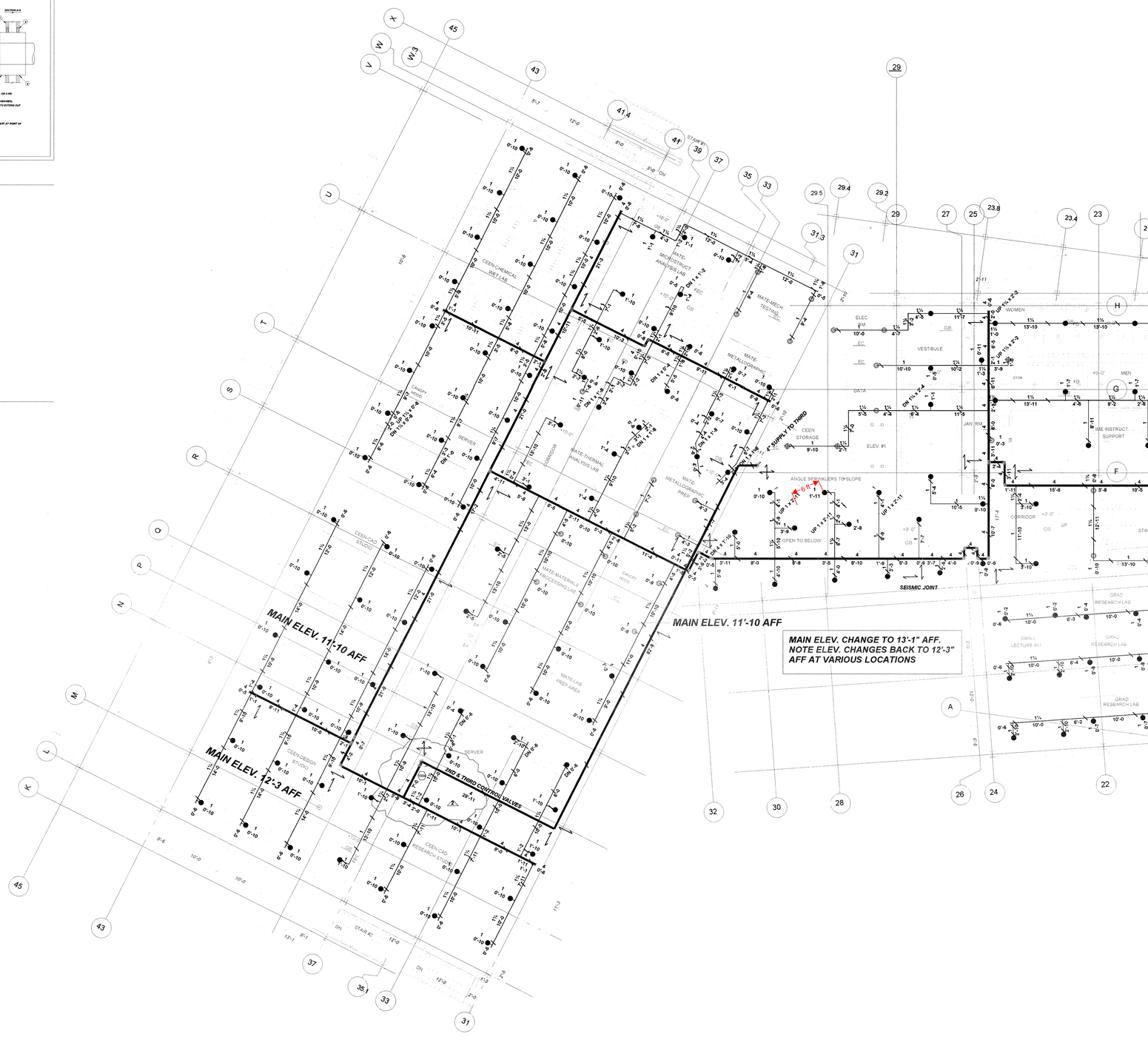




FIRE STOPPING PENETRATION DETAILS



EXPANSION JOINT DETAIL



FIRE SPRINKLER PLAN
SECOND FLOOR - WEST

NOTES:
1. SEE FP-1 FOR RISER DETAIL AND CONTINUATION OF UG.
2.SEE FP-1 FOR HANGER AND EQB DETAILS.

SCALE: 1/8" = 1'-0

AS BUILT DRWG.

IDENTIFICATION STAMP
CALIFORNIA STATE FIRE MARSHAL
NO. 18-40-03-0001
RECEIVED BY:
DATE:

⚠ ***ALL MANUAL WET STANDPIPES AND DEVICES WERE OMITTED***

HANGER LEGEND	HANGER LEGEND
#1 EXPANSION SHELL, ROD AND RING	#9 ALL THREAD ROD AND RING
#2 C-CLAMP, ROD AND RING	#10 U-HOOK
#3 POWDER DRIVEN STUD, ROD AND RING	#10A WRAP AROUND U-HOOK
#4 ANGLE CLIP ROD AND RING	#11 PIPE STRAP (SHORT)
#5 L-ROD AND RING	#12 PIPE STRAP (LONG)
#6 EYE ROD AND RING	#13 HILTI KWIK BOLT, ROD, RING
#7 COACH SCREW ROD AND RING	#14 RISER CLAMP (LONG EAR)
#8 CEILING FLANGE, ROD AND RING	#15 PIPE STAND

STANDARD SYMBOLS	STANDARD SYMBOLS
POST INDICATOR VALVE	ALARM CHECK VALVE
KEY VALVE	RISER W/ ALARM CHECK VALVE
FIRE HYDRANT	RISER W/ DELUGE VALVE
FIRE DEPARTMENT CONNECTION	RISER W/ DRY PIPE VALVE
OSY GATE VALVE	RISER W/ ELECT FLOW SWITCH
SWING CHECK VALVE	WATER MOTOR ALARM GONG
NEW UNDERGROUND	ELECTRIC ALARM BELL
EXISTING UNDERGROUND	FLUSH FIRE DEPT CONNECTION

SPRINKLER HEAD LEGEND	SYMBOL	ORIFICE	K-FACTOR	HEAD FINISH	PLATE FINISH	TEMP	QUAN.
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625		*1/2"*	*5.6*	*BRASS*	*N/A*	*155°*	*43*
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625		*1/2"*	*5.6*	*BRASS*	*N/A*	*200°*	*3*
RELIABLE MODEL Q4A CONCEALED PENDENT SIN # 5415	●	*1/2"*	*5.6*	*BRASS*	*WHITE*	*155°*	*254*
APPROVALS BY:				TOTAL SPRINKLERS = HEAD COUNTS REFLECT ENTIRE FLOOR			*300*

MK	DATE	BY	COORD	REVISIONS - LOCATE BY GRID COORDINATES
				FOR APPROVAL - 10-18-05
1				REVISED 12-12-05 CALIFORNIA STATE FIRE MARSHAL
2				AS-BUILT CONDITIONS 2-3-07

FIELD INSPECTED BY:
1.
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3.
4.
WATER DEPT:
ADDRESS:
CITY:
PHONE:

CONTRACT WITH:
ADDRESS:
CITY:
PHONE:
ARCHITECT:
ADDRESS:
CITY:
PHONE:

LICENSED FIRE PROTECTION CONTRACTOR · COSCO FIRE PROTECTION INC · CLASSIFICATION C-16 · LICENSE NO. 577921 · FRESNO · STATE OF CALIFORNIA

