

Monticello Office Building

FPE 596 Culminating Project



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STATEMENT OF DISCLAIMER

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It has been requested by the design-engineering firm that the client's name, address and the design firm's information be removed from all documents. The building has been renamed Monticello Office Building for the purpose of this report.

Keywords (5): Building Fire Protection, Prescriptive Design, Performance Based Design, Life Safety, NFPA

EXECUTIVE SUMMARY

A Fire and Life Safety analysis was performed on the existing Monticello Office Building located in Delaware, USA. The Monticello Office Building is a mixed use building that contains office space to support a population of 700 people, dining facilities to accommodate approximately 400 people, and a conference area for up to 125 people. The building is composed of two major components; a five (5) story office wing and a one (1) and two (2) story amenities wing that mainly houses the food service, dining, kitchen, retail and conference areas.

A prescriptive analysis of this building was performed to determine if the fire suppression systems, fire alarm systems, structural fire protection and egress components of this building are in compliance with the applicable codes and standards utilized at the time of construction.

A performance-based analysis was also performed for this building using computer-based software. Three separate fire scenarios including stacks of plastic chairs, a furniture fire in the main atrium, and a kitchen fire were analyzed to determine if the occupants have adequate time to egress the building prior to unsafe conditions.

The Monticello Office Building meets or exceeds all the applicable codes and standards for which it was originally designed to. It is determined that the majority of the facility was actually over designed based on these codes; including but not limited to, sprinkler design criteria and number of exits. In addition to the prescriptive analysis, it is determined through the performance-based design that during a fire event the building is capable of discharging the total volume of occupants prior to the existence of unsafe conditions within the building envelope.

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Abbreviations

ADA	Americans for Disabilities Act
AFF	Above Finished Floor
ASET	Available Safe Egress Time
C	Celsius
Cd	Candela
CO	Carbon Monoxide
D	Population Density
dba	Decibels
F	Fahrenheit
F _s	Specific Flow
FACP	Fire Alarm Control Panel
FDC	Fire Department Connection
FDS	Fire Dynamics Simulator
ft	Feet
GPM	Gallons per Minute
H	Height / Hour
HRR	Heat Release Rate
IBC	International Building Code
in	Inch
kg	Kilogram
kW	Kilowatt
LSC	Life Safety Code
m	Meter
MOB	Monticello Office Building
MW	Megawatt
NAC	Notification Appliance Circuit
NFPA	National Fire Protection Association
OLF	Occupant Load Factor
PIV	Post Indicator Valve
PPM	Parts per million
PSI	Pounds per square inch
QTY	Quantity
ROR	Rate of Rise
RSET	Required Safe Egress Time
RTI	Response Time Index
S	Speed of Movement
SFPE	Society of Fire Protection Engineers
SQ FT	Square Feet
SQ M	Square Meter
T	Time / Temperature
UFAD	Under Floor Air Distribution
W/	With
W/O	Without

BUILDING INFORMATION

The Monticello Office Building is a five (5) story structure measuring a total of 77.5 feet from the ground level to the roof of the highest accessible floor. This building does not contain an occupiable penthouse at the roof or a basement below the finished grade. Each floor level in this structure is 15 feet high from the structural floor to the structural ceiling or roof above. This building is fully sprinklered and includes a fully operational fire alarm and detection system.

The Monticello Office Building includes two main stair enclosures that connect all five (5) floors, with only one connecting to the roof. In addition to these two stairs, one stair component is located at the main entrance of the building directly in the atrium space. This stair connects the first and second floor only. Also, the building is equipped with passenger elevators located in the center of the office wing that connect all floors of the building.

FIRST FLOOR

The first floor of this building contains a large servery, dining and commercial kitchen areas. These spaces in combination make up the footprint of the amenities wing of the building. The other half of the floor, the business wing, is comprised of open office areas, a break room, conference rooms, and miscellaneous storage and electrical spaces. The first floor also includes a two story atrium located at the main entrance on the plan North side of the structure. Other notable areas of the first floor include the main electrical room, fire command center, and the fire water riser room which can all be found in the south west portion of the business wing.

The following image, *Figure 1*, is the first floor architectural layout indicating the egress components and the occupancy groups per area. Refer to *Appendix A* for full size architectural plans for all floors.

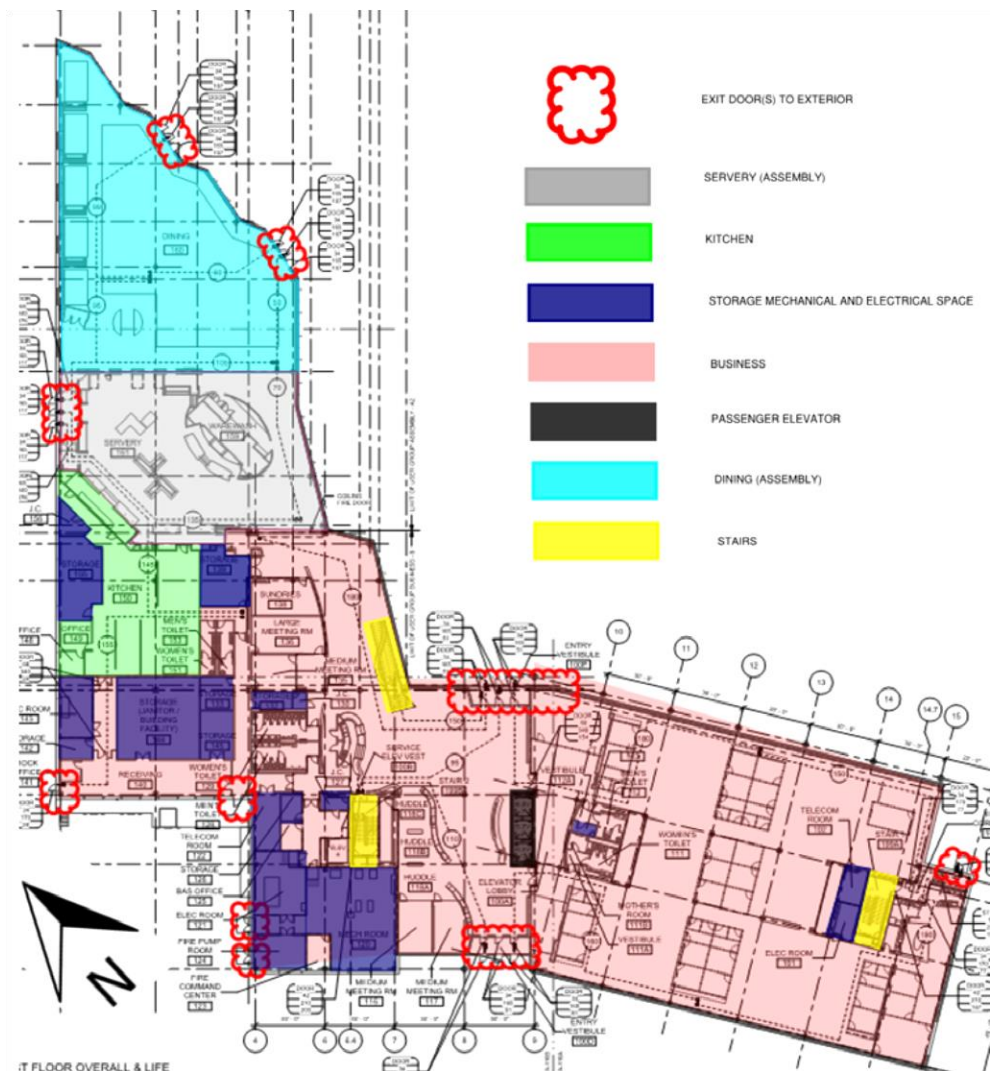


Figure 1: First Floor Layout

SECOND FLOOR

The second floor mainly consists of open office areas, a break room, conference rooms, miscellaneous storage, and electrical spaces. The second floor also includes the second level of the atrium area, where the atrium is separated from the rest of the floor by a glass partition. The floor's main egress components include the two stair enclosures, elevators, and the atrium stair. There is also a small terrace area on the west side of the floor directly above the first floor dining area. The entire floor is raised to accommodate the mechanical Under Floor Air Distribution (UFAD) system. The average ceiling height from the top of the raised floor to the architectural ceiling is 9 feet. The following image, *Figure 2*, is the second floor architectural layout indicating the egress components and the occupancy groups per area. Refer to *Appendix A* for full size architectural plans for all floors.

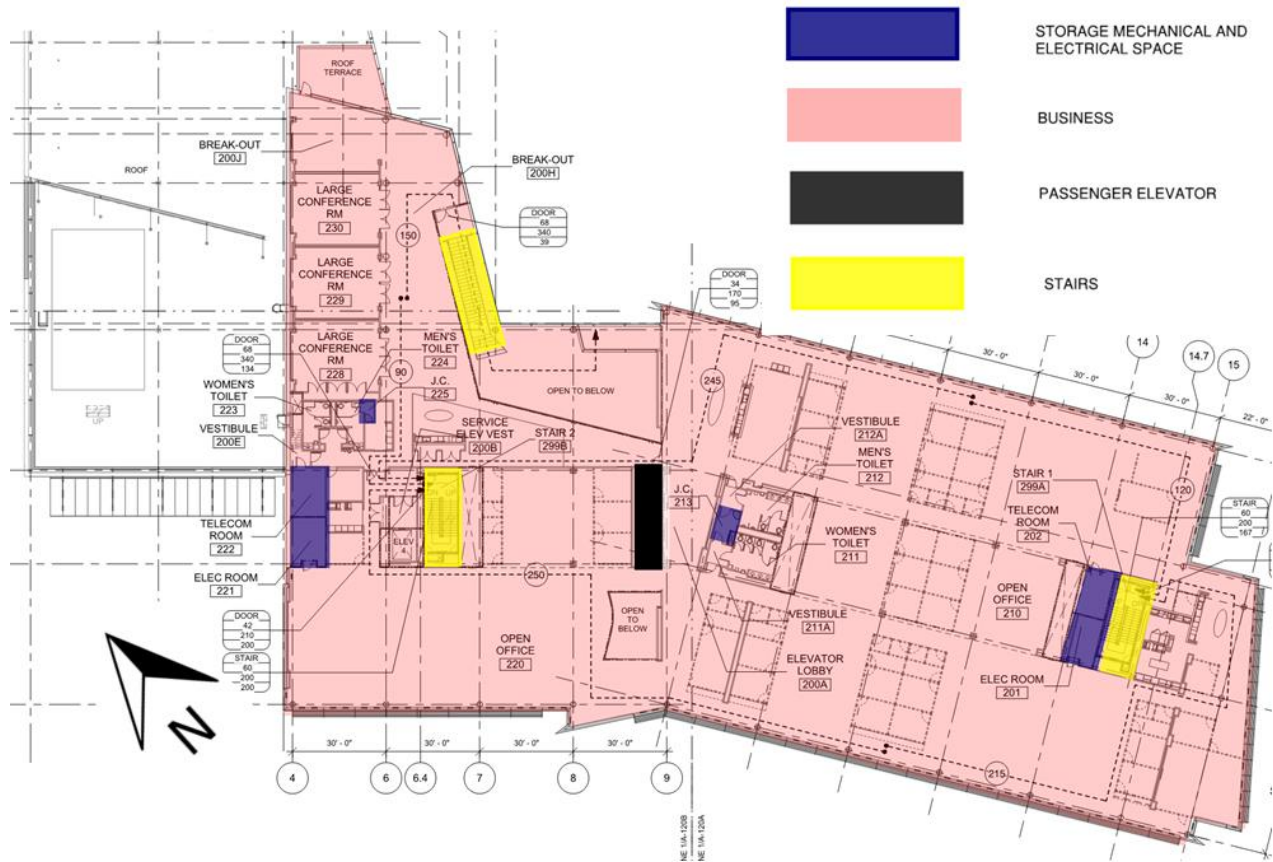


Figure 2: Second Floor Layout

THIRD AND FOURTH FLOOR

The third and fourth floors of this building are identical in footprint and usage. Both floors consist of mainly office space with several enclosed offices scattered throughout the floor. Similar to the second floor, these floors include the two main stair enclosures and the elevators as its only source of egress. These floors also contain miscellaneous storage and electrical spaces and a single break room on the east side of the floor. These floors also include the raised floor for the mechanical system and an average ceiling height of 9 feet. The following image, *Figure 3*, is the third and fourth floor architectural layout indicating the egress components and the occupancy groups per area. Refer to *Appendix A* for full size architectural plans for all floors.

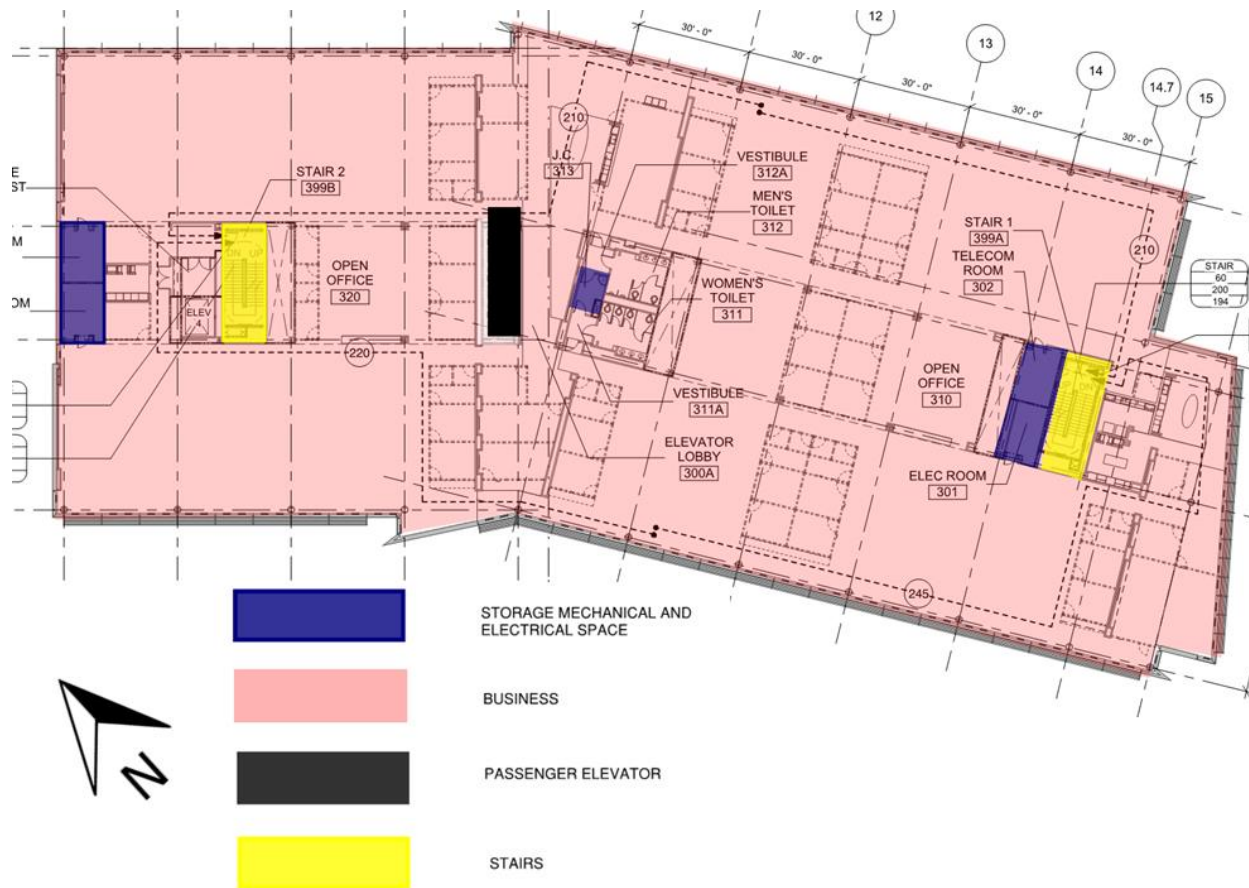


Figure 3: Third and Fourth Floor Layout

FIFTH FLOOR

The fifth floor of this building is almost identical to the floor below, except that a portion of the north east section of the floor has been converted to an exterior terrace area. Similar to most floors, the fifth floor consists of mainly office space with several enclosed offices scattered throughout the floor. This floor includes the two main stair enclosures and elevators as its only means of egress. This floor also contains miscellaneous storage and electrical spaces and a single break room on the east side of the floor. This floor also includes the raised floor for the mechanical system and an average ceiling height of 9 feet. The following image, *Figure 4*, is the fifth floor architectural layout indicating the egress components and the occupancy groups per area. Refer to *Appendix A* for full size architectural plans for all floors

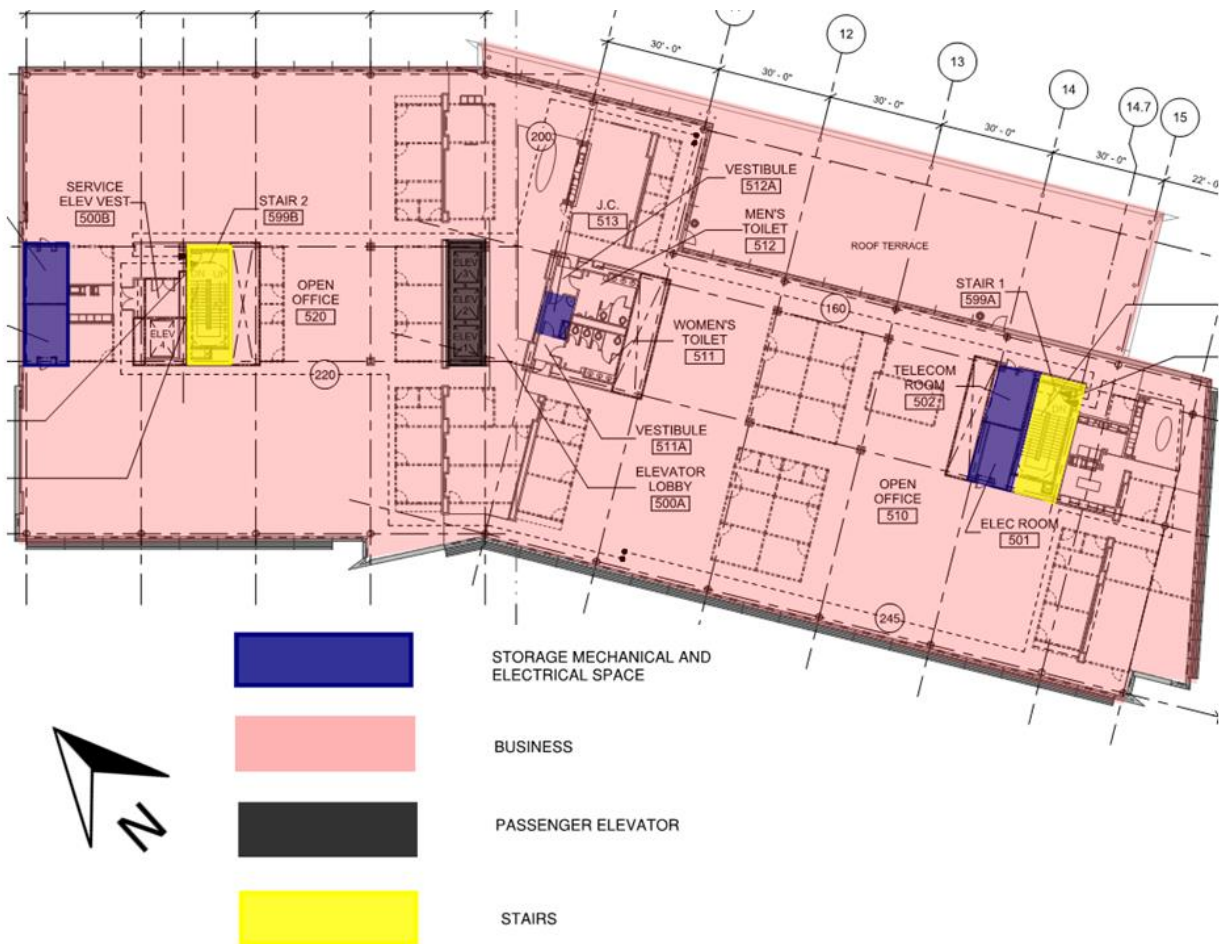


Figure 4: Fifth Floor Layout

ROOF

The roof of the building includes the elevator machine rooms and miscellaneous mechanical and plumbing equipment only. Due to the roof not being used for storage or occupancy, the roof can be considered a non-occupiable floor. The western stair enclosure opens up onto the roof for the purpose of accessibility of the equipment and general access to the roof for maintenance personnel only. The following image, *Figure 5*, is a partial roof layout showing the western half of the roof.

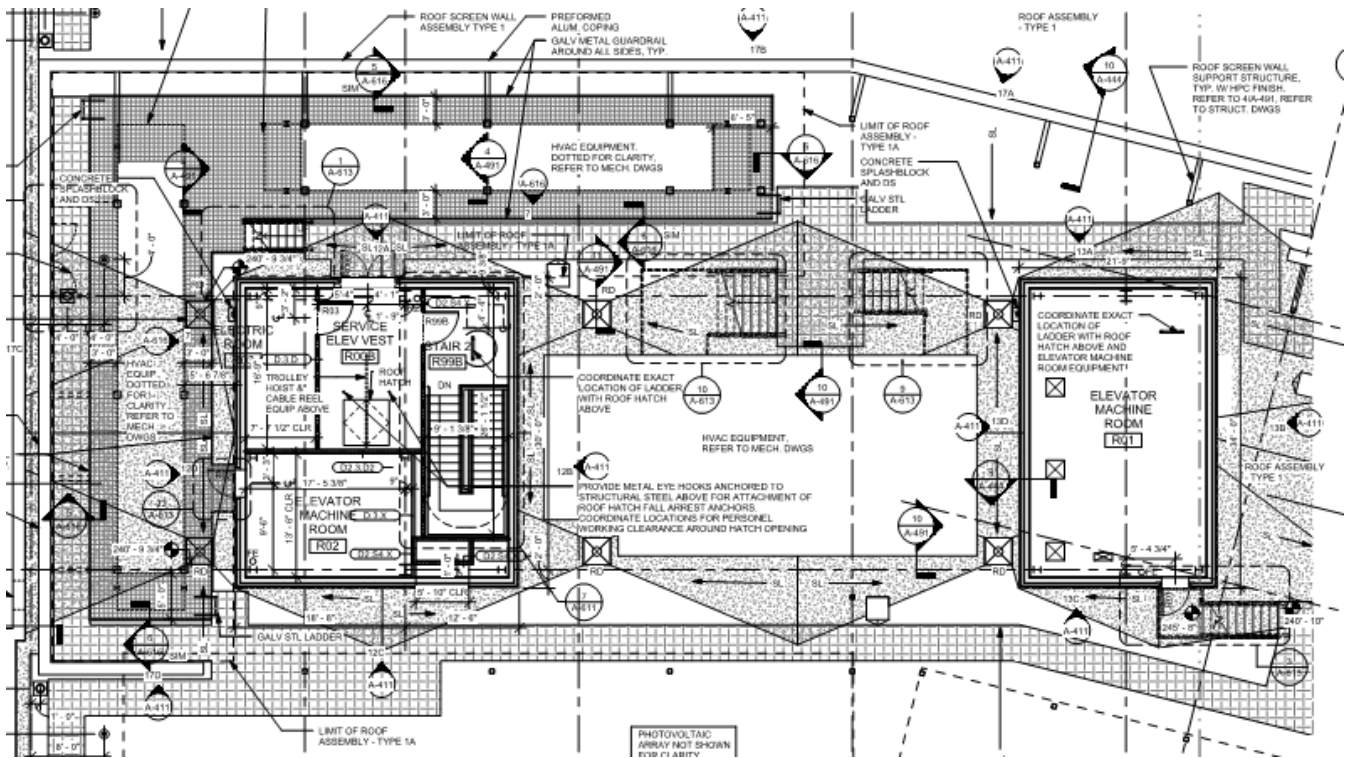


Figure 5: Partial Roof Layout (West)

APPLICABLE BUILDING CODES AND STANDARDS

The Monticello Office Building was designed to various building codes and standards. The table provided below, *Table 1*, provides a non-inclusive list of the various applicable codes and standards used to design and construct this building. In addition to the codes listed in the table, the local jurisdiction amendments and owner requirements/standards have been implemented in the construction of this building. The 2006 International Building Code (IBC) and the 2009 Life Safety Code (LSC) were the main two building codes used to design this structure. Whichever code, IBC or LSC, requires a more conservative approach regarding any component, that particular building code section was utilized. An example of this can be found in the exit capacity section of this report.

Table 1: Applicable Codes and Standards

2009 – NFPA 101 Life Safety Code
2006 - International Building Code (IBC)
2006 - International Plumbing Code (IPC)
2006 - International Fire Code (IFC)
2006 - International Mechanical Code (IMC)
2008 - National Electrical Code (NEC)
2010 – NFPA 10 Standard for Portable Fire Extinguishers
2010 – NFPA 13 Installation of Sprinkler Systems
2010 – NFPA 14 Installation of Standpipe and Hose Systems
2010 – NFPA 24 Standard for the Installation of Private Fire Service Mains
2010 – NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
2010 – NFPA 72 National Fire Alarm Code

PRESCRIPTIVE ANALYSIS

A prescriptive building design is the construction of a building utilizing the minimum code requirements that are applicable to that particular location. The minimum codes can include the international building codes, local amendments, Authority Having Jurisdiction (AHJ) requirements and all referenced standards from the governing codes. In this section, the prescriptive design of the Monticello Office Building will be analyzed to determine if the code requirements have been met, where they exceed and where they are lacking. As part of this analysis, the fire suppression, fire alarm, structural fire protection and egress components will be evaluated.

STRUCTURAL FIRE PROTECTION

Structural components of a building are required to withstand a fire to a minimum duration of time as specified in the building codes. It is imperative that the structural frame remains intact for both life safety as well as structural preservation of the building. The following sections detail the Monticello Office Building's structural fire protection design and components used to prevent catastrophic structural failures that can be caused as a result of a fire.

OCCUPANCY CLASSIFICATION

To determine the required fire resistance rating of each of the building components, the occupancy classification needs to be determined. Based on the IBC and the LSC, the occupancy of the building is classified as both Business and Assembly (A-2 in accordance with IBC). Refer to the table below, *Table 2*, for the breakdown between the two separate use groups found in this building.

Table 2: Occupancy Classification

Occupancy	IBC	LSC
Office, Support and Accessory Spaces	Business (B)	Business
Dining, Servery and Kitchen Areas	Assembly (A-2)	Assembly

BUILDING CODE DEFINITIONS

BUSINESS GROUP B

- IBC (2006) **304.1**: Business Group B occupancy includes, among others, the use of a building or structure, or a portion thereof, for office, professional or service-type transactions, including storage of records and accounts.
- LSC (2009) **6.1.11.1**: An occupancy used for the transaction of business other than mercantile.

ASSEMBLY GROUP

- IBC (2006) **303**: **A-2** Assembly uses intended for food and/or drink consumption including, but not limited to: Banquet halls, Night clubs, Restaurants, and Taverns and bars.
- LSC (2009) **6.1.2**: An occupancy (1) used for a gathering of 50 or more persons for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses; or (2) used as a special amusement building, regardless of occupant load.

CONSTRUCTION TYPE

The Monticello Office Building would have been considered a Type IB construction type in accordance with the applicable building codes due to its characteristics; height, area and occupancies. However, the building codes allow modifications to the allowable building heights and areas when the building is protected by an approved sprinkler system. Also, additional increases can be made based on the allowable frontage of the building. Utilizing these allowances, the building is classified as a Type IIA construction type.

HEIGHT MODIFICATIONS

- IBC (2006) **504.2:** In buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1, the maximum height and stories as specified in Table 503 are increased by one story and 20 feet.

Refer to *Table 3* below for the construction type's allowable building height, stories and the actual building values.

Table 3: Construction Type Classification (IBC)

	TYPE IB (No Increases)	Type IIA (No Increases)	Type IIA (With Increases)	Actual Building
Allowable Height (IBC)	A-2 – 160 ft B – 160 ft	A-2 – 65 ft B – 65 ft	A-2 – 85 ft B – 85 ft	77.5 ft
Allowable Stories (IBC Table 503)	A-2 – 11 B – 11	A-2 – 3 B - 5	A-2 – 4 B – 6	A-2 – 1 B – 5
Allowable Area (IBC Table 503)	B – UL	B – 37,500 sf	B - 843,750 sf	220,246 sf

AREA MODIFICATIONS

FRONTAGE INCREASE

The entire perimeter around the building is open to a public way that is 30 feet wide, therefore the maximum allowable area as specified in Table 503 of the IBC is increased by 75%. Area Increase = 28,125 sf

- IBC (2006) **506.2:** . Every building shall adjoin or have access to a public way to receive an area increase for frontage. Where a building has more than 25 percent of its perimeter on a public way or open space having a minimum width of 20 feet (6096 mm), the frontage increase shall be determined in accordance with the following: $I_f = [F/P - 0.25] W/30$

where:

I_f = Area increase due to frontage.

F = Building perimeter that fronts on a public way or open space having 20 feet (6096 mm) open minimum width (feet).

P = Perimeter of entire building (feet).

W = Width of public way or open space (feet) in accordance with Section 506.2.1.

SPRINKLER INCREASE

In buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1 of the IBC, the maximum area as specified in Table 503 is increased by 200% for multi-story buildings.

Area Increase = (37,500 sf x 200%) = 75,000 sf

- IBC (2006) **506.3:** Automatic sprinkler system increase. Where a building is equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1, the area limitation in Table 503 is permitted to be increased by an additional 200 percent (AS = 2) for buildings with more than one story above grade plane.

AREA MODIFICATION

Total Area Modification = (37,500 sf + 75,000 sf + 28,125 sf) = 140,625 sf

- IBC (2006) **506.1:** The areas limited by Table 503 shall be permitted to be increased due to frontage (FI) and automatic sprinkler system protection (AS) in accordance with the following: AA = AT + AS + FI where:
 AA = Allowable area per story (square feet).
 AT = Tabular area per story in accordance with Table 503(square feet).
 AS = Area increase factor due to sprinkler protection as calculated in accordance with, Section 506.3.
 FI = Area increase factor due to frontage as calculated in accordance with Section 506.2.

AREA DETERMINATION

Per exception 2 of the IBC section 506.4, the maximum area of a building shall be calculated by multiplying the allowable area of the first floor by the maximum number of stories allowed. Refer to *Table 3* above for the construction type’s allowable areas and the actual building values.

Use Group B, Type IIA: Maximum Building Area = (140,625 sf x 6 stories) = 843,750 sf

- IBC (2006) **506.4:** The maximum area of a building with more than one story above grade plane shall be determined by multiplying the allowable area of the first story (Aa),as determined in Section 506.1, by the number of stories above grade plane as listed below:

Exceptions:

- (2) The maximum area of a building equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.2 shall be determined by multiplying the allowable area per story (Aa), as determined in Section 506.1, by the number of stories above grade plane.

Table 4: Calculated Building Areas

Floor	First	Second	Third	Fourth	Fifth	Total
Area (GSF)	68,060	40,594	38,880	38,880	33,832	220,246

The actual area of the building as shown in the table provided above, *Table 4*, indicates that the total area of the building is 220,246. This value is less than the maximum allowable building area calculated above resulting in the use of a Type IIA construction type. The reduced construction type rating to a Type IIA allows the ability to reduce all fire rating requirements by a factor of 1 hour, excluding the roof rating which remains at 1. The next section will go into detail regarding the fire rating requirements for a type IIA construction.

STRUCTURAL FIRE RATING

The following table, *Table 5*, provides the minimum required fire-resistant ratings for all structural components enclosed within a Type IIB construction. These values were gathered from both the IBC and the LSC. Note that all the fire resistance ratings are identical between both sources of building codes.

Table 5: Fire-Resistance Rating

Building Element	IBC (Table 601) Type IIA	LSC (Table 4.1) Type II (111)
Structural Frame	1	1
Bearing Walls <ul style="list-style-type: none">• Exterior• Interior	1 1	1 1
Non-bearing Walls <ul style="list-style-type: none">• Exterior (> 30 ft. for Fire Separation)• Interior	0 0	0 0
Floor Construction	1	1
Roof Construction	1	1

STRUCTURAL FRAME

To accommodate the architectural and interior design requirements of the building, the Monticello Office Building contains an average column grid spacing of 30 feet in both directions. To meet the requirements of a Type IIA Construction, a 1-hour fire rating is required for elevated decks, beams, girders, columns and bracing. To achieve this rating, a steel frame was used to support this structure.

WALL CONSTRUCTION

All exterior and interior walls that are used as load bearing walls where they are required to support additional weight besides their own, are required to be at a minimum fire rating of a least 1-hour. All other walls except where required elsewhere in the building codes do not require a fire rating in accordance with the table above, *Table 6*. Refer to *Appendix C* for floor plans indicating the structural fire ratings for each wall component.

FLOOR CONSTRUCTION

The Monticello Office Building utilized a floor slab system consisting of 3-1/2" normal weight concrete on a 3" composite metal deck. The combination of the concrete and the metal deck achieved the required 1-hour fire rating for all floors.

ROOF CONSTRUCTION

The roof deck of this building uses 4-1/2" normal weight concrete on a 3-inch deep, 18 gage galvanized composite metal deck. This composite concrete and metal deck system was chosen for this building to (1) meet the fire rating requirements of the roof, (2) provide greater load capacity and (3) provide superior sound attenuation and vibration characteristics.

MIXED OCCUPANCIES

A mixed occupancy is the use of more than one distinctive occupancy group within a structure. The Monticello Office Building, as stated previously in the report, contains both assembly and business occupancy use groups. The fire rating separation requirement based on the aforementioned usage of the building are in accordance with the applicable building codes.

- IBC (2006) **508.3.3: Separated Uses:** Provide 1-Hour Fire Barrier Separation between Use Groups B & A-2 per Table 508.3.3 and Exception to Section 508.3.3.

Table 6: Required Separation of Occupancies Fire-Resistance Rating (IBC, Table 508.3.3)

Occupancy	Business	
	Sprinklered	Non-Sprinklered
Assembly	1 - Hour	2 - Hours

- LSC (2009) **6.1.14.4: Separated Occupancies:** Provide 1-Hour Fire Resistive Separation Assembly between Occupancy Classes per Table 6.1.14.4.1 & Section 6.1.14.4.3.

Table 7: Required Separation of Occupancies Fire-Resistance Rating (LSC, Table 6.1.14.4.1 b)

Occupancy	Business
Assembly	2*

*Minimum Fire Resistance Rating. The fire resistance rating is permitted to be reduced by 1 hour, but in no case less than 1 hour, where the building is protected throughout by an approved automatic sprinkler system.

In accordance with the sections above from the IBC and the LSC, a fire barrier wall is provided between the Assembly and Business occupancies in the building. In *Figure 6* below, the red demarcation line indicates the location of the 1-hour fire barrier. Any penetrations through this wall are fire stopped with an approved material. All duct penetrations require a fire/smoke damper. A fire cooling door is provided to maintain the rating of the separation in case of a fire event.

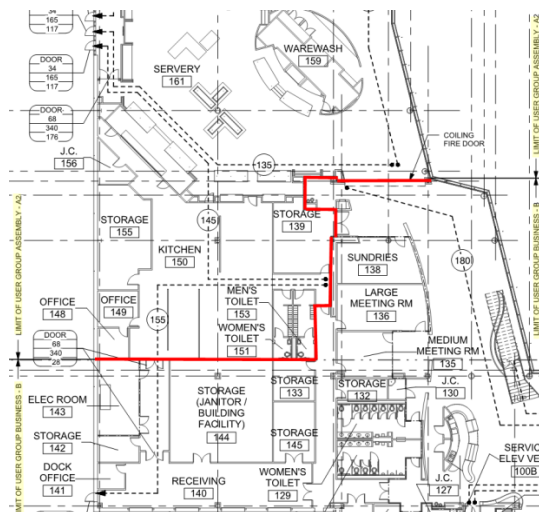


Figure 6: First Floor Fire Barrier

ATRIUM

The Monticello Office Building contains a small atrium at the main entrance of the facility. This atrium, shown in *Figures 7 and 8* below, can be found on the north side of the structure and connects both the first and second floor. Refer to *Appendix A* for the location of this atrium in respect to the entire floor layout. The second floor space is separated from the atrium by a glass partition and an egress door located at the second floor main landing of the stair.

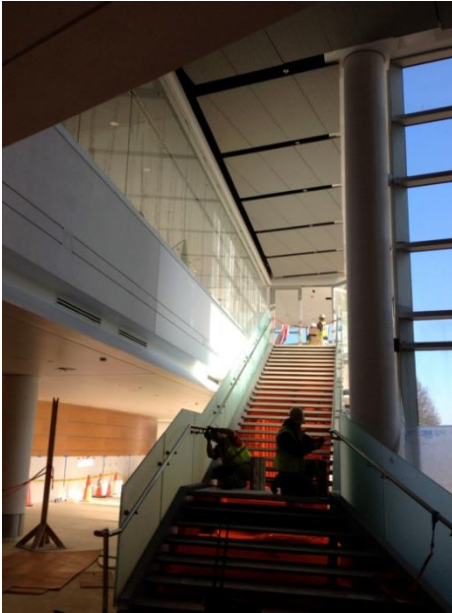


Figure 7: Atrium Stair Photo

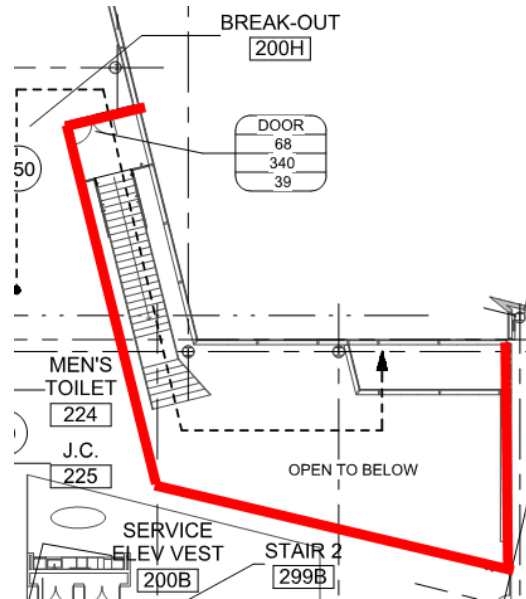


Figure 8: Second Floor Atrium Glass Wall

BUILDING CODE DEFINITIONS

ATRIUM

- IBC (2006) **404.1**: An opening connecting two or more stories other than enclosed stairways, elevators, hoistways, escalators, plumbing electrical, air-conditioning or other equipment which is closed at the top.
- LSC (2009) **3.3.27**: A large-volume space created by a floor opening or series of floor openings connecting two or more stories that is covered at the top of the series of openings and is used for purposes other than an enclosed stairway; an elevator hoistway; an escalator opening; or as a utility shaft used for plumbing, electrical, air-conditioning, or communications facilities.

SMOKE CONTROL

Per an exception to the 2006 IBC Building Code, a smoke control system installed in accordance with Section 909 of the IBC is not required for an atrium that connects only two stories and therefore not provided for this building.

- IBC (2006) **404.4**: A smoke control system shall be installed in accordance with Section 909.

Exception:

Smoke control is not required for atriums that connect only two stories.

ATRIUM ENCLOSURE

The building codes require a minimum of a 1-hour fire barrier wall to separate the atrium area from the office space directly adjacent to it on the second floor. However, the building codes provide exceptions to this requirement when a glass partition in combination with closely spaced sprinklers is provided. The Monticello Building opted to use this building code exception in order to provide a more aesthetically pleasing atrium space. In *Figure 9* below, the closely spaced sprinklers on the room side of the second floor atrium area can be observed.

- IBC (2006) **404.5**: Atrium spaces will be separated from adjacent spaces by a 1-hour fire barrier wall.

Exception:

- (1) A glass wall forming a smoke partition where automatic sprinklers are spaced 6 feet or less along both sides of the separation wall, or on the room side only if there is not a walkway on the atrium side, and between 4 inches and 12 inches away from the glass and designed so that the entire surface of the glass is wet upon activation of the sprinkler system without obstruction.

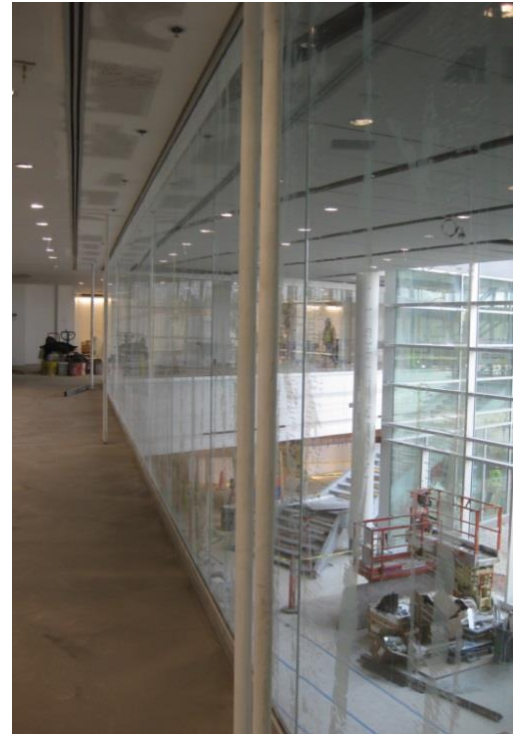


Figure 9: Atrium Glass Partition with Sprinklers

VERTICAL EXIT ENCLOSURES

Vertical exit enclosures connecting multiple floors via stairs are used to provide a safe means of egress for occupants on the floors above the first level of the building. In accordance with the codes provided below, the two stairways connecting more than 4 floors require a minimum rating of 2 hours. This rating requirement has been implemented in this building. Per the exceptions stated in the building codes, the atrium stair does not require an enclosure because the stair connects only the first and second floors and two additional means of egress are provided on the upper floors.

- IBC (2006) **1020.1**: Interior exit stairways and interior exit ramps shall be enclosed with fire barriers constructed in accordance with Section 706 or horizontal assemblies constructed in accordance with Section 711, or both. Exit enclosures shall have a fire-resistance rating of not less than 2 hours where connecting four stories or more and not less than 1 hour where connecting less than four stories. The number of stories connected by the exit enclosure shall include any basement.

Exception:

In other than Group H and I occupancies, interior egress stairways serving only the first and second stories of a building equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 are not required to be enclosed, provided at least two means of egress are provided from both floors served by the unenclosed stairways. Such interconnected stories shall not be open to other stories. Unenclosed exit stairways shall be remotely located as required in Section 1015.2.

SHAFT ENCLOSURES

Shaft enclosures are required for all floor openings that penetrate multiple floors. The Monticello Office Building includes several shaft enclosures that connect a number of floors. The elevator shaft located in the center of the business wing and several shafts used for HVAC and electrical equipment are provided within 2-hour rated wall enclosures. *Figure 10* is an example of two mechanical shafts found in the building floor plan. The red double dot line denotes a 2-hour rated wall partition. Refer to *Appendix C* for all shaft locations and associated fire ratings of walls.

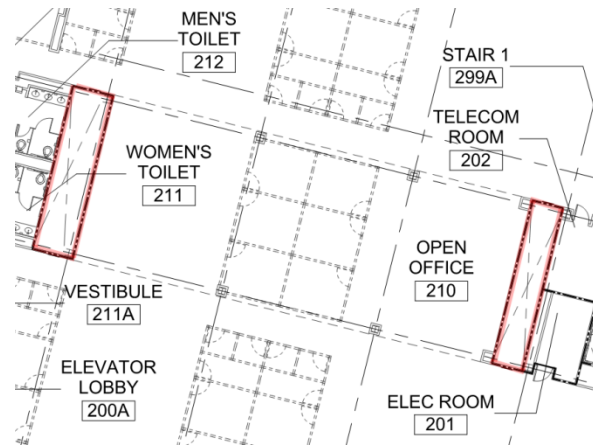


Figure 10: Example Shaft Enclosures

- **IBC (2006) 707.2: Shaft enclosure required.** Openings through a floor/ceiling assembly shall be protected by a shaft enclosure complying with this Section.

IBC (2006) 707.4: Fire-resistance rating. Shaft enclosures shall have a fire-resistance rating of not less than 2 hours where connecting four stories or more, and not less than 1 hour where connecting less than four stories.

- **LSC (2009) 8.6.5: Required Fire Resistance Rating.** The minimum fire resistance rating for the enclosure of floor openings shall be as follows (see 7.1.3.2.1 for enclosure of exits):
 - (1) Enclosures connecting four or more stories in new construction — 2-hour fire barriers.

STRUCTURAL SUMMARY

The structural fire protection for the Monticello Office Building has been designed and installed in accordance with the applicable codes and standards. Several exceptions to certain code sections were used to allow for a more aesthetically pleasing facility. The exceptions used are all allowed by code and will not hinder the buildings structural capabilities. In the next section, a detailed analysis of the egress portion of the building will be discussed.

EGRESS

Egress is the action of physically exiting a building or area. It is important to recognize that an occupant shall not only be capable of exiting a building, they must also safely egress the building prior to unsafe conditions that may prevent or stop the egress process all together. Over the course of building construction in history, building codes have evolved to address the many concerns that can adversely affect an occupant’s ability to exit a structure in a safe manner. The following sections detail the egress capabilities of the Monticello Office Building and how it complies with the applicable codes and standards.

OCCUPANT LOAD

The occupant load of a building is the maximum allowable human capacity of a space as determined by dividing the maximum floor area by the occupant load factor (OLF) as detailed in the IBC and LSC. The table below, *Table 8*, details the maximum floor area per occupant for various locations that can be found in the Monticello Office Building.

Table 8: Allowable Occupant Loads

Occupancy	Floor Area Per Occupant
Business Area	100 gross
Assembly Area (w/o fixed seats) <ul style="list-style-type: none"> • Concentrated (chairs only) • Unconcentrated (tables and chairs) 	7 net 15 net
Kitchen (IBC)	200 gross
Kitchens (LSC)	100 gross
Storage, Mechanical and Equipment Rooms	300 gross

Note that the IBC and LSC have differing values for the kitchen occupancy. For this particular case, the LSC was utilized as this value (100) is more conservative than what has been described in the IBC (200). The maximum floor area per occupant was then used to determine the maximum occupant load for each space, floor and building as a whole. The total occupant load for this building is 3,003 people. Refer to *Table 9* below for the calculated occupant load for each space and floor.

Table 9: Calculated Occupant Load

Floor	Occupancy	Area (SF)	Occupant Load
1	Business	46,045	461
	Servery	2,800	400
	Dining	5,500	564
	Kitchen	8,450	55
2	Business	40,594	406
3	Business	38,880	389
4	Business	38,880	389
5	Business	33,832	339
Total			3003

EXIT CAPACITY

In order to minimize the delay in egress times, the total capacity of all egress components for a floor must be less than the total occupant load of that floor. Utilizing the egress widths provided by the IBC and the LSC, the capacity for each egress component was calculated for the various doors and stairways that can be found in the Monticello Office Building. The LSC values given for egress widths are slightly larger than the IBC resulting in the use of the LSC for this calculation. Refer to *Table 10* below for the allowable egress widths as provided by the building codes.

Table 10: Allowable Egress Widths

Component	Egress Width (inches per occupant)	
	IBC Table 1005.1	LSC Table 7.3.3.1
Stairways	0.2	0.3
All Other Egress Components	0.15	0.2

It is observed from the results in the following table, *Table 11*, the capacity of the egress components are able to accommodate the calculated occupant load determined in the previous section. For example, the maximum allowable capacity of the two stairways on the third floor is 400 people. As documented in *Table 10*, the maximum occupant load of the third floor is 389 people, which is less than the maximum capacity of that floor.

Table 11: Calculated Egress Widths

Floor	Occupancy	Component	Quantity/Size	Capacity
1	Business	Stairways	(1) 60"	200
		Level Components	(1) 42"	210
	Assembly	Level Components	(6) 34" (9) 34"	510 1530
2	Business	Stairways	(2) 60"	400
		Level Components	(1) 72" (2) 42"	240 420
3	Business	Stairways	(2) 60"	400
		Level Components	(2) 42"	420
4	Business	Stairways	(2) 60"	400
		Level Components	(2) 42"	420
5	Business	Stairways	(2) 60"	400
		Level Components	(2) 42"	420

ACCESSIBLE MEANS OF EGRESS

In accordance with the IBC and LSC, for each accessible space within the building at least two accessible means of egress are provided. Where more than one means of egress is required from an accessible space, all of the additional means of egress shall also be accessible.

- IBC (2006) **1007.1**: Accessible means of egress shall comply with this section. Accessible spaces shall be provided with not less than one accessible means of egress. Where more than one means of egress is required by Section 1015.1 or 1019.1 from any accessible space, each accessible portion of the space shall be served by not less than two accessible means of egress.
- LSC (2009) **7.5.4.1**: Areas accessible to people with severe mobility impairment, other than in existing buildings, shall have not less than two accessible means of egress, unless otherwise provided in 7.5.4.1.2 through 7.5.4.1.4.

LSC (2009) **7.5.4.1.1**: Access within the allowable travel distance shall be provided to not less than one accessible area of refuge or one accessible exit providing an accessible route to an exit discharge.

BUILDING CODE DEFINITIONS

ACCESSIBLE MEANS OF EGRESS

- IBC (2006) **1002**: A continuous and unobstructed way of egress travel from any accessible point in a building or facility to a public way.
- LSC (2009) **3.3.170**: A continuous and unobstructed way of travel from any point in a building or structure to a public way consisting of three separate and distinct parts: (1) the exit access, (2) the exit, and (3) the exit discharge.

COMMON PATH OF TRAVEL

The maximum common path of travel for this building, in accordance with the applicable building codes, are 75 feet for the assembly space and 100 feet for all other spaces located in the building. As the majority of the Monticello Office Building is open office space, the common path of egress never exceeds the maximum allowable distances.

- IBC (2006) **1014.3**: In occupancies other than Groups H-1, H-2 and H-3, the common path of egress travel shall not exceed 75 feet (22 860 mm). In Group H-1, H-2 and H-3 occupancies, the common path of egress travel shall not exceed 25 feet (7620 mm). For common path of egress travel in Group A occupancies having fixed seating, see Section 1025.8.

Exception:

(1) The length of a common path of egress travel in Group B, F and S occupancies shall not be more than 100 feet (30 480 mm), provided that the building is equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.

- LSC (2009) **A.7.6**: Table A.7.6 (*Table 12*) is a compilation of the requirements of the individual occupancy chapters (Chapters 12 through 42) for permissible length of common path of travel, dead-end corridors, and travel distance to not less than one of the required exits.

Table 12: Common Path Limits (LSC, Table A.7.6)

Type of Occupancy	Common Path Limit	
	Unsprinklered	Sprinklered
Assembly	20 / 75	20 / 75
Business	75	100

BUILDING CODE DEFINITIONS

COMMON PATH OF TRAVEL

- IBC (2006) **1002**: That portion of exit access which the occupants are required to traverse before two separate and distinct paths of egress travel to two exits are available. Paths that merge are common paths of travel. Common paths of egress travel shall be included within the permitted travel distance.
- LSC (2009) **3.3.47**: The portion of exit access that must be traversed before two separate and distinct paths of travel to two exits are available.

EXIT ACCESS TRAVEL DISTANCE

The maximum travel distance for this building, in accordance with the applicable building codes, is 250 feet for the assembly space and 300 feet for all other spaces located in the building. The travel distances to an exit at building grade or a stair enclosure does not exceed the maximum allowable distances for this building.

- IBC (2006) **1016:** Exits shall be so located on each story such that the maximum length of exit access travel, measured from the most remote point within a story to the entrance to an exit along the natural and unobstructed path of egress travel, shall not exceed the distances given in Table 1016.1 (*Table 13*).

Table 13: Travel Distance Limits (IBC, Table 1016.1)

Type of Occupancy	Travel Distance Limit	
	Unsprinklerd	Sprinklered
Assembly	200	250
Business	200	300

- LSC (2009) **A.7.6:** Table A.7.6 (*Table 14*) is a compilation of the requirements of the individual occupancy chapters (Chapters 12 through 42) for permissible length of common path of travel, dead-end corridors, and travel distance to not less than one of the required exits.

Table 14: Common Path Limits (LSC, Table A.7.6)

Type of Occupancy	Travel Distance Limit	
	Unsprinklerd	Sprinklered
Assembly	200	250
Business	200	300

BUILDING CODE DEFINITIONS

EXIT ACCESS

- IBC (2006) **1002:** That portion of a means of egress system that leads from any occupied portion of a building or structure to an exit.
- LSC (2009) **3.3.82:** That portion of a means of egress that leads to an exit.

CORRIDORS

The Monticello Office Building contains only a few corridors throughout the building. Where corridors do exist, they can all be found on the first floor only. One corridor is located on the far east side; connecting the stair enclosure with the exterior door. Additional corridors can be found in the mechanical and kitchen areas located on the west side of the first floor. Refer to *Appendix A* for the first floor plan layout. These corridors are in compliance with the applicable building codes as detailed below.

WIDTHS

- IBC (2006) **1017.2**: The minimum corridor width shall be as determined in Section 1005.1, but not less than 44 inches (1118 mm).
 - LSC (2009) **12.2.3.8**: The width of any exit access corridor serving 50 or more persons shall be not less than 44 in. (1120 mm).
- LSC (2009) **38.2.3.2**: The clear width of any corridor or passageway serving an occupant load of 50 or more shall be not less than 44 in.(1120 mm)

DEAD ENDS

- IBC (2006) **1017.3**: Where more than one exit or exit access doorway is required, the exit access shall be arranged such that there are no dead ends in corridors more than 20 feet (6096mm) in length.

Exception:

- (2) In occupancies in Groups B and F where the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, the length of dead-end corridors shall not exceed 50 feet (15 240 mm).
- LSC (2009) **A.7.6**: Table A.7.6 (*Table 15*) is a compilation of the requirements of the individual occupancy chapters (Chapters 12 through 42) for permissible length of common path of travel, dead-end corridors, and travel distance to not less than one of the required exits.

Table 15: Dead End Limits (LSC, Table A.7.6)

Type of Occupancy	Dead-End Limit	
	Unsprinklerd	Sprinklered
Assembly	20	20
Business	20	50

BUILDING CODE DEFINITIONS

DEAD ENDS

- LSC (2009) **A.7.6**: A dead end exists where an occupant enters a corridor thinking there is an exit at the end and, finding none, is forced to retrace the path traveled to reach a choice of egress travel paths.

NUMBER OF EXITS

The number of exits for this building was designed based on the minimum requirements of the applicable building codes. The IBC and the LSC require a minimum of two (2) exits for areas where the occupant load is 500 people or less and a minimum of three (3) exits for areas where the occupant load is between 501 to 1000 people. The only floor that exceeds 500 occupants is the first floor. On this floor it can be seen that the number of exits provided is in excess of the minimum number as stated in the IBC and the LSC.

- IBC (2006) **1019.1**: Minimum number of exits. All rooms and spaces within each story shall be provided with and have access to the minimum number of approved independent exits required by *Table 16* (IBC Table 1019.1) based on the occupant load of the story

Table 16: Minimum Number of Exits (IBC, Table 1019.1)

Occupant Load (persons per story)	Minimum Number of Exits (per story)
1-500	2
501-1,000	3

- LSC (2009) **7.4.1.2**: The number of means of egress from any story or portion thereof, other than for existing buildings as permitted in Chapters 11 through 43, shall be as follows:
 - (1) Occupant load more than 500 but not more than 1000 —not less than 3
 - (2) Occupant load more than 1000 — not less than 4

LSC (2009) **38.2.4.1**: Not less than two separate exits shall be provided on every story.

EXIT DISCHARGE

Exit doors located in the Monticello Office Building discharge directly to the exterior of the building at grade. A maximum of 50% of the number and capacity of required egress enclosures is permitted to egress through areas on the level of discharge in accordance with the exception noted in the IBC.

- IBC (2006) **1024.1**: Exits shall discharge directly to the exterior of the building. The exit discharge shall be at grade or shall provide direct access to grade. The exit discharge shall not reenter a building.

Exceptions:

- (1) A maximum of 50 percent of the number and capacity of the exit enclosures is permitted to egress through areas on the level of discharge
- LSC (2009) **7.7.2**: Exits shall be permitted to discharge through interior building areas, provided that all of the following are met:

Exceptions:

- (1) Not more than 50 percent of the required number of exits, and not more than 50 percent of the required egress capacity, shall discharge through areas on any level of discharge.

BUILDING CODE DEFINITIONS

EXIT DISCHARGE

- IBC (2006) **1002**: That portion of a means of egress system between the termination of an exit and a public way.
- LSC (2009) **3.3.83**: That portion of a means of egress between the termination of an exit and a public way.

LSC (2009) **3.3.83.1**: Level of Exit Discharge. The story that is either (1) the lowest story from which not less than 50 percent of the required number of exits and not less than 50 percent of the required egress capacity from such a story discharge directly outside at the finished ground level; or (2) where no story meets the conditions of item (1), the story that is provided with one or more exits that discharge directly to the outside to the finished ground level via the smallest elevation change.

ELEVATORS

The Monticello Office Building contains a bank of elevators in the center of the business wing that ascend to all 5 floors of the building. Due to the number of stories for this building, the elevators were required to satisfy the building code requirement that an elevator shall be provided as an accessible means of egress for buildings exceeding 4 stories. Refer to *Figure 11* below for the location of elevator shafts in relation to the entire building layout.

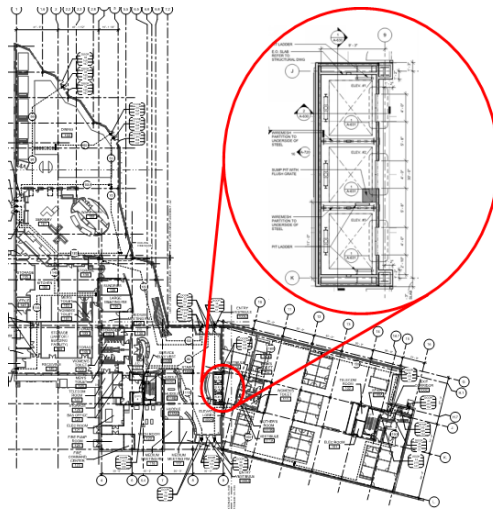


Figure 11: First Floor Layout with Elevators

- IBC (2006) **1007.2.1**: In buildings where a required accessible floor is four or more stories above or below a level of exit discharge, at least one required accessible means of egress shall be an elevator complying with Section 1007.4.
- IBC (2006) **1007.4**: In order to be considered part of an accessible means of egress, an elevator shall comply with the emergency operation and signaling device requirements of Section 2.27 of ASME A17.1. Standby power shall be provided in accordance with Sections 2702 and 3003. The elevator shall be accessed from either an area of refuge complying with Section 1007.6 or a horizontal exit.

EXIT SIGNS

An occupant unfamiliar with a building can become confused and disoriented when egressing a building during a fire event. In order to aid occupants during the egress process, and in accordance with the applicable codes, exit signs are provided throughout the Monticello Office Building. The illuminated signs installed in the building, shown in *Figure 12 and 13* below, provide the occupants a directional path to the nearest exit. Refer to *Appendix B* for the location of all exit sign within this building.

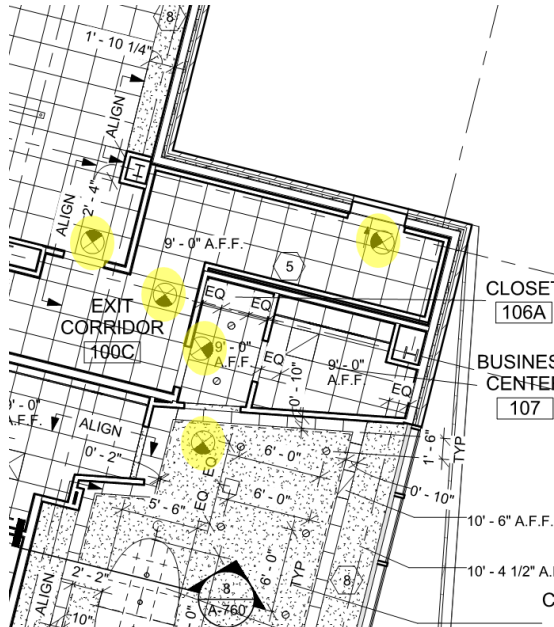


Figure 12: First Floor East Layout with Exit Signs



Figure 13: Photo of Existing Exit Signs

- IBC (2006) **1011**: Exits and exit access doors shall be marked by an approved exit sign readily visible from any direction of egress travel. Access to exits shall be marked by readily visible exit signs in cases where the exit or the path of egress travel is not immediately visible to the occupants. Exit sign placement shall be such that no point in a corridor is more than 100 feet (30 480 mm) or the listed viewing distance for the sign, whichever is less, from the nearest visible exit sign.
- LSC (2009) **7.10.1.2.1**: Exits, other than main exterior exit doors that obviously and clearly are identifiable as exits, shall be marked by an approved sign that is readily visible from any direction of exit access.

LSC (2009) **7.10.1.2.2**: Horizontal components of the egress path within an exit enclosure shall be marked by approved exit or directional exit sign

AREAS OF REFUGE

Areas of refuge are located within the building to provide occupants that are unable to use the stairways, with a temporary waiting location. The areas of refuge for this building are located on the main landings of each stair enclosure from the second floor and above. Also, an area of refuge is located within the elevator vestibule on each floor.

- LSC (2009) **7.2.12.3.1**: Each area of refuge shall be sized to accommodate one wheelchair space of 30 in. × 48 in. (760 mm × 1220 mm) for every 200 occupants, or portion thereof, based on the occupant load served by the area of refuge. Such wheelchair spaces shall maintain the width of a means of egress to not less than that required for the occupant load served and to not less than 36 in. (915 mm).

BUILDING CODE DEFINITIONS

AREA OF REFUGE

- IBC (2006) **1002**: An area where persons unable to use stairways can remain temporarily to wait instructions or assistance during emergency evacuation.
- LSC (2009) **3.3.3.22**: An area that is either (1) a story in a building where the building is protected throughout by an approved, supervised automatic sprinkler system and has not less than two accessible rooms or spaces separated from each other by smoke-resisting partitions; or (2) a space located in a path of travel leading to a public way that is protected from the effects of fire, either by means of separation from other spaces in the same building or by virtue of location, thereby permitting a delay in egress travel from any level.

EGRESS SUMMARY

The prescriptive analysis of the egress components of the building has shown that the building has been designed and installed in accordance with the applicable building codes. Utilizing both the Life Safety Code (LSC) and the International Building Code (IBC) allowed for the most conservative approach to designing this building. As discussed previously, whichever code section is more stringent, that particular code would be used resulting in a safer building. In the next section, a detailed analysis of the fire alarm systems of the building will be discussed.

FIRE DETECTION AND ALARM SYSTEMS

In accordance with the IBC and LSC, a fire alarm system for this building is required. Based on this requirement, a fire alarm system was designed and installed to comply with the IBC, LSC and the Monticello Office standards. The building is equipped with a fully functional fire detection and alarm system comprised of automatic and manual fire alarm initiating devices and evacuation devices. Refer to *Appendix F* for fire alarm details and drawings showing the locations of all associated components.

- **IBC (2006) 907.2:** An approved manual, automatic or manual and automatic fire alarm system installed in accordance with the provisions of this code and NFPA 72 shall be provided in new buildings and structures in accordance with Sections 907.2.1 through 907.2.23 and provide occupant notification in accordance with Section 907.9, unless other requirements are provided by another section of this code. Where automatic sprinkler protection installed in accordance with Section 903.3.1.1 or 903.3.1.2 is provided and connected to the building fire alarm system, automatic heat detection required by this section shall not be required. The automatic fire detectors shall be smoke detectors. Where ambient conditions prohibit installation of automatic smoke detection, other automatic fire detection shall be allowed.

IBC (2006) 907.2.2: Group B. A manual fire alarm system shall be installed in Group B occupancies having an occupant load of 500 or more persons or more than 100 persons above or below the lowest level of exit discharge.

- **LSC (2009) 38.3.4.1:** A fire alarm system in accordance with Section 9.6 shall be provided in all business occupancies where any one of the following conditions exists:
 - (1) The building is three or more stories in height.
 - (2) The occupancy is subject to 50 or more occupants above or below the level of exit discharge.
 - (3) The occupancy is subject to 300 or more total occupants.

FIRE ALARM CONTROL PANEL

The main fire alarm component of the building is the fire alarm control panel (FACP). The FACP is manufactured by GE Security/EST and the specific model is an EST3. The FACP is located in the Fire Command Center located on the south side of the first floor near the fire riser room. Refer to *Figure 14* for the location of the FACP and *Figure 15* for the used FACP for this building.

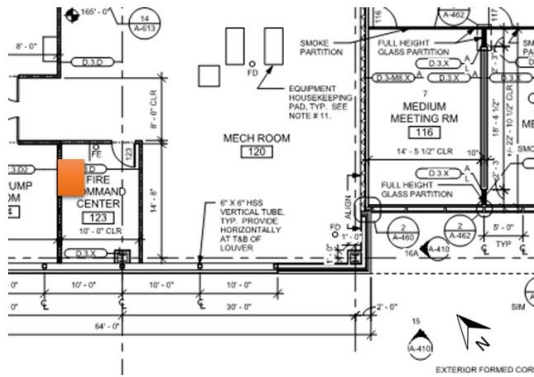


Figure 14: Fire Alarm Control Panel Location



Figure 15: EST3 Control Panel

The Fire Alarm Control Panel (FACP) provides the monitoring and control of all fire alarm system devices located within the building. The fire alarm initiating devices (manual pull station, smoke detector, etc.) in the building are individually addressable. Whenever an alarm is initiated, the individual device location and device type is immediately identified. The fire alarm system is connected to the site EST fire alarm network to provide centralized reporting of alarm, supervisory and trouble conditions to the Client's Central Alarm Station and the Local Central Station.

The FACP provides the direct control of all audible and visual evacuation devices located throughout the building. Also, this voice evacuation type fire alarm system has the capability to make announcements for mass notification.

BUILDING CODE DEFINITIONS

ADDRESSABLE DEVICE

- NFPA 72 (2010) **3.3.4**. A fire alarm system component with discrete identification that can have its status individually identified or that is used to individually control other functions.

FIRE COMMAND CENTER

- NFPA 72 (2010) **3.3.96**. The principal attended or unattended location where the status of the detection, alarm communications, and control systems is displayed and from which the system(s) can be manually controlled.

SIGNALS

- NFPA 72 (2010) **3.3.240**. A status indication communicated by electrical or other means.
 - 3.3.240.1 **Alarm Signal**. A signal indicating an emergency condition or an alert that requires action.
 - 3.3.240.6 **Supervisory Signal**. A signal indicating the need for action in connection with the supervision of guard tours, the fire suppression systems or equipment, or the maintenance features of related systems.
 - 3.3.240.7 **Trouble Signal**. A signal initiated by a system or device indicative of a fault in a monitored circuit, system, or component.

INITIATING DEVICES

Initiating devices, as defined by NFPA 72, are system components that originate the transmission of a change-of-state condition, such as in a smoke detector, manual fire alarm box, or supervisory switch. The Monticello Office Building utilizes a various number of devices, all addressable, that will indicate to the main fire alarm control panel that an unwanted occurrence is happening at some location in the building i.e. smoke, heat, or valve tampering. The subsequent sections indicate the types of devices used and the purpose of each.

MANUAL FIRE ALARM BOX

Manual pull stations, or fire alarm boxes (*Figure 16*), are provided at the ground floor exits and at the entrance to each stair tower on all floors. Additional pull stations are provided as required to ensure that the horizontal travel distance from any point in the building to the nearest pull station does not exceed 200 feet, per NFPA 72 Section 17.14.8. Refer to *Appendix F* for fire alarm drawings that indicate the locations of all fire alarm boxes.



Figure 16. Fire Alarm Box

- NFPA 72 (2010) **3.38.3:** Definition. Manual Fire Alarm Box. A manually operated device used to initiate a fire alarm signal.
- NFPA 72 (2010) **17.14.8:** Additional manual fire alarm boxes shall be provided so that the travel distance to the nearest fire alarm box will not be in excess of 200 ft (61.0 m), measured horizontally on the same floor.

SPOT-TYPE SMOKE DETECTORS



Smoke detectors, *Figure 16*, are located in open office areas, corridors, copy rooms, telecommunication rooms, elevator lobbies, electrical rooms, corridors, copy rooms, telecommunication rooms and electrical rooms. Area smoke detectors are also installed in elevator lobbies, and in elevator machine rooms for automatic elevator recall. Refer to *Appendix F* for fire alarm drawings that indicate the locations of all smoke detectors.

Figure 16: Smoke Detector

- NFPA 72 (2010) **3.59.21:** Definition. A device in which the detecting element is concentrated at a particular location. Typical examples are bimetallic detectors, fusible alloy detectors, certain pneumatic rate-of-rise detectors, certain smoke detectors, and thermoelectric detector.

HEAT DETECTORS



Heat Detectors, *Figure 18*, are located in elevator machine rooms and elevator hoistways. In addition, heat detectors are installed in break rooms, kitchenettes, preaction system protected areas and similar rooms which may cause smoke detector false alarms. Refer to *Appendix F* for fire alarm drawings that indicate the locations of all heat detectors.

Figure 18: Heat Detector

- NFPA 72 (2010) **3.3.59.9:** Definition. A fire detector that detects either abnormally high temperature or rate of temperature rise, or both.

WATER FLOW SWITCH

Water flow switches, *Figure 19*, are devices located on the wet sprinklers system, where under a fire or test condition the device would recognize the flow of water in the piping network. The water flow detection switches will transmit an alarm signal to the building fire alarm control panel upon detection of water flow.



Figure 19: Water Flow Switch

PRESSURE SWITCH

Pressure switches, *Figure 20*, can be found on the single-interlock preaction system. A loss of air pressure within the dry pipe system would activate this device causing the device to transmit a signal to the fire alarm control panel. Additional information regarding the purpose of this device can be found in the single-interlock preaction system section of this report.



Figure 20: Pressure Switch

TAMPER SWITCH

All valves controlling water supplies to the wet pipe and preaction sprinkler systems are provided with tamper detection devices, *Figure 21*. A trouble/supervisory signal will be transmitted to the building fire alarm control panel upon detection of an unauthorized valve closure or open, depending on the function of the associated valve.



Figure 21: Control Valve with Tamper Switch

NOTIFICATION DEVICES



Notification devices as defined by NFPA 72, are fire alarm components such as a bell, horn, speaker, light, or text display that provides audible, tactile, or visual outputs, or any combination thereof. The Monticello Office Building contains a combination speaker/strobe device, *Figure 22*, which is provided throughout the building. This device provides both the visual and audible notifications as required by the design parameters of the building fire alarm system.

The notification devices are located in corridors, lobbies, rest rooms, conference rooms, copy rooms, open office areas and in all other common areas of the building to meet the requirements of the Americans For Disabilities Act (ADA) and NFPA 72.

Figure 22: Speaker/Strobe

AUDIBLE EVACUATION DEVICES (SPEAKERS)

The audible portion of the speaker/strobe device is to provide an audible signal to notify an occupant that an event is occurring in the building and they should begin to exit immediately. To determine the minimum sound output of the device, 15 dBA must be added to the average ambient sound level of an area. The table below, *Table 17*, shows the ambient sound levels detailed by NFPA 72 as it pertains to this building.

Table 17: Average Ambient Sound Level According to Location

Average Ambient Sound Level According to Location (NFPA 72, Table A.18.4.3)	
Location	Average Ambient Sound Level (dBA)
Business Occupancies	55
Mechanical Rooms	85
Places of Assembly	55
Storage Occupancies	30

NFPA 72 requires that the devices meet a particular set of requirements including the spacing of the devices, sound levels, installation, etc. In addition to the provisions detailed in NFPA 72, the devices shall also comply with the manufacturer's recommendations and requirements. An example of the manufacturer's recommendation for the suggested sound levels, duration and spacing can be seen in the following image, *Figure 23*.

Speaker Application

The suggested sound pressure level for each signaling zone used with alert or alarm signals is a minimum of 15 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds, whichever is greater. This is measured 5 feet (1.5 m) above the floor. The average ambient sound level is the RMS, A-weighted sound pressure measured over a 24-hour period.

Doubling the distance from the signal to the ear will theoretically cause a 6dB reduction in the received sound pressure level. The actual effect depends on the acoustic properties of materials in the space. Doubling the power output of a device (e.g.: a speaker from 1W to 2W) will increase the sound pressure level by 3dBA. A 3dBA difference represents a barely noticeable change in volume.

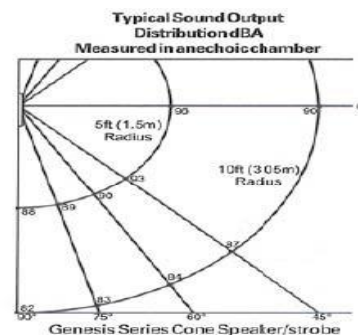


Figure 23: Genesis Speaker/Strobe Application Detail

VISUAL EVACUATION DEVICES (STROBES)

The visual portion of the devices is to provide a visual signal to notify occupants that an event is occurring in the building and they should begin to exit immediately. The spacing requirements and the required light output for the used ceiling mounted strobes are in accordance with the following table, *Table 18*. In this table, NFPA 72 details the minimum light output required for a particular room size and device height.

Table 18: Room Spacing for Ceiling-Mounted Strobes (NFPA 72, Table 18.4.3.1(b))

Room Spacing for Ceiling-Mounted Visible Appliances. Not all inclusive (NFPA 72, Table 18.4.3.1(b))		
Maximum Room Size (ft)	Maximum Lens Height (ft)	Minimum Required Light Output (Effective Intensity): One Light (cd)
20 x 20	10	15
30 x 30	10	30
40 x 40	10	60
44 x 44	10	75
50 x 50	10	95
53 x 53	10	110
55 x 55	10	115

Similar to the audio function of the device, the speaker/strobe devices have been installed in accordance with the manufacturer’s recommendations. An example of the spacing requirements per the manufacturer (Genesis) can be found below.

Strobe Spacing

The following guidelines are based on ANSI/NFPA 72 *National Fire Alarm Code* (1999). When applied and installed in accordance with that code, Genesis strobes meet or exceed the illumination produced by the ADA-specified 75 candela (cd) strobe at 50 feet.*

Non-Sleeping Rooms	EST wall mounted strobes*
Up to 20' x 20' (6.1 m x 6.1 m)	One 15 cd strobe
Up to 30' x 30' (9.1 m x 9.1 m)	One 30 cd or two 15 cd strobes
Up to 40' x 40' (12.2 m x 12.2 m)	One 75 cd or two 30 cd strobes
Up to 50' x 50' (15.2 m x 15.2 m)	One 110 cd or two 75 cd strobes
Corridors	
Any length. Maximum width: 20' (6.1m).	15 cd strobes spaced at 100' (30.5 m) max. Strobes must be placed within 15' (4.5m) of each end of the corridor.

* ADA suggests using 75 cd strobes throughout an area, with spacing that never exceeds 50ft from the strobe to any point in the protected space.

Figure 24: Genesis Strobe Spacing Detail

SEQUENCE OF OPERATIONS

The sequence of operations is the description of actions that will occur once a particular device activates. The following image, *Figure 25*, illustrates the fire alarm sequence of events for the Monticello Office Building provided by the fire alarm contractor. For example, when a smoke detector activates on any particular floor, several actions will occur including the activation of an evacuation message and the initiation of the horn/strobe devices. Elevator recall signal, elevator power disconnect, and activation of the system alarm will also occur during this event.

This specific matrix has been rejected during the construction submittal process by the engineer of record due to various missing components and the broadness of other particular components. For example, sprinkler water flow switch, pressure switches, tamper switches, and trouble signals are missing from the following table. Refer to *Appendix F* for the full matrix located on sheet “Fire Alarm Devices Termination Details”

INPUT OR FUNCTION	RESULT OR ACTION																				
	CHANNEL																				
	1	2	3	4	5	COMMON ALARM SIGNAL	STROBE OUTPUT ACTIVATION/ALL STROBES	DOOR HOLD RELAY (ON ALARM FLOOR ONLY)	EGRESS DOORS FIRE ALARM SIGNAL	EGRESS DOORS FIRE ALARM SIGNAL	ELEVATOR RECALL SIGNAL	ALTERNATE ELEVATOR RECALL SIGNAL	ELEVATOR POWER DISCONNECT	SHUTDOWN ASSOCIATED FAN UNIT	UNLOCK ESD DOOR	TEST FIRE CONTROL	TEST SUPERVISORY CONTROL	TEST PHONE CALL-IN CONTROL	TEST STATUS ZONE CONTROL	TEST STATUS ZONE CONTROL	
SMOKE DETECTOR	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
HEAT DETECTOR	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DUCT SMOKE DETECTOR	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPRINKLER MONITORING																					
FIRE PUMP MONITORING																					
MANUAL PULL STATION	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ANSUL HOOD MONITORING	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Figure 25: Sequence of Operations

MASS NOTIFICATION SYSTEM

In accordance with the Monticello Building standards, a mass notification system was required and implemented for this building. The FACP, as stated previously, has the capabilities of broadcasting notifications via a phone connected to the panel. This allows the operator in the fire command center to make emergency announcements throughout the building. In addition to this method, mass e-mails are widely used to notify all employees of any announcements. For example, a mass e-mail would be sent out to notify all employees that a scheduled fire alarm test will occur at a particular date and time.

POWER SUPPLY

A battery calculation was performed to determine if the batteries provided for the alarm systems are sized to be no less than the required minimums as stated in NFPA 72. To perform this analysis, one (1) Notification Appliance Circuit (NAC) was selected. The selected NAC contains a combination of four circuits, S1-S4. Refer to *Appendix F* for fire alarm contractor riser diagram including all notification devices per circuit.

The following tables 19-21 were used to determine the total system alarm currents, the required alarm current, and the required battery capacity.

Table 19: Calculated System Alarm Currents (S1-S4)

Item	Description	Standby Current Per Unit		QTY		Total Standby Current Per Unit (AMPS)	Total Alarm Current Per Unit (AMPS)		QTY		Total System Alarm Current (AMPS)
A	Speaker/Strobe 15 cd	0	x	1	=	0	0.059	x	1	=	0.059
B	Speaker/Strobe 30 cd	0	x	9	=	0	0.088	x	9	=	0.792
C	Speaker/Strobe 95 cd	0	x	18	=	0	0.192	x	18	=	3.456
D	Speaker/Strobe 110 cd	0	x	5	=	0	0.11	x	5	=	0.55
Total System Standby Current						0	Total System Alarm Current				4.857

Table 20: Calculated Required Alarm Current (S1-S4)

Required Standby Time (Hours)		Total System Standby Current (AMPS)		Required Standby Capacity (AMP-Hours)	Required Alarm Time (Hours)		Total System Alarm Current (AMPS)		Required Alarm Current (AMP-Hour)
24	x	0	=	0	0.0833	x	1	=	0.4045881

Table 21: Calculated Battery Capacity (S1-S4)

Required Standby Capacity (AMP-Hour)		Required Alarm Capacity (AMP-Hour)		Total Required Capacity (AMP-Hours)		Safety Factor		Required Battery Capacity (AMP-Hour)
0	x	0.4045881	=	0.4045881	x	1.2	=	0.48550572

Based on the results from the above tables, the required battery capacity for the calculated NAC S1-S4 is 0.4855 AMP-hours. The fire alarm contractor has supplied a 12 volt, 7 AMP-hour battery, *Figure 26*, for the use of these 4 circuits (S1-S4). This battery size is more than sufficient to meet the requirements of NFPA 72.



Figure 26: UB 1270 Battery (12 V, 7 Amp)

INSPECTION, TESTING, AND MAINTENANCE

All components of the fire alarm system have some type of inspection, testing and maintenance requirements to assure that all components are and will continue to be in working condition. The following section will include several of the NFPA 72 requirements for the inspection, testing, and maintenance of alarm notification appliances.

- NFPA 72 (2010) **14.1.1:** The inspection, testing and maintenance of systems, their initiating devices, and notification appliances shall comply with the requirements of chapter (14).

INSPECTION

- NFPA 72 (2010) **14.3.1** Unless otherwise permitted by 14.3.2 visual inspection shall be performed in accordance with the schedules in Table 14.3.1 or more often if required by the authority having jurisdiction.
- NFPA 72 (2010) **14.3.2** Devices or equipment that is inaccessible for safety considerations (e.g., continuous process operations, energized electrical equipment, radiation, and excessive height) shall be permitted to be inspected during scheduled shut-downs if approved by the authority having jurisdiction.
- NFPA 72 (2010) **14.3.3** Extended intervals shall not exceed 18 months.
- NFPA 72 (2010) **14.3.4** The visual inspection shall be made to ensure that there are no changes that affect equipment performance.

TESTING

AUDIBLE (SPEAKER)



Initial and reacceptance testing shall comply with the following: Sound pressure levels for signals shall be measured with a sound level meter, *Figure 27*, meeting the requirements of ANSI S1.4a. Sound pressure levels throughout the protected area shall be measured to confirm that they are in compliance with Chapter 18 of NFPA 72.

Periodic testing shall comply with the following: sound pressure levels for signals shall be measured with a sound level meter meeting ANSI S1.4a. Sound pressure levels shall be measured for conformity to Chapter 18 where building, system, or occupancy changes have occurred.

Frequency – Initial, Reacceptance and Annually.

Figure 27: Sound Meter

VISUAL (STROBES)

Testing of the visual aspects of the devices shall be performed in accordance with the manufacturer’s published instructions. Device locations shall be verified to be per the approved layout, and it shall be confirmed that no floor plan changes affect the approved layout. It shall also be verified that the candela rating marking agrees with the approved drawing and that each device flashes.

Frequency – Initial, Reacceptance and Annually.

MAINTENANCE

- NFPA 72 (2010) **14.5.1** Systems equipment shall be maintained in accordance with the manufacturer's published instructions.
- NFPA 72 (2010) **14.5.2** The frequency of maintenance of system equipment shall depend on the type of equipment and the local ambient conditions.
- NFPA 72 (2010) **14.5.3** The frequency of cleaning of system equipment shall depend on the type of equipment and the local ambient conditions.

FIRE DETECTION AND ALARM SYSTEM SUMMARY

The prescriptive analysis of the building has shown that the building fire alarm system has been designed and installed in accordance with the applicable building codes including NFPA 72. All Notification and Initiating device have been selected, located and installed to comply with NFPA 72 requirements and the manufacturer's recommendations. The majority of the fire alarm components have been oversized to provide a higher level of safety. In the next section, a detailed analysis of the smoke control systems of the building will be discussed.

SMOKE CONTROL SYSTEM

FIRE SMOKE DAMPERS

As previously stated in the atrium section, a smoke control system is not required by code for an atrium that only connects 2 levels. The smoke control features within this building are limited to the mechanical ventilation system only. A combination fire/smoke damper has been installed at all penetrations into the main mechanical shafts for both the supply and return systems. The purpose of this device is to eliminate the possibility of smoke and fire from circulating throughout the building. Refer to *Figure 30* below for a riser diagram showing several fire smoke damper locations.

The fire smoke dampers, *Figure 29*, for this building are classified as a 1.5 fire rated devices in accordance with the IBC. This rating is used for fire rated wall penetrations that are no more than 3-hour. Due to the shaft enclosure only requiring a minimum 2-hour rated wall, this device rating is acceptable. The smoke portion of the device is classified as a leakage class 1 meaning that the smoke leakage through the closed damper is no more than 11 cfm/ft³ in accordance with IBC section 717.3.2.2.

The fire/smoke damper is operated by either a fusible link that will break upon increased temperatures which would activate the closure. Or, an adjacent smoke detector would signal to the device that smoke is present within the duct work which would also close the damper.

The duct smoke detectors, *Figure 28*, are installed in the supply and return ductwork of the building's air handling units and in each unit's return air ductwork on each floor per NFPA 72 Section 5.16 and NFPA 90A Section 6.4. Return air duct smoke detectors on each floor are located where the floor's return air ductwork intersects each associated common vertical shaft. In addition, duct smoke detectors are installed within 5 feet of any fire/smoke damper.



Figure 28: Duct smoke Detector



Figure 29: Fire/Smoke Damper

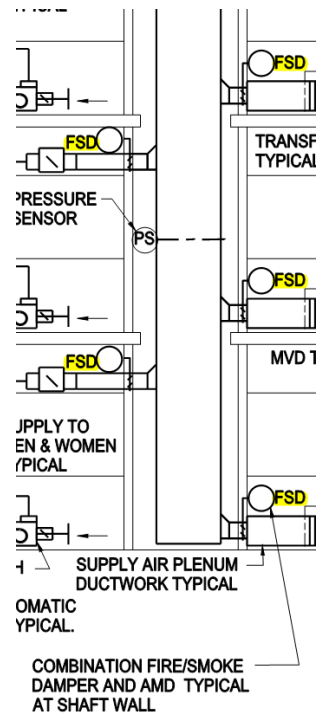


Figure 30: Dampers in Mechanical Shaft

FIRE SUPPRESSION SYSTEMS

The Monticello Office Building is equipped with fully functional fire suppression systems that include water based, chemical suppression systems and fire extinguishers. The water based system, in compliance with NFPA 13, 14, 24 and 25, include wet-pipe sprinklers, preaction sprinklers and standpipe systems. The building also includes a wet chemical system for the kitchen equipment as well as various types of fire extinguishers throughout the facility.

FIRE WATER SUPPLY SYSTEM

Fire water is supplied to the building from a dedicated site fire protection water main system. The site system is supplied by a remote fire booster pump; however, information regarding this pump is unavailable. An 8-inch main is extended from the site fire water main to the mechanical room (fire riser room) at the south side of the building. Refer to *Figure 31* for a diagram of the site fire water distribution system.

UNDERGROUND FIRE MAIN

The underground fire main is a cement-lined ductile iron pipe, Class 52. The underground piping and related devices comply with NFPA 24 (2010), local water authority requirements, and Monticello standards.

POST INDICATOR VALVES

Post Indicator Valves (PIV's) are located in various locations on the site including one on the building incoming service main. In accordance with Monticello standards, the PIV's are required to be at least 40 feet from the building to allow for fire department control of the sprinkler system without entering the building.

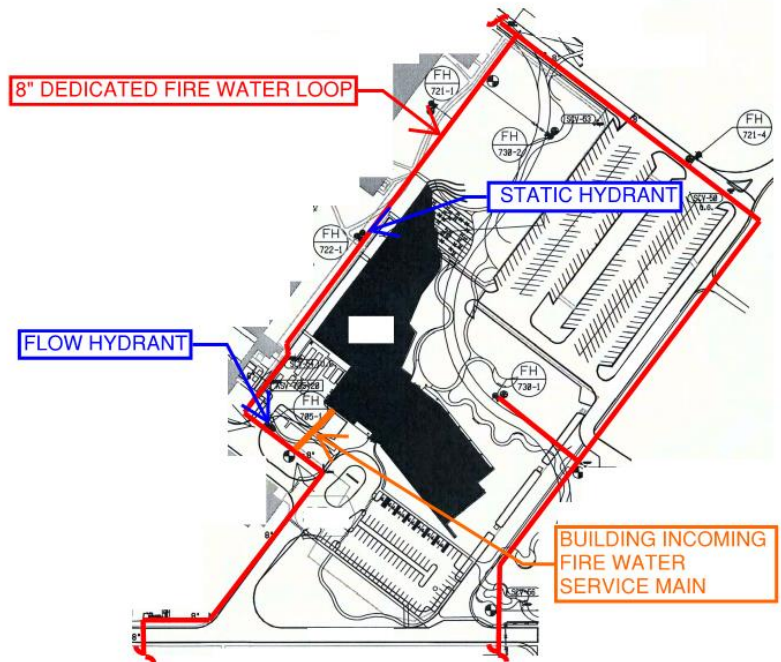
FIRE HYDRANTS



Figure 32: Fire Hydrant

This facility is also protected with fire hydrants, *Figure 32*. Spacing between hydrants in the vicinity of the office buildings is a maximum of 500 feet.

Hydrants are also spaced in that the fire department connection located at the main entrance of the building is within 300 ft of a hydrant.



FIRE DEPARTMENT CONNECTION

A fire department connection (FDC), *Figure 33*, is provided for the building and arranged to supply the standpipes and sprinkler risers throughout the building. The FDC is located at the main entrance of the facility.



Figure 33: Fire Department Connection (Flush)

HYDRANT FLOW TEST DATA

In order to determine the pressure and flows of the existing site system, a hydrant test was performed with the site fire booster pump running. This flow test information was conveyed to the fire protection contractor via the contract documents for use in performing hydraulic calculations for the building sprinklered system. The following table, *Table 22*, shows the information gathered from this test.

Table 22: Fire Hydrant Flow Test

Fire Hydrant Flow Test Data	
Date	July 30, 2010
Location	
• Flow Hydrant	723-4
• Pressure Hydrant	721-3
Outlets Flowed	One - 2 ½" Hose
Static Pressure (psig)	128
Residual Pressure (psig)	99
Flow (gpm)	1216

STANDPIPE SYSTEM

The Monticello Office Building contains a standpipe system installed in accordance with NFPA 14 and IBC requirements. The standpipe system is classified as a Class 1 system where all hose valves, for fire department use only, are provided throughout the building. The hose valves, *Figure 34*, are 2-1/2" and are located at the intermediate landings. In addition to the standpipes in the stairs, additional fire hose valves are provided where fire hose travel distances exceed the maximum allowable distance in accordance with NFPA 14.

- IBC (2009) **905.3.1** Standpipe systems shall be installed where required by Sections 905.3.1 through 905.3.7 and in the locations indicated in Sections 905.4, 905.5 and 905.6. Standpipe systems are allowed to be combined with automatic sprinkler systems.
- IBC (2009) **905.3.1 Building height.** Class III standpipe systems shall be installed throughout buildings where the floor level of the highest story is located more than 30 feet (9144 mm) above the lowest level of fire department vehicle access, or where the floor level of the lowest story is located more than 30 feet (9144 mm) below the highest level of fire department vehicle access.

Exceptions:

Class I standpipes are allowed in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2.



Figure 34: Fire Hose Valve Cabinet

DESIGN CRITERIA

The standpipe water supply system was designed to provide not less than 500 gpm for the first standpipe and 250 gpm for each additional standpipe, with the total demand not to exceed 1,000 gpm in accordance with NFPA 14 requirements.

Per NFPA 14, a minimum 100 psig residual pressure is required to be maintained at the most hydraulically remote hose connection while providing the above flows. This pressure could not be maintained without a fire booster pump being installed for this building. Per the Delaware State Fire Prevention Regulations, a fire pump is not required to be installed merely to satisfy standpipe pressure demands when the building is fully sprinklered.

WET PIPE SPRINKLER SYSTEM

The building is protected throughout with hydraulically calculated sprinkler systems. All areas of the building are protected, including electrical rooms (switchgear, transformers, closets, etc.), machine rooms, loading docks, stair towers and mechanical rooms.

Each floor includes a sprinkler zone connection to the combination sprinkler standpipe system. Refer to *Figure 35* below for a typical stair enclosure riser diagram showing the connection of the sprinkler system to the stair riser pipe.

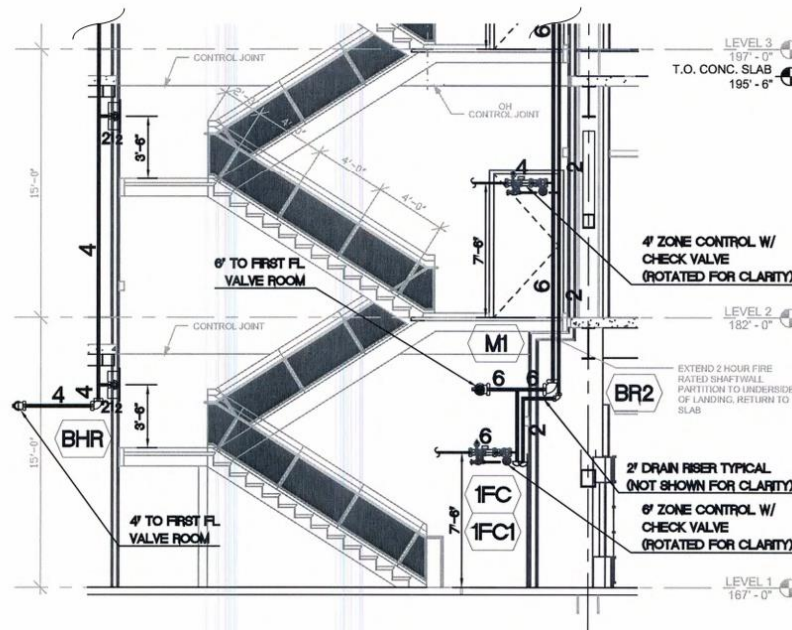


Figure 35: Sprinkler Standpipe Detail

DESIGN CRITERIA

The sprinkler system for this building was designed based on the following criteria found in *Table 23*. The criteria used for this building is above the minimum requirements as described in NFPA 13. The Monticello fire protection standards are loosely based on the requirements of Factory Mutual Global (insurance underwriter), which are more conservative than NFPA 13.

Table 23: Wet Sprinkler System Criteria

WET SYSTEM				
Occupancy/ Area	Design Density (GPM/SQ. FT)	Design Area (SQ. FT)	Area Per Sprinkler (SQ. FT)	Hose Stream (GPM)
General Areas	0.15	2000	130	500
Mechanical/ Electrical	0.15	2000	130	500
Storage Rooms	0.15	2000	130	500

SPRINKLER HEAD TYPE

The wet-pipe sprinkler system for this building contains several different types of sprinkler heads. Refer to the table below, *Table 24*, for the sprinklers used and the characteristics of each.

Table 24: Wet Pipe Sprinkler Types

Area	Response	Type	Orifice (inches)	Temperature (F)
Office/Common Areas	Quick	Pendent/Upright/Sidewall	0.5	165
Mechanical/Electrical	Standard	Upright	0.5	286
Storage Rooms	Standard	Upright	11/32	286
Loading Dock Canopy	Standard	Dry Sidewall	0.5	165

WATER DEMAND

The required water demand for this sprinkler system has been calculated using computer-based hydraulic software (HASS). This program allows the user to input all required information to determine the minimum pressure and flows needed at the test hydrant. The most water demanding area for this building is located on the east side of the 5th floor, *Figure 36*. Refer to *Appendix J* for Computer-based hydraulic calculations and *Appendix N* for an enlarged sprinkler plan.

Based on this calculation, the system's minimum demand information is as follows:

- Pressure Demand 91.67 PSIG
- Sