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Fire and Life Safety Evaluation of the Christopher Cohan Center

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Statement of Disclaimer

This project is an academic exercise, as part of the MS Fire Protection Engineering program of California Polytechnic State University. The project is a culminating report with regards to life safety analysis of the Christopher Cohan Center of Cal Poly, which builds on the fundamental courses of the program.

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Keywords:

- Life Safety Code
- Egress Analysis
- Performance Based Analysis
- Egress Modeling
- Fire Modeling

Christopher Cohan Center

FPE 596 Culminating Project

EXECUTIVE SUMMARY

This project is an academic exercise, as part of the MS Fire Protection Engineering program of California Polytechnic State University. The project is a culminating report with regards to life safety analysis of the Christopher Cohan Center of Cal Poly, which builds on the fundamental and applied courses of the program.

The analysis is twofold, where the first part is a Prescriptive Analysis of the building and its features, followed by a Performance Based Life Safety Analysis. Both parts are performed in accordance with NFPA 101 Life Safety Code 2015 edition, Codes/Standards references within NFPA 101, and supplemented by methods of the SFPE Handbook of Fire Protection Engineering. California have yet to adopt the Life Safety Code, which per definition, makes it impossible to determine if the building is a new or existing structure. Nevertheless, the building has been analyzed as an existing building. Where noted, necessary assumptions were made to complete the analysis.

The building in question is part of the Performing Arts Center of Cal Poly, and consists of assembly-, business-, and storage occupancies. Two adjacent buildings make up the remaining parts of the Performing Arts Center, but these buildings will not be analyzed in this report. The Cohan Center is separated from adjecent buildings by 4-hour rated walls, and/or separation distances of 60 ft.

The prescriptive analysis concludes that the building in general meets the requirements of the applicable codes and standards, with the following exceptions: a place of assembly at the Balcony Level have no other means of egress than through the communicating space, the spacing of smoke detectors does not meet prescriptive requirements in the Entry Lobby, and the water supply for the sprinkler system is insufficient. All conclusions are based on the information available. The recommended actions are to perform a new waterflow test, and based on the result, consider installing a fire pump to provide sufficient flow and pressure to the most remote area of the sprinkler system.

The performance based analysis addressed life safety in the event of fire in scenery on stage. The fire was modeled at floor level, and in the fly-gallery. Based on building inspections, the author considers ignition more likely in the fly-gallery, than at the stage floor. The main focus of this model was to evaluate consequences of smoke spread, if the proscenium wall curtain fails to deploy. The analysis concluded that the fly-gallery fire meets the performance criteria, and results in an acceptable level of life safety. The scenery fire at the stage floor fails to meet the performance criteria of the Life Safety Code, with the current building design and feature. Further analysis concludes that installing addressable smoke detectors at the stage ceiling, that activates all smoke vents and sends an alarm signal to the fire alarm control panel, resulted in meeting the performance criteria regardless of the modeled fire location.

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1 PROJECT SCOPE

The following Fire and Life Safety Analysis is performed for completion of the FPE S596 Culminating Experience in Fire Protection Engineering course at California Polytechnics State University.

The analysis is twofold, where the first part is a Prescriptive Analysis of the building and its protection features, followed by a Performance Based Life Safety Analysis. The prescriptive analysis includes structural fire protection, egress analysis, fire suppression systems, fire detection and notification system, fire safety management, and smoke management. The performance based analysis is performed in accordance with NFPA 101 Life Safety Code, supplemented by methods of SFPE Handbook of Fire Protection Engineering 5th edition.

A summary of the prescriptive and performance based analysis, their findings, and the authors recommendations, will conclude this report.

1.1 Life Safety Code Goals and Objectives

1.1.1 Life Safety Goals

The Life Safety Code's main objective is to provide building occupants with an acceptable level of safety from fire. This objective involves protecting occupants that are not intimate with ignition or the first item ignited during the initial fire event. Another goal of the Life Safety Code is to improve the survivability of occupants who are intimate with the initial fire development.

For the Performing Arts Center of Cal Poly, all occupants of a space are not necessarily considered intimate with ignition. For instance, occupants of the theatre need to be protected in the event of a fire in the theater, or other emergencies that might be mitigated using methods comparable to those in a fire.

1.1.2 Life Safety Objectives

1.1.2.1 *Occupant protection*

The building design, construction and maintenance shall be such that occupants have sufficient time to evacuate, in the event of a fire.

1.1.2.2 *Structural integrity*

A structure shall be designed, constructed, and maintained to protect occupants who are not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place.

1.1.2.3 *Fire Protection Systems Effectiveness*

Systems utilized to achieve the project goals shall be effective in mitigating the hazard or condition. They shall be reliable, maintained to the level at which they were designed to operate, and shall remain operational.

1.2 Underlying building documents

The following documents lay the basis for information regarding the structure, and how it is managed:

- Original Construction document (1993)
- For Automatic suppression:
  - Wet-pipe sprinkler system layout
  - Pre-action system layout
  - Fire Pump Removal Memo
- For the Fire Alarm System:
  - Device location layout
  - Riser diagrams
- PAC User Guide and Technical References
- Seating Capacity guide for event planning
- PAC Policies and Procedures

1.3 Applicable Codes and Standards

The following Codes and Standards are applied and/or referenced in the prescriptive analysis of this report.

- NFPA 101 Life Safety Code
- NFPA 13 Standard for Installation of Sprinkler Systems
- NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-based Fire Protection Systems
- NFPA 20 Standard for the Installation of Stationary Pumps for Fire Protection
- NFPA 72 National Fire Alarm and Signaling Code
- NFPA 70 National Electrical Code
- NFPA 5000 Building Construction and Safety Code
- NFPA 92 Standard for Smoke Control Systems
- NFPA 701 Standard Methods for Fire Tests for Flame Propagation of Textiles and Films
- NFPA 160 Standard for the Use of Flame Effects Before and Audience
- NFPA 1126 Standard for Use of Pyrotechnics Before a Proximate Audience
- NFPA 289 Standard Method of Fire Test for Individual Fuel Packages

2 BUILDING DESCRIPTION

The Performing Arts Center of Cal Poly was constructed in 1993 using the following Codes with regards to fire protection:

- California Building Code (1992)
- California Fire Code (1992)
- California Electric Code (1991)

The building consists of six floors, and is 100 feet tall from the lowest floor to the ceiling. However, it is not considered a high rise, as the elevation difference between the lowest level of fire department access and the highest occupied floor is less than 75 feet. Table 2-1 show the area of each of the six floors.

Table 2-1 - Floor and Area Overview

Floor	Area [ft^2]	Occupiable floor?
Trap room level	7 750	Yes
Stage Level	11 580	Yes
Entry Lobby Level	34 050	Yes
Balcony Level	20 620	Yes
Gallery Level	11 000	Yes
Catwalk Level	2600	Sporadically (staff only)

The PAC is located at 1 Grand Avenue, San Luis Obispo on Cal Poly campus. The building is accessible by vehicle at two locations, shown with green line and red marks in Figure 1. The yellow arrow indicates the main entrance.

Figure 1 - Building Location

2.1 VENUES

The building consists of several occupancies with three main venues: the Harman Hall, the Pavilion and Philips Hall. All venues are located at the stage floor, though the Harman Hall is open to a total of 5 floors. The Harman Hall and Pavilion are used for performances and shows, but the Philips Hall is a classroom/lecture hall.

Figure 2 shows the whole Performing Arts Center of Cal Poly. Note however that this analysis only covers the Cohan Center.

The adjecent buildings are the Spanos Theather and Cal Poly Music Department. The Spanos Theater is separated from Christopher Cohan Center by a 4 hour fire rated construction with no openings, according to the original construction plan. The Music Department has a 60 ft separation Christopher Cohan Center.

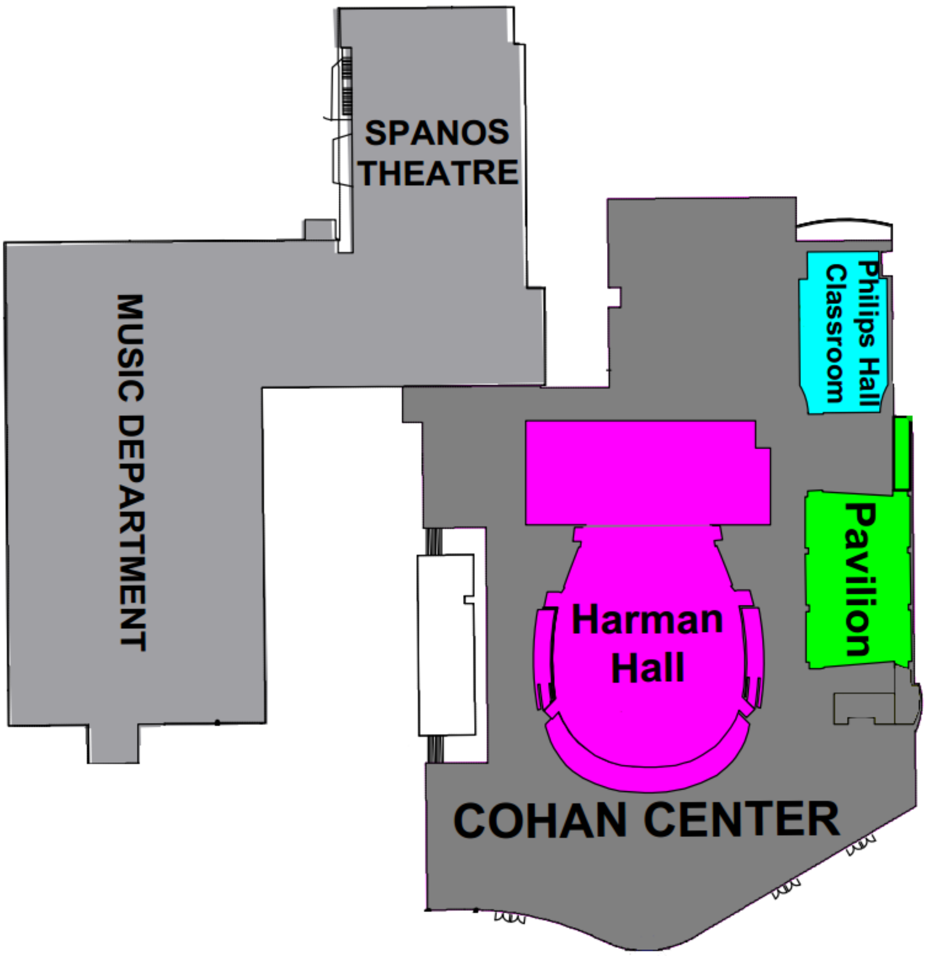

Figure 2 - Location of main venues of the Performing Arts Center

The seating capacity listed in the Performing Arts Center event planning document is given in Table 2-2. The listed seating capacity is excluding staff and performers on stage. Occupancy and egress is addressed in chapter 3.3.3.1.

Table 2-2 - Seating Capacity of the Cohan Center Venues

Venue	Seating capacity
Harman Hall	1285
Pavilion	220
Philips hall (classroom)	180

2.1.1 Multipurpose Pavilion

Figure 3 and Figure 4 shows the Multipurpose Pavilion when there is no seating set up. However, occasionally there will be tables and seating for up to 220 persons.

There are 4 exits from the Pavilion, two of which connects through a common exit access corridor.

Figure 3 - Multi Purpose Pavilion view I

Figure 4 - Multi Purpose Pavilion view II

2.1.2 Sydney Harman Hall

The Harman Hall has the highest occupant capacity of the building. The theater is a large open volume, reaching 5 stories high. Figure 5 shows the theater viewed from the stage, and Figure 6 shows the view from the balcony. The occupant load, and exit capacity varies for each floor, see chapter 3.3.3.

The proscenium wall has a 2-hour fire rating, and separates the backstage area from the theater. An automatically deploying fire curtain covers the proscenium wall opening, upon heat exposure to fusible links, or activation of a rate-of-rise heat detector.

Figure 5 - Harman Hall, View from the Stage

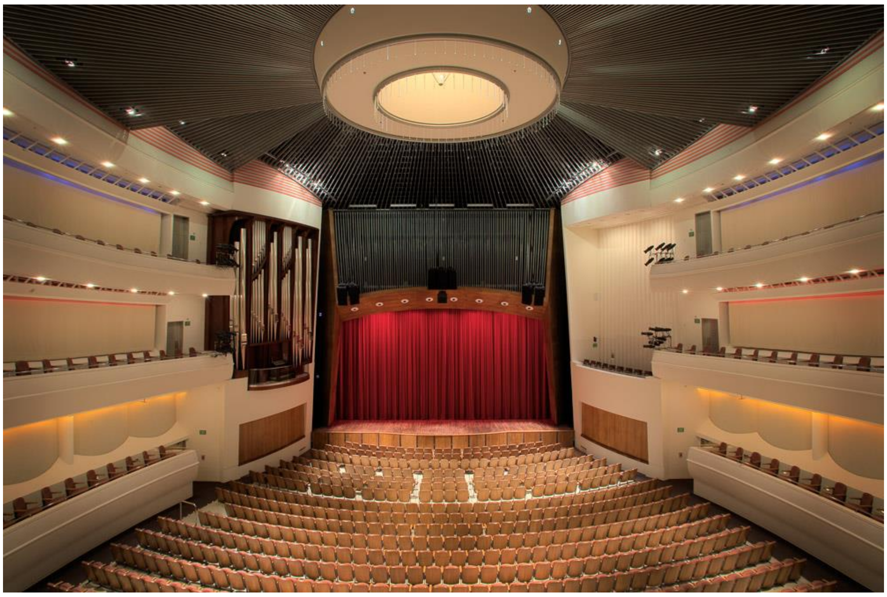

Figure 6 - Harman Hall, View from the Balcony

2.1.3 Communicating Space

The entry lobby is open to the lounge at the balcony level above, as well as down to the Foyer at the stage level. Figure 7 shows the communicating space, where the lowest level is the entry lobby. Figure 8 is taken from the entry lobby, and shows the exit access corridor outside the Harman Hall, at the stage level.

The Life Safety Code requirements for communicating spaces are analyzed in chapter 3.3.7.

Figure 7 - Communicating Space, seen from the Entry Lobby

Figure 8 - Communicating Space, Exit Access Corridor of the Stage Level

3 Prescriptive Analysis

3.1 Structural Fire protection

The Life Safety Code limits the allowable construction types based on the number of stories in height, as defined in the code.

3.1.1 Stories in Height

Stories in height is defined as all stories counting from the lowest level of exit discharge, to the highest occupiable level containing the occupancy considered. Even though the main entrance is usually considered the main means of egress, per definition of the LSC, the stage level is the level of exit discharge. The stage level is considered the level of exit discharge, because it is the lowest level with sufficient means of egress and egress capacity directly to the outside.

The total number of stories for assembly is four, and the total number of stories in total is five, see Table 3-1. Note that the lower level is subject to occupancy, but as it is lower than the level of exit discharge, per LSC 4.6.3, it is not defined as a story.

Table 3-1 - Stories in Height

Floor description	Occupancy	Count as a story?
Catwalk Level	(Sporadically occupied by staff)	Yes
Gallery Level	Assembly	Yes
Balcony Level	Assembly	Yes
Entry Lobby Level	Assembly	Yes
Stage Level (exit discharge level)	Assembly	Yes
Lower Level	Assembly/Storage	No

3.1.2 Construction Type Limitations

The PAC is fully covered with automatic suppression systems, as analyzed in chapter 3.6. Therefore, per Table 13.1.6 of the LSC, with five stories in height, the construction limitations allowed for the building is type I (442), I (332) or II (222).

The allowable construction types can be characterized as follows:

- Type I (442): Concrete structure with structural members rated between two to four hours
- Type I (332): Concrete structure with structural members rated between two to three hours
- Type II (222): Protected steel structure with members rated at two hours

Type I constructions have structural members of noncombustible materials, while type II constructions might allow using some limited-combustible materials[1].

3.1.3 Height and Area Requirements

Buildings of construction type II (222) that are fully protected by automatic sprinkler systems, are limited to a height of 180 ft (NFPA 5000 Table 7.4.1). All occupancy classes within the building are limited to 12 floors. Floors of Assembly and business have no area limitation, but storage of low- and ordinary hazard are limited to 39,000 ft^2 and 26,000 ft^2, respectfully.

3.1.3.1 *Vertical Shaft Enclosures*

All shafts of this building are enclosed with 2-hour fire resistive constructions. Shaft openings are protected with 1.5-hour fire-rated assemblies.

[1] NFPA Handbook of Fire Protection Engineering, Section 19: chapter 1.

3.1.4 As-built Construction

The original construction document states that the building was originally classified as a type II FR construction, in accordance with the California Building Code of 1992. This is equivalent to a type II (222) construction in the LSC[2], which is also the minimum allowable construction type per LSC.

Table 3-2 shows the required fire resistance ratings vs. the as-built fire resistance ratings:

Table 3-2 - As-built construction vs. requirements of the LSC

Building Component	As-Built Fire Resistance Rating (hr)	Type II (222) requirements for Fire Resistance Ratings (hr)
Exterior bearing walls	4[b]	2[a]
Interior Bearing walls	2	2[a]
Columns	2	2[a]
Beams, Girders, Trusses, and Arches	2	2[a]
Floor-Ceiling Assemblies	2	2
Roof-Ceiling Assemblies	1[c]	1
Interior Nonbearing walls	[d]	0
Exterior Nonbearing walls	0	0

a. 1-hour requirement where only supporting roofs
b. Unprotected openings, as shown in Figure 13, Figure 15, Figure 19, and Figure 21.
c. Non-rated, non-combustible construction where it is ≥ 25 feet above any floor surface, including balcony floors.
d. Not specified, see Figure 13, Figure 15, Figure 19, and Figure 21.

3.1.5 Protection of Structural Members

2-hour fire rating of columns have been achieved by applying spray-on cementous fireproofing, in accordance with the UL # x772 design. Circular and square columns are protected similarly, in accordance with the UL # x771 design. Figure 9 illustrate fire proofing of beams.

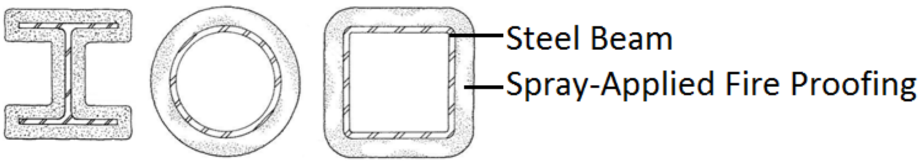

Figure 9 - Fire Proofing of Columns

2-hour fire rating of floor beams was achieved by combining spray-on cementous fire proofing with concrete slabs, in accordance with the UL # N 706 design, see Figure 10.

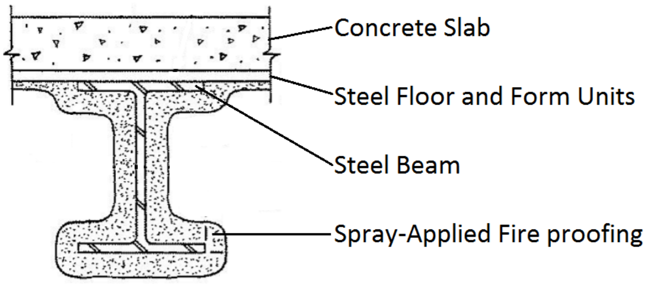

Figure 10 - Fire Proofing of floor beams

2-hour fire rating of roof beams was achieved by combining spray-on cementous fire proofing with concrete slabs, in accordance with the UL # S715 design, see Figure 11. The construction document state that the UL # S 701 was applied for roof beams as well.

[2] NFPA Handbook of Fire Protection Engineering – Table 19.1.2

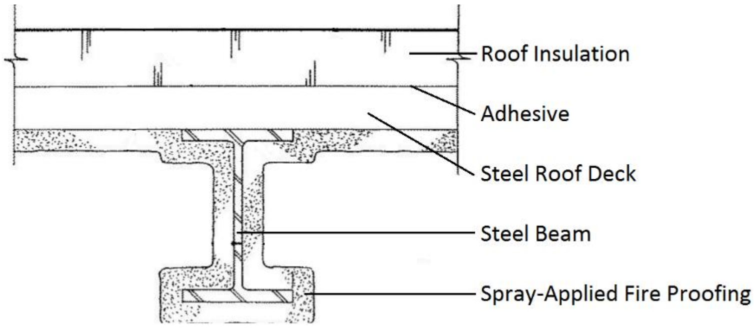

Figure 11 - Fire Proofing of roof beams

3.1.6 Separation from Adjacent Buildings.

As seen in Figure 2, there are two buildings in proximity to the Christopher Cohan Center. Per the construction drawing, the Spanos Theater is separated from the Cohan Center with 4-hour fire rated constructions, and the Music Department is separated from the Coahn Center by 60 ft.

3.1.7 Summary of Structural Fire Protection

The NFPA 101 and NFPA 5000 allowable construction types, based on area and height of the building, have been compared to the as-built construction. Methods to achieve the required fire protection of structural members have been listed and illustrated. Separation from adjacent buildings have also been described.

This section concludes that the minimum construction requirements (Type II [222]) of NFPA 101 and NFPA 5000 are met.

In addition to structural elements to be able to withstand stresses from fires, flammability of materials has a major impact on life safety in a fire event. The following section (3.2) Address the flammability of interior finishes.

3.2 Interior Finishes

Table 3-3 shows the interior finish requirements for existing assembly buildings, as well as for the business and storage occupancies within the structure. The Cohan Center is fully covered by automatic suppression systems, and is, therefore, subject to the requirement reduction stated below. Because of this, the interior finishes listed in the original construction document meet the requirements of the LSC.

Table 3-3 - Interior Finish Classification Limitation

From LSC Table A.10.2.2 "*Interior Finish Classification Limitation*"			
Occupancy	**Exits**	**Exit accsess corridors**	**Other spaces**
Existing assembly > 300 occupants	A	A or B	A or B
Existing assembly < 300 occupants	A	A or B	A, B or C
Existing Business	A or B	A or B	A, B or C
Storage	A or B I or II	A, B or C	A, B or C N/A

A interior wall and ceiling finish: flame spread index, 0-25. Smoke develop index, 0-450
B interior wall and ceiling finish: flame spread index, 26-75. Smoke develop index, 0-450
C interior wall and ceiling finish: flame spread index, 76-200. Smoke develop index, 0-450

I interior floor finish — critical radiant flux, not less than 0.45 W/cm^2
II interior floor finish — critical radiant flux, not more than 0.22 W/cm^2, but less than 0.45 W/cm^2

Fully sprinklered buildings: Class C to allowed instead of B, and class B allowed instead of class A.

Interior finishes are evaluated with regards to flame spread index, and smoke development. The interior finishes listed in the construction drawings meet the requirements of the Life Safety Code with regards to flammability. In addition to meeting flamespread and smoke development requirements, the building egress must be evaluated against the LSC requirements. Occupancy and egress analysis is performed in the following section (3.3), to determine if the LSC life safety goals are met.

3.3 Occupancy and Egress Analysis

3.3.1 Mixed occupancies

Multiple occupancies are not considered protected as separate occupancies if they use a shared exit access corridor system. Different spaces with different occupancy classification share the same exit access, are considered mixed occupancy, even if separated by fire resistant building components.

For these mixed occupancies, the most restrictive requirements of these occupancies will apply.

3.3.2 Lower Level

The lowest level of Christopher Cohan Center is shown in Figure 12. The floor consists of storage occupancies such as pump rooms, and electrical rooms. There is also an area of preparation for performers of the theater. This space is considered a less concentrated assembly area.

There is also a hydraulic lift, used to regulate the elevation of floor area that can be used for either seating or as part of the stage.

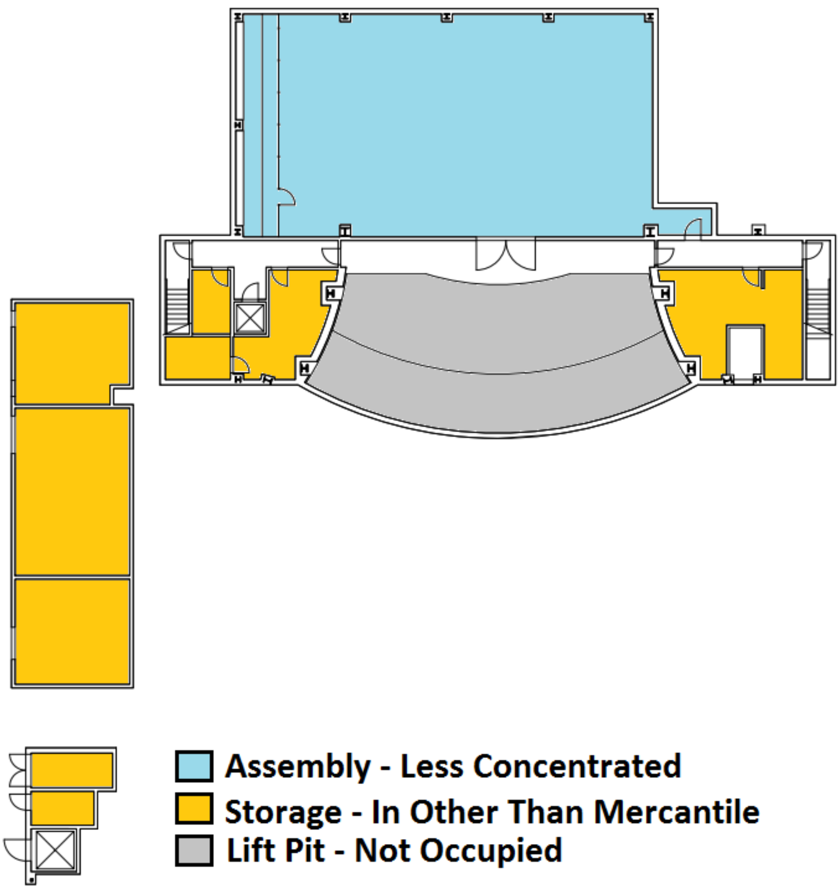

Figure 12 - Occupancy of the Lower Level

3.3.2.1 *Occupancy Load*

Table 3-4 shows the occupant load of each space, as well as the total occupant load for the floor. The total calculated number of occupants of the floor is 221. This estimate is considered conservative, as 212 performers are not expected to occupy room 011. During building inspection, staff confirmed that occasionally performers had access to room 011 of Table 3-4 prior to shows, yet it is not a dedicated preparation area for performers.

Table 3-4 - Occupant Load of the Lower Level

LOWER LEVEL							
Nr.	**Description**	**Chapter 6.1 Occupancy classification**	**Table 7.3.1.2 occupant load factor Occupancy use**	**ft2/person**	**Floor area [ft2]**	**Occupant load**	**Rounded Up**
011	Aud. service	Assembly - less concentrated	In other than storage and mercantile occupancies	15	3178	211.9	212
012	Gen. Storage	Storage	In other than storage and mercantile occupancies	500	330	0.7	1
013	Pump room	Storage	In other than storage and mercantile occupancies	500	86	0.2	1
014	Electrical room	Storage	In other than storage and mercantile occupancies	500	401	0.8	1
015	Equipment room	Storage	In other than storage and mercantile occupancies	500	96	0.2	1
016	Equipment room	Storage	In other than storage and mercantile occupancies	500	75	0.2	1
017	Equipment room	Storage	In other than storage and mercantile occupancies	500	422	0.8	1
018	Equipment room	Storage	In other than storage and mercantile occupancies	500	671	1.3	2
019	Equipment room	Storage	In other than storage and mercantile occupancies	500	394	0.8	1
				Sum	**7750**		**221**

3.3.2.2 *Means of Egress from the Lower Level*

As Seen in Figure 13 there is no exit discharge from the Lower Level. Means of egress is through two separate 2-hour fire rated exit stairs that, that leads upwards to the floors above. There are two exit access corridors leading to the exit stairs, which results in meeting the code requirements for travel distance from the most remote area of the floor.

The structural components of Figure 13 consist of Concrete Masonry Unit (CMU), and Gypsum Wallboard (GWB).

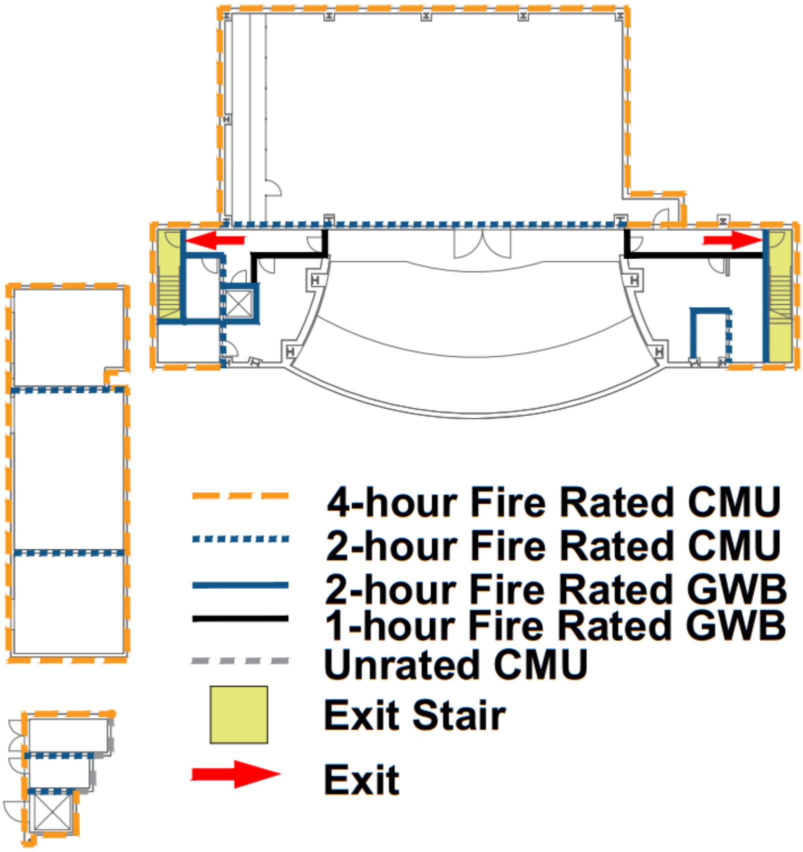

Figure 13 - Separation- and Means of Egress from the Lower Level

3.3.2.3 *Capacity of Means of Egress*

The lower level has two means of egress, both of which are through exit access corridors leading to exit stairs going up in elevation. The exit capacity of each stair is estimated in accordance with methods of the LSC, and shown in Table 3-5. Exit capacity for each space is shown in Table A-1 in Appendix A.

The requirements for egress capacity is met for all spaces. The egress capacity of the floor also exceeds the occupant load of the Table 3-4.

Table 3-5 - Egress Capacity of the Lower Level

Egress Capacity of Floor							
Means of egress	**Door width [in]**	**Stairway width**	**Stair factor**	**Level factor**	**Door Capacity**	**Stairway Capacity**	**Rounded down**
North East stair	36	48	0.3	0.2	180	165	165
North West stair	36	48	0.3	0.2	180	165	165
				Sum		**330.1**	**330**

3.3.3 Stage Level

The three venues of the Cohan Center are located at the stage level, though the Harman Hall is open to a total of four floors. Dressing rooms, and the lounge area outside the Harman Hall is classified as less concentrated assembly use. The green room is considered a concentrated assembly use. All business occupancies consist of offices. The figure below shows technical rooms as storage occupancies.

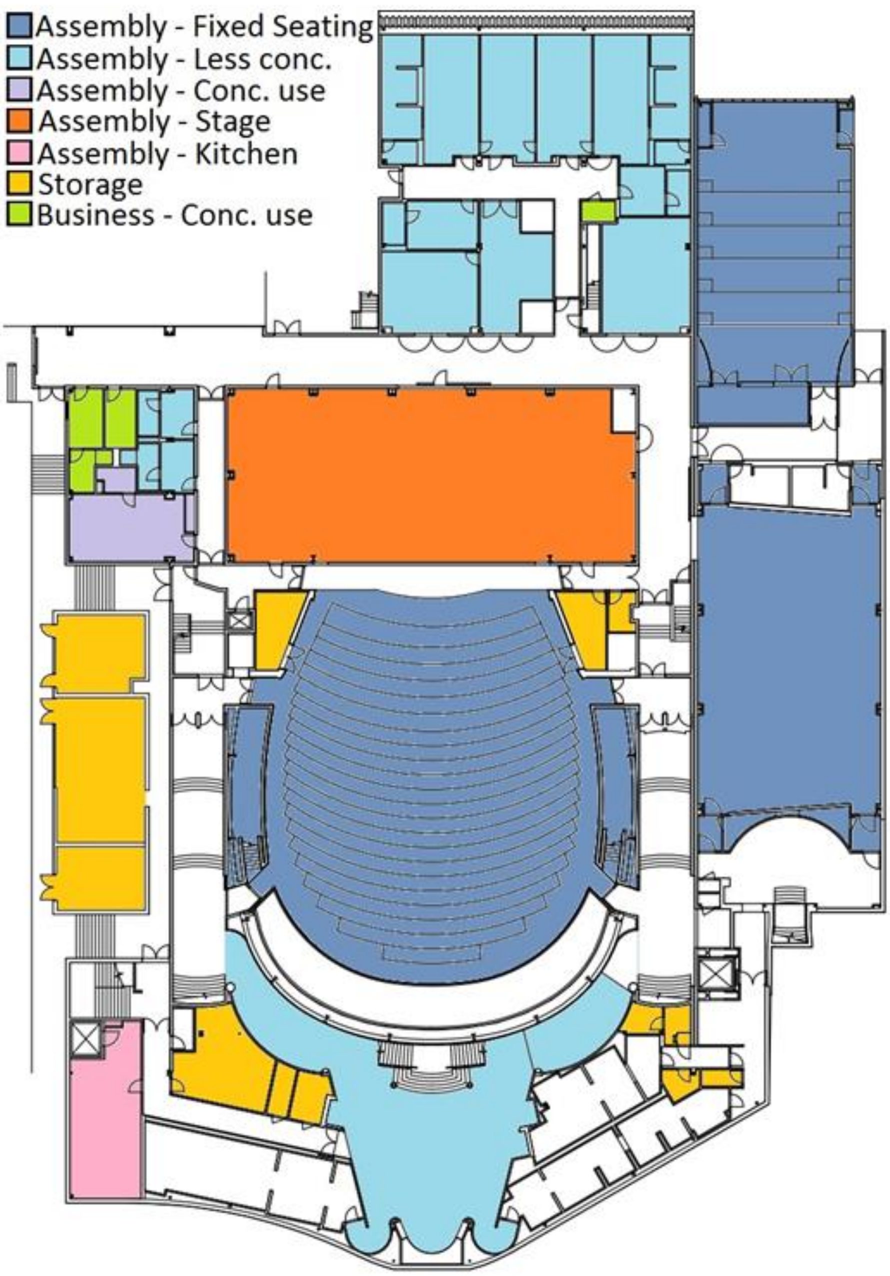

Figure 14 - Occupancy of the Stage Level

3.3.3.1 *Occupancy Load*

Table 3-6 - Occupant Load of the Stage Level

STAGE LEVEL							
Room Number	**Description**	**Chapter 6.1 Occupancy classification**	**Table 7.3.1.2 occupant load factor Occupancy use**	**ft2/person**	**Floor area [ft2]**	**Occupant load**	**Rounded up**
100	Lounge	Assembly	Lounge (Waiting area)	3	2685	*	*
101	Main hall	Assembly	Fixed seating	Fixed	42979	811.0	811
101 A	Gen Storage	Storage	In other than storage and mercantile occupancies	500	133	0.3	1
101 D	Gen Storage	Storage	In other than storage and mercantile occupancies	500	133	0.3	1
102	Stage	Assembly	Stages	15	3977	132.6	133
103	(Lavatory)	N/A	N/A	N/A	786	N/A	0
104	(Electrical)	Storage	In other than storage and mercantile occupancies	500	95	0.2	1
105	Satellite term.rm	Storage	In other than storage and mercantile occupancies	500	64	0.1	1
106	Gen storage	Storage	In other than storage and mercantile occupancies	500	432	0.9	1
108	Food handling	Assembly	Kitchen	100	676	6.8	7
109 & 109A	Green room	Assembly	Concentrated use without fixed seating	7	515	36.8	37
110	Dressing room	Assembly	Less concentrated use without fixed seating	15	163	5.4	6
111	Dressing room	Assembly	Less concentrated use without fixed seating	15	151	5.0	6
112	Manager/receiving	Business	Concentrated business use	50	109	2.2	3
113	Security	Business	Concentrated business use	50	188	3.8	4
114	Wardrobe	Assembly	Less concentrated use without fixed seating	50	460	4.6	5
115	Wardrobe	Assembly	Less concentrated use without fixed seating	15	262	8.7	9
116	Wardrobe	Assembly	Less concentrated use without fixed seating	15	416	13.9	14
117	Dressing room	Assembly	Less concentrated use without fixed seating	15	405	13.5	14
118	Dressing room	Assembly	Less concentrated use without fixed seating	15	405	13.5	14
119	Dressing room	Assembly	Less concentrated use without fixed seating	15	435	14.5	15
120	Dressing room	Assembly	Less concentrated use without fixed seating	15	405	13.5	14
121	Dressing room	Assembly	Less concentrated use without fixed seating	15	199	6.6	7
122	Wardrobe	Assembly	Less concentrated use without fixed seating	15	588	19.6	20

123	Janitor	Business	Concentrated business use	50	41	0.8	1
124 & 124B	Classroom	Assembly	Fixed seating	Fixed	2668	180	180
125	(Lavatory)	N/A	N/A	N/A	144	N/A	0
126	(Lavatory)	N/A	N/A	N/A	132	N/A	0
127	Satellite term.rm	Storage	In other than storage and mercantile occupancies	500	60	0.1	1
128	Rehearsal pavilion	Assembly	Fixed seating	Fixed	2952	400	400
129	Storage	Storage	In other than storage and mercantile occupancies	500	39.44	0.1	1
130	Electrical	Storage	In other than storage and mercantile occupancies	500	55	0.1	1
131 & 131A	Storage	Storage	In other than storage and mercantile occupancies	500	113	0.2	1
				Sum	**11582**		**1709**

***** Waiting area is for occupants of the Harman Hall, and does not introduce additional occupants

3.3.3.2 *Means of Egress from the Stage Level*

As seen on Figure 15 there are several exits to the outside from the Stage Level. Means of egress from the Harman Hall is through the upper floor, via a 1-hour exit access corridor, as shown in the figure below. Guests are expected to choose this path of egress, as it leads to the main entrance[3]. However, for events of more than 250 guests there is a requirement for crowd managers that would help direct people to other exits as well.

Philips hall has two exits, one of which leads directly to the outside. The Multipurpose Pavilion has three exits, two of which connects and leads up to the entry lobby level above the Pavilion.

The structural components of Figure 15 consists of Concrete Masonry Unit (CMU), and Gypsum Wallboard (GWB).

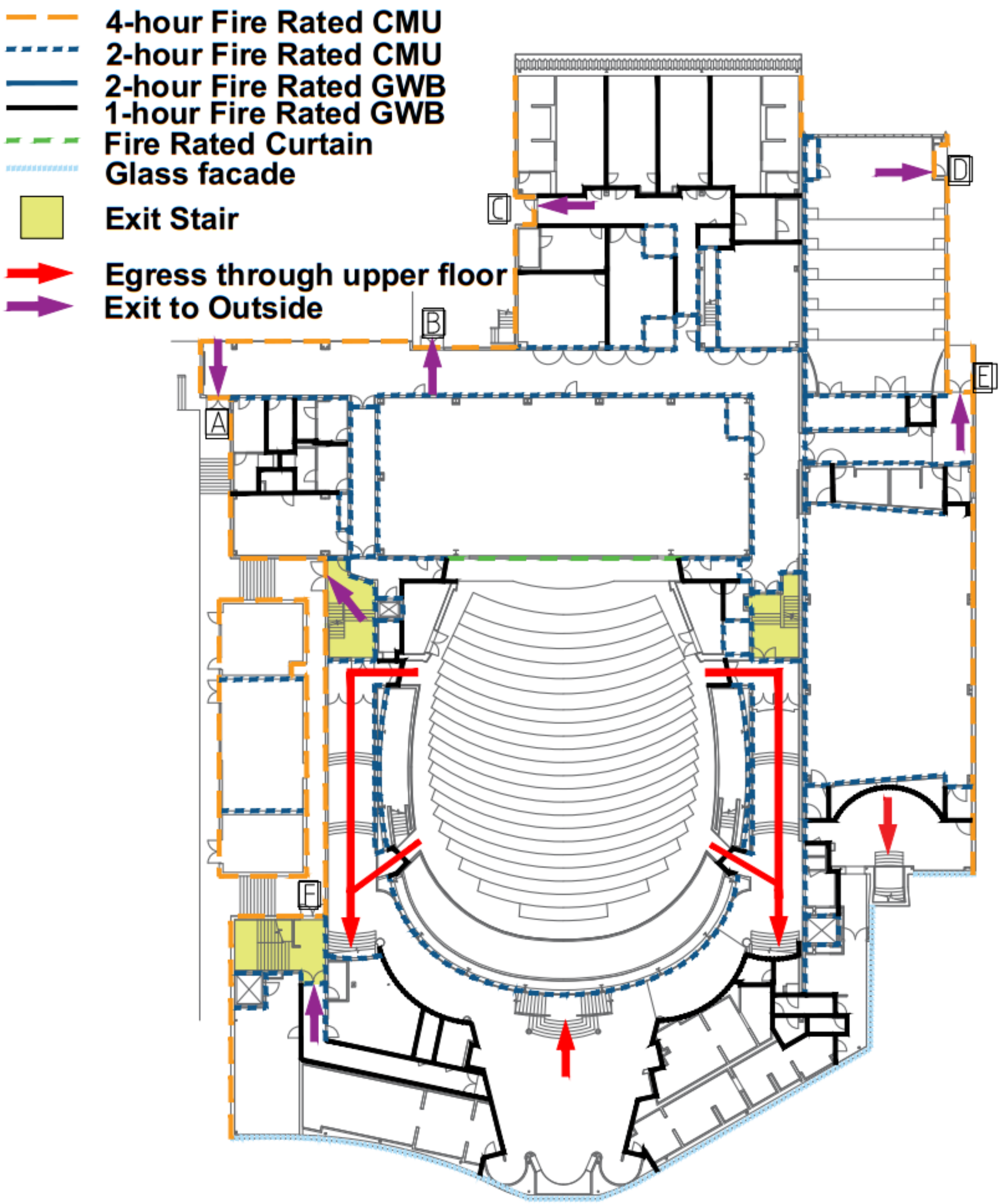

Figure 15 - Separation- and Means of Egress from the Stage Level

[3] The SFPE Handbook of Fire Protection Engineering 5th Edition – Chapter 58 Human Behavior

3.3.3.3 *Capacity of means of egress*

Table 3-7 and Table 3-8 show both the exit capacity of the exits leading to the outside from the stage level, as well as the capacity of the staircases leading to the floor above. Note that the non-enclosed stairs are included in Table 3-8. From the calculated occupant load of the floor, we see that the exit capacity is sufficient.

Table 3-7 - Exit Discharge Capacity of the Stage Level

Stage Level			
Exit discharge capacity from the whole floor			
Means of egress	Door width [in]	Level factor	Door Capacity
Exit door A	72	0.2	360
Exit door B	72	0.2	360
Exit door C	36	0.2	180
Exit door D	76	0.2	380
Exit door F	72	0.2	360
Exit door G	36	0.2	180
Sum	**364**	**1.2**	**1820**
Exit from Classroom to the Outside			
Exit door E	36	0.2	180

Table 3-8 - Staircase Exit Capacity of the Stage Level

Stage Level							
Egress paths through upper floor							
Means of egress	Door width [in]	Stairway width	Stair Factor	Level factor	Door Capacity	Stairway Capacity	Rounded down
West gallery Stair	-	152	0.3	-	-	642.1	642
East gallery stair	-	152	0.3	-	-	642.1	642
Lounge stair	-	86	0.3	-	-	339.4	339
Foyer stair	-	88	0.3	-	-	348.5	348
South Exit stair	72	89	0.3	0.2	360	353.1	353
						Sum	**2324**

3.3.4 Entry Lobby Level

Figure 16 shows the main entrance of the Cohan Center. Immediately within the entrance, there is an assembly occupancy. It is shown as less concentrated assembly on the figure, but appreciate that on occasions there will also be seating and tables. The area might also function as a waiting area for guests attending events in the Harman Hall. Note that there is never more than one show per day, so the waiting area does not introduce additional occupants to the total occupant load calculation.

The business occupancy consists of offices, as well as the ticket office. As for all occupiable floors, there are fixed seating for the Harman Hall. The storage occupancies consist of technical rooms, such as pump rooms, electrical rooms, and equipment rooms.

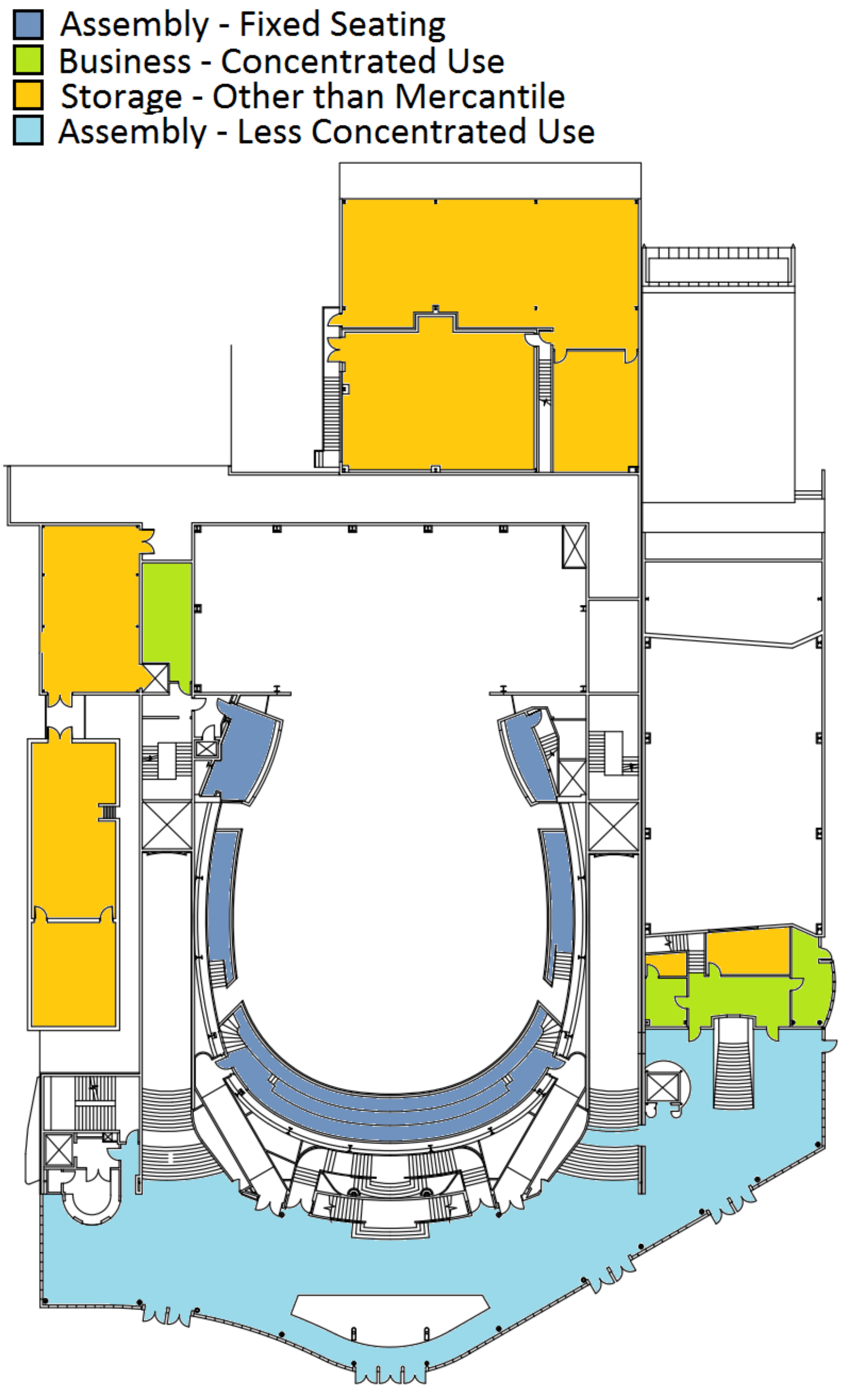

Figure 16 - Occupancy of the Entry Lobby Level

3.3.4.1 *Occupancy Load*

The calculated occupant load of the Entry Lobby Level is 211. On occasions, the fixed seating occupants of Table 3-9 will be in the entry lobby.

Table 3-9 - Occupant Load of the Entry Lobby Level

ENTRY LOBBY LEVEL							
Nr.	**Description**	**LSC 6.1 Occupancy classification**	**LSC 7.3.1.2 occupant load factor Occupancy use**	**ft2/person**	**Floor area [ft2]**	**Occupant load**	**Occupant load rounded up**
200	Entry lobby	Assembly	Lobby (Waiting space)	3	6290	*	*
201	Dress circle	Assembly	Fixed seating	Fixed	18891	154	154
202	Other-Misc. (concession)	Assembly	Less concentrated use	15	228	15.2	16
203 & 203A	Equipment	Storage	Other than storage or mercantile	500	1474	2.94	3
204	Equipment	Storage	Other than storage or mercantile	500	1029	2.05	3
205	Aud. service (main communication room)	Business	Concentrated business use	50	336	6.72	7
206	Equipment	Storage	Other than storage or mercantile	500	1698	3.39	4
207 & 207 A	Electrical	Storage	Other than storage or mercantile	500	3150	6.3	7
208	Staff office (reception)	Business	Concentrated business use	50	338	6.76	7
208A	Admin office	Business	Concentrated business use	50	120	2.4	3
208B	Gen storage	Storage	Other than storage or mercantile	500	50	0.1	1
208C	Aud. service	Storage	Other than storage or mercantile	500	210	0.42	1
208D	Aud. service (box office)	Business	Concentrated business use	50	237	4.74	5
				Sum	**34051**		**211**

* Waiting area is for occupants of the Harman Hall, and does not introduce additional occupants

3.3.4.2 ***Means of Egress from the Entry Lobby Level***

Occupants of the Harman Hall at this level have egress through 1-hour rated exit access corridors, leading to exit discharges. There is also a 2-hour rated enclosed staircase available via the exit access corridor.

The structural components of Figure 17 consists of Concrete Masonry Unit (CMU), and Gypsum Wallboard (GWB).

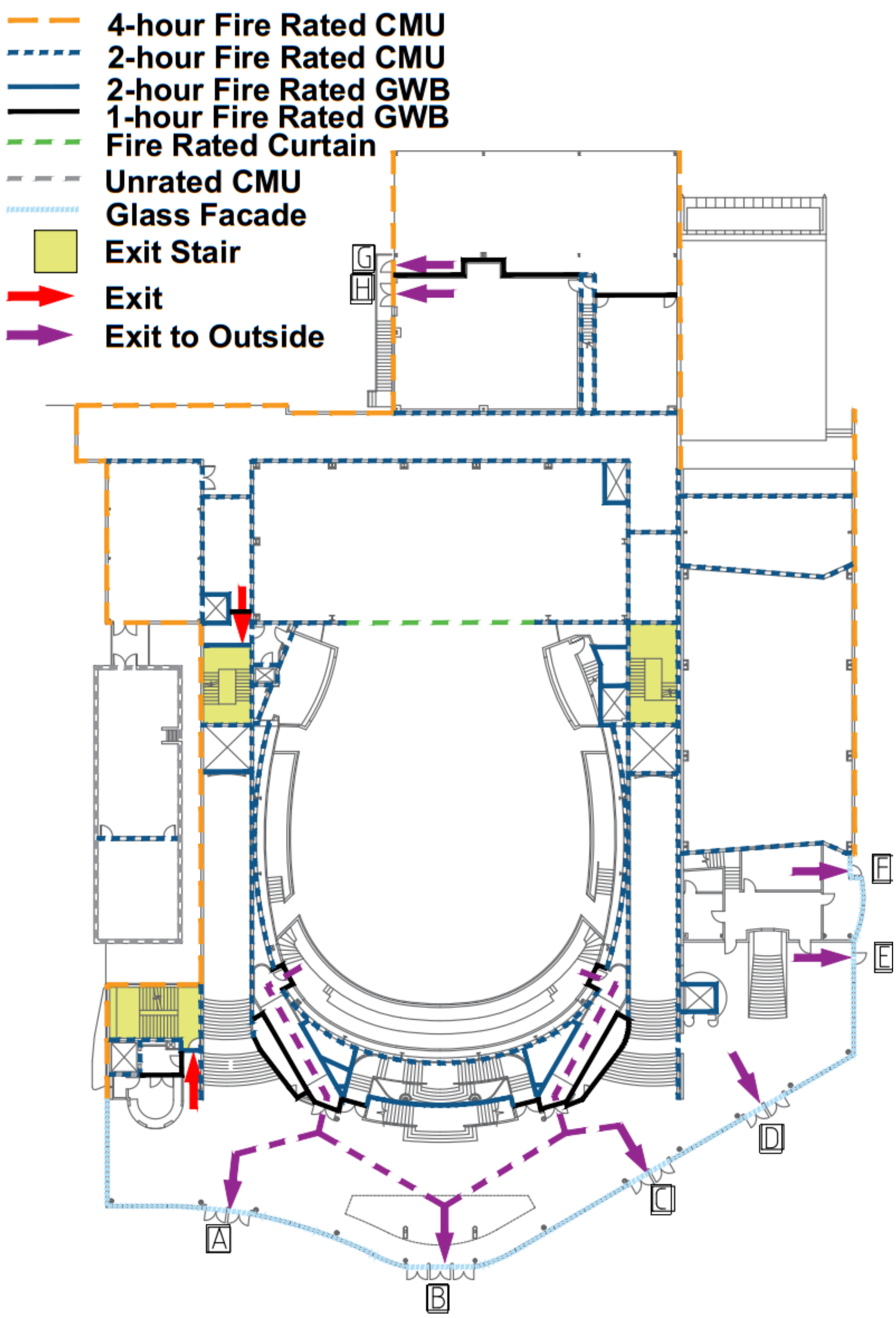

Figure 17 - Separation- and Means of Egress from the Entry Lobby Level

3.3.4.3 ***Capacity of means of egress***

The exit capacity of the floor is divided into exit discharge door capacity and exit capacity of stairs. Table 3-10 and Table 3-11 tables show that the exit capacity exceeds the occupant load of Table 3-9.

Table 3-10 - Exit Discharge Capacity of the Entry Lobby Level

Entry Lobby Level			
Exit-door capacity from the whole floor			
Means of egress	**Door width [in]**	**Level factor**	**Door Capacity**
Exit-doors at point A	130	0.2	650
Exit-doors at point B	195	0.2	975
Exit-doors at point C	130	0.2	650
Exit-doors at point D	130	0.2	650
Exit-door at point E	36	0.2	180
		Sum	**3105**

Table 3-11 - Staircase Exit Capacity of the Entry Lobby Level

Entry Lobby Level							
Egress capacity of stairways							
Means of egress	**Door width [in]**	**Stairway width [in]**	**Stair factor**	**Level factor**	**Door Capacity**	**Stairway capacity**	**Rounded down**
North West Exit-stair	36	48		0.2	180	165	165
South Exit-stair	36	72		0.2	180	275.1	180
Stair by 207	36	36	0,3	0.2	180	120	120
						Sum	**465**

3.3.5 Balcony Level

There are auditorium service rooms and control rooms associated with Harman Hall, located at the Balcony level. These are classified as concentrated business uses. In addition to fixed seating of the Harman Hall, there is an assembly lounge at this level.

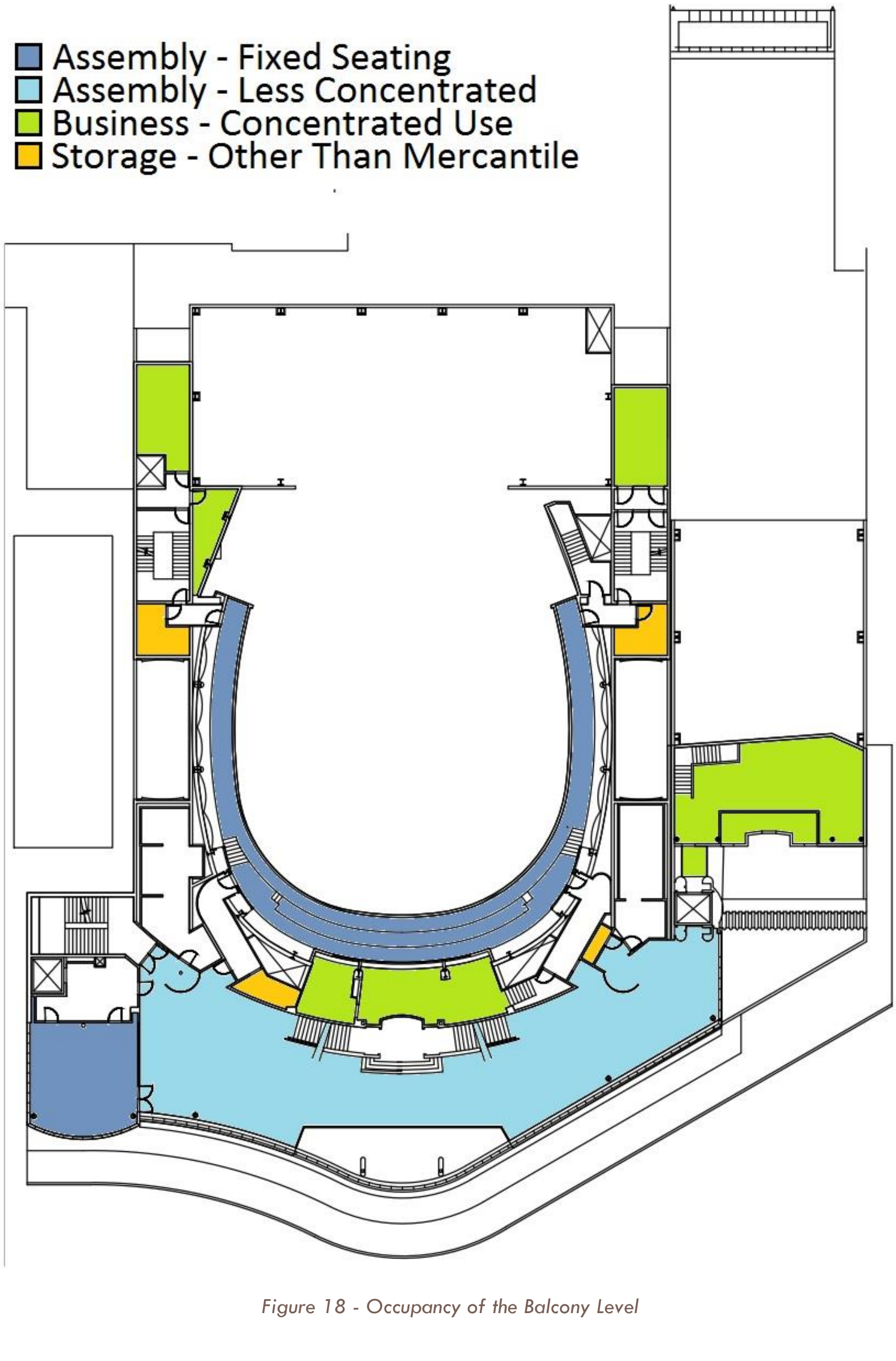

Figure 18 - Occupancy of the Balcony Level

3.3.5.1 *Occupancy Load*

The total occupant load of the balcony floor is 278, as seen in Table 3-12.

Table 3-12 - Occupant Load of the Balcony Level

BALCONY LEVEL							
Nr.	**Description**	**LSC 6.1 Occupancy Classification**	**LSC 7.3.1.2 occupant load factor**		**Floor area [ft2]**	**Occupant load**	**Occupant load rounded up**
			Occupancy use	**ft2/person**			
300	Balcony lobby	Assembly	Waiting Area	15	3474	*	*
301	Auditoria (lower balcony)	Assembly	Fixed seating	Fixed seating	13045	169.00	169
302 & 302A	Control room	Business	Concentrated business use	50	586	11.72	12
303	Gen storage	Storage	Other than storage and mercantile	500	63	0.13	1
304	Conf. Room (founders lounge)	Assembly	Fixed seating	42	625	42.00	42
305	Other-Misc.	Assembly	Less concentrated without fixed seating	15	300	20.00	20
306	Lavatory	N/A	N/A	N/A	429	N/A	N/A
307	Gen storage	Storage	Other than storage and mercantile	500	120	0.24	1
308	Aud. service	Business	Concentrated business use	50	288	5.76	6
309	Aud. service	Business	Concentrated business use	50	125	2.50	3
310	Business	Business	Concentrated business use	50	290	5.80	6
311	Gen storage	Storage	Other than storage and mercantile	500	120	0.24	1
312 & 312A	Aud. service	Business	Concentrated business use	50	780	15.60	16
313	Lavatory	N/A	N/A	N/A	342	N/A	N/A
314	Storage	Storage	Other than storage and mercantile	500	29	0.1	1
				Sum	**20616**		**278**

* Waiting area is for occupants of the Harman Hall, and does not introduce additional occupants

3.3.5.2 *Means of Egress from the Balcony Level*

In addition to the Harman Hall being open to several floors, the balcony level is connected to the entry lobby through a communicating space. The communicating space has 1-hour rated constructions separating it from adjacent spaces.

Note that the occupants of the Harman Hall have additional exits from this level, compared to the levels below. Two exit stairs are accessible from the North end of each balcony. Egress through the communicating space leads to a 2-hour enclosed stair, and internal stairs.

The structural components of Figure 19 consists of Concrete Masonry Unit (CMU), and Gypsum Wallboard (GWB).

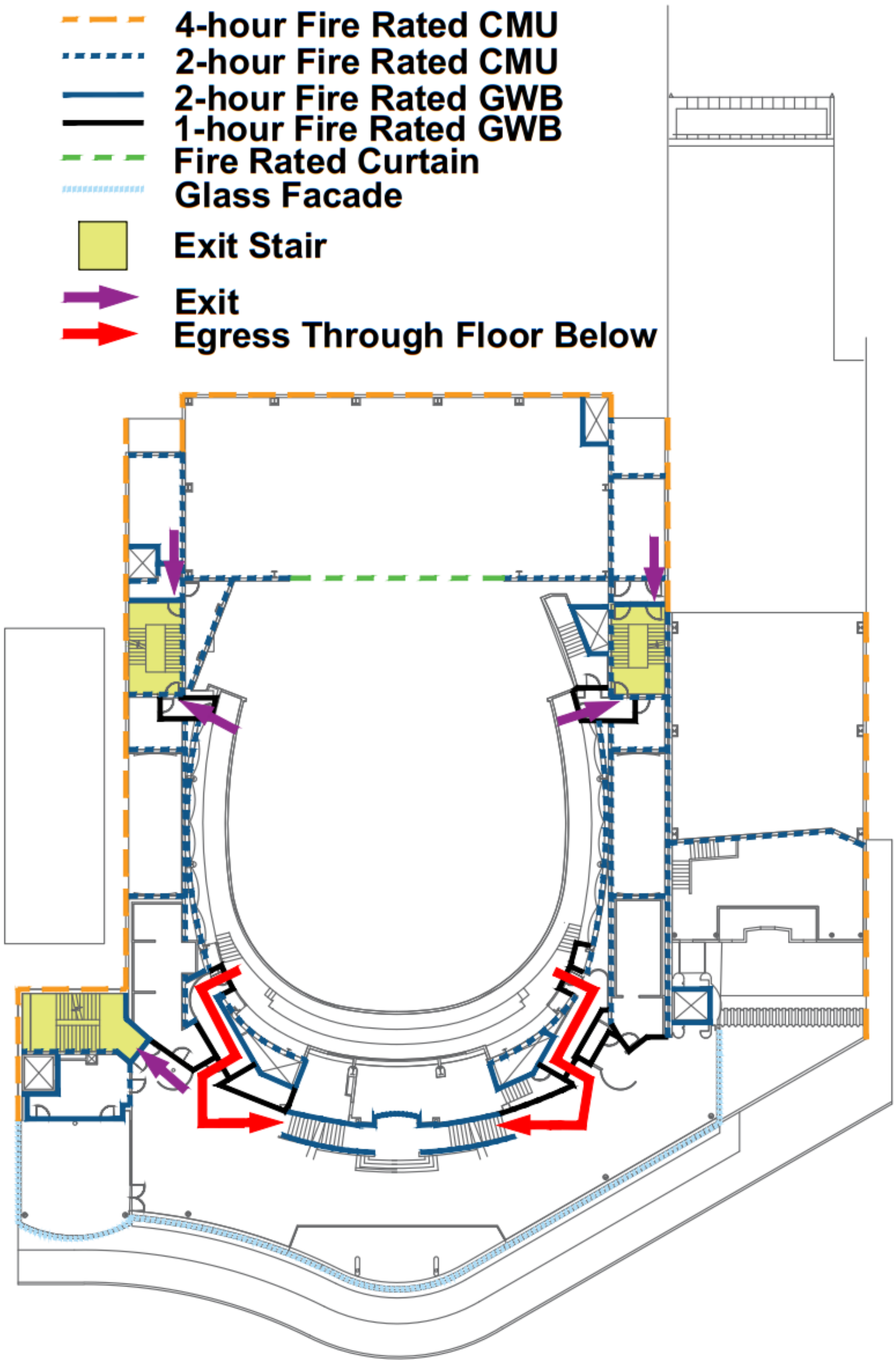

Figure 19 - Separation- and Means of Egress from the Balcony Level

3.3.5.3 *Capacity of means of egress*

As shown in Table 3-13, the egress capacity of this level exceeds the calculated occupant load of 278.

Table 3-13 - Exit Capacity of the Balcony Level

Balcony Level							
Egress capacity of stairways							
Means of egress	**Door width [in]**	**Stairway width [in]**	**Stair factor**	**Level factor**	**Door Capacity**	**Stairway capacity**	**Rounded down**
North East Exit-stair	36	48	0.3	0.2	180	165	165
North West Exit-stair	36	48	0.3	0.2	180	165	165
South Exit-stair	72	72	0.3	0.2	360	275.1	275
2 Exit access stairs	-	144	0.3	0.2	-	605.4	605
					Total capacity		**1210**

3.3.6 Gallery Level

The gallery level, Figure 20, is the highest occupiable assembly floor. Fixed seating is provided for the Harman Hall, with the possibility to utilize the space outside the hall as a waiting area. There are also technical rooms at this level, classified as storage occupancies.

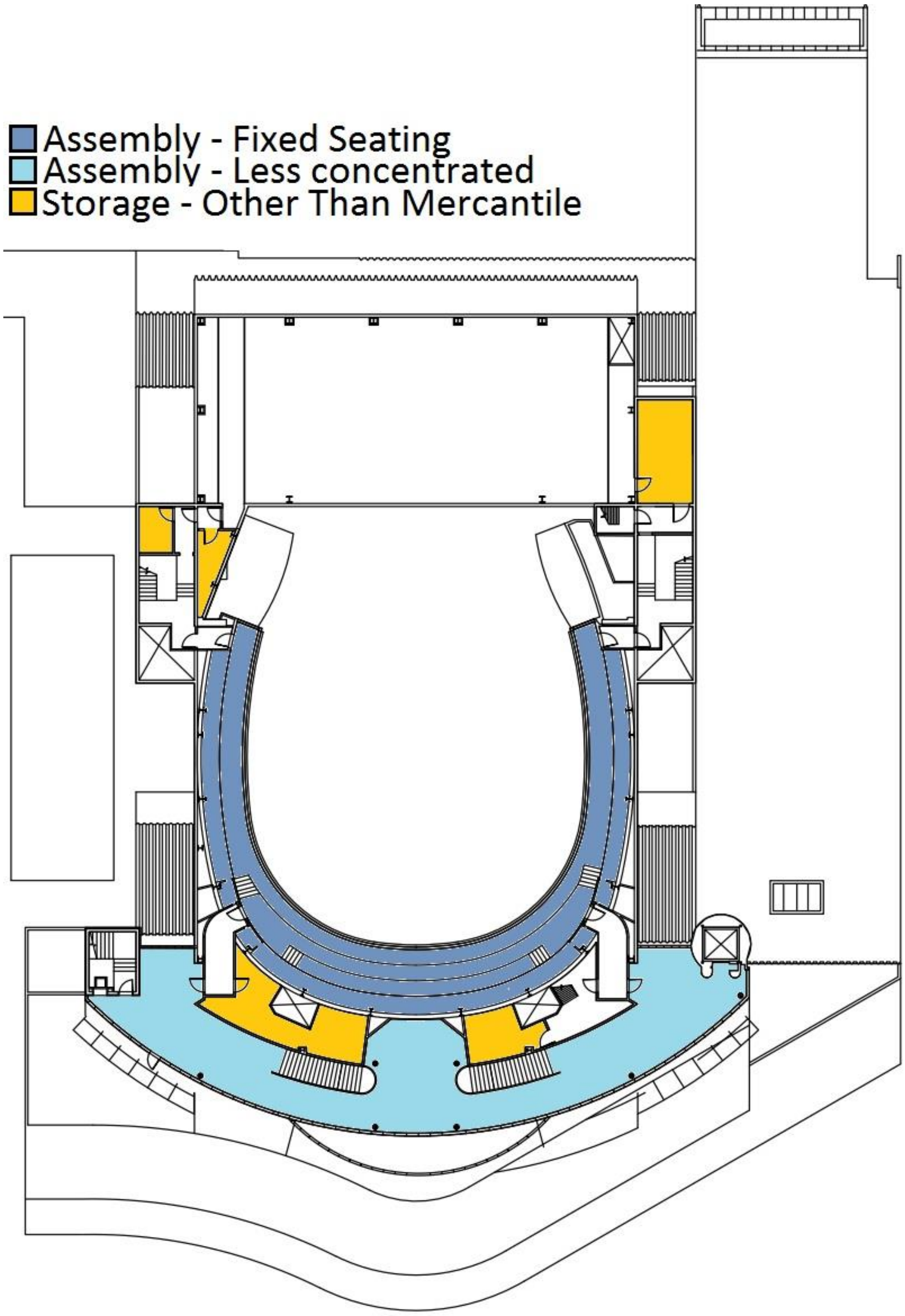

Figure 20 - Occupancy of the Gallery Level

3.3.6.1 *Occupancy Load*

The occupant load of Table 3-14 considers that there will not be occupants of both the Harman Hall and the gallery lobby simultaneously, as shows are never held directly after another show.

Table 3-14 - Occupant Load of the Gallery Level

GALLERY LEVEL							
Nr.	**Description**	**LSC 6.1 Occupancy classification**	**LSC 7.3.1.2 occupant load factor Occupancy use**	**ft2/person**	**Floor area [ft2]**	**Occupant load**	**Occupant load rounded up**
400	Gallery lobby	Assembly	Waiting Area	3	2330	*	*
401	Auditoria	Assembly	Fixed seating	Fixed	7672	152	152
402	Gen storage	Storage	In other than storage and mercantile occupancies	500	360	0.7	1
403	Gen storage	Storage	In other than storage and mercantile occupancies	500	78	0.2	1
404	Gen storage	Storage	In other than storage and mercantile occupancies	500	80	0.2	1
405	Equipment room	Storage	In other than storage and mercantile occupancies	500	293	0.6	1
406	Equipment room	Storage	In other than storage and mercantile occupancies	500	163	0.3	1
* Waiting area is for occupants of the Harman Hall, and does not introduce additional occupants				**Sum**	**10976**		**157**

3.3.6.2 *Means of Egress from the Gallery Level*

Means of egress from the Gallery level is equivalent to means of egress from the balcony level. There are exit stairs accessible from the North side of each balcony, as well as an exit access corridor leading to an internal stair, and a 2-hour rated exit stair.

The structural components of Figure 21 consists of Concrete Masonry Unit (CMU), and Gypsum Wallboard (GWB).

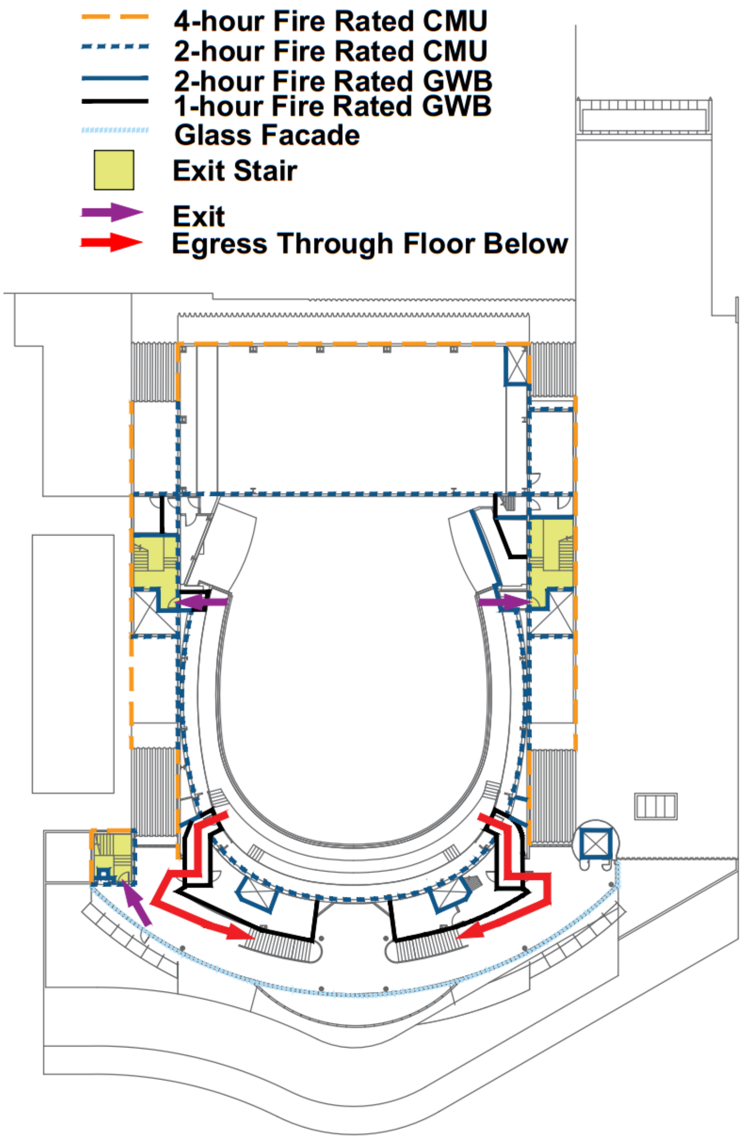

Figure 21 - Separation- and Means of Egress from the Gallery Level

The exit capacity of Table 3-15 exceeds the occupant load of Table 3-14.

Table 3-15 - Total Exit Capacity of the Gallery Level

Egress capacity of stairways							
Means of egress	**Door width [in]**	**Stairway width [in]**	**Stair factor**	**Level factor**	**Door Capacity**	**Stairway capacity**	**Rounded down**
North East Exit-stair	36	48	-	0.2	180	165	165
North West Exit-stair	36	48	-	0.2	180	165	165
South Exit-stair	36	60	-	0.2	180	220.1	180
2 Exit access stairways	72	144	-	0.2	360	605.4	360
					Total capacity		**870**

3.3.7 Communicating Space

The Entry Lobby, Balcony Lounge, and West- and East Gallery of the stage level, are communicating spaces, as described in chapter 2.1.3.

The LSC 8.6.6 lists the following eight criteria that needs to be met for communicating spaces:

1) The communicating space does not connect more than three contiguous stories.
2) The lowest or next-to-lowest story within the communicating space is a street floor.
3) The entire floor area of the communicating space is open and unobstructed, such that a fire in any part of the space will be readily obvious to the occupants of the space prior to the time it becomes an occupant hazard.
4) The communicating space is separated from the remainder of the building by fire barriers with not less than a 1-hour fire resistance rating
5) The communicating space has ordinary hazard contents protected throughout by an approved automatic sprinkler system in accordance with Section 9.7 or has only low hazard contents.
6) Egress capacity is sufficient to allow all the occupants of all levels within the communicating space to simultaneously egress the communicating space by considering it as a single floor area in determining the required egress capacity.
7) Each occupant within the communicating space has access to not less than one exit without having to traverse another story within the communicating space.
8) Each occupant not in the communicating space has access to not less than one exit without having to enter the communicating space.

The building design meets all 8 requirements. It can appear as point LSC 8.6.6 (8) is violated for the Founders Lounge (room 304), as there is no other means of egress other than through the communicating space, from the lounge, see Figure 22. However, the lounge is considered a part of the communicated space as it is not separated from it with fire-rated constructions. Therefore, the lounge is subject to LSC 8.6.6 (7), but not 8.6.6 (8).

It appears also from Figure 22 that the doors to the exit stair open in the incorrect direction. Doors are required to open in the direction of egress travel, to avoid crowd crushing and impaired evacuation flow. The opening direction of the door in question has not been confirmed during building inspection.

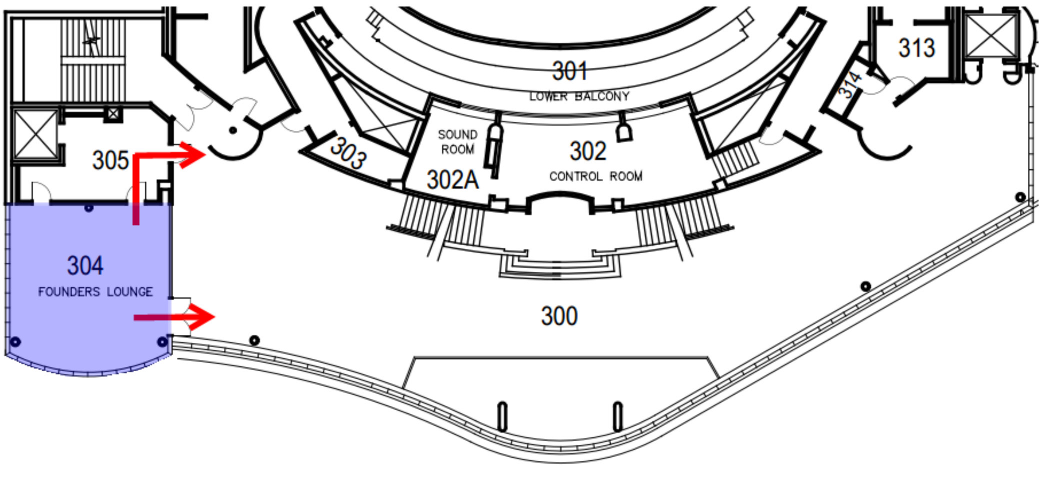

Figure 22 - Egress from the Founders Lounge

3.3.8 Exit Signs

As the building have several assembly occupancies, occupants cannot be expected to be familiar with the building layout. Markings of means of egress enhance the wayfinding abilities of patrons. In the event of reduced sight, glowing signs will also contribute to an efficient evacuation.

Marking of means of egress requirements are determined in accordance with the LSC chapter 7.10, as required by LSC 13.2.10.1. The LSC require all exits to be marked with approved signs that is readily visible from any direction of exit access. An exception can be made where it is obvious that the doors are exit doors. Even though the exit doors of the entry lobby might be considered obvious exit doors (LSC A.7.10.1.2.1), exit signs are provided above exit doors of the entry lobby.

The building construction document states that exit signs have a minimum illumination of 1 foot-candle (lumen/ft^2), and that aisles of the Harman Hall are illuminated with 0.2 foot-candle (lumen/ft^2) at floor level.

3.3.9 Summary on Egress Analysis

Occupancy classification, and means of egress have been compared to the requirements of the Life Safety Code 2015.

Occupant loads have been calculated in accordance with the LSC, based on the assigned occupancy classification, and compared to the calculated prescriptive egress capacity. Egress capacity of all rooms, and all floors exceed the occupant load. Floor plans showing egress paths utilizing exit access corridors, exit passageways, exit stairs, or exits directly to the outside have been provided for each floor.

The prescriptive requirements addressed in this section meet the requirements of the Life Safety Code.
The following section (3.4) address the fire safety management of the building, including evacuation procedures, use of pyrotechnics, and flammability of scenery and decorations.

3.4 Fire Safety Management

The Fire Safety Management is a crucial aspect of the fire safety in a building, both with regards to egress management, as well as flammability of the structure and its contents.

The PAC User Guide states that during performances, a minimum of one person shall function as Stage Manager/Flyman. This person is responsible for supervision of backstage activities. Additional crew might be required, depending on the event. Having crew responsible for curtains and flown scenery improves the likelihood of manual detection of potential fires in the backstage areas. Backstage personnel are important with regards to fire detection and notification, as drawings indicate that sprinkler water-flow is the only means of automatic initiation of horn strobes. They are expected to activate at a late stage in a fire, due to the high elevation.

3.4.1 Special Equipment and Pyrotechnics

The PAC User Guide and Technical Services document states that Pyrotechnics, any open flame devices or flammable liquids are allowed on stage in the Harman Hall, with the following requirements:

- The State Fire Marshal must approve the use of pyrotechnics
- Operators of pyrotechnics need to be licensed, and have the proper permits

It is permitted to use special equipment that requires bypassing of smoke alarms, such as smoke/fog machines. However, this requires an additional crew member whose sole purpose is to function as a fire watch.

NFPA 101 Life Safety Code gives the following regulations of pyrotechnics:

- Open flames or pyrotechnics is permitted under performances, if the AHJ approves of the means to prevent ignition of combustible materials, and use of Pyrotechnics comply with NFPA 1126.
- Alternatively, flame effects are permitted if performed in accordance with NFPA 160.

Both NFPA 160 and NFPA 1126 require a fire department representative present during performances that utilizes fire effect, or any kind of pyrotechnics.

3.4.2 Furnishing, Decorations, and Scenery

There are several restrictions regarding decorations and scenery, in the PAC User Guide and Technical Services:

All scenic materials brought in must be flame-proofed and/or conform to the Uniform Fire Code. Cardboard is prohibited due to its flammability. Scenery, drops, properties, decorations (tissue paper, crepe paper, etc.) or other combustible effects shall not be used unless treated for flame-retardancy. Scenery constructions or paintings are not permitted; touch-ups with a drop cloth only. Spray cans are not allowed inside the facility, as all scenery is required to be finished before entering the building. Ultimately, all scenery is required to be approved by the Technical Services Manager prior to use.

To prevent accumulation of combustibles after shows, the PAC regulations require that all scenery, props, costumes and other equipment be removed after the final performance. The PAC reserves the right to dispose of materials that gets left behind.

NFPA 101 Life Safety Code gives the following regulations for furnishings and scenery:

Loosely hanging furnishings, such as curtains and draperies shall meet the flame propagation performance criteria of Test Method 1- or 2, of *NFPA 701 Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.

Exposed foam plastics are allowed, if not exceeding a HRR of 100 kW where tested in accordance with ANSI/UL 1975 or NFPA 289, using the 20 kW ignition source. This requirement applies also to materials covered by thermally thin combustible fabric or paint. Individual foam plastics of weight less than 0.45 kg is excempt from these requirements.

3.4.3 Crowd Managers

The Christopher Cohan Center use volunteer Ushers to assist crowd managing during performances. For events where maximum occupant capacity might occur, a total of 30-35 Ushers are present, according to the Patron Service Manager. This greatly exceeds the LSC requirement of one crowd manager for every 250 occupants. Note that these volunteers only assist with “front-house” evacuations, and do not operate the FACP, or participate in backstage evacuations. Those tasks are covered by the buildings permanent staff.

The Harman Hall is divided into four different sections, and each Usher have a designated area of attendance within their section. There are also “floor managers” that instruct Usher in emergency situations. Mandatory annual drills are performed, to keep all Ushers familiar with the building layout, evacuation routes, and how to react in an emergency.

The emergency procedure document for these crowd managers recommends using all exits, rather than directing all occupants to the main entrance. Detailed instructions on optimal exit distribution for each of the four zones are provided in the document.

Note that the volunteer Ushers are not required to physically aid patrons. However, if they choose to do so they are protected by the “Good Samaritan” rule[4]. The PAC disclaims all responsibility for crowd managers physically aiding patrons. Consequently, even though Evac-chairs are provided for the Balcony and Gallery level, the procedure for occupants in wheelchairs is to gather by the elevator alcoves and await emergency responder assistance. Crowd managers are instructed not to leave their site until this assistance is provided.

[4] https://definitions.uslegal.com/g/good-samaritans/

3.5 Fire Detection, Notification, and Alarm System

The LSC requires the installation of a Fire Alarm system, in accordance with NFPA 70 and NFPA 72. Approved existing systems are exempt to this requirement, but as no documentation of such approval is successfully obtained, the system is compared to requirements of NFPA 72 and NFPA 70.

3.5.1 Description of the System installed in the building

The Christopher Cohan Center is a protected premise, that also utilizes the University Police Department for central station monitoring services. The building was originally equipped with a Simplex fire alarm system. The system was replaced in 2005 with the current Notifier system, allegedly due to nuisance alarms and troubles stemming from an improper original installation. The replacement was an in-kind maintenance replacement of the faulty system, so consequently, the system layout shown in Appendix B is still valid, though the current devices are listed in Table 3-16. With regards to device location, the color codes of Appendix B are to be interpreted as follows:

- Red: Smoke detectors
- Purple: Heat detectors
- Orange: Manual pull stations
- Light green: Speaker strobes
- Dark green: Duct detectors
- Dark gray: Addressable module for the proscenium fire curtain
- Yellow: Tamper- or water-flow switch

The Fire Alarm Control Panel (FACP) is a NFS-640 model, located in room 314 of the Stage Level, see Appendix C As mentioned, the FACP is connected to the University Police Department, for transmission of alarm, supervisory, and trouble signals.

As required by NFPA 72, there is an automatic voice alarm communications system installed. A prerecorded evacuation message will sound upon detection, but there are also means for manual instructions provided by the FACP.

As seen in Appendix B, duct detectors are provided in the HVAC system in technical rooms, such as mechanical- service- and electrical rooms.

Table 3-16 - Detection and Initiation Devices

Detection and Initiation Devices		
Type of Device	**Model Number**	**CSFM Number**
Addressable Smoke Detector	Notifier FSP-851	7272-0028:0206
Addressable Heat Detector	Notifier FST-851	7270-0028:196
Addressable Duct Detector	Notifier FSD-751PL	3240-0028:205
Addressable Pull Station	Notifier NBG-12LX	7150-0028:0199

Manual pull stations are located adjacent to stage exits, adjacent to all exit stair doors, with a maximum spacing of 200 feet between each pull station.

The notification appliances identified in the building are wall mounted speaker strobes. They appear to be of the Notifier E70 Series, assumed to be model E70-24MCWH-FR, as it meets a 130-strobe candela requirement for the Harman Hall. Other devices of the E70-series might be installed in other spaces than the Harman Hall.

3.5.1.1 *Elevator Control*

Elevators are not to be used in emergency evacuation. Consequently, there are smoke detectors installed in elevator lobbies, that initiate elevator re-call to the main floor level, upon smoke detection. Activation of elevator machine room heat detectors will automatically disconnect the main power supply to the affected elevator, prior to application of water.

3.5.1.2 *Waterflow Alarms:*

The sprinkler system waterflow is supervised by waterflow detection devices at lateral connections to the sprinkler risers. There are also valve supervision devices on all sprinkler water valves. The University Police Department monitor the supervision- and waterflow detection devices.

3.5.1.3 *Notification Appliances*

For the PAC, requirements of public mode apply. The audibility of notification appliances must be at least 15 dBA above average ambient sound levels, and at least 5 dBA above maximum sound level having a duration of at least one minute. This is to be measured five feet above floor in area served by the system (18.4.3.1*).

Table A.18.4.3 of NFPA 72 lists assembly occupancies as expected to have an average ambient sound level of 55 dBA. However, the sound level of the Harman Hall is expected to reach 105 dBA during shows, in accordance with values for concert halls and casinos in NFPA 72. The total sound pressure is not permitted to exceed 110 dBA at the minimum hearing distance. Initiation of notification appliances upon an ambient sound level of 105 dBA is expected to exceed the sound pressure limit. Consequently, NFPA 72 requires visible notification appliances. This requirement is met by the appliance of horn-strobes. In order to not exceed 110 dBA, the FACP should be programmed to eliminate all speaker systems related to the show in the event of an alarm signal. Per the construction document, the FACP will interrupt the performance sound of the speakers, upon fire/smoke detection. The *PAC Rules, Procedures & Practices* also require all clients to immediately shut down sound operations upon fire alarm.

3.5.2 Backup Power Requirements

NFPA 72 10.6.7.3.1 require a secondary power supply of either a storage battery dedicated to the system, or an automatic-starting engine-driven generator. The Cohan Center uses storage battery as secondary power supply.

The secondary power supply shall be capable of operating for 24 hours in a non-alarm condition, followed by 5 minutes of operating all alarm notification appliances. The retired SIMPLEX system applied two batteries with a capacity of 50 Ah each, as backup power. Appendix B show the battery calculations, plan view, and system riser for the retired SIMPLEX system. Due to uncertainty regarding specifications of some of the current devices, it is not clear whether additional capacity is required for the current system.

3.5.3 Requirements for Spacing and placement of detection devices

There are several different geometries for spaces within the Cohan Center. Consequently, all the following spacing requirements from NFPA 72 is applicable to the building.

3.5.3.1 *Heat Detectors*

Smooth ceiling:

Location of heat detectors in areas with smooth ceilings shall be in accordance with NFPA 72 Figure A.17.6.3.1.3.1. The distance between detectors shall not exceed their listed spacing, and there shall be detectors within one-half the listed spacing, measured at right angles from all walls or partitions extending upward to within the top 15 percent of the ceiling height.

All points on the ceiling shall have a detector within a distance equal to or less than 0.7 times the listed spacing.

Irregular areas:

For irregularly shaped areas, the spacing between detectors shall be permitted to be greater than the listed spacing, if the maximum spacing from a detector to the farthest point of a sidewall or corner within its zone of protection is not greater than 0.7 times the listed spacing.

Sloping ceiling:

Location of heat detectors in areas with smooth ceilings shall be in accordance with NFPA 72 Figure A.17.6.3.4 (a) and (b).

For a ceiling slope of less than 30 degrees, all detectors shall be spaced using the height at the peak. The designer assumes the ceiling height is established by the peak of the roof.

For ceiling slopes of 30 degrees or greater, all detectors, other than those located in the peak, shall be spaced using the average slope height or the height of the peak. The spacing is in the up-slope direction. to compensate for the slope, the horizontal projection down onto the floor is used. The actual distance between the detectors will be greater as the slope gets steeper, but the buoyancy effects will also be greater, accelerating the ceiling jet up the slope.

High ceilings:
One way to compensate for the cooler and slower flow of the ceiling jet at high ceiling elevations is to move the detectors closer together and, accordingly, closer to the fire plume centerline, where velocity and temperature will be higher. NFPA 72 Table 17.6.3.5.1 gives correction factors for the spacing of detectors due to the height of the ceiling. This reduction shall be done prior to spacing reductions of other geometry factors.

3.5.3.2 *Smoke Detectors*

NFPA 72 - 17.7.3.2.3.1*: "*In the absence of specific performance-based design criteria, one of the following requirements shall apply:*

(1) *The distance between smoke detectors shall not exceed a nominal spacing of 30 ft (9.1 m) and there shall be detectors within one-half the nominal spacing, measured at right angles from all walls or partitions extending upward to within the top 15 percent of the ceiling height.*
(2) *All points on the ceiling shall have a detector within a distance equal to or less than 0.7 times the nominal 30 ft (9.1 m) spacing (0.7S)*".

To determine if the detection device spacing of the building is in accordance with NFPA 72, a section of the building is analyzed. The entry lobby level, leading to the main exit discharges is chosen, as seen in Figure 23. The entry lobby has a flat ceiling, covered by addressable smoke detectors.

NFPA 72 section 17.7.3.2.3.1 provide two methods for smoke detector spacing. Figure 23 show method 2 (described in 3.5.3.2 Smoke Detectors), though both methods for smoke detector spacing have been analyzed. There is an area of 530 ft^2 (red color) that is not covered by the smoke detectors. Method 1 also resulted in uncovered areas of the entry lobby. The section is therefore not in accordance with prescriptive requirements of NFPA 72.

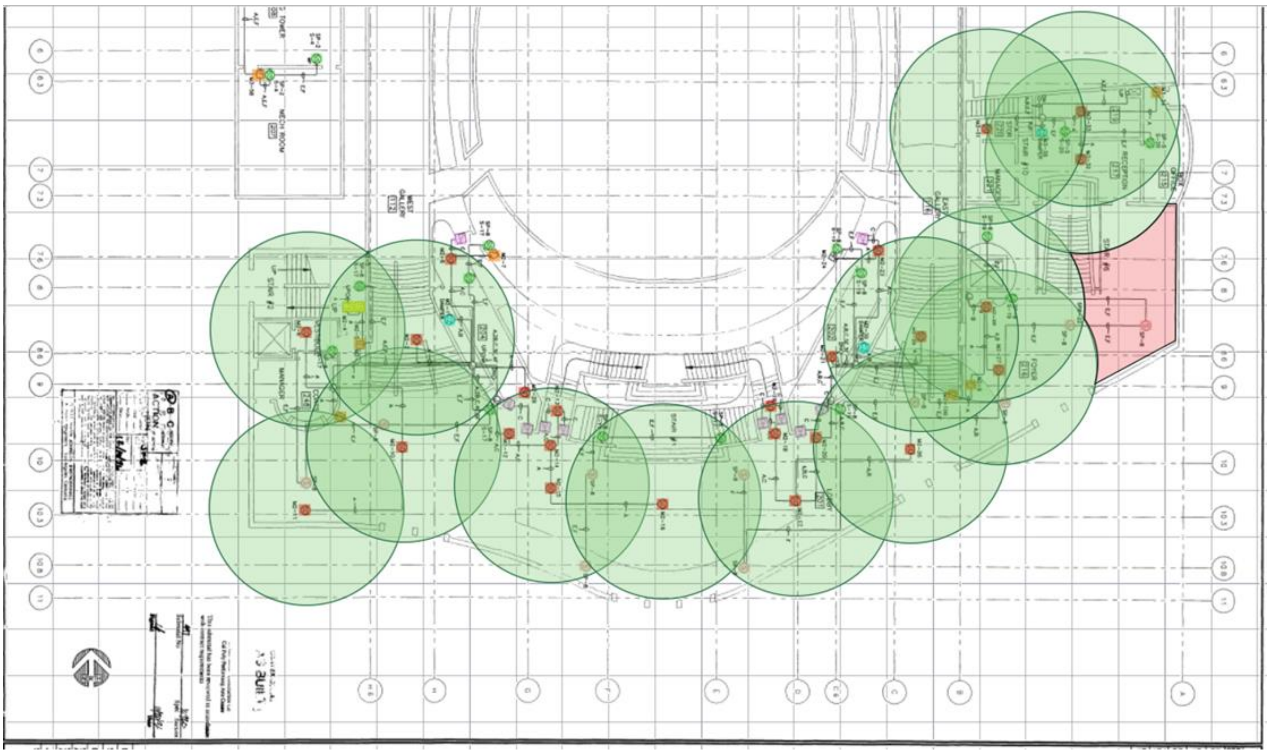

Figure 23 - Smoke Detector Spacing in the Entry Lobby

3.5.4 Requirements on signal monitoring:

The LSC requires an audible alarm signal to a constantly attended receiving station within the building, when the building is occupied. The building will be occupied by staff and performers on occasions when there are no guests present, without constant attendance of the FACP. However, audible notification signals are transmitted to the University Police Department, which is always attended during occupation of the PAC. During performances, the FACP will also have constant supervision.

3.5.4.1 *NFPA 72 requirements for Central Station Signal Disposition:*

Alarm Signals

Upon receipt of an alarm signal from the PAC, the operator of the central station must perform the following four actions:

1. Retransmit the alarm to the communications center.
2. If equipment needs to be reset by the prime contractor, dispatch a technician to the premises to arrive within two hours after receipt of the signal. If allowed by the AHJ, the technician can be recalled if qualified personnel can reset the system into operating condition before the arrival of the technician.
3. Immediately notify the subscriber.
   With immediately, what is meant is “without unreasonable delay”. Appendix A.26.3.8.1.1 of NFPA 72 specifies a maximum of 90 seconds for routine handling of alarm signals.
4. Provide notice to the subscriber or AHJ. If required, both shall be notified.

Supervisory Signals

Upon receipt of a supervising signal from the PAC, the operator of the central station must perform the following four actions:

1. Communicate immediately with the people designated by the subscriber. If this notification cannot be made, it might be appropriate to notify law enforcement or the fire department.
2. Dispatch a runner or maintenance person to arrive within two hours to investigate, like the procedure for alarm signals.
3. Notify the AHJ and the subscriber when the sprinkler system has been out of service for eight hours.
4. After the service, has been restored to normal operation, notification of the nature of the signal, the time of occurrence and the restoration of service shall be given to both the AHJ and the subscriber.

Trouble Signals

Upon receipt of trouble signals or other signals pertaining solely to matters of equipment maintenance of the alarm systems, the central station shall perform the following actions:

1. Communicate immediately with the people designated by the subscriber.
2. Dispatch personnel to arrive within four hours to initiate maintenance, if necessary
3. In the event of an interruption of more than eight hours, notification to the subscriber and the fire department (if required by the AHJ), regarding the nature of the interruption, the time of occurrence and the restoration of service.

3.5.5 Summary of Fire Detection, Alarm, and Notification

Based on the documentation available, The Fire Detection, Alarm, and Notification systems appears to comply with requirements of NFPA 72 and NFPA 70, with the following exception: the spacing of smoke detectors of the entry lobby does not comply with NFPA 72 Section 17.7.3.2.3.1.

Detailed documentation regarding the system replacement is not readily available. Efforts should be made to provide and store updated information about the currently installed system.

In addition to fire/smoke detection, and notification of occupants, limiting the severity of potential fires impacts life safety. The following section (3.6) covers the automatic suppression systems installed in the building.

3.6 AUTOMATIC SUPPRESSION SYSTEMS

The Christopher Cohan Center is fully covered by automatic suppression systems. There is mainly a wet-pipe sprinkler system throughout the building, in addition to a pre-action system covering the organ, and an independent Ansul suppression system in the kitchen. See Appendix D for system layouts.

3.6.1 Ansul Range Suppression System

The Ansul suppression system is a wet-chemical suppression system, that is independent of the automatic sprinkler system. The system activates on fusible links, and covers fire hazards such as kitchen hoods.

3.6.2 Double Interlock System

The pipe organ of the Harman Hall is protected by a double interlock suppression system. In essence, this is a dry-pipe system that requires both activation of smoke detectors and activation of individual sprinkler heads in order for water to flow. This is to reduce the risk of accidental discharge of water to sensitive and expensive features and components of the pipe organ.

The following figure shows the pre-action system riser. The water supply is from a connection to the wet-pipe network, controlled by the deluge valve.

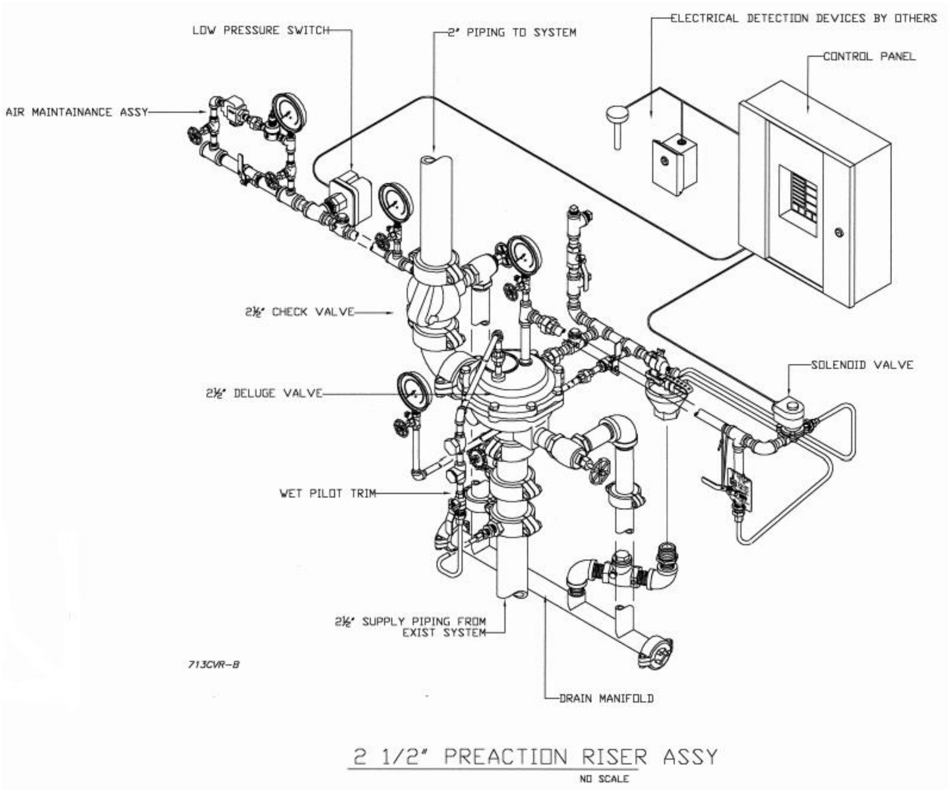

Figure 24 - Preaction System Riser

As seen in Table 3-17, Both pendent- and upright sprinkler heads with a k-factor of 5.6 is applied to the system.

Table 3-17 - Sprinkler Heads of the Preaction System

SPRINKLERS						
MFG / MODEL	SIN	FINISH	K	TYPE	TEMP	QTY
1/2" VICTAULIC 3605K DRY PENDANT		CHRM	5.6	⊗	155	5
1/2" TYCO TY-B GB UPRIGHT	TY3151	BRASS	5.6	O	200	2

Figure 25 shows the pipe organ room, and some of the features that are protected by the pre-action system.

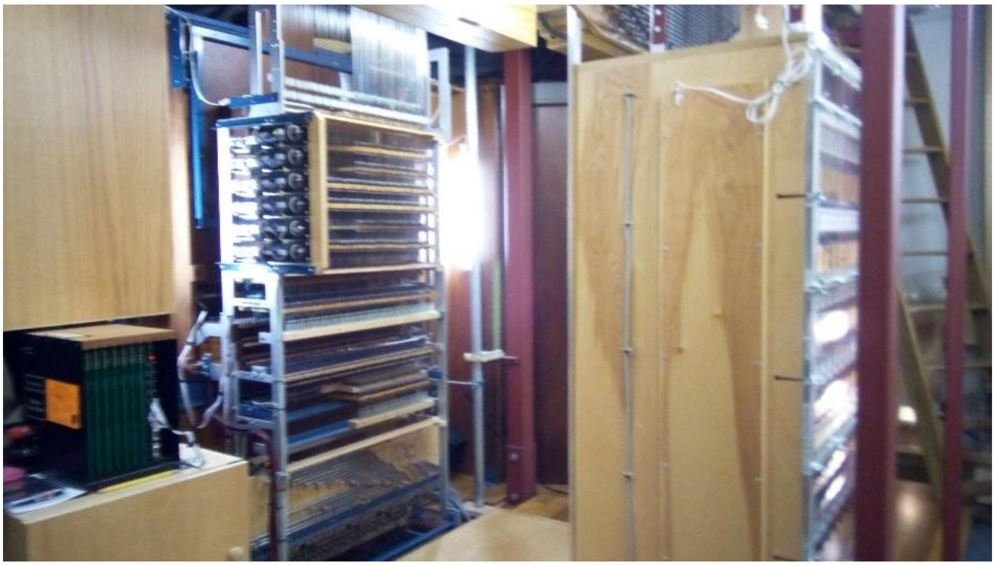

Figure 25 - Features of the Pipe Organ, Protected by the Pre-Action System

Note that the coverage area of the double interlock pre-action system is 30 percent higher than for other systems. The increased coverage area is due to the delay time for water spray, which can cause a larger number of sprinkler heads to activate before the water reaches the sprinklers, as well as allowing the fire to grow larger. However, the most remote area is covered by the wet-pipe system.

3.6.3 Wet Pipe Automatic Sprinkler System

Besides the pipe organ, there is a wet-pipe sprinkler system installed throughout the building. This system is analyzed with regards to requirements of NFPA 13 2015th edition. Hydraulic calculations are performed based on requirements of density/area method.

3.6.3.1 *Water Demand*

Due to different occupancies, there are a total of three different hazard classifications in the building:

Light Hazard: Offices, auditorium seating area
Ordinary Hazard 1: Storage, kitchen, and mechanical rooms
Ordinary Hazard 2: Stage and Orchestra Pit

Figure 26 states requirements for coverage area and water density for each occupancy. As the most remote area is identified to be above the stage, a water density of 0.2 gpm/ft² over an area of 1500 ft² is chosen.

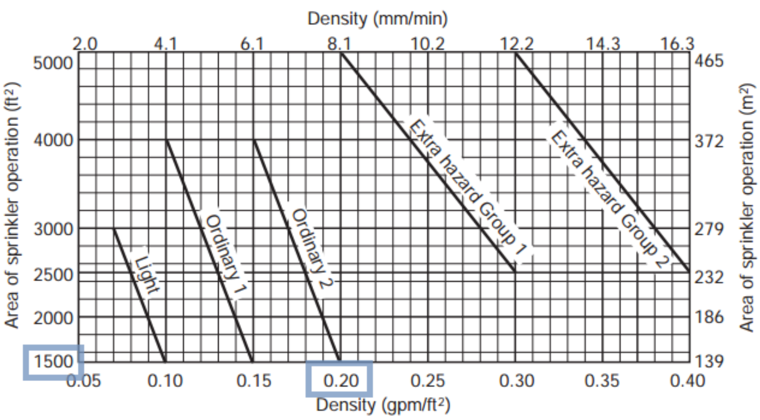

Figure 26 - Water Density and Coverage Area Requirements

For Ordinary Hazard, the required hose stream is 250 gpm, over a duration of minimum 60 minutes, see Table 3-18. The lower duration of 60 minutes is acceptable since there is remote central station water flow alarm service provided (University Police Department).

Table 3-18 - Requirement for Hose Stream and Flow Duration

Occupancy	Inside Hose		Total Combined Inside and Outside Hose		Duration (minutes)
	gpm	L/min	gpm	L/min	
Light hazard	0, 50, or 100	0, 189, or 379	100	379	30
Ordinary hazard	0, 50, or 100	0, 189, or 379	250	946	60–90
Extra hazard	0, 50, or 100	0, 189, or 379	500	1893	90–120

3.6.3.1.1 Most Remote Area

The hydraulically most demanding area is in the gridiron level above the stage, see Figure 27, and Figure 28. These sprinklers are about 80 ft above the stage, and have the highest water density requirement and hose stream allowance of the building.

As seen in Table 3-19, Ordinary hazard 2 classifications have a maximum coverage area of 130 ft² per sprinkler head, with spacing limited to 15 ft.

Table 3-19 - Protection Area, and Maximum Spacing for Ordinary Hazard

Construction Type	System Type	Protection Area		Maximum Spacing	
		ft²	m²	ft	m
All	All	130	12.1	15	4.6

Therefore, the minimum amount of sprinkler heads for the coverage area is as follows:

$$\frac{\text{Total design area}}{\text{Maximum area per sprinkler}} = \frac{1500\,ft^2}{130\,ft^2} = 11.54$$

It is not possible to have fractions of sprinklers, so a minimum of 12 sprinklers are required in the hydraulic calculation. The location each sprinkler head considered is shown in Figure 28, and the coverage area of each head is shown in Table 3-20. Table 3-20 shows that due to non-uniform spacing, and each head covering less than 130 ft², the 12 most remote sprinklers are insufficient in covering 1500 ft². A total of 17 sprinkler heads are needed. Note that the sum of 1777 ft² in Table 3-20 is subject to some overlapping, and the minimum area requirement is just barely met by these 17 sprinklers.

The number of sprinklers per branch lines is determined as follows, to ensure a desired rectangular shaped coverage area:

$$\frac{1.2\sqrt{(\text{Area of operation})}}{\text{Spacing on branch line}} = \frac{1.2\sqrt{1500\,ft^2}}{\left(11+\frac{2.5}{12}\right)ft} = 4.15$$

NFPA 13 requires the calculated amount of sprinkler to be rounded up, but due to the layout of sprinklers it is not possible to have more than four heads per branch line in this area. The desired rectangular coverage area with the longest side parallel to the branch line is still maintained.

The following table shows the coverage area of each sprinkler head in the remote area. The location of each sprinkler is shown in Figure 28. A total of 17 sprinklers are needed. Due to some overlapping of sprinkler coverage areas, the total area appears to be greater than 1500 ft², yet these 17 sprinklers just barely cover 1500 ft².

Table 3-20 - Coverage Area of Each Sprinkler Head

Device ID	Distance between branch lines (L) [ft]	Distance along branch line (S) [ft]	Coverage Area [ft²]
BL1 - 1	7.17	11.21	80.33
BL1 - 3	7.17	11.21	80.33
BL1 - 5	7.00	11.21	78.46
BL1 - 7	7.17	11.21	80.33
BL1 - 2	8.25	11.29	93.16
BL1 - 4	8.25	11.21	92.47
BL1 - 6	8.25	11.21	92.47
BL1 - 8	8.25	11.29	93.16
BL2 - 1	10.50	11.88	124.69
BL2 - 2	10.50	11.88	124.69
BL2 - 3	10.50	11.88	124.69
BL2 - 4	10.50	10.88	114.19
BL3 - 1	10.50	11.88	124.69
BL3 - 2	10.50	11.88	124.69
BL3 - 3	10.50	11.88	124.69
BL3 - 4	10.50	10.88	114.19
BL4 - 1	10.50	10.50	110.25
		Total	**1777.44**

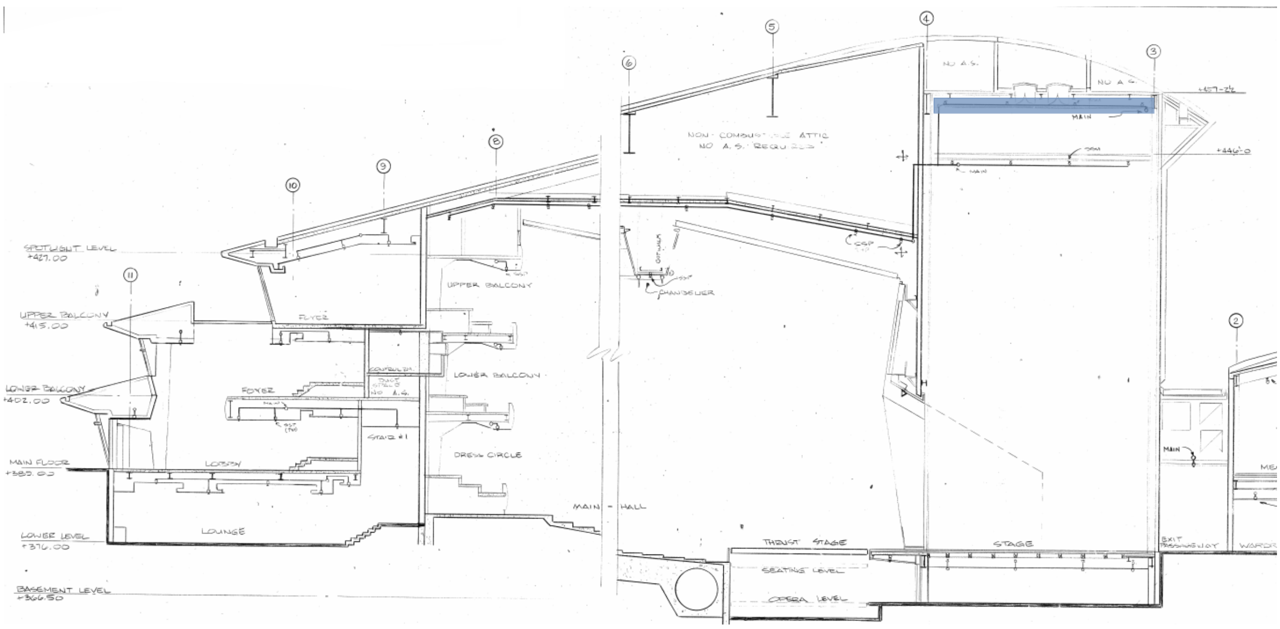

Figure 27 - Most Remote Area, Section View

Figure 28 show the remote area, where each branch line and sprinkler head is given an ID. Note that BL1 connect sprinkler 1, 3, 5, and 7 by sprigs.

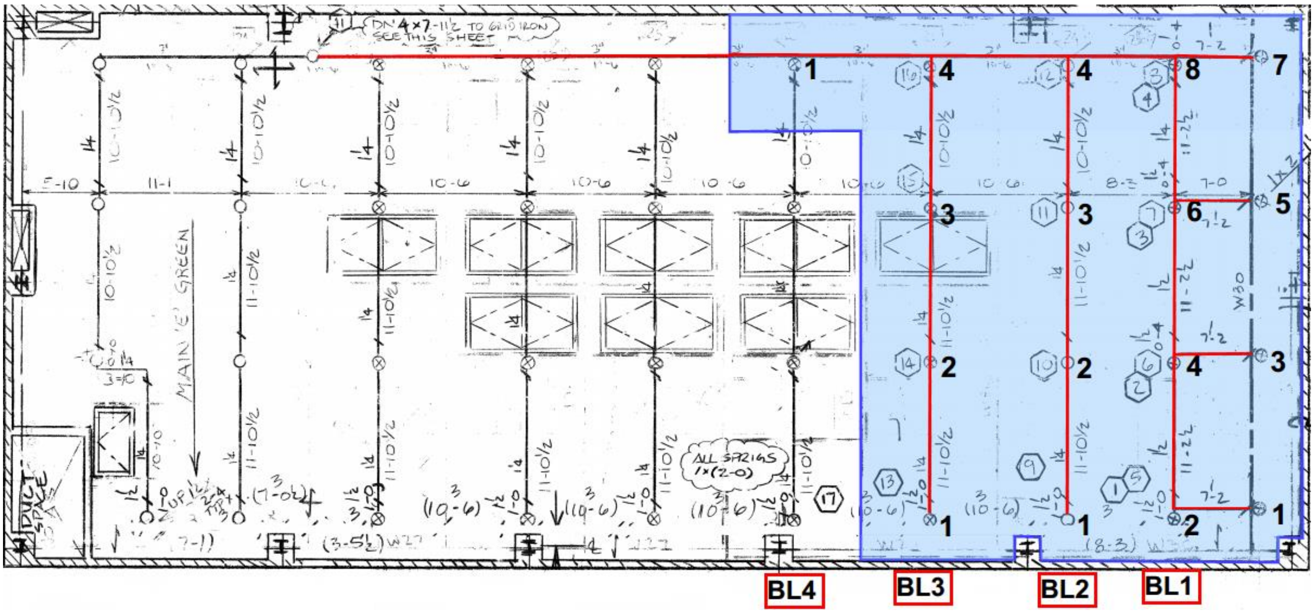

Figure 28 - Most Remote Area, Plan View

3.6.3.1.2 Hydraulic Calculations

From the SFPE Handbook of Fire Protection Engineering Table 42.1, wet-pipe systems utilizing steel pipes uses a C-factor of 120.

The original construction drawing states that pipes are of Schedule 40. Table A.6.3.2 of NFPA 13 Handbook determines all actual inner diameters of pipes. Table 23.4.3.1.1 of NFPA 13 determines equivalent pipe lengths for fittings and valves.

The estimated flow and pressure demand is 585 gpm and 162 psi, see Figure 31. The hydraulic calculation is included in Appendix E. Note that for BL1, sprinkler 2 has a higher coverage area than sprinkler 1, and consequently this is considered the most remote sprinkler.

3.6.3.2 ***Water Supply***

3.6.3.2.1 City Water Supply

Flow test data from a hydrant close to the point of connection is as follows:

- Static pressure: 130 psi
- Flow: 1100 gpm
    - Residual pressure: 60 psi

The test was done in 1994, and can therefore not be considered to give a realistic representation of the water supply today. However, the data from the flow test is used in this report to determine the city water supply, as this report is for educational purposes.

Figure 29 show the location of the flow test hydrant (red) on Tahoe Road, and the location of the fire department connection (blue). There is a 6-inch underground piping connection between the hydrant and the test header.

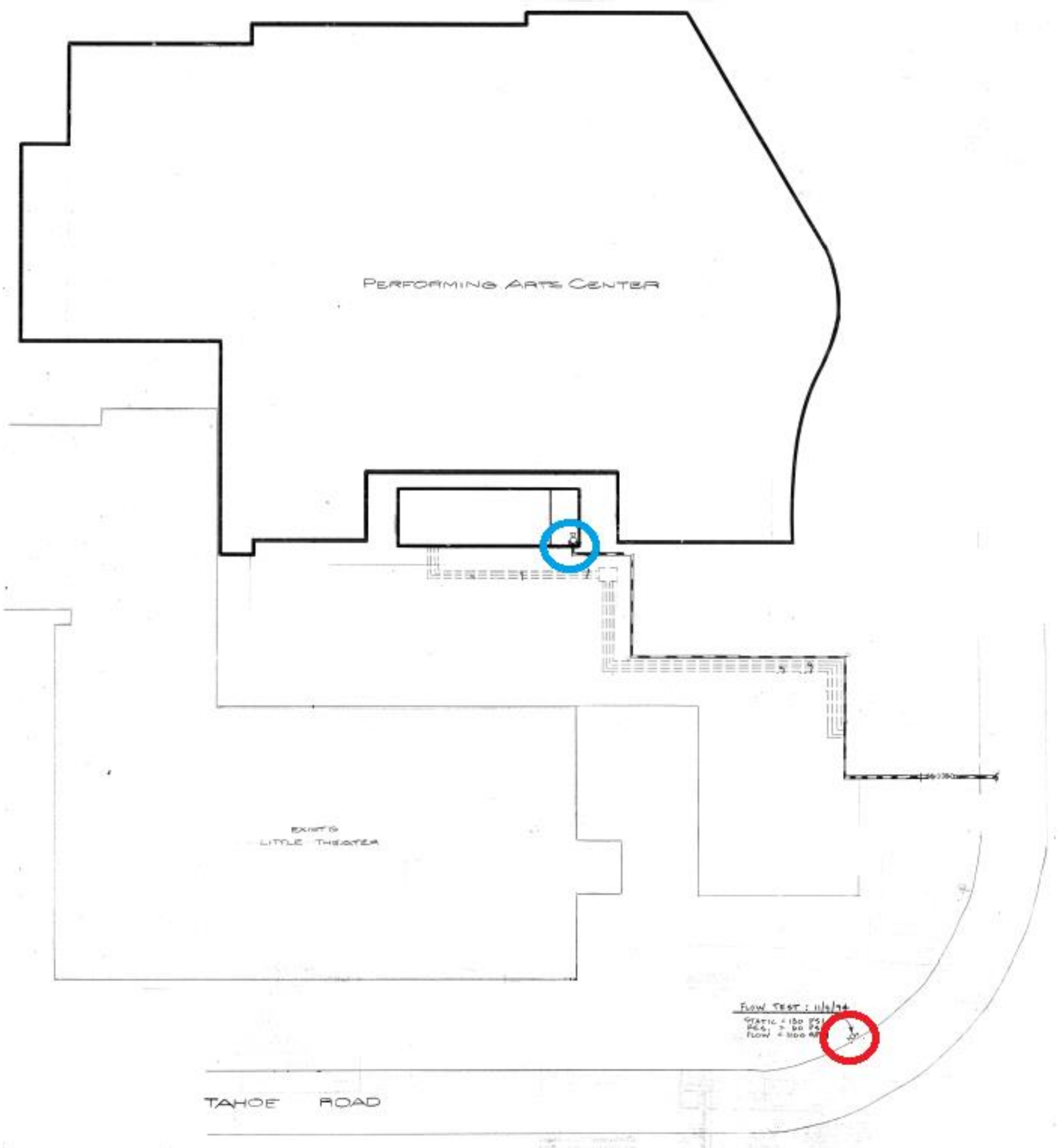

Figure 29 - Test Hydrant Location

3.6.3.2.2 Fire Pump

Originally there was a fire pump installed in the building, rated at 750 gpm at 90 psi. In 2001 the Facilities Planning Department of Cal Poly requested to remove the pump, with the following justification: "*With the completion of the structure, the required water pressure is now achieved without the need for this pump. Currently the pump is disconnected and the existing system pressure reads 140 PSI*".

Inspection in 2017 confirmed that the pump was not present in the location indicated in Figure 30, and from this it is concluded that the system strictly relies on the city water supply. No new flow test data has been successfully obtained, but do note that the one listed above is dated.

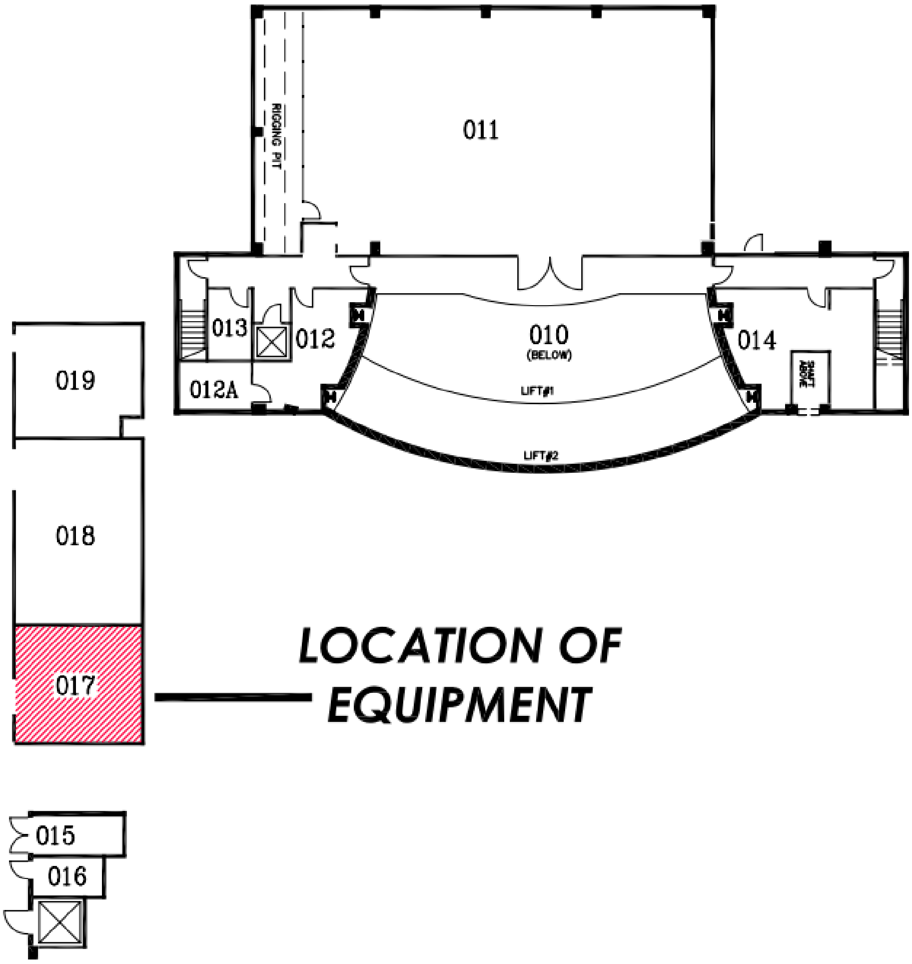

Figure 30 - Original location of the fire pump

3.6.3.3 *Demand Vs. Supply*

Figure 31 shows the water supply from the city (in green), and the system demand (in red). The pressure gauge reading used to justify removing the pump is also included (teal color).

From the available supply data and the hydraulic calculation of Appendix E, it's concluded that removing the pump resulted in insufficient water supply. Note that additional pressure loss would occur in the underground piping, from the riser to the location of the flow test. This pressure loss is not included, as we already see failure to deliver enough water at sufficient pressure.

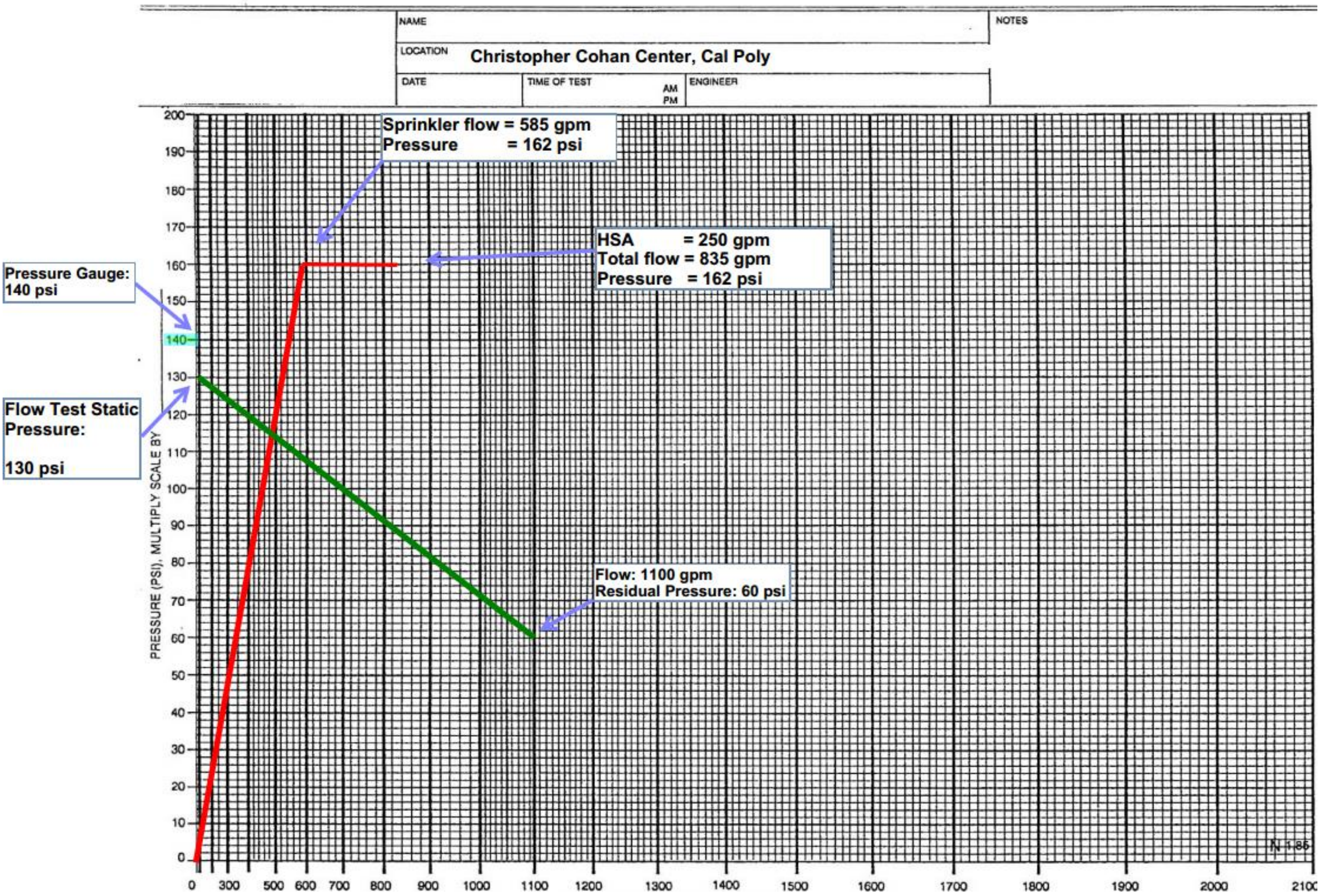

Figure 31 - Water Demand vs. Water Supply

3.6.3.3.1 Original Hydraulic Calculation (1994)

The design engineer of the sprinkler system performed hydraulic calculations in 1994, using HASS Computer Program. Table 3-21and Figure 32 show excerpts from the 1994 hydraulic calculation document, where the remote area of Figure 28 is calculated. Note that between node 203 and 300 of Table 3-21, the needed pressure drops with 90 psi. Further investigation shows that node 203 was the fire pump, so the design engineer takes the pressure of the pump into account mid-calculation. This approach differs from the 2015 version of NFPA 13.

NFPA 20 states that pumps must be able to operate at minimum 150 % of rated capacity at no less than 65 % of total rated head. Also, the churn pressure shall not exceed 140 % of rated pressure. None of this appear to be addressed in the 1994 hydraulic calculation. Furthermore, as the pressure effect of the pump is included in the calculation of Table 3-21, the churn pressure and effect at 65 % capacity is not shown graphically in Figure 32.

Figure 32 shows that the water and pressure requirement is 826.5 gpm at 72.58 psi. Since the pressure result is including the effect of the pump, it can appear misleading, as without the pump the requirement would be 826.5 gpm at 162.58 psi. This is consistent with the hand calculation performed by the author of this report, shown in Figure 31.

Due to lack of obtained documentation regarding the removal of the fire pump, it is not clear if there are additional factors that come into play, with regards to removing the fire pump. However, it appears that a possibility is that the fire pump was removed due to the misleading illustration of Figure 32, where it appears that the flow and pressure requirement is met by the city water supply alone.

Table 3-21 - Excerpt from the Original Hydraulic Calculation (1994)

NODE ANALYSIS DATA

NODE TAG	ELEVATION (FT)	NODE TYPE	PRESSURE (PSI)	DISCHARGE (GPM)
1	409.0	K= 5.50	24.7	27.3
2	409.0	K= 5.50	27.2	28.7
3	409.0	K= 5.50	26.3	28.2
4	409.0	- - - -	29.0	- - -
5	409.0	K= 5.50	30.2	30.2
6	409.0	K= 5.50	39.3	34.5
7	409.0	K= 5.50	46.2	37.4
8	409.0	K= 5.50	55.1	40.8
9	409.0	K= 5.50	60.2	42.7
10	409.0	- - - -	64.3	- - -
11	410.0	K= 5.50	21.0	25.2
12	410.0	K= 5.50	23.1	26.4
13	410.0	K= 5.50	26.0	28.0
14	410.0	K= 5.50	31.5	30.9
15	410.0	K= 5.50	34.3	32.2
16	410.0	K= 5.50	47.8	38.0
17	410.0	K= 5.50	55.6	41.0
18	410.0	K= 5.50	60.8	42.9
19	410.0	- - - -	64.9	- - -
20	403.5	K= 5.50	58.7	42.1
21	403.5	- - - -	63.6	- - -
22	403.5	- - - -	64.9	- - -
23	403.5	- - - -	66.2	- - -
24	403.5	- - - -	66.8	- - -
24A	403.5	- - - -	67.7	- - -
24B	410.5	- - - -	65.4	- - -
25	410.5	- - - -	66.1	- - -
26	410.5	- - - -	67.1	- - -
27	405.0	- - - -	81.1	- - -
28	393.0	- - - -	95.0	- - -
95	393.0	- - - -	102.1	- - -
96	393.0	- - - -	113.5	- - -
97	389.0	- - - -	116.9	- - -
98	389.0	- - - -	135.6	- - -
100	375.0	- - - -	146.5	- - -
200	369.0	- - - -	150.6	- - -
201	369.0	- - - -	152.8	- - -
202	374.0	- - - -	151.0	- - -
203	374.0	- - - -	151.8	- - -
300	374.0	- - - -	61.6	- - -
301	374.0	- - - -	62.0	- - -
302	369.0	- - - -	64.4	- - -
303	369.0	- - - -	64.6	- - -
304	375.0	- - - -	62.2	- - -
305	375.0	- - - -	69.2	- - -
306	369.0	- - - -	72.1	- - -
400	369.0	SOURCE	72.6	576.5

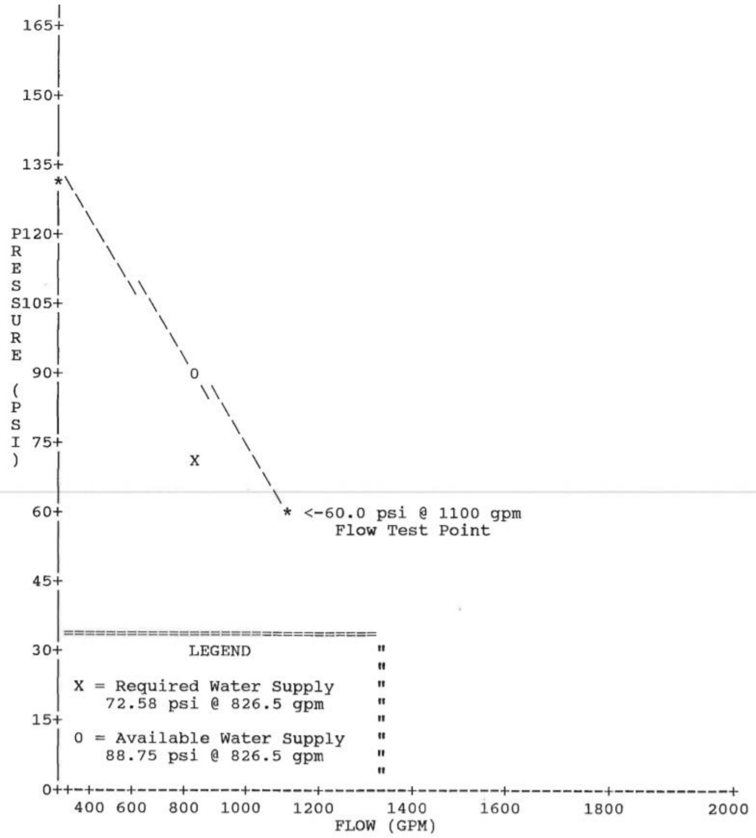

Figure 32 - Original Water Demand vs. Supply Curve (1994)

3.6.3.4 ***Qualitative Evaluation of Sprinkler Effectiveness***

The effectiveness of sprinklers relies on other factors than meeting the water flow and pressure requirements. It is crucial to deliver water to the fire source in order to have successful suppression, and the following issues was observed during building inspection.

Sprinklers are installed at two heights above the stage; the gridiron level, and upper balcony level. The sprinklers at highest elevation (i.e. gridiron) are expected to activate first, as they will be engulfed in the ceiling jet at an earlier stage (assuming no smoke stratification). Consequently, the smoke plume might become 80 ft high, entraining large amounts of air, before a ceiling jet develops. This entrainment is expected to cool the gas considerably, resulting in a delayed response of sprinklers. A delay in sprinkler activation will allow the fire to develop, and, therefore, require larger droplets to penetrate the hot smoke plume. For sprinkler heads with a K-factor of 5.5 (i.e. ½ inch orifice), it is assumed that relatively small droplets are produced.

Another challenge is the amount of obstructions between the stage floor and the sprinklers. Walkable platforms, curtains, and hanging scenery are among the obstructions identified during inspection of the building.

Suppression will not be modeled in the Performance Based Analysis, but smoke temperature will be identified, and give further basis for a qualitative evaluation of sprinkler sprays ability to penetrate the plume without vaporizing.

3.6.3.5 ***Summary of Suppression Systems***

Three suppression systems are installed in the building; Ansul kitchen suppression system, Pre-action system, and wet-pipe sprinkler system. The Ansul system is not analyzed in detail, as it is assumed to be a pre-engineered system. As the most remote area is covered by the wet-pipe sprinkler system, it has been the focus of the analysis. It appears that originally the system complied with NFPA 13, but based on the documents readily available, removing the fire pump resulted in insufficient water and pressure supply.

With the sprinkler system deemed insufficient, it is crucial to ensure proper design and management of alternative fire safety systems. The following section (3.7) addresses smoke management of the building.

3.7 SMOKE CONTROL

3.7.1 Roof vents

The LSC requires smoke control systems for stages in assembly areas. The PAC has a spring-operated roof vent system, which activates by fusible links with a temperature rating of 74 °C (165 °F). The thermal response time index (RTI) of these links are unknown, but RTI's of 167-180 $(m{\cdot}s)^{0.5}$ have been reported for fusible links[5]. Manual means of roof vent activation is also provided.

A minimum of two roof vents are required above the center area of the stage. The combined area of vents must be at least five percent of the total stage area. This requirement is met with the installation of eight vents of a combined area of 224 ft^2, above the approximately 4160 ft^2 stage, see Figure 33.

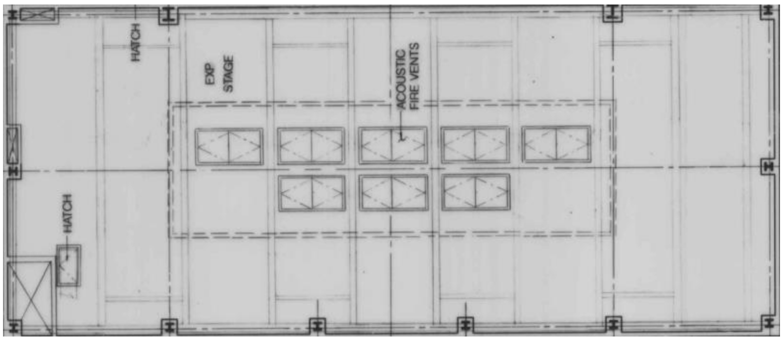

Figure 33 - Roof vents above the stage

The obtained documentation of the smoke ventilation system includes no information about the designated makeup-air inlets. As all doors from the stage lead to a 2-hour fire rated exit corridor, none of these are considered appropriate for that purpose. It is possible that the HVAC system is designed to provide makeup-air at low elevation, but that would require manual interaction, as the smoke vents are not connected to the fire alarm system, but activate on fusible links. All vents activate simultaneously upon sufficient heat exposure to any fusible link.

3.7.2 Proscenium Wall Fire Curtain

In addition to this natural smoke exhaust system, the LSC requires proscenium wall protection. The wall separating the theater and the backstage area have a fire rating of two hours, and the opening is equipped with an automatically applied fire curtain. The curtain has a 2-hour fire rating, and is activated on fusible links, rate of rise heat detector, or manual interaction. The proscenium wall opening is shown in Figure 34.

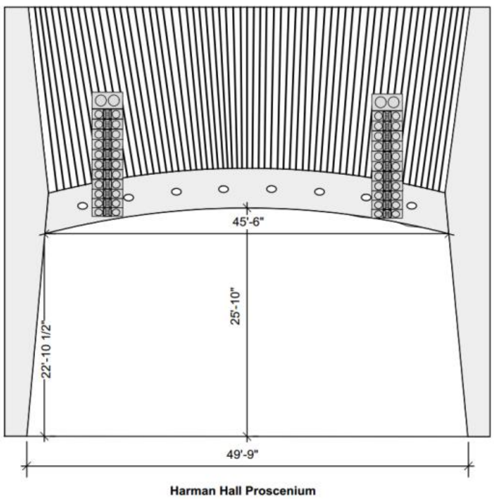

Figure 34 - Proscenium Wall Opening

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[5] Sprinkler, Smoke & Heat Vent, Draft Curtain Interaction -- Large Scale Experiments and Model Development

4 PRESCRIPTIVE SUMMARY

The prescriptive Life Safety Analysis have been performed in accordance with NFPA 101 Life Safety Code, and referenced Codes/Standards within the LSC. The analysis addressed structural fire protection, interior finish requirements, egress analysis, fire safety management, fire alarm systems, automatic suppression systems, and smoke management.

The building meets the prescriptive requirements of the applicable codes listed in chapter 1.3, with the following exceptions:

- Spacing of Smoke Detectors of the Entry Lobby is not in accordance with prescriptive requirements of the LSC.
- The sprinkler system appears to have insufficient water supply, due to the removal of the fire pump. This conclusion is based on the information available, where the flow test data is dated.

The building design is not in accordance with the prescriptive requirements of the Life Safety Code. The following section (5) evaluates the building design against the performance based life safety objectives of the LSC.

5 PERFORMANCE BASED ANALYSIS

This performance based analysis is done in accordance with chapter five of the LSC Handbook 2015 edition, and supplemented by the approaches of the SFPE Handbook of Fire Protection 5th edition.

5.1 SCOPE

The focus of the analysis is on life safety of occupants of the Christopher Cohan Center. Other potential stakeholder interests, such as structural protection and continuity of operations, are assumed met by the prescriptive design.

The available safe egress time (ASET) needs to exceed the required safe egress time (RSET), including a sufficient margin of safety. However, common goals and objectives for the prescriptive- and performance based analysis is described in Chapter 1.1.1 and 1.1.2.

As this report is an analysis of an existing building, certain limitations of suggested changes/improvements follow from a practical standpoint.

5.2 PERFORMANCE CRITERIA

The Life Safety Code performance criteria is that any occupant who is not intimate with ignition shall not be exposed to instantaneous or cumulative untenable conditions. Persons who are intimate with the initial fire development is defined as person(s) at the ignition source or first item ignited, not necessarily all occupants occupying the area of ignition.

To meet the LSC performance criteria, the following must be met for all occupants not intimate with ignition:

- Prevention of incapacitation by fire or smoke
- Prevention of thermal damage
- Providing sufficient visibility such that people can navigate means of egress.

5.2.1 Tenability Criteria

The tenability criteria are a way of quantifying how to meet the performance criteria stated above. Method 1 of the LSC is applied. The tenability thresholds are divided into three categories; visibility, toxic gases and exposure to heat.

5.2.1.1 *Visibility*

The tenability threshold for visibility is 10 meters.

Visibility conditions impact people's decision making, travel speeds and wayfinding abilities during evacuation. As the highest levels of occupancies consist of balconies, there is also an associated fall hazard with lower levels of visibility. The line of vision from any point of the balconies to the exit doors not exceed 41 ft (12.5 m).

There is a widespan of values for visibility and smoke density among researchers, but ten meters is recommended for large enclosures[6]. This value is largely based on experimental results with regards to turn-back behaviors. Less than five percent turn-back was reported for visibilities of more than nine meters.

The visibility threshold is expected to be exceeded prior to other tenability criteria.

5.2.1.2 *Toxicity*

The tenability threshold for Carbon Monoxide is selected to be 1750 ppm.

ISO 13571 apply 35 000 ppm·min as the value in which causes incapacitation. This concentration is for humans performing exercises associated with light to moderate work (i.e. walking horizontally or down stairs). This level of effort is considered applicable to evacuation of the Harman Hall, as no occupants are subject to ascending more than a few stair steps (which can be considered heavy work). Therefore, for an exposure duration of 20

[6] SFPE Handbook of Fire Protection Engineering 5th edition, table 63.5

minutes, a concentration of 1750 ppm CO will cause incapacitation, per ISO 13571. For conservatism, the instant this concentration occurs for any space, that space is considered untenable.

Hypoxia is also caused by oxygen depletion. Studies have concluded however, that for oxygen concentrations of 15 % or more, little other effect than an increased heart rate is expected. Below this oxygen concentration, the effect can be severe. Therefore, 15 % oxygen concentration is the tenability threshold.

5.2.1.3 *Heat Exposure*

5.2.1.3.1 Air/gas temperature:

The tenability criterion for air/gas temperature is 60 °C.

For fully saturated air, it has been found that temperatures above 60 °C is unbreathable[7]. Although fires are not expected to create saturated conditions themselves, occupancies covered by automatic water suppression systems are recommended to use 60 °C as a tenability criterion. This tenability threshold is particularly relevant for this case, as concern to whether the sprinkler system would be successful to suppress the fire is raised. The water applied to the fire/plume would be evaporated, creating steam that saturates the air. 60 °C is lower than reported thresholds for both temperatures causing hyperthermia, and skin burns by convection.

5.2.1.3.2 Skin burns by radiation:

The tenability criterion for radiation heat exposure is 2.5 kW/m^2.

Radiation heat flux is reported to cause severe skin pain for exposures exceeding five minutes[8]. Although the required safe egress time including safety margin is expected to exceed five minutes, the moment any person is subject to this heat flux, that person is considered exposed to untenable conditions.

[7] SFPE Handbook of Fire Protection Engineering 5th Edition, chapter 63.
[8] SFPE Handbook of Fire Protection Engineering 5th Edition, Figure 63.30

5.3 FIRE SCENARIOS

The process of performance based design in the SFPE Handbook states that trial designs must be evaluated. As the PAC is an existing building, the current design is evaluated.

The Life Safety Code requires that the following eight Fire Scenarios are considered with regards to applicability, level of challenge, and how realistic they are:

1. Occupancy-specific
2. Fire in primary egress, interior doors open
3. Normally unoccupied room
4. Concealed wall/ceiling
5. Shielded from suppression
6. Most severe fire
7. Outside exposure
8. Ordinary fire, no detection or suppression

To assess the applicability and level of challenge of each scenario listed above, building characteristics, occupant characteristics and expected fire characteristics of the Performing Arts Center needs to be evaluated.

The Prescriptive analysis is referenced for building characteristics.

5.3.1 Occupant Characteristics

The characteristics of occupants are evaluated with respect to egress, and divided into two categories: Staff and other occupants. Staff is all people permanently stationed in the PAC, and therefore assumed to be familiar with their surroundings, and participate in evacuation drills in the building of concern. Other occupants include spectators of shows, people attending banquettes/meetings and performers.

Table 5-1 - Occupant Characteristics of the Building

Characteristics	Staff	Other Occupants
Familiarity	Familiar	Unfamiliar
Training	Yes	None
Ages	Adults	Children, adults, elderly
Disabilities	Small range possibility	Wide range possibility
Level of Intoxication	Conscious	Intoxication possible
Awake	Awake	Awake
Social Groupings	Individual, co-workers	Individuals, couples, families, groups
Role	Crowd manager/subordinate	Guest (expects assistance)

5.3.2 Analyzed Scenario

<u>Scenario 1: Fire in stage-area of the Harman Hall.</u>

This scenario is considered to cover occupant specific, most severe non-arson fire, and therefore analyzed in this report.

Figure 35 gives a section view of fire scenario 1. The firewall (i.e. fire curtain) will be modeled as unsuccessful to deploy, allowing for fluid flow into the theater through the proscenium wall opening. Note that the elevation from the stage floor to the ceiling above is 80 ft. Two main consequences follow from this:

1. The gridiron is expected to function as a smoke reservoir delaying the smoke spread to the theater.
2. Air entrainment into the smoke plume will result in lower temperature and buoyancy of the fire products.

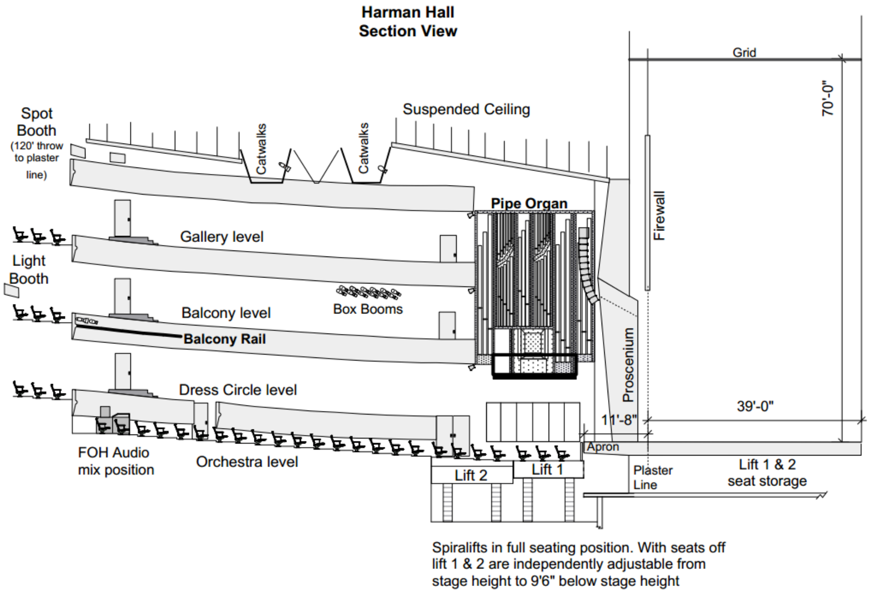

Figure 35 - Section View of Fire Scenario 1

As a worst-case scenario, with respect to the required safe egress time, a fully seated theater will be considered where both lifts are in the upright position with occupant seating. This gives a total of 1285 fixed seats.

5.3.3 Other Scenarios

Scenario 2: Fire in the lobby of the entry lobby level.

This scenario addresses a fire in the primary means of egress. There is a kiosk in the entry lobby, assumed to have coffee makers or other electrical ignition sources. In addition, the entry lobby have several Christmas trees in the entry lobby during Christmas season. These are also possible fuel, and are known to burn rapidly. The scenario would address separation distances for trees, to prevent fire spread.

Scenario 3: Arsonist igniting a liquid accelerant.

This scenario could be considered most severe in the event of ignition in a fully seated theater. For this case, the flammability of the seats of the Harman Hall amongst other combustibles would need to be evaluated.

Scenario 4: Fire in a Service Space

Ignition could occur in unoccupied areas, such as electrical rooms, mechanical rooms, and other technical service areas. Technical service rooms are located at all floors, and some utilize heat detectors rather than smoke detectors, which could result in delayed notification, in the event of a fire.

Fire scenario 4 should address how failure of fire rated constructions/openings affects life safety of occupants of adjacent spaces.

5.3.3.1 ***Model Selection***

The fires are modeled with Fire Dynamics Simulator (FDS) version 6. FDS is a Computational Fluid Dynamics program, developed by the National Institute of Science and Technology (NIST).

To evaluate the models applicability for this analysis, a verification and validation evaluation is performed as follows:

5.3.3.1.1 Verification

The SFPE Handbook of Fire Protection Engineering 5th Edition states that verification responsibility of computer models is shared between developers and users. NIST have performed extensive work to verify that the governing equations of FDS are solved correctly. The most important work of the FDS user is therefore to ensure that an appropriate resolution of the underlying computational grid is used, in order ensure an acceptable level of calculation accuracy. This evaluation has been done by both performing a grid sensitivity analysis with respect to activation of sprinklers and heat vents, as well as using a mesh size calculator to evaluate that fluid flow and fire dynamics are solved with sufficient accuracy.

Grid Sensitivity Analysis

The grid sensitivity analysis was performed by running FDS with cell sizes of 100 cm, 50 cm, and 25 cm. The impact of the grid resolution was evaluated by the difference in time to activation of sprinklers and smoke vents at the gridiron level. The activation time is evaluated because smoke vents are crucial to the ASET, and activation of sprinklers are the first means of automatic initiation of notification appliances.

The activation time with each grid size is summarized in Figure 36. The time for one of the fusible links associated with the smoke vents to reach a temperature of 74 °C varies with 7 seconds from 50 cm to 25 cm mesh size. From this result, it seems like there is some computational accuracy to gain from further reduction of the mesh size, though that requires exceptionally long computational time. From a practical standpoint, a grid resolution of 25 is therefore considered beneficial for this application.

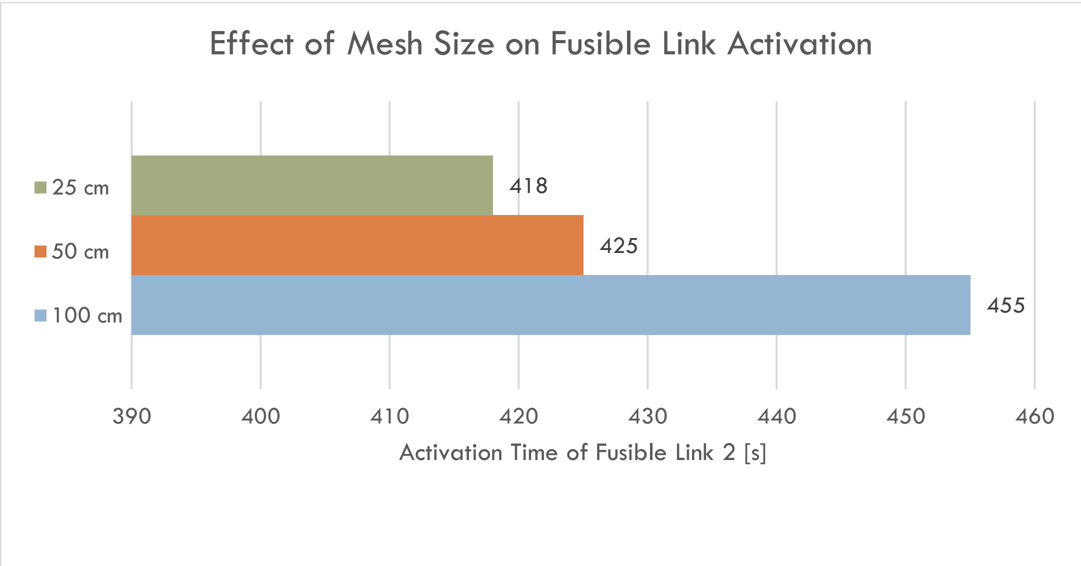

Figure 36 - Results of the Grid Sensitivity Analysis

Mesh Size

The so-called FDS Mesh Size Calculator has been used as a means of determining mesh size. A characteristic fire diameter is calculated, to estimate the models ability to resolve fluid flow and fire dynamics. The characteristic fire diameter is calculated in accordance with Equation 1 below:

Equation 1 - Characteristic Fire Diameter

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

Where:

D^* : characteristic fire diameter

ρ_∞ : fluid density

c_p : specific heat of fluid

T_∞ : ambient temperature of fluid

g : gravity

$\dot{Q}$: heat release rate

Each model will be run for 600 seconds, in which a t-squared fire[9] with a growth coefficient of 0.0469 kW/s^2 reaches 16884 kW. Therefore, the characteristic fire diameter is calculated using a heat release rate of 16884 kW, and properties of air at an ambient temperature of 293 K.

$$D^* = \left(\frac{16884kW}{\left(1.204kg/m^3\right)\left(1.005kJ/kg\cdot K\right)\left(293K\right)\sqrt{9.81m/s^2}} \right)^{2/5} = 2.97$$

There is an unofficial rule of thumb that the characteristic fire diameter (D^*) divided by the cell size (dx) of value more than 10 gives a reasonable accuracy of flow and heat calculations, though greater values results in better accurate calculations. A rule of thumb in itself is insufficient to determine the mesh size, as a fairly severe fire is modeled in a large enclosure.

In the Nuclear Power Industry of the US, models have been validated with D^*/dx in the range of 4 to 16[10]. Based on that range, the following meshes are considered for this scenario:

- Coarse mesh: cubical cells of 72 cm
- Moderate mesh: cubical cells of 29 cm
- Fine mesh: cubical cells of 18 cm

Ultimately, a cell size of 0.25 m was applied, giving $D^*/dx = 11.88$

[9] http://www.koverholt.com/t-squared-fire-ramp-calculator/
[10] http://www.koverholt.com/fds-mesh-size-calc/

5.3.3.2 *Validation*

In accordance with methods of SFPE Handbook 5th Edition, the validation process of FDS is performed by evaluating the applicability of validations studies, followed by quantifying the model uncertainties. Validation studies of The FDS Validation Guide, and NUREG 1824 Supplement 1 are referenced.

5.3.3.2.1 Applicability of Validation Studies

To determine the applicability of validation studies, certain model parameters of interest are quantified. These parameters are normalized, and compared to the validation ranges of the validation studies. Table 5-2 show the parameters evaluated in the modeling of fire scenario 1.

All parameters appear within the range of both NUREG 1824 and the FDS Validation Guide, except for the Fire Froude Number (0.02) of the largest burner area modeled in the fly gallery. Due to the large fire diameter, this parameter is not covered by any of the referenced validation experiments. Note that the Fire Froude Number is also applied to calculating the flame height. Note however that both burner areas described in Chapter 5.5.1 was modeled in the fly gallery.

Table 5-2 - Normalized Parameters of FDS, in accordance with NUREG 1824 Supplement 1, Table 3-3.

	Normalized Parameter	Definition	Range used in this Analysis	NUREG 1824 Experimental Range	FDS Studies Within the Model Range
Fire Froude Number	$\dot{Q}^* = \frac{\dot{Q}}{\rho_\infty c_p T_\infty \sqrt{gD} D^2}$	Ratio of inertial and buoyancy-induced velocities. A typical accidental fire has a Froude number of order 1. Momentum-driven fire plumes, like jet flares, have relatively high values. Buoyancy-driven fire plumes have relatively low values.	0.02 – 0.60	0.2 – 9.1	No experiments cover 0.02
Flame Length Ratio	$\frac{H_f + L_f}{H}$ $\frac{L_f}{D} = 3.7\dot{Q}^{*2/5} - 1.02$	A convenient parameter for expressing the "size" of the fire relative to the height of the compartment. A value of 1 means that the flames reach the ceiling.	0.20 – 0.33	0.0 – 1.6	Several experiments cover the modeled range
Ceiling jet radial distance	$\frac{r_{cj}}{H}$	Indicates the distance from the fire plume of a sprinkler, fusible link, etc., relative to the compartment height, H.	0.18 – 0.24	0.0 – 6.0	Several experiments cover the modeled range
Equivalence Ratio	$\phi = \frac{\dot{m}_F / \dot{m}_{O_2}}{r} = \frac{\dot{Q} \Big/ \Delta H_c \Big/ 0.23 \cdot \frac{1}{2} \frac{A_o \sqrt{h_o}}{A_t}}{r}$	The equivalence ratio relates the energy release rate of the fire to the energy release that can be supported by the mass flow rate of oxygen into the compartment, $\dot{m}_{O_2}$.	0.46	0.0 – 6.0	Several experiments cover the modeled range

		The fire is considered over- or under ventilated based on whether ϕ is less than or greater than 1 respectively.			
Compartment Aspect Ratio	$\frac{W}{H}$ or $\frac{L}{H}$	This parameter indicates the general shape of the compartment, where W is room width, L is room length, and H is room height	1.22 – 2.2	0.8 – 7.1	Several experiments cover the modeled range
Radial Distance Ratio	$\frac{r_{rad}}{D}$	Indicates whether a "target" is near or far from the fire.	3.37	0.3 – 8.0	Hamins CH_4, NIST/NRC, PRISME

5.3.3.2.2 Model Uncertainty

The model uncertainty of this analysis is evaluated based on the uncertainty metrics of both the FDS Validation Guide, and NUREG 1824 Supplement 1. Table 5-3 show that the studies have bias factors within a few percent of each other for each quantity, except for the smoke detector activation.

Quantities impacting tenability and time to activation of devices are particularly important in this analysis. As visibility is expected to be the initial tenability criteria to be violated, the following quantities are evaluated: HGL depth, and smoke concentration. For activation of sprinklers and smoke vents, the HGL temperature rise, and target temperature rise are particularly important.

It appears that FDS tends to overpredict the temperature and depth of the gas layer by a few percent, but overpredicts the smoke concentration by a factor of more than 2.5. Note the relatively large standard deviation of the smoke concentration. The uncertainty of target temperature rise varies for these validation studies. NUREG under predicts-, and FDS Validation Guide overpredicts the temperature rise of targets by a few percent.

Table 5-3 - Uncertainty Metrics of the Validation Studies

Output Quantity	**NUREG 1824** (Average for all experiments)		**FDS Validation Guide** (Average for all experiments)	
	Bias Factor (δ)	Relative Std. Deviation $(\tilde{\sigma}_M)$	Bias Factor (δ)	Relative Std. Deviation $(\tilde{\sigma}_M)$
HGL Temp. Rise, Natural Ventilation	1.02	0.12	1.05	0.07
HGL Depth	1.03	0.06	1.04	0.05
Ceiling Jet Temp. Rise	0.98	0.14	1.05	0.14
Plume Temp. Rise	1.20	0.21	1.18	0.16
Oxygen Concentration	1.01	0.11	0.99	0.12
Smoke Concentration	2.63	0.59	2.54	0.60
Target Temp. Rise	0.98	0.18	1.03	0.20
Surface Heat Flux	0.92	0.15	0.99	0.22
Sprinkler Activation Time	0.93	0.15	0.95	0.16
Smoke Detector Activation Time	0.85	0.29	0.58	0.27

5.4 Required Safe Egress Time

The timeline of Figure 37 is applied to evaluate the required time for occupants to reach an area of safety, against the time they have available before they would be subject to untenable conditions.

The required safe egress time is divided into the following subcategories:

- Detection time
- Time from detection to notification
- Pre-movement time
    - Recognition time
    - Response time
- Travel time

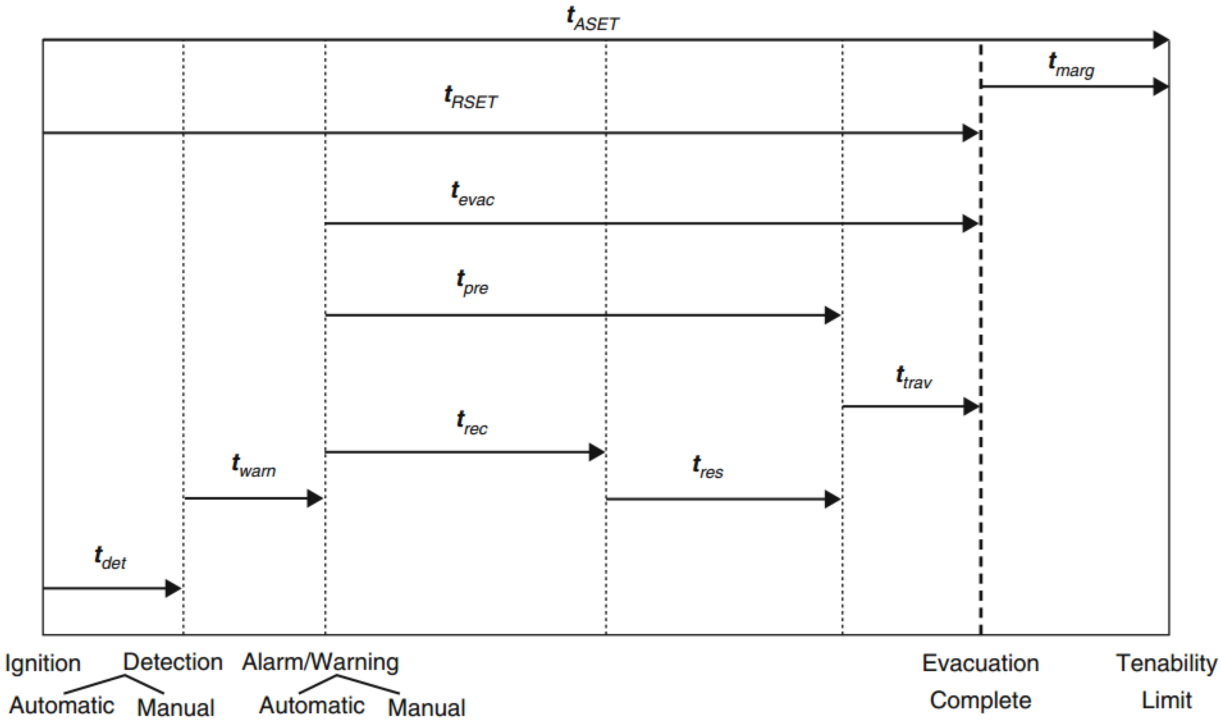

Figure 37 - Engineering Timeline (From SFPE Handbook of Fire Protection)

For conservativism, the required safe egress time is calculated without considering manual fire detection. Time to automatic detection, and time from detection to notification is addressed in the chapter on available safe egress time.

5.4.1 Detection and Notification Time

5.4.1.1 *Detection time for fire at the stage floor:*

From Chapter 5.5.4.1.4, the automatic detection and initiation of notification appliances can approach 9 minutes, from ignition. By this time, the design fire reaches a severe HRR and is estimated to already have rapidly exposed occupants of the theater to smoke.

Manual pull stations are provided at required locations, and there is always minimum one staff member present at the backstage area. However, there is no designated fire watch unless smoke/fog effects are used. Therefore, human reliability with regards to fire detection and notification initiation is not considered reliable enough to replace automatic detection and notification.

For the fire on the stage floor, the worst case with regards to detection time is considered 520 seconds.

5.4.1.2 *Detection time for fly gallery fire:*

The fly gallery fire has been modeled with two different burner areas, and at two locations. The time until activation of the first sprinkler ranged from 5 minutes and 30 seconds to 6 minutes depending on horizontal fire location, allowing the fire to approach 8 MW before triggering the water flow switch and initiation notification appliances.

For the fire in the fly gallery, the worst case with regards to detection time is therefore considered 6 minutes.

5.4.2 Pre-movement Time

Referencing the SFPE Handbook, humans will typically feel safe initially upon receipt of a fire signal. Upon alarm signal, people will start to gather information to make decisions. Due to the following 3 factors, the pre-movement time is expected to be limited;

1. The FACP shuts down the speaker system upon fire/smoke detection, and performers are instructed to halt all activity.
2. There is a voice alarm communication system installed, with both a pre-recorded message as well as means to give manual instructions.
3. Trained crowd managers function as people of authority that initiate evacuation, and will direct patrons to the exits.

The pre-movement time is quantified based on experiments performed by Purser and Bensilum, for 3-story theaters. Purser and Bensilum report pre-evacuation times of 10-36 seconds[11]. A total number of 311 occupants participated in the experiment, including staff. The Harman Hall has a capacity of several times that, and therefore the most conservative value is used, i.e. 36 seconds.

5.4.3 Movement Time

The movement time is modeled in the 2016th edition of Pathfinder. Pathfinder is validated against codes, fire drills/ experiments, against other models, as well as literature on past experiments[12].

The total occupant load of this simulation is 1421, where 133 are performers on stage, and the remaining occupants are spectators of the show. The egress paths of each floor are presented in the prescriptive part of this presentation, but appreciate that performers will not use the main entrance, but have a separate egress path. The simulated travel time is 4 minutes and 20 seconds.

Profiles:

Occupants are given different profiles, where the size of agents are specified, as well as their travel speed.

Profile 1 is the profile assigned to most agents, and is based on the reported exit movement speeds of (table 64.14) the SFPE Handbook. The range of exit movement differs from 0.8 to 1.5 m/s. As everyone is not going to have the same movement speed, a normal distribution of this travel speed is assigned this profile, with the limits 0.8 and 1.5 and an average of 1.

Profile 2 is simulating agents in wheelchairs. This profile uses a width of 66 cm[13] to simulate a wheelchair. There is a variety of reported travel speeds, from different tests, but a value of 0.4 is chosen based on both data for movement horizontally and vertically[14]. A total of 6 agents have been assigned this profile, located by the 6 wheelchair lifts. They are identified as the red agents in Figure 38.

Behaviors:

The default behavior in Pathfinder is that they can go to any exit. As mentioned, most occupants are not expected to be familiar with the building, so initially this is considered a poor representation of reality. However, as stated in 3.3.7, crowd managers will direct occupants and are instructed to utilize all exits.

[11] SFPE Handbook of Fire Protection Engineering 5th edition, table 64.11.
[12] SFPE Handbook of Fire Protection Engineering 5th edition, table 60.1
[13] https://www.reference.com/health/dimensions-standard-wheelchair-45f8c65bc8b23f29
[14] SFPE Handbook of Fire Protection Engineering 5th edition, table 64.24 and 64.25

Note that with the default behavior of using any exit, one of the main egress paths leading to the main entrance (where people are expected to go) was not used. Therefore, occupants in the mid-section are instructed to head to the main entrance exit discharges, and the people on the east and west wing have the choice of either the main exit, or the available exit stairs. Performers on stage are instructed to choose from backstage exits. For shows with less than 250 occupants, different behaviors should be expected, as crowd managers would not be required.

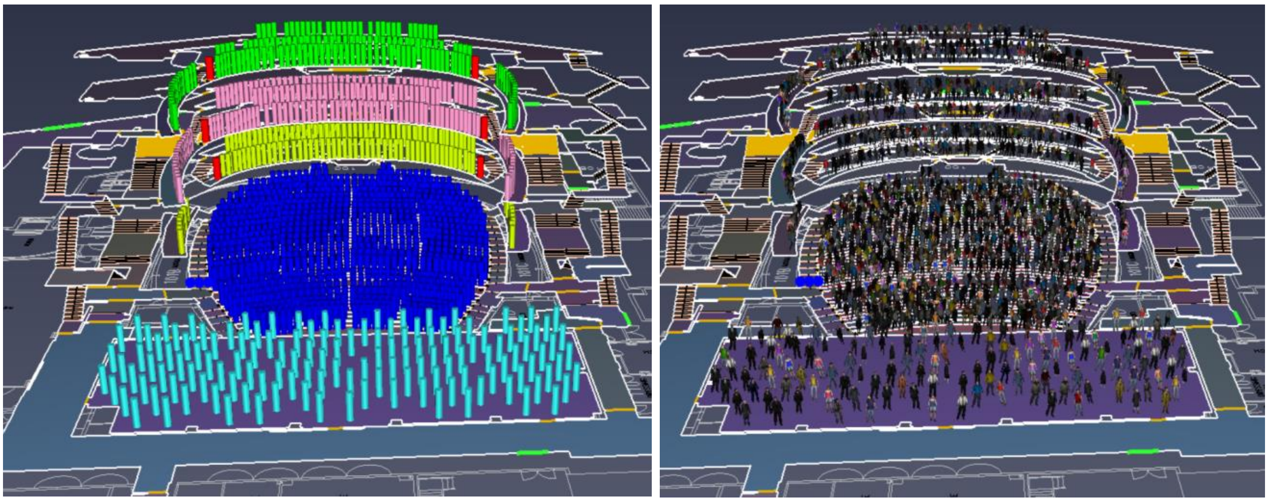

Figure 38 - Pathfinder Model Illustration

Result of travel time:

Figure 39 shows the accumulated density of path of travel, chosen by the agents based on their specified behavior characteristics. The exit access corridors leading to the main entrance was frequently used by the spectator occupants, and the performers used their separate exits, in addition to the exit in the North-West staircase. This behavior is considered a realistic result based on expected human behavior, as well as the intention of crowd managers. Note that all occupants of the main seating had to que up in their seating rows, before reaching the aisles. When analyzing the Pathfinder result file, it is concluded that the doors of the Harman Hall at the stage floor are causing a so-called bottleneck effect. Improving egress flow through these doors would result in an overall lower RSET.

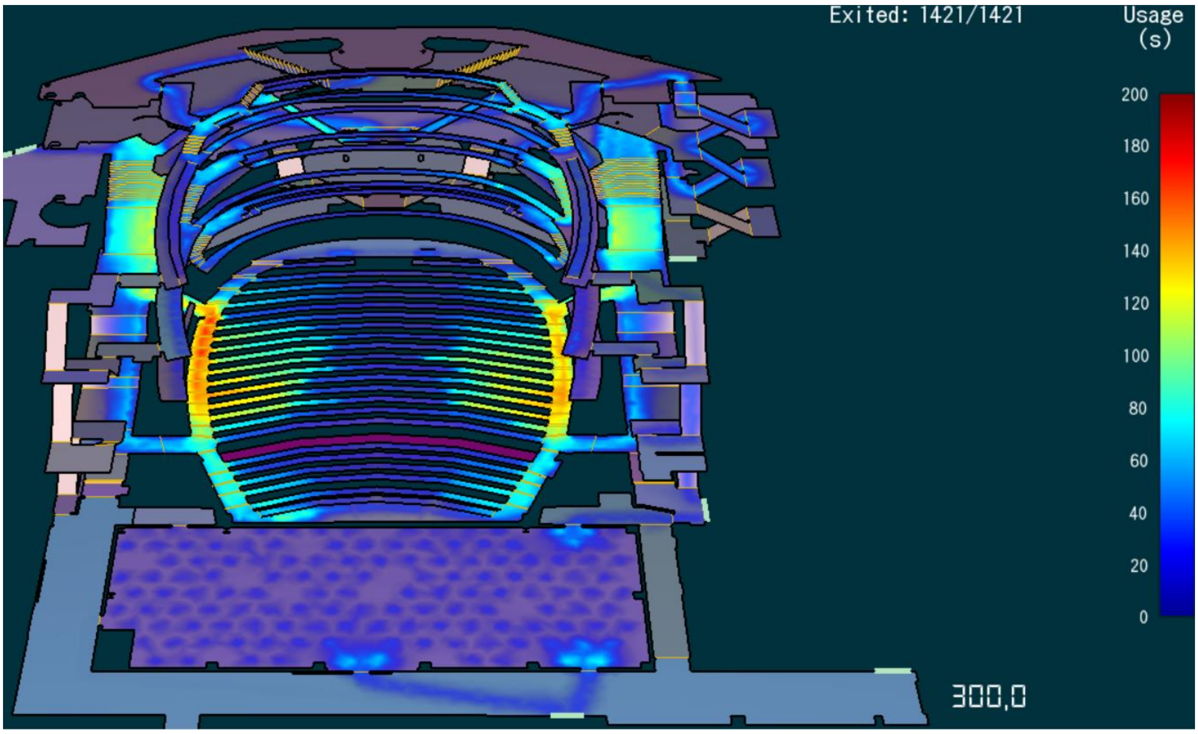

Figure 39 - Accumulated Use of Travel Path

The total travel time for all occupants to reach the exit discharges was modeled to be 4 minutes and 20 seconds, which makes 5 minutes including pre-movement time. Note that detection time is not yet added, nor is a margin of safety.

For this scenario, it is of interest to analyze the time for occupants of each floor to exit the Harman Hall, as the theater is the location where tenable conditions are evaluated. The result is given in Table 5-4:

Table 5-4 - Time to Exit the Harman Hall, for Each Space (included pre-movement time)

Exit Location	Occupant Load	Time to exit the Harman Hall [sec]
Gallery Level	153	150
Upper Balcony	171	167
Lower Balcony	136	140
Stage Level – Stage	133	110
Stage Level – Theater	828	275

5.4.4 Parameter sensitivity

Table 5-5 shows the results for total travel time, when varying certain parameters. The top rows of each parameter show the effect of increasing the parameter, middle row is initial value, and bottom row show effect of decreasing the value. All sensitivities are absolute, and is calculated by dividing change in result by change in input.

Table 5-5 - Parameter Sensitivity

Parameter	Value	Result	Sensitivity
Travel Speed of *profile 1*	1.1 m/s on average	241 seconds	0.87
	1 m/s on average	264 seconds	(original input)
	0.9 m/s on average	339 seconds	2.84
Travel Speed of *profile 2*	0.6 m/s	300 seconds	0.27
	0.4 m/s	264 seconds	(original input)
	0.2 m/s	388	0.94
Number of agents assigned *profile 2*	9 Agents	266	0.02
	6 Agents	264 seconds	(original input)
	3 Agents	281 seconds	0.13

Some of the calculated sensitivities appear counter intuitive, as increasing travel speeds resulted in longer travel times, and decreasing number of agents assigned profile 2 resulted in increased travel time. This result shows that the individual decision making of agents of Pathfinder is changed due to the parameter changes, and implies that a sensitivity analysis of this sort might be more applicable to simpler mathematical models (e.g. spreadsheet fire models).

The bottleneck effect at the stage level also suggests that the parameters above are not the most significant, but rather the evacuation flow through the theater doors.

5.4.5 Conclusion on RSET

5.4.5.1 *RSET for Scenery Fire at the Stage Floor*

The time to detection and initiation of notification might reach 8 minutes and 40 seconds (see Chapter 5.5.4.1.4). Evacuation time for occupants to exit the Harman Hall is estimated to take between 2 minutes and 30 seconds to 5 minutes, depending on floor level. Note that the evacuation time is based on smoke free conditions.

The required safe egress time is therefore 13 minutes and 40 seconds, before introducing a margin of safety, see Table 5-6.

Table 5-6 - RSET for Floor Level Fire

Floor Level	Total RSET
Gallery Level	11 minutes 10 seconds
Balcony Level	11 minutes 30 seconds
Entry Lobby Level	11 minutes
Stage level	13 minutes 40 seconds

The detection time is significant in the large RSET, and means to reduce it should be implemented.

5.4.5.2 *RSET for Fly Gallery fire*

The time to detection and initiation of notification might reach 6 minutes (see Chapter 5.5.3.2). Pre-movement- and travel time for all occupants to exit the Harman Hall is estimated to take between 2 minutes and 30 seconds to 5 minutes, depending on floor level. Note that the evacuation time is based on smoke free conditions.

The required safe egress time is therefore as follows for each floor, before introducing a margin of safety, see Table 5-7.

Table 5-7 - RSET for Fly-gallery Fire

Floor Level	Total RSET
Gallery Level	7 minutes 30 seconds
Balcony Level	7 minutes 50 seconds
Entry Lobby Level	7 minutes 20 seconds
Stage level	11 minutes

The detection time is significant in the large RSET, and means to reduce it should be implemented.

5.5 AVAILABLE SAFE EGRESS TIME

5.5.1 Design Fire

The stage fire of the Harman Hall addresses the assumed most severe fire in the building. From building inspections, it is concluded that hanging curtains and other stage sceneries are the most likely fuel. Ignition source is considered possible by pyrotechnics, or elevated electrical equipment, such as lighting. As a worst-case scenario, the fire curtain in the proscenium wall opening will be modeled as unsuccessful to deploy.

Fire Location:

The fire is modeled at two different locations, see Figure 40 and Figure 41:

1) At stage floor level, close to the proscenium wall opening.
2) Elevated hanging scenery/curtains

Although it is considered more likely that ignition would occur in the fly gallery, the floor level fire is included to consider worst case scenario with regards to radiation heat exposure to occupants.

Burner Surface Area

Scenery might have a variety of sizes and surface areas, which is considered within the model. Initially, the fire is modeled as an obstruction with burner surfaces on all sides except z-min (the bottom). The front and back surface is 5 m^2 each, see Figure 40. This burner is modeled both at stage floor level, as well as at higher elevation in the fly gallery.

In the event of a fire in the fly gallery, curtains are expected to burn out eventually, but also spread the fire to adjacent surfaces. The flamespread is expected to potentially create combustion over large surface areas simultaneously, regardless of burnout. As neither burnout or flamespread is modeled specifically, the burner is modeled with the surface area of a whole curtain capable of covering the proscenium opening, see Figure 41. This fire is modeled with- and without surrounding thin obstructions, simulating adjacent curtains/scenery.

Note that the heat release rate per unit area is adjusted, so that both burners have the same total heat release rate (i.e. an uninterrupted fast growing t-squared fire).

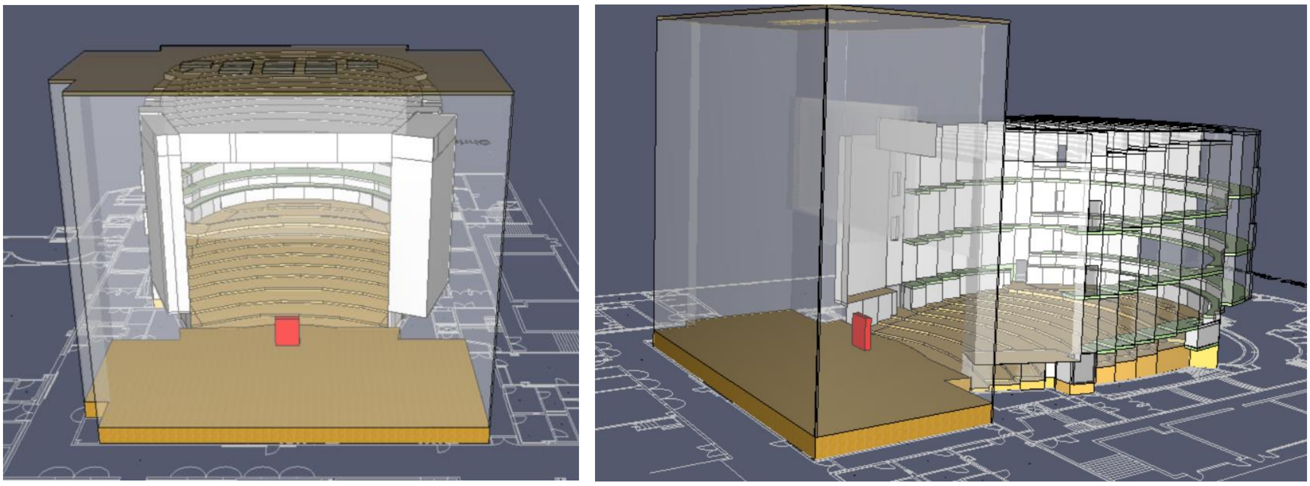

Figure 40 - Fire Location 1, with the smallest surface area

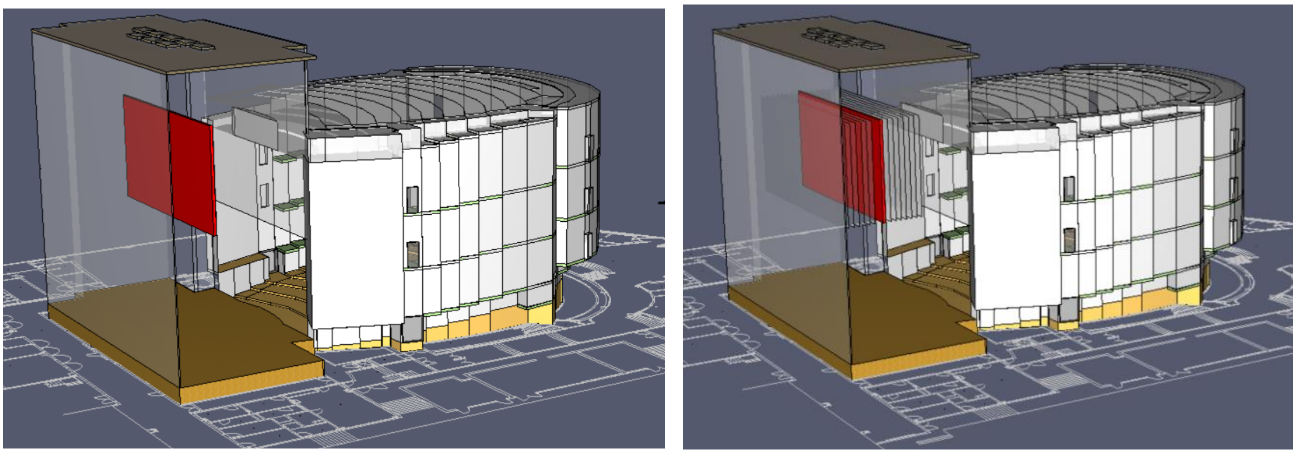

Figure 41 - Fire location 2, with the largest surface area.

Fire Characteristics:

Ove Arup & Partners PC performed a research project titled "*Fire Safety in Theatres - A New Design Approach*", where they addressed fire safety in theaters with emphasis on stage fires. A survey was conducted to estimate typical materials- and quantities used in scenery. The conclusion drawn was that a mass relationship of 75 % natural materials and 25 % synthetic materials are typical for sceneries in theatres. The design fire of this analysis is based on the survey results, and fuel property data reported in the SFPE Handbook 5th edition.

As seen in Table 5-8, the fire will be modeled with a heat of combustion of 15.9 kJ/g, a radiative fraction of 0.36, soot yield of 0.026 g/g, and CO yield of 0.014 g/g.

The heat of combustion is relatively low compared to other fuels (e.g. most polymers). However, it is considered realistic, as heats of combustion for curtains/draperies have also been reported in the range of 11-14 kJ/g[15].

Fire Growth, and maximum effect:

For conservativism, the fire will be modeled as a fast-growing t-squared fire. Inspections of the premise confirms a large fuel load, so consequently no burnout will be modeled in the time interval of interest in this analysis. As indicated in 3.6.3, the effectiveness of sprinklers above the stage is questioned. Consequently, the model will be run with an uninterrupted growth.

[15] http://www.firebid.umd.edu/database-curtains.php

Table 5-8 - Design Fire Characteristics

Excerpt from SFPE Handbook of Fire Protection Engineering 5th edition, Table A.39					
	Material	Chemical Heat of Combustion [kJ/g]	Soot Yield [y_s]	CO Yield [y_{CO}]	Radiative Fraction
Natural materials	Tissue Paper	11.4			0.41
	Newspaper	14.4			
	Wood (red oak)	12.4	0.015	0.004	0.37
	Wood (Douglas fir)	13		0.004	0.38
	Wood (Pine)	12.4		0.005	0.30
	Corrugated Paper	13.2			
	Wood (hemlock)	13.3	0.015		
	Wool 100 %	19.5	0.008		
	Average	**13.7**	**0.013**	**0.004**	**0.36**
Synthetic Materials	ABS	30	0.105		
	POM	14.4		0.001	0.22
	PMMA	24.2	0.022	0.01	0.31
	PE	38.4	0.06	0.024	0.43
	PP	38.6	0.059	0.024	0.00
	PS	27	0.164	0.06	0.59
	Silicone	10.6	0.065	0.021	0.31
	Polyester-1	20.6	0.091	0.07	0.48
	Polyester-2	19.5	0.089	0.08	
	Epoxy-1	17.1		0.08	0.50
	Epoxy-2	12.3	0.098	0.086	
	Nylon	27.1	0.075	0.038	0.40
	Polyamide-6	28.8	0.011		
	IPST	23.3	0.08		
	PVEST	22	0.076		
	Silicone rubber	10.9	0.078	0.021	
	Polyether ether ketone	17.5	0.008	0.029	
	Polysulfone	24.3	0.02	0.034	
	Polyethersulfone	20.4	0.021	0.04	
	Polyetherimide	27.2	0.014	0.026	
	Polycarbonate	18.4	0.112	0.054	
	Average	**22.50**	**0.066**	**0.041**	**0.36**
	75 % Natural and 25 % Synthetic	**15.90**	**0.026**	**0.014**	**0.36**

5.5.2 Model Design

Thermal Boundaries

Obstructions are given thermal properties to account for heat loss through boundaries. Properties are assigned in accordance with Figure 13, Figure 15, Figure 17, Figure 19, and Figure 21, see Table 5-9. Stage walls and ceiling consist of exposed concrete, while the theater boundaries are layered with concrete and gypsum. The stage is modeled with properties of yellow pine. All wall- and ceiling boundaries have air gap backings.

Table 5-9 - Material Properties

Material Properties				
Material	**Thermal Conductivity [W/m·K]**	**Density [kg/m³]**	**Specific Heat [kJ/kg·K]**	**Reference**
Concrete	1.8	2280	1.04	NBSIR 88-3752 – ATF NIST Multi-Floor Validation
Gypsum	0.17	930	1.09	NBSIR 88-3752 – ATF NIST Multi-Floor Validation
Yellow Pine	0.14	640	2.85	Quintiere, Fire Behavior – NOST NRC Validation

Sprinkler system

Sprinklers are installed at gridiron level, and will initiate alarm notification appliances upon activation. Sprinkler heads are modeled with the spacing shown in Figure 28. The sprinkler heads are of the type Viking SSU, and have k-factors of 5.5 gpm/psi$^{0.5}$, and activation temperatures of 93.3 °C (200 °F). The RTI have not been successfully identified, so consequently a sensitivity analysis of RTI is performed in Chapter 5.5.4.1.

Temperature of sprinkler heads are modeled by applying measurement devices for velocity- and temperature of the hot gases. Sprinkler spray and suppression is not modeled, due to validity limitations of suppression and sprinkler spray in FDS.

Smoke Ventilation

Eight smoke vents with a total area of 224 ft^2 (20.8 m^2) are located at the ceiling above the stage. The vents are activated on fusible links, with a temperature rating of 74 °C (162 °F). Heat detectors are placed close to the vents, to simulate fusible links. Upon activation of either heat detector, all vents open. Datasheets of the Vents do not include the RTI of the fusible links. This analysis used an RTI of 175 (m·s)$^{0.5}$, which is the median value reported in "*Sprinkler, Smoke & Heat Vent, Draft Curtain Interaction -- Large Scale Experiments and Model Development*".

There is a total of 14 exit doors from the theater, all of which have been modeled as openings. This allows for a total makeup-air inlet area of 360 ft^2 (31.22 m^2). Note that as the proscenium wall curtain is modeled as failing to deploy, these openings will provide makeup air to the enclosure, but upon successful deployment of the proscenium curtain, they would not. See also discussion on makeup-air in Chapter 3.7.1.
7 of the 14 openings are shown in Figure 42. The remaining openings are of identical order, on the east side of the building.

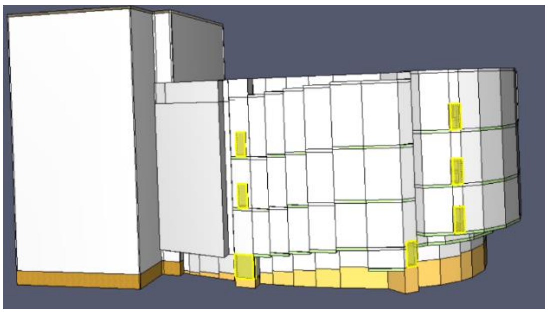

Figure 42 - Location of Openings

Exhaust Ventilation Efficiency:

To evaluate the efficiency of the smoke ventilation of this model, the smoke vent area is compared to the makeup-air area. The inlet area divided by the outlet area gives a value of 1.6. Assuming equal flow coefficients (C) through inlets and outlets, Figure 43[16] shows the flow efficiency of the exhaust as a function of the area ratio. It can be concluded that an exhaust flow efficiency of about 0.86 applied to this model. The figure below is based on the following equation, so consequently increased inside temperature results in increased exhaust efficiency.

Equation 2 - Exhaust Flow Efficiency

$$\frac{\dot{m}_o}{\dot{m}_{o,\max}} = \sqrt{\frac{1}{1+\left(\frac{T_o}{T_i}\right)\left(\frac{C_o A_o}{C_i A_i}\right)^2}}$$

Where:

$\dot{m}_o$: estimated outlet flow

$\dot{m}_{o,\max}$: ideal outlet flow

T_o : outside temperature

T_i : inside temperature

$C_o A_o$: effective outlet area

$C_i A_i$: effective inlet area

Note that the calculated efficiency is based on a one-zone stack principle, and is merely intended to estimate whether the inlet areas are within a reasonable and realistic range of an effective ventilation design.

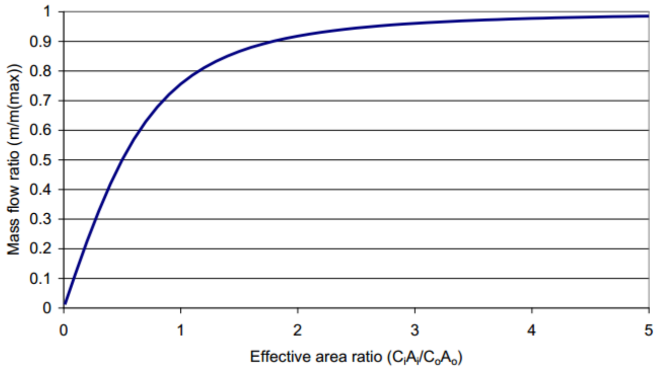

Figure 43 - Exhaust Mass Flow Ratio (from Cal Poly FPE 504 – Module 6 Notes)

[16] Cal Poly, FPE 504 Fire Modeling – Module 6 Notes

5.5.3 Results of Fly Gallery Fire

5.5.3.1 *Activation of Smoke Vents and Sprinklers*

Activation of smoke vents occurred 338 seconds into the simulation, at which time the smoke layer had descended just below the proscenium wall opening. The ventilation was effective and is considered successful, as tenable conditions was maintained within the theater throughout the whole simulation. Burner surface area, and horizontal location had little impact on this result, see Figure 44 and Figure 45.

Activation of sprinklers occurred 420 seconds into the simulation. Conclusively, smoke vents activate prior to the sprinklers. This activation order is expected due to the difference in activation temperature, which is not consider coincidental. Activation of sprinklers prior to smoke vents could prevent activation of the vents, while activation of smoke vents prior to sprinklers are showed in Figure 46 to only delay sprinkler activation.

5.5.3.2 *Activation of Notification Appliances*

The water flow switch will be triggered upon activation of sprinklers, and an alarm signal will be sent. The sprinkler activation is the first operation to automatically initiate notification appliances. Manual pull stations are also provided, but time to manual detection and notification is not quantified.

5.5.3.3 *Tenability*

No tenability threshold was exceeded throughout the whole duration of the model. Upon activation of smoke vents, ventilation was successful and the smoke layer interface appeared to stabilize, see Figure 44. However, as the model was designed with an uninterrupted fast growing fire development, the smoke layer is assumed to continue descending at some point in time beyond the modeled time duration.

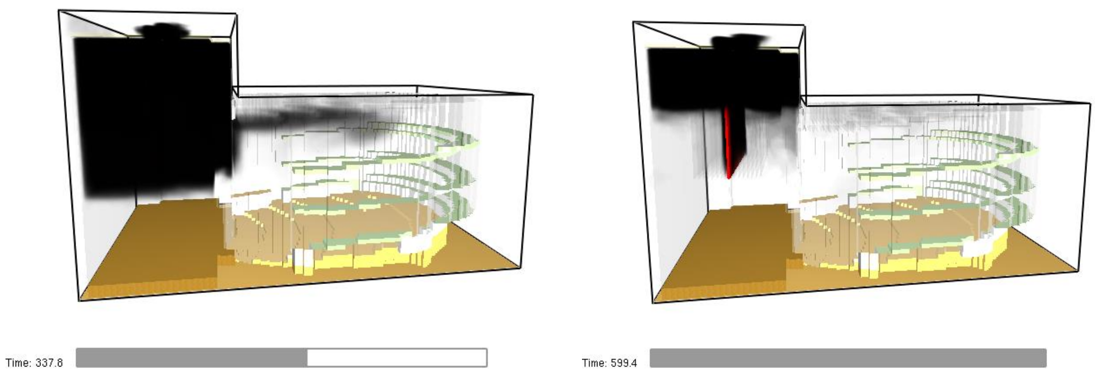

Figure 44 - Smoke Ventilation Success, for the Fly-Gallery Fire

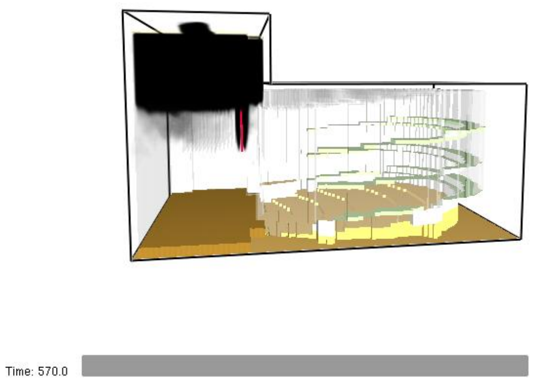

Figure 45 - Effect of Burner Location on Ventilation, for the Fly-Gallery Fire

5.5.4 Result of Stage Floor Fire

5.5.4.1 *Activation of Smoke Vents and Sprinklers*

5.5.4.1.1 Effect of RTI on Sprinkler Activation

As discussed previously, the RTI of fusible links and sprinkler heads are a matter of uncertainty. Therefore, devices measuring the velocity and temperature of hot gases was placed at sprinkler- and fusible link locations, so that the effect of different RTI's could be estimated with Equation 3. Note that this approach does not account for conduction heat loss to sprinkler mounting.

Equation 3 - Temperature change of devices with respect to time

$$\frac{dT_d}{dt} = \frac{\sqrt{U_g}\left(T_g - T_d\right)}{RTI} \rightarrow \Delta T_d = \frac{\sqrt{U_g}\left(T_g - T_d\right)}{RTI}\Delta t$$

Where:

ΔT_d : temperature change of the time step

U_g : gas velocity

T_g : gas temperature

T_d : sprinkler temperature of last time step

RTI : thermal response time index

Δt : time step

As sprinklers are spaced with 10ft 6 inches by 10ft 10.5 inches, the longest possible horizontal distance from any sprinkler to the center of the fire is 7ft 7 inches. The 3rd most remote sprinkler of branch line 4 of Figure 28 is analyzed, due to its distance from the fire. The sprinkler activates at 93.3 °C (200 °F).

From Figure 46 we see that activation of sprinklers by the stage ceiling could have a difference in activation time of 50 seconds, depending on the RTI. Note also the changed temperature development trend 400-430 seconds. This effect is assumed to be due to initiation of smoke ventilation, which occurred in that time interval.

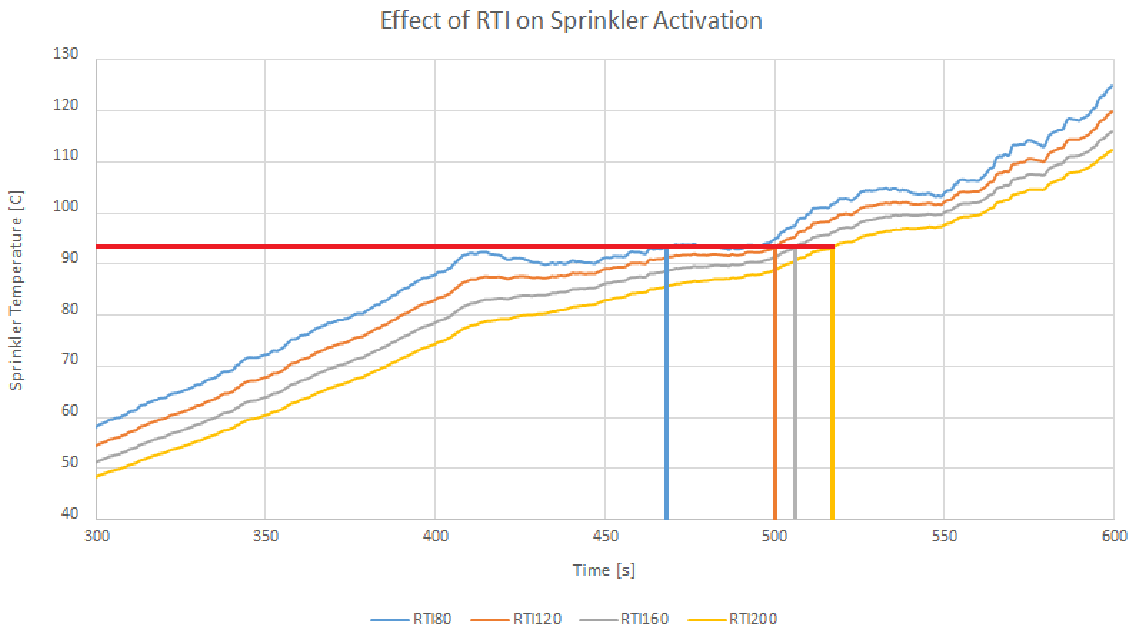

Figure 46 - Calculated temperature development of sprinkler heads of different RTI-rating

5.5.4.1.2 Effect of RTI on Smoke Vent Activation

As discussed in chapter 3.7.1, RTI of fusible links have been reported in the range of 167-180 $(m \cdot s)^{0.5}$. Using Equation 3 and the measured gas temperature and velocity, the time to activation of roof vents would only differ with about 5 seconds, for this RTI interval.

Figure 47 shows the smoke layer descent at the time of smoke vent activation. The smoke has descended below the proscenium wall opening, entered the theater, and started to descend towards the levels of occupancy.

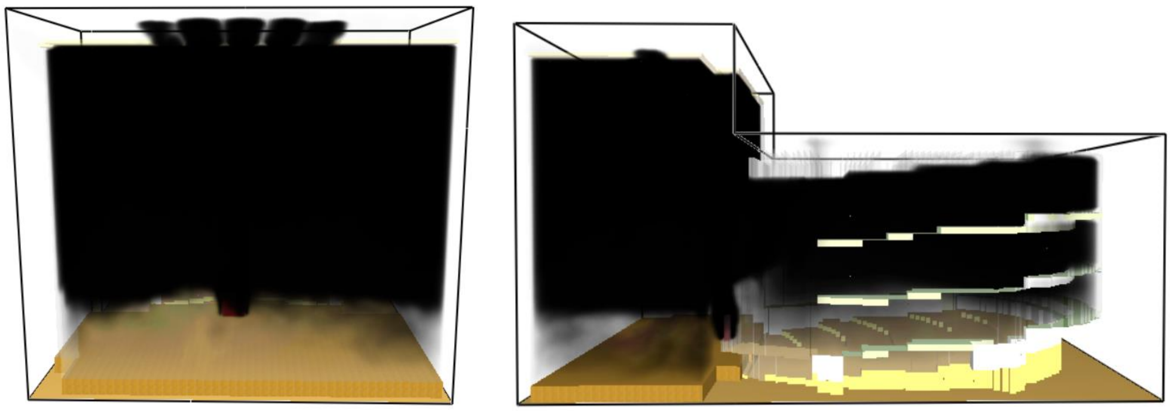

Figure 47 - Smoke Layer Descent upon Activation of Smoke Vents

5.5.4.1.3 Heat Loss Through Boundaries

The thermal boundaries of the stage are of exposed concrete, and is expected to have an impact on the time until activation of sprinklers and fusible links, due to thermal properties of concrete. To estimate the impact of this heat loss, the model was also run with inert boundaries. Inert boundaries are not intended to represent reality, but merely give an indication of the impact of conduction heat loss through the ceiling and walls.

The smoke vents initially activated at 406 seconds into the simulation. Re-running the model with inert walls and ceiling of the stage only resulted in the vents activating 10 seconds faster. From this result, it is concluded that heat loss through thermal boundaries are insignificant in activation of the smoke ventilation system.

5.5.4.1.4 Activation of Notification Appliances

Automatic activation of alarm notification appliances is performed upon sprinkler activation. For a worst-case scenario with respect to fire location and sprinkler spacing, it takes between 470-520 seconds for the first sprinkler to activate, depending on the RTI. Consequently, the fire reaches a HRR of 10.5-12.15 MW before automatic initiation of notification appliances. At this time the theater will already be filled with smoke.

5.5.4.2 *Tenability*

5.5.4.2.1 Visibility

Visibility was the first tenability threshold to be exceeded. This occurred at 336 seconds by the far end of the East gallery level balcony, see Figure 48. The figure shows that the visibility is less than 10 meters by the exit doors to the enclosed staircase. FDS calculates visibility individually for each cell, so the visibility over a range of cells along the balcony appears to be of more than 10 meters. However, the whole gallery level got untenable visibility conditions at 370 seconds.

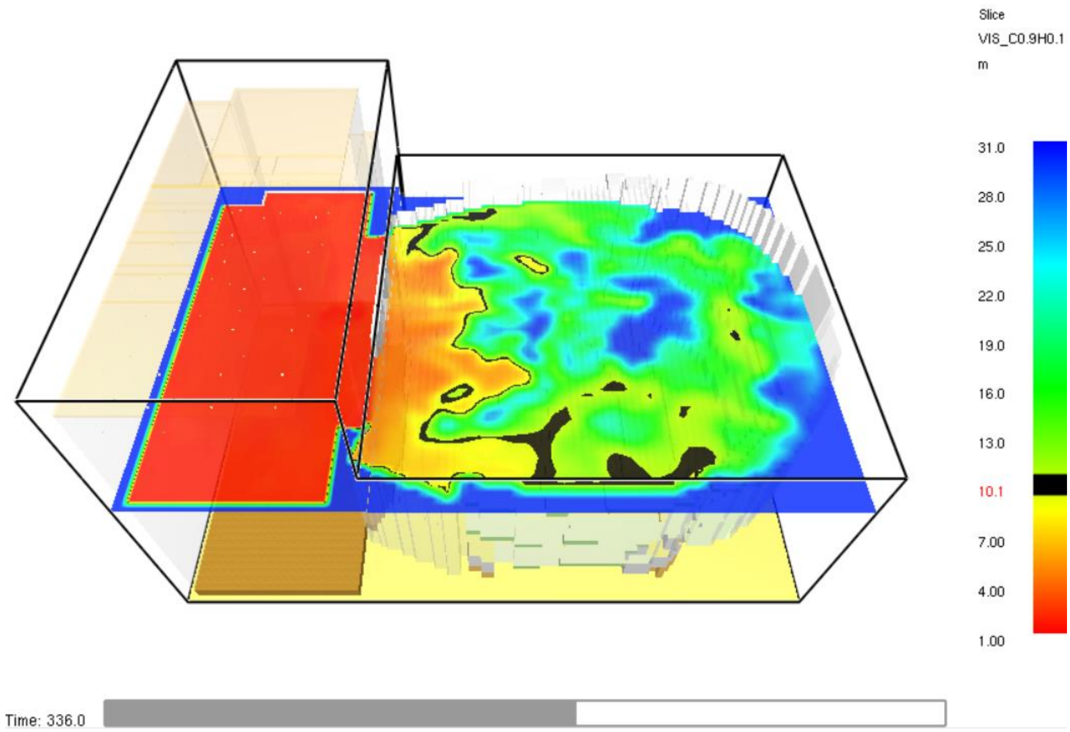

Figure 48 - Visibility of the Gallery Level

Table 5-10 show the time from ignition until the visibility threshold gets exceeded, for each level of the large open space.

Table 5-10 - Time of untenable conditions, per floor

Floor	Time of initial failure [s]	Time of failure, entire floor [s]
	For the Theater	
Gallery Level	336	370
Balcony Level	365	400
Entry Lobby Level	402	535
Stage Level Seating	500	N/A
	For the Stage	
Stage	N/A	N/A

Even though there was smoke mixing within the whole elevation of the stage, visibility stayed more than 10 meters throughout the simulation.

5.5.4.2.2 Toxicity

FDS calculates FED based on a method developed by Purser. The combined effect of asphyxia from uptake of toxic gases, oxygen depletion, and increased respiration due to uptake of CO_2 is considered in FDS. With this method, an FED of 1 is when half of the occupants are expected to become incapacitated. As this measurement is only possible at single points, the FED is estimated by applying slice files for gas-concentrations.

The instant the slice-file indicates concentrations exceeding the tenability limit of 1750 ppm CO, conditions are considered untenable.

A more accurate method would be applying Equation 4, where the selected tenability criterion is the specific exposure dose. Consequently, for an FED of 1, conditions are considered untenable. Yet, this method is also subject to single-point measurements.

Equation 4 - Fractional Effective Dose

$$FED = \int_{t_1}^{t_2} \sum_{i=1}^{n} \frac{C_i}{(C_t)_i} \Delta t$$

Where:

FED: fractional effective dose

$(C_t)_i$: specific exsporue dose [ppm $\cdot$ min]

C_i: concentration over the chosen time increment [ppm]

Δt: chosen time increment [min]

The CO-concentration of the theater never exceeded 50 ppm at any location, throughout the simulation.

FED by oxygen depletion is calculated in accordance with Equation 5. This equation is from the N-gas Model, and was derived empirically.

Equation 5 - FED_{O2}

$$FED_{O_2} = \frac{21 - f_{O_2}}{21 - (C)_{O_2}}$$

Where:

f_{O_2}: volume percentage of O_2

C_{O_2}: depletion threshold

FED of CO and O_2 combined results in values far less than 1 for all floors. Conclusively, toxicity will not be the limiting factor of the ASET in this scenario.

5.5.4.2.3 Heat Exposure

Figure 49 shows the temperature distribution within the enclosure, at the end of the simulation. The plan view shows temperature 6 feet above the highest occupied balcony. The temperature never exceeded 60 °C, for any occupied space during this simulation.

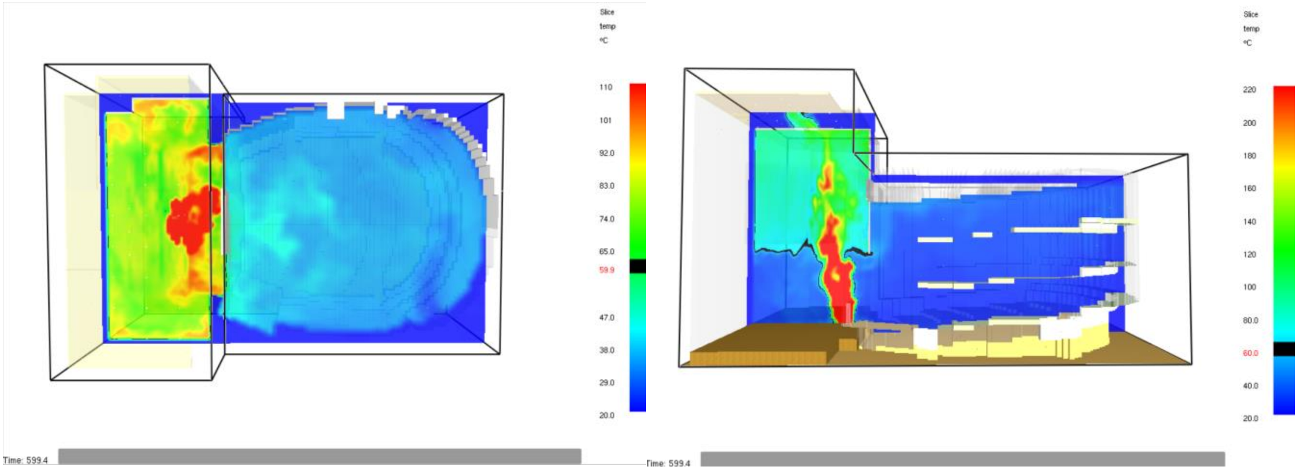

Figure 49 - Air/gas Temperature of Scenario 1

The radiation heat flux that occupants are exposed to is determined by the radiative heat flux to all surfaces. The radiative heat flux to any surface never exceeded 1 kw/m², for the duration of the simulation, see Figure 50. Note that the incident heat flux approach 2 kW/m² within a range of about 10 meters from the fire.

From this, radiation heat exposure will not be the limiting factor of the ASET in this scenario.

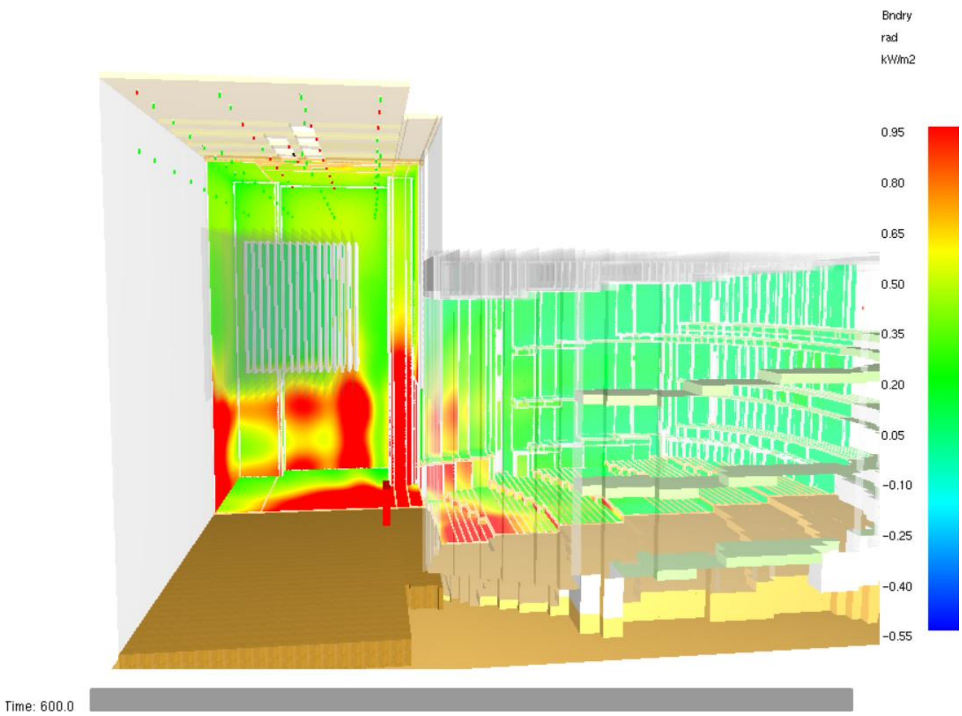

Figure 50 - Radiative Heat Flux

5.5.4.3 *Conclusion for Stage Floor Fire*

Table 5-11 shows ASET, and the estimated worst- and best case for RSET, depending on the sprinkler head RTI. As the required safe egress time is greater than the available safe egress time, the scenario fails to meet the performance criterion.

Table 5-11 - Conclusion on RSET vs. ASET for Scenery Fire at the Stage Floor

Detection Time [s]	520	470			
Floor	RSET [s]		ASET [s]	ASET/RSET	
	Worst Case	Best Case		Worst Case	Best Case
Gallery Level	670	620	336	**0,50**	0,54
Balcony Level	687	637	365	**0,53**	0,57
Entry Lobby Level	660	610	402	**0,61**	0,66
Stage Level	795	745	500	**0,63**	0,67

To emphasize the significance of the detection time, Table 5-12 shows the relationship between the available safe egress time, and the evacuation time (pre-movement and movement time). Neglecting the detection time results in a safety margin of 1.8, for this scenario. Therefore, means to reduce the detection time is necessary.

Table 5-12 - Comparison of ASET vs. Evacuation Time

Floor	t_{EVAC} [s]	ASET [s]	ASET/t_{EVAC}
Gallery Level	150	336	**2,24**
Balcony Level	167	365	**2,19**
Entry Lobby Level	140	402	**2,87**
Stage Level	275	500	**1,82**

5.5.4.3.1 Effect of Having Smoke Vents Activate on Smoke Detectors

As the Stage Floor scenario failed to meet the performance criterion, means to reduce RSET and increase ASET is necessary. Therefore, the FDS fire model have been re-run with smoke detectors at the gridiron, that both activate all smoke vents upon detection, and send alarm signal to the FACP. This resulted in detection 43 seconds into the model.

Table 5-13 show the effect this has on the RSET and ASET. The reduced RSET is due to the decreased detection time. ASET is increased because ventilation is initiated at an earlier stage. Note however that ventilation is still less effective than for the fly gallery scenario, due to cooler smoke at the ceiling. Consequently, the smoke eventually reaches below the proscenium wall opening, and enters the theater.

Having addressable smoke detection devices initiate both notification and ventilation results in meeting the performance criterion, and gives a safety margin of 2.6.

Table 5-13 - Effect of Smoke Detectors on RSET vs. ASET

Floor	RSET [s]	ASET [s]	ASET/RSET
Gallery	193	571	2.9
Balcony	210	643	3.1
Entry Lobby	183	696	3.8
Stage	318	834	2.6

5.5.5 Discussion

The prescriptive analysis includes a qualitative evaluation of the effectiveness of sprinklers, with regards to droplet size and fire plume temperatures. Concern about high elevation and relatively small orifice size of the sprinkler heads, was raised, and concluded that results of the fire models will give further basis to evaluate the water droplets ability to penetrate the fire plume and reach the burning item. Chapter 5.5.3 and 5.5.4 show that due to the heat of combustion of the design fire, and air entrainment, the smoke has a relatively low temperature. Lower gas temperatures are less challenging for the water droplets to penetrate, so replacing sprinklers heads of the gridiron above the stage might therefore not be beneficial.

The scenery fire in the fly gallery resulted in successful activation of smoke vents prior to violating any tenability criteria. With the modeled makeup-air openings, the ventilation was successful in preventing the smoke layer from creating untenable conditions, throughout the whole simulation. The smoke layer appeared to stabilize, though the fire would continue to develop if the model was run for a longer time duration, as no suppression was modeled.

For a scenery fire at floor level, the temperature of the ceiling jet is not high enough to activate sprinkler systems and thereby initiate notification of occupants, prior to untenable conditions. Similarly, the smoke vents do not activate prior to occupants being exposed to products of the fire. This result is mainly due to air entrainment in the smoke plume, which causes cooling of the gases. The heat of combustion is also relatively low, compared to other fuels such as polymers. The fuel characteristics are, however, considered to be realistic for this scenario.

RTI of smoke vents are determined insignificant, within the range reported. Low RTI of sprinklers can potentially reduce the RSET to some extent, but it is not significant enough as the sole means of improvement of the RSET. Nor conduction heat loss through boundaries of the stage is a significant reason for the late activation of fire protection systems.

Smoke detection devices at the stage ceiling allow for much more rapid detection than the current heat elements of the sprinkler heads. Yet, as mentioned in chapter 3.5, the alarm system was replaced due to nuance alarms, and it is important to consider the possibility for smoke detectors to possibly re-introduce that issue. The suggested means of improvement of the detection issue is to install addressable smoke detectors at the stage ceiling. Means of bypassing the smoke detectors should be implemented in the fire safety management procedures, by applying fire-watches (similarly to the current procedures described in 3.4.1).

The performance based analysis is conservative in the sense that it assumes no manual detection occurs, as well as failure to deploy the proscenium fire curtain, but concludes that the required safe egress time exceeds the available safe egress time.

Even though manual detection time is not quantified in this analysis, recognize that both NFPA 160 and NFPA 1126 require a fire department representative present during performances that utilizes fire effect, or any kind of pyrotechnics. This greatly increases the probability for early manual detection of ignition by pyrotechnics.

6 Overall Conclusion

6.1 Prescriptive Analysis

The building meets the prescriptive requirements of the applicable codes listed in chapter 1.3, with the following exceptions:

Spacing of Smoke Detectors of the Entry Lobby is not in accordance with prescriptive requirements of the LSC.

The sprinkler system appears to have insufficient water supply, due to the removal of the fire pump. This conclusion is based on the information available, where the flow test data is dated.

6.2 Performance Based Analysis

One fire scenario with two different fire locations has been analyzed in detail, and other scenarios of interest have been listed.

The analyzed scenery fire scenario resulted in meeting the performance criteria when the fire was modeled in the fly gallery. This scenario resulted in activation of smoke vents above the stage before untenable conditions occurred in the theater, and the available safe egress time consequently lasted throughout the whole time-increment.

A scenery fire at floor level of the stage resulted in untenable conditions for occupants of the theater, if the proscenium fire curtain fails to deploy. Further analysis concludes that plume entrainment is the main cause of this, due to late activation of the fusible elements of the sprinkler system, which initiates notification appliances. Although a fire in the fly gallery is considered more likely than a fire at the stage floor level, the floor level fire is considered a worst-case scenario that could occur. The late notification is significant, as it greatly increases the required safe egress time of occupants. Manual detection time is not quantified, as it comes with great uncertainty. However, having addressable smoke detectors at the stage ceiling, that both initiate all smoke vents, and send an alarm signal to the FACT results in meeting the performance criterion with a safety margin of 2.6.

7 Recommendations

To meet the water demand of the sprinkler system, a first means of effort should be to perform a new flow test. Based on the result of this test, installing a new fire pump should be considered.

Installation of addressable smoke detectors at the stage roof is recommended, for earlier detection and initiation of ventilation. This change will contribute to limit the detection time, and consequently the overall required safe egress time, as well as increase the available safe egress time for the theater.

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Appendix A - Egress Capacity of Each Room

Table A-1 - Exit Capacity of each Space of the Lower Level

Egress Capacity of Each Space							
Nr.	**Room**	**Occupant load**	**Amount of doors/paths**	**Total Width [in]**	**Level components width per person**	**Egress Capacity**	**Capacity > Load**
011	Aud. service	212	2	168	0.2	840	yes
012 & 12A	Gen. Storage	1	1	36	0.2	180	yes
013	Pump room	1	1	36	0.2	180	yes
014	Electrical room	1	1	36	0.2	180	yes
015	Equipment room	1	1	72	0.2	360	yes
016	Equipment room	1	1	36	0.2	180	yes
017	Equipment room	1	1	72	0.2	360	yes
018	Equipment room	2	1	84	0.2	420	yes
019	Equipment room	1	2	72	0.2	360	yes

Table A-2 - Exit Capacity of each Space of the Stage Level

Egress Capacity of Each Space							
Nr.	**Room**	**Occupant load**	**Amount of doors/paths**	**Total Width [in]**	**Level components width per person**	**Egress Capacity**	**Capacity > load?**
101	Main hall	811	4	224	0.2	1120	yes
101 A	Gen Storage	1	1	72	0.2	360	yes
101 D	Gen Storage	1	1	72	0.2	360	yes
102	Stage	133	5	180	0.2	900	yes
103	(Lavatory)	0	1	N/A	0.2	N/A	yes
104	(Electrical)	1	1	36	0.2	180	yes
105	Satellite term.rm	1	1	36	0.2	180	yes
106	Gen storage	1	1	36	0.2	180	yes
108	Food handling	7	1	36	0.2	180	yes
109 & 109A	Green room	37	1	72	0.2	360	yes
110	Dressing room	6	1	36	0.2	180	yes
111	Dressing room	6	1	36	0.2	180	yes
112	Manager/receiving	3	1	36	0.2	180	yes
113	Security	4	1	36	0.2	180	yes
114	Wardrobe	5	2	72	0.2	360	yes
115 & 115A	Wardrobe	9	1	36	0.2	180	yes
116	Wardrobe	14	3	168	0.2	840	yes
117	Dressing room	14	1	36	0.2	180	yes
118	Dressing room	14	1	36	0.2	180	yes
119	Dressing room	15	1	36	0.2	180	yes
120	Dressing room	14	1	36	0.2	180	yes
121 & 121A	Dressing room	7	1	36	0.2	180	yes
122	Wardrobe	20	2	72	0.2	360	yes
123	Janitor	1	1	36	0.2	180	yes
124 & 124B	Classroom	180	2	108	0.2	540	yes
125	(Lavatory)	0	1	N/A	0.2	N/A	yes
126	(Lavatory)	0	1	N/A	0.2	N/A	yes
127	Satellite term.rm	1	1	36	0.2	180	yes
128	Rehearsal pavilion	400	4	144	0.2	720	yes
129	Storage	1	1	36	0.2	180	yes
130	Electrical	1	1	36	0.2	180	yes
131 &131A	Storage	1	1	36	0.2	180	yes

Table A-3 - Egress Capacity of Each Space of the Entry Lobby Level

Egress Capacity of Each Space							
Nr.	**Room Description**	**Occupant load**	**Amount of doors/paths**	**Total Width [in]**	**Level components width per person**	**Egress Capacity**	**Capacity > load?**
200	Entry lobby	1049	5	364	0,2	1820	yes
201	Dress circle	154	2	72	0,2	360	yes
202	Other-Misc. (concession)	16	1	36	0,2	180	yes
203 & 203A	Equipment	3	1	72	0,2	360	yes
204	Equipment	3	1	72	0,2	360	yes
205	Aud. service (main communication room)	7	1	36	0,2	180	yes
206	Equipment	4	2	108	0,2	540	yes
207 & 207 A	(electrical)	7	2	72	0,2	360	yes
208	Staff office (reception)	7	2	72	0,2	360	yes
208A	Admin office	3	1	36	0,2	180	yes
208B	Gen storage	1	1	36	0,2	180	yes
208C	Aud. service	1	1	36	0,2	180	yes
208D	Aud. service (box office)	5	2	72	0,2	360	yes

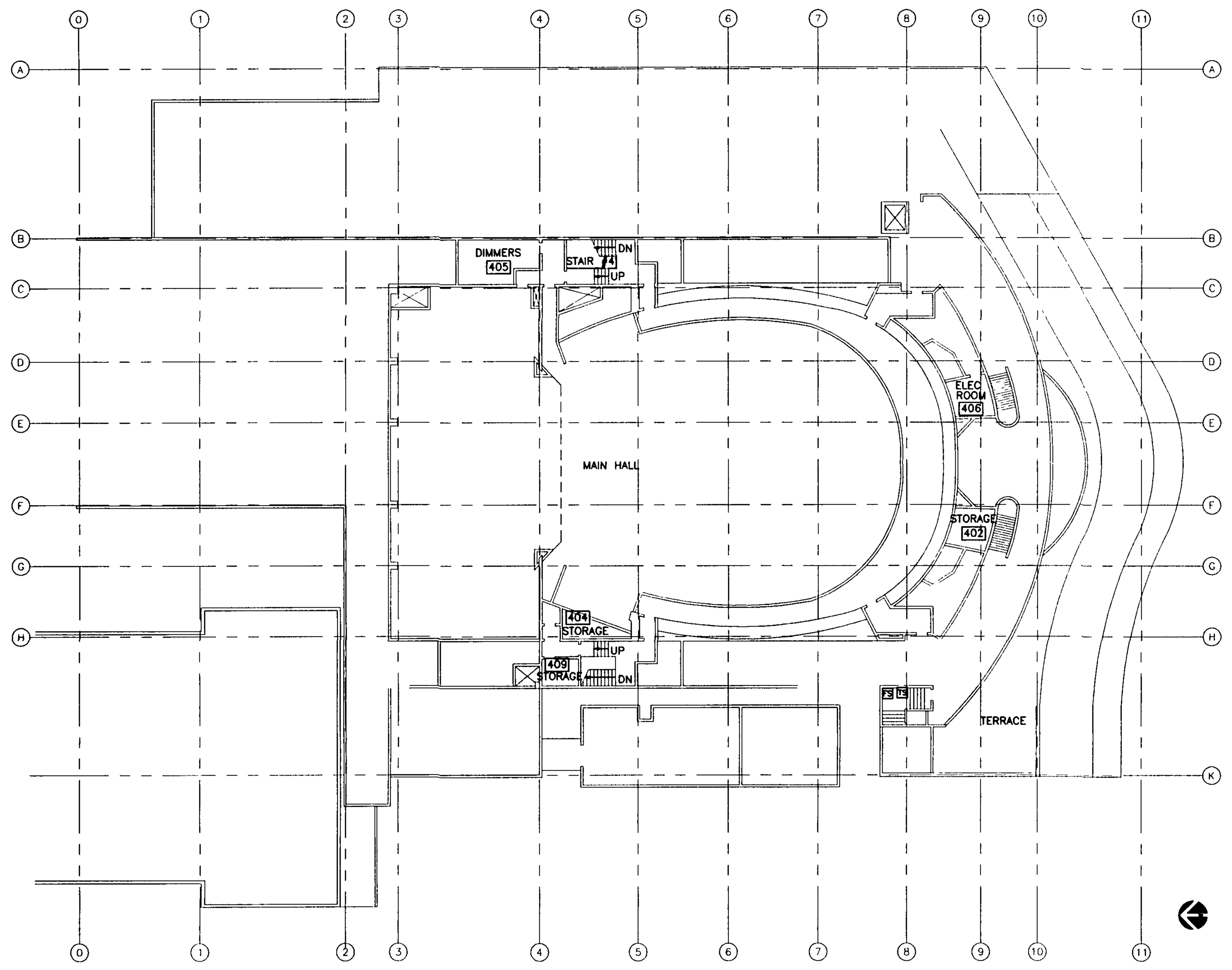
Table A-4 - Exit Capacity of Each Space of the Balcony Level

Egress Capacity of Each Space							
Nr.	**Room**	**Occupant load**	**Amount of doors/paths**	**Total Width [in]**	**Level components width per person**	**Egress Capacity**	**Capacity > load?**
301	Auditoria (lower balcony)	169	4	144	0.2	720	yes
302 & 302A	Control room	12	1	36	0.2	180	yes
303	Gen storage	1	1	36	0.2	180	yes
304	Conf. Room (founders lounge)	42	1	72	0.2	360	yes
305	Other-Misc.	20	1	36	0.2	180	yes
306	(Lavatory)	N/A	N/A	N/A	0.2	N/A	N/A
307	Gen storage	1	1	36	0.2	180	yes
308	Aud. service	6	1	36	0.2	180	yes
309	Aud. service	3	1	36	0.2	180	yes
310	Business	6	2	72	0.2	360	yes
311	Gen storage	1	1	36	0.2	180	yes
312 & 312A	Aud. service	16	1	48	0.3	160	yes
313	Lavatory	N/A	N/A	N/A	0.2	N/A	N/A
314	Storage	1	1	36	0.2	180	yes

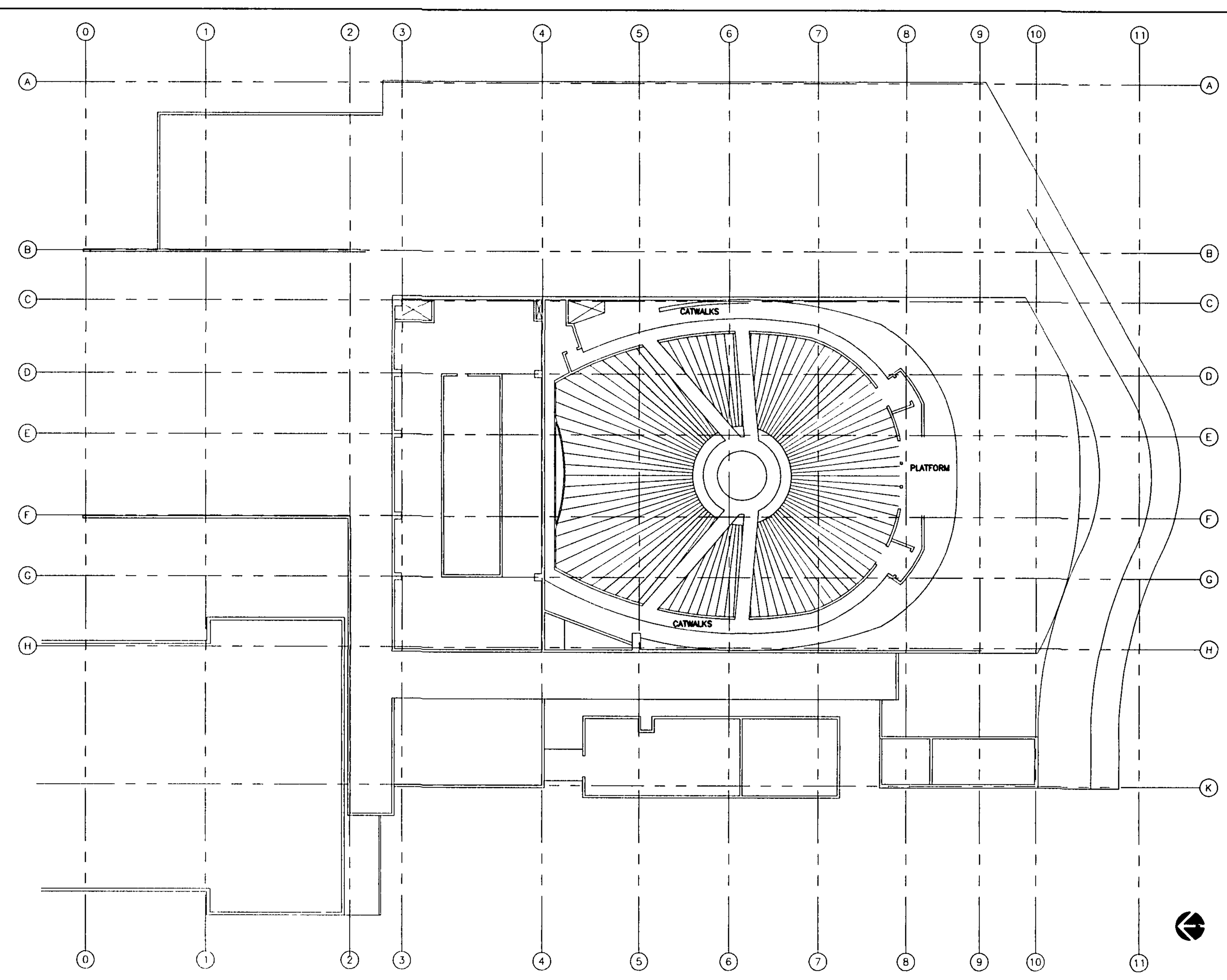
Table A-5 - Exit Capacity of Each Space of the Gallery Level

Egress Capacity of Each Space							
Nr.	**Room**	**Occupant load**	**Amount of doors**	**Total Width [in]**	**Level components width per person**	**Egress Capacity**	**Capacity > load?**
400	Gallery lobby	78	1	72	0,2	360	yes
401	Auditoria	152	4	144	0,2	720	yes
402	Gen storage	1	1	36	0,2	180	yes
403	Gen storage	1	1	36	0,2	180	yes
404	Gen storage	1	1	36	0,2	180	yes
405	Equipment room	1	1	36	0,2	180	yes
406	Equipment room	1	1	36	0,2	180	yes

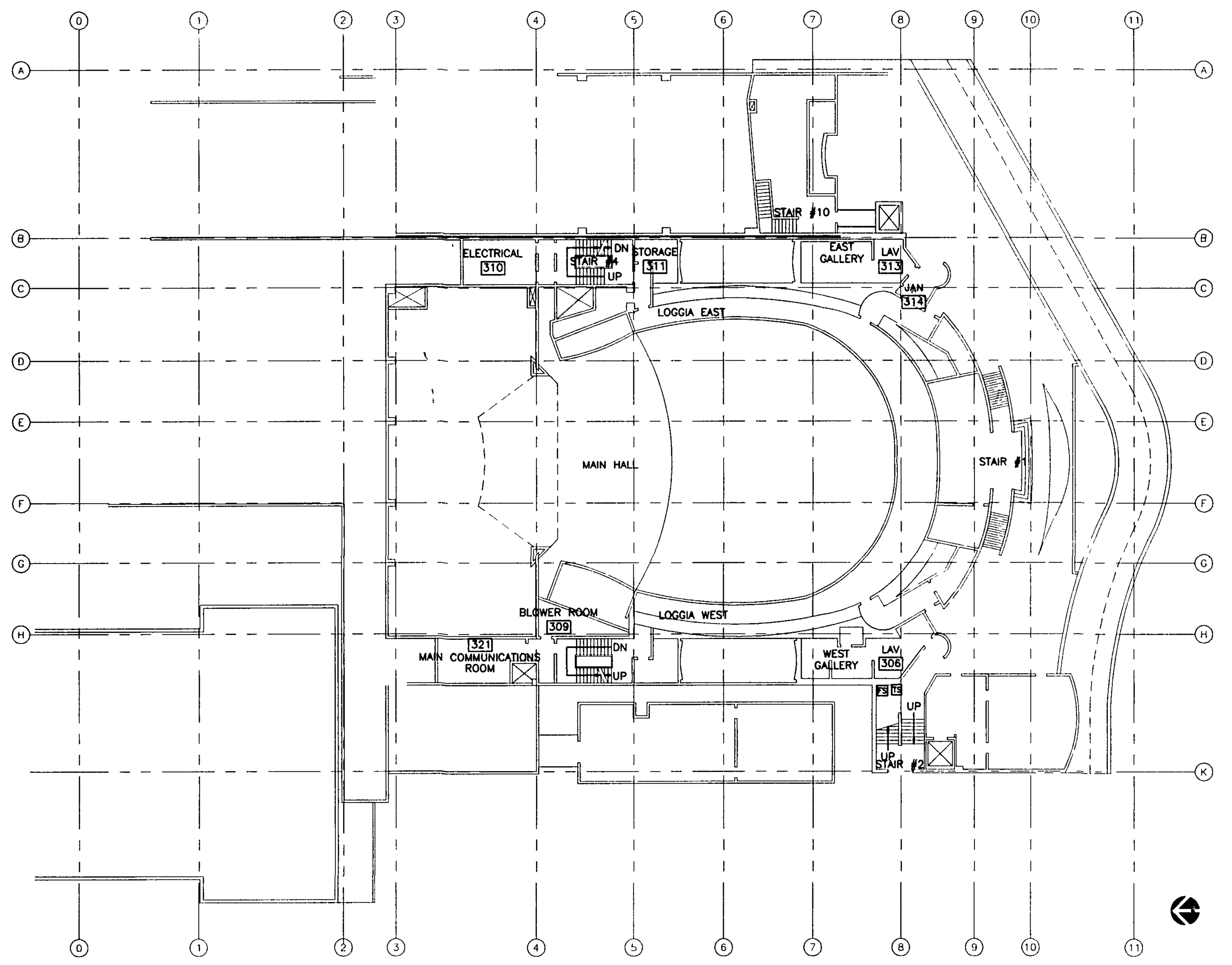
Appendix B - FIRE ALARM SYSTEM LAYOUT



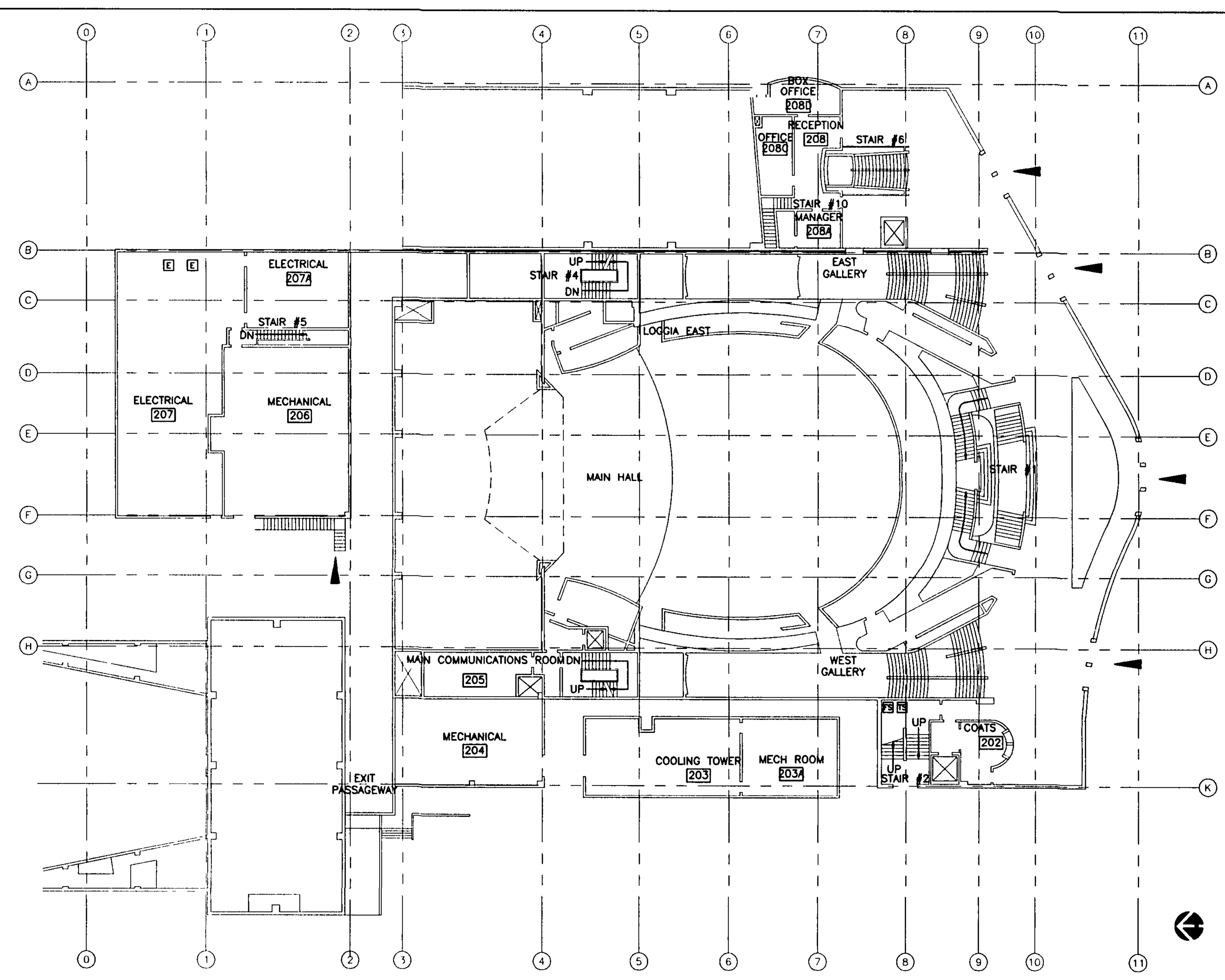
UPPER BALCONY



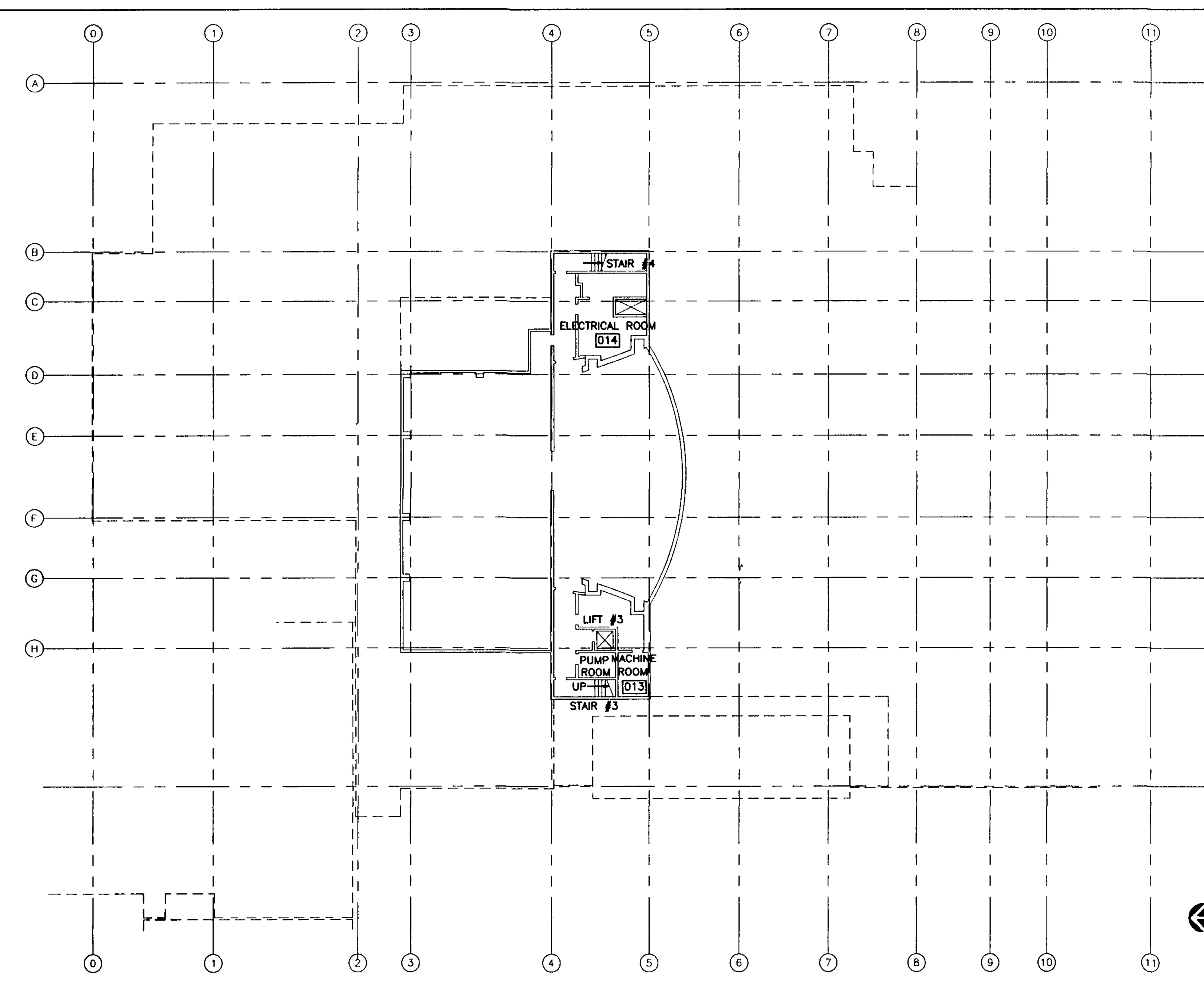
SPOTLIGHT PLATFORM AND CATWALK



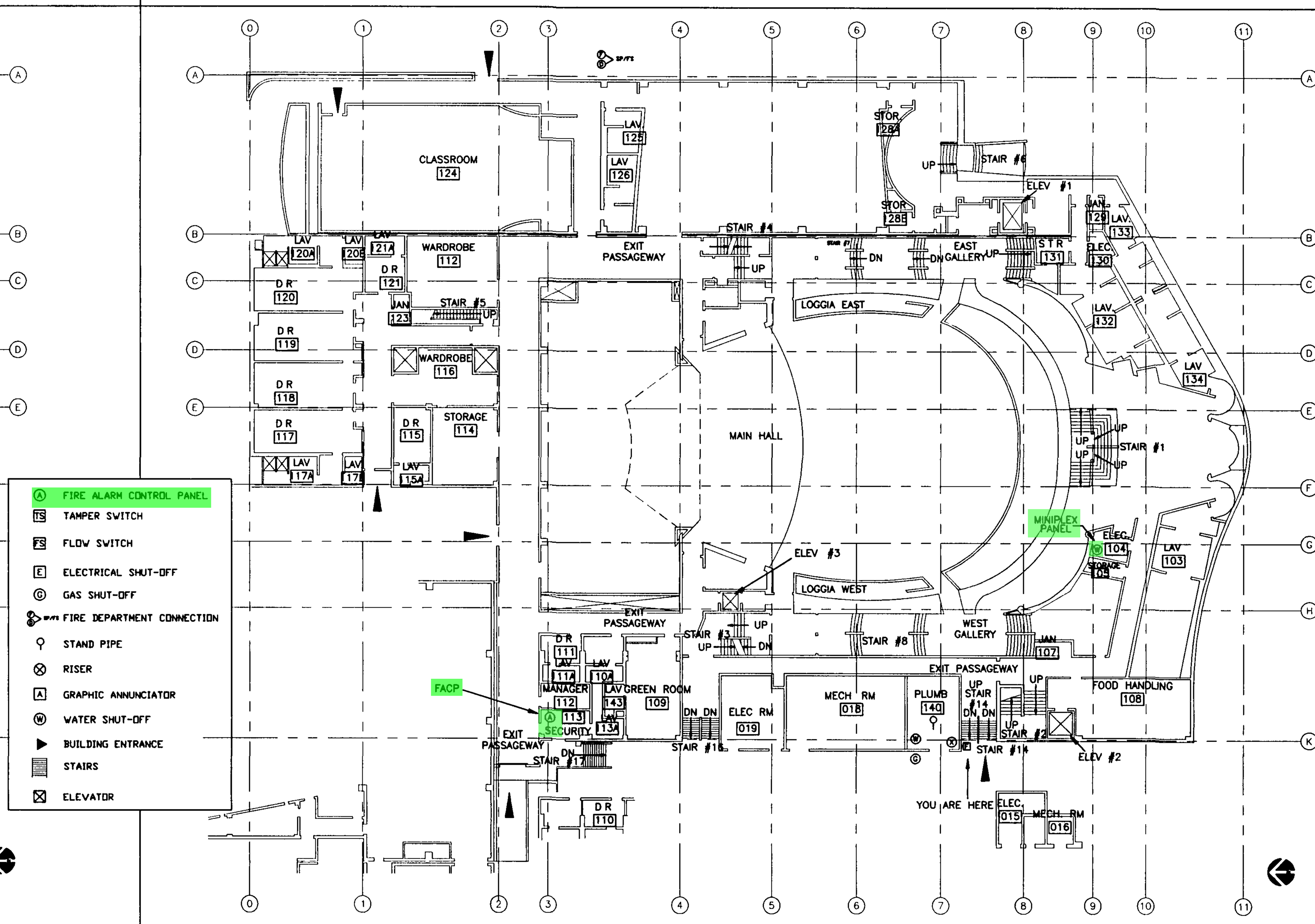
LOWER BALCONY



MAIN FLOOR

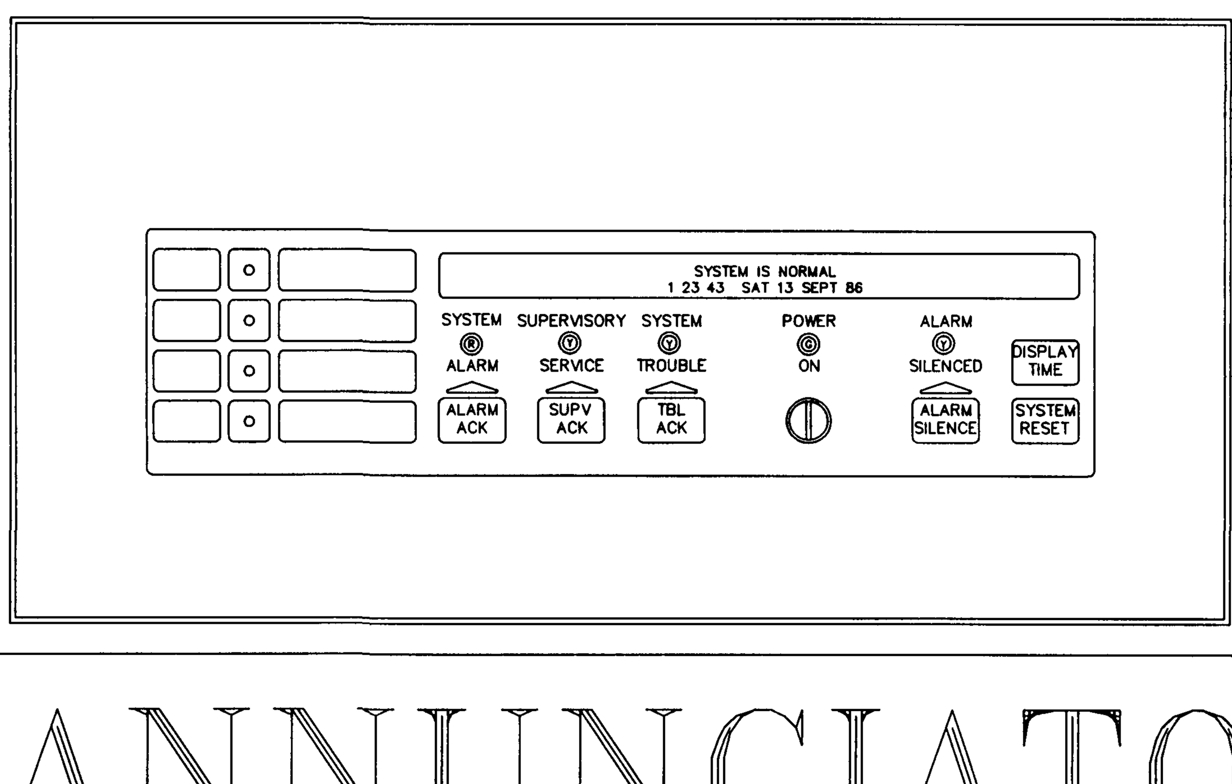


BASEMENT



LOWER LEVEL

4 1/2" X 11 13/16" TRIM PLATE



CENTEX GOLDEN
AS BUILT

Centex Golden Construction Co
Cal Poly Performing Arts Center
This submittal has been reviewed in accordance with contract requirements

Submittal No 497 — Spec Section 16720
Signed — Date 11/20/96

GRAPHIC ANNUNCIATOR LAYOUT

PERFORMING ARTS CENTER
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CALIFORNIA

FIRE ALARM SUPPLIER
SIMPLEX
570 SOUTH HILLVIEW DRIVE
MILPITAS, CA 95035

ELECTRICAL CONTRACTOR
COLLINS ELECTRIC
385 RESERVATION ROAD
MARINA, CA 93933

LEGEND

FACP — FIRE ALARM CONTROL PANEL (CLASS A) △3
MODEL #4120-8210
C S F M #7165-0026 160

MINIPLEX — FIRE ALARM MINIPLEX PANEL (CLASS A) △3
MODEL #4120-8219
C S F M #7165-0026 160

SD — SMOKE DETECTOR
MODEL #2098-9201 HEAD
C S F M #7272-0026 132
MODEL #2098-9651 BASE
C S F M #7300-0026 149

SD R — SMOKE DETECTOR
MODEL #4098-9783 BASE
C S F M #7300-0026 165
MODEL #4098-9701 HEAD
C S F M #7272-0026 166
MODEL #2098-9737 RELAY
C S F M #7300-0026 013

HD — HEAT DETECTOR
MODEL #4098-9731 HEAD
C S F M #7270-0026 176
MODEL #4098-9781 BASE
C S F M #7300-0026 165

F — MANUAL PULL STATION
MODEL #2099-9795
C S F M #7150-0026 175

SS — SPEAKER STROBE (WALL MOUNTED)
MODEL #ET-1070-LSM-24-VFR
C S F M #7125-0785 125

SS — SPEAKER STROBE
MODEL #ET-1070-LSM-24-VFR
C S F M #7125-0785.125

△3 S — SPEAKER ONLY
MODEL #4902-9702
C S F M #7320-0026 199

△3 V — VISUAL ONLY
MODEL #4904-9135
C S F M #7125-0026 198

DH — DOOR HOLDER
MODEL #2088-9585
C S F M #3550-0026 176

DD — DUCT DETECTOR
MODEL #2098-9702 HOUSING
C S F M #3240-0026 159
MODEL #20988-9201 HEAD
C S F M #7272-0026 132

TS — TAMPER SWITCH
MODEL # PROVIDED BY OTHERS

FS — WATERFLOW SWITCH
MODEL # PROVIDED BY OTHERS

RL — REMOTE LAMP
MODEL #2098-9808
C S F M #7300-0026 150

CZ — CONTROL ZAM
MODEL #2190-9163
C S F M #7300-0026 182

IAM — INDIVIDUAL ADDRESSABLE MODULE
MODEL #2190-9172A
C S F M #7300-0026 189

△4 TABLE OF CONTENTS

WIRE SCHEDULE

* A = TWO #18AWG TWISTED SHIELDED PAIR FOR ADDRESSABLE DEVICE WIRING
B = ONE PAIR #14AWG COPPER FOR DUCT DETECTOR POWER
C = ONE PAIR #12AWG COPPER FOR DOOR HOLDER
D = ONE PAIR #12AWG COPPER FOR INDICATING DEVICE WIRING (NOT USED)
* E = TWO #16AWG TWISTED SHIELDED PAIR COPPER FOR SPEAKER CIRCUIT WIRING
* F = TWO PAIR #12AWG COPPER FOR INDICATING DEVICE WIRING
G = ONE #18AWG TWISTED SHEILDED PAIR FOR REMOTE UNIT COMMUNICATION WIRING
H = ONE PAIR #14AWG COPPER FOR REMOTE UNIT POWER WIRING
J = ONE PAIR #14AWG COPPER FOR CONTROL CIRCUIT WIRING
K = EXISTING CAMPUS FIBER OPTIC NETWORK FOR NETWORK INTERFACE WIRING

△3 * ONE PAIR RETURNS TO FACP AFTER LAST DEVICE – CLASS A

FIRE ALARM NOTES

1 ALL REQUIREMENTS OF CONTRACT SPECIFICATIONS AND DRAWINGS APPLY
2 INSTALLATION SHALL CONFORM TO REQUIREMENTS OF APPLICABLE CODES
3 WIRING METHODS AND MATERIALS SHALL CONFORM WITH ALL APPLICABLE SECTIONS OF NEC ARTICLE 760
4 SEE SIMPLEX 4100 FIELD WIRING SPECIFICATIONS (841-731) FOR ADDITIONAL INSTALLATION REQUIREMENTS
5 120VAC 60 Hz INPUT POWER FOR FIRE ALARM CONTROLS SHALL BE A DEDICATED, LOCKING BREAKER PROPERLY LABELED "SOURCE FROM LINE SIDE OF MAIN DISCONNECT" OR "EMERGENCY POWER"
6 ALL WIRING, INCLUDING SHIELDS, MUST BE DRY AND FREE OF SHORTS AND GROUNDS
7 PROVIDE SIMPLEX WITH ONE COPY OF "AS BUILT" DRAWINGS SO THAT ACCURATE DOCUMENTATION CAN BE MAINTAINED
8 120VAC IS NOT PERMITTED IN SAME CONDUIT WITH LOW VOLTAGE WIRING
9 DO NOT APPLY POWER EXCEPT IN THE PRESENCE OF A FACTORY-TRAINED SIMPLEX TECHNICAL REPRESENTATIVE
10 ANY SMOKE DETECTOR HEAD INSTALLED BEFORE BUILDING IS CLEANED AND ACCEPTED SHALL BE COVERED TO PROTECT FROM DUST ANY FALSE ALARMS DUE TO DIRT-CONTAMINATED HEADS SHALL BE THE RESPONSIBILITY OF THE ELECTRICAL CONTRACTOR
11 THERE WILL BE NO CONDUIT ENTRY ALLOWED 18" OR LOWER ON THE SIDE PANELS OR THROUGH THE BOTTOM OF ALL CONTROL EQUIPMENT BACKBOXES
12 MANUAL PULL STATIONS SHALL BE MOUNTED AT 48" ABOVE FINISHED FLOOR TO CENTERLINE OF DEVICE
13 LOCAL FIRE AUTHORITY SHALL WITNESS FINAL TEST
14 ALL WIRE, PANEL AND DEVICE TERMINATIONS, CONDUIT, PHYSICAL MOUNTING, ETC, SHALL BE PROVIDED BY OTHER THAN SIMPLEX
15 SMOKE DETECTOR SHALL NOT BE LOCATED DIRECTLY IN THE AIR STREAM OF SUPPLY REGISTERS (NFPA 72E 4-6 5 3)
16 DUCT VELOCITY & PRESSURE DIFFERENTIAL OF DUCT SMOKE DETECTORS INSTALLATIONS SHALL BE TESTED & VERIFIED IN ACORDANCE WITH THEIR LISTING & MANUFACTURERS SPECIFICATION (NFPA 72 2-1 2)

APPLICABLE CODES·

1991	UBC AND 1992 CALIFORNIA AMENDMENTS (92 CALIFORNIA BUILDING CODE – PART 2, TITLE 24, CCR)			
1990	NEC AND 1990 CALIFORNIA AMENDMENTS (91 CALIFORNIA ELECTRICAL CODE – PART 3, TITLE 24, CCR)			
1991	UMC AND 1992 CALIFORNIA AMENDMENTS (92 CALIFORNIA MECHANICAL CODE – PART 4, TITLE 24, CCR)			
199[illegible]	UPC AND 1992 CALIFORNIA AMENDMENTS (92 CALIFORNIA PLUMBING CODE – PART 5, TITLE 24, CCR)			
1991	UNIFORM FIRE CODE WITH STATE AMENDMENTS (CALIFORNIA FIRE CODE PART 9, TITLE 24, CCR)			
199[illegible]	BUILDING STANDARS CODE (92 STATE REFERENCED STANDARDS CODE – PART 12 TITLE 24, CCR)			
72	[illegible] ALARM SYSTEMS (WI[illegible] [illegible]IFORNIA AMENDMENTS)	1990	6004(A)	CBC
72E	[illegible] FIRE DE[illegible]TORS	1990	760-1	CE[illegible]
72C	[illegible] APPLIANCES [illegible]NIA AMENDMENTS)	1989	6004(I)	CB[illegible]
[illegible]	S[illegible] [illegible]EDURES	1988		

SIGNAL CIRCUIT SCHEDULE

SIGNAL CIRCUIT (STROBES)		SIGNAL CIRCUIT (SPEAKERS)	
SIGNAL CIRCUIT 1 (STROBES)	BASEMENT	SIGNAL CIRCUIT 1 (SPEAKERS)	BASEMENT
SIGNAL CIRCUIT 2 (STROBES)	BASEMENT	SIGNAL CIRCUIT 2 (SPEAKERS)	LOWER LEVEL
SIGNAL CIRCUIT 3 (STROBES)	LOWER LEVEL	SIGNAL CIRCUIT 3 (SPEAKERS)	LOWER LEVEL
SIGNAL CIRCUIT 4 (STROBES)	LOWER LEVEL	SIGNAL CIRCUIT 4 (SPEAKERS)	LOWER LEVEL
SIGNAL CIRCUIT 5 (STROBES)	LOWER LEVEL	SIGNAL CIRCUIT 5 (SPEAKERS)	LOWER LEVEL
SIGNAL CIRCUIT 6 (STROBES)	LOWER LEVEL	SIGNAL CIRCUIT 6 (SPEAKERS)	LOWER LEVEL
SIGNAL CIRCUIT 7 (STROBES)	LOWER LEVEL	SIGNAL CIRCUIT 7 (SPEAKERS)	MAIN LEVEL
SIGNAL CIRCUIT 8 (STROBES)	LOWER LEVEL	SIGNAL CIRCUIT 8 (SPEAKERS)	MAIN LEVEL
SIGNAL CIRCUIT 9 (STROBES)	LOWER LEVEL	SIGNAL CIRCUIT 9 (SPEAKERS)	LOWER BALCONY
SIGNAL CIRCUIT 10 (STROBES)	LOWER LEVEL	SIGNAL CIRCUIT 10 (SPEAKERS)	LOWER BALCONY
SIGNAL CIRCUIT 11 (STROBES)	LOWER LEVEL	SIGNAL CIRCUIT 11 (SPEAKERS)	UPPER BALCONY
SIGNAL CIRCUIT 12 (STROBES)	LOWER LEVEL	SIGNAL CIRCUIT 12 (SPEAKERS)	UPPER BALCONY
SIGNAL CIRCUIT 13 (STROBES)	LOWER LEVEL	SIGNAL CIRCUIT 13 (SPEAKERS)	CATWALK
SIGNAL CIRCUIT 14 (STROBES)	LOWER LEVEL	SIGNAL CIRCUIT 14 (SPEAKERS)	MAIN LEVEL
SIGNAL CIRCUIT 15 (STROBES)	MAIN LEVEL		
SIGNAL CIRCUIT 16 (STROBES)	MAIN LEVEL		
SIGNAL CIRCUIT 17 (STROBES)	MAIN LEVEL		
SIGNAL CIRCUIT 18 (STROBES)	MAIN LEVEL		
SIGNAL CIRCUIT 19 (STROBES)	MAIN LEVEL		
SIGNAL CIRCUIT 20 (STROBES)	MAIN LEVEL		
SIGNAL CIRCUIT 21 (STROBES)	LOWER BALCONY		
SIGNAL CIRCUIT 22 (STROBES)	LOWER BALCONY		
SIGNAL CIRCUIT 23 (STROBES)	LOWER BALCONY		
SIGNAL CIRCUIT 24 (STROBES)	LOWER BALCONY		
SIGNAL CIRCUIT 25 (STROBES)	LOWER BALCONY		
SIGNAL CIRCUIT 26 (STROBES)	UPPER BALCONY		
SIGNAL CIRCUIT 27 (STROBES)	UPPER BALCONY		
SIGNAL CIRCUIT 28 (STROBES)	CATWALK		
SIGNAL CIRCUIT 29 (STROBES)	LOWER LEVEL		

ACTION

AS BUILT

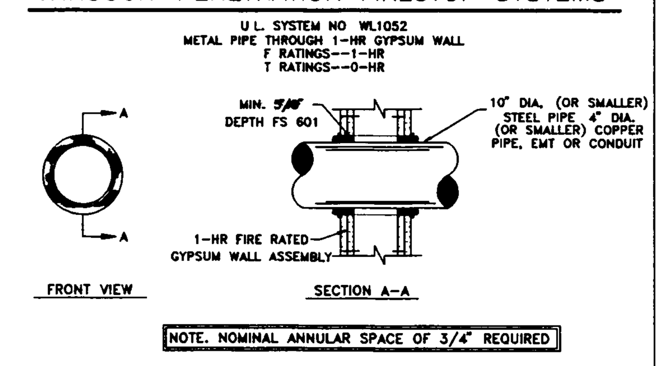
Cen-Cal Golden Construction Co
Cal Poly Performing Arts Center

This submittal has been reviewed in accordance with contract requirements

Submittal No — Spec Section

Signed — Date

THROUGH-PENETRATION FIRESTOP SYSTEMS



△4

INSTALLATION INSTRUCTIONS FOR U L. NO WL1052

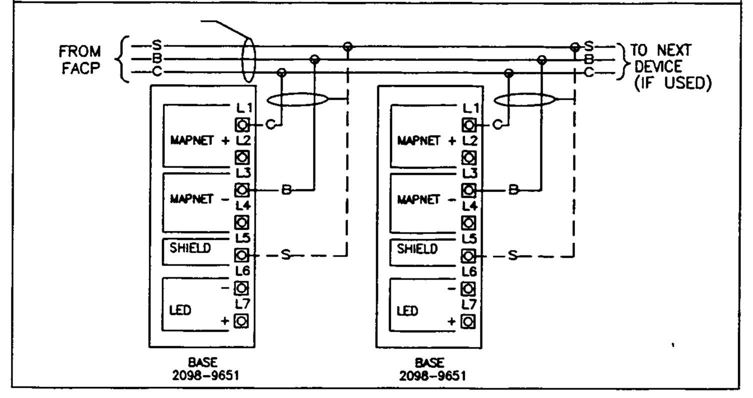
STEP 1- PREPARATION ALL SURFACE MUST BE CLEAN, SOUND, DRY & FROST FREE PRIOR TO APPLICATION OF FIRESTOPPHING MATERIALS

STEP 2 – FIRESTOP SEALANT APPLY A MIN OF 5/8" DEPTH OF FS 601 IN THE ANNULAR SPACE BETWEEN THE PIPE AND WALL ON BOTH SIDES & TOOL IT WITH A PUTTTY KNIFE UNTIL FLUSH WITH THE SURFACE TOOL EXCESS SEALANT BEYOND THE PERIMETER OF THEOPENING 1/2" ONTO THE WALL SURFACE LEAVE COMPLETE SEAL UNDISTURBED FOR 48 HOURS

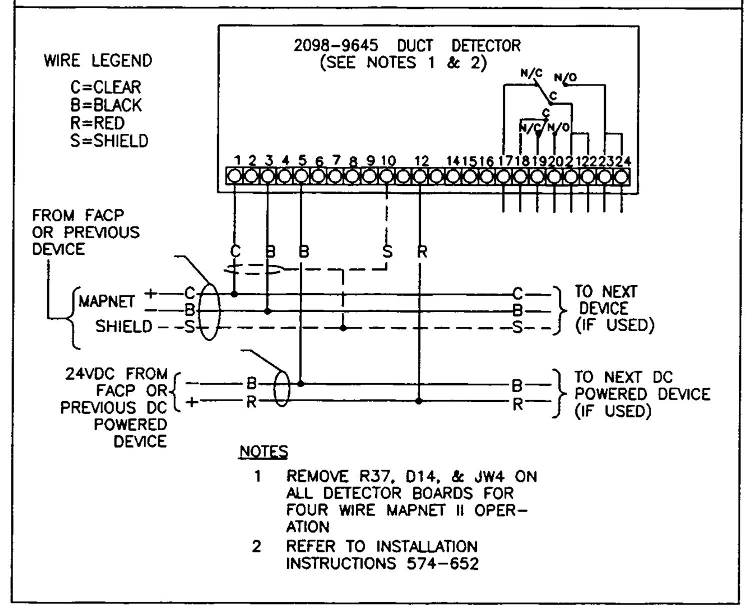
△4 SYSTEM OPERATION MATRIX

DEVICE	ACTIVATE SPEAKER /STROBE	SIGNAL SECURITY/ ENGINEERING	TROUBLE INDICATION	SUPERVISORY SIGNAL	SYSTEM TO RUN ON BATTERY BACKUP
MANUAL PULL STATION	X	X			
SMOKE DETECTOR	X	X			
HEAT DETECTOR	X	X			
DUCT DETECTOR	X				
WATER FLOW					
TAMPER SWITCH				X	
SYSTEM TROUBLE					
POWER FAILURE					X

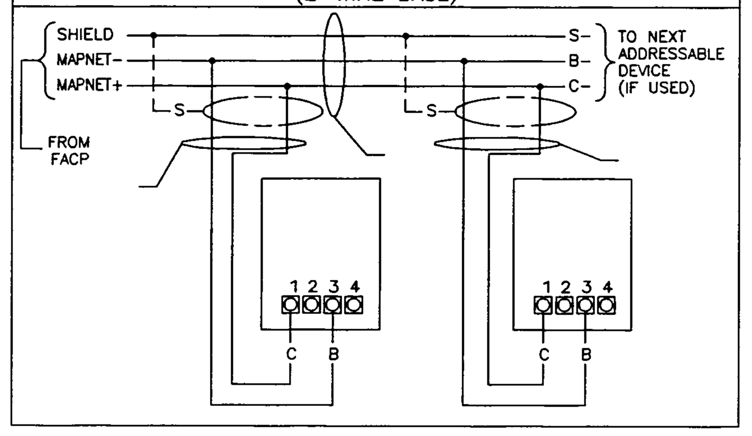
TYPICAL ADDRESSABEL DETECTOR BASE WIRING DETAIL
(STYLE B)



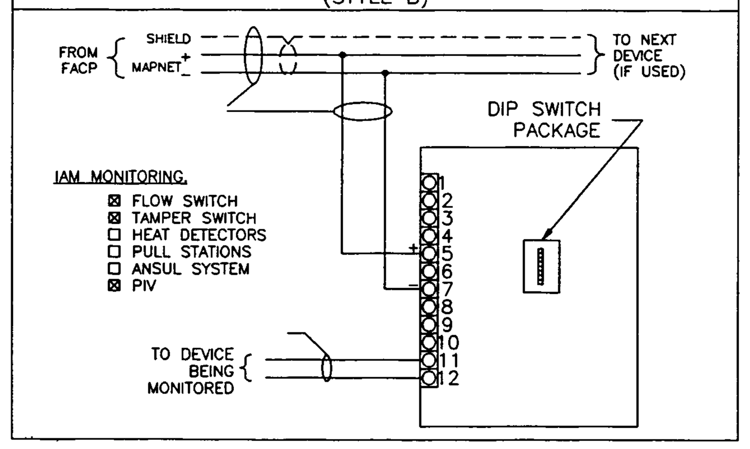
TYPICAL DUCT DETECTOR WIRING DIAGRAM
(STYLE B)



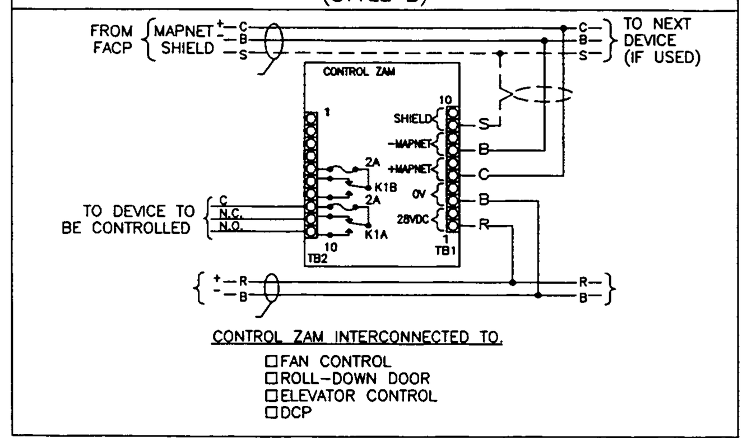
TYPICAL ADDRESSABLE PULL STATION WIRING DIAGRAM
(2-WIRE BASE)



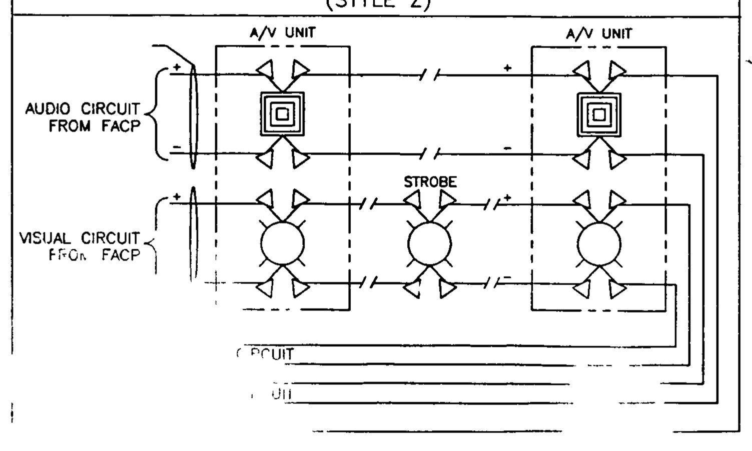
TYPICAL IAM WIRING DETAIL
(STYLE B)



TYPICAL CONTROL ZAM WIRING DETAIL
(STYLE B)



TYPICAL SIGNAL CIRCUIT WIRING DIAGRAM
(STYLE Z)



MAPNET ADDRESS CHART

1 2 3 4 5 6 7 8
LSB — MSB

SWITCH=ON SELECTS ADDRESS

DO NOT USE ADDRESS 0 FOR A MAPNET ADDRESS

SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6	SW1-7	SW1-8		DEVICE ADDRESS
ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	=	ADDRESS 1
OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	=	ADDRESS 2
ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	=	ADDRESS 3
OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	=	ADDRESS 4
ON	OFF	ON	OFF	OFF	OFF	OFF	OFF	=	ADDRESS 5
OFF	ON	ON	OFF	OFF	OFF	OFF	OFF	=	ADDRESS 6
ON	ON	ON	OFF	OFF	OFF	OFF	OFF	=	ADDRESS 7
OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF	=	ADDRESS 8
ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	=	ADDRESS 9
OFF	ON	OFF	ON	OFF	OFF	OFF	OFF	=	ADDRESS 10
ON	ON	OFF	ON	OFF	OFF	OFF	OFF	=	ADDRESS 11
OFF	OFF	ON	ON	OFF	OFF	OFF	OFF	=	ADDRESS 12
ON	OFF	ON	ON	OFF	OFF	OFF	OFF	=	ADDRESS 13
OFF	ON	ON	ON	OFF	OFF	OFF	OFF	=	ADDRESS 14
ON	ON	ON	ON	OFF	OFF	OFF	OFF	=	ADDRESS 15
OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	=	ADDRESS 16
ON	OFF	OFF	OFF	ON	OFF	OFF	OFF	=	ADDRESS 17
OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	=	ADDRESS 18
ON	ON	OFF	OFF	ON	OFF	OFF	OFF	=	ADDRESS 19
OFF	OFF	ON	OFF	ON	OFF	OFF	OFF	=	ADDRESS 20
ON	OFF	ON	OFF	ON	OFF	OFF	OFF	=	ADDRESS 21
OFF	ON	ON	OFF	ON	OFF	OFF	OFF	=	ADDRESS 22
ON	ON	ON	OFF	ON	OFF	OFF	OFF	=	ADDRESS 23
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ON	OFF	OFF	ON	ON	OFF	OFF	OFF	=	ADDRESS 25
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ON	ON	OFF	ON	ON	OFF	OFF	OFF	=	ADDRESS 27
OFF	OFF	ON	ON	ON	OFF	OFF	OFF	=	ADDRESS 28
ON	OFF	ON	ON	ON	OFF	OFF	OFF	=	ADDRESS 29
OFF	ON	ON	ON	ON	OFF	OFF	OFF	=	ADDRESS 30
ON	ON	ON	ON	ON	OFF	OFF	OFF	=	ADDRESS 31
OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	=	ADDRESS 32
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OFF	ON	OFF	OFF	OFF	ON	OFF	OFF	=	ADDRESS 34
ON	ON	OFF	OFF	OFF	ON	OFF	OFF	=	ADDRESS 35
OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	=	ADDRESS 36
ON	OFF	ON	OFF	OFF	ON	OFF	OFF	=	ADDRESS 37
OFF	ON	ON	OFF	OFF	ON	OFF	OFF	=	ADDRESS 38
ON	ON	ON	OFF	OFF	ON	OFF	OFF	=	ADDRESS 39
OFF	OFF	OFF	ON	OFF	ON	OFF	OFF	=	ADDRESS 40
ON	OFF	OFF	ON	OFF	ON	OFF	OFF	=	ADDRESS 41
OFF	ON	OFF	ON	OFF	ON	OFF	OFF	=	ADDRESS 42
ON	ON	OFF	ON	OFF	ON	OFF	OFF	=	ADDRESS 43
OFF	OFF	ON	ON	OFF	ON	OFF	OFF	=	ADDRESS 44
ON	OFF	ON	ON	OFF	ON	OFF	OFF	=	ADDRESS 45
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ON	ON	ON	ON	OFF	ON	OFF	OFF	=	ADDRESS 47
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ON	OFF	OFF	OFF	ON	ON	OFF	OFF	=	ADDRESS 49
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ON	ON	OFF	OFF	ON	ON	OFF	OFF	=	ADDRESS 51
OFF	OFF	ON	OFF	ON	ON	OFF	OFF	=	ADDRESS 52
ON	OFF	ON	OFF	ON	ON	OFF	OFF	=	ADDRESS 53
OFF	ON	ON	OFF	ON	ON	OFF	OFF	=	ADDRESS 54
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ON	ON	ON	ON	ON	ON	OFF	OFF	=	ADDRESS 63
OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	=	ADDRESS 64
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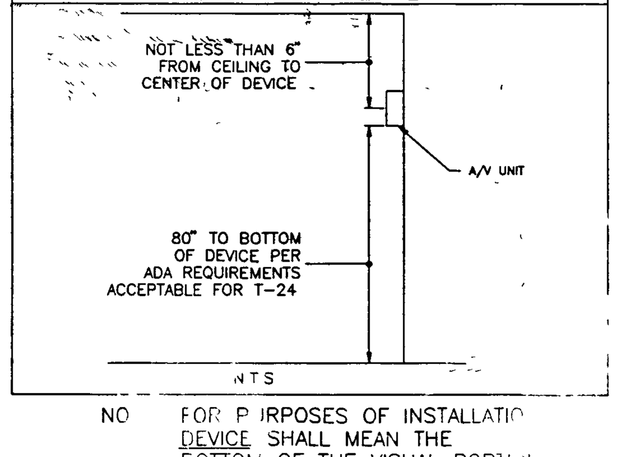
ON	ON	ON	OFF	OFF	OFF	ON	OFF	=	ADDRESS 71
OFF	OFF	OFF	ON	OFF	OFF	ON	OFF	=	ADDRESS 72
ON	OFF	OFF	ON	OFF	OFF	ON	OFF	=	ADDRESS 73
OFF	ON	OFF	ON	OFF	OFF	ON	OFF	=	ADDRESS 74
ON	ON	OFF	ON	OFF	OFF	ON	OFF	=	ADDRESS 75
OFF	OFF	ON	ON	OFF	OFF	ON	OFF	=	ADDRESS 76
ON	OFF	ON	ON	OFF	OFF	ON	OFF	=	ADDRESS 77
OFF	ON	ON	ON	OFF	OFF	ON	OFF	=	ADDRESS 78
ON	ON	ON	ON	OFF	OFF	ON	OFF	=	ADDRESS 79
OFF	OFF	OFF	OFF	ON	OFF	ON	OFF	=	ADDRESS 80
ON	OFF	OFF	OFF	ON	OFF	ON	OFF	=	ADDRESS 81
OFF	ON	OFF	OFF	ON	OFF	ON	OFF	=	ADDRESS 82
ON	ON	OFF	OFF	ON	OFF	ON	OFF	=	ADDRESS 83
OFF	OFF	ON	OFF	ON	OFF	ON	OFF	=	ADDRESS 84
ON	OFF	ON	OFF	ON	OFF	ON	OFF	=	ADDRESS 85
OFF	ON	ON	OFF	ON	OFF	ON	OFF	=	ADDRESS 86
ON	ON	ON	OFF	ON	OFF	ON	OFF	=	ADDRESS 87
OFF	OFF	OFF	ON	ON	OFF	ON	OFF	=	ADDRESS 88
ON	OFF	OFF	ON	ON	OFF	ON	OFF	=	ADDRESS 89
OFF	ON	OFF	ON	ON	OFF	ON	OFF	=	ADDRESS 90
ON	ON	OFF	ON	ON	OFF	ON	OFF	=	ADDRESS 91
OFF	OFF	ON	ON	ON	OFF	ON	OFF	=	ADDRESS 92
ON	OFF	ON	ON	ON	OFF	ON	OFF	=	ADDRESS 93
OFF	ON	ON	ON	ON	OFF	ON	OFF	=	ADDRESS 94
ON	ON	ON	ON	ON	OFF	ON	OFF	=	ADDRESS 95
OFF	OFF	OFF	OFF	OFF	ON	ON	OFF	=	ADDRESS 96
ON	OFF	OFF	OFF	OFF	ON	ON	OFF	=	ADDRESS 97
OFF	ON	OFF	OFF	OFF	ON	ON	OFF	=	ADDRESS 98
ON	ON	OFF	OFF	OFF	ON	ON	OFF	=	ADDRESS 99
OFF	OFF	ON	OFF	OFF	ON	ON	OFF	=	ADDRESS 100
ON	OFF	ON	OFF	OFF	ON	ON	OFF	=	ADDRESS 101
OFF	ON	ON	OFF	OFF	ON	ON	OFF	=	ADDRESS 102
ON	ON	ON	OFF	OFF	ON	ON	OFF	=	ADDRESS 103
OFF	OFF	OFF	ON	OFF	ON	ON	OFF	=	ADDRESS 104
ON	OFF	OFF	ON	OFF	ON	ON	OFF	=	ADDRESS 105
OFF	ON	OFF	ON	OFF	ON	ON	OFF	=	ADDRESS 106
ON	ON	OFF	ON	OFF	ON	ON	OFF	=	ADDRESS 107
OFF	OFF	ON	ON	OFF	ON	ON	OFF	=	ADDRESS 108
ON	OFF	ON	ON	OFF	ON	ON	OFF	=	ADDRESS 109
OFF	ON	ON	ON	OFF	ON	ON	OFF	=	ADDRESS 110
ON	ON	ON	ON	OFF	ON	ON	OFF	=	ADDRESS 111
OFF	OFF	OFF	OFF	ON	ON	ON	OFF	=	ADDRESS 112
ON	OFF	OFF	OFF	ON	ON	ON	OFF	=	ADDRESS 113
OFF	ON	OFF	OFF	ON	ON	ON	OFF	=	ADDRESS 114
ON	ON	OFF	OFF	ON	ON	ON	OFF	=	ADDRESS 115
OFF	OFF	ON	OFF	ON	ON	ON	OFF	=	ADDRESS 116
ON	OFF	ON	OFF	ON	ON	ON	OFF	=	ADDRESS 117
OFF	ON	ON	OFF	ON	ON	ON	OFF	=	ADDRESS 118
ON	ON	ON	OFF	ON	ON	ON	OFF	=	ADDRESS 119
OFF	OFF	OFF	ON	ON	ON	ON	OFF	=	ADDRESS 120
ON	OFF	OFF	ON	ON	ON	ON	OFF	=	ADDRESS 121
OFF	ON	OFF	ON	ON	ON	ON	OFF	=	ADDRESS 122
ON	ON	OFF	ON	ON	ON	ON	OFF	=	ADDRESS 123
OFF	OFF	ON	ON	ON	ON	ON	OFF	=	ADDRESS 124
ON	OFF	ON	ON	ON	ON	ON	OFF	=	ADDRESS 125
OFF	ON	ON	ON	ON	ON	ON	OFF	=	ADDRESS 126
ON	ON	ON	ON	ON	ON	ON	OFF	=	ADDRESS 127

△3

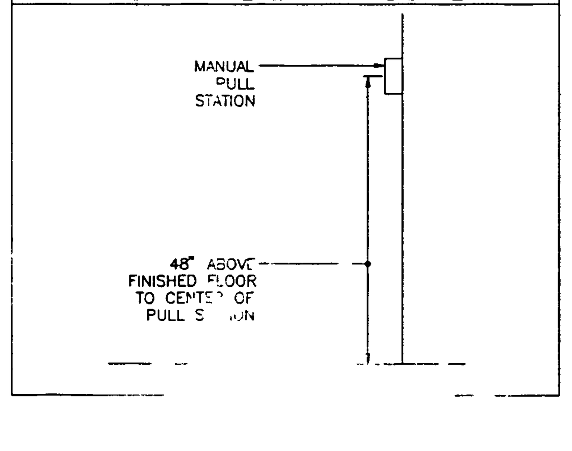
TYPICAL STROBE ONLY OR SPEAKER STROBE ELEVATION DETAIL



NO[illegible] FOR PURPOSES OF INSTALLATION DEVICE SHALL MEAN THE BOTTOM OF THE VISUAL PORTION OF LENS OF THE FIXTURE

△4

TYPICAL MANUAL PULL STATION ELEVATION DETAIL



REVISIONS

REVISED WIRE & DUCT DETECTORS 07-07-94	△1
REVISIONS 07-27-94	△2
REVISIONS 11-03-94	△3
REVISIONS 06-22-95	△4
REVISIONS 09-25-95	△5
REVISIONS AS-BUILTS 11/12/96	△6

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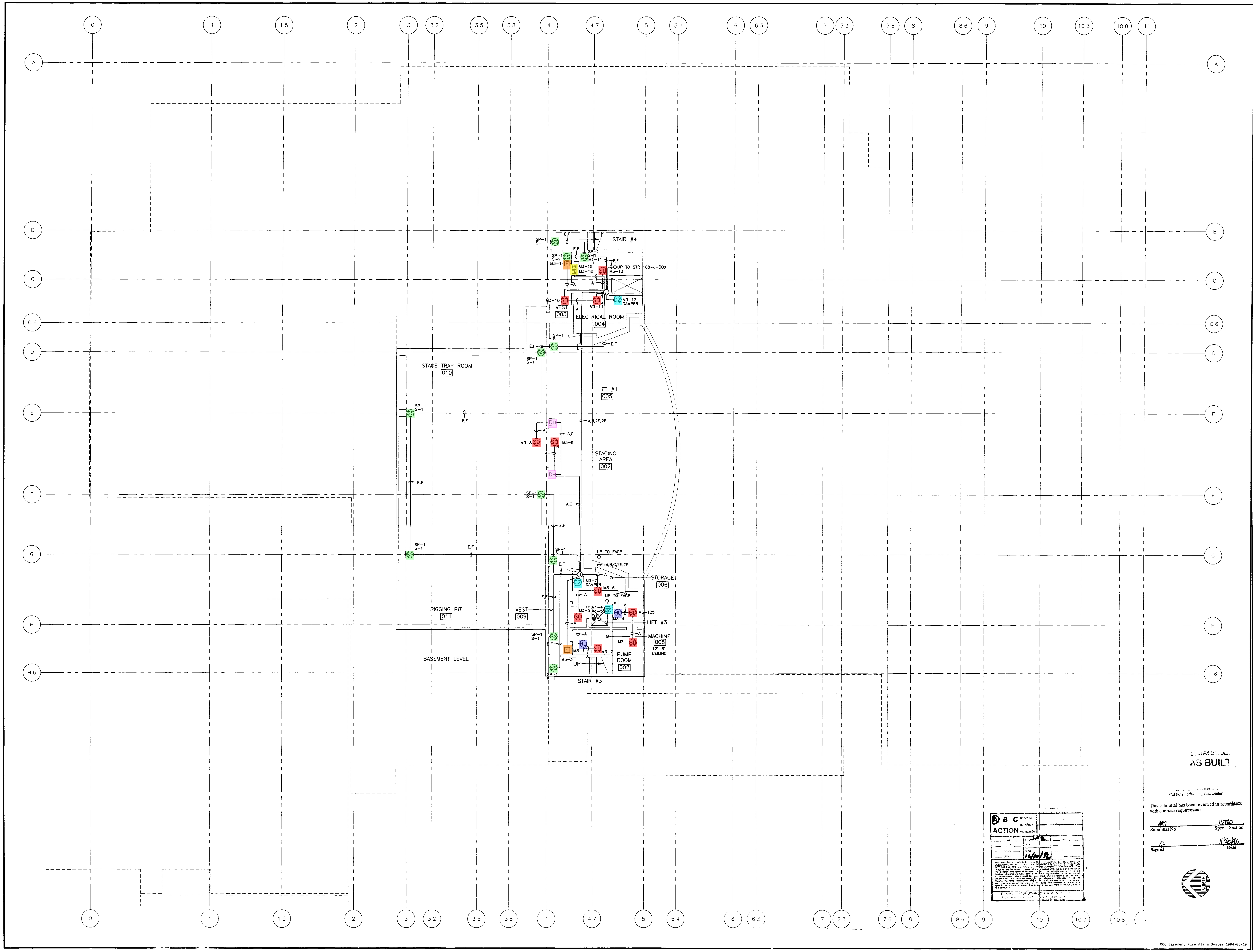
(805) 543-6287

COVER SHEET

PERFORMING ARTS CENTER
CALIFORNIA POLYTECHNIC
STATE UNIVERSITY
SAN LUIS OBISPO, CALIFORNIA

Date 5-19-94
Scale 1/8" = 1'0"
Drawn J VALENTE
Sales Apprv'l
Service Apprv'l
Job [illegible]
Sheet [illegible]



REVISIONS

REVISED WIRE & DUCT DETECTORS 07-07-94	1
REVISIONS 07-27-94	2
REVISIONS 11-03-94	3
REVISIONS 11/17/95	4
REVISIONS AS-BUILT 11/5/96	5

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BASEMENT
FIRE ALARM SYSTEM

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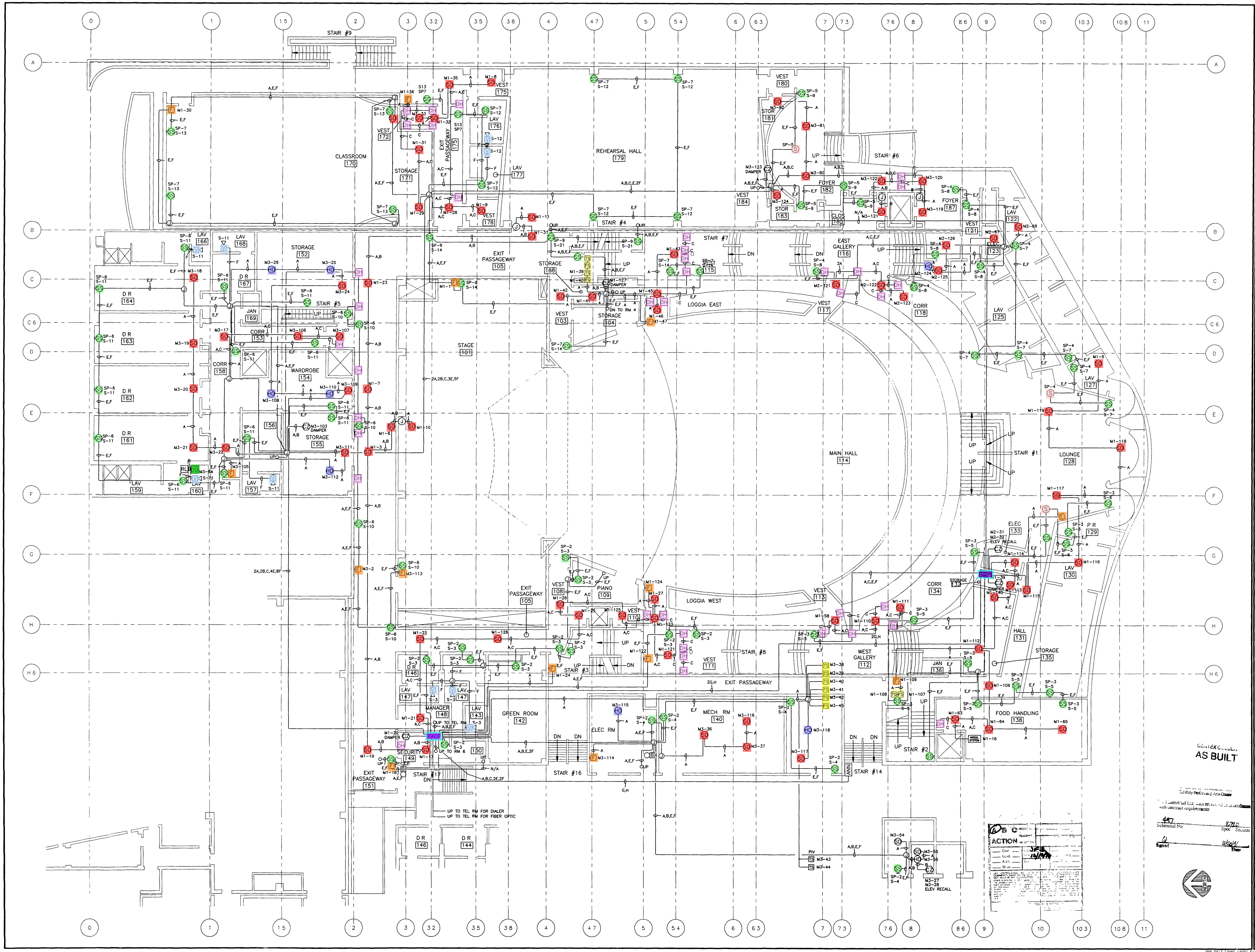
STATE UNIVERSITY
SAN LUIS OBISPO, CALIFORNIA

Date 5-19-94
Scale 1/8" = 1'0"
Drawn J VALENTE
Sales Appr'l
Service Appr'l
Job PERFORMING ARTS CENTER
Sheet
FA-

006 Basement Fire Alarm System 1994-05-19



REVISIONS	
REVISED WIRE & DUCT DETECTORS 07-07-94	1
REVISIONS 07-27-94	2
REVISIONS 11-03-94	3
REVISIONS 09-25-95	4
REVISIONS AS-BUILTS 11/12/96	5

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LOWER LEVEL FIRE ALARM SYSTEM

PERFORMING ARTS CENTER
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, CALIFORNIA

Date 5-6-94
Scale 1/8" = 1'0"
Drawn J VALENTE
Sales Apprv'l
Service Apprv'l
Job PERFORMING ARTS CENTER
Sheet FA-3 of Sheets

REVISIONS

REVISED WIRE & DUCT DETECTORS 07-07-94	1
REVISIONS 07-27-94	2
REVISIONS 11-03-94	3
REVISIONS 09-25-95	4
REVISIONS 11/17/95	5
REVISIONS As Builts 11/6/96	6

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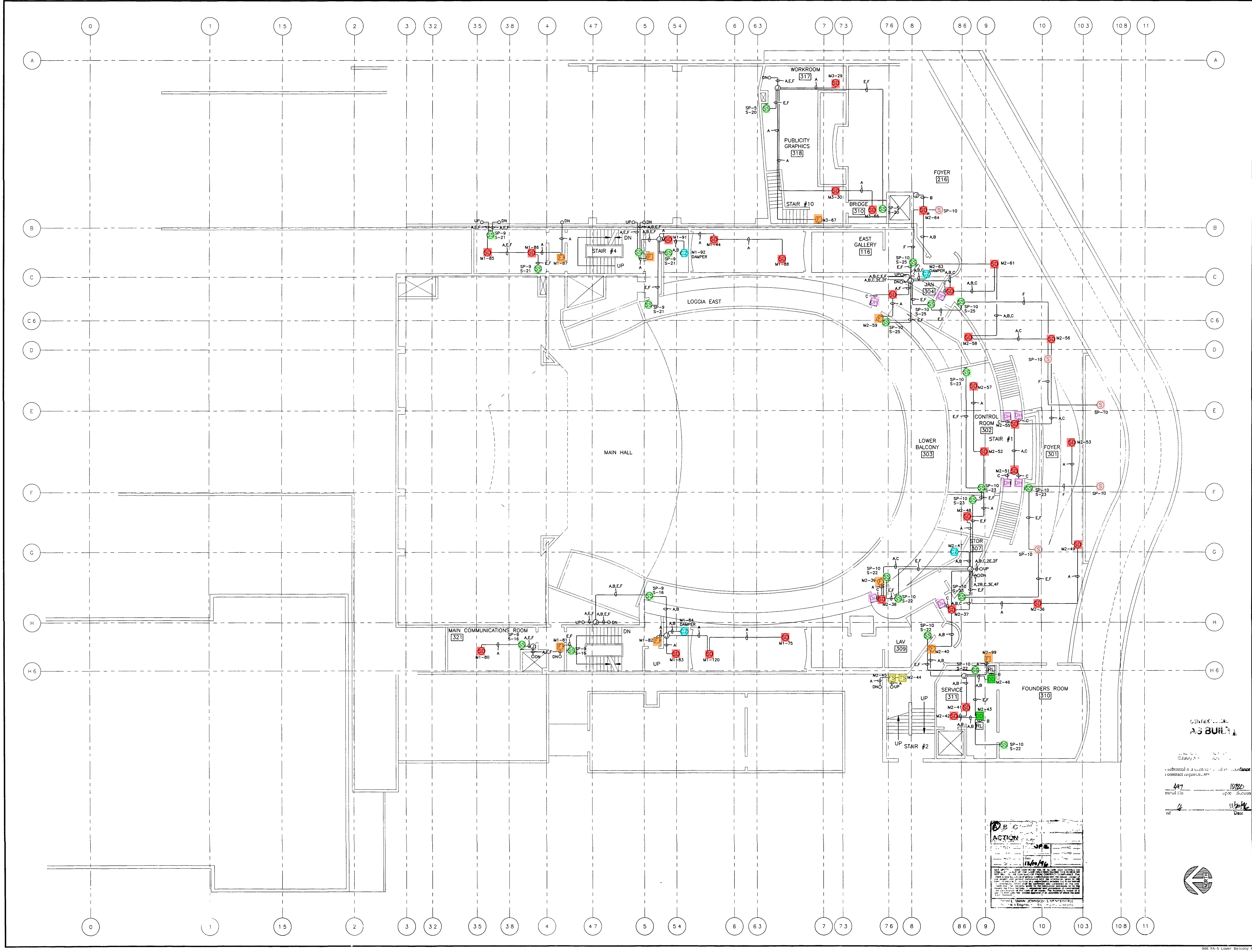
(805) 543-6287

MAIN FLOOR
FIRE ALARM SYSTEM

PERFORMING ARTS CENTER
CALIFORNIA POLYTECHNIC
STATE UNIVERSITY
SAN LUIS OBISPO, CALIFORNIA

Date 5-19-94
Scale 1/8"=1'0"
Drawn J VALENTE
Sales Apprv'l
Service Apprv'l
Job PERFORMING ARTS CENTER
Sheet FA-4
of



REVISIONS	
REVISED WIRE & DUCT DETECTORS 07-07-94	1
REVISIONS 07-27-94	2
REVISIONS 11-03-94	3
REVISIONS 09-25-95	5
REVISIONS 11/17/95	6
REVISIONS AS-BUILTS 11/6/96	7

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LOWER BALCONY
FIRE ALARM SYSTEM

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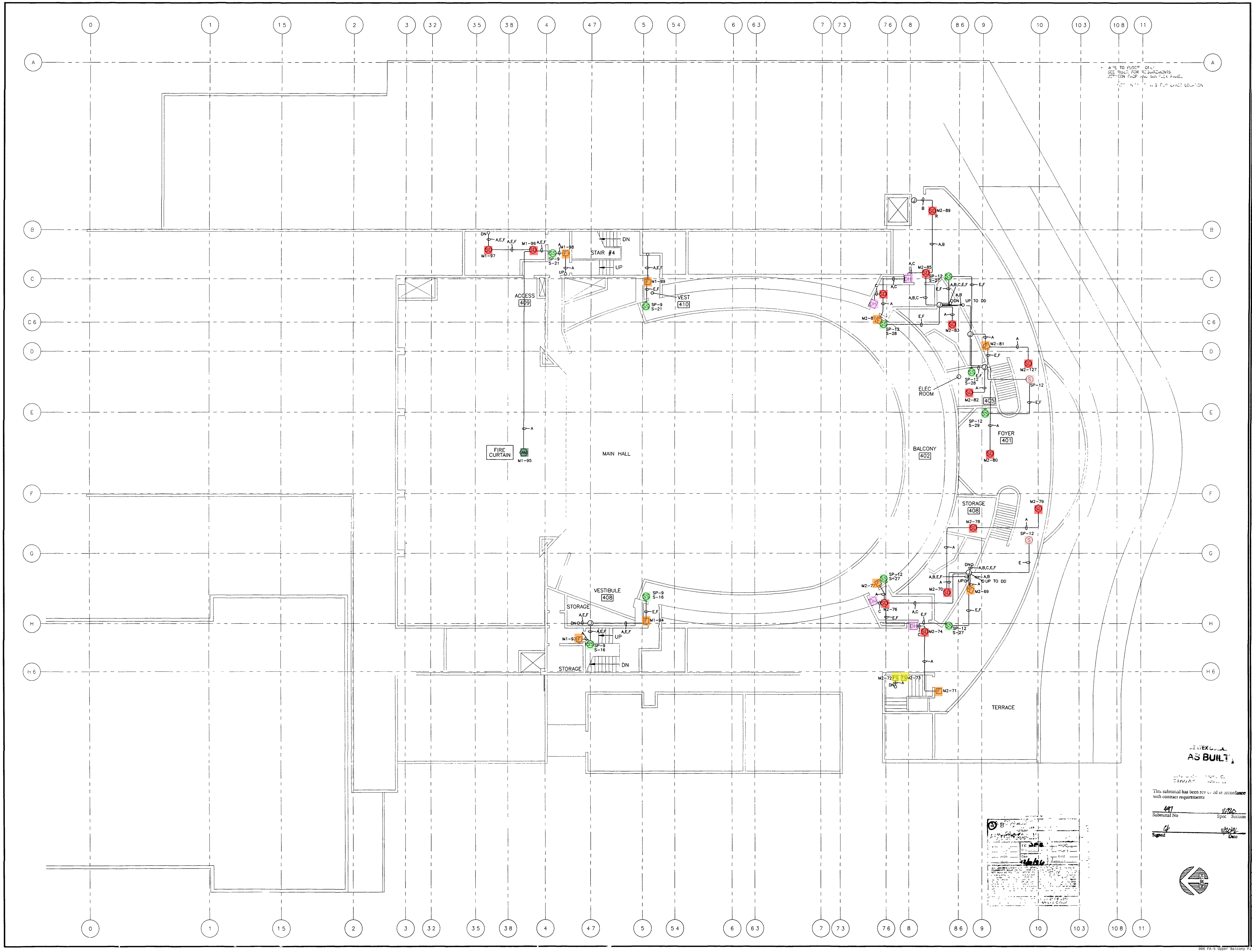
STATE UNIVERSITY
SAN LUIS OBISPO, CALIFORNIA

AS BUILT

Date 5-19-94
Scale 1/8" = 1'0"
Drawn J VALENTE
Sales Apprv'l
Service Apprv'l
Job PERFORMING ARTS CENTER
Sheet FA-5 of Sheets



REVISIONS

REVISED WIRE & DUCT DETECTORS 07-07-94	1
REVISIONS 07-27-94	2
REVISIONS 11-03-94	3
REVISIONS AS-BUILT 11/12/96	4

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UPPER BALCONY
FIRE ALARM SYSTEM

PERFORMING ARTS CENTER
CALIFORNIA POLYTECHNIC
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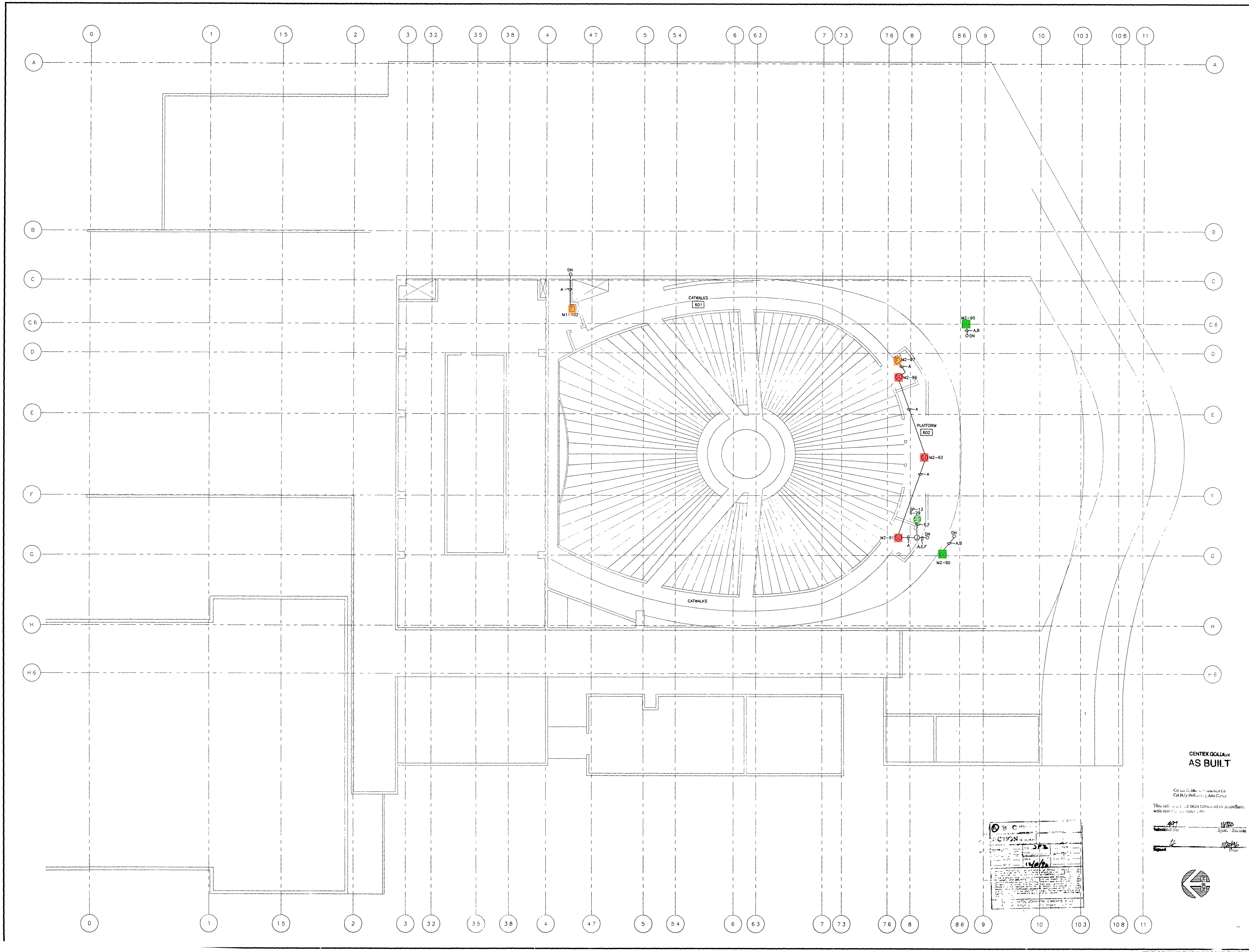
Scale 1/8" = 1'0"
Drawn J VALENTE
Sales Apprv'l
Service Apprv'l
Job PERFORMING ARTS CENTER
Sheet FA-6
of Sheets



REVISIONS	
REVISED WIRE & DUCT DETECTORS 07-07-94	1
REVISIONS 07-27-94	2
REVISIONS 11-03-94	3
REVISIONS 11/17/95	4
REVISIONS AS-BUILTS 11/5/96	5

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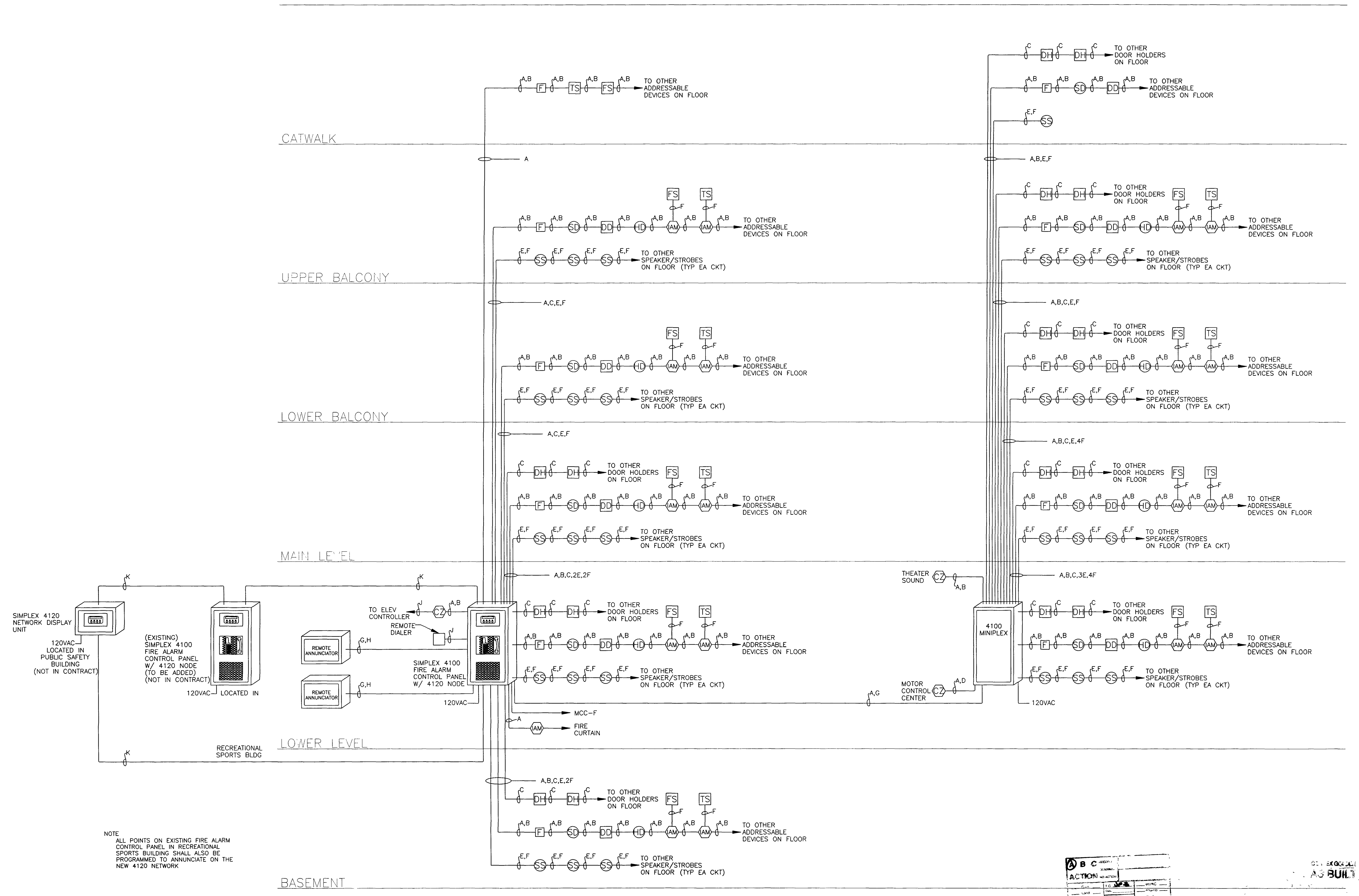
SPOTLIGHT PLATFORM AND CATWALK FIRE ALARM SYSTEM

PERFORMING ARTS CENTER
CALIFORNIA POLYTECHNIC
STATE UNIVERSITY
SAN LUIS OBISPO, CALIFORNIA

Date 5-19-94
Scale 1/8"=1'0"
Drawn J VALENTE
Sales Apprv'l
Service Apprv'l
Job PERFORMING ARTS CENTER
Sheet FA-7
of Sheets

006 FA-7 Spotlight Platform And Catwalk Fire Alarm System 1994-05-19



NOTE
ALL POINTS ON EXISTING FIRE ALARM CONTROL PANEL IN RECREATIONAL SPORTS BUILDING SHALL ALSO BE PROGRAMMED TO ANNUNCIATE ON THE NEW 4120 NETWORK

AS BUILT

REVISIONS

REVISED WIRE & DUCT DETECTORS 07-07-94	1
REVISIONS 07-27-94	2
REVISIONS AS-BUILTS 11-12-96	4

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RISER DIAGRAM

PERFORMING ARTS CENTER
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STATE UNIVERSITY
SAN LUIS OBISPO, CALIFORNIA

Date 5-19-94
Scale NTS
Drawn J VALENTE
Sales Apprv'l
Service Apprv'l
Job PERFORMING ARTS CENTER
Sheet FA-8 of Sheets

SIG CKT #-------- 1

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	75	53	13	34	6	8	0	0	0	0
AMPS @ DEVICE	0.115	0 115	0 115	0 115	0 115	0 115	0	0	0	0
AMPS DEVELOPED	0.69	0.575	0.46	0.345	0 23	0 115	0	0	0	0
VOLT. DROP	0 16457	0 09691	0 01902	0.0373	0.00439	0.00293	0	0	0	0

TOTAL CKT V.D.= 0.32511

CKT VOLTAGE= 24

% VOLTAGE DROP= 1 35461

WIRE SIZE	RESIS. /M FT.	CIRC. MILS.
12	1.59	6530
14	2.52	4110
16	4.02	2580

** FORMULA **
I X FEET X OHMS/FT /FT

SIG CKT #-------- 2

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	28	16	38	54	40	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0 115	0	0	0	0	0
AMPS DEVELOPED	0 575	0 46	0 345	0 23	0 115	0	0	0	0	0
VOLT DROP	0 0512	0 0234	0 04169	0 0395	0 01463	0	0	0	0	0

TOTAL CKT V D = 0.17042

CKT VOLTAGE= 24

% VOLTAGE DROP= 0 71007

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #--------3

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	3	22	47	12	79	16	5	38	10	61
AMPS @ DEVICE	0 238	0 238	0 015	0 015	0 015	0 238	0 015	0 015	0 015	0 015
AMPS DEVELOPED	1 31	1 072	0 834	0 819	0 804	0 789	0 551	0 536	0 521	0 506
VOLT. DROP	0 0125	0 075	0 12465	0 03125	0 20198	0.04014	0 00876	0 06477	0 016568	0 098154

DEVICE #	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	15	37	9	0	0	0	0	0	0	0
AMPS @ DEVICE	0 238	0 015	0 238	0	0	0	0	0	0	0
AMPS DEVELOPED	0 491	0 253	0 238	0	0	0	0	0	0	0
VOLT DROP	0 02342	0 02977	0 00681	0	0	0	0	0	0	0

TOTAL CKT V D = 0 73378

CKT VOLTAGE= 24

% VOLTAGE DROP= 3 0574

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT

SIG CKT #-------- 4

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	111	35	50	42	26	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0 115	0	0	0	0	0
AMPS DEVELOPED	0 575	0 46	0 345	0 23	0 115	0	0	0	0	0
VOLT DROP	0 20296	0 0512	0 05486	0 03072	0 00951	0	0	0	0	0

TOTAL CKT V D = 0 34924

CKT VOLTAGE= 24

% VOLTAGE DROP= 1 45518

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 5

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	44	11	40	61	24	40	66	38	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0 115	0 115	0 115	0 115	0	0
AMPS DEVELOPED	0 92	0 805	0 69	0 575	0 46	0 345	0 23	0 115	0	0
VOLT DROP	0 12873	0 02816	0 08777	0 11154	0 03511	0 04388	0 04827	0 013897	0	0

TOTAL CKT V D = 0 49735

CKT VOLTAGE= 24

% VOLTAGE DROP= 2 0723

WIRE SIZE	RESIS /M FT.	CIRC MILS
12	1.59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 6

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	27	7	6	17	85	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0 115	0	0	0	0	0
AMPS DEVELOPED	0 575	0 46	0 345	0 23	0 115	0	0	0	0	0
VOLT DROP	0 04937	0 01024	0 00658	0 01243	0 03108	0	0	0	0	0

TOTAL CKT V D = 0 10971

CKT VOLTAGE= 24

% VOLTAGE DROP= 0 45713

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 7

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	86	6	26	12	53	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0 115	0	0	0	0	0
AMPS DEVELOPED	0 575	0 46	0 345	0 23	0 115	0	0	0	0	0
VOLT DROP	0 15725	0 00878	0 02852	0 00878	0 01938	0	0	0	0	0

TOTAL CKT V D = 0 22271

CKT VOLTAGE= 24

% VOLTAGE DROP= 0 92796

WIRE SIZE	RESIS /M FT	CIRC. MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 8

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	140	27	8	52	15	37	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0 115	0 115	0	0	0	0
AMPS DEVELOPED	0 69	0 575	0 46	0 345	0 23	0 115	0	0	0	0
VOLT DROP	0 30719	0 04937	0 0117	0 05705	0 01097	0 01353	0	0	0	0

TOTAL CKT V D = 0 44981

CKT VOLTAGE= 24

% VOLTAGE DROP= 1 87421

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 9

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	191	10	19	34	0	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0	0	0	0	0	0
AMPS DEVELOPED	0 46	0 345	0 23	0 115	0	0	0	0	0	0
VOLT. DROP	0 27939	0 01097	0 0139	0 01243	0	0	0	0	0	0

TOTAL CKT V.D.= 0 3167

CKT VOLTAGE= 24

% VOLTAGE DROP= 1 31957

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 11

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	160	41	19	38	8	11	56	15	15	16
AMPS @ DEVICE	0 238	0 238	0 015	0 015	0 1	0 1	0 015	0 015	0 015	0 015
AMPS DEVELOPED	1 104	0 866	0 628	0 613	0 598	0 498	0 398	0 383	0 368	0 353
VOLT DROP	0 56172	0 11291	0 03794	0 07407	0 01521	0 01742	0 07088	0 018269	0 017554	0 017961

DEVICE #	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	37	6	0	0	0	0	0	0	0	0
AMPS @ DEVICE	0 238	0 1	0	0	0	0	0	0	0	0
AMPS DEVELOPED	0 338	0 1	0	0	0	0	0	0	0	0
VOLT DROP	0 03977	0 00191	0	0	0	0	0	0	0	0

TOTAL CKT V D = 0 98561

CKT VOLTAGE= 24

% VOLTAGE DROP= 4 10672

WIRE SIZE	RESIS /M FT	CIRC MILS
10	1 21	10380
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 10

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	60	36	30	37	38	44	52	18	20	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0 115	0 115	0 115	0 115	0 1	0
AMPS DEVELOPED	1 02	0 905	0 79	0 675	0 56	0 445	0 33	0 215	0 1	0
VOLT DROP	0 19462	0 1036	0 07537	0 07942	0 06767	0 06226	0 05457	0 012307	0 00636	0

TOTAL CKT V D = 0 65618

CKT VOLTAGE= 24

% VOLTAGE DROP= 2 73407

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 12

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	148	5	59	53	58	25	40	25	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0 115	0 115	0 115	0 115	0	0
AMPS DEVELOPED	0 92	0 805	0 69	0 575	0 46	0 345	0 23	0 115	0	0
VOLT DROP	0 43299	0 0128	0 12946	0 09691	0 08484	0 02743	0 02926	0 009143	0	0

TOTAL CKT V D = 0 82283

CKT VOLTAGE= 24

% VOLTAGE DROP= 3 42844

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 13

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	218	68	18	111	30	8	48	7	27	13
AMPS @ DEVICE	0.115	0 115	0 115	0 115	0 1	0 1	0 115	0 115	0 115	0 115
AMPS DEVELOPED	1 12	1 005	0 89	0 775	0 66	0 56	0 46	0 345	0 23	0 115
VOLT DROP	0 77643	0 21732	0 05094	0 27356	0 06296	0.01425	0 07021	0 00768	0 019748	0 004754

TOTAL CKT V D = 1 49786

CKT VOLTAGE= 24

% VOLTAGE DROP= 6 24108

WIRE SIZE	RESIS /M FT	CIRC MILS.
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 14

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	200	37	13	19	17	54	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0 1	0 1	0	0	0	0
AMPS DEVELOPED	0 66	0 545	0.43	0 315	0 2	0 1	0	0	0	0
VOLT. DROP	0 41976	0 06412	0 01778	0 01903	0 01081	0 01717	0	0	0	0

TOTAL CKT V D = 0.54868

CKT VOLTAGE= 24

% VOLTAGE DROP= 2.28616

WIRE SIZE	RESIS /M FT	CIRC MILS.
12	1.59	6530
14	2.52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 15

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	180	37	2	59	29	35	45	55	62	0
AMPS @ DEVICE	0.115	0.115	0.115	0.115	0.115	0.115	0 115	0 115	0.115	0
AMPS DEVELOPED	1.035	0.92	0.805	0.69	0.575	0.46	0.345	0.23	0.115	0
VOLT. DROP	0.59243	0.10825	0.00512	0 12946	0 05303	0 0512	0 04937	0.040227	0.022673	0

TOTAL CKT V.D.= 1.05175

CKT VOLTAGE= 24

% VOLTAGE DROP= 4.38231

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT /FT

SIG CKT #-------- 16

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	62	52	87	24	36	66	57	30	13	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0.115	0 115	0 115	0 115	0 115	0
AMPS DEVELOPED	1 035	0 92	0 805	0 69	0 575	0 46	0 345	0 23	0 115	0
VOLT DROP	0 20406	0 15213	0 22271	0 05266	0 06583	0 09654	0 06253	0 021942	0 004754	0

TOTAL CKT V D = 0 88317

CKT VOLTAGE= 24

% VOLTAGE DROP= 3 67986

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 17

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	43	33	26	0	0	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0	0	0	0	0	0	0
AMPS DEVELOPED	0 345	0 23	0 115	0	0	0	0	0	0	0
VOLT DROP	0 04718	0 02414	0 00951	0	0	0	0	0	0	0

TOTAL CKT V D = 0 08082

CKT VOLTAGE= 24

% VOLTAGE DROP= 0 33675

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 18

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	43	33	26	0	0	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0	0	0	0	0	0	0
AMPS DEVELOPED	0 345	0 23	0 115	0	0	0	0	0	0	0
VOLT DROP	0 04718	0 02414	0 00951	0	0	0	0	0	0	0

TOTAL CKT V D = 0 08082

CKT VOLTAGE= 24

% VOLTAGE DROP= 0 33675

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 19

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	132	57	16	60	41	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0 115	0	0	0	0	0
AMPS DEVELOPED	0 575	0 46	0 345	0 23	0 115	0	0	0	0	0
VOLT DROP	0 24136	0 08338	0 01755	0 04388	0 01499	0	0	0	0	0

TOTAL CKT V D = 0 40117

CKT VOLTAGE= 24

% VOLTAGE DROP= 1 67155

WIRE SIZE	RESIS. /M FT	CIRC. MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 20

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	180	32	38	20	0	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0	0	0	0	0	0
AMPS DEVELOPED	0 46	0 345	0 23	0 115	0	0	0	0	0	0
VOLT DROP	0 2633	0 03511	0 02779	0 00731	0	0	0	0	0	0

TOTAL CKT V D = 0 33352

CKT VOLTAGE= 24

% VOLTAGE DROP= 1 38966

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 21

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	72	20	38	200	24	38	26	22	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0.115	0 115	0 115	0 115	0 115	0	0
AMPS DEVELOPED	0 92	0 805	0 69	0 575	0.46	0 345	0.23	0 115	0	0
VOLT. DROP	0 21064	0 0512	0.08338	0 3657	0.03511	0.04169	0 01902	0 008045	0	0

TOTAL CKT V D = 0 81478

CKT VOLTAGE= 24

% VOLTAGE DROP= 3.39492

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

A 3 C RECORD RESUBMIT
ACTION NO ACTION
Land Arch Struc
Date 12/10/96

REVISIONS

REVISED WIRE & DUCT DETECTORS 07-07-94	△1
REVISIONS 07-27-94	△2
REVISIONS 11-03-94	△3
REVISIONS AS-BUILTS 11/12/96	△4

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VOLTAGE DROP CALCULATIONS

AS BUILT

Centex Golden Construction Co.
Cal Poly Performing Arts Center
This submittal has been reviewed in accordance with contract requirements.
497 Submittal No. 16720 Spec Section
Signed 11/26/96 Date

PERFORMING ARTS CENTER
CALIFORNIA POLYTECHNIC
STATE UNIVERSITY
SAN LUIS OBISPO, CALIFORNIA

Date	5-19-94
Scale	NTS
Drawn	J VALENTE
Sales Apprv'l	
Service Apprv'l	
Job	PERFORMING ARTS CENTER
Sheet	FA-9
of	Sheets

VOLTAGE DROP CALCULATIONS

SIG CKT #-------- 22

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	60	31	56	25	79	6	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0 115	0 115	0	0	0	0
AMPS DEVELOPED	0 69	0 575	0 46	0 345	0 23	0 115	0	0	0	0
VOLT DROP	0 13165	0 05668	0 08192	0 02743	0 05778	0 00219	0	0	0	0

TOTAL CKT V D = 0 35765

CKT VOLTAGE= 24

% VOLTAGE DROP= 1 49023

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 23

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	82	5	55	0	0	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0	0	0	0	0	0	0
AMPS DEVELOPED	0 345	0 23	0 115	0	0	0	0	0	0	0
VOLT DROP	0 08996	0 00366	0 02011	0	0	0	0	0	0	0

TOTAL CKT V D = 0 11373

CKT VOLTAGE= 24

% VOLTAGE DROP= 0 47389

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 24

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	132	48	10	20	0	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0	0	0	0	0	0
AMPS DEVELOPED	0 46	0 345	0 23	0 115	0	0	0	0	0	0
VOLT DROP	0 19309	0 05266	0 00731	0 00731	0	0	0	0	0	0

TOTAL CKT V D = 0 26038

CKT VOLTAGE= 24

% VOLTAGE DROP= 1 08491

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 25

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	165	38	80	36	0	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0	0	0	0	0	0
AMPS DEVELOPED	0 46	0 345	0 23	0 115	0	0	0	0	0	0
VOLT DROP	0 24136	0 04169	0 05851	0 01317	0	0	0	0	0	0

TOTAL CKT V D = 0 35473

CKT VOLTAGE= 24

% VOLTAGE DROP= 1 47804

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 26

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	68	43	165	43	0	0	0	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0	0	0	0	0	0
AMPS DEVELOPED	0 46	0 345	0 23	0 115	0	0	0	0	0	0
VOLT DROP	0 09947	0 04718	0 12068	0 01573	0	0	0	0	0	0

TOTAL CKT V D = 0 28305

CKT VOLTAGE= 24

% VOLTAGE DROP= 1 17938

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 27

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	76	44	103	71	51	53	44	0	0	0
AMPS @ DEVICE	0 115	0 115	0 115	0 115	0 115	0 115	0 115	0	0	0
AMPS DEVELOPED	0 805	0 69	0 575	0 46	0 345	0 23	0 115	0	0	0
VOLT DROP	0 19455	0 09654	0 18834	0 10386	0 05595	0 03876	0 01609	0	0	0

TOTAL CKT V D = 0 6941

CKT VOLTAGE= 24

% VOLTAGE DROP= 2 89208

WIRE SIZE	RESIS /M FT	CIRC MILS
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT/FT

SIG CKT #-------- 28

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	84	0	0	0	0	0	0	0	0	0
AMPS @ DEVICE	0.115	0	0	0	0	0	0	0	0	0
AMPS DEVELOPED	0.115	0	0	0	0	0	0	0	0	0
VOLT. DROP	0.03072	0	0	0	0	0	0	0	0	0

TOTAL CKT V.D= 0 03072

CKT VOLTAGE= 24

% VOLTAGE DROP= 0.128

WIRE SIZE	RESIS /M FT	CIRC MILS.
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT /FT

SIG CKT #-------- 29

DEVICE #	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
GAUGE WIRE	12	12	12	12	12	12	12	12	12	12
DISTANCE (FT)	10	15	7	0	0	0	0	0	0	0
AMPS @ DEVICE	0.115	0.115	0.115	0	0	0	0	0	0	0
AMPS DEVELOPED	0.345	0 23	0.115	0	0	0	0	0	0	0
VOLT. DROP	0.01097	0.01097	0.00256	0	0	0	0	0	0	0

TOTAL CKT V.D.= 0.0245

CKT VOLTAGE= 24

% VOLTAGE DROP= 0 10209

WIRE SIZE	RESIS. /M FT.	CIRC MILS.
12	1 59	6530
14	2 52	4110
16	4 02	2580

** FORMULA **
I X FEET X OHMS/FT /FT

BATTERY CALCULATIONS

PERFORMING ARTS - MINIPLEX

PANEL MODULES

QTY	PRODUCT ID	DESCRIPTION	STANDBY EACH	STANDBY TOTAL	ALARM EACH	ALARM TOTAL
1	4120-0110	MAPNET II MODULE	0 470000	0 470000	0 490000	0 490000
1	4120-0203	AUDIO AMP 25W	0 250000	0 250000	8 750000	8 750000
3	4120-4331	6 SIGNAL CIRCUIT, STYLE Y	0 025000	0 075000	0 070000	0 210000
1	4120-3003	8 POINT AUX RELAY	0 025000	0 025000	0 280000	0 280000
		PANEL STANDBY CURRENT		0 820000		
		PANEL ALARM CURRENT				9 730000

FIELD DEVICES

QTY	PRODUCT ID	DESCRIPTION	STANDBY EACH	STANDBY TOTAL	ALARM EACH	ALARM TOTAL
4	2098-9645	ADDRESSABLE DUCT DETECTOR	0 024000	0 096000	0 024000	0 096000
9	2190-9163	CONTROL ZAM	0 010000	0 090000	0 040000	0 360000
2	2098-9808	REMOTE ALARM INDICATOR	0 000000	0 000000	0 001000	0 002000
74	ET-1070-LSM-24-VFR	WHEELOCK AUDIO/VISUAL	0 000000	0 000000	0 115000	8 510000
		DEVICE STANDBY CURRENT		0 186000		
		DEVICE ALARM CURRENT				8 968000

TOTAL SYSTEM CURRENT

DESCRIPTION	STANDBY	ALARM
CONTROL PANEL	0 820000	9 730000
FIELD DEVICES	0 186000	8 968000
TOTAL STANDBY CURRENT	1 006000	
X 24 HOUR STANDBY	24.144000	
TOTAL ALARM CURRENT		18 698000
5 MINUTES OF ALARM (X 083)		1 551934
TOTAL BATTERY REQUIREMENT		25 695934
BATTERY SUPPLIED		50AH

PERFORMING ARTS - MAIN PANEL

PANEL MODULES

QTY	PRODUCT ID	DESCRIPTION	STANDBY EACH	STANDBY TOTAL	ALARM EACH	ALARM TOTAL
1	4120-0110	MAPNET II MODULE	0 470000	0 470000	0 490000	0 490000
1	4120-0201	AUDIO AMP 25W	0 150000	0 150000	2 000000	2 000000
2	4120-0203	100W AMPLIFIER W/P S 120V	0 250000	0 500000	8 750000	17 500000
1	4120-0210	SINGLE CHANNEL AUDIO CONTROLLER	0 185000	0 185000	0 185000	0 185000
1	4120-0301	LED/SW CONTROLLER	0 015000	0 015000	0 260000	0 260000
1	4120-3002	4 RELAYS	0 015000	0 015000	0 175000	0 175000
4	4120-4321	6 SIGNAL CIRCUIT, STYLE Y	0 025000	0 100000	0 070000	0 280000
1	4120-6011	RS-485 NETWORK INTERFACE CARD	0 150000	0 150000	0 150000	0 150000
		PANEL STANDBY CURRENT		1 585000		
		PANEL ALARM CURRENT				21 040000

FIELD DEVICES

QTY	PRODUCT ID	DESCRIPTION	STANDBY EACH	STANDBY TOTAL	ALARM EACH	ALARM TOTAL
9	4904-9135	WALL-MOUNT STROBE	0 000000	0 000000	0 100000	0 900000
11	2098-9645	ADDRESSABLE DUCT DETECTOR	0 024000	0 264000	0 024000	0 264000
7	2190-9163	CONTROL ZAM	0 010000	0 070000	0 040000	0 280000
2	2098-9808	REMOTE ALARM INDICATOR	0 000000	0 000000	0 001000	0 002000
90	ET-1070-LSM-24-VFR	WHEELOCK AUDIO/VISUAL	0 000000	0 000000	0 115000	10 350000
		DEVICE STANDBY CURRENT		0 334000		
		DEVICE ALARM CURRENT				11.796000

TOTAL SYSTEM CURRENT

DESCRIPTION	STANDBY	ALARM
CONTROL PANEL	1 585000	21 040000
FIELD DEVICES	0 334000	11 796000
TOTAL STANDBY CURRENT	1.919000	
X 24 HOUR STANDBY	46.056000	
TOTAL ALARM CURRENT		32 836000
5 MINUTES OF ALARM (X 083)		2 725388
TOTAL BATTERY REQUIREMENT		48 781388
BATTERY SUPPLIED		50AH

Arch
Struc
HVAC
12/10/96

CENTEX GOLDEN
AS BUILT

Centex Golden Construction Co
Cal Poly Performing Arts Center

This subm[illegible] has been reviewed in accordance with co[illegible] [illegible]equirements

491 Submittal No
16720 Spec Section
Signed 11/20/96 Date

REVISIONS	
REVISED WIRE & DUCT DETECTORS 07-07-94	1
REVISIONS 07-27-94	2
REVISIONS 11-03-94	3
REVISIONS AS-BUILTS 11/12/96	4

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VOLTAGE DROP AND BATTERY CALCULATIONS

PERFORMING ARTS CENTER
CALIFORNIA POLYTECHNIC
STATE UNIVERSITY
SAN LUIS OBISPO, CALIFORNIA

Date 5-19-94
Scale NTS
Drawn J VALENTE
Sales Apprv'l
Service Apprv'l
Job PERFORMING ARTS CENTER
Sheet FA-10
of Sheets

Appendix C - FIRE ALARM DEVICE DATA SHEETS

NFS-640

Intelligent Addressable Fire Alarm System

NOTIFIER® by Honeywell

Intelligent Fire Alarm Control Panels

General

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

As a stand-alone small-to-large system, or as a large network, the ONYX® Series of products meets virtually every application requirement.

Designed with modularity and for ease of system planning, the NFS-640 can be configured with just a few devices for small building applications, or for a large campus or high-rise application. Simply add additional peripheral equipment to suit the application.

NFS-640 shown in CAB-B4 with NCA 640-character display.

Features

- One, expandable to two, isolated intelligent Signaling Line Circuit (SLC) Style 4, 6 or 7.
- Up to 159 detectors (any mix of ion, photo, thermal, or multi-sensor) and 159 modules (N.O. manual stations, two-wire smoke, notification, or relay) per SLC. 318 devices per loop/ 636 per FACP or network node.
- Standard 80-character display, 640-character large display, or display-less (a node on a network).
- Network option – 103 nodes supported (NFS-640, NCA Network Annunciator, or NCS Network Control Station) using wire or fiber-optic connections.
- 6.0 amp switch mode power supply with four Class A/B built-in Notification Appliance Circuits (NAC). Selectable System Sensor strobe synchronization.
- Built-in Alarm, Trouble, and Supervisory relays.
- Up to 64 output circuits per FACP or network node; circuits configurable online.
- ***VeriFire® Tools*** offline program option. Sort Maintenance Reports by compensation value (dirty detector), peak alarm value, or address.
- Autoprogramming and Walk Test reports.
- Optional universal 636-point DACT.
- 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 tally.
- Autoprogramming and Walk Test reports.
- Positive Alarm Sequence (PAS) Presignal.
- 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.
- Charger for up to 90 hours of standby power.
- 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.

NCA 640-CHARACTER DISPLAY FEATURES:

- Backlit, 640-character display.
- Supports SCS Series smoke control system in both HVAC or FSCS modes (not UL-Listed for FSCS).
- Printer and CRT EIA-232 ports.
- EIA-485 annunciator and terminal mode ports.
- Alarm, Trouble, Supervisory, and Security relays.

FLASHSCAN® INTELLIGENT FEATURES:

- Poll 318 devices in less than two seconds.
- Activate up to 159 outputs in less than five seconds.
- Multicolor LEDs blink device address during Walk Test.
- Fully digital, high-precision protocol (U.S. Patent 5,539,389).
- Manual sensitivity adjustment — nine levels.
- Pre-alarm intelligent sensing — nine levels.
- Day/Night automatic sensitivity adjustment.
- Sensitivity windows:
  - **– Ion –** 0.5 to 2.5%/foot obscuration.
  - **– Photo –** 0.5 to 2.35%/foot obscuration.
  - **– Laser (VIEW®) –** 0.02 to 2.0%/foot obscuration.
  - **– Acclimate Plus™ –** 0.5 to 4.0%/foot obscuration.
  - **– HARSH™ –** 0.5 to 2.35%/foot obscuration.
- Drift compensation (U.S. Patent 5,764,142).
- Degraded mode — in the unlikely event that the CPU-640 microprocessor fails, FlashScan® detectors revert to degraded operation and can activate the CPU-640 NAC circuits and alarm relay. Each of the four built-in panel circuits includes a Disable/Enable switch for this feature.

- Multi-detector algorithm involves nearby detectors in alarm decision (U.S. Patent 5,627,515).
- Automatic detector sensitivity testing.
- Maintenance alert (two levels).
- Self-optimizing pre-alarm.

VIEW® (VERY INTELLIGENT EARLY WARNING) SMOKE DETECTION TECHNOLOGY:

- Revolutionary spot laser design.
- Advanced intelligent sensing algorithms differentiate between smoke and non-smoke signals (U.S. Patent 5,831,524).
- Addressable operation pinpoints the fire location.
- No moving parts to fail or filters to change.
- Early warning performance comparable to the best aspiration systems at a fraction of the lifetime cost.

ACCLIMATE PLUS™ LOW-PROFILE INTELLIGENT MULTI-SENSOR:

- Detector automatically adjusts sensitivity levels without operator intervention or programming. Sensitivity increases with heat.
- Microprocessor-based technology; combination photo and thermal technology.
- FlashScan® or classic mode compatible with NFS-640.
- Low-temperature warning signal at 40°F ± 5°F (4.44°C ± 2.77°C).

HARSH™ HOSTILE-AREA SMOKE HEAD:

- Provides early warning of smoke detection in environment where traditional smoke detectors are not practical.
- The detector's filters remove particulates down to 30 microns in size.
- Intake fan draws air into photo chamber, while airborne particles and water mist are removed.
- Requires auxiliary 24 VDC from system or remote power supply.

RELEASING FEATURES:

- Ten independent hazards.
- Sophisticated cross-zone (three options).
- Delay timer and Discharge timers (adjustable).
- Abort (four options).
- Low-pressure CO_2 listed.

VOICE AND TELEPHONE FEATURES:

- Solid state message generation.
- Hard-wired voice control module options.
- Firefighter telephone option.
- 30- to 120-watt high-efficiency amplifiers (AA Series).
- Backup tone generator and amplifier option.
- Multichannel voice transponder (XPIQ).

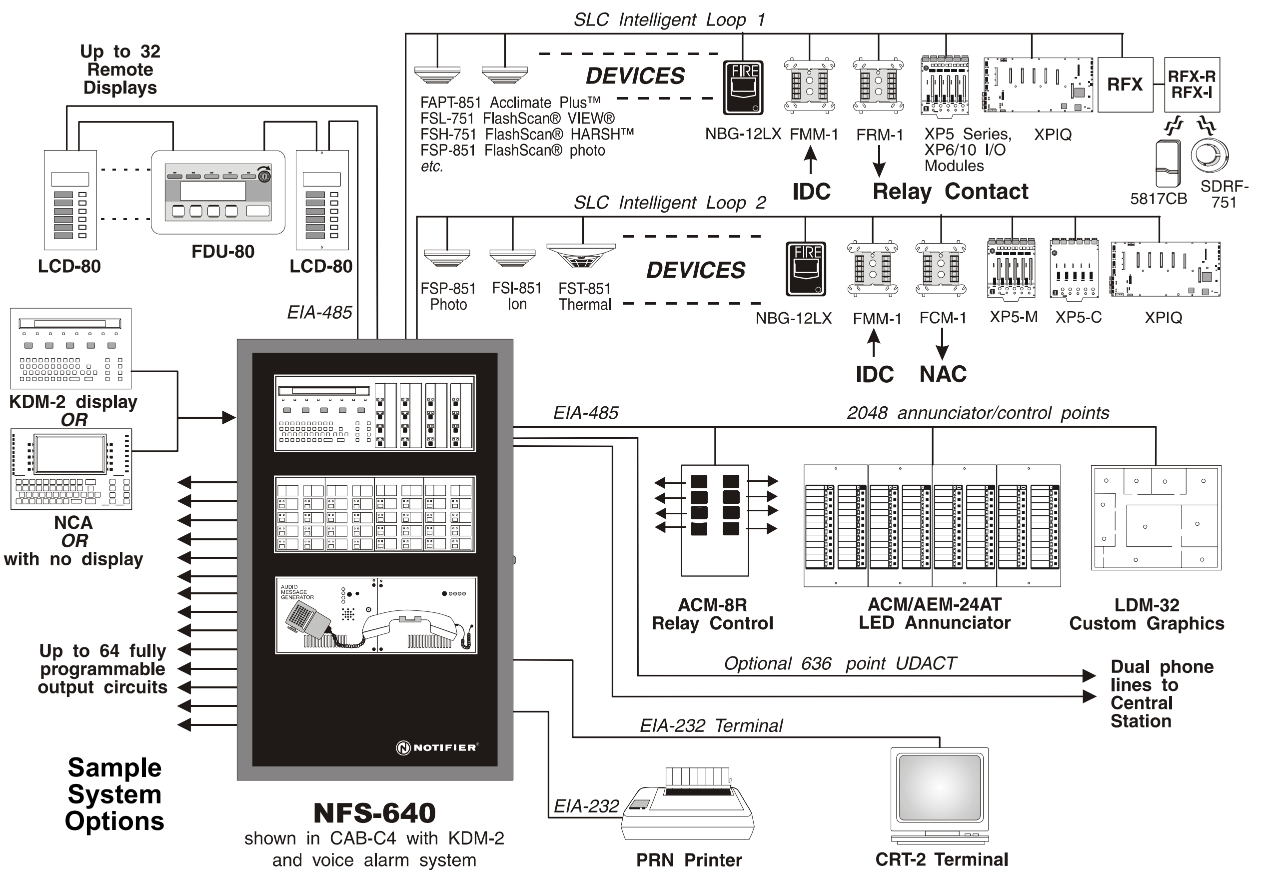
HIGH-EFFICIENCY OFFLINE SWITCHING 3.0 AMP POWER SUPPLY (6.0 A IN ALARM):

- 120 or 220/240 VAC.
- Displays battery current/voltage on panel (with display).

FlashScan® Exclusive World-Leading Detector Protocol

At the heart of the NFS-640 is a set of detection devices and device protocol — FlashScan® (U.S. Patent 5,539,389). FlashScan® is an all-digital protocol that gives superior precision and high noise immunity.

In addition to providing quick identification of an active input device, this protocol can also activate many output devices in a fraction of the time required by competitive protocols. This high



Sample System Options

speed also allows the NFS-640 to have the largest device per loop capacity in the industry — 318 points — yet every input and output device is sampled in less than two seconds. The microprocessor-based FlashScan® detectors have bicolor LEDs that can be coded to provide diagnostic information, such as device address during Walk Test.

Intelligent Sensing

Intelligent sensing is a set of software algorithms that provide the NFS-640 with industry-leading smoke detection capability. These complex algorithms require many calculations on each reading of each detector, and are made possible by the very-high-speed microcomputer used by the NFS-640.

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

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

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

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

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

Field Programming Options

Autoprogram is a timesaving feature of the NFS-640. It is a special software routine that allows the NFS-640 to "learn" what devices are physically connected and automatically load them in the program with default values for all parameters. Requiring less than one minute to run, this routine allows the user to have almost immediate fire protection in a new installation, even if only a portion of the detectors are installed.

Keypad Program Edit (with KDM-2) The NFS-640, like all NOTIFIER intelligent panels, has the exclusive feature of program creation and editing capability from the front panel keypad, ***while continuing to provide fire protection***. The architecture of the NFS-640 software is such that each point entry carries its own program, including control-by-event links to other points. This allows the program to be entered with independent per-point segments, while the NFS-640 simultaneously monitors other (already installed) points for alarm conditions.

VeriFire® Tools is an offline programming and test utility that can greatly reduce installation programming time, and increase confidence in the site-specific software. It is Windows® based and provides technologically advanced capabilities to aid the installer. The installer may create the entire program for the NFS-640 in the comfort of the office, test it, store a backup file, then bring it to the site and download from a laptop into the panel.

ENTER PROG OR STAT PASSWORD, THEN ENTER
<ESCAPE TO ABORT> *****

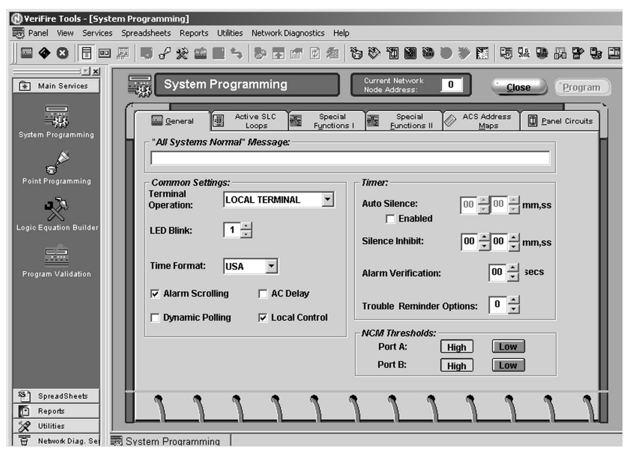
0=CLR 1= AUTO 2=POINT 3=PASSWORD 4=MESSAGE

Above: Keypad program editing.

Below: Autoprogram function.

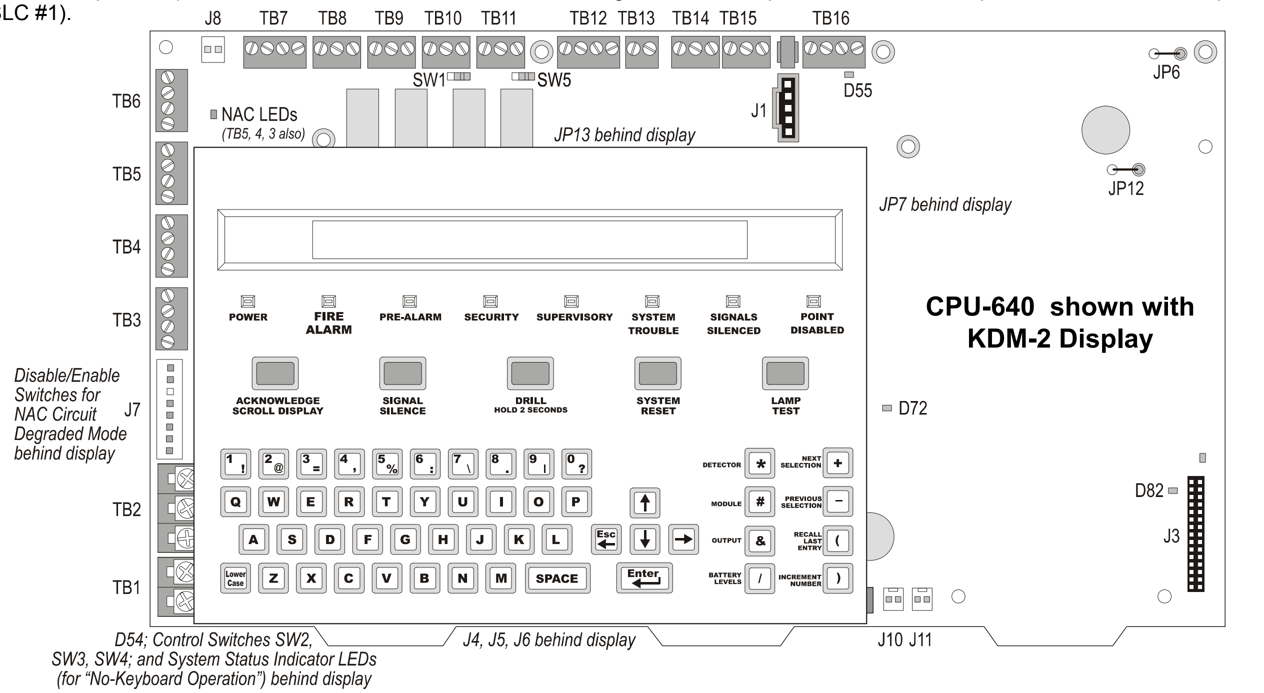
AUTOPROGRAM PLEASE WAIT

L1:80 DETS, 15 MODS L2:93 DETS, 35 MODS
PANEL OUTPUTS:24 BELLS: 04



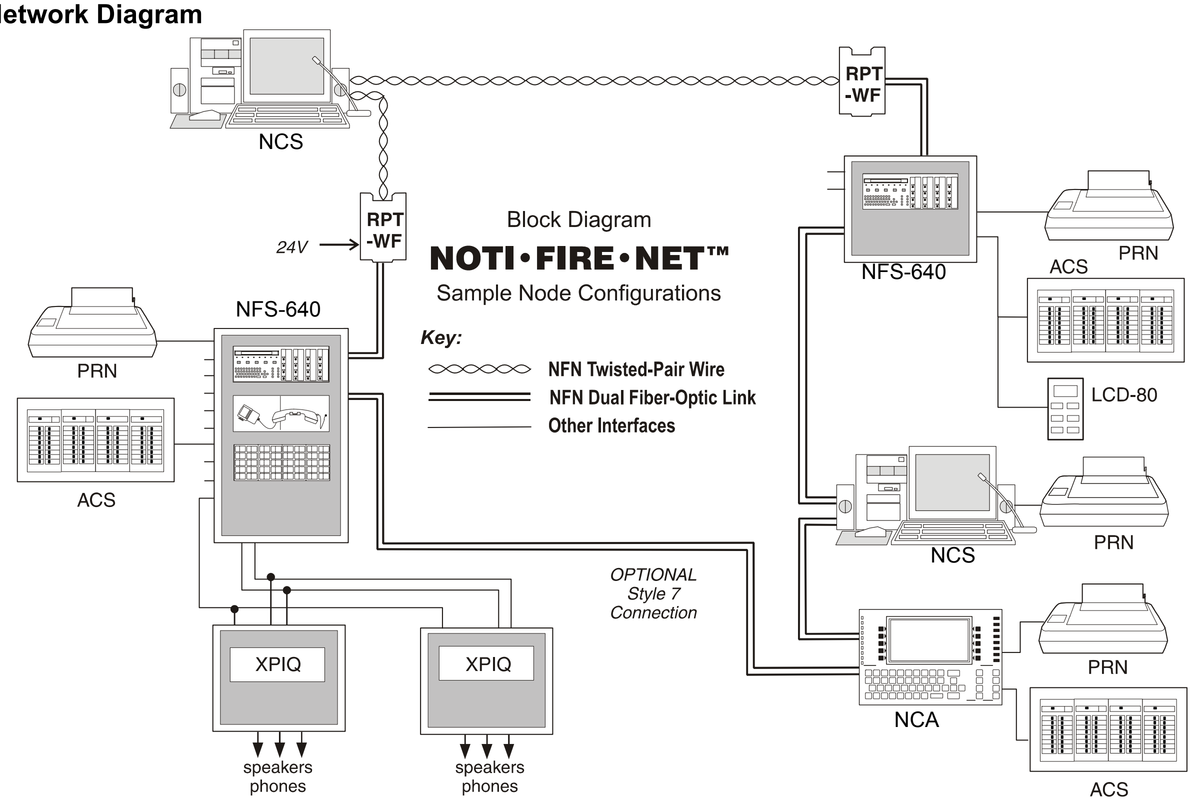
VeriFire ToolsSystem Programming screen

TOP, LEFT to RIGHT: **J8** Zone Code Input; **TB7** DC Power (24 VDC power-limited, both resettable and non-resettable available); **TB8** Alarm Relay; **TB9** Trouble Relay; **TB10** Supervisory Relay; **TB11** Security Relay; **SW1**, **SW5** Relay Switches; **JP13** General Board Earth Fault Jumper; **TB12** EIA-485 Terminal Mode (supervised); **TB13** EIA-485 ACS Mode (supervised); **TB14** EIA-232 Printer; **TB15** EIA-232 PC Terminal; **J1** NUP (network/service connection: power-limited, supervised); **TB16** SLC #1 Connections (detectors, modules; supervised); **D55** Main SLC Ground Fault LED; **JP7** Charger Disable Jumper; **JP12** 200MA Jumper; **JP6** Earth Fault Jumper (SLC #1).



LEFT SIDE, TOP to BOTTOM: **TB6** NAC #1, **TB5** NAC #2, **TB4** NAC #3, **TB3** NAC #4 (all NAC circuits power-limited and supervised, and each NAC TB has an NAC LED to the right of it); **J7** Accessory Power; Disable/Enable Switches for Degraded Mode; **TB2** AC Power Connection; **TB1** Battery Connection (overcurrent protected). ***BOTTOM, LEFT to RIGHT:*** D54 AC On LED; System Status Indicator LEDs for "No-Keyboard Operation"; System Switches **SW2** (Acknowledge), **SW3** (Silence), **SW4** (Reset) for "No-Keyboard Operation"; **J4** KDM-2 Connector; **J5**, **J6** Panel Circuits (ONYX® Panel Output Modules, supervised); **D72** General Board Ground Fault LED; **J10** Security Tamper Switch; **J11** Auxiliary Trouble Input; **D82** AC Power LED; **J3** LEM-320 Connector (SLC Loop #2).

Network Diagram



Placement of Equipment in Chassis and Cabinet

The following guidelines outline the NFS-640's flexible system design.

Rows: The first row of equipment in the cabinet mounts in chassis **CHS-M2**. Mount the second, third, or fourth rows of equipment in chassis **CHS-4MB** (see NFS-640 Installation Manual regarding panel output modules) or **CHS-4L** (for voice components, see Voice Alarm System Manual).

Wiring: When designing the cabinet layout, consider separation of power-limited and non-power-limited wiring as discussed in the NFS-640 Installation Manual.

Positions: A chassis offers four basic side-by-side positions for components; the number of modules that can be mounted in each position depends on the chassis model and the size of the individual module. There are a variety of standoffs and hardware items available for different combinations and configurations of components.

It is critical that all mounting holes of the NFS-640 are secured with a screw or standoff to ensure continuity of Earth Ground.

Layers: The CHS-M2 accepts four layers of equipment, including the control panel. The **CPU-640** fills three positions (left to right) in the first-installed layer (the back of the chassis); its integral power supply occupies (the left) two positions in the next two layers; the optional display occupies (the left) two positions at the front, flush with the door. Panel output modules can be mounted in several layers with standoffs or an L-bracket as required. Some equipment, such as the **NCA**, may be door-mounted directly in front of the control panel. The NCA mounts onto the DP-DISP or ADP-4B. The NCA can be used as a primary display for the NFS-640 by directly connecting their network ports (required in Canadian stand-alone applications).

Expansion: Installing an **LEM-320** Loop Expander Module adds a second SLC loop to the control panel. The LEM-320 is mounted onto the CPU-640, occupying the middle-right, second (back) slot on the chassis. If networking two or more control panels, each unit requires a **NCM-W** (wire) or **NCM-F** (fiber) Network Control Module. The NCM-W/-F can be installed in any panel output module position (see manual); the default position is at the back of the chassis next to the control panel. **Option boards** can be mounted in front of the LEM-320 or NCM modules; for ease of access, complete installation of those devices before mounting another layer.

KDM-2 Controls and Indicators

Program Keypad: QWERTY type (keyboard layout).

8 LED indicators: Power; Fire Alarm; Pre-Alarm; Security; Supervisory; System Trouble; Signals Silenced; Points Disabled.

Membrane Switch Controls: Acknowledge/Scroll Display; Signal Silence; Drill; System Reset; Lamp Test.

LCD Display: 80 characters (2 x 40) with long-life LED backlight.

Configuration Guidelines

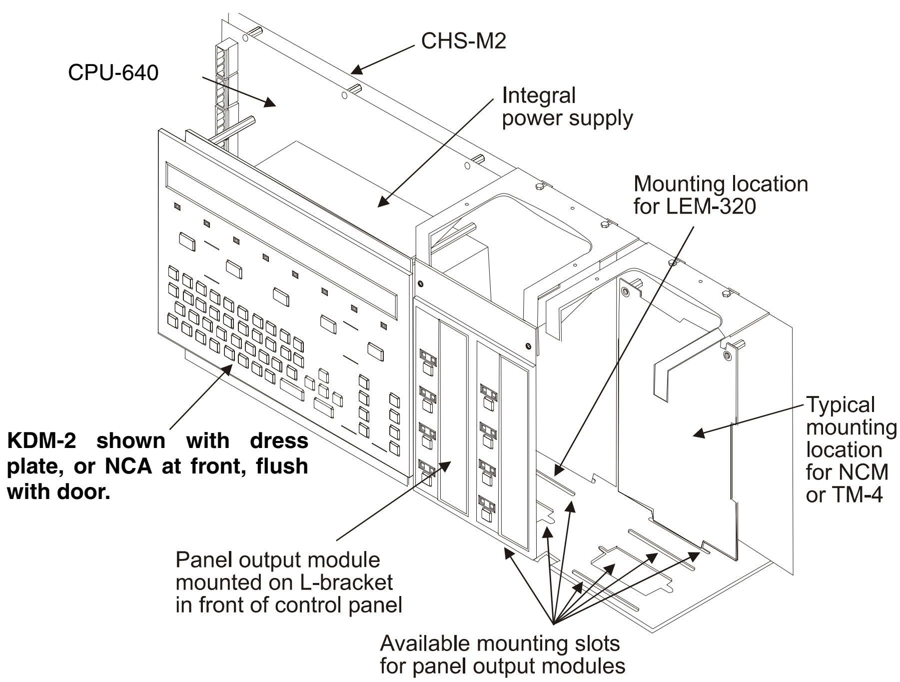
Stand-alone and network systems require a main display. On single-CPU systems (one CPU-640/-640E), display options are the KDM-2 or the NCA. On network systems (two or more CPU-640/-640Es), at least one NCA or NCS annunciation device is required. Other options listed as follows:

KDM-2: 80-character backlit LCD display with QWERTY programming and control keypad. Order two BMP-1 blank modules and DP-DISP mounting plate separately. *Requires top row of a cabinet. Required for each stand-alone 80-character display system. The KDM-2 may mount in network nodes to display "local" node information as long as at least one NCA or NCS network display is on the system to display network information.*

NCA: Network Control Annunciator, 640 characters. On single CPU-640/-640E systems, the NCA is the Primary Display for the panel and connects directly to the CPU-640/-640E. On network systems (two or more CPU-640/-640Es), one network display (either NCA or NCS) is required for every system. On network systems, the NCA connects (and requires) an NCM network communications module. Mounts in a row of FACP node or in two annunciator positions. Mounting options include the DP-DISP, ADP-4B, or in an annunciator box, such as the ABS-2D. In CAB-4 top-row applications, a DP-DISP and two BMP-1 blank modules are required for mounting. *See NCA data sheet DN-6858.*

CPU-640: Central processing unit with integral 3.0 amp (6.0 A in alarm) power supply for an NFS-640 system. Includes CPU; one Signaling Line Circuit expandable to two; installation, programming and operating manuals. *Order one per system or as necessary (up to 103 network nodes) on a network system.*

CPU-640E: Same as CPU-640 but requires 220 VAC, 1.5 amp, (3.0 A in alarm).



CHS-M2: Mounting chassis for CPU-640. One required for each CPU-640/-640E.

DP-DISP: Dress panel for top row in cabinet with CPU-640/-640E installed.

BMP-1: Blank module for unused module positions.

System Modules

The NFS-640 includes the ability to communicate with up to eight conventional modules each with up to eight circuits. Any mix of notification, relay, speaker, or telephone may be used. Choose any combination of up to eight output modules: ICM/ICE, CRM/CRE, DCM-4 or VCM/VCE. Panel modules mount on either: the two far-right positions of the DP-DISP (next to the primary display); or on any of the four positions on the CHS-4N chassis (CHS-4MN kit required).

***NOTES:** 1) These modules/expanders are NOT to be used for releasing applications. 2) For additional information on these panel output modules and expanders, see data sheet DN-6859.*

CHS-4MB: Expansion Chassis. Mounts up to four modules. Includes CHS-4N, MP-1B (Module Dress Panel), and Expander Ribbon Cable.

ICM-4RK: Notification Appliance Circuit Module, provides four Style Y (Class B) or Style Z (Class A) alarm Notification Appliance Circuits. Maximum signaling current is 3.0 amps per circuit or 6.0 amps per module, subject to power supply limitations (includes auxiliary power harness, ELRs and slide-in labels).

Includes ON/OFF controls and ON/OFF LEDs.

ICE-4: Notification Appliance Circuit Expander, expands ICM-4 to provide a total of eight Style Y or Style Z alarm Notification Appliance Circuits. Circuit ratings are same as ICM-4.

***NOTE:** Maximum of one per ICM-4RK. May also be used to add four Notification Appliance Circuits to VCM-4.*

CRM-4RK: Control Relay Module, four Form-C relay contacts, rated at 5.0 A, 120 VAC or 28 VDC (resistive) per circuit. Includes manual ON/OFF controls and LEDs.

CRE-4: Control Relay Expander, expands CRM-4 to provide a total of eight Form-C relay contacts. Note: maximum of one per CRM-4RK. May also be connected to add four relays to ICM-4, TCM-2, TCM-4, or VCM-4.

VCM-4RK: Voice Control Module provides four Style Y (25 and 70 Vrms) and Style Z (25 Vrms only) speaker circuits, eight manual select switches and indicators, slide-in labels, and plug-in terminal blocks. Move jumper to convert to telephone circuits with remote ring signal and local call-in flash. May be expanded to eight circuits with VCE-4, ICE-4, or CRE-4.

VCE-4: Voice Control Expander adds four circuits to VCM-4. Note: VCM-4/ VCE-4 combination must be eight speaker or eight phone circuits.

DCM-4RK: Dual Channel Module pro-vides four Class B (Style Y, 25 & 70 Vrms) or Class A (Style Z, 25 Vrms only) speaker circuits plus four channel A/B select relays. Not expandable.

OTHER OPTION MODULES

ARM-4: Auxiliary Relay Module, four Form-C relays controlled by a relay module (CRM-4 or CRE-4). N.O. contacts rated 20 amps; N.C. contacts rated 10 amps at 125 VAC and 30 VDC.

***NOTE:** Maximum of one for each CRM-4 or CRE-4.*

VCC-1B: Voice Control Center. Provides a variety of user-selectable tones on a single channel. Up to two different tones or messages may be selected on a single channel. Also provides optional digital voice message capability and **on-site** programmable voice messages. Includes Audio Message Generator (AMG-1) microphone, cables, dress panels, and instructions.

VTCC-1B: Voice/Telephone Control Center. Provides all that the VCC-1 provides plus two-way Fire Fighters Telephone (FFT-7) capability.

TCC-1B: Telephone Control Center. Provides a stand-alone two-way Fire Fighters telephone (FFT-7S).

Includes cables, dress panel and instructions.

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

AMG-E: Audio Message Generator (without microphone). Order in addition to VCC-1 or VTCC-1 if two-channel system is required.

FFT-7/FFT-7S: Fire Fighters Telephone control with master handset.

FTM-1: Firephone Control Module connects a remote firefighter telephone to a centralized telephone console. Reports status to panel. Wiring to jacks and handsets is supervised.

AA-30: Audio Amplifier, 30 watts. Switch-mode power. Includes amplifier and audio input supervision, backup input, and automatic switchover, power supply, cables. *See AA Series data sheet, DN-3224.*

AA-120/AA-100: Audio Amplifier provides up to 120 watts of 25 Vrms audio power for the NFS-640. The amplifier contains an integral chassis for mounting to a CAB-B4, -C4, or -D4 backbox (consumes one row). Switch-mode power. Includes audio input and amplified output supervision, backup input, and automatic switchover to backup tone. Order the AA-100 for 70.7 Vrms systems and 100 watts of power. *See AA Series data sheet, DN-3224.*

VROM-(n): Factory-programmed message for installation in AMG-1. Provides up to 24 seconds of evacuation message on nonvolatile memory chip. Choose one of many standard messages available. Up to two of these messages may be installed in one AMG. Includes VROM, instructions for installation and operation, and written text of message. *See VROM data sheet, DN-3576.*

VRAM-1: Field-programmed memory to be installed in AMG-1. Provides up to 24 seconds of field-programmable evacuation message on nonvolatile memory chip. Message is programmed from microphone or cassette tape. Up to two of these nonvolatile memory chips may be installed in one AMG. Includes VRAM and instructions for installation and operation.

APS-6R: Auxiliary Power Supply (expander). Provides up to 6.0 amperes of regulated power for compatible Notification appliance circuits. Includes battery input and transfer relay, and overcurrent protection. Mounts on one of four positions on a CHS-4L or CHS-4 chassis. *See APS-6R data sheet, DN-5952.*

ACPS-2406: 6.0 amp addressable charger power supply. *See ACPS-2406 data sheet, DN-6834.*

FCPS-24: The FCPS-24 is a remote six-amp (four-amp continuous) repeater/power supply. *See FCPS-24 data sheet, DN-5132.*

FCPS-24S6/-24S8: Remote six-amp and eight-amp power supplies with battery charger. *See FCPS-24S6/-24S8 datasheet, DN-6927.*

UZC-256: Programmable Universal Zone Coder provides positive non-interfering successive zone coding. Microprocessor-controlled, field-programmable from IBM®-compatible PCs (requires optional programming kit). *See UZC-256 data sheet, DN-3404.*

LCD-80/LCD-80TM/FDU-80: 80-character, backlit LCD display. Mounts up to 6,000 ft. (1828.8 m) from panel. Up to 32 per NFS-640. *See LCD-80/-80TM (DN-3198) and FDU-80 (DN-6820) data sheets.*

ACS: Annunciator Control Modules ACM-16AT, AEM-16AT, ACM-32A, and AEM-32A. *See data sheets, DN-0524 and DN-6862..*

AFM: Annunciator Fixed Modules AFM-16A, AFM-16AT, and AFM-32A. *See AFM data sheet, DN-0056.*

LDM: Lamp Driver Modules LDM-32, LDM-E32, and LDM-R32. *See LDM data sheet, DN-0551.*

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

SCS: Smoke control station; eight (expandable to 16) circuits. *See SCS data sheet, DN-4818.*

RPT-485: Repeats EIA-485 over twisted pair or converts to fiber-optic medium. *See RPT data sheet, DN-4737.*

XP5: The XP5-M and XP5-C provide FlashScan® transponder points. *See XP5 data sheet, DN-6625.*

XP: The XP Series Transponder provides conventional monitor and control points (CLIP mode only). *See XP Series data sheet, DN-0759.*

XPIQ: The XPIQ quad intelligent voice transponder for distributed multichannel voice evacuation systems, an integrated audio amplification and distribution subsystem controlled by FACP. Capable of playing up to four simultaneous messages. Accepts up to four 25-watt amplifiers. *See XPIQ data sheet, DN-6823.*

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

CHS-4L: Low-profile four-position Chassis. Mounts two AA-30 amplifiers or one AMG-E and one AA-30.

DP-1B: Blank Dress panel. Provides dead-front panel for unused tiers or to cover AA-30, AA-120, or one AMG-E and one AA-30.

CAB-4 Series: The CAB-4 Series cabinets are fabricated from 16-gauge steel with unique full-front LEXAN®, reverse-silk-screened for durability. The cabinet assembly consists of two basic parts: a Backbox (SBB-_4), and a Locking Door (DR-_4) that may hinge right or left. Cabinets are available in four sizes, “A” through “D”, with one to four tiers. A trim ring option is available for semi-flush mounting. *See CAB-4 Series data sheet, DN-6857.*

CAB-M Series: Marine cabinets required for Lloyd’s Register or U.S. Coast Guard listed use. *See DN-5063.*

COMPATIBLE DEVICES, EIA-232 PORTS

PRN-5: 80-column printer. *See DN-6769.*

PRN-6: 80-column printer. *See DN-6956.*

VS4095/S2: Printer, 40-column, 24 V. Mounted in external backbox. *Order from Keltron, Inc. See DN-3260.*

CRT-2: Video display terminal. *See DN-3756.*

COMPATIBLE DEVICES, EIA-485 PORTS

ACS Series: Remote serial annunciator/control systems. *See DN-0524.*

FDU-80: Remote LCD display, 80 characters, with LEDs. *See DN-6820.*

LCD-80: Remote LCD display, 80 characters. *See DN-3198.*

LCD-80TM: Remote LCD display, 80 characters, terminal mode. *See DN-3198.*

LDM Series: Remote custom graphic driver modules. S*ee DN-0551.*

ACM-8R: Remote relay module. 8 Form-C relays. *See DN-3558.*

RPT-485 Series: Repeater, isolator and/or fiber-optic modem. *See DN-4737.*

UDACT: Universal Digital Alarm Communicator Transmitter, 636 channel. *See DN-4867.*

UZC-256: Zone Coder. Up to 256 programmable codes. *See DN-3404.*

COMPATIBLE INTELLIGENT DEVICES

BEAMHK: Heating kit for transmitter/receiver unit of FSB-200(S) below. *See DN-6985.*

BEAMHRK: Heating kit for use with the reflector of FSB-200(S) below. *See DN-6985.*

BEAMLRK: Long-range accessory kit, FSB-200(S) below.

BEAMMRK: Multi-mount kit, FSB-200(S) below.

BEAMSMK: Surface-mount kit, FSB-200(S) below.

FSB-200: Intelligent beam smoke detector. *See DN-6985.*

FSB-200S: Intelligent beam smoke detector with integral sensitivity test. *See DN-6895.*

FSI-851: Low-profile FlashScan® ionization detector, will replace FSI-751. *See DN-6934.*

FSI-751: Low-profile FlashScan® ionization detector. *See DN-6714.*

FSP-851: Low-profile FlashScan® photoelectric detector, will replace FSP-751. *See DN-6935.*

FSP-751: Low-profile FlashScan® photoelectric detector. *See DN-6714.*

FSP-851T: Low-profile FlashScan® photoelectric detector with 135°F (57°C) thermal, will replace FSP-751T. *See DN-6935.*

FSP-751T: Low-profile FlashScan® photoelectric detector with 135°F (57°C) thermal. *See DN-6714.*

FST-851: FlashScan® thermal detector 135°F (57°C), will replace FST-751. *See DN-6936.*

FST-751: FlashScan® thermal detector 135°F (57°C). *See DN-6716.*

FST-851R: FlashScan® thermal detector 135°F (57°C) with rate-of-rise, will replace FST-751R. *See DN-6936.*

FST-751R: FlashScan® thermal detector 135°F (57°C) with rate-of-rise. *See DN-6716.*

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

FSD-751P: FlashScan® photo duct detector with housing. *See DN-6821.*

FSD-751PL: Low-flow FlashScan® photo duct detector with housing, will replace FSD-751P. *See DN-6955.*

FSD-751RP: FlashScan® photo duct detector with relay and housing.

FSD-751RPL: Low-flow FlashScan® photo duct detector with relay and housing, will replace FSD-751RP. *See DN-6955.*

FAPT-851: FlashScan® Acclimate Plus™ low-profile multi-sensor detector, will replace FAPT-751. *See DN-6937.*

FAPT-751: Acclimate Plus™ low-profile multisensor detector. *See DN-6833.*

FSH-751: FlashScan® HARSH™ Hostile Area Smoke Head. *See DN-6875.*

FSL-751: FlashScan® VIEW® laser photo detector, will replace LPX-751. *See DN-6886.*

LPX-751: Low-profile VIEW® laser photo detector. *See DN-5306.*

B224RB: Low-profile relay base.

B224BI: Isolator base for low-profile detectors.

B710LP: Low-profile base. Standard U.S. style.

B501: European-style, 4" (10.16 cm) base.

B501BH: Sounder base, includes B501 base above. Constant tone.

B501BHT: Sounder base, includes B501 base above. Temporal three tone.

FMM-1: FlashScan® monitor module. *See DN-6720.*

FDM-1: FlashScan® dual monitor module. *See DN-6720.*

FZM-1: FlashScan® two-wire detector monitor module. *See DN-6720.*

FMM-101: FlashScan® miniature monitor module. *See DN-6720.*

FCM-1: FlashScan® NAC control module. *See DN-6724.*

FRM-1: FlashScan® relay module. *See DN-6724.*

FSM-101: FlashScan® pull station monitor module.

NBG-12LX: Manual fire alarm station, addressable. *See DN-6726.*

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

XP Series: Transponder. *See DN-0759.*

XP5-M: FlashScan® transponder, five monitor points. *See DN-6625.*

XP5-C: FlashScan® transponder, five control points or Form-C relays. *See DN-6625.*

XP6-C: FlashScan® six-circuit supervised control module. *See DN-6924.*

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

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

XP10-M: FlashScan® ten-input monitor module. *See DN-6923.*

XPIQ: Intelligent quad transponder. *See DN-6823.*

OTHER OPTIONS

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

LEM-320: Loop Expander Module. Expands each 640 to two Signaling Line Circuits. *See DN-6881.*

TM-4: Transmitter Module. Includes three reverse-polarity circuits and one municipal box circuit. Mounts in panel module position (single-address-style) or in CHS-M2 position. *See DN-6860.*

NCM-W: Network Communications Module, Wire. Order one NCM per network node (CPU-640 or NCA). *See DN-6861.*

NCM-F: Network Communications Module, Fiber. Order one NCM per network node (CPU-640 or NCA). *See DN-6861.*

NCS5-W-ONYX: Network Control Station, Wire. UL-Listed graphics PC with mouse, 17" color flat-screen LCD monitor. Order as necessary for network systems. Each NCS consumes one of 103 network addresses. *See DN-6868 (previous NCS-W), ONYX® DN-6869.*

NCS5-F-ONYX: Network Control Station, Fiber. UL-Listed graphics PC with mouse, 17" color flat-screen LCD monitor. Order as necessary for network systems. Each NCS consumes one of 103 network addresses. *See DN-6868 (previous NCS-F), ONYX® DN-6869.*

VeriFire-TCD: VeriFire® Tools CD-ROM. Contains programming software for the NFS-640, NCA, and XPIQ. Includes local panel connection cable. Programming PC requires a serial port connection. *See DN-6871.*

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

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

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

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

BAT Series: Batteries. NFS-640 utilizes two 12 volt, 12 to 55 AH batteries. *See DN-6933.*

PS Series: Batteries. NFS-640 utilizes two 12 volt, 12 to 55 AH batteries. *See DN-1109.*

NFS-LBB: Battery Box (required for batteries over 25 AH).

BR: Same as above but red.

SYSTEM SPECIFICATIONS

System Capacity

- Intelligent Signaling Line Circuits ....1 expandable to 2
- Intelligent detectors .... 159 per loop
- Addressable monitor/control modules .... 159 per loop
- Programmable internal hardware and output circuits (4 standard) 68
- Programmable software zones 99
- Special programming zones 14
- LCD annunciators per CPU-640/-640E and NCA *(observe power)*... 32
- ACS annunciators per CPU-640/-640E ....32 address x 64 points
- ACS annunciators per NCA ....32 address x 64 or 96 points

NOTE: *The* NCA *supports up to 96 annunciator address points per ACM-24/48.*

Specifications

- Primary input power, **CPU-640 board:** 120 VAC, 50/60 Hz, 3.0 amps. **CPU-640E board:** 220/240 VAC, 50/60 Hz, 1.5 Amps.
- **Total** output 24 V power: 6.0 A in alarm.

NOTE: *The power supply has a total of 6.0 Amps of available power. This is shared by all internal modules.*

- Standard notification circuits (4): 2.5 A each.
- Four-wire detector power: 1.25 A.
- Non-resettable regulated power outputs: 1.25 A each.
- Battery charger range: 12 AH – 55 AH. Use separate cabinet for batteries over 25 AH.
- Optional high-capacity (25 – 120 AH) battery charger: CHG-120 (see CHG-120 data sheet, DN-6040).
- Float rate: 27.6 V.

Temperature and Humidity Ranges

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

Agency Listings and Approvals

The listings and approvals below apply to the basic NFS-640 control panel. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL:** S635
- **ULC:** CS118
- **FM APPROVED** *Exceptions – CPU-640E, PRN-5, Proprietary service*
- **CSFM:** 7165-0028:214, 7170-0028:216
- **MEA:** 317-01-E
- **City of Chicago**
- **City of Denver**
- **Lloyd's Register:** 02/60007
- **U.S. Coast Guard:** 161.002/42/1
- **China Classification Society (CCS):** #NL05T00001 *(NFS-640E)*
- **CCCF:** Certif. # 2003081801600815

Standards

The NFS-640 complies with the following UL Standards and NFPA 72 Fire Alarm Systems requirements :

– **UL 864** (Fire)
– **UL 1076** (Burglary)
– **LOCAL** (Automatic, Manual, Waterflow and Sprinkler Supervisory).
– **AUXILIARY** (Automatic, Manual and Waterflow) (requires 4XTMF).
– **REMOTE STATION** (Automatic, Manual and Waterflow) (requires 4XTMF).
– **PROPRIETARY** (Automatic, Manual and Waterflow). *Not applicable for FM.*
– **EMERGENCY VOICE/ALARM**.

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ISO 9001 CERTIFIED ENGINEERING & MANUFACTURING QUALITY SYSTEMS

This document is not intended to be used for installation purposes.
We try to keep our product information up-to-date and accurate.
We cannot cover all specific applications or anticipate all requirements.
All specifications are subject to change without notice.

Made in the U.S. A.

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

FSD-751PL(A), FSD-751RPL(A)

Intelligent Low-Flow Photoelectric Duct Smoke Detectors with FlashScan®

NOTIFIER® by Honeywell

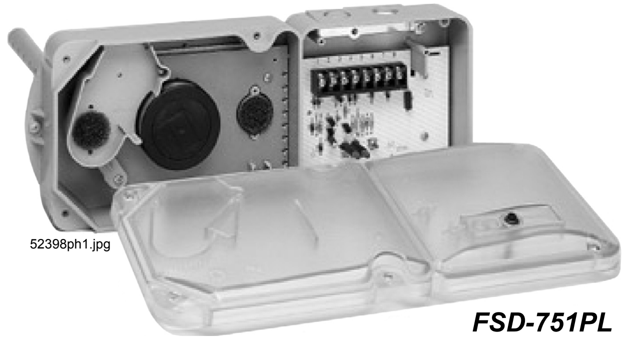
Intelligent Addressable Devices

General

NOTIFIER FSD-751PL(A) and FSD-751RPL(A) Intelligent Photoelectric Smoke Duct Detectors provide ***low-flow*** technology that enables duct smoke detection throughout a broad range of airflow environments in HVAC applications. The low-flow technology can detect smoke at air speed velocities of 100 feet per minute (0.5 m/sec) or greater, while continuing the same reliable performance to 4,000 feet per minute (20.32 m/sec). The intelligent low-flow duct detectors sample air currents passing through a duct and gives dependable performance for shutdown of fans, blowers, and air conditioning systems, preventing the spread of toxic smoke an fire gases through the protected area.

FSD-751PL(A) and FSD-751RPL(A) are compatible with all NOTIFIER addressable panels. FSD-751PL(A) and FSD-751RPL(A) provide a remote alarm output for use with auxiliary devices, such as the RA400Z(A) remote LED annunciator, as well as remote test capability with the RTS451(A) or RTS451KEY(A) Remote Test Stations.

Traditional panels support addresses of 0 – 99. The FlashScan® protocol supports addresses of 0 – 159. The patented FlashScan communication protocol was developed by NOTIFIER Engineering, it greatly enhances the speed of communication between analog intelligent devices and the Notifier control panel. Intelligent devices communicate in a grouped fashion. If one of the devices within the group has new information, the panel stops the group poll and concentrates on single points. The net effect is response speed greater than five times that of earlier designs.



52398ph1.jpg

FSD-751PL

52398ph2.jpg

FSD-751RPL

3242ra4z.jpg

RA400Z

3242rts4.jpg

RTS451

3242key.jpg

RTS451KEY

Applications

Duct smoke detectors have specific limitations, they are:

- ***NOT*** a substitute for open area smoke detectors.
- ***NOT*** a substitute for early warning detection.
- ***NOT*** a replacement for a building's regular fire detection system.

Please call NOTIFIER for a copy of System Sensor's application guide, *Proper Use of Smoke Detectors in Duct Applications*, (A05-1004-00).

Features

- Air velocity rating from 100 to 4,000 feet per minute (0.5 to 20.32 m/sec).
- Patented telescopic sampling tube.
- Easily accessible code wheels for addressing detector.
- Outside mounting tabs.
- Mounts to round or rectangular ducts from 1' to 12' (0.3 to 3.7 meters) wide.
- Transparent cover for convenient visual inspection.

Installation

Refer to installation manuals for control panel and duct detector for detailed information or to install equipment. Installation manuals for detectors: I561978-003R for FSD-751PL(A), 156-1979-004R for FSD-751RPL(A).

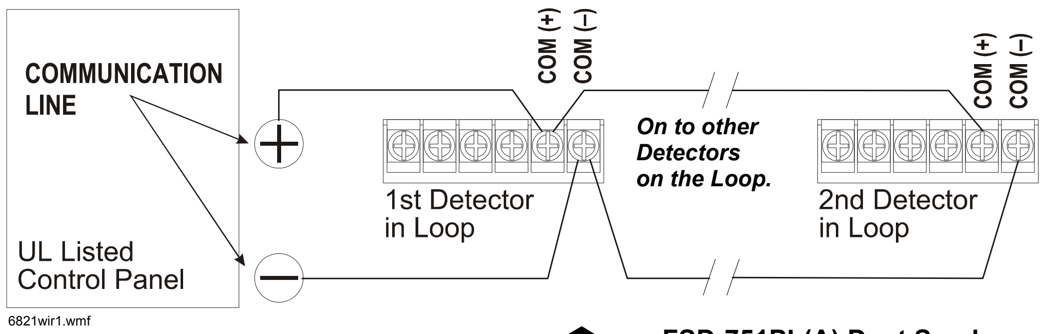
Wiring: For signal wiring (the wiring between detectors or from detectors to auxiliary devices), it is recommended that single conductor wire be no smaller than 18 AWG (0.821 mm²). The duct smoke detector terminals accommodate wire sizes up to 12 AWG (3.31 mm²). Flexible conduit is recommended for the last foot (30.48 cm) of conduit; solid conduit connections may be used if desired.

Smoke detectors and alarm system control panels have specifications for Signaling Line Circuit (SLC) wiring. Consult the control panel specifications for wiring requirements before wiring the detector loop. The FSD-751PL(A) and FSD-751RPL(A) detectors are designed for ease of wiring; their housing provides a terminal strip with clamping plates.

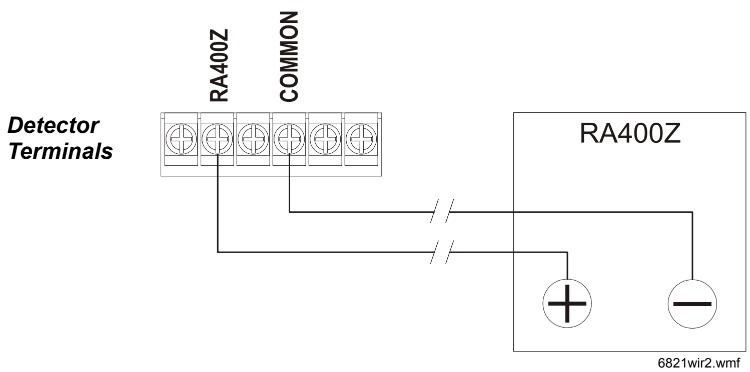
LED Features: If programmed with the system control panel, two LEDs on each duct smoke detector light to provide local visible indication.

Programming specifications/requirements for intelligent system control panels: The number of devices that can have their LEDs programmed to illuminate is limited by the features of the panel and the individual devices. 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.

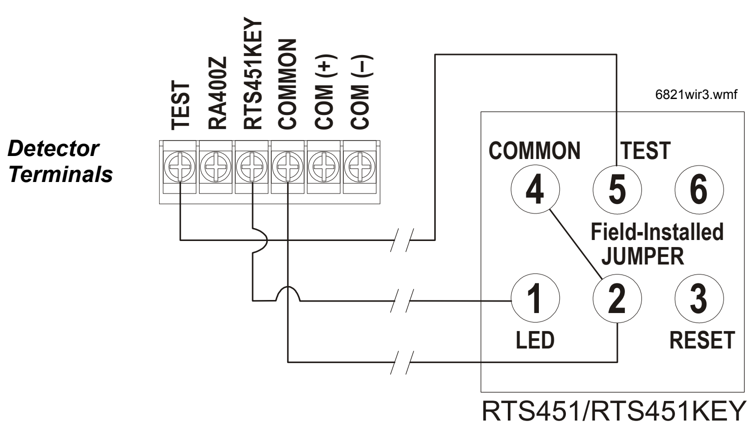
Wiring Diagrams for FSD-751PL(A)



FSD-751PL(A) Duct Smoke Detector using a UL or ULC Listed control panel.



FSD-751PL(A) Duct Smoke Detector with an optional RA400Z(A).



FSD-751PL(A) Duct Smoke Detector with RTS451(A)/ RTS451KEY(A).

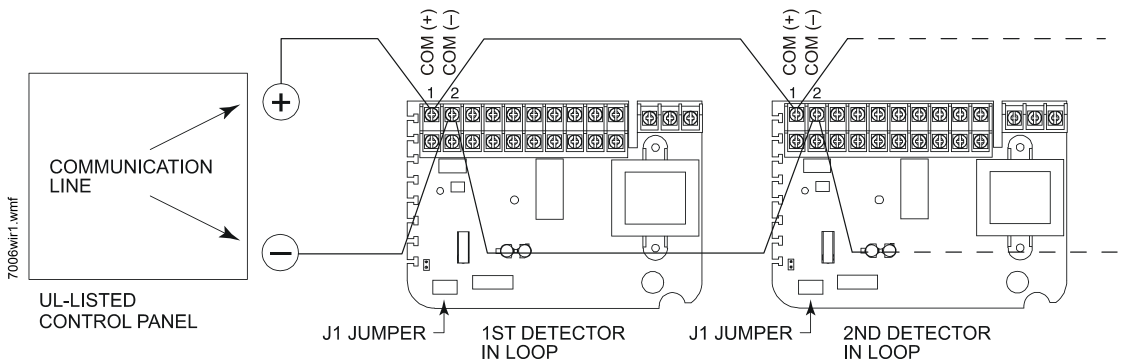
***NOTE:** For **RTS451(A)**, Terminal 3 is not used. RTS451(A) does not have a Terminal 6. For **RTS451KEY(A)**, Terminals 3 and 6 are not used.*

Inlet Tube Selection

Outside Duct Width	Inlet Tube*
Up to 2 feet (0.6096 m)	ST-1.5(A)
2 to 4 feet (0.6096 to 1.2192 m)	ST-3(A)
4 to 8 feet (1.2192 to 2.4384 m)	ST-5(A)
8 to 12 feet (2.4384 to 3.6576 m)	ST-10(A)
**Inlet tube is required and must be purchased separately. Order One inlet tube for each duct smoke detector ordered.*	

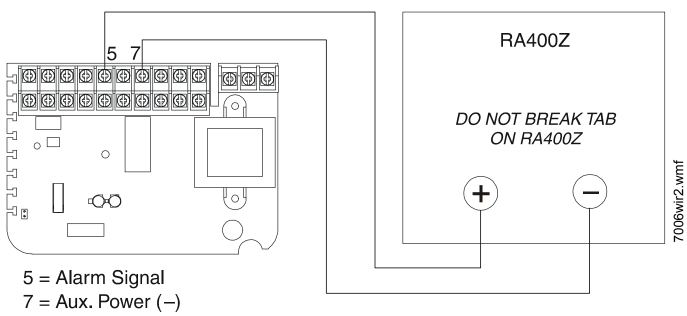
Wiring Diagrams for FSD-751RPL(A)

FSD-751RPL(A) Duct Smoke Detector using a UL-Listed control panel:

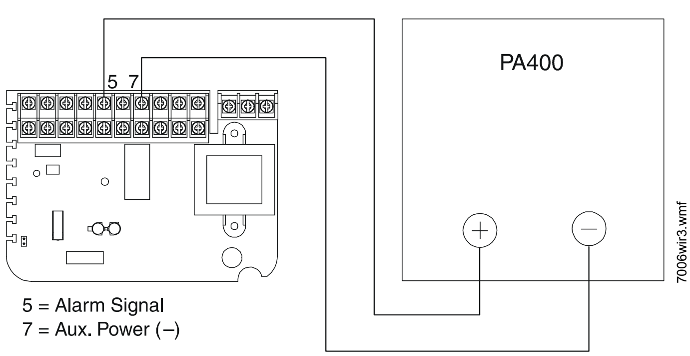


NOTE: 1) Jumper J1 shunt** must be installed for 2-W applications. J1 shunt must be removed for power PCB supervision. Note that removal of shunt without adding external power will prevent communications to the panel over the SLC. **2)** External power of 24 V AC/DC or 120/220 VAC must be connected in order to **power all remote horn or strobe accessories.

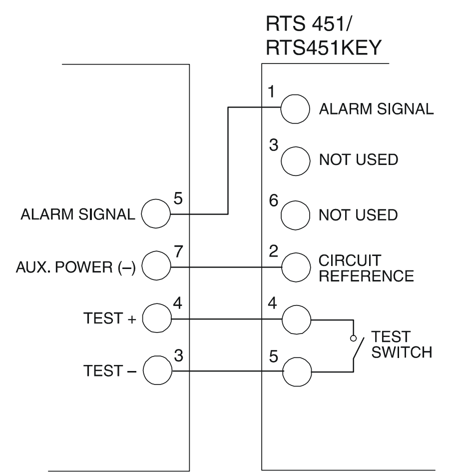
FSD-751RPL(A) Duct Smoke Detector with an optional RA400Z(A):



FSD-751RPL(A) Duct Smoke Detector with an optional PA400:



FSD-751RPL(A) Duct Smoke Detector with RTS451(A)/RTS451KEY(A):



FOR RTS451, TERMINAL 3 IS NOT USED. (RTS451 DOES NOT HAVE A TERMINAL 6.) FOR RTS451KEY, TERMINALS 3 AND 6 ARE NOT USED.

7006wir4.wmf

Product Line Information

NOTE: "A" model suffix is for Canadian models.

FSD-751PL: Addressable low-flow duct detector housing with photoelectric smoke detector.

FSD-751PLA: Same as above with ULC listing.

FSD-751RPL: Addressable low-flow duct detector housing with photoelectric smoke detector with DPDT relay.

FSD-751RPLA: Same as above with ULC listing.

A5053FS: Replacement photoelectric sensor board.

A5067: Replacement power board (without relay).

A5060: Replacement power board (with relay).

ST-1.5(A): Metal sampling tube, duct widths 1' to 2' *(see Inlet Tube Selection table on page 2 for metric lengths)*.

ST-3(A): Metal sampling tube, duct widths 2' to 4'.

ST-5(A): Metal sampling tube, duct widths 4' to 8'.

ST-10(A): Metal sampling tube, duct widths 8' to 12'.

RA400Z(A): Remote annunciator alarm LED.

RTS451(A): Remote test station. Mounts in single-gang box. Includes red alarm LED and magnet test switch.

RTS451KEY(A): Key-activated remote test station.

F36-09-11: Replacement filters.

M02-04-00: Test magnet.

M02-09-00: Test magnet with telescoping handle.

S08-39-01: Replacement photo insect screen.

P48-61-00: Replacement end cap for plastic sampling tube.

P48-21-00: Replacement end cap for metal sampling tube.

T80-71-00: Replacement plastic sampling tube.

Specifications

FOR FSD-751PL(A)

Operating voltage range: 15 to 30 VDC.

Standby current: 300 µA @ 24 VDC (one communication every 5 seconds with LED blink enabled).

Operating temperature range: 32° to 131°F (0° to 55°C).

Operating humidity range: 10% to 93% relative humidity (non-condensing).

Storage temperature range: –22°F to +158°F (–30°C to +70°C).

Duct air velocity: 100 to 4,000 feet/min (0.5 to 20.32 m/s).

Shipping weight: 3.35 lbs. (1.5 kg).

Dimensions: 14.75" (37 cm) length x 5.50" (14 cm) width x 2.75" (7 cm) deep.

FSD-751PL(A) accessory current loads @ 24 VDC: ***RA400Z(A):*** 0 mA standby, 10 mA maximum in alarm. ***RTS451(A) and RTS451KEY(A):*** 0 mA standby, 7.5 mA maximum in alarm.

FOR FSD-751RPL(A)

Operating voltage range: 20 to 30 VDC, 24 VAC/VDC, 120/240 VAC auxiliary power (requires a separate auxiliary source).

Standby current: 300 µA @ 24 VDC (one communication every 5 seconds with LED blink enabled).

Operating temperature range: 32° to 131°F (0° to 55°C).

Operating humidity range: 10% to 93% relative humidity (non-condensing).

Storage temperature range: –22°F to +158°F (–30°C to +70°C).

Duct air velocity: 100 to 4,000 feet/min (0.5 to 20.32 m/s).

Shipping weight: 3.90 lbs. (1.8 kg).

Dimensions: 14.75" (37 cm) length x 5.50" (14 cm) width x 2.75" (7 cm) deep.

FSD-751RPL(A) CONTACT RATINGS

Alarm auxiliary contacts (DPDT): 10 A @ 30 VDC; 10 A @ 277 VAC (0.75 power factor); 240 VA @ 249 VAC (0.4 power factor); 1/8 HP @ 120 VAC; 1/4 HP @ 240 VAC.

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

Supervisory contact (SPST): 2.0 A @ 30 VDC (resistive).

FSD-751RPL(A) accessory current loads @ 24 VDC: ***PA400:*** refer to PA400 data sheet DN-2405. ***RA400Z(A):*** 0 mA standby, 12 mA maximum in alarm. ***RTS451(A) and RTS451KEY(A):*** 0 mA standby, 10 mA maximum in alarm.

FSD-751RPL(A) CURRENT REQUIREMENTS (USING NO ACCESSORIES)

20 – 30 VDC power supply voltage: 26 mA maximum standby current; 87 mA maximum alarm current; 3 to 10 second alarm response time; 2 second power-up time.

24 VAC, 50/60 Hz power supply voltage: 65 mA RMS maximum standby current; 182 mA RMS maximum alarm current; 3 to 10 second alarm response time; 2 second power-up time.

120 VAC, 50/60 Hz power supply voltage: 44 mA RMS maximum standby current; 52 mA RMS maximum alarm current; 3 to 10 second alarm response time; 2 second power-up time.

220/240 VAC, 50/60 Hz power supply voltage: 25 mA RMS maximum standby current; 30 mA RMS maximum alarm current; 3 to 10 second alarm response time; 2 second power-up time.

Agency Listings and Approvals

The listings and approvals below apply to FSD-751PL(A) and FSD-751RPL(A) Intelligent Low-Flow Photoelectric Smoke Duct Detectors. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL** Listed: file S1115 *(FSD-751PL, FSD-751RPL)*.
- **ULC** Listed: file S115 *(FSD-751PLA, FSD-751RPLA)*.
- **CSFM** approved: file 3240-0028:205.
- **FM** approved.
- **MEA** approved: file 384-02-E.
- **Maryland State Fire Marshal** approved: Permit #2127.

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www.notifier.com

FSP-851(A) Series

Intelligent Plug-In Photoelectric Smoke Detectors with FlashScan®

NOTIFIER® by Honeywell

Intelligent/Addressable Devices

General

Notifier FSP-851(A) Series intelligent plug-in smoke detectors with integral communication provide features that surpass conventional detectors. Detector sensitivity can be programmed in the control panel software. Sensitivity is continuously monitored and reported to the panel. Point ID capability allows each detector's address to be set with rotary, decimal address switches, providing exact detector location for selective maintenance when chamber contamination reaches an unacceptable level. The FSP-851(A) photoelectric detector's unique optical sensing chamber is engineered to sense smoke produced by a wide range of combustion sources. Dual electronic thermistors add 135°F (57°C) fixed-temperature thermal sensing on the FSP-851T(A). The FSP-851R(A) is a remote test capable detector for use with DNR(A)/DNRW duct detector housings. FSP-851(A) series detectors are compatible with Notifier Onyx and CLIP series Fire Alarm Control Panels (FACPs).

FlashScan® (U.S. Patent 5,539,389) is a communication protocol developed by Notifier that greatly increases the speed of communication between analog intelligent devices. Intelligent devices communicate in a grouped fashion. If one of the devices in the group has new information, the panel's CPU stops the group poll and concentrates on single points. The net effect is response speed greater than five times that of earlier designs.

Features

- Sleek, low-profile design.
- Addressable-analog communication.
- Stable communication technique with noise immunity.
- Low standby current.
- Two-wire SLC connection.
- Compatible with FlashScan® and CLIP protocol systems.
- Rotary, decimal addressing (1-99 on CLIP systems, 1-159 on FlashScan systems).
- Optional remote, single-gang LED accessory.
- Dual LED design provides 360° viewing angle.
- Visible bi-color LEDs blink green every time the detector is addressed, and illuminate steady red on alarm *(FlashScan systems only)*.
- Remote test feature from the panel.
- Walk test with address display (an address on 121 will blink the detector LED: 12-[pause]-1 *(FlashScan systems only)*.
- Built-in functional test switch activated by external magnet.
- Built-in tamper-resistant feature.
- Sealed against back pressure.
- Constructed of off-white fire-resistant plastic, designed to commercial standards, and offers an attractive appearance.
- 94-5V plastic flammability rating.
- SEMS screws for wiring of the separate base.
- Optional relay, isolator, and sounder bases.

B210-2951.jpg

FSP-851(A) in B210LP(A) Base

Specifications

Sensitivity: 0.5% to 2.35% per foot obscuration

Size: 2.1" (5.3 cm) high; base determines diameter.

- **B210LP(A):** 6.1" (15.5 cm) diameter.
- **B501(A):** 4.1" (10.4 cm) diameter.
- **B200S(A):** 6.875" (17.46 cm) diameter.
- **B200SR(A):** 6.875" (17.46 cm) diameter.
- **B224RB(A):** 6.2" (15.748 cm) diameter.
- **B224BI(A):** 6.2" (15.748 cm) diameter.

Shipping Weight: 5.2oz. (147g).

Operating Temperature range: FSP-851(A), 0°C to 49°C (32°F to 120°F). FSP-851T(A), 0°C to 38°C (32°F to 100°F). Low temperature signal for FSP-851T(A) at 45°F +/- 10°F (7.22°C +/- 5.54°C). FSP-851R(A) installed in a DNR(A)/DNRW, -20°C to 70°C (-4°F to 158°F).

UL/ULC Listed Velocity Range: 0-4000 ft/min. (1219.2 m/min.), suitable for installation in ducts.

Relative Humidity: 10%-93% noncondensing.

Thermal Ratings: Fixed-temperature setpoint 135°F (57°C).

Detector Spacing and Applications

Notifier recommends spacing detectors in compliance with NFPA 72. In low airflow applications with smooth ceiling, space detectors 30 feet (9.144m) for ceiling heights 10 feet (3.148m) and higher. For specific information regarding detector spacing, placement, and special applications refer to NFPA 72. *System Smoke Detector Application Guide*, document A05-1003, is available at **systemsensor.com**

Electrical Specifications

Voltage Range: 15-32 volts DC peak.

Standby Current (max. avg.): 300µA @ 24VDC (one communication every five seconds with LED enabled).

LED Current (max.): 6.5mA @ 24 VDC ("ON").

Installation

FSP-851(A) plug-in detectors use a separate base to simplify installation, service, and maintenance. A special tool allows maintenance personnel to plug in and remove detectors without using a ladder.

Mount base (all base types) on an electrical backbox which is at least 1.5" (3.81 cm) deep. For a chart of compatible junction boxes, see *DN-60054.*

NOTE: *1) Because of inherent supervision provided by the SLC loop, end-of-line resistors are not required. Wiring "T-taps" or branches are permitted for Style 4 (Class "B") wiring. 2) When using relay or sounder bases, consult the ISO-X(A) installation sheet I56-1380 for device limitations between isolator modules and isolator bases.*

Agency Listings and Approvals

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

- **UL Listed:** S1115.
- **ULC Listed:** S1115 (FSP-851A, FSP-851RA, FSP-851TA).
- **MEA Listed:** 225-02-E .
- **FM Approved.**
- **CSFM:** 7272-0028:0206 .
- **Maryland State Fire Marshal:** Permit # 2122 **.**
- **BSMI:** CI313066760036.
- **CCCF:** Certif. # 2004081801000017 (FSP-851T)
  Certif. # 2004081801000016 (FSP-851).
- **U.S. Coast Guard:** 161.002/42/1 (NFS-640); 161.002/50/0 (NFS2-640/NFS-320/NFS-320C, excluding B210LP(A)).
- **Lloyd's Register:** 11/600013 (NFS2-640/NFS-320/NFS-320C, excluding B210LP(A)).

Product Line Information

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

FSP-851: Low-profile intelligent photoelectric sensor. Must be mounted to one of the bases listed below.

FSP-851A: Same as FSP-851 but with ULC listing.

FSP-851T: Same as FSP-851 but includes a built-in 135°F (57°C) fixed-temperature thermal device.

FSP-851TA: Same as FSP-851T but with ULC listing.

FSP-851R: Low-profile intelligent photoelectric sensor, remote test capable. For use with DNRA/DNRW.

FSP-851RA: Same as FSP-851R but with ULC listing. For use with DNRA.

Intelligent Bases

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

NOTE: *For details on intelligent bases, see DN-60054.*

B210LP(A): Standard U.S. flanged low-profile mounting base.

B210LPBP: Bulk pack of B210LP; package contains 10.

B501(A): Standard European flangeless mounting base.

B501BP: Bulk pack of B501; package contains 10.

B200S(A): Intelligent, programmable sounder base capable of producing sound output in high or low volume with ANSI Temporal 3, ANSI Temporal 4, continuous tone, marching tone, and custom tone.

B200SR(A): Intelligent sounder base capable of producing sound output with ANSI Temporal 3 or continuous tone. Replaces B501BH series bases in retrofit applications.

B224RB(A): Plug-in System Sensor **relay** base. Screw terminals: up to 14 AWG (2.0 mm²). Relay type: Form-C. Rating: 2.0 A @ 30 VDC resistive; 0.3 A @ 110 VDC inductive; 1.0 A @ 30 VDC inductive.

B224BI(A): Plug-in System Sensor ***isolator*** detector base. Maximum 25 devices between isolator bases.

Accessories

F110: Retrofit flange to convert B210LP(A) to match the B710LP(A) profile, or to convert older high-profile bases to low-profile.

F110BP: Bulk pack of F110; package contains 15.

F210: Replacement flange for B210LP(A) base.

RA100Z(A): Remote LED annunciator. 3 – 32 VDC. Mounts to a U.S. single-gang electrical box. For use with B501(A) and B210LP(A) bases only.

SMB600: Surface mounting kit

M02-04-00: Test magnet.

M02-09-00: Test magnet with telescoping handle.

XR2B: Detector removal tool. Allows installation and/or removal of detector heads from bases in high ceiling applications.

XP-4: Extension pole for XR2B. Comes in three 5-foot (1.524 m) sections.

T55-127-010: Detector removal tool without pole.

BCK-200B: Black detector covers for use with FSP-851(A) only; box of 10.

WCK-200B: White detector covers for use with FSP-851(A) only; box of 10.

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ISO 9001 CERTIFIED ENGINEERING & MANUFACTURING QUALITY SYSTEMS

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We cannot cover all specific applications or anticipate all requirements.
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For more information, contact Notifier. Phone: (203) 484-7161, FAX: (203) 484-7118.
www.notifier.com

FST-851 Series

Intelligent Thermal (Heat) Detectors with FlashScan®

NOTIFIER® by Honeywell

Intelligent/Addressable Devices

General

Notifier FST-851 Series intelligent plug-in smoke detectors with integral communication provide features that surpass conventional detectors. Detector sensitivity can be programmed in the control panel software. Sensitivity is continuously monitored and reported to the panel. Point ID capability allows each detector's address to be set with decade address switches, providing exact detector locations for selective maintenance when chamber contamination reaches an unacceptable level. FST-851 Series thermal detectors use an innovative thermistor sensing circuit to produce 135°F/57°C fixed-temperature (FST-851) and rate-of-rise thermal detection (FST-851R) in a low-profile package. FST-851H provides fixed high-temperature detection at 190°F/88°C. These thermal detectors provide cost effective, intelligent property protection in a variety of applications. FST-851 Series detectors are compatible with all Notifier intelligent Fire Alarm Control Panels (FACPs).

FlashScan® (U.S. Patent 5,539,389) is a communication protocol developed by Notifier Engineering that greatly enhances the speed of communication between analog intelligent devices and certain NOTIFIER systems. Intelligent devices communicate in a grouped fashion. If one of the devices within the group has new information, the panel's CPU stops the group poll and concentrates on single points. The net effect is response speed greater than five times that of earlier designs.

Features

- Sleek, low-profile, stylish design.
- State-of-the-art thermistor technology for fast response.
- Rate-of-rise model (FST-851R), 15°F (8.3°C) per minute.
- Factory preset at 135°F (57°C); high-temperature model at 190°F (88°C).
- Addressable by device.
- FlashScan® (NFS-640, NFS-3030) and classic CLIP system (AFP-100, AFP-200, AFP-300, AFP-400, NFS-640, AFP1010, AM2020, NFS-3030, NFS2-3030) compatible.
- Rotary, decimal addressing (1 – 99 on current classic systems, 1 – 159 on FlashScan® systems).
- Two-wire SLC connection.
- Visible LEDs "blink" every time the unit is addressed.
- 360°-field viewing angle of the visual alarm indicators (two bi-color LEDs). LEDs blink green in Normal condition and turn on steady red in Alarm.
- Integral communications and built-in device-type identification.
- Remote test feature from the panel.
- Built-in functional test switch activated by external magnet.
- Walk test with address display (an address of 121 will blink the detector LED 12-(pause)-1).
- Low standby current.
- Listed to UL 521.
- Backward-compatible.
- Built-in tamper-resistant feature.
- Designed for direct-surface or electrical-box mounting.
- Sealed against back pressure.

FST-851 Series in B710LP base

- Plugs into separate base for ease of installation and maintenance. Separate base allows interchange of photoelectric, ionization and thermal sensors.
- SEMS screws for wiring of the separate base.
- Constructed of off-white Bayblend®, designed to commercial standards, and offers an attractive appearance.
- 94-5V plastic flammability rating.
- Remote LED output connection to optional RA400Z remote LED annunciator.
- Optional sounder, relay, and isolator bases.
- Optional recessed (RMK400) or surface (SMK400) base mounting kits.

Specifications

Size: 2.1" (5.3 cm) high x 4.1" (10.4 cm) diameter installed in B501 base, 6.1" (15.5 cm) diameter installed in B710LP base.

Shipping weight: 4.8 oz. (137 g).

Operating temperature range: FST-851 Series, FST-851R: –20°C to 38°C (–4°F to 100°F); FST-851H: –20°C to 66°C (–4°F to 150°F).

Detector spacing: UL approved for 50 ft. (15.24 m) center to center. FM approved for 25 x 25 ft. (7.62 x 7.62 m) spacing.

Relative humidity: 10% – 93% noncondensing.

Thermal ratings: fixed-temperature setpoint 135°F (57°C), rate-of-rise detection 15°F (8.3°C) per minute, high temperature heat 190°F (88°C).

ELECTRICAL SPECIFICATIONS:

Voltage range: 15 - 32 volts DC peak.

Standby current (max. avg.): 200 μA @ 24 VDC (without communication); 300 μA @ 24 VDC (one communication every 5 seconds with LED enabled).

LED current (max.): 6.5 mA @ 24 VDC ("ON").

Bases available:

B710LP: 6.1" (15.5 cm) diameter.

B501: 4.1" (10.4 cm) diameter.

B501BH or B501BHT: Sounder base assembly. Includes B501 base.

B224RB Relay Base: Screw terminals: up to 14 AWG (2.0 mm²). Relay type: Form-C. Rating: 2.0 A @ 30 VDC resistive; 0.3 A @ 110 VDC inductive; 1.0 A @ 30 VDC inductive. Dimensions: 6.2" (15.748 cm) x 1.2" (3.048 cm).

B224BI Isolator Base: Dimensions: 6.2" (15.748 cm) x 1.2" (15.748 cm). Maximum: 25 devices between isolator bases. See Note 2 under Installation.

Applications

Use thermal detectors for protection of property. For further information, go to systemsensor.com for manual I56-407-00, Applications Manual for System Smoke Detectors, which provides detailed information on detector spacing, placement, zoning, wiring, and special applications.

Installation

The FST Series plug-in intelligent thermal detector uses a separate base to simplify installation, service, and maintenance. Installation instructions are shipped with each detector.

Mount base (all base types) on an electrical backbox which is at least 1.5" (3.81 cm) deep. Suitable boxes include:

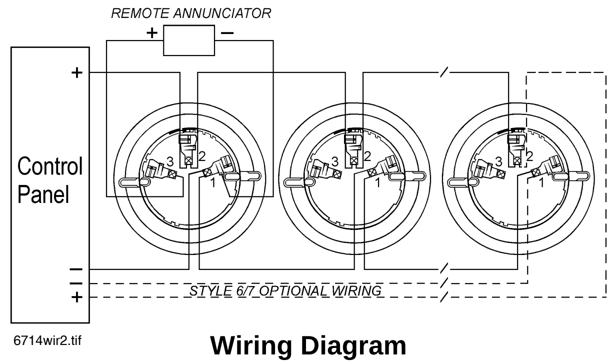
- 4.0" (10.16 cm) square box.
- 3.5" (8.89 cm) or 4.0" (10.16 cm) octagonal box.
- Single-gang box (except relay or isolator base).
- With B501BH or B501BHT base, use a 4.0" (10.16 cm) square box.
- With B224RB or B224BI base, use a 3.5" (8.89 cm) or 4.0" (10.16 cm) octagonal box, or a 4.0" (10.16 cm) square box.

NOTE: 1) *Because of the inherent supervision provided by the SLC loop, end-of-line resistors are not required. Wiring "T-taps" or branches are permitted for Style 4 (Class "B") wiring.* ***2)*** *When using relay or sounder bases, consult data sheet DN-2243 (ISO-X) for device limitations between isolator modules and isolator bases.*

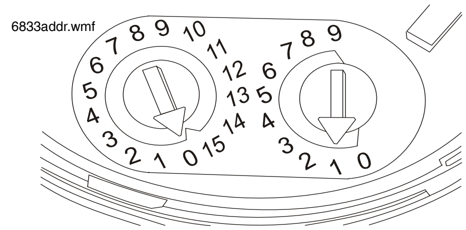
Agency Listings and Approvals

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

- **UL Listed:** S747
- **ULC Listed:** CS630 (ML255)(FST-851A, FST-851HA, FST-851RA)
- **MEA Listed:** 383-02-E
- **FM Approved**
- **CSFM:** 7270-0028:196
- **BSMI:** CI313066760025
- **CCCF:** Certif. # 2004081801000018
- **U.S. Coast Guard:** 161.002/23/3 (AFP-200); 161.002/27/3 (AFP1010/AM2020); 161.002/42/1 (NFS-640)
- Lloyd's Register: 03/60011



Wiring Diagram



Address dial on back of detector

Product Line Information

"A" suffix indicates ULC Listed model.

FST-851 Series: Intelligent thermal detector. Must be mounted to one of the bases listed below.

FST-851 SeriesA: Same as FST-851 Series but with ULC Listing.

FST-851R: Intelligent thermal detector with rate-of-rise feature.

FST-851RA: Same as FST-851R but with ULC Listing.

FST-851H: Intelligent high-temperature thermal detector.

FST-851HA: Same as FST-851H but with ULC Listing.

BASES:

B710LPBP: Standard U.S. low-profile base, pkg. of 10.

B710LPA: Standard U.S. low-profile base, ULC Listing.

B501BP: Standard European flangeless base, pkg. of 10.

B501A: Standard European flangeless base, ULC Listing.

B501BH(A): Sounder base, includes B501(A) base.

B501BHT(A): Same as B501BH(A), but includes temporal sounder.

B224RB(A): Intelligent relay base.

B224BI(A): Intelligent isolator base. Isolates SLC from loop shorts.

ACCESSORIES:

F110: Retrofit replacement flange for older style high profile bases. Converts bases for use with FlashScan® detectors.

RA400Z(A): Remote LED annunciator. 3 – 32 VDC. Fits U.S. single-gang electrical box. Supported by B710LPBP(A) and B501(A) bases only.

SMK400: Surface mounting kit provides for entry of surface wiring conduit. For use with B501(A) base only.

RMK400: Recessed mounting kit. For use with B501(A) base only.

SMB600: Surface mounting kit for use with B710LPBP(A).

BCK-200B: Black detector covers, box of 10.

M02-04-01: Test magnet.

M02-09-00: Test magnet with telescope stick.

XR2B: Detector removal tool. Allows installation and/or removal of FlashScan® Series detector heads from base in high ceiling installations.

T55-127-000: Detector removal tool without pole.

XP-4: Extension pole for XR2B. Comes in three 5-ft. sections.

DETECTOR GUARDS:

NOTE: Some guards listed below may not be applicable to FST Series.

STI9601: Low-profile, flush-mount smoke detector guard, wire.*

STI9602: Low-profile, surface-mount, smoke detector guard, wire.*

STI9609: High-profile, flush-mount, smoke detector guard, wire.*

STI9605: High-profile, surface-mount, smoke detector guard, wire.*

STI 9604: Flush-mount heat detector guard, wire.*

STI 9610: Surface-mount heat detector guard, wire.*

*For dimensions and additional information on STI Steel Web Stoppers, see data sheet DN-4936.

STI8200-SS: Flush-mount stainless steel smoke detector guard (compatibility pending).

STI8230-SS: Surface-mount stainless steel smoke detector guard (compatibility pending).

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www.notifier.com

NBG-12LX

Addressable Manual Pull Station

NOTIFIER®
by Honeywell

Intelligent/Addressable Devices

‘General

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

Features

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

Construction

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

Specifications

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

The NBG-12LX
Addressable Manual Pull Station

Installation

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

Operation

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

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

Architectural/Engineering Specifications

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

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

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

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

Product Line Information

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

NBG-12LXSP: Spanish/English labelled version.

NBG-12LXP: Portuguese labelled version.

SB-10: Surface backbox; metal.

SB-I/O: Surface backbox; plastic.

BG12TR: Optional trim ring.

17021: Keys, set of two.

NY-Plate: New York City trim plate.

Agency Listings and Approvals

In some cases, certain modules or applications may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

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

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

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Wheelock E Series

Low-Profile Public Speakers and Speaker Strobes

NOTIFIER® by Honeywell

Audio / Visual Devices

General

Wheelock Series E Low Profile Speakers and Speaker Strobes are designed for high efficiency sound output, with dual voltage (25/70 VRMS) capability and field selectable taps from 1/8 to 2 watts. The low profile design incorporates a speaker mounting plate for faster and easier installation. Each model has a built-in level adjustment feature and an aesthetic two (2) screw grille cover.

The Series E Speaker Strobe models incorporate the low current draw series RSS strobes.

Strobe options for wall mount models include 1575 or Wheelock's patented MCW multi-candela strobe with field selectable candela settings of 15/30/75/110cd or the high intensity MCWH strobe with field selectable 135/185cd.

Ceiling mount models are available in Wheelock's patented MCC multi-candela ceiling strobe with field selectable intensities of 15/30/75/95cd or the high intensity MCCH strobe with field selectable 115/177cd.

Series E Speakers and Speaker Strobes provide high audio output with clear audibility and are designed to meet the critical needs of the life safety industry for effective emergency voice communications, tone signaling and visible signaling to alert the hearing impaired.

The strobe portion of all Series E Speaker Strobes may be synchronized when used in conjunction with the Wheelock SM, DSM Sync Modules or a power supply with patented Wheelock sync protocol. Wheelock's synchronized strobes offer an easy way to comply with ADA recommendations concerning photosensitive epilepsy.

Series E Speaker Strobes are UL Listed for indoor use under Standard 1971 (Signaling Devices for the Hearing-Impaired) and Standard 1480 (Speaker Appliances), and use a Xenon flashtube with solid state circuitry enclosed in a rugged Lexan® lens to provide maximum reliability for effective visual signaling. All inputs are supervised and employ IN/OUT wiring terminals for fast installation using #12 to #18 AWG wiring.

Color options for the E Series Speakers and Speaker Strobes offered are colored red or white.

Features

- ADA/NFPA/ANSI compliant
- Complies with OSHA 29 Part 1910.165
- Wall mount models are available with field selectable candela settings of 15/30/75/110cd or 135/185cd (multi-candela models), or 1575cd (single candela model)
- Ceiling mount models are available with field selectable candela settings of 15/30/75/95cd or 115/177cd (multi-candela models)
- Strobes produce 1 flash per second over the regulated voltage range
- 24 VDC with wide UL "Regulated Voltage" using filtered DC or unfiltered VRMS input voltage
- Synchronize with Wheelock SM, DSM or panels with built-in Wheelock patented synch protocol
- Field selectable taps for 25 or 70 VRMS operation from 1/8 watt up to 2 watts
- High efficiency design for maximum output at minimum wattage across a frequency range of 400 to 4000 HZ

E70 Series Speaker strobe.jpg

E70 Series Speaker Strobe

E90 Series Speaker strobe.jpg

E90 Series Speaker Strobe

Multi-Candela Indicator.jpg

Multi-Candela Indicator(bottom of Strobe Lens)

- Fast installation with IN/OUT screw terminals using #12 to #18 AWG wires

General Notes

- Strobes are designed to flash at 1 flash per second minimum over their "Regulated Voltage Range". Note that NFPA-72 specifies a flash rate of 1 to 2 flashes per second and ADA Guidelines specify a flash rate of 1 to 3 flashes per second.
- All candela ratings represent minimum effective Strobe intensity based on UL Standard 1971.
- Series E Speaker Strobes and Series E Speakers are listed under UL Standard 1971 for indoor use with a temperature range of 32°F to 120°F (0°C to 49°C) and maximum humidity of 85%.
- "Regulated Voltage Range" is the newest terminology used by UL to identify the voltage range. Prior to this change UL used the terminology "Listed Voltage Range".

***NOTE:** 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.*

Specifications and Ordering Information

MODEL	STROBE CANDELA	MODEL COLOR	WALL/ CEILING MOUNT	AGENCY APPROVALS				
				UL	MEA	CSFM	FM	BFP
E70-24MCW-FR	15/30/75/110	Red	Wall	X	X	X	*	X
E70-24MCW-FW	15/30/75/110	White	Wall	X	X	X	*	X
E70-241575W-FR	15 (75 on Axis)	Red	Wall	X	X	X	*	X
E70-R	-	Red	Wall/Ceiling	X	X	X	*	X
E70-W	-	White	Wall/Ceiling	X	X	X	*	X
E70-24MCWH-FR	135/185	Red	Wall	X	*	*	*	*
E70-24MCWH-FW	135/185	White	Wall	X	*	*	*	*
E90-24MCC-FW	15/30/75/95	White	Ceiling	X	*	X	*	*
E90-W	-	White	Wall/Ceiling	X	X	X	*	X
E90-R	-	Red	Wall/Ceiling	X	X	X	*	X
E90-24MCCH-FW	115/177	White	Ceiling	X	*	*	*	*

E70/E90 Speaker Strobes	E-70 Strobe Current - Wall Mount							E90 Strobe Current - Ceiling Mount					
	241575W	24MCW				24MCWH		24MCC				24MCCH	
	1575cd	15cd	30cd	75cd	110cd	135cd	185cd	15cd	30cd	75cd	95cd	115cd	177cd
16-33 VDC	0.090	0.060	0.092	0.165	0.220	0.300	0.420	0.065	0.105	0.189	0.249	0.300	0.420

UL Max Current*

*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.

watts	1/8	1/4	1/2	1	2
E Speaker	77	81	83	86	89
E Speaker Strobe	76	80	82	85	88

E70/E90 UL Reverberant dBA @ 10 Feet **

**dBA ratings are based on testing under UL Standard 1480

Architect and Engineer Specifications

The speaker appliances shall be Wheelock Series E Speakers and the speaker strobe appliances shall be Wheelock Series E Speaker Strobes or approved equals. The speakers shall be UL Listed under Standard 1480 for Fire Protective Service and speakers equipped with strobes shall be listed under UL Standard 1971 for Emergency Devices for the Hearing-Impaired. In addition, the strobes shall be certified to meet the requirements of FCC Part 15, Class B.

All speakers shall be designed for a field selectable input of either 25 or 70 VRMS, with selectable power taps from 1/8 watt to 2 watts. All models shall have listed sound output of up to 87 dB at 10 feet and a listed frequency response of 400 to 4000 Hz. The speaker shall also incorporate a sealed back construction. All inputs shall employ terminals that accept #12 to #18 AWG wire sizes. The strobe portion of the appliance shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range and shall incorporate a Xenon flashtube enclosed in a rugged Lexan® lens. The strobe shall be of low current design. Where Multi-Candela Speaker Strobes are specified, the strobe intensity shall have field selectable settings and shall be rated per UL Standard 1971 at 15/30/75/110cd or 135/185cd for wall mount and 15/30/75/95cd or 115/177cd for ceiling mount. The selector switch for selecting the candela shall be tamper resistant. The 1575 candela strobe shall be specified when 15 candela UL Standard 1971 Listing with 75 candela on-axis is required (e.g. ADA compliance). When synchronization is required, the strobe portion of the appliance shall be compatible with Wheelock's SM, DSM sync modules or the power supply with built-in Patented Wheelock Sync Protocol. The strobes shall not drift out of synchronization at any time during operation. If the sync module or Power Supply fails to operate, (i.e., contacts remain closed), the strobe shall revert to a non-synchronized flash rate.

The speaker and speaker strobe appliances shall be designed for indoor surface or flush mounting. The speaker and speaker strobe shall incorporate a speaker mounting plate with a grille cover which is secured with two screws for a level, aesthetic finish and shall mount to standard electrical hardware requiring no additional trimplate or adapter.

The finish of the Series E speakers and strobe speakers shall be white, red, or nickel plate.

All speaker and speaker strobe appliances shall be backward compatible.

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).

Warning:

- Current required by all appliances connected to system secondary power sources.
- Fuse ratings on notification appliance circuits to handle peak currents from all appliances on those circuits.
- Composite flash rate from multiple strobes within a person's field of view.
- Adding, replacing or changing appliances or changing candela settings will affect current draw.
- Recalculate current draw to insure that the total average current and total peak required by all appliances do not exceed the rated capacity of the power sources or fuses.
- The voltage applied to these products must be within their "regulated voltage range".
- Installation of 110 candela strobe products in sleeping areas.
- Installation in office areas and other specification and installation issues.
- Use strobes only on circuits with continuously applied operating voltage. Do not use strobes on coded or interrupted circuits in which the applied voltage is cycled on and off as the strobes may not flash.
- Failure to comply with the installation instructions or general information sheets could result in improper installation, application, 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.
- Conductor size (awg), length and ampacity should be taken into consideration prior to design and installation of these products, particularly in retrofit installations.

Agency Listings and Approvals

- UL Listed: S2652 (Speakers); S2652 / S5391 (Strobe/Speakers)
- California State Fire Marshall: 7320-0785:134 (Speakers); 7125-0785:145 , 7125-0785:152 (Strob/Speakers)
- MEA: 151-92-E Vol. 21

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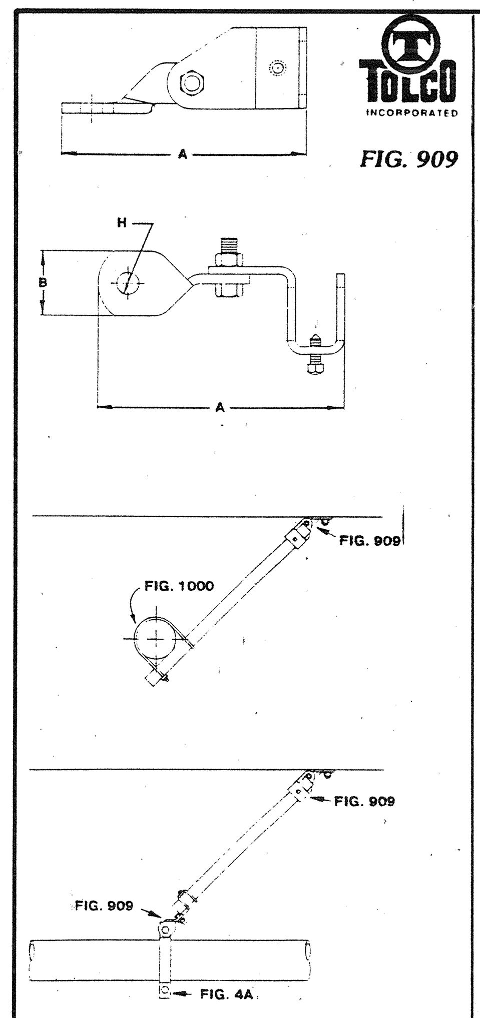
ISO 9001 CERTIFIED
ENGINEERING & MANUFACTURING QUALITY SYSTEMS

This document is not intended to be used for installation purposes.
We try to keep our product information up-to-date and accurate.
We cannot cover all specific applications or anticipate all requirements.
All specifications are subject to change without notice.

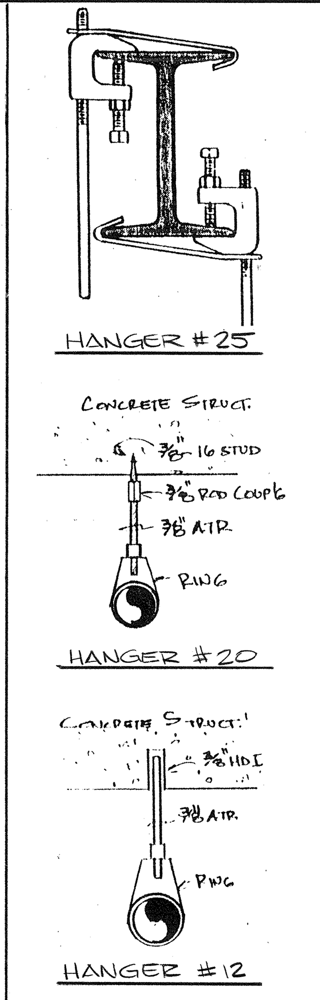
Made in the U.S. A.

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

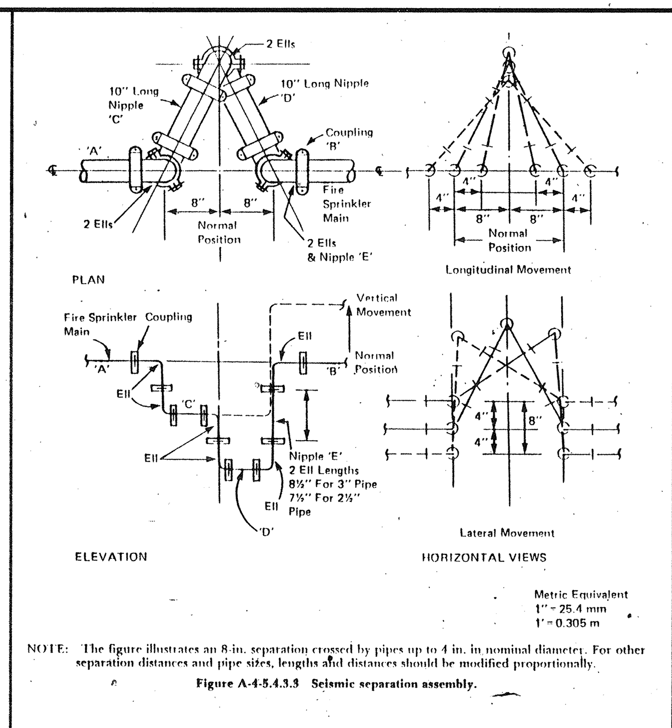
Appendix D - SPRINKLER SYSTEM LAYOUT



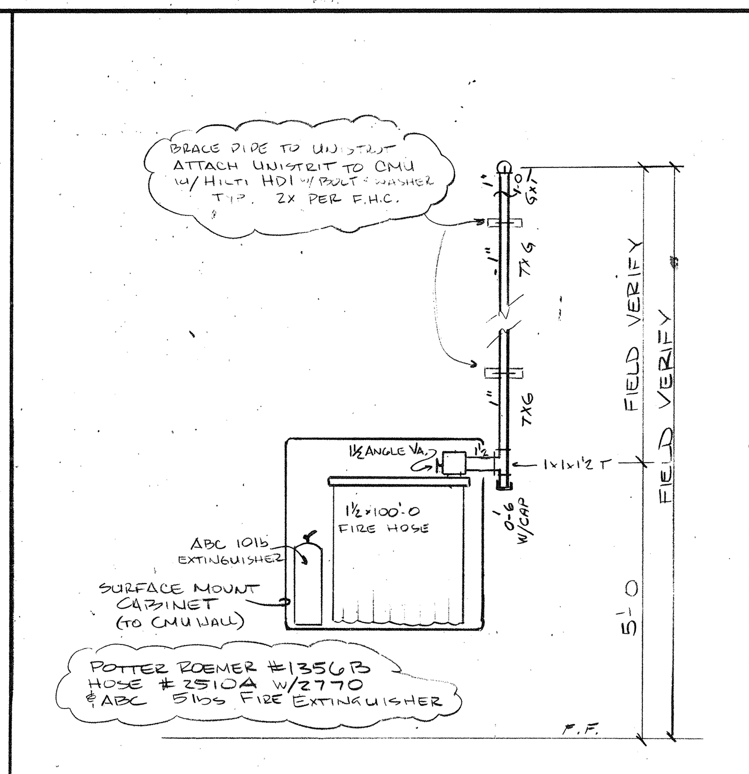
SWAY BRACE DTL.
NTS



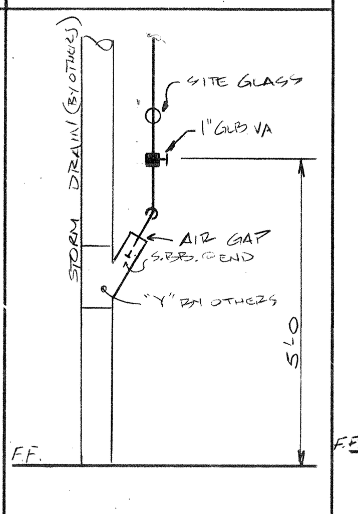
HANGER DETAIL
NTS



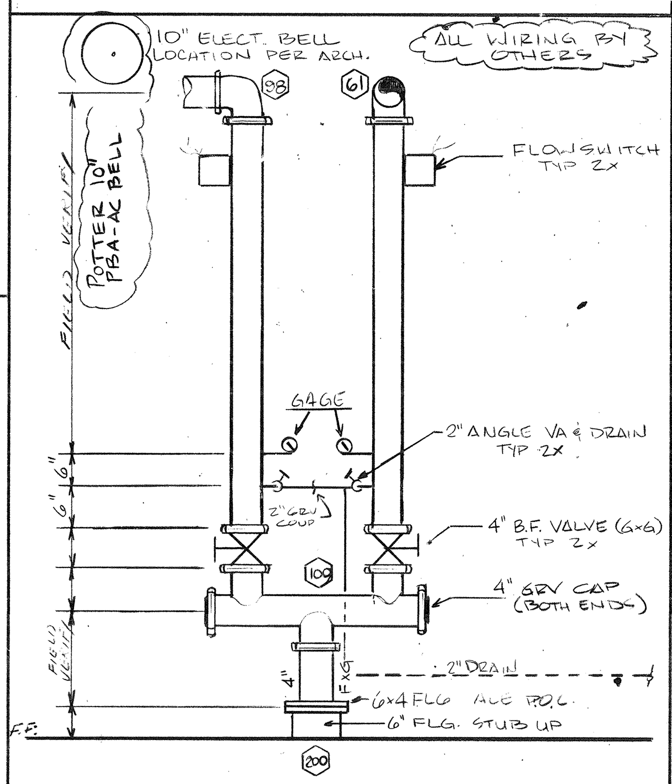
SEISMIC JOINT DETAIL
NTS



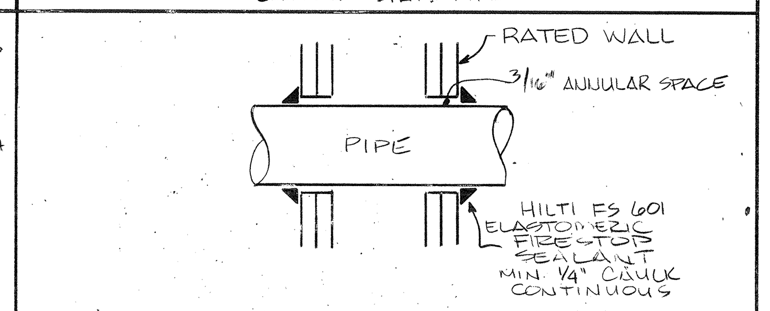
F.H.C. DETAIL
CLASS II STANDPIPE



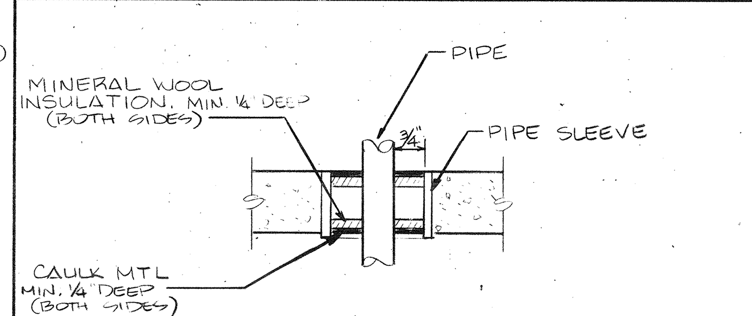
INSPECTORS TEST
NTS



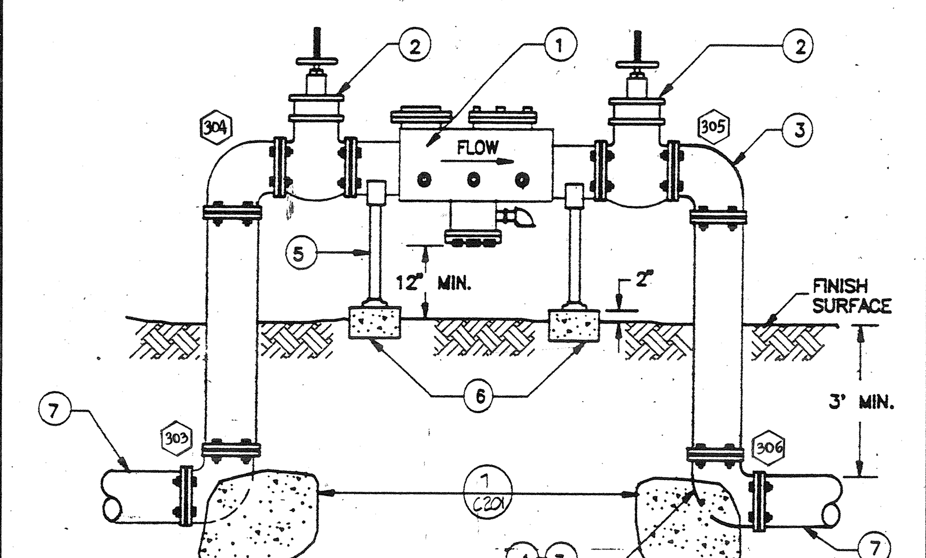
RISER DETAIL
NTS



PIPE THROUGH RATED WALL
U.L. SYSTEM NO. 147
NTS



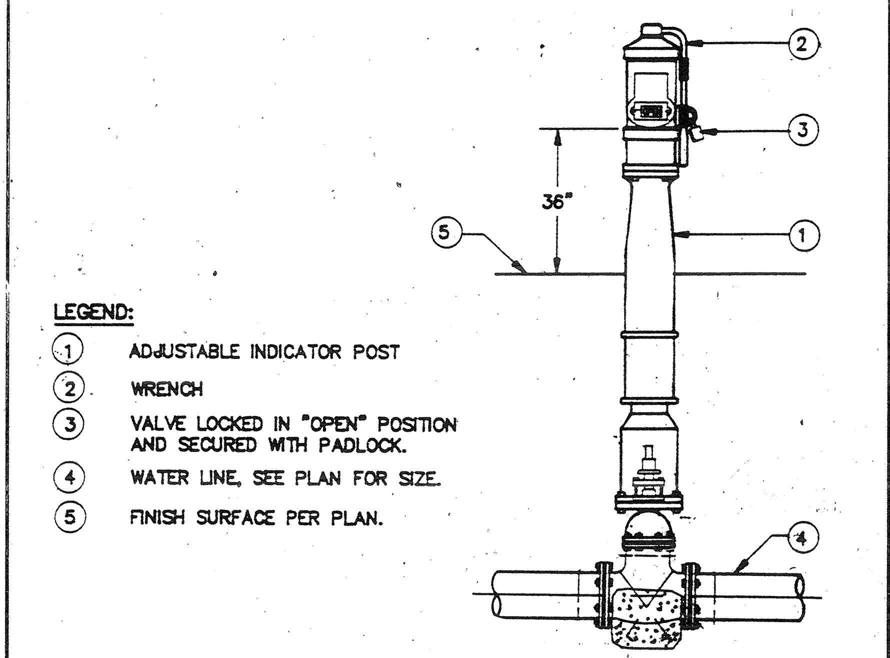
PIPE THROUGH RATED FLOOR
U.L. SYSTEM NO. 268
NTS



LEGEND:

1. REDUCED PRESSURE BACKFLOW DEVICE (SIZE EQUAL TO WATER LINE)
2. O. S. & Y. VALVES (SIZE EQUAL TO WATER LINE)
3. ALL CONNECTIONS ON ASSEMBLY TO BE FLANGED
4. ADAPT INLET AND OUTLET FITTINGS TO MAIN LINE AS REQUIRED
5. APPROVED PIPE SUPPORTS
6. 6"x18"x18" PORTLAND CEMENT CONCRETE BASES
7. SEE PLAN FOR WATER LINE SIZE

BACKFLOW PREVENTER
FOR REFERENCE ONLY
NOT IN ACE CONTRACT

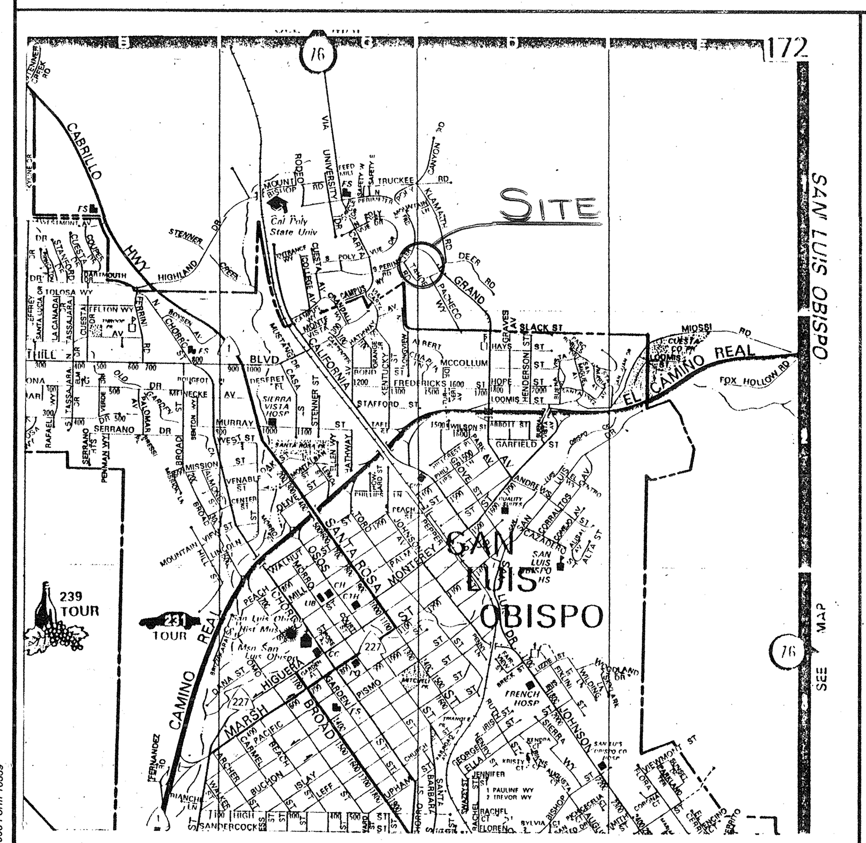


LEGEND:

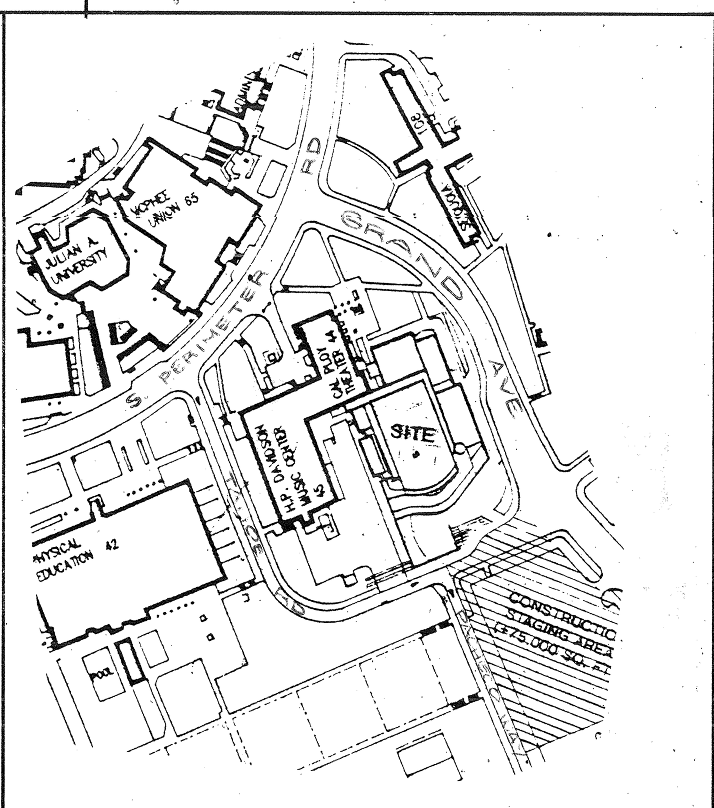
1. ADJUSTABLE INDICATOR POST
2. WRENCH
3. VALVE LOCKED IN "OPEN" POSITION AND SECURED WITH PADLOCK.
4. WATER LINE, SEE PLAN FOR SIZE.
5. FINISH SURFACE PER PLAN.

NOTES:
P.I.V. TO BE REMOTE SENSING TYPE COORDINATE INSTALLATION WITH FIRE/ LIFE SAFETY SYSTEMS.

P.I.V. DETAIL
FOR REFERENCE ONLY
NOT IN ACE CONTRACT



VICINITY MAP
NTS



AREA MAP
NTS

GENERAL NOTES:

1. ALL MATERIALS & INSTALLATION SHALL CONFORM TO NFPA 13 (94ED), AUTHORITIES HAVING JURISDICTION.
2. SWAY BRACING TO BE INSTALLED IN ACCORDANCE WITH NFPA #13. SHT. 9 OF 9
3. ALL UNDERGROUND PIPING & FITTINGS SHALL BE PROPERLY RODDED AND THRUST BLOCKED IN ACCORDANCE WITH NFPA #24. MINIMUM BURY ON UNDERGROUND PIPING SHALL BE 36".
4. ALL PIPE 2" AND SMALLER TO BE SCH. 40
5. ALL PIPE 2 1/2" AND LARGER TO BE SCH. 40
6. LINE FITTINGS TO BE 125lb. CAST IRON OR DUCTILE.
7. MAIN FITTINGS TO BE DUCTILE IRON GROOVED.
8. ALL VALVES TO BE LOCKED IN THE OPEN POSITION W/TAMPERS.
9. CENTRAL STATION MONITORING TO BE PROVIDED BY OTHERS.
10. SYSTEM TO BE HYDROSTATICALLY TESTED AT 200 PSI FOR 2 HOURS.
11. THIS BUILDING TO BE CLASSIFIED AS: LIGHT HAZ. & ORD. HAZ.
12. HYDRAULIC CALCULATION DENSITY TO BE: .10/1500 & .21/1500
13. WATER SUPPLY INFORMATION: STATIC P.S.I = 130; RESIDUAL P.S.I. = 60; FLOW GPM = 1100; PUMP INFO: 90psi @ 750gpm

INFORMATION SOURCE: ACE SPRINKLER CO.

CONSTRUCTION
TYPE 1. FIRE RESISTIVE, FULLY SPRINKLERED

I. OCCUPANCY GROUP
A. MAIN OCCUPANCY LEGITIMATE THEATER WITH OCCUPANCY LOAD GREATER THAN 1,000. — GROUP A, DIVISION 1
B. MINOR OCCUPANCIES
1. CLASSROOMS (LESS THAN 300 OCCUPANTS — GROUP A, DIVISION 3
2. OFFICE SPACE — GROUP B, DIVISION 2
3. REHEARSAL HALL/ THEATER IN THE ROUND — GROUP A, DIVISION 3

II. DESCRIPTION OF USE
THEATER/ CLASSROOM/ REHEARSAL

III. TYPE OF CONSTRUCTION II– FR
FULLY SPRIKLERED

IV. STORIES
3 STORIES W/MEZZANINE
1 BASEMENT

V. HEIGHT –90'-0"

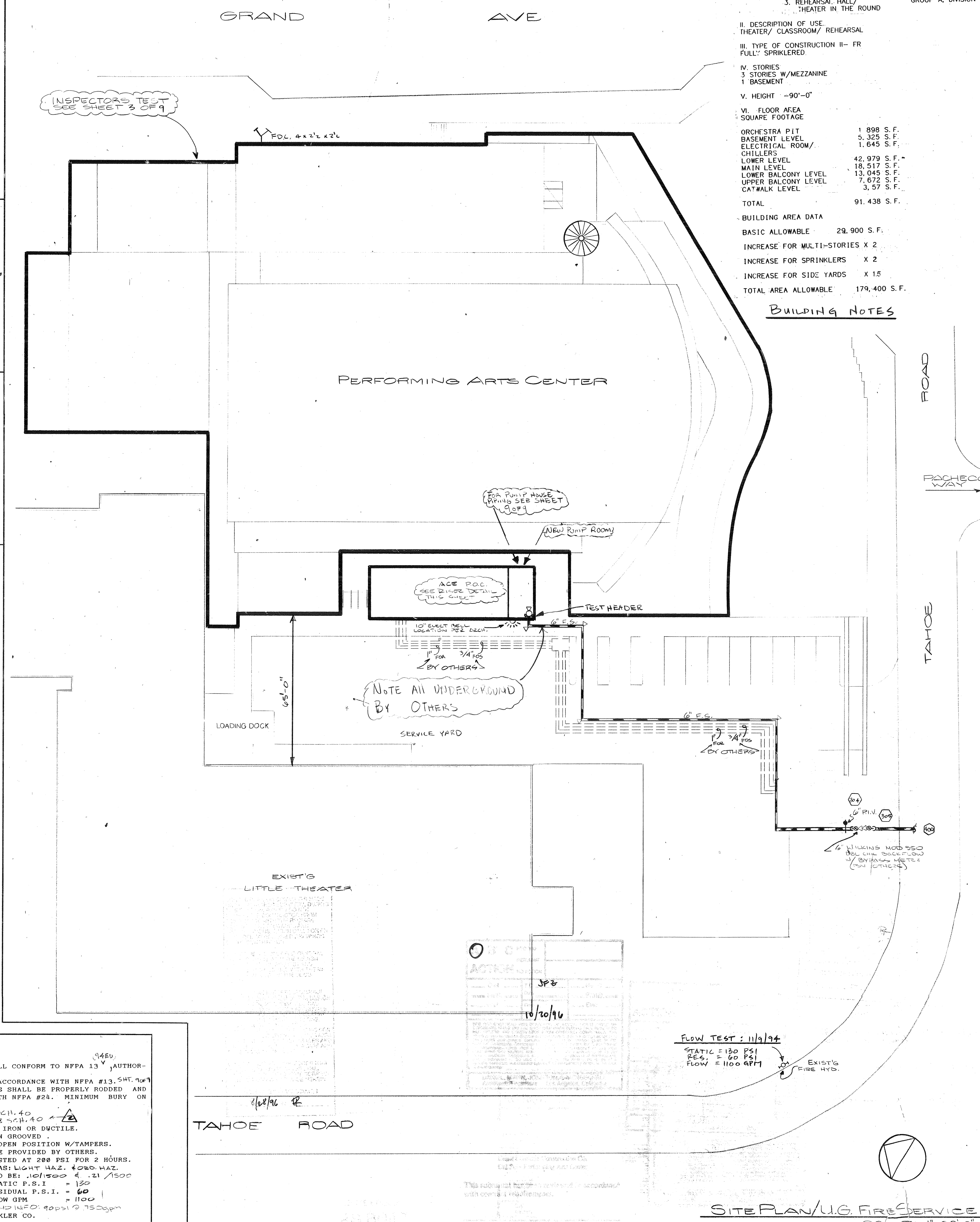
VI. FLOOR AREA
SQUARE FOOTAGE

ORCHESTRA PIT	1 898 S.F.
BASEMENT LEVEL	5,325 S.F.
ELECTRICAL ROOM/ CHILLERS	1,645 S.F.
LOWER LEVEL	42,979 S.F.
MAIN LEVEL	18,517 S.F.
LOWER BALCONY LEVEL	13,045 S.F.
UPPER BALCONY LEVEL	7,672 S.F.
CATWALK LEVEL	3,57 S.F.
TOTAL	91,438 S.F.

BUILDING AREA DATA

BASIC ALLOWABLE	29,900 S.F.
INCREASE FOR MULTI-STORIES	X 2
INCREASE FOR SPRINKLERS	X 2
INCREASE FOR SIDE YARDS	X 1.5
TOTAL AREA ALLOWABLE	179,400 S.F.

BUILDING NOTES



SITE PLAN/ U.G. FIRE SERVICE
SCALE: 1"=20'-0"

AS-BUILT - 2-26-96
Bldg # 06

HANGER NUMBERS AND DESCRIPTIONS

#1	U-Hook	#13	Eye-Rod, Nut And Washer, And Hanger Ring
#2	Wrap-Around U-Hook	#20	Power-Driven Stud For Concrete, Rod-Coupling, Machine-Thread Rod, And Hanger Ring
#3	U-Hook w. Uneven Legs	#21	Pipe-Strap
#4	Threaded U-Bolt	#24	C-Clamp, Machine-Thread Rod, And Hanger Ring
#5	Ceiling Plate, Machine-Thread Rod, And Hanger Ring	#25	Top-Beam Clamp, Machine-Thread Rod, And Hanger Ring
#7	Side Beam Bracket, Machine-Thread Rod, And Hanger Ring		
#9	Double-Nut, Washers, Machine-Thread Rod, And Hanger Ring		
#10	Lag End Rod And Hanger Ring (Rod Button Optional)		
#11	Toggle Wing, Machine-Thread Rod, And Hanger Ring (Rod Button Optional)		
#12	Expansion Shield For Concrete, Machine-Thread Rod, Hanger Ring		

SYMBOLS AND ABBREVIATIONS

GROOVED COUPLING
GROOVED CAP
GROOVED ELBOW
RIGID COUPLING
SCREWED PLUG
SYSTEM RISER
(B/B) BOTTOM OF BEAM TO ℄ OF PIPE
(B/J) BOTTOM OF JOIST (OR PURLIN) TO ℄ OF PIPE
(B/S) BOTTOM OF SHEATHING TO ℄ OF PIPE
( ) ℄ PIPE TO TOP OF STRUCTURE/STEEL

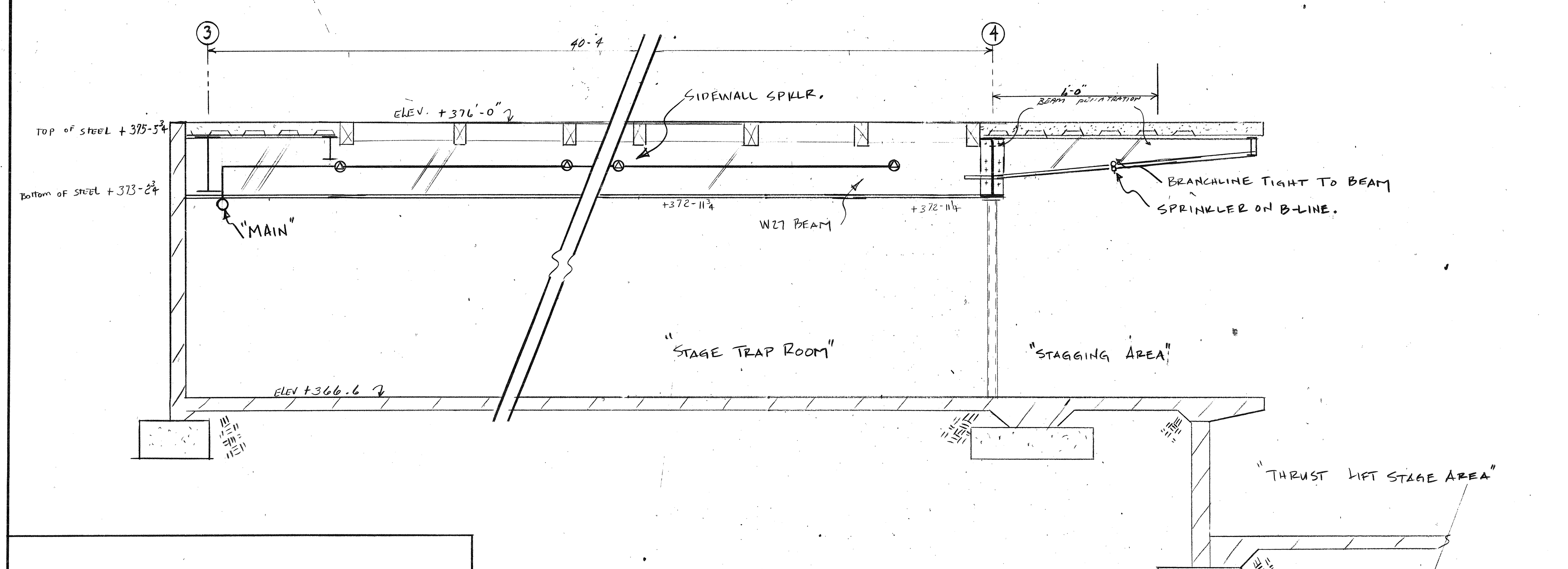
QTY	SYMB	TYPE	TEMP.	FINISH	ORIF.	CANOPY	FINISH

SPRINKLERS

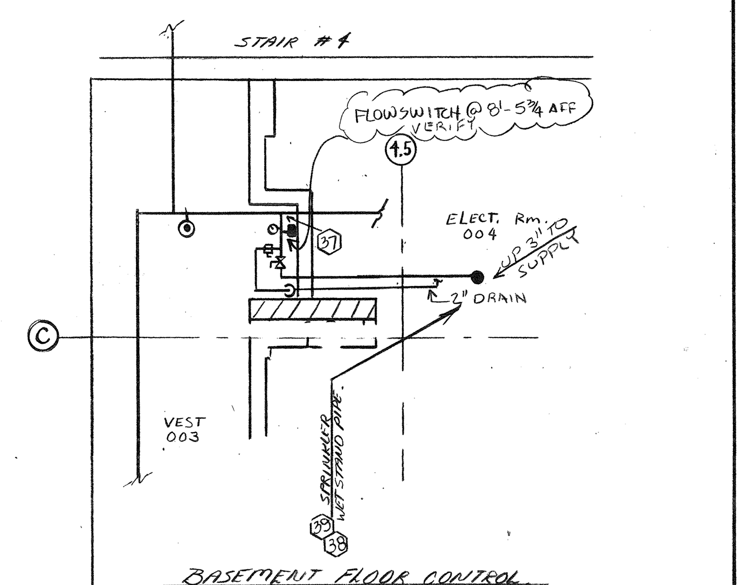
JOB DESCRIPTION
PERFORMING ARTS CENTER
CAL POLY STATE UNIVERSITY
SAN LUIS OBISPO, CA
RECORD DOCUMENTS
SITE PLAN

ACE SPRINKLER COMPANY
Quality by Design
2800 S. Orange Ave. • Fresno, CA 93725 • Ph. 209/441-1235
5880 District Blvd. Ste 25 • Bakersfield, CA 93313 • 805/832-6700
Fire Protection • Contractors and Engineers

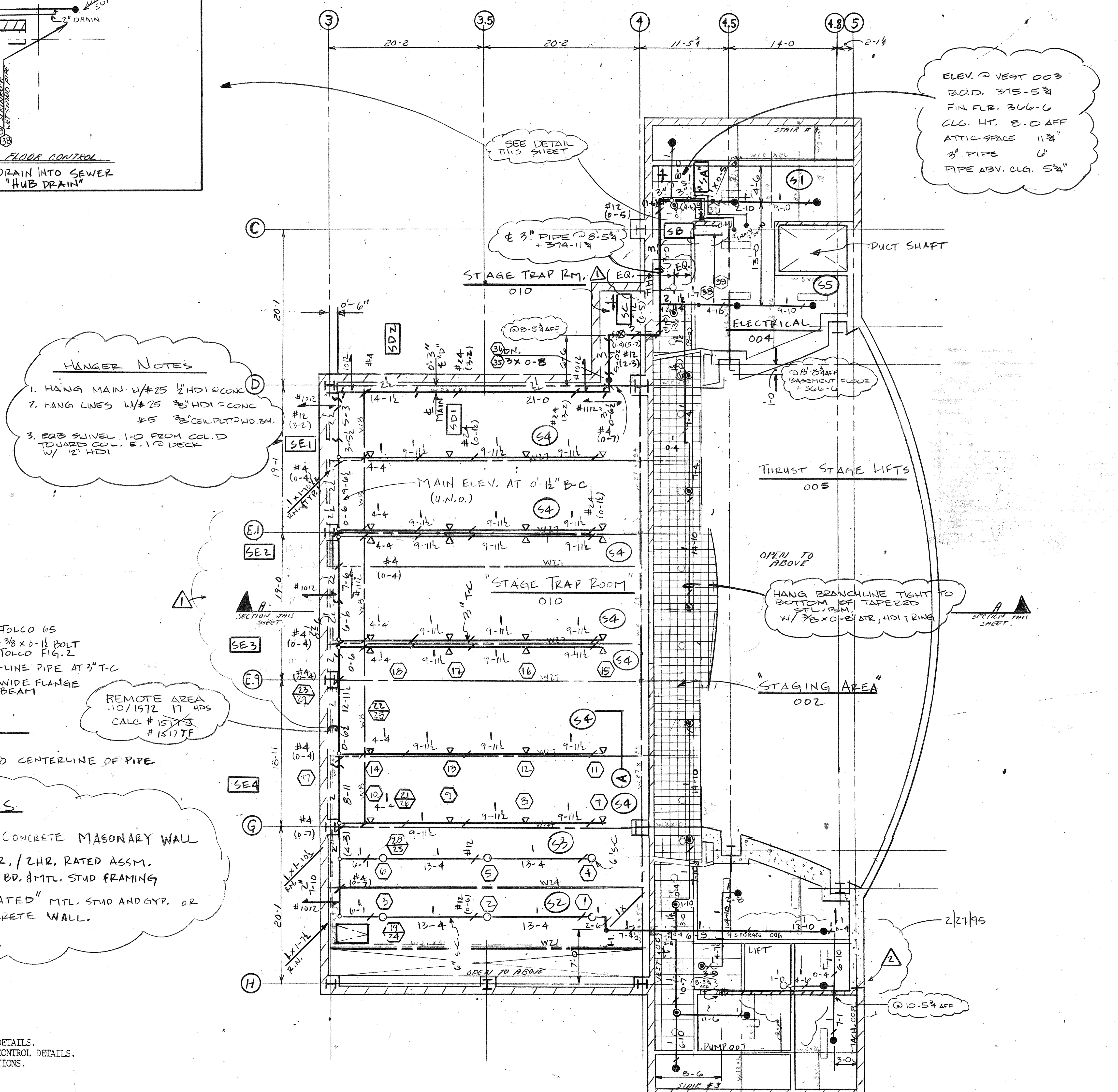
DESIGNED BY: | DATE 6/7/94 | JOB No. 1517
SCALE AS NOTED | SHEET No. 1 OF 9



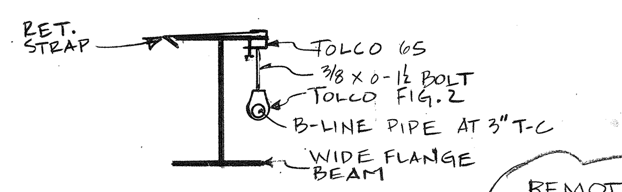
CROSS SECTION A-A
3/8"=1-0



BASEMENT FLOOR CONTROL
TERMINATE DRAIN INTO SEWER PER SHT. P401 "HUB DRAIN"



PIPE UNDER STAGE 1/8"=1'-0"



"A" NO SCALE

"T-C" TOP OF BEAM TO CENTERLINE OF PIPE

WALLS

RATED CONCRETE MASONARY WALL

1 HR. / 2HR. RATED ASSM. GYP. BD. & MTL. STUD FRAMING

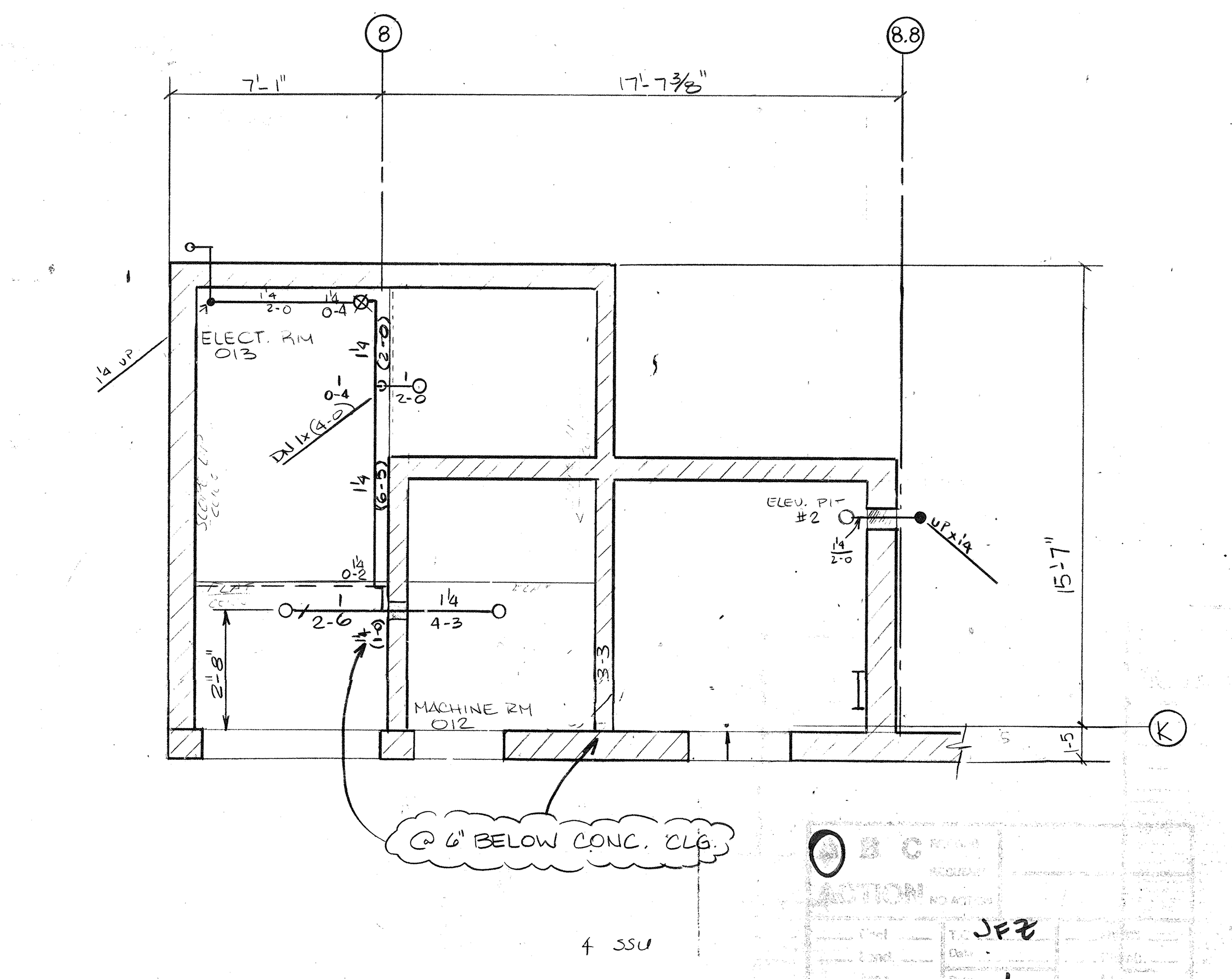
"UNRATED" MTL. STUD AND GYP. OR CONCRETE WALL.

GENERAL NOTES:

- SEE SHEET 1 OF 9 FOR ALL HANGER DETAILS.
- SEE SHEET 7 OF 9 FOR TYP. FLOOR CONTROL DETAILS.
- SEE SHEET 7,8 OF 9 FOR CROSS SECTIONS.

HANGER RODS SIZED PER SMACNA:

2" and smaller	3/8" ATR
2½" to 3½" pipe	1/2" ATR
4" to 5" pipe	5/8" ATR
6" pipe	3/4" ATR
8" pipe	7/8" ATR



BASEMENT FIRE SPRINKLER PLAN
3/8"=1'-0
NORTH

10/20/96

AS-BUILTS 2-26-96

HANGER NUMBERS AND DESCRIPTIONS

REV. 2/22/95
REV. 4/24/95

- #1 U-Hook
- #2 Wrap-Around U-Hook
- #3 U-Hook w/ Uneven Legs
- #4 Threaded U-Bolt
- #5 Ceiling Plate, Machine Thread Rod, And Hanger Ring
- #7 Side Beam Bracket, Machine-Thread Rod, And Hanger Ring
- #9 Double-Nut, Washers, Machine-Thread Rod, And Hanger Ring
- #10 Lag-End Rod And Hanger Ring (Rod Button Optional)
- #11 Toggle-Wing, Machine-Thread Rod, And Hanger Ring (Rod Button Optional)
- #12 Expansion Shield For Concrete, Machine-Thread Rod, Hanger Ring
- #13 Eye-Rod, Nut And Washer, And Hanger Ring
- #20 Power-Driven Stud For Concrete, Rod-Coupling, Machine-Thread Rod, And Hanger Ring
- #21S Pipe-Strap
- #24 C-Clamp, Machine Thread Rod, And Hanger Ring
- #25 Top-Beam Clamp, Machine-Thread Rod, And Hanger Ring

REVISED 7/28/94 RFI 128

SYMBOLS AND ABBREVIATIONS

- GROOVED COUPLING
- GROOVED CAP
- GROOVED ELBOW
- RIGID COUPLING
- SCREWED PLUG
- SYSTEM RISER
- (B-C) BOTTOM OF BEAM TO ℄ OF PIPE
- (J-C) BOTTOM OF JOIST (OR PURLIN) TO ℄ OF PIPE
- (S-C) BOTTOM OF SHEATHING TO ℄ OF PIPE
- [ ] ℄ PIPE TO TOP OF STRUCTURE/STEEL

SPRINKLERS

QTY	SYMB	TYPE	TEMP.	FINISH	ORIF.	CANOPY	FINISH
4	○	VIKING "M" K=5.5 SSU	200°	BRASS	.5	⌀	⌀
8	◉	VIKING "M" K=5.5 SSP	155°	CHROME	.5	REC	CHROME
37	◎	SSU ON SPRIG					
5	▽	VIKING "M" K=5.5 HORIZ. SIDEWALL	155°	BRASS	.5	⌀	⌀
11	●	SSP ON LINE					
1	⊗	SSP ON 1" DROP	200°	BRASS	1/2"	401	CH.

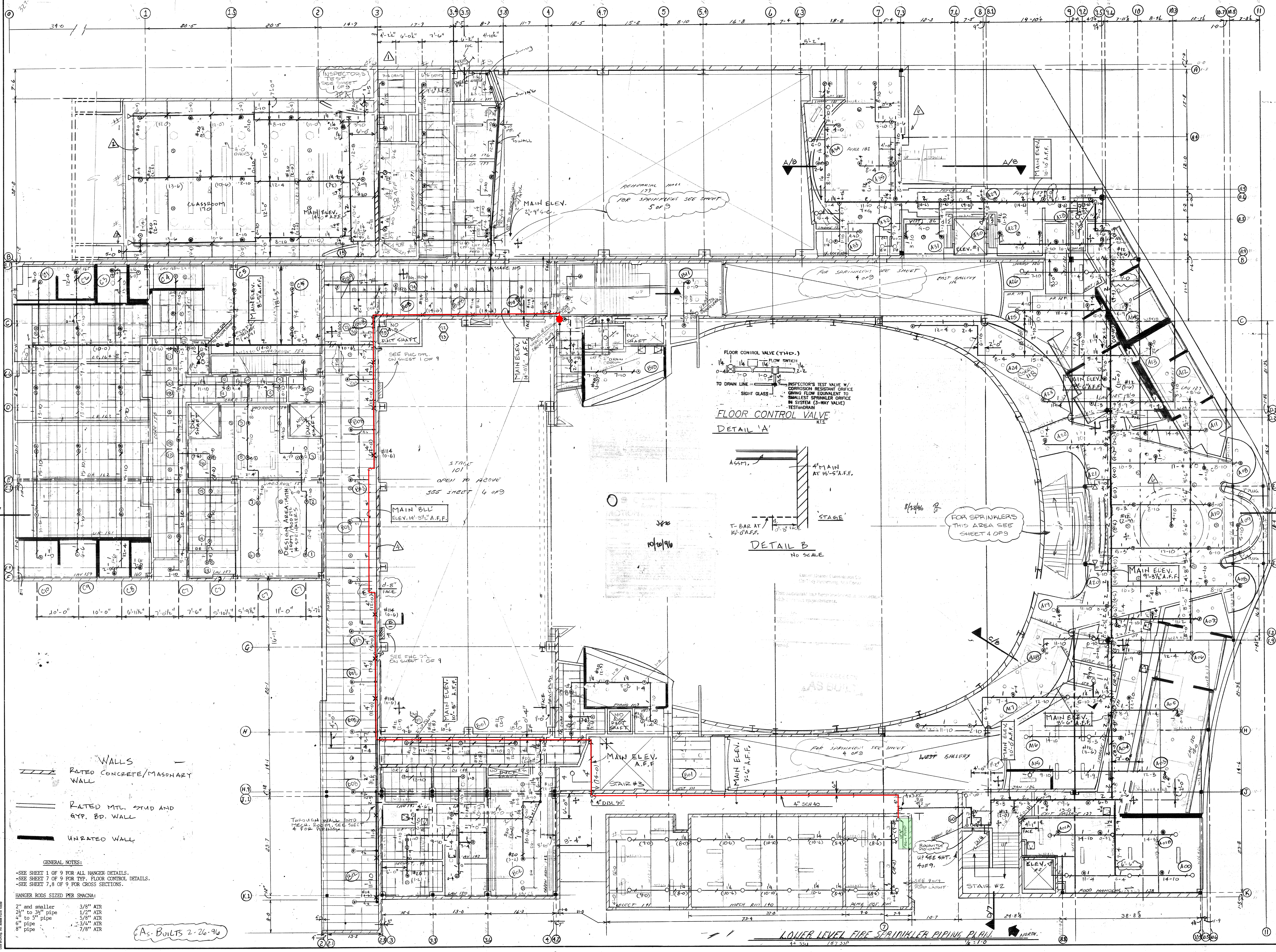
JOB DESCRIPTION

PERFORMING ARTS CENTER
CAL POLY STATE UNIVERSITY
SAN LUIS OBISPO, CALIF.

RECORD DOCUMENTS
BASEMENT LEVEL

ACE SPRINKLER COMPANY
Quality by Design
2803 S. Orange Ave. • Fresno, CA 93725 • Ph. 209/441-1235
5880 District Blvd., Ste 25 • Bakersfield, CA 93313 • 805/832-6700
Fire Protection • Contractors and Engineers

DESIGNED BY:	DATE: 6/7/94	JOB No. 1517
SCALE: AS NOTED		SHEET No. 2 OF 9



WALLS

- Rated concrete/masonary wall
- Rated mtl. stud and gyp. bd. wall
- Unrated wall

GENERAL NOTES:

-SEE SHEET 1 OF 9 FOR ALL HANGER DETAILS.
-SEE SHEET 7 OF 9 FOR TYP. FLOOR CONTROL DETAILS.
-SEE SHEET 7,8 OF 9 FOR CROSS SECTIONS.

HANGER RODS SIZED PER SMACNA:

2" and smaller	3/8" ATR
2½" to 3½" pipe	1/2" ATR
4" to 5" pipe	5/8" ATR
6" pipe	3/4" ATR
8" pipe	7/8" ATR

AS-BUILTS 2-26-96

Océ Bruning, Inc. 80998 Form 10339

HANGER NUMBERS AND DESCRIPTIONS

#1	U-Hook
#2	Wrap-Around U-Hook
#3	U-Hook w/ Uneven Legs
#4	Threaded U-Bolt
#5	Ceiling Plate, Machine Thread Rod, And Hanger Ring
#7	Side Beam Bracket, Machine-Thread Rod, And Hanger Ring
#9	Double-Nut, Washers, Machine-Thread Rod, And Hanger Ring
#10	Lag-End Rod And Hanger Ring (Rod Button Optional)
#11	Toggle-Wing, Machine-Thread Rod, And Hanger Ring (Rod Button Optional)
#12	Expansion Shield For Concrete, Machine-Thread Rod, Hanger Ring
#13	Eye-Rod, Nut And Washer, And Hanger Ring
#20	Power-Driven Stud For Concrete, Rod-Coupling, Machine-Thread Rod, And Hanger Ring
#21S	Pipe-Strap
#24	C-Clamp, Machine Thread Rod, And Hanger Ring
#25	Top-Beam Clamp, Machine-Thread Rod, And Hanger Ring
#114	ANGLE BRAKET W/ THD. U-BOLT.

△1 11/30/94
△2 11/30/94
△3 11/30/94
△4 11/30/94.
△5 11/30/94.
REV. 4/24/95

SYMBOLS AND ABBREVIATIONS

- GROOVED COUPLING
- GROOVED CAP
- GROOVED ELBOW
- RIGID COUPLING
- SCREWED PLUG
- SYSTEM RISER
- (B-C) BOTTOM OF BEAM TO ℄ OF PIPE
- (J-C) BOTTOM OF JOIST (OR PURLIN) TO ℄ OF PIPE
- (S-C) BOTTOM OF SHEATHING TO ℄ OF PIPE
- ℄ PIPE TO TOP OF STRUCTURE-STEEL
- A/8 SECTION A ON SHEET 8 OF 9

SPRINKLERS

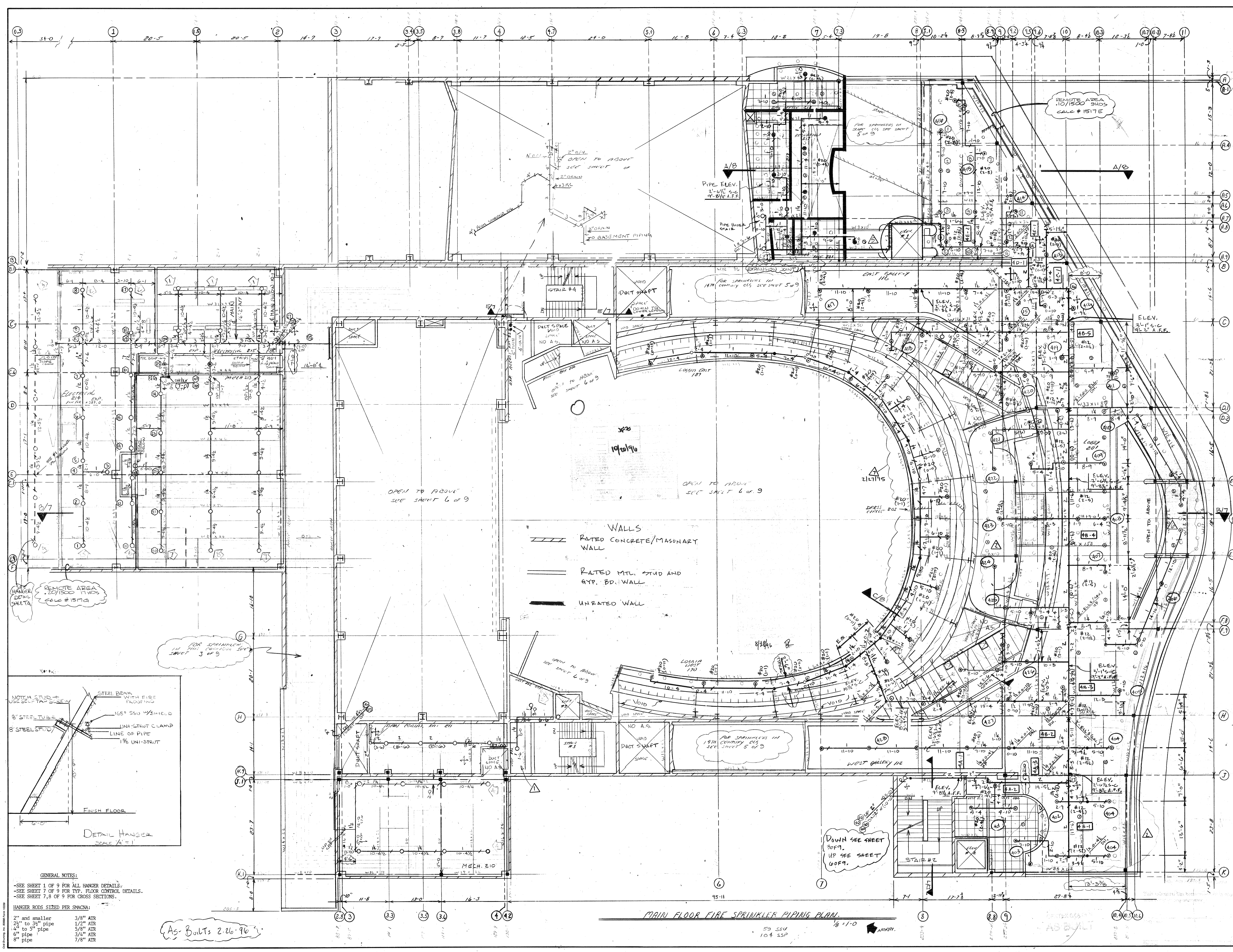
QTY	SYMB	TYPE	TEMP.	FINISH	ORIF.	CANOPY	FINISH
44	○	VIKING "M" K=5.5 SSU	200°	BRASS	.5	∅	∅
187	◎	VIKING "M" K=5.5 SSP	155°	CHROME	.5	REC.	CHROME
17	⋈	VIKING "M" VSW	155°	CH.	.5	401	CH.
248		TOTAL					

JOB DESCRIPTION

PERFORMING ARTS CENTER
CAL POLY STATE UNIVERSITY
SAN LUIS OBISPO, CALIF.
RECORD DOCUMENTS
LOWER LEVEL

ACE SPRINKLER COMPANY
Quality by Design
2803 S. Orange Ave. • Fresno, CA 93725 • Ph. 209/441-1235
5880 District Blvd., Ste 25 • Bakersfield, CA 93313 • 805/832-6700
Fire Protection • Contractors and Engineers Lic. No. 389388

DESIGNED BY: KEN GOULD
DATE: 6/7/94
JOB No. 1517
SHEET No. 3 OF 9
SCALE: AS NOTED



GENERAL NOTES:

-SEE SHEET 1 OF 9 FOR ALL HANGER DETAILS.
-SEE SHEET 7 OF 9 FOR TYP. FLOOR CONTROL DETAILS.
-SEE SHEET 7,8 OF 9 FOR CROSS SECTIONS.

HANGER RODS SIZED PER SMACNA:

2" and smaller	3/8" ATR
2½" to 3½" pipe	1/2" ATR
4" to 5" pipe	5/8" ATR
6" pipe	3/4" ATR
8" pipe	7/8" ATR

JOB DESCRIPTION

PERFORMING ARTS CENTER
CAL POLY STATE UNIVERSITY
SAN LUIS OBISPO, CALIF.

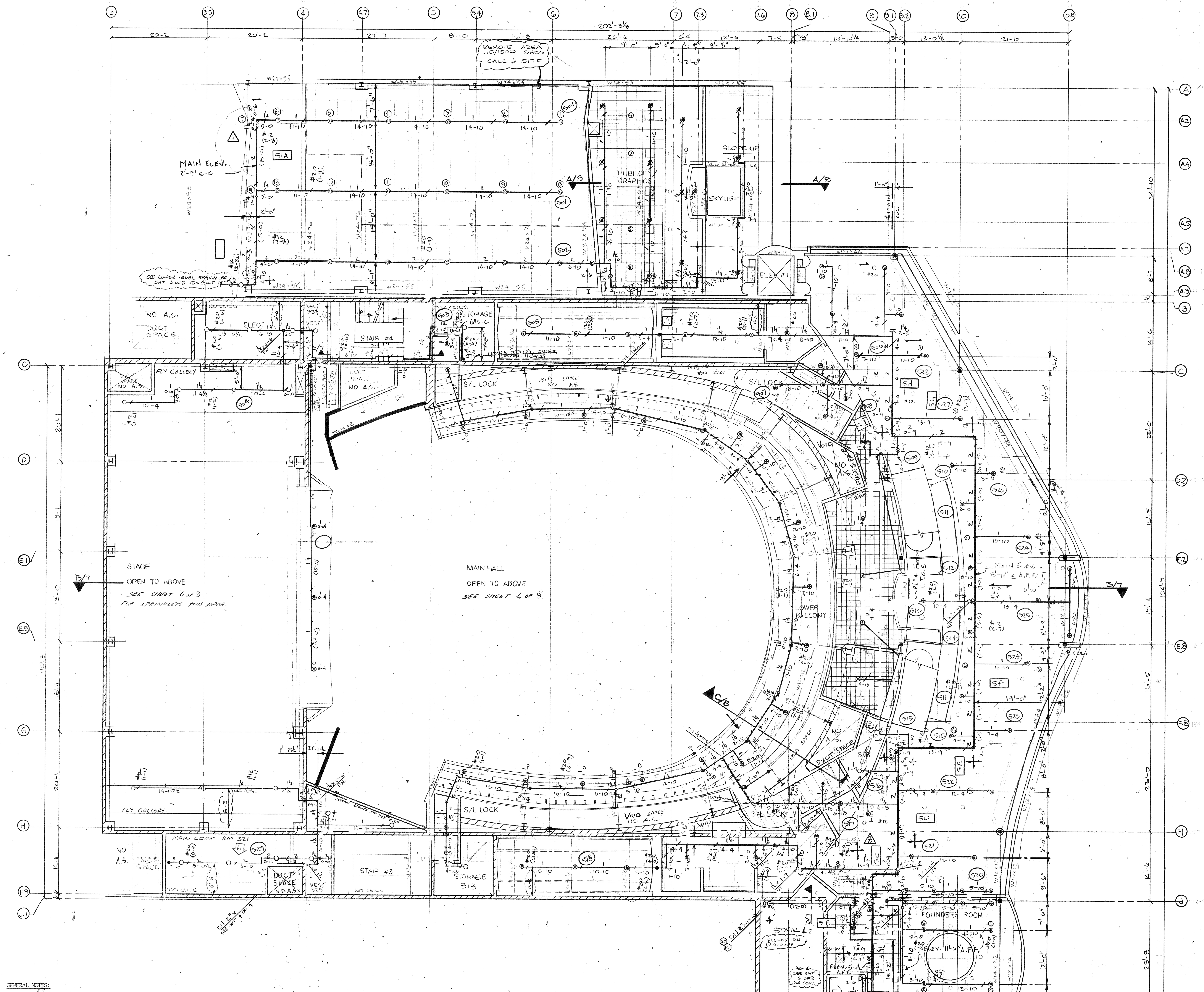
RECORD DOCUMENTS

MAIN LEVEL.

ACE SPRINKLER COMPANY
Quality by Design
2803 S. Orange Ave. • Fresno, CA 93725 • Ph. 209/441-1235
5880 District Blvd., Ste 25 • Bakersfield, CA 93313 • 805/832-6700
Fire Protection • Contractors and Engineers Lic. No. 389308

DESIGNED BY: Ken Guido DATE: 6/7/94 JOB No. 1517
SCALE: AS NOTED SHEET No. 4 OF 9

Océ Bruning, Inc. 80998 Form 10339



WALLS

RATED CONCRETE/MASONARY WALL

RATED MTL. STUD AND GYP. BD. WALL

UNRATED WALL

GENERAL NOTES:

-SEE SHEET 1 OF 9 FOR ALL HANGER DETAILS.
-SEE SHEET 7 OF 9 FOR TYP. FLOOR CONTROL DETAILS.
-SEE SHEET 7,8 OF 9 FOR CROSS SECTIONS.

HANGER RODS SIZED PER SMACNA:

2" and smaller	3/8" ATR
2½" to 3½" pipe	1/2" ATR
4" to 5" pipe	5/8" ATR
6" pipe	3/4" ATR
8" pipe	7/8" ATR

LOWER BALCONY FIRE SPRINKLER PIPING PLAN. 1/8" = 1'-0"

NORTH.

(As-BUILTS 2-26-96)

HANGER NUMBERS AND DESCRIPTIONS

#1	U-Hook
#2	Wrap-Around U-Hook
#3	U-Hook w/ Uneven Legs
#4	Threaded U-Bolt
#5	Ceiling Plate, Machine Thread Rod, And Hanger Ring
#6	Side Beam Bracket, Machine-Thread Rod, And Hanger Ring
#7	Double-Nut, Washers, Machine-Thread Rod, And Hanger Ring
#9	Lag End Rod And Hanger Ring (Rod Button Optional)
#11	Toggle Wing, Machine-Thread Rod, And Hanger Ring (Rod Button Optional)
#12	Expansion Shield For Concrete, Machine-Thread Rod, Hanger Ring
#13	Eye-Rod, Nut And Washer, And Hanger Ring
#20	Power-Driven Stud For Concrete, Rod-Coupling, Machine-Thread Rod, And Hanger Ring
#21S	Pipe-Strap
#24	C-Clamp, Machine Thread Rod, And Hanger Ring
#25	Top Beam Clamp, Machine Thread Rod, And Hanger Ring

SYMBOLS AND ABBREVIATIONS

GROOVED COUPLING
GROOVED CAP
GROOVED ELBOW
RIGID COUPLING
SCREWED PLUG
SYSTEM RISER
(B-B) BOTTOM OF BEAM TO ℄ OF PIPE
(J-C) BOTTOM OF JOIST (OR PURLIN) TO ℄ OF PIPE
(S-C) BOTTOM OF SHEATHING TO ℄ OF PIPE
(T-C) ℄ PIPE TO TOP OF STRUCTURE/STEEL
A/B SECTION A ON SHEET B OF 9

SPRINKLERS

QTY	SYMB	TYPE	TEMP.	FINISH	ORIF.	CANOPY	FINISH
22	○	VIKING "M" K-5.5 SSU	200°	BRASS	.5	∅	∅
103	●	VIKING "M" K-5.5 SSP W/ DROP	155°	CHROME	.5	REC	CHROME
19	⊗	SSP ON LINE					
16	∅	VIKING MOD. QUICK RESPONSE	155°	CHR	.5	REC	CHR
C.R.	149						
177		TOTAL					

JOB DESCRIPTION

PERFORMANCE ARTS CENTER
CAL POLY STATE UNIVERSITY
SAN LUIS OBISPO, CALIF.

RECORD DOCUMENTS
LOWER BALCONY

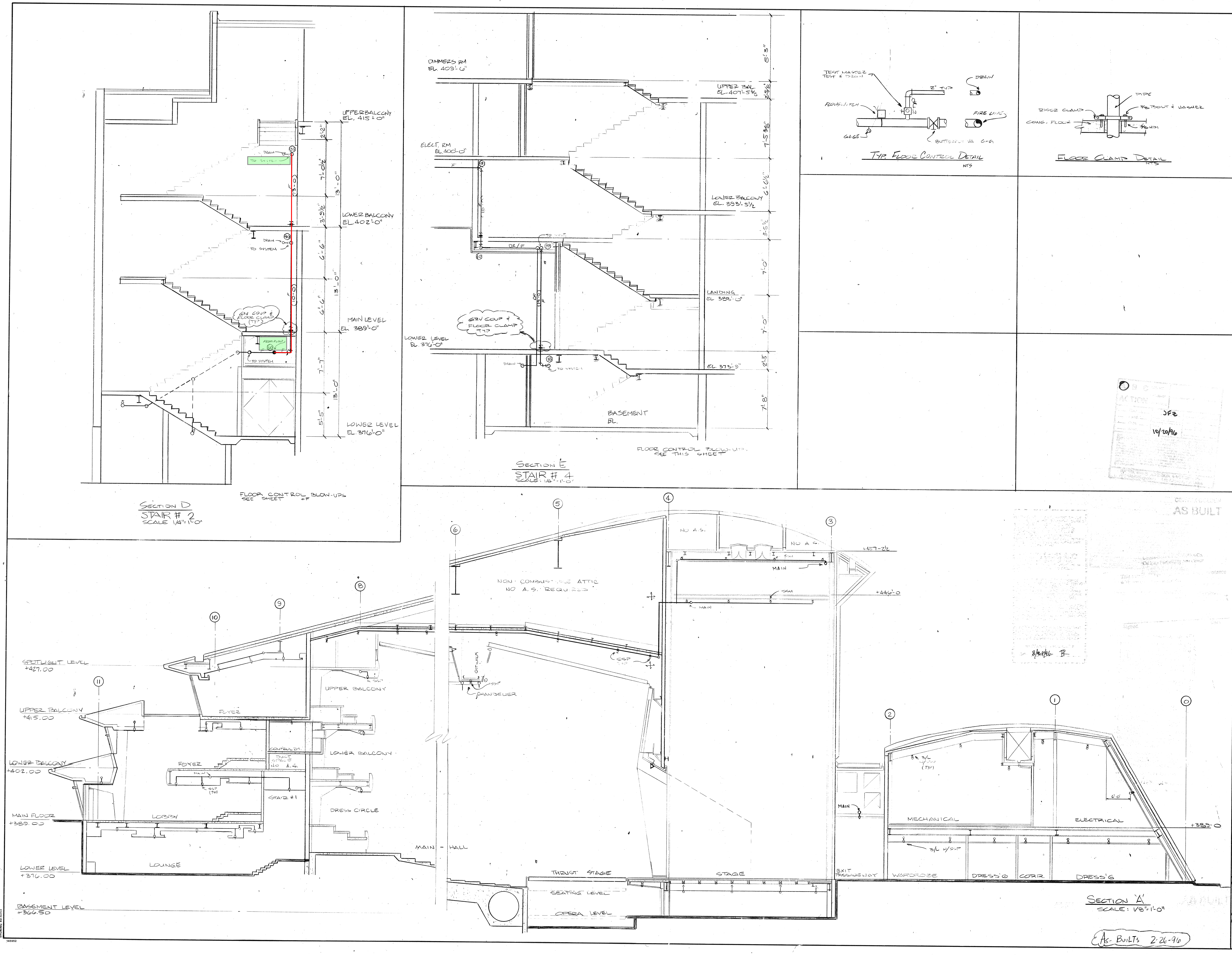
ACE SPRINKLER COMPANY
Quality by Design
2803 S. Orange Ave. • Fresno, CA 93725 • Ph. 209/441-1235
5880 District Blvd., Ste 25 • Bakersfield, CA 93313 • 805/832-6700
Fire Protection • Contractors and Engineers   Lic. No. 389308

DESIGNED: Ken Gould   DATE: 6/7/94   JOB No. 1517   SHEET No. 5 OF 9

△ 11/30/94.

Océ Bruning, Inc. 80998 Form 10339

WALLS
RATED CONCRETE/MASONARY WALL
RATED MTL. STUD AND GYP. BD. WALL
UNRATED WALL
FOR SPRINKLERS THIS AREA SEE UPPER BALCONY PLAN THIS SHEET
MAIN C-BLUE
MAIN B-RED
MAIN A-WHITE
REMOTE AREA .21/1500 17HDS. CALC # 1517C
HANG MAIN TIGHT TO W36 BEAM W/#20×(1-2) TO CONCRETE DECK
BL4
BL3
BL2
BL1
GENERAL NOTES:
-SEE SHEET 1 OF 9 FOR ALL HANGER DETAILS.
-SEE SHEET 7 OF 9 FOR TYP. FLOOR CONTROL DETAILS.
-SEE SHEET 7,8 OF 9 FOR CROSS SECTIONS.
HANGER RODS SIZED PER SPMACNA:
2" and smaller 3/8" ATR
2½" to 3½" pipe 1/2" ATR
4" to 5" pipe 5/8" ATR
6" pipe 3/4" ATR
8" pipe 7/8" ATR
CATWALK LEVEL SPRINKLERS 1/8" = 1'-0
UPPER BALCONY SPRINKLERS 1/8" = 1'-0
STAGE
NO A.S.
DUCT SPACE
DOWN SEE SHEET 4 OF 9 FOR CONT.
AS-BUILTS 2-26-96
HANGER NUMBERS AND DESCRIPTIONS
SYMBOLS AND ABBREVIATIONS
SPRINKLERS
JOB DESCRIPTION
PERFORMING ARTS CENTER
CAL POLY STATE UNIVERSITY
SAN LUIS OBISPO, CALIF.
RECORD DOCUMENTS
UPPER BALCONY
CATWALK LEVEL.
ACE SPRINKLER COMPANY
Quality by Design
2803 S. Orange Ave. • Fresno, CA 93725 • Ph. 209/441-1235
5880 District Blvd., Ste 25 • Bakersfield, CA 93313 • 805/832-6700
Fire Protection • Contractors and Engineers Lic. No. 389308
DESIGNED KEN GOULD
DATE: 11/16/94
JOB No. 1517
SHEET No. 6 OF 9



HANGER NUMBERS AND DESCRIPTIONS

#1	U-Hook
#2	Wrap-Around U-Hook
#3	U-Hook w/ Uneven Legs
#4	Threaded U-Bolt
#5	Ceiling Plate, Machine Thread Rod, And Hanger Ring
#7	Side Beam Bracket, Machine-Thread Rod, And Hanger Ring
#9	Double-Nut, Washers, Machine-Thread Rod, And Hanger Ring
#10	Lag-End Rod And Hanger Ring (Rod Button Optional)
#11	Toggle-Wing, Machine-Thread Rod, And Hanger Ring (Rod Button Optional)
#12	Expansion Shield For Concrete, Machine-Thread Rod, Hanger Ring
#13	Eye-Rod, Nut And Washer, And Hanger Ring
#20	Power-Driven Stud For Concrete, Rod-Coupling, Machine-Thread Rod, And Hanger Ring
#21S	Pipe-Strap
#24	C-Clamp, Machine Thread Rod, And Hanger Ring
#25	Top-Beam Clamp, Machine-Thread Rod, And Hanger Ring

SYMBOLS AND ABBREVIATIONS

GROOVED COUPLING
GROOVED CAP
GROOVED ELBOW
RIGID COUPLING
SCREWED PLUG
SYSTEM RISER

(B-C) BOTTOM OF BEAM TO ℄ OF PIPE
(J-C) BOTTOM OF JOIST (OR PURLIN) TO ℄ OF PIPE
(S-C) BOTTOM OF SHEATHING TO ℄ OF PIPE
[ ] ℄ PIPE TO TOP OF STRUCTURE/STEEL

SPRINKLERS

QTY	SYMB	TYPE	TEMP.	FINISH	ORIF.	CANOPY	FINISH

JOB DESCRIPTION

PERFORMING ARTS CENTER
CAL POLY STATE UNIVERSITY
SAN LUIS OBISPO, CA
RECORD DOCUMENTS
CROSS SECTIONS

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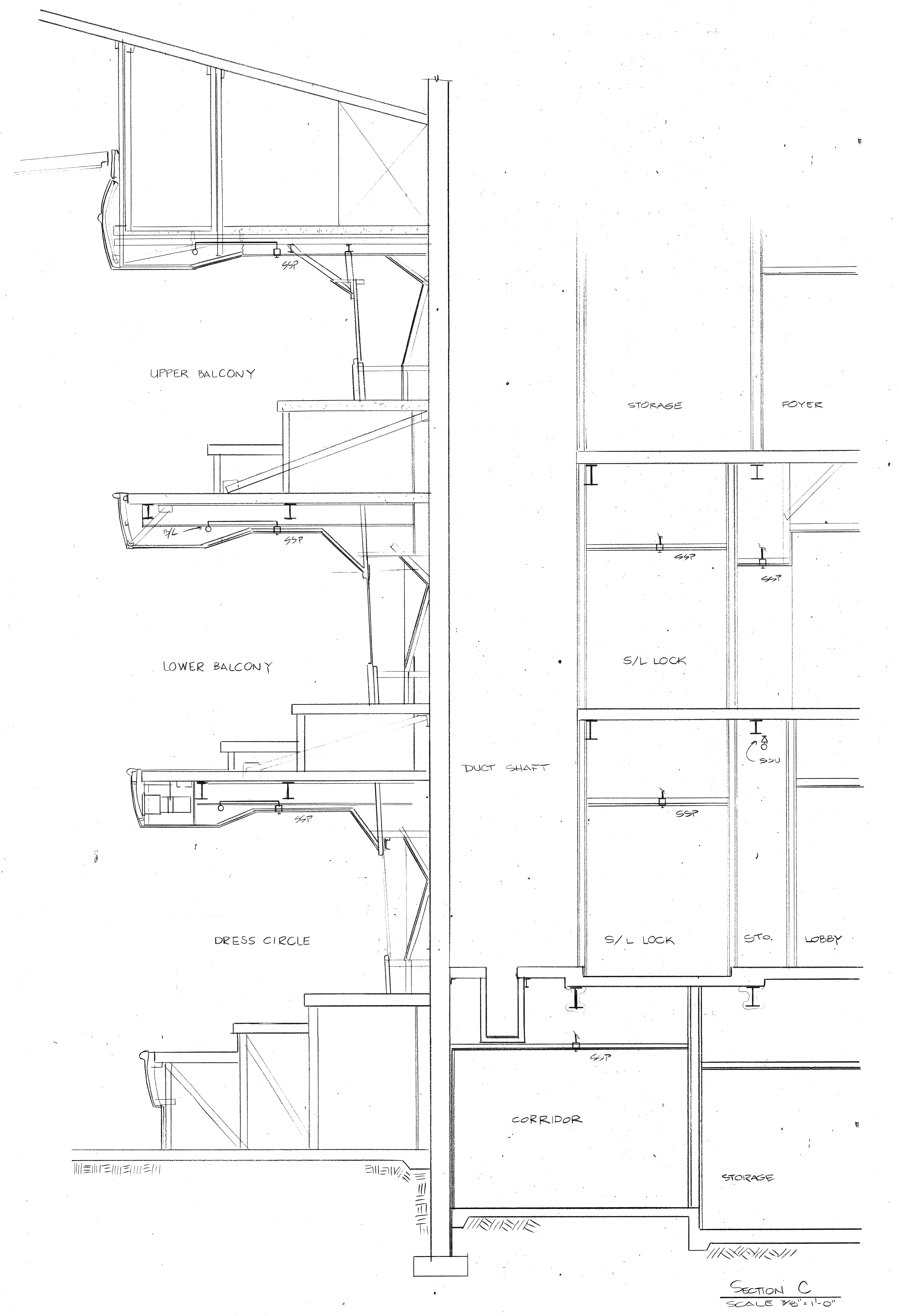
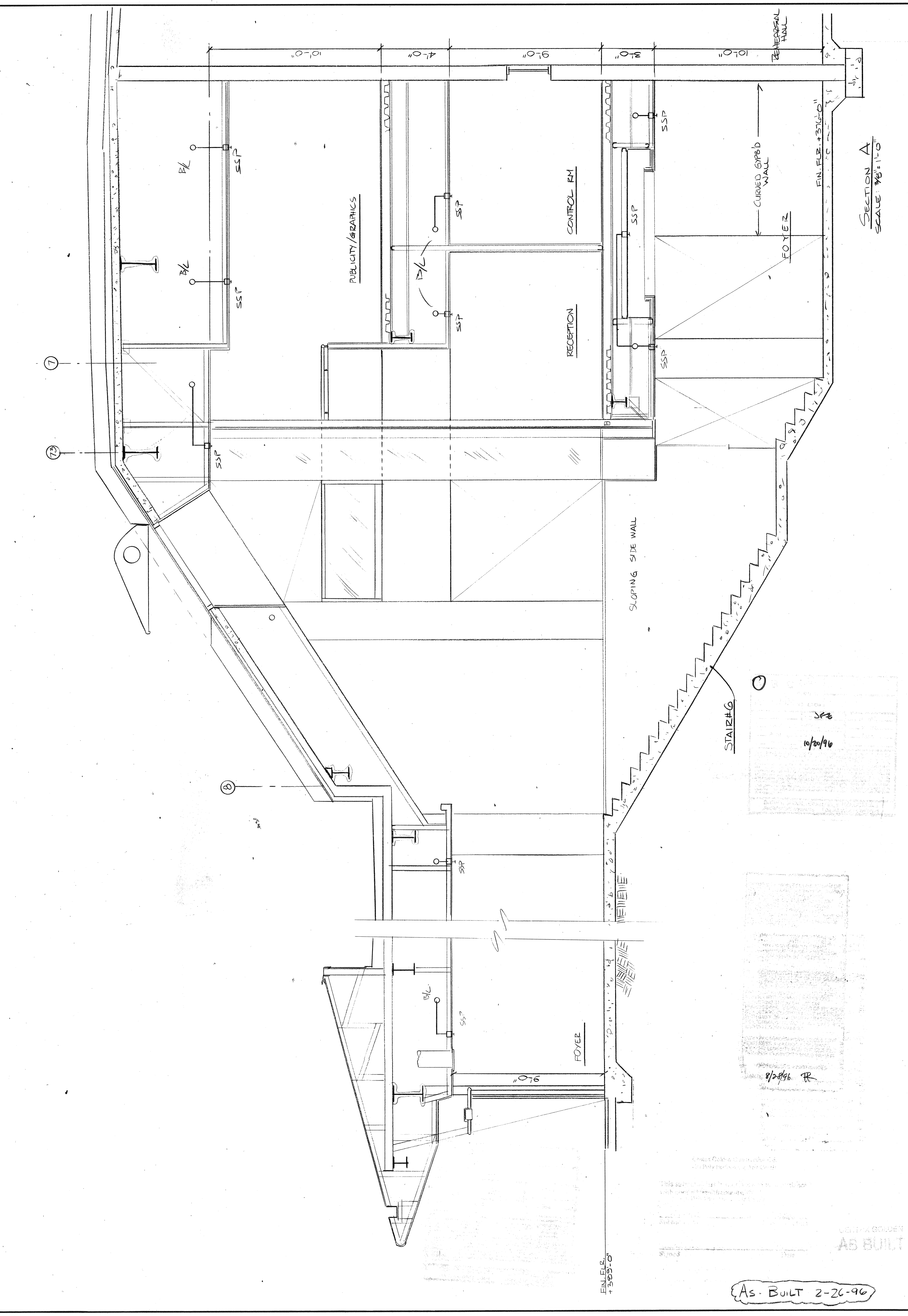
5880 District Blvd. Ste 12 • Bakersfield, CA 93313 • 805/832-6700
Fire Protection • Contractors and Engineers

JOB No. 1517
DATE 6/7/94
SHEET No. 7 of 9
SCALE AS NOTED





SYMBOLS AND ABBREVIATIONS

- GROOVED COUPLING
- GROOVED CAP
- GROOVED ELBOW
- RIGID COUPLING
- SCREWED PLUG
- SYSTEM RISER
- (B-C) BOTTOM OF BEAM TO ℄ OF PIPE
- (J-C) BOTTOM OF JOIST (OR PURLIN) TO ℄ OF PIPE
- (S-C) BOTTOM OF SHEATHING TO ℄ OF PIPE
- [ ] ℄ PIPE TO TOP OF STRUCTURE/STEEL

HANGER NUMBERS AND DESCRIPTIONS

- #1 U-Hook
- #2 Wrap-Around U-Hook
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- #4 Threaded U-Bolt
- #5 Ceiling Plate, Machine Thread Rod, And Hanger Ring
- #7 Side Beam Bracket, Machine-Thread Rod, And Hanger Ring
- #9 Double-Nut, Washers, Machine-Thread Rod, And Hanger Ring
- #10 Lag-End Rod And Hanger Ring (Rod Button Optional)
- #11 Toggle-Wing, Machine-Thread Rod, And Hanger Ring (Rod Button Optional)
- #12 Expansion Shield For Concrete, Machine-Thread Rod, Hanger Ring
- #13 Eye-Rod, Nut And Washer, And Hanger Ring
- #20 Power-Driven Stud For Concrete, Rod-Coupling, Machine-Thread Rod, And Hanger Ring
- #21S Pipe-Strap
- #24 C-Clamp, Machine Thread Rod, And Hanger Ring
- #25 Top-Beam Clamp, Machine-Thread Rod, And Hanger Ring

		SPRINKLERS					
QTY	SYMB	TYPE	TEMP.	FINISH	ORIF.	CANOPY	FINISH

JOB DESCRIPTION

Performing Arts Center
Cal Poly State University
San Luis Obispo, Ca
Record Documents
Cross Sections

ACE SPRINKLER COMPANY
Quality by Design
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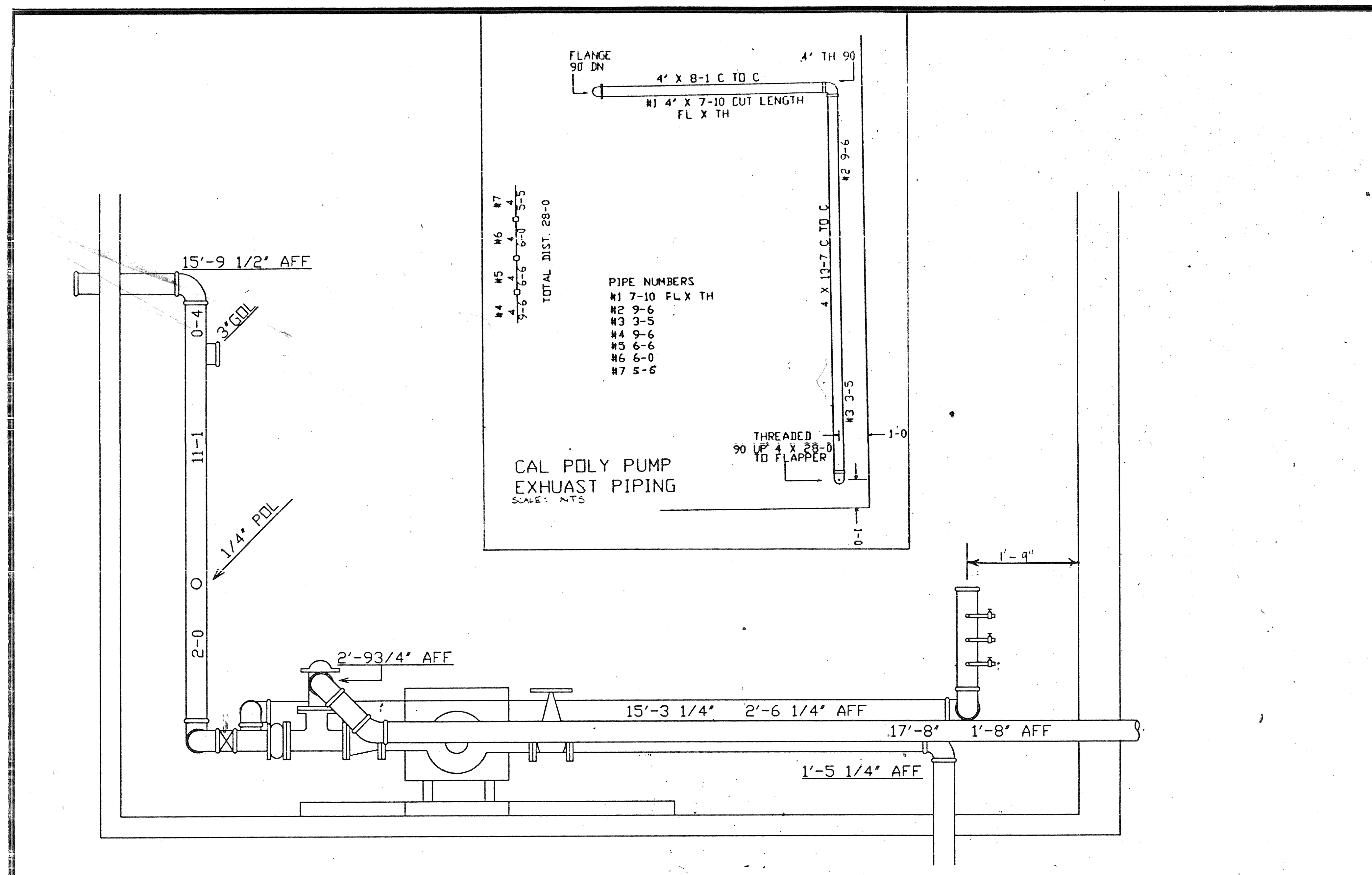
5880 District Blvd., Ste 25 • Bakersfield, CA 93313 • 805/832-6700
Fire Protection • Contractors and Engineers *Lic. No. 389308*

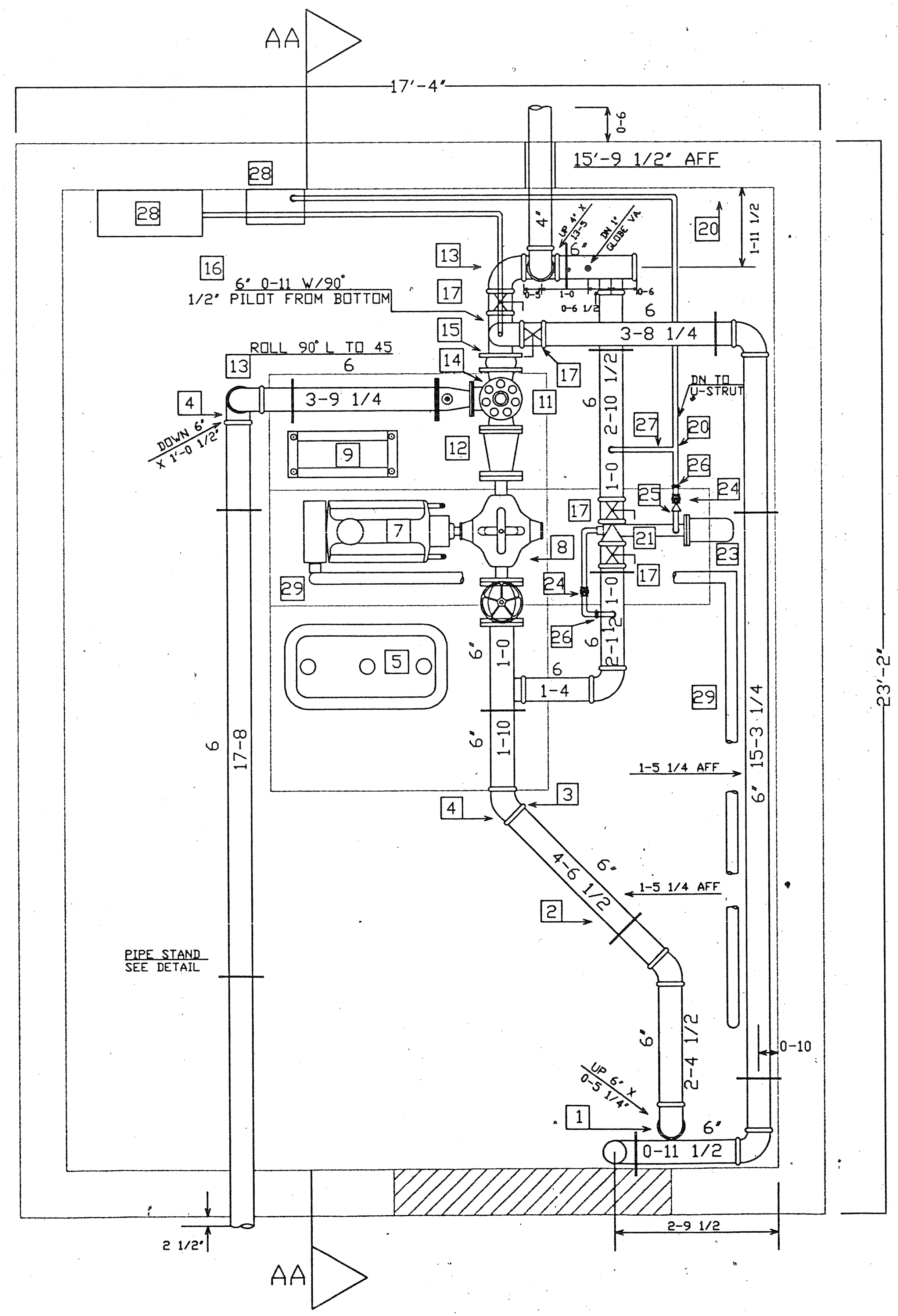
DESIGNED BY: Ken Gould DATE: 6/7/94 JOB No. 1517
SCALE: As Noted SHEET No. 8 OF 9

06-66-64

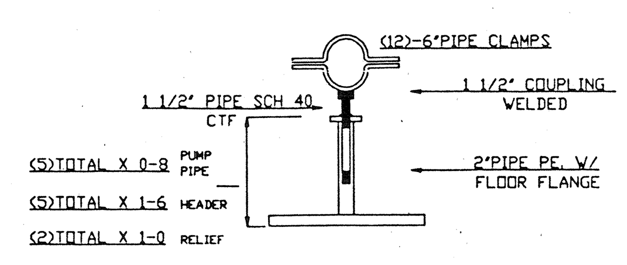


SECTION AA CROSS SECTION DETAIL

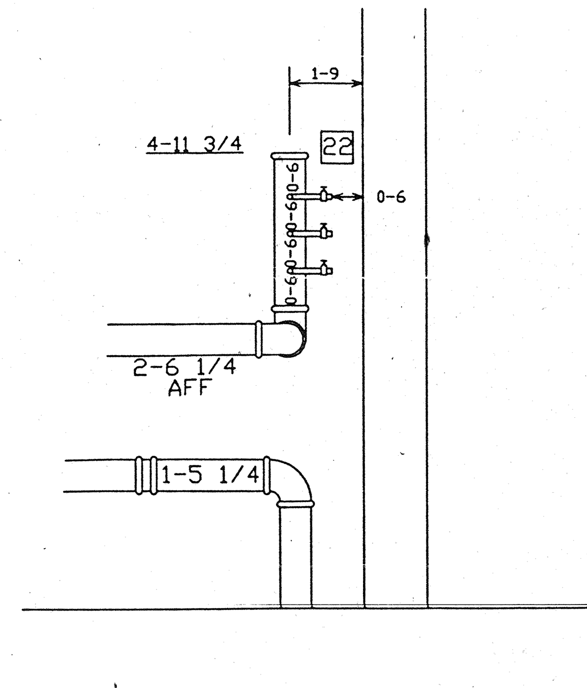
SCALE = NTS



PUMP PLAN SCALE: 1/2"=1'



PIPE STAND DETAIL SCALE= NTS

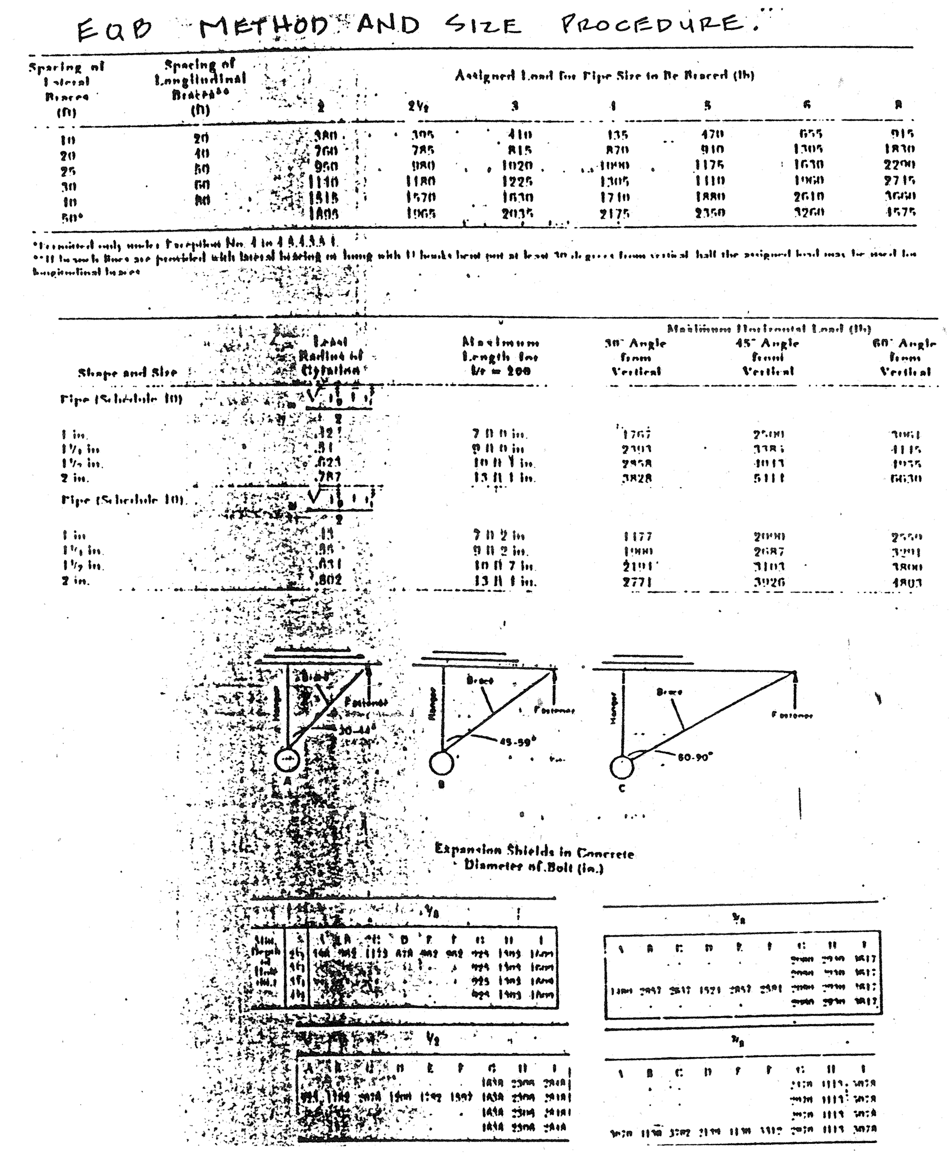


HEADER DETAIL SCALE= NTS

FIRE PUMP ROOM SCHEDULE

1. 6" STUB UP FROM SUPPLY (GROOVED END PIPE)
2. 6" PUMP SUPPLY 1'-5 1/4" AFF
3. 6" GROOVED VICTAULIC STYLE 75 STANDARD COUPLING (TYP)
4. 6" GROOVED VICTAULIC FIRELOCK 45 L (TYP)
5. DIESEL FUEL TANK (BY OTHERS)
6. 6" FL. OS & Y VALVE
7. 62 HP 1760 RPM CLARKE DIESEL ENGINE
8. PATTERSON 750 G.P.M. 6x5 LISTED FIRE PUMP
9. BATTERY RACK W/2-12 V BATTERIES
10. 5" x 6" CONCENTRIC DISCHARGE INCREASER
11. AMES MODEL A820-UL 4" FIRE PUMP RELIEF VA.
12. 4" x 6" ENCLOSED WASTE CONE
13. 6" GROOVED VICTAULIC FIRELOCK 90 L (TYP)
14. 6" x 6" x 4" FLANGED TEE
15. 6" WAFER CHECK VALVE
16. 6" x 0'-11" FL x GR SPOOL WITH 6" G.O.L. UP & 1/2" POL DN
17. 6" GROOVED VICTAULIC BFV W/TAMPER
18. 4" FEED AT 15'- 9 1/2
19. 1/2" COPPER LINE TO MAIN PUMP CONTROLLER
20. 1/2" COPPER LINE TO JOCKEY PUMP CONTROLLER
21. 6" GR. CHECK VA. VICTAULIC
22. 6" TEST HEADER W/3- 2 1/2 HOSE VALVES P.R. #4315 W/CAPS #4625
23. STA-RITE 1 HP 115/230 11 GPM JOCKEY PUMP
24. 1 1/4 OS&Y
25. 1 1/4 BRASS CHECK VALVE
26. 1 1/4 UNION
27. 1 1/4 JOCKEY PUMP PIPING - 0-8" A.F.F.
28. PRESSURE SENSING LINE TO MERCOID SWITCH (SEE NFPA DETAIL)
29. 4" EXHAUST PIPING

EQB METHOD AND SIZE PROCEDURE.



A-7-5.2.1 Installation of the pressure-sensing line in between the discharge check valve and the control valve is necessary to facilitate isolation of the jockey pump controller (and sensing line) for maintenance without having to drain the entire system. [See Figures A-7-5.2.1(a) and (b).]

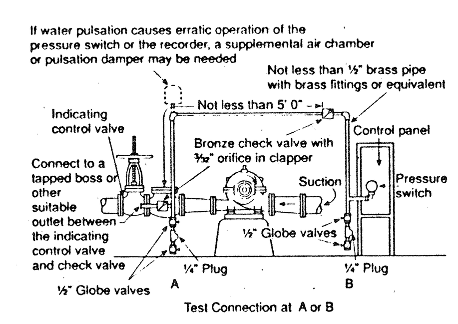


Figure A-7-5.2.1(a) Piping connection for each automatic pressure switch (for fire pump and jockey pumps).

For SI Units: 1 in. = 25.4 mm; 1 ft = 0.3048 m.

NOTE: Solenoid drain valve used for engine-driven fire pumps may be at A, B, or inside of controller enclosure.

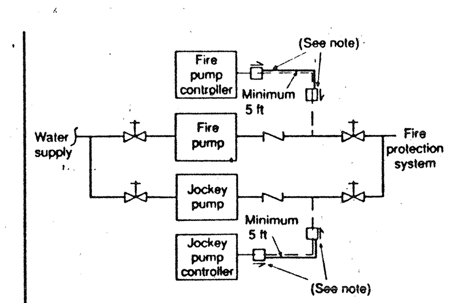
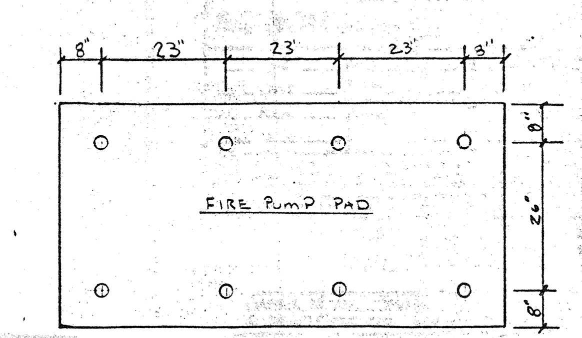


Figure A-7-5.2.1(b) Piping connection for pressure-sensing line.

For SI Units: 1 in. = 25.4 mm; 1 ft = 0.3048 m.

NOTE: Three check valves or ground-face unions complying with 7-5.2.1.

ANCHOR BOLT PLAN SCALE= 1/2" = 1'



8/29/96 IR

JPB

10/21/96

AS BUILTS - 2-26-96

REV. △ 1-16-96 EXHAUST PIPING

HANGER NUMBERS AND DESCRIPTIONS

SYMBOLS AND ABBREVIATIONS

SPRINKLERS

QTY	SYMB	TYPE	TEMP	FINISH	ORIF.	CANOPY	FINISH

ACE SPRINKLER
QUALITY BY DESIGN

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2803 S. Orange Ave. Fresno CA. 93725 ph. 209-441-1235
Fire Protection @ Contracters and Enginners Lic. 389308

DATE: 12-11-95	DESIGNED BY: IGNACIO REYES	JOB NO. 1702
SCALE: AS NOTED	CAD FILE NO. PUMP.DWG	SHEET NO. 9 of 9

JOB DESCRIPTION

CALPOLY
PUMP ROOM PLAN

PERFORMING ARTS CENTER
CAL POLY STATE UNIVERSITY
SAN LUIS OBISPO.CA.

RECORD DOCUMENTS

#G6-64-01

Appendix E - HYDRAULIC CALCULATION

Project name:	Christopher Cohan Center													Date:	16.02.2017	
Step No.	Nozzle Ident and Location		Flow in gpm		Pipe size Actual (ID)	Pipe Fittings and Devices	Equivalent Pipe Length		Friction loss (psi/ft)		Pressure Summary		Normal Pressure		C = 120 K = 5.5 D = 0.2	
1	2	BL1	q	18,6			L	1,00	C=	120,00	Pt	11,48			A =	93,16
					1,61	T-8	F	8,00			Pe	0,43			q =	A * D
			Q	18,6			T	9,00	pf	0,01	Pf	0,13			P =	(Q/k)^2
2			q				L		C=		Pt	12,04				P2 = 11.60
							F				Pe					
			Q				T		pf		Pf					
3	1	BL1	q	16,1		90 elbow	L	7,17	C=	120,00	Pt	8,53				
					1,61	T-8	F	10,00			Pe				q =	A * D
			Q	16,1			T	17,17	pf	0,01	Pf	0,18			P =	(Q/k)^2
4	1	BL1	q	18,9			L	11,21	C=	120,00	Pt	8,72			k = Q/sqrt(P)	
					1,61		F				Pe				k =	5,44
			Q	37,5			T	11,21	pf	0,05	Pf	0,58			q =	k * p(2)^0.5
5	4	BL1	q	19,5			L	0,33	C=	120,00	Pt	12,62				
					1,61	T-8	F	8,00			Pe	0,14			q =	k * p^0.5
			Q	57,0			T	8,33	pf	0,11	Pf	0,94				
6			q				L		C=		Pt	14,28				P4 = 13.09
							F				Pe					
			Q				T	0,00	pf		Pf					
7	3	BL1	q	16,1		90 elbow	L	7,17	C=	120,00	Pt	8,53			A =	80,33
					1,61	T-8	F	10,00			Pe				q =	A * D
			Q	16,1			T	17,17	pf	0,01	Pf	0,18			P =	(Q/k)^2
8	3	BL1	q	20,8			L	7,17	C=	120,00	Pt	8,72			k3 = Q(3)/sqrt(P(3))	
					1,61	T-8	F	8,00			Pe				k3 =	5,5
			Q	77,8			T	15,17	pf	0,20	Pf	3,03			q3 =	k * p(4)^0.5
9	6	BL1	q	22,9			L	0,33	C=	120,00	Pt	17,30				
					1,38	T-8	F	8,00			Pe	0,14			q =	k * p^0.5
			Q	100,7			T	8,33	pf	0,68	Pf	5,67				
10			q				L		C=	120,00	Pt	26,15				
							F				Pe					
			Q				T	0,00	pf		Pf					
11	5	BL1	q	15,7			L	7,00	C=	120,00	Pt	8,14			A =	78,46
					1,38	T-8	F	8,00			Pe				q =	A * D
			Q	15,7			T	15,00	pf	0,02	Pf	0,33			P =	(Q/k)^2
12	5	BL1	q	28,1			L	11,21	C=	120,00	Pt	8,47			k5 = Q(5)/sqrt(P(6))	
					1,38	T-8	F	8,00			Pe				k5 =	5,5
			Q	128,8			T	19,21	pf	1,07	Pf	20,63			q5 =	k * p(6)^0.5
13	8	BL1	q	37,6			L	0,33	C=	120,00	Pt	46,77				
					1,38	T-6	F	6,00			Pe	0,14			q =	k * p^0.5
			Q	166,4			T	6,33	pf	1,73	Pf	10,93				
14			q				L		C=		Pt	78,47				
							F				Pe					
			Q				T		pf		Pf					
15	7	BL1	q	16,1			L	7,17	C=	120,00	Pt	8,53			A =	80,33
					1,38	T-6	F	6,00			Pe				q =	A * D
			Q	16,1			T	13,17	pf	0,02	Pf	0,30			P =	(Q/k)^2
16			q	48,7			L	7,17	C=	120,00	Pt	8,83			k7 = Q(7)/sqrt(P(8))	
	7	CM			1,38	T-6	F	6,00			Pe				k7 =	5,5
			Q	215,2			T	13,17	pf	2,77	Pf	36,52			q7 =	k * p(8)^0.5
17			q				L		C=		Pt	**45,35**			K_{eq} = Q/Pt^(1/2)	
	K_{eq} (BL1)						F				Pe				**K_{eq}**	**31,95**
			Q	**215,2**			T		pf		Pf					
18	1	BL2	q	24,9			L	12,88	C=	120,00	Pt	20,56			A =	124,69
					1,38	T-6	F	6,00			Pe	0,43			q =	A * D
			Q	24,9			T	18,88	pf	0,05	Pf	0,97			P =	(Q/k)^2
19	2	BL2	q	25,8			L	11,88	C=	120,00	Pt	21,96				
					1,38		F				Pe				q = k * P^0.5	
			Q	50,7			T	11,88	pf	0,19	Pf	2,27				
20	3	BL2	q	27,1			L	10,88	C=	120,00	Pt	24,24				
					1,38		F				Pe				q = k * P^0.5	
			Q	77,8			T	10,88	pf	0,42	Pf	4,59				

21		q	29,5			L	0,33	C=	120,00	Pt	28,83				
	4 CM			1,38	T-6	F	6,00			Pe				q = k * P^0.5	
		Q	107,3			T	6,33	pf	0,77	Pf	4,85				
22		q				L		C=		Pt	**33,68**			k_{eq} = Q/Pt^(1/2)	
	K_{eq} (BL2)					F				Pe				**k_{eq}**	**23,58**
		Q	**136,9**			T		pf		Pf					
23		q				L		C=		Pt				k_{eq} (BL3) = k_{eq} (BL2)	
	K_{eq} (BL3)					F				Pe				**k_{eq}**	**23,58**
		Q				T		pf		Pf					
24	1 BL4	q	22,1			L	0,33	C=	120,00	Pt	16,07			A =	110,25
				1,38	T-6	F	6,00			Pe				q =	A * D
		Q	22,1			T	6,33	pf	0,04	Pf	0,26			P =	(Q/k)^2
25		q				L		C=		Pt	16,33			k_{eq} = Q/Pt^(1/2)	
	K_{eq} (BL4)					F				Pe				**k_{eq}**	**5,46**
		Q	**22,1**			T		pf		Pf					
26	BL1	q				L	8,25	C=	120,00	Pt	45,35				
	CM TO			3,068	T-15	F	15,00			Pe					
	BL2	Q	215,2			T	23,25	pf	0,06	Pf	1,32				
27	BL2	q	161,1			L	10,50	C=	120,00	Pt	46,67			k (BL2) = 23.58	
	CM TO			3,068	T-15	F	15,00			Pe				q = k(BL2) * P^0.5	
	BL3	Q	376,3			T	25,50	pf	0,16	Pf	4,06				
28	BL3	q	168,0			L	10,50	C=	120,00	Pt	50,74			k (BL3) = 23.58	
	CM TO			3,068	T-15	F				Pe				q = k(BL3) * P^0.5	
	BL4	Q	544,2			T	10,50	pf	0,32	Pf	3,31				
29	BL3	q	40,1			L	36,75	C=	120,00	Pt	54,05			k (BL4) = 5.46	
	CM TO			3,068	2*T-15	F	30,00			Pe				q = k(BL4) * P^0.5	
	RISER	Q	584,4			T	77,25	pf	0,36	Pf	27,79				
30	Down to	q			7 *T-20	L	372,50	C=	120,00	Pt	81,84				
	base of			4,026	13 *90	F	270,00			Pe	18,40			Pe = 0,433*42.5	
	riser	Q	584,4			T	642,50	pf	0,10	Pf	61,54				
31	Demand	q				L		C=		Pt	**161,78**				
	at base of					F				Pe					
	riser	Q	**584,4**			T		pf		Pf					

Appendix F - SMOKE VENT DATA SHEET

NYSTROM'S FULL LINE OF BUILDING PRODUCTS

Extinguishers & Cabinets

Access Panels

Roof Hatches & Smoke Vents

Floor Hatches

THE NYSTROM WARRANTY

NYSTROM reserves the right to change the design or details of its products without notice. NYSTROM warrants all products sold to be free from defects in materials and workmanship for a period of five years from the date of purchase, but limits liability expressly to the replacement of products not complying with this warranty, or at its election, a credit to the buyer of the purchase price paid.

NYSTROM

Nystrom Inc. 1701 Madison Street, N.E. Minneapolis, Minnesota, 55413 • Phone 612-781-7850 • Fax 612-781-1363

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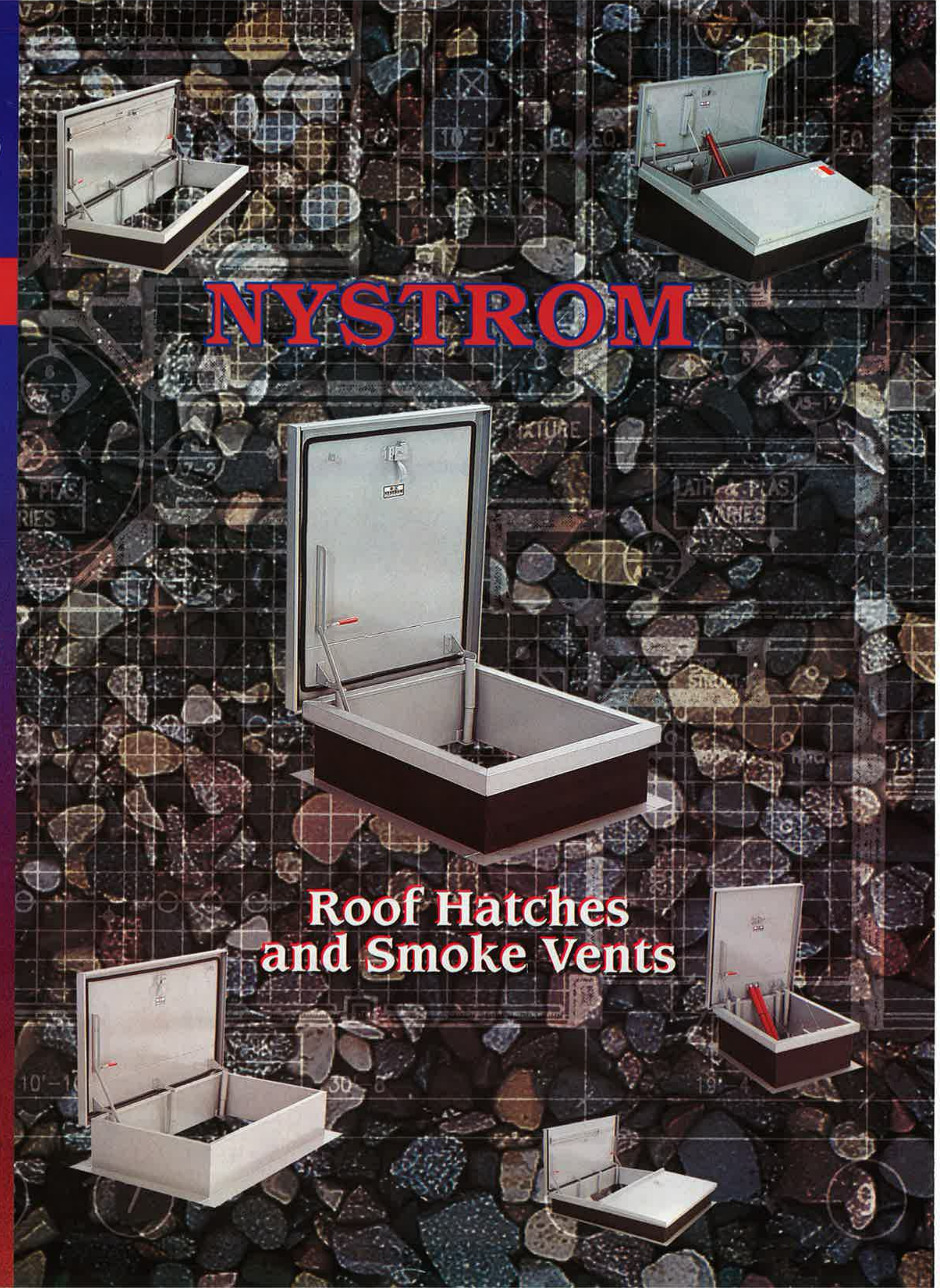
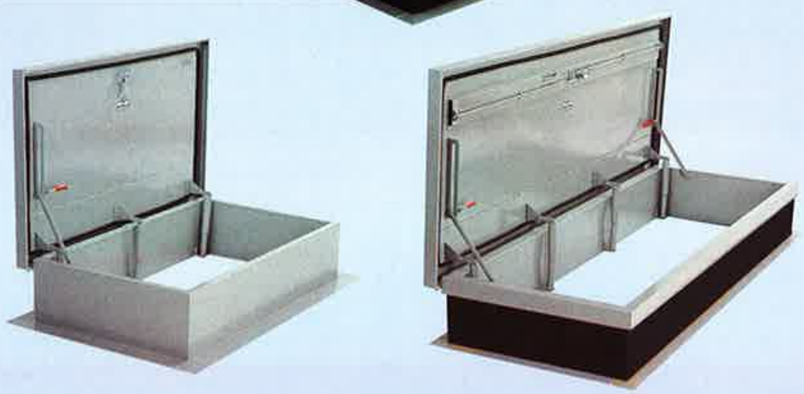
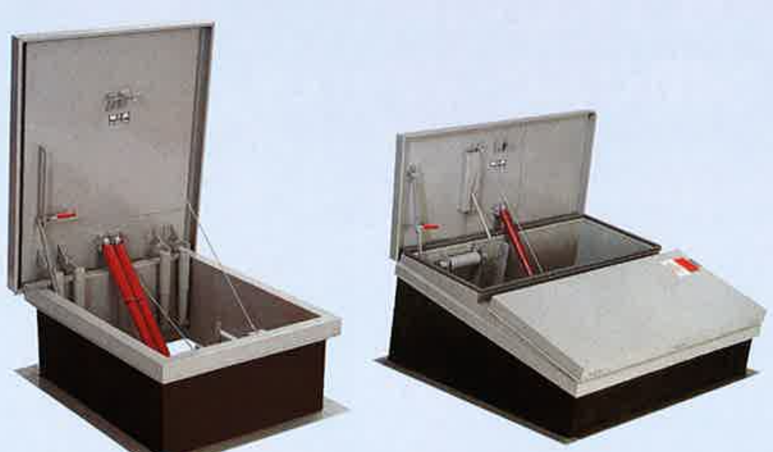
NYSTROM 07720 Roof Hatches and Smoke Vents



NYSTROM ROOF HATCHES AND SMOKE VENTS





CONDENSED SPECIFICATIONS

For complete specifications in the three part CSI format or project specific specifications please call the factory at 1-800-547-2635. Specifications and CADD drawings are also available on computer disk.

RH Roof Hatches Galvanized Steel and Aluminum

Specify **Nystrom, Inc.** roof hatches for ladders, service stairs, ship stairs and equipment hatches model (indicate metal and size: model RHG (size) for galvanized steel; model RHA (size) for aluminum). Curb shall be constructed of not less than 14 gauge galvanized steel or 11 gauge aluminum. Curb height shall be 12" and equipped with counterflashing, 1" rigid insulation on exterior and 3 1/2" mounting flange. Cover shall be constructed of not less than 14 gauge galvanized steel or 11 gauge aluminum. Cover shall be complete with heavy duty hinges, 1" rigid insulation covered by a metal liner, neoprene draft-stop gasketing and inside spring latch and handle with provisions for padlock. Finish to be factory applied gray primer; mill finish for aluminum.

SV Automatic Smoke Vents Galvanized Steel and Aluminum

Specify **Nystrom, Inc.** smoke vents of (indicate metal and size: SVG (size) for galvanized steel; SVA (size) for aluminum). Curb shall be constructed of 14 gauge galvanized steel or 11 gauge aluminum. Curb height shall be 13" high on hinged side and be equipped with counterflashing, 1" rigid insulation on the exterior, and 3 1/2" mounting flange. Cover shall be constructed of 14 gauge steel or 11 gauge aluminum. Cover shall be pitched 5 degrees to fixed center channel to provide drainage. Vents shall be provided completely assembled with heavy duty torsion spring operators, heavy duty hydraulic shock absorbers, hinges and neoprene draft seals. Doors shall open automatically when heat breaks a UL approved fusible link. Doors shall open against a 10 lbs. per square foot wind load. Doors shall remain closed against a 30 lbs. per square foot uplift pressure. Vents shall be equipped with inside and outside manual pull-ring operators which shall not affect the fusible link mechanism.

Contractor shall test for proper operation after installation by manual pull ring operators and by melting of fusible link. A replacement fusible link shall be supplied with each unit; doors shall be manually closed from the roof and automatically engage latches.

OPTIONS

Hardware: All types 316 stainless steel

Latch Options: Mortise lock preparation to receive 1-1/8" mortise cylinder by Best, Russwin/Corbin, Yale Schlage, etc. with threaded protective brass cover.

Heavy duty detention dead bolt lock (high security applications)

Curb Options: Curb can be provided with double wall curb over insulation which replaces the capflashing.

Curb can be manufactured to match slope of roof. Specify pitch of roof.

Mounting flange can be configured to match most brands of metal building roof panels. Specify manufacturer and model name of roof.

Cover Inserts: View windows with security glazing

Electric Thermo-link (automatic smoke vents only): Automatic smoke vents can be equipped with a 12 volt electric thermo-link which, when activated by alarm system or other electrical signal, will release the hatch electrically.

Call directly to our factory for help with specification and ordering information

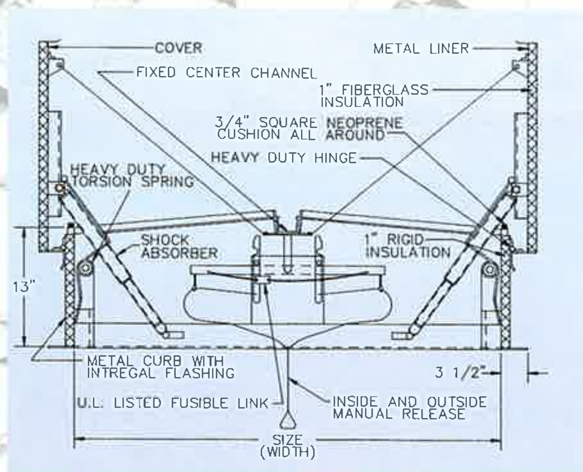
Call 1-800-54Panel (1-800-547-2635)

or Fax 612-781-1363

SV SERIES AUTOMATIC SMOKE VENTS

SVG

Shown with optional sloped curb



SVG

NYSTROM automatic smoke vents are designed to provide quick ventilation in hazardous conditions. The vents will spring open when the temperature beneath the hatch reaches 165 degrees allowing heat and smoke out of the building. The latch is operated by a UL listed 165 degree fusible link and by manual pull rings which permit instant operation from inside or at roof level. The SV series features a low design 13" curb and 5 degree lid door pitch for drainage. Curb and door are insulated with 1" thick rigid insulation to help prevent condensation and heat loss. Door is lined by an interior metal liner panel. Door remains closed against 30lbs. per square foot uplift pressure. Door opens against 10 lbs per square foot snow or wind load and automatically locks in open position. Curb can be configured to match metal roof systems and/or sloped roofs. Please refer to options on page 7.

SVG Smoke vent galvanized steel with prime coat finish.

SVA Smoke vent aluminum with mill finish.

Listing: Automatic Smoke Vents are LISTED to applicable U.L. standards and requirements by Underwriters Laboratories, Inc. (sizes 48"x48" and larger)

SPECIFICATIONS

Material:
SVG: High quality commercial grade 20 gauge galvanized steel cover and frame with 14 gauge curb.
SVA: High quality commercial grade .125 aluminum cover frame and curb with .040 aluminum cover liner.

Finish:
SVG: Factory applied gray primer.
SVA: Mill finish

Insulation: One inch fiberglass insulation in cover, one inch exposed rigid insulation at curb exterior. Neoprene draft-stop gasketing between cover and curb.

Hinge:
SVG: Steel pintle type with brass pin
SVA: Aluminum pintle type with brass pin

Opening Devices: Heavy duty torsion spring operators with hydraulic shock absorbers. Automatically locks into open position.

Latch/Lock: Unit is equipped with 165 degree UL listed fusible link which automatically opens the vent.. Unit is also equipped with pull rings for manual operation which shall not affect the fusible link.

Installation: Curb shall be integral with the unit, self-flashing, 13" high and equipped with 3 1/2 inch mounting flange. Doors shall be pitched 5 degrees to fixed center channel to provide drainage.

CALL 1-800-54PANEL (1-800-547-2635) FAX 612-781-1363

RH SERIES FOR LADDER ACCESS

NYSTROM roof hatches are designed to provide easy ladder access to the roof and eliminate the need for a penthouse. The RH series can be constructed from either aluminum or galvanized steel and is manufactured with counter-balancing compression springs with inside and outside lever handle for ease of operation. All Nystrom roof hatches have corrosion resistant hardware for durability and safety. Curbs can be configured to match metal roof systems and/or sloped roofs. Please refer to options on page 7.

RHG Roof hatch galvanized steel with prime coat finish.

RHA Roof hatch aluminum with mill finish.

RHG

SPECIFICATIONS

Material:
RHG: High quality commercial grade 14 gauge galvanized steel cover frame and curb. 22 gauge galvanized steel cover liner.

RHA: High quality commercial grade .125 aluminum cover frame and curb with .040 aluminum cover liner.

Finish:
RHG: Factory applied gray primer.
RHA: Mill finish

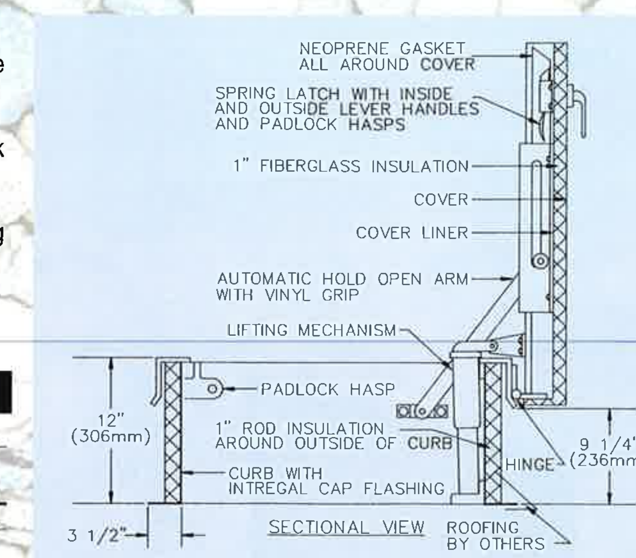
Insulation: One inch fiberglass insulation in cover, one inch rigid insulation at curb exterior. Neoprene draft-stop gasketing between cover and curb.

Hinge:
RHG: Steel pintle type with brass pin
RHA: Aluminum pintle type with brass pin

Opening Devices: Fully enclosed compression spring operator and positive action automatic hold open arm with red vinyl grip.

Latch/Lock: Inside and outside lever handles, interior and exterior padlock hasps for security.

Installation: Curb shall be 12" high and equipped with 3 1/2 inch mounting flange. Roof hatch sizes are inside curb dimensions.



Ladder Series Size Chart

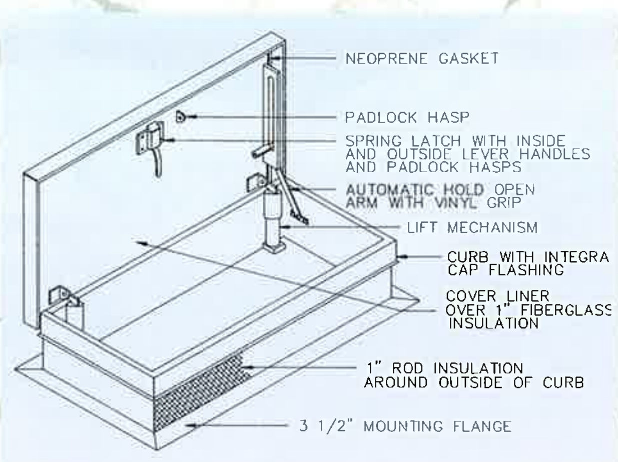
SIZE Width x Length Inside dimension (inches)	(mm)	WEIGHT Steel (#)	Steel (kg)	Aluminum (#)	Aluminum (kg)
24 x 24	611 x 611	115	253	75	165
24 x 36	611 x 916	150	330	90	198
30 x 30	764 x 764	155	341	95	209
30 x 36	764 x 916	170	374	100	220
36 x 36	916 x 916	190	418	120	264
48 x 48	1222 x 1222	370	814	210	462

CALL 1-800-54PANEL (1-800-547-2635) FAX 612-781-1363

RH SERIES FOR SHIP AND SERVICE STAIRS

RHG

Shown with optional double wall curb



NYSTROM roof hatches are designed to provide easy stair access to the roof and eliminates the need for a penthouse. The RH series can be constructed from either aluminum or galvanized steel and is manufactured with counter-balancing compression springs with inside and outside lever handle for ease of operation. All Nystrom roof hatches have corrosion resistant hardware for durability and safety. Curbs can be configured to match metal roof systems and/or sloped roofs. Please refer to options on Page 7.

RHG Roof hatch galvanized steel with prime coat finish.

RHA Roof hatch aluminum with mill finish.

SPECIFICATIONS

Material:
RHG: High quality commercial grade 14 gauge galvanized steel cover frame and curb. 22 gauge galvanized steel cover liner.
RHA: High quality commercial grade .125 aluminum cover frame and curb with .040 aluminum cover liner.

Finish:
RHG: Factory applied gray primer.
RHA: Mill finish

Insulation: One inch fiberglass insulation in cover, one inch rigid insulation at curb exterior. Neoprene draft-stop gasketing between cover and curb.

Hinge:
RHG: Steel pintle type with brass pin
RHA: Aluminum pintle type with brass pin

Opening Devices: Fully enclosed compression spring operator and positive action automatic hold open arm with red vinyl grip.

Latch/Lock: Inside and outside lever handles, inside and outside padlock hasps for security.

Installation: Curb shall be 12" high and equipped with 3 1/2 inch mounting flange. Roof hatch sizes are inside curb dimensions.

RHG

ROOF STAIR SERIES SIZE CHART

Size		Weight			
Width x Length Inside dimension		Steel		Aluminum	
(inches)	(mm)	(#)	(kg)	(#)	(kg)
30 x 54	764 x 1215	215	473	140	308
30 x 96	764 x 2438	380	836	230	506
36 x 96	916 x 2438	395	869	250	550

RH SERIES FOR EQUIPMENT ACCESS

NYSTROM equipment hatches are designed to provide access for equipment in all roof applications. Hatches wider than 4'0" are manufactured with special double leaf construction. It is recommended that hatches 72" or longer be constructed of aluminum for ease of operation. The RH series can be constructed from either aluminum or galvanized steel (smaller than 72") and is manufactured with counter-balancing compression springs with inside/outside lever handle for ease of operation. All Nystrom roof hatches have corrosion resistant hardware for durability and safety. Curbs can be configured to match metal roof systems and/or sloped roofs. Please refer to options on page 7.

RHG Roof hatch galvanized steel with prime coat finish.

RHA Roof hatch aluminum with mill finish.

RHG

SPECIFICATIONS

Material:
RHG: High quality commercial grade 14 gauge galvanized steel cover frame and curb. 22 gauge galvanized steel cover liner.
RHA: High quality commercial grade .125 aluminum cover frame and curb with .040 aluminum cover liner.

Finish:
RHG: Factory applied gray primer.
RHA: Mill finish

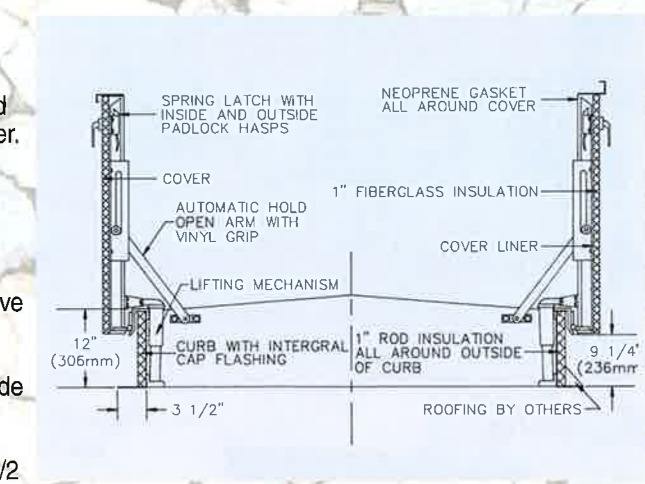
Insulation: One inch fiberglass insulation in cover, one inch exposed rigid insulation at curb exterior. Weathertight gasketing between curb and cover.

Hinge:
RHG: Steel pintle type with brass pin
RHA: Aluminum pintle type with brass pin

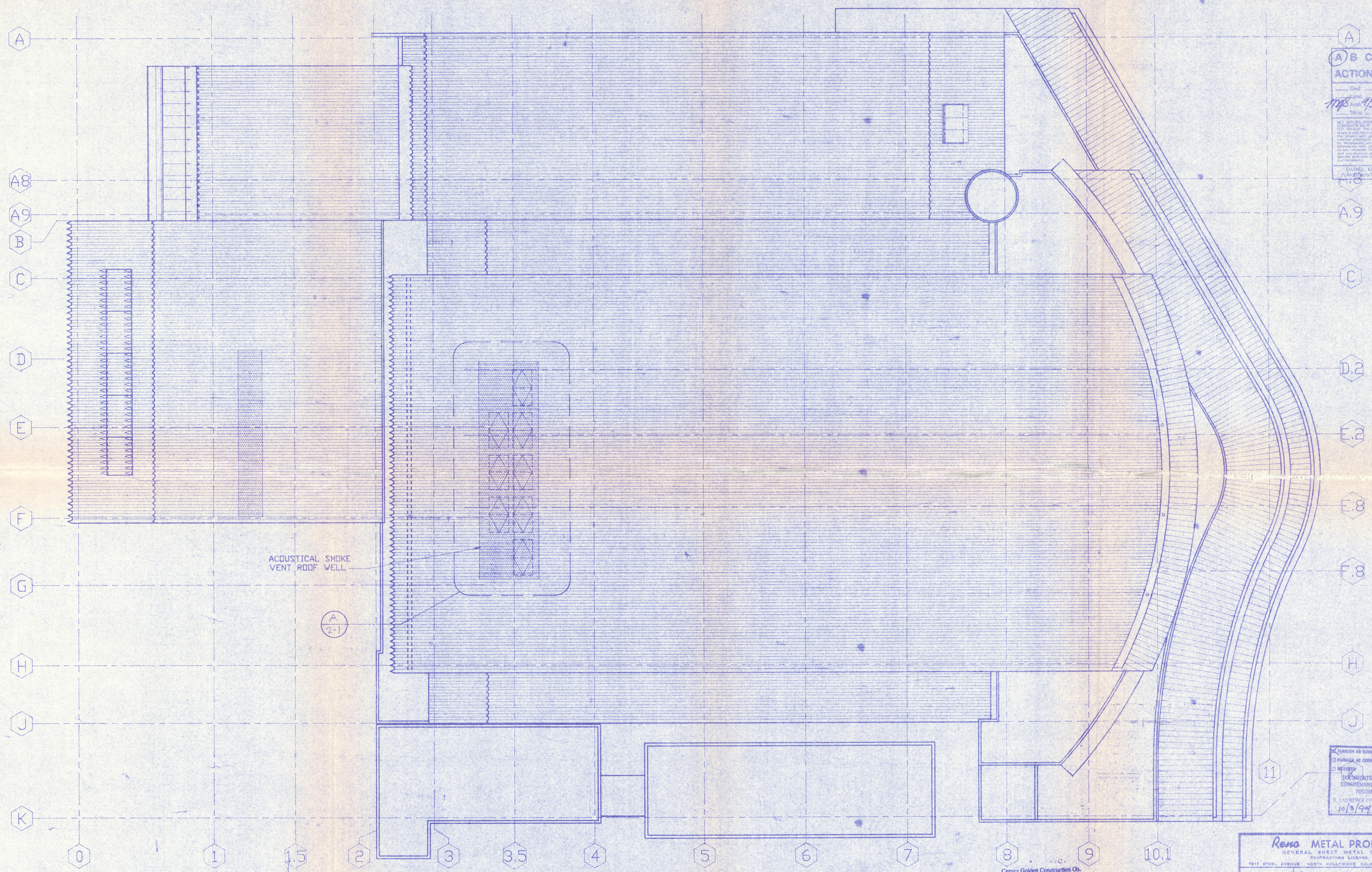
Opening Devices: Fully enclosed compression spring operator and positive action automatic hold open arm with red vinyl grip.

Latch/Lock: Inside and outside lever handles with two point latching, inside and outside padlock hasps for security.

Installation: Curb shall be 12" high, self flashing, and equipped with 3 1/2 inch mounting flange. Roof hatch sizes are inside dimensions.



EQUIPMENT HATCHES ARE SPECIFICALLY MANUFACTURED FOR OPENING SIZE REQUIRED.



ROOF PLAN

REF. DETAIL SHEET A207

3/32"=1'-0"

A

(A) B C RECORD RESUBMIT 07720-01

ACTION NO ACTION

Civil | Land | mjs Arch 9/30 | Struc.

T.O. mSmith | Date 10/5/94 | Date SEP 22 1994

HVAC | Plumb | Elec. | JB Acoustic 10/3

SEE SPECIFICATIONS FOR DEFINITION OF ACTION. CORRECTIONS OR COMMENTS MADE ON THE SHOP DRAWINGS DURING THIS REVIEW DO NOT RELIEVE THE CONTRACTOR FROM CONTRACT COMPLIANCE. 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. Contractor's responsibility includes, but is not limited to: dimensions, which shall be confirmed and correlated at the site; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences, and procedures of construction; and coordination of the work of all trades. The Architect's review of a specific item does not indicate approval of an assembly of which the item is a component.

DANIEL, MANN, JOHNSON, & MENDENHALL
Architects/Engineers Los Angeles, California

☒ FURNISH AS SUBMITTED ☐ REVISE AND RESUBMIT
☐ FURNISH AS CORRECTED ☐ RESUBMIT ITEMS NOTED
☐ REJECTED ☐ NOT REQUIRED FOR REVIEW

DOCUMENTS HAVE BEEN REVIEWED FOR CONFORMANCE WITH ACOUSTICS DESIGN RECOMMENDATIONS ONLY

R. LAWRENCE KIRKEGAARD

D 10/3/94 BY J.X. Bolaym

Centex Golden Construction Co.
Cal Poly Performing Arts Center

This submittal has been reviewed in accordance with contract requirements.

Submittal No. 136 — Section 7720

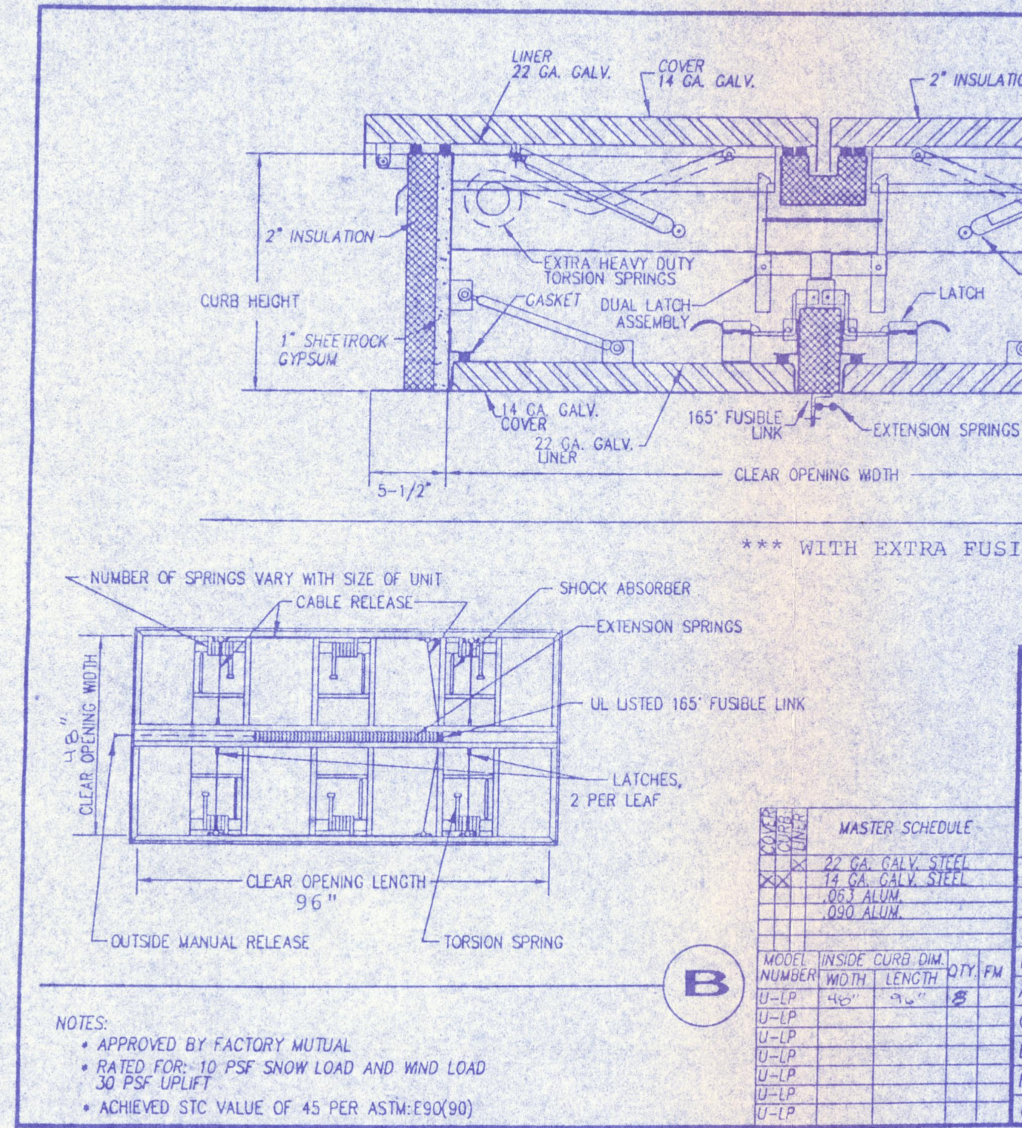
Signed — Date 9/29/94

Reno METAL PRODUCTS INC.
GENERAL SHEET METAL CONTRACTORS
CONTRACTORS LICENSE #260763
7317 ETHEL AVENUE NORTH HOLLYWOOD CALIF. 91605 875-2220 • 983-1519

PROJECT	PERFORMING ARTS CENTER
LOCATION	CAL POLY SAN LUIS OBISPO
ARCHITECT	WARNECKE / DMJM
CONTRACTOR	CENTEX GOLDEN
SUB-CONTR.	
SUBJECT	

2.0

9-14-94 Set of 2



SIZES: 6072 TO 60144, 6672 TO 144, AND 7272 TO 72144

ACOUSTICAL HEAT & SMOKE VENT (ULP STC-45)			
MATERIAL SCHEDULE			
QUANTITY	SIZE	COVER	FRAME
8 ea	4'0" x 8'0"	GASL	GALV

MILCOR LIMITED PARTNERSHIP
1150 N. CABLE RD., P.O. BOX 28
LIMA, OH. 45805 (800) 528-1411

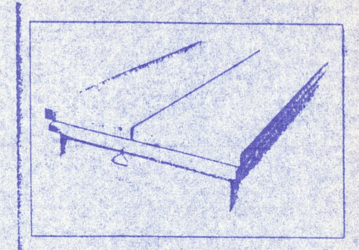
DEALER	Excel West
PROJECT	Performing Arts Center
LOCATION	San Luis Obispo, CA
ARCH.	Warnecke/DMJM
CONT'D	Reno Metal Product s
DATE 8-1-94	DRAWN RK
REV	JOB NO.
ULPSTC45	SHEET 2 of 2

NOTES:
- APPROVED BY FACTORY MUTUAL
- RATED FOR 10 PSF SNOW LOAD AND WIND LOAD 30 PSF UPLIFT
- ACHIEVED STC VALUE OF 45 PER ASTM-E90(90)

ACOUSTICAL HEAT & SMOKE VENT DETAIL 1

MILCOR PRODUCT DATA SHEET
U-LP Acoustical STC-45 Heat and Smoke Vents

MILCOR *Low Profile – 4'0", 4'6" and 5'0" Clear Opening Length*

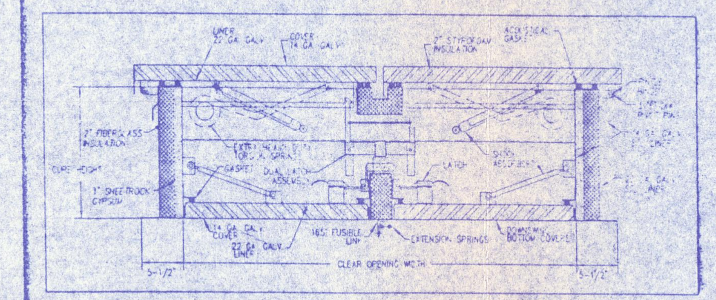


Milcor's low profile ULP Acoustical STC-45 vent provides the dual benefit of fire safety and protection from noise penetration through the roof assembly. Doors automatically lock in the fully open position.

Unwanted sound penetration is prevented by 2" of styrofoam insulation in both upper and lower covers. 2" fiberglass insulation in the frame also reduces sound transmission. When the fusible link is broken, upper covers spring up and lower covers spring down. An acoustical gasket around the frame/cover perimetor further blocks noise.

This vent achieved an STC (Sound Transmission Coefficient) of 45 when tested in accordance with ASTM E90(90). The higher the STC number the better the sound blocking performance.

Product Details



Standard Sizes and Model Numbers*

Acoustical (ULP STC-45) Galvanized Steel

	5'0" width		5'6" width		6'0" width	
Length (Clear Opening)	Model No.	lbs. ea.	Model No.	lbs. ea.	Model No.	lbs. ea.
6'0"	ULP STC-45 6072 †	1080	ULP STC-45 6672 †	1100	ULP STC-45 7272	1155
7'0"	ULP STC-45 6084	1155	ULP STC-45 6684	1185	ULP STC-45 7284	1270
8'0"	ULP STC-45 6096	1245	ULP STC-45 6696	1310	ULP STC-45 7296	1395
9'0"	ULP STC-45 60108	1320	ULP STC-45 66108	1450	ULP STC-45 72108	1575
10'0"	ULP STC-45 60120	1470	ULP STC-45 66120	1605	ULP STC-45 72120	1745
11'0"	ULP STC-45 60132	1605	ULP STC-45 66132	1750	ULP STC-45 72132	1920
12'0"	ULP STC-45 60144	1745	ULP STC-45 66144	1920	ULP STC-45 72144	2095

† 9/16" Big Smoky torsion spring (Standard acoustical torsion spring is 5/8")
☐ Sizes with 2 torsion springs per leaf
☐ Sizes with 3 torsion springs per leaf
■ Sizes with 4 torsion springs per leaf

8 EA - ULP STC 45 - 4896

Guide Specifications

Milcor U-LP Acoustical STC-45 automatically operating heat and smoke vents carry an STC-45 acoustical rating and are Factory Mutual approved. Sizes are listed below.

Product

Frame
Welded 18" height, 14 guage galvanized steel curb complete with 3½" pre-drilled mounting flanges and same guage counterflashing. Acoustical insulation is fully covered and protected by a 22 guage galvanized steel liner.

Covers
Upper covers are 14 guage galvanized steel. Acoustical insulation of upper covers is styrofoam 2" in thickness fully welded and protected by a 22 guage galvanized steel cover liner. Lower covers are continuously hinged and are 14 guage galvanized steel. Acoustical insulation in the lower covers is fully covered and protected by a 22 guage galvanized steel liner.

Operation

1. Covers automatically spring open to approximately 90 degrees in the event of fire, actuated by the parting of a single UL-listed or FM approved 165°F fusible link, located on the underside of the lower covers and automatically lock in the fully open position.

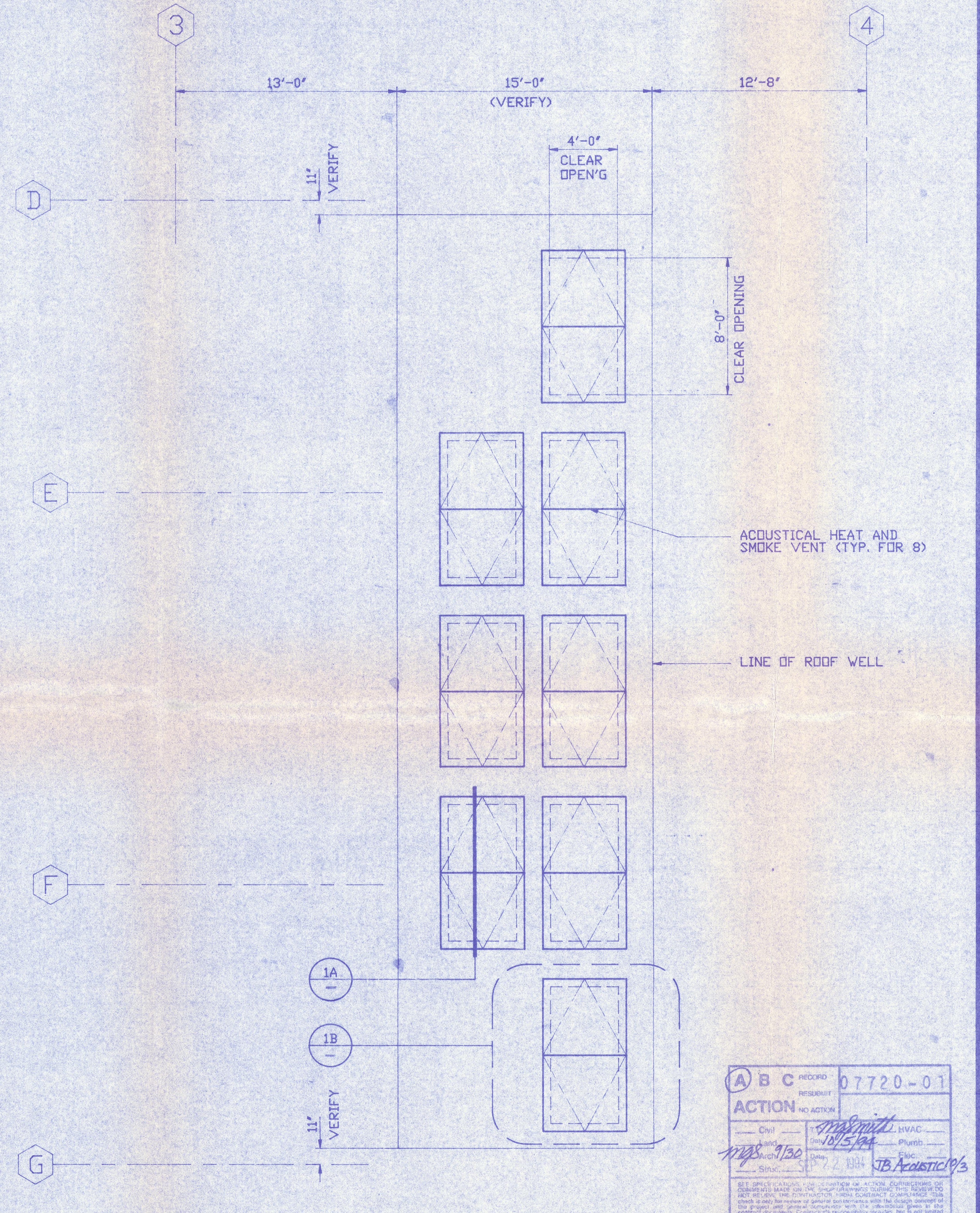
2. Upper covers are of double-leaf construction, equipped with sufficient torsion spring operators to open against a 10 psf snow or wind load. Lower covers spring down when link is broken.

3. Units are equipped with hydraulic shock absorbers to control opening speed and prevent over-travel.

4. Covers will not open when subjected to uplift pressure up to 30 psi.

5. Vent design allows covers to be released manually from inside or outside without disturbing the fusible link assembly. Manual release available on standard units only. May be deleted on vents with optional special releases. Consult Milcor Customer Service for special unit requirements.

6. Covers latch automatically and manual release mechanism resets automatically by closing covers



A B C RECORD RESUBMIT
ACTION NO ACTION
07720-01
Civil / Land / Arch mgs 9/30 / Struc. / T mgSmith / Date 10/5/94 / Date SEP 22 1994 / HVAC / Plumb. / Elec. / JB Acoustic 10/3

SEE SPECIFICATIONS FOR DEFINITION OF ACTION. CORRECTIONS OR COMMENTS MADE ON THE SHOP DRAWINGS DURING THIS REVIEW DO NOT RELIEVE THE CONTRACTOR FROM CONTRACT COMPLIANCE. 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. Contractor's responsibility includes, but is not limited to dimensions, which shall be confirmed and correlated at the site; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences, and procedures of construction, and coordination of the work of all trades. The Architect's review of a specific item does not indicate approval of an assembly of which the item is a component.

DANIEL, MANN, JOHNSON, & MENDENHALL
Architects/Engineers Los Angeles, California

PLAN @ AC. SMOKE VENT WELL A

REF. DETAIL A207,F/A513,1/A613

1/4"=1'-0"

Centex Golden Construction Co.
Cal Poly Performing Arts Center

This submittal has been reviewed in accordance with contract requirements.

Submittal No. 135 Spec. Section 7720
Signed Date 9/20/94

REVISION	DATE	BY	DESCRIPTION

PROJECT NAME: PERFORMING ARTS CENTER
LOCATION: CAL POLY SAN LUIS OBISPO
GENERAL CONTRACTOR: CENTEX GOLDEN
ARCHITECT: WARNECKE / DMJM

DRAWN BY	DATE	JOB NO.	DRAWING
db	9.13.94	596	8.1
CHECKED BY	DATE		

RENO Metal Products, Inc. Since 1900
License No. 260763
7317 ETHEL AVENUE
NO. HOLLYWOOD, CA 91605
(213) 875-2220
(818) 983-1518
FAX (818) 764-8475