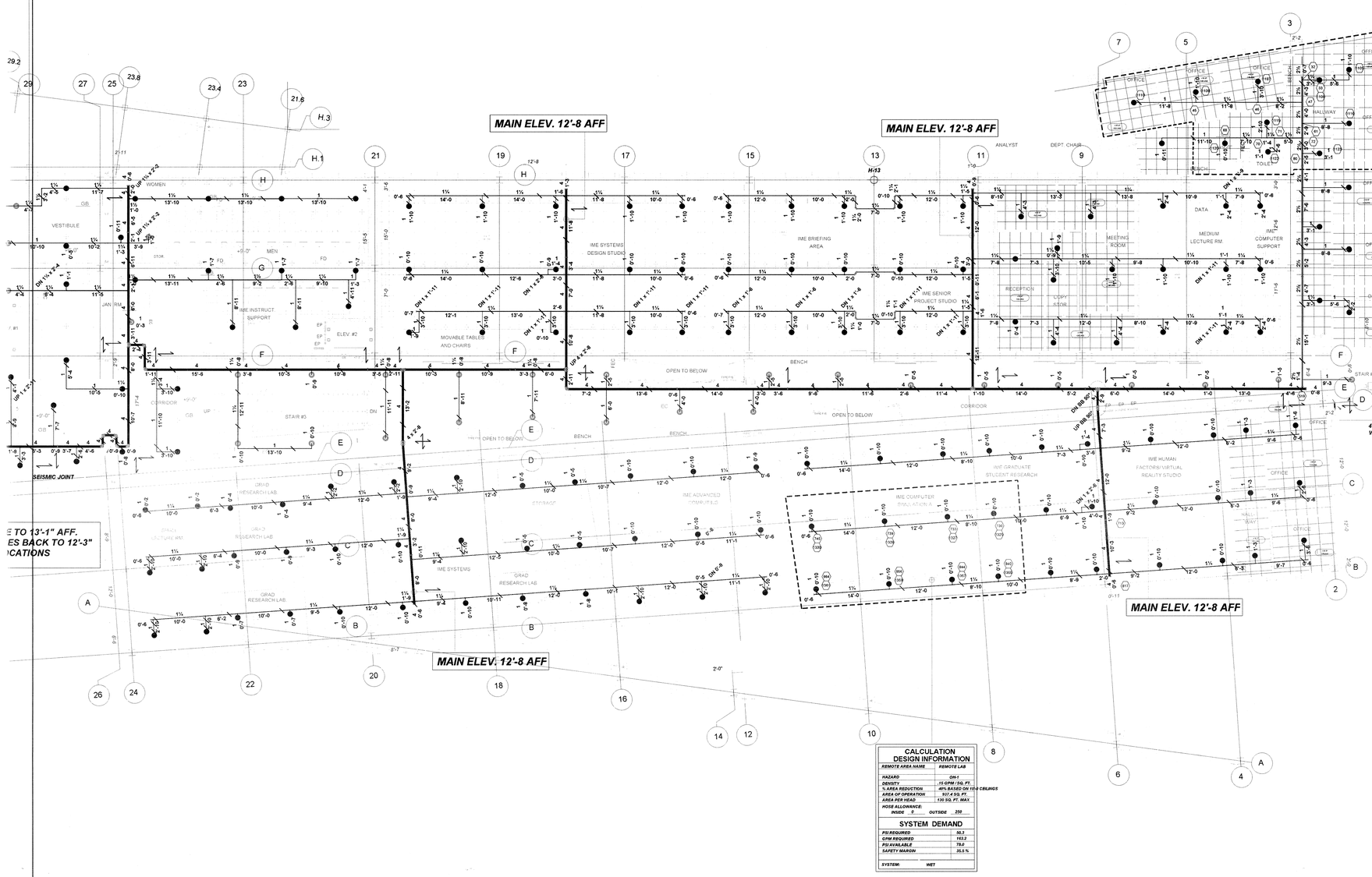
SCALE: 1/8" = 1'-0

PROJECT: ***ENGINEERING IV BUILDING***
ADDRESS: ***CALIFORNIA POLYTECHNIC STATE UNIVERSITY***
CITY: ***SAN LUIS OBISPO, CALIFORNIA***
TITLE:

COSCO FIRE PROTECTION INC.

4233 W. SIERRA MADRE #108
FRESNO, CA 93722
559-275-3795 FAX: 559-275-8006
LICENSE NO. C-16-577921

SURVEYED: DATE: *10-18-05*
DRAWN: *KDT*
CONTRACT:
DRAWING NO.
FP-4 of 7



CALCULATION DESIGN INFORMATION

REMOTE AREA NAME	REMOTE LIGHT
HAZARD	LIGHT
DENSITY	.10 GPM / SQ. FT.
% AREA REDUCTION	40% BASED OF 1000 CEILINGS
AREA OF OPERATION	1500.0 SQ. FT.
AREA PER HEAD	225 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0 OUTSIDE 100	

SYSTEM DEMAND

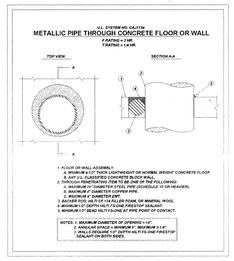
PSI REQUIRED	66.4
GPM REQUIRED	250.3
PSI AVAILABLE	78.5
SAFETY MARGIN	15.4 %
SYSTEM:	WET

CALCULATION DESIGN INFORMATION

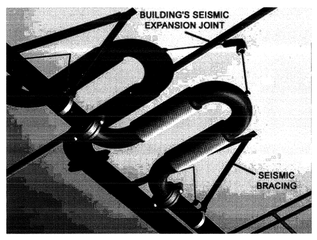
REMOTE AREA NAME	REMOTE LAB
HAZARD	ORH
DENSITY	.15 GPM / SQ. FT.
% AREA REDUCTION	40% BASED ON 1014 CEILINGS
AREA OF OPERATION	937.4 SQ. FT.
AREA PER HEAD	130 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0 OUTSIDE 250	

SYSTEM DEMAND

PSI REQUIRED	50.3
GPM REQUIRED	163.2
PSI AVAILABLE	78.0
SAFETY MARGIN	35.5 %
SYSTEM:	WET



FIRE STOPPING PENETRATION DETAILS



EXPANSION JOINT DETAIL

FIRE SPRINKLER PLAN SECOND FLOOR - EAST

SCALE 1/8" = 1'-0

NOTES:
1. SEE FP-1 FOR RISER DETAIL AND CONTINUATION OF UG.
2.SEE FP-1 FOR HANGER AND EQB DETAILS.

⚠2 ALL MANUAL WET STANDPIPES AND DEVICES WERE OMITTED

AS BUILT DRWG.

IDENTIFICATION STAMP
CALIFORNIA STATE FIRE MARSHAL
NO. 18-40-03-0001
RECEIVED BY:
DATE:

HANGER LEGEND	HANGER LEGEND
#1 EXPANSION SHELL, ROD AND RING	#9 ALL THREAD ROD AND RING
#2 C-CLAMP, ROD AND RING	#10 U-HOOK
#3 POWDER DRIVEN STUD, ROD AND RING	#10A WRAP AROUND U-HOOK
#4 ANGLE CLIP ROD AND RING	#11 PIPE STRAP (SHORT)
#5 L-ROD AND RING	#12 PIPE STRAP (LONG)
#6 EYE ROD AND RING	#13 HILTI KWIK BOLT, ROD, RING
#7 COACH SCREW ROD AND RING	#14 RISER CLAMP (LONG EAR)
#8 CEILING FLANGE, ROD AND RING	#15 PIPE STAND

STANDARD SYMBOLS	STANDARD SYMBOLS
POST INDICATOR VALVE	ALARM CHECK VALVE
KEY VALVE	RISER W/ ALARM CHECK VALVE
FIRE HYDRANT	RISER W/ DELUGE VALVE
FIRE DEPARTMENT CONNECTION	RISER W/ DRY PIPE VALVE
OSY GATE VALVE	RISER W/ ELECT FLOW SWITCH
SWING CHECK VALVE	WATER MOTOR ALARM GONG
NEW UNDERGROUND	ELECTRIC ALARM BELL
EXISTING UNDERGROUND	FLUSH FIRE DEPT CONNECTION

SPRINKLER HEAD LEGEND :	SYMBOL	ORIFICE	K-FACTOR	HEAD FINISH	PLATE FINISH	TEMP.	QUAN.
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625	⊙	*1/2"*	*5.6*	*BRASS*	*N/A*	*155°*	*43*
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625	⊙	*1/2"*	*5.6*	*BRASS*	*N/A*	*200°*	*3*
RELIABLE MODEL Q4A CONCEALED PENDENT SIN # 5415	●	*1/2"*	*5.6*	*BRASS*	*WHITE*	*155°*	*254*

APPROVALS BY:

TOTAL SPRINKLERS = *300*
HEAD COUNTS REFLECT ENTIRE FLOOR

MK	DATE	BY	COORD.	REVISIONS - LOCATE BY GRID COORDINATES
				FOR APPROVAL - 10-18-05
1				REVISED 12-12-05 CALIFORNIA STATE FIRE MARSHAL
2				AS-BUILT CONDITIONS 2-3-07

FIELD INSPECTED BY:
1.
2.
3.
4.
WATER DEPT:
ADDRESS:
CITY:
PHONE:

CONTRACT WITH:
ADDRESS:
CITY:
PHONE:
ARCHITECT:
ADDRESS:
CITY:
PHONE:

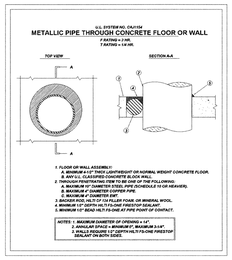
COSCO FIRE PROTECTION CONTRACTOR INC. — LICENSED FIRE PROTECTION CONTRACTOR — CLASSIFICATION C-16 — LICENSE NO. 577921 — FRESNO — STATE OF CALIFORNIA

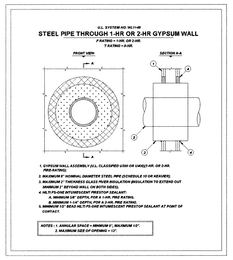
SCALE: 1/8" = 1'-0

PROJECT: ***ENGINEERING IV BUILDING***
ADDRESS: ***CALIFORNIA POLYTECHNIC STATE UNIVERSITY***
CITY: ***SAN LUIS OBISPO, CALIFORNIA***
TITLE:

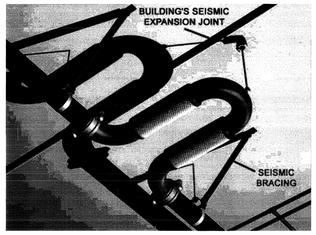
COSCO FIRE PROTECTION INC.
4233 W. SIERRA MADRE #108
FRESNO, CA 93722
559-275-3795 FAX: 559-275-8006
LICENSE NO. C-16-577921

SURVEYED:
DATE: ***10-18-05***
DRAWN: ***KOT***
DRAWING NO:
CONTRACT:
FP-5 of 7





FIRE STOPPING PENETRATION DETAILS



EXPANSION JOINT DETAIL

CALCULATION DESIGN INFORMATION

REMOTE AREA NAME	LIGHT PROOF
HAZARD	LIGHT
DENSITY	.10 GPM / SQ. FT.
% AREA REDUCTION	40% BASED OF 10X CEILINGS
AREA OF OPERATION	924.0 SQ. FT.
AREA PER HEAD	225 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0 OUTSIDE 100	

SYSTEM DEMAND

PSI REQUIRED	68.9
GPM REQUIRED	272.5
PSI AVAILABLE	78.3
SAFETY MARGIN	12.2 %
SYSTEM:	WET

CALCULATION DESIGN INFORMATION

REMOTE AREA NAME	WATER CURTAIN
HAZARD	LIGHT
DENSITY	.10 GPM / SQ. FT.
% AREA REDUCTION	40% BASED OF 10X CEILINGS
AREA OF OPERATION	1001.3 SQ. FT.
AREA PER HEAD	148.17 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0 OUTSIDE 100	

SYSTEM DEMAND

PSI REQUIRED	66.2
GPM REQUIRED	341.8
PSI AVAILABLE	77.7
SAFETY MARGIN	25.6 %
SYSTEM:	WET

FIRE SPRINKLER PLAN
THIRD FLOOR - WEST

NOTES:
1. SEE FP-1 FOR RISER DETAIL AND CONTINUATION OF UG.
2.SEE FP-1 FOR HANGER AND EQB DETAILS.

SCALE: 1/8" = 1'-0

AS BUILT DRWG.

IDENTIFICATION STAMP
CALIFORNIA STATE FIRE MARSHAL
NO. 18-40-03-0001
RECEIVED BY:
DATE:

⚠ ***ALL MANUAL WET STANDPIPES AND DEVICES WERE OMITTED***

HANGER LEGEND	HANGER LEGEND
#1 EXPANSION SHELL, ROD AND RING	#9 ALL THREAD ROD AND RING
#2 C-CLAMP, ROD AND RING	#10 U-HOOK
#3 POWDER DRIVEN STUD, ROD AND RING	#10A WRAP AROUND U-HOOK
#4 ANGLE CLIP ROD AND RING	#11 PIPE STRAP (SHORT)
#5 L-ROD AND RING	#12 PIPE STRAP (LONG)
#6 EYE ROD AND RING	#13 HILTI KWIK BOLT, ROD, RING
#7 COACH SCREW ROD AND RING	#14 RISER CLAMP (LONG EAR)
#8 CEILING FLANGE, ROD AND RING	#15 PIPE STAND

STANDARD SYMBOLS	STANDARD SYMBOLS
POST INDICATOR VALVE	ALARM CHECK VALVE
KEY VALVE	RISER W/ ALARM CHECK VALVE
FIRE HYDRANT	RISER W/ DELUGE VALVE
FIRE DEPARTMENT CONNECTION	RISER W/ DRY PIPE VALVE
OSY GATE VALVE	RISER W/ ELECT FLOW SWITCH
SWING CHECK VALVE	WATER MOTOR ALARM GONG
NEW UNDERGROUND	ELECTRIC ALARM BELL
EXISTING UNDERGROUND	FLUSH FIRE DEPT CONNECTION

SPRINKLER HEAD LEGEND:	SYMBOL	ORIFICE	K-FACTOR	HEAD FINISH	PLATE FINISH	TEMP.	QUAN.
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625		*1/2"*	*5.6*	*BRASS*	*N/A*	*155°*	*46*
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625		*1/2"*	*5.6*	*BRASS*	*N/A*	*200°*	*7*
RELIABLE MODEL G4A CONCEALED PENDENT SIN # 5415		*1/2"*	*5.6*	*BRASS*	*WHITE*	*155°*	*165*
TYCO MODEL WS VERTICAL PENDENT SIN # TY3486		*1/2"*	*5.6*	*BRASS*	*N/A*	*155°*	*30*
APPROVALS BY:						TOTAL SPRINKLERS HEAD COUNTS REFLECT ENTIRE FLOOR	= *248*

MK	DATE	BY	COORD	REVISIONS - LOCATE BY GRID COORDINATES
				FOR APPROVAL - 10-18-05
1				REVISED 12-12-05 CALIFORNIA STATE FIRE MARSHAL
2				AS-BUILT CONDITIONS 2-3-07

FIELD INSPECTED BY:	CONTRACT WITH:
1.	ADDRESS:
2.	CITY:
3.	PHONE:
4.	ARCHITECT:
WATER DEPT.:	ADDRESS:
ADDRESS:	CITY:
CITY:	PHONE:
PHONE:	

LICENSED FIRE PROTECTION CONTRACTOR — COSCO FIRE PROTECTION, INC. — CLASSIFICATION C-16 — LICENSE NO. 577821 — FRESNO — STATE OF CALIFORNIA

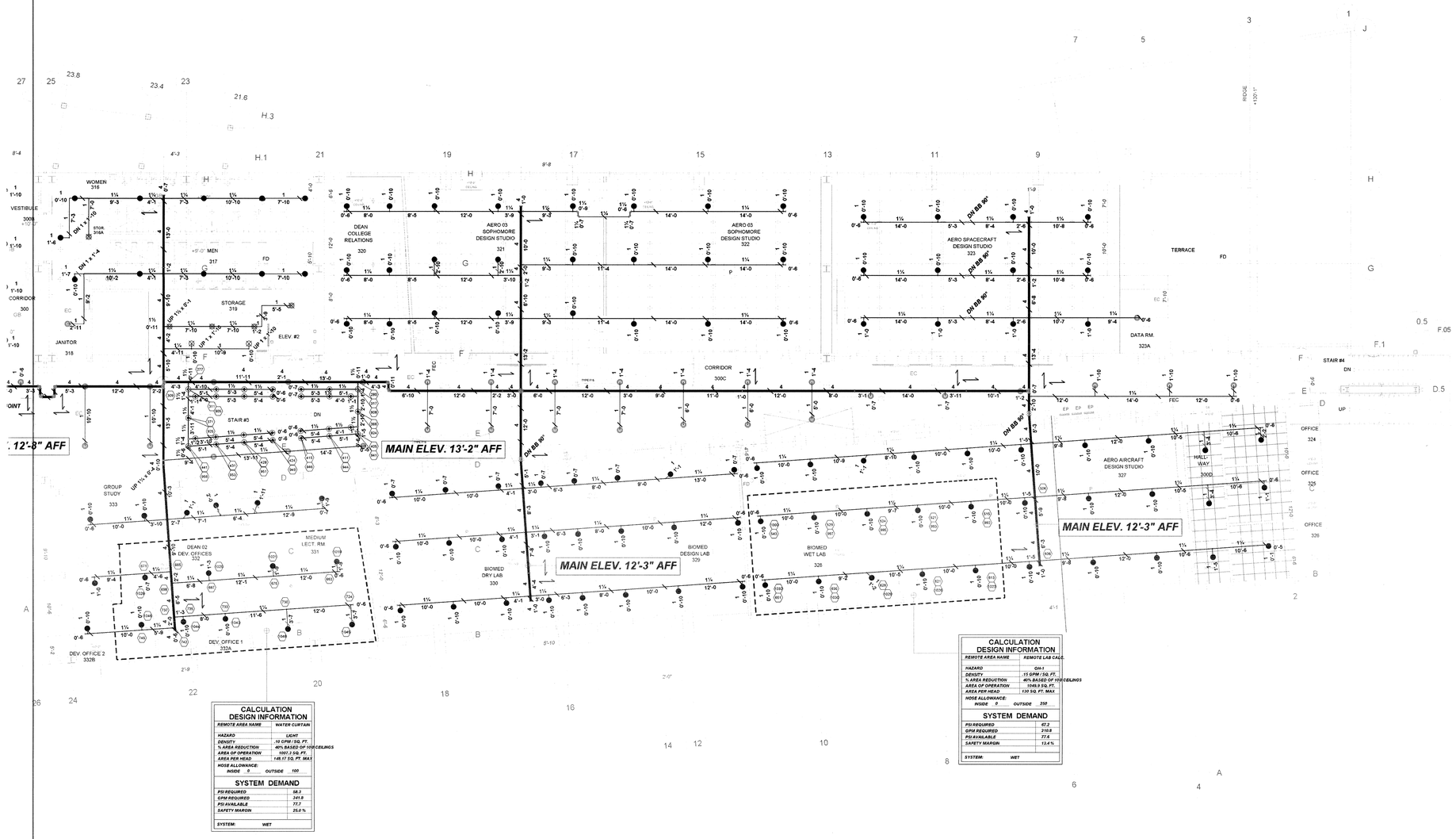
SCALE: 1/8" = 1'-0"

PROJECT: ***ENGINEERING IV BUILDING***
ADDRESS: ***CALIFORNIA POLYTECHNIC STATE UNIVERSITY***
CITY: ***SAN LUIS OBISPO, CALIFORNIA***
TITLE:

COSCO FIRE PROTECTION INC.

4233 W. SIERRA MADRE #108
FRESNO, CA 93722
559-275-3795 FAX: 559-275-9006
LICENSE NO. C-16-577821

SURVEYED:	DATE: *10-18-05*
DRAWN: *KDT*	DRAWING NO.:
CONTRACT:	FP-6 of 7



CALCULATION DESIGN INFORMATION

REMOTE AREA NAME	WATER CURTAIN
HAZARD	LIGHT
DENSITY	.10 GPM / SQ. FT.
% AREA REDUCTION	40% BASED OF 100 CEILINGS
AREA OF OPERATION	1500 / 3 SQ. FT.
AREA PER HEAD	148.17 SQ. FT. MAX
HOSE ALLOWANCE: INSIDE 0	OUTSIDE 100

SYSTEM DEMAND

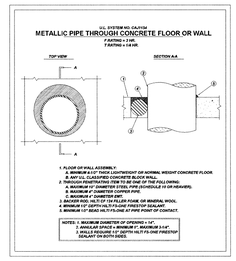
PSI REQUIRED	58.3
GPM REQUIRED	249.8
PSI AVAILABLE	77.7
SAFETY MARGIN	25.0 %
SYSTEM:	WET

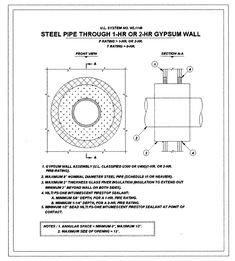
CALCULATION DESIGN INFORMATION

REMOTE AREA NAME	REMOTE LAB CALC.
HAZARD	ORD.
DENSITY	.15 GPM / SQ. FT.
% AREA REDUCTION	40% BASED OF 100 CEILINGS
AREA OF OPERATION	1848.9 SQ. FT.
AREA PER HEAD	130 SQ. FT. MAX.
HOSE ALLOWANCE: INSIDE 0	OUTSIDE 250

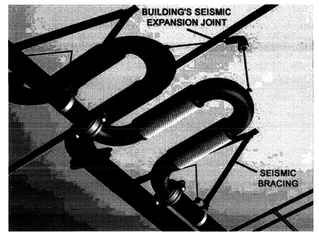
SYSTEM DEMAND

PSI REQUIRED	67.2
GPM REQUIRED	210.9
PSI AVAILABLE	77.6
SAFETY MARGIN	13.4 %
SYSTEM:	WET





FIRE STOPPING PENETRATION DETAILS



EXPANSION JOINT DETAIL

FIRE SPRINKLER PLAN
THIRD FLOOR - EAST

SCALE: 1/8" = 1'-0

NOTES:
1. SEE FP-1 FOR RISER DETAIL AND CONTINUATION OF UG.
2.SEE FP-1 FOR HANGER AND EQB DETAILS.

AS BUILT DRWG.

IDENTIFICATION STAMP
CALIFORNIA STATE FIRE MARSHAL
NO: 19-45-03-0001
RECEIVED BY:
DATE:

1 ALL MANUAL WET STANDPIPES AND DEVICES WERE OMITTED

HANGER LEGEND	HANGER LEGEND
#1 EXPANSION SHELL, ROD AND RING	#9 ALL THREAD ROD AND RING
#2 C-CLAMP, ROD AND RING	#10 U-HOOK
#3 POWDER DRIVEN STUD, ROD AND RING	#10A WRAP AROUND U-HOOK
#4 ANGLE CLIP ROD AND RING	#11 PIPE STRAP (SHORT)
#5 L-ROD AND RING	#12 PIPE STRAP (LONG)
#6 EYE ROD AND RING	#13 HILTI KWIK BOLT, ROD, RING
#7 COACH SCREW ROD AND RING	#14 RISER CLAMP (LONG EAR)
#8 CEILING FLANGE, ROD AND RING	#15 PIPE STAND

STANDARD SYMBOLS	STANDARD SYMBOLS
POST INDICATOR VALVE	ALARM CHECK VALVE
KEY VALVE	RISER W/ ALARM CHECK VALVE
FIRE HYDRANT	RISER W/ DELUGE VALVE
FIRE DEPARTMENT CONNECTION	RISER W/ DRY PIPE VALVE
OSY GATE VALVE	RISER W/ ELECT FLOW SWITCH
SWING CHECK VALVE	WATER MOTOR ALARM GONG
NEW UNDERGROUND	ELECTRIC ALARM BELL
EXISTING UNDERGROUND	FLUSH FIRE DEPT CONNECTION

SPRINKLER HEAD LEGEND :	SYMBOL	ORIFICE	K-FACTOR	HEAD FINISH	PLATE FINISH	TEMP.	QUAN.
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625	○	*1|2"*	*5.6*	*BRASS*	*N/A*	*155°*	*46*
RELIABLE MODEL F1FR UPRIGHT ON 1" SPRIG / SIN # 3625	◎	*1|2"*	*5.6*	*BRASS*	*N/A*	*200°*	*7*
RELIABLE MODEL G4A CONCEALED PENDENT SIN # 5415	●	*1|2"*	*5.6*	*BRASS*	*WHITE*	*155°*	*165*
TYCO MODEL WS VERTICAL PENDENT SIN # TY3488	⊛	*1|2"*	*5.6*	*BRASS*	*N/A*	*155°*	*30*

APPROVALS BY:

TOTAL SPRINKLERS = *248*
HEAD COUNTS REFLECT ENTIRE FLOOR

MK	DATE	BY	COORD.	REVISIONS - LOCATE BY GRID COORDINATES
				FOR APPROVAL - 10-18-05
1				REVISED 12-12-05 CALIFORNIA STATE FIRE MARSHAL
2				AS-BUILT CONDITIONS 2-3-07

FIELD INSPECTED BY:
1.
2.
3.
4.
WATER DEPT:
ADDRESS:
CITY:
PHONE:

CONTRACT WITH:
ADDRESS:
CITY:
PHONE:
ARCHITECT:
ADDRESS:
CITY:
PHONE:

LICENSED FIRE PROTECTION CONTRACTOR - COSCO FIRE PROTECTION INC. - CLASSIFICATION C-16 LICENSE NO. 577921 - FRESNO - STATE OF CALIFORNIA

SCALE: 1/8" = 1'-0

PROJECT: *ENGINEERING IV BUILDING*
ADDRESS: *CALIFORNIA POLYTECHNIC STATE UNIVERSITY*
CITY: *SAN LUIS OBISPO, CALIFORNIA*
TITLE:

COSCO FIRE PROTECTION INC.
4233 W. SIERRA MADRE #108
FRESNO, CA 93722
559-275-3795 FAX: 559-275-8006
LICENSE NO. C-16-577921

SURVEYED:
DATE: *10-18-05*
DRAWN: *KDT*
DRAWING NO.
CONTRACT:
FP-7 of 7

Reliable®

Model F1FR Series Quick Response Glass Bulb Sprinklers

Bulletin 014 Rev. P

Model F1FR56 Sprinkler Types

Standard Spray Upright
Standard Spray Pendent
Conventional Upright/Pendent
Vertical Sidewall
Horizontal Sidewall

Model F1FR56 Recessed Sprinkler Types

Standard Spray Pendent
Horizontal Sidewall

Model F1FR56 Concealed Sprinkler Types

Standard Spray Pendent

Model F1FR42, F1FRXLH & F1FR28 Sprinkler Types

Standard Spray Upright
Standard Spray Pendent

Model F1FR40 Sprinkler Types

Standard Spray Pendent

Model F1FR42, F1FR40, F1FRXLH & F1FR28 Recessed Sprinkler Types

Standard Spray Pendent

Model F1FR56LL & F1FR42LL Low Lead Sprinkler Types

Standard Spray Pendent with less than 0.25% Lead Content

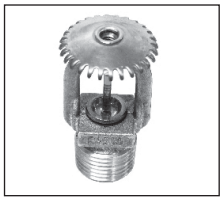
Listing & Approvals

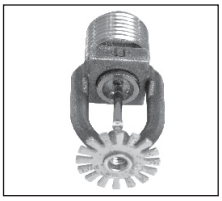
The following organizations provide Listings or Approvals for various Model F1FR series sprinklers. See the Design and Installation table in this Bulletin for information on specific listings and approvals applicable to each sprinkler.

1. Underwriters Laboratories Inc. and Certified for Canada (cULus) in accordance with ANSI/UL199.
2. FM Approvals (FM)
3. Loss Prevention Certification Board (LPCB)
4. VdS Schadenverhütung GmbH (VdS)
5. Underwriters Laboratories Inc. and Underwriters Laboratories of Canada Certified for Health Effects to NSF/ANSI Standard 61 Annex G (ULH)
6. EC Certificate: 0786-CPD-40239 (RA1414), 0786-CPD-40251 (RA1425), 0786-CPD-40252 (RA1475) (EC)

UL Listing Category

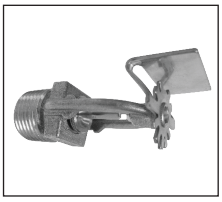
Sprinklers, Automatic & Open (VNIV)
Quick Response Sprinkler


Upright

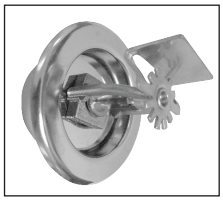

Pendent


Conventional

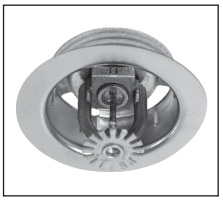

Vertical Sidewall

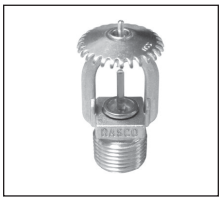

Horizontal Sidewall


Recessed Pendent/F1/F2


Recessed Horizontal Sidewall


Concealed Pendent

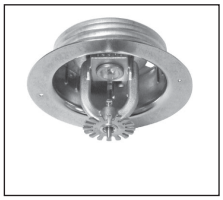

Recessed Pendent/FP


XLH Upright


XLH Pendent


XLH Recessed Pendent F1/F2

Product Description


XLH Recessed Pendent FP

Reliable Model F1FR series sprinklers are quick-response automatic sprinklers with a glass bulb thermal element. Model F1FR series sprinklers are Standard Spray sprinklers, with the exception of the Model F1FR56 Conventional sprinkler which is an Old-style/Conventional sprinkler.

The Model F1FR Series automatic sprinklers utilize a 3.0 mm frangible glass bulb. These sprinklers have demonstrated response times in laboratory tests which are five to ten times faster than standard response sprinklers. This quick response enables the Model F1FR Series sprinklers to apply water to a fire faster than standard-response sprinklers of the same temperature rating.

The glass bulb consists of an accurately controlled amount of special fluid hermetically sealed inside a precisely manufactured glass capsule. This glass bulb is specially constructed to provide fast thermal response.

WFDTH
Waterflow Detector

The System Sensor WFDTH Retard T-Tap Waterflow Detector is designed for primary signaling in residential systems and fits within 2×4 stud wall construction.

Features

- Residential sprinkler systems
- Sealed retard mechanism
- Visual switch activation
- Rugged, dual SPDT switches enclosed in a durable terminal block
- Easy to install and maintain design
- Vertical or horizontal mount
- Field replaceable retard mechanism and switch assembly
- Twelve different flexible paddles
- Durable, tamper resistant enclosure
- Two conduit openings
- Handy depth gauge
- Accommodates up to 12 AWG wire
- 100% synchronization fires alarm panel and local bell simultaneously

The WFDTH fits any tee that has a 1˝ NPT branch, including: 1˝, 1¼˝, 1½˝, and 2˝ NPT threaded ferrous and brass tees; 1˝, 1¼˝, 1½˝ and 2˝ copper sweat tees; Central, Spears®, and Victaulic® brand 1˝ CPVC tees; and 1½˝ polybutylene tees.

Design. The design of the WFDTH makes it easy to install and simple to maintain. It can be mounted in the vertical or horizontal position. Two conduit openings permit easy attachment to the local alarm system. The retard mechanism and switch assembly are field-replaceable.

Features. Twelve different flexible paddles fit 1˝, 1¼˝, 1½˝, and 2˝ tees. Sizes are marked clearly on the paddle for ease of installation. Plastic paddles slip over the actuating lever and are securely fastened with one screw. The handy depth gauge insures the proper installation depth and clearance of the detector to the tee.

Construction. The WFDTH includes a durable and tamper resistant enclosure. Its sealed retard assures that the delay mechanism is not contaminated by dust and dirt when the cover is removed. The long lasting cover completely encloses the electrical components to further keep out dust and dirt. Improved self-guiding security screws and removal tools make detectors resistant to tampering and simplify field maintenance.

Agency Listings

UL LISTED	ULC	VdS	MEA approved	FM APPROVED
S739	CS169	7770-1653:114	167-93-E	3033305

WFDTH Specifications

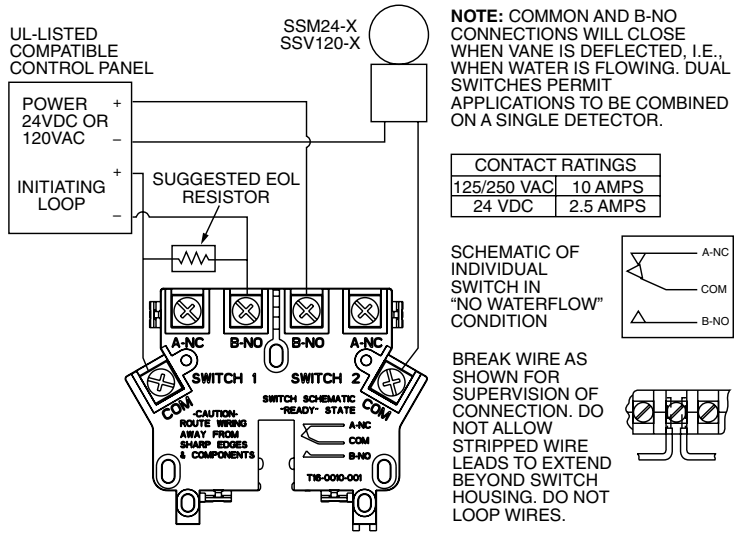
Architectural/Engineering Specifications

Model shall be a WFDTH as manufactured by System Sensor. T-tap waterflow detectors shall be installed on a tee that has a 1˝ NPT branch including: 1˝, 1¼˝, 1½˝, or 2˝ threaded ferrous or brass tee; 1–2˝ copper sweat tees; Central, Spears®, and Victaulic® brand 1˝ CPVC tees; or 1½˝ polybutylene tee as designated on the drawings and/or as specified herein. Detectors shall mount on any clear pipe span of the appropriate size, either a vertical or horizontal run at least 6˝ from any fittings or valves which may change water direction, flow rate, or pipe diameter or no closer than 24˝ from a valve or drain. Detectors shall have a sensitivity in the range of 4 to 10 gallons per minute and a static pressure rating of 250 psi. The retard t-tap detector shall be a sealed mechanical pneumatic unit with visual indication of actuation. The actuation mechanism shall include a polyethylene vane inserted through the tee fitting and connected by a mechanical linkage to the delay mechanism. Outputs shall consist of dual SPDT switches (Form C contacts). Two conduit entrances (one of which is a knockout type) for standard fittings of commonly used electrical conduit shall be provided on the detectors. A grounding provision is provided. WFDTH is listed by Underwriters Laboratories for indoor use.

Physical/Operating Specifications

Static Pressure Rating	250 PSI (max.)	**Operating Temperature Range**	32°F to 120°F (0°C to 49°C)
Maximum Surge	18 FPS	**Enclosure Rating**	UL listed for indoor use
Triggering Threshold Bandwidth (Flow Rate)	4–10 GPM	**Cover Tamper Switch**	Canadian models only, factory installed
Overall Dimensions, Installed	4.5˝ H × 3.55˝ W × 6.7˝ L (11.4cm H × 9cm W × 17cm L)	**Service Use**	Automatic Sprinkler: NFPA 13 One or Two Family Dwelling: NFPA 13D Residential Occupancies up to 4 Stories: NFPA 13R National Fire Alarm Code: NFPA 72
Contact Ratings	Two sets of SPDT (Form C) 10.0 A @ 125/250 VAC 2.5 A @ 24 VDC	**Shipping Weight**	2.6 lbs. (1.2 kg.)
Compatible Tee Fittings	Threaded ferrous and brass tees, copper sweat tees, CPVC tees, and polybutylene tees	**Warranty**	3 years
Conduit Entrances	Two openings for ½˝ conduit.	**U.S. Patent Numbers**	3,845,259; 4,782,333; 5,213,205

Electrical Connections



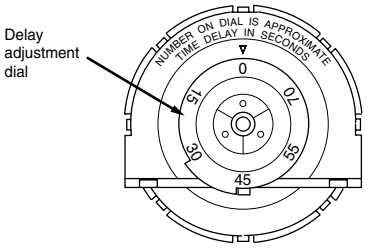
NOTE: COMMON AND B-NO CONNECTIONS WILL CLOSE WHEN VANE IS DEFLECTED, I.E., WHEN WATER IS FLOWING. DUAL SWITCHES PERMIT APPLICATIONS TO BE COMBINED ON A SINGLE DETECTOR.

CONTACT RATINGS	
125/250 VAC	10 AMPS
24 VDC	2.5 AMPS

SCHEMATIC OF INDIVIDUAL SWITCH IN "NO WATERFLOW" CONDITION

BREAK WIRE AS SHOWN FOR SUPERVISION OF CONNECTION. DO NOT ALLOW STRIPPED WIRE LEADS TO EXTEND BEYOND SWITCH HOUSING. DO NOT LOOP WIRES.

Delay Adjustment Dial



NOTE: Retard time may exceed 90 seconds.
Adjust and verify that time does not exceed 90 seconds.

Ordering Information

UL Model No.	ULC/Canadian Model No.	Description
WFDTH	WFDTHA	Waterflow Detector, Fits 1˝, 1¼˝, 1½˝, 2˝ ferrous and brass threaded tees; 1˝, 1¼˝, 1½˝, 2˝ copper sweat tees; 1˝ CPVC tees; and 1½˝ polybutylene tees

Accessories

A77-01-02	Replacement terminal block for WFDTH	S07-66002	Replacement tamper screws for covers of WFDTH
PRK9	Replacement paddle kit – 12 paddles for WFDTH (see WFDTH for sizes included)	WFDW	Replacement tamper proof wrench for cover of WFDTH
A3008-00	Replacement retard mechanism	C58-0009-000	Replacement metal cover

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

A05-0941-008 • 7/10 • #2451

OSY2
Supervisory Switch

The System Sensor OSY2 is used to monitor the open position of an Outside Screw and Yoke (OS&Y) type gate valve.

Features

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

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

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

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

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

Agency Listings

S739 CS169 OW6A8.AY 167–93–E 7770-1653:118

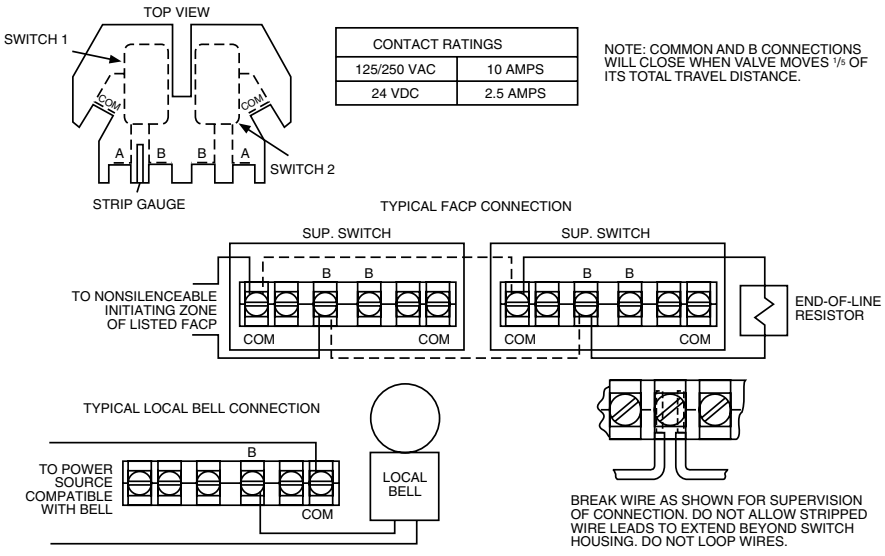
OSY2 Specifications

Architectural/Engineering Specifications

Model shall be model number OSY2 supervisory switch as manufactured by System Sensor. OSY2 shall be installed on each valve as designated on the drawings and/or as specified herein. Switches shall be mounted so as not to interfere with the normal operation of the valve and shall be adjusted to operate within two revolutions of the valve control or when the stem has moved no more than one-fifth of the distance from its normal position. The mechanism shall be contained in a weatherproof die cast metal housing that provides a side entrance for ½˝ conduit and incorporates the necessary facilities for attachment to the valve. A grounding provision is provided. The switch assembly shall include two switches each with a rated capacity of 10 Amp @ 125/250VAC and 2.5 Amp @ 24VDC. The cover shall contain tamper-resistant screws for which a security wrench will be provided with each switch. The OSY2 shall be Underwriters Laboratories listed for indoor or outdoor use. The OSY2 shall be Factory Mutual, CSFM, and MEA approved.

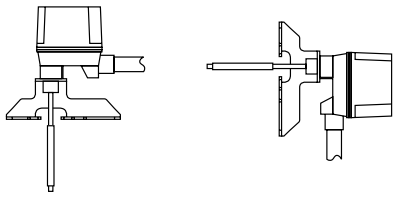
Physical Specifications		Operating Specifications	
Overall Switch Dimensions	5¾˝H x 3½˝W x 3¼˝D (14.6cm x 8.9cm x 8.2cm)	**Contact Ratings**	Two sets of SPDT (Form C) 10.0 A @ 125/250VAC; 2.5 @ 6/12/24VDC
Shipping Weight	2.8 lbs. (1.3 kg)	**Enclosure Rating**	UL indoor/outdoor NEMA 3R when mounted with the actuator vertical
Operating Temperature Range	32°F to 120°F (0°C to 49°C) NOTE: The OSY2 will operate from –40°F to 120°F (–40°C to 49°C); however UL does not test control valve supervisory switches below 32°F (0°C).	**Cover Tamper Switch**	Standard with ULC model Optional for UL model, part no. 546-7000
Maximum Stem Extension	2⅝˝ (6.7cm)	**Service Use**	Automatic Sprinkler: NFPA 13 One or Two Family Dwelling: NFPA 13D Residential Occupancies up to 4 stories: NFPA 13R National Fire Alarm code: NFPA 72
Bracket Span	¼˝H x 6¾˝W x 1˝D (5.7cm x 17.1cm x 2.5cm)	**Warranty**	3 years
Conduit Entrances	One single side open for ½˝ conduit	**U.S. Patent Nos.**	5,478,038; 5,213,205

Electrical Connections for OSY2



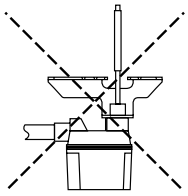
OSY2 Mounting

The following are examples of acceptable mounting positions:



Actuator Vertical (Down) Actuator Horizontal

The following mounting position is <u>not acceptable:</u>



Actuator Vertical (Pointing Up)

Ordering Information

Part No.	Description
OSY2	Outside Screw and Yoke valve supervisory switch
OSY2A	Outside Screw and Yoke valve supervisory switch (ULC model)

Accessories

OSYRK	Replacement hardware kit (wrenches, screw pack and J–hooks)	WFDW	Replacement tamper-proof wrench for cover
546-7000	Cover tamper switch kit	HEXW	Replacement hex wrench
S07-66-XX	Tamper screws for cover		

SYSTEM SENSOR®

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

A05-0196-010 • 1/09 • #1960

Motor bells

10" BELL

6" BELL

RSSP REMOTE PLATE

Description

The Wheelock MB motor bells provide a specifically designed motor bell for fire and life safety alarm systems. The Wheelock MB bells include higher dBA, low current draw, built-in trimplate for semi-flush mounting, low frequency aluminum shells, and low RFI noise. The motor for MB bells is a durable, high-torque permanent magnet motor selected for its high performance and long life.

These DC vibrating MB motor bells are offered in 6" and 10" shell sizes in both 12 and 24 VDC models.

The RSSP Sync/Non-Sync retrofit plates are used in conjunction with the MB motor bell when combination appliances are required. The RSSP retrofit plates are available with either multi-candela or single candela strobes and easily mount to a 4" square or Wheelock SBL-2 backbox. All RSSP strobe appliances meet or exceed the requirements of NFPA 72 (National Fire Alarm Code), ANSI 117.1 (American National Standard for Accessible and Usable Buildings and Facilities), ADA (Americans with Disabilities Act) and UL Standard 1971 (Signaling Devices for the Hearing Impaired).

The RSSP retrofit plates may be synchronized when installed with the Wheelock Series DSM, Sync Modules or Wheelock Power Supplies with Wheelock patented sync protocol. Wheelock synchronized strobes offer an easy way to comply with ADA requirements concerning photo-sensitive epilepsy.

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Features & benefits

- Meets OSHA 29 Part 1910.165
- High sound output with low current draw
- Low frequency aluminum shells for better audibility through walls, doors and other structures
- 6" and 10" shell sizes in 12 or 24 VDC models
- Integral RFI suppression to minimize included noise on the NAC circuit
- Mounting options for surface, semi-flush, outdoor, and concealed conduit installation
- Built-in trimplate makes semi-flush mounting simpler and less expensive
- Screw terminals permit fast in-out field wiring of #12 to #18 AWG wire
- Polarized for DC supervision of NAC circuits
- Operates on filtered or unfiltered DC
- For combined audible (bell) and visual signaling, convenient retrofit plate assemblies are available with Multi-Candela or Single candela strobes (Refer to Fire Alarm Products Catalog for Series RSSP Sync/Non-Sync Strobes specifications and technical information)

Note: All CAUTIONS and WARNINGS are identified by the symbol ⚠. All warnings are printed in bold capital letters.

⚠ WARNING

PLEASE READ THESE SPECIFICATIONS AND ASSOCIATED INSTALLATION INSTRUCTIONS CAREFULLY BEFORE USING, SPECIFYING OR APPLYING THIS PRODUCT. FAILURE TO COMPLY WITH ANY OF THESE INSTRUCTIONS, CAUTIONS OR WARNINGS COULD RESULT IN IMPROPER APPLICATION, INSTALLATION AND/OR OPERATION OF THESE PRODUCTS IN AN EMERGENCY SITUATION, WHICH COULD RESULT IN PROPERTY DAMAGE, AND SERIOUS INJURY OR DEATH TO YOU AND/OR OTHERS.

Approvals & compliances

- Approvals include: UL Standard 464, Factory Mutual (FM), California State Fire Marshal (CSFM), New York (MEA) and Chicago (BFP)
- Meets OSHA 29 Part 1910.165

Drawings

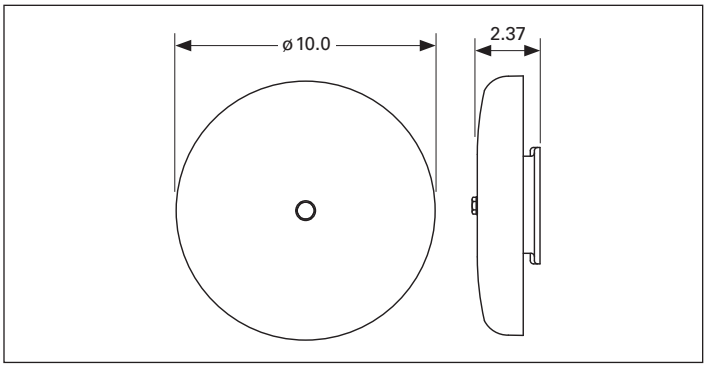

Figure 1. MB-G10 front and side views

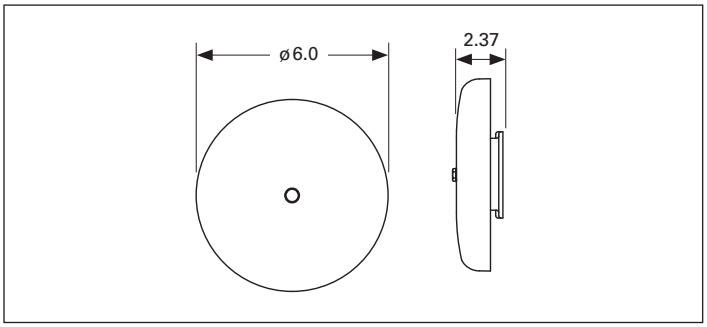

Figure 2. MB-G6 front and side views

Table 1. Specifications and ordering information: MB models

Model Number	Order Code	Shell Size	Input Voltage (VDC)	Average RMS Current	UL Max ①	dBA @ 10 ft.	Mounting Options
MB-G6-12-R	3942	6"	12	0.060	0.090	92	D, E, J, K, N, O, P, R, S
MB-G6-12-S	4221	6"	12	0.060	0.090		
MB-G6-24-R	3941	6"	24	0.030	0.040		
MB-G6-24-S	4222	6"	24	0.030	0.040		
MB-G10-12-R	3944	10"	12	0.060	0.090		
MB-G10-12-S	4223	10"	12	0.060	0.090		
MB-G10-24-R	3943	10"	24	0.030	0.040		
MB-G10-24-S	4224	10"	24	0.030	0.040		

① RMS current ratings are per UL average RMS method. UL max current rating is the maximum RMS current within the listed voltage range (16-33v for 24v units). For strobes the UL max current is usually at the minimum listed voltage (16v for 24v units). For audibles the max current is usually at the maximum listed voltage (33v for 24v units). For unfiltered FWR ratings, see installation instructions.

Notes: 1. Typical dBA at 10 feet is measured in an anechoic chamber.

Notes: 2. For bells all 12 VDC models are UL rated for 9.0 to 15.6 VDC and all 24 VDC models for 18.0 to 31.0 VDC.

Table 2. Specifications and ordering information: RSSP models

Model Number	Order Code	Nominal Voltage (VDC)	Strobe Candela	Average Current (AMPS) at Listed VDC	UL Max ①	Mounting Options ②
RSSP-24MCW-FR	9402	24	15/30/75/110	0.041/0.063/0.109/0.140	0.060/0.092/0.165/0.220	D, E, Z
RSSP-241575W-FR	7793	24	15 (75 on-axis)	0.060	0.090	D, E, Z
RSSP-121575W-FR	7798	12	15 (75 on-axis)	0.152	0.255	D, E, Z

① RMS current ratings are per UL average RMS method. UL max current rating is the maximum RMS current within the listed voltage range (16-33v for 24v units). For strobes the UL max current is usually at the minimum listed voltage (16v for 24v units). For audibles the max current is usually at the maximum listed voltage (33v for 24v units). For unfiltered FWR ratings, see installation instructions.

② Refer to data sheet TD450028EN for mounting options.

Wheelock products must be used within their published specifications and must be PROPERLY specified, applied, installed, operated, maintained and operationally tested in accordance with their installation instructions at the time of installation and at least twice a year or more often and in accordance with local, state and federal codes, regulations and laws. Specification, application, installation, operation, maintenance and testing must be performed by qualified personnel for proper operation in accordance with all of the latest National Fire Protection Association (NFPA), Underwriters' Laboratories (UL), National Electrical Code (NEC), Occupational Safety and Health Administration (OSHA), local, state, county, province, district, federal and other applicable building and fire standards, guidelines, regulations, laws and codes including, but not limited to, all appendices and amendments and the requirements of the local authority having jurisdiction (AHJ).

Architects and engineers specifications

The alarm appliances shall be Wheelock MB vibrating motor bells or approved equal. They shall be UL Standard 464 Listed for Fire Protective Service. Shells shall be aluminum in 6" or 10" diameter. Sound output at 10 feet shall be 92 dBA. The bells shall incorporate a permanent magnet motor and suppression circuitry to minimize RFI. They shall include a built-in trimplate for semi-flush mounting to a standard 4" square backbox or surface mounting to Wheelock's indoor BB backbox or outdoor WBB backbox.

For bell strobe applications, retrofit plates Wheelock RSSP with multi-candela or single candela strobes shall be used. All bell models shall be polarized for line supervision and shall have screw terminals for in/out field wiring of #12 to #18 AWG wire. Operating voltage shall be nominal 24 VDC or 12 VDC. Finish on all models shall be textured enamel.

Note: Due to continuous development of our products, specifications and offerings are subject to change without notice in accordance with Cooper Wheelock, Inc., dba Eaton, standard terms and conditions.

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Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Eaton
Life safety & mass notification solutions
273 Branchport Ave.
Long Branch, NJ 07740
www.eaton.com/massnotification

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Appendix H

CONTRACT NAME Engineering IV SHEET 1 OF 1

	NOZZLE IDENT. AND LOCATION	FLOW IN GPM	PIPE SIZE	PIPE FITTINGS AND DEVICES	EQUIV. PIPE LENGTH	FRICTION LOSS PSI/FT	PRESSURE SUMMARY	NORMAL PRESSURE	NOTES
1	BL-1 1	q Q 19.5	1¼		L 10.0 F T 10.0	C=100 0.046	Pt 12.6 Pe Pf 0.458	Pt Pv Pn	Q = 130 × 0.15 = 19.5 (12.6) P = (19.5/5.6)² = 12.1 10" Drop K=5.5
2	2	q 20.3 Q 39.8	1¼		L 10.0 F T 10.0	0.171	Pt 13.1 Pe Pf 1.71	Pt Pv Pn	q = 5.6 × √13.1
3	3	q 21.5 Q 61.3	1¼		L 10.0 F T 10.0	0.38	Pt 14.8 Pe Pf 3.8	Pt Pv Pn	q = 5.6 × √14.8
4	4	q 24.2 Q 85.5	1¼		L 10 F T 10	0.7	Pt 18.6 Pe Pf 7	Pt Pv Pn	q = 5.6 × √18.6
5	UP RN 5	q 28.3 Q 119	1¼	2T	L 13.75 F 6+1.3 T 24	18.8 1.2	Pt 25.6 Pe 0.97 Pf 39 40.8 42	Pt Pv Pn	q = 5.6 × √25.6 Pe = 2.25 × 0.433 = 0.97
6	CM TO BL-2	q Q 114	4	1E 4T BV	L 13 F T 13	32.55 .005	Pt 37.6 → Pt 65.6 Pe Pf 0.065	Pt Pv Pn	K = 114/√65.6 = 14
7	BL-2 TO CM TO BOR	q 113 Q 227	4		L 432 F 265 T 697	0.018	Pt 65.7 Pe 12.1 Pf 12.5	Pt Pv Pn	q = 14 √65.7 Pe = 28' × .433 = 12.1
	BOR TO POC	q Q (227)		5E 2(45) 2 Check	L 350 F 285 T 635	0.001	Pt 90.3 Pe 1.7 Pf 0.69	Pt Pv Pn	Pe = 4' × .433 = 1.87
		q Q			L F T		Pt (92.7) Pe Pf	Pt Pv Pn	
		q Q			L F T		Pt Pe Pf	Pt Pv Pn	
		q Q			L F T		Pt Pe Pf	Pt Pv Pn	
							Pt		

American Fire Sprinkler Association
12750 Merit Drive, Suite 350, Dallas, Texas 75251
Tele: 214.349.5965
Fax: 214.343.8898
www.firesprinkler.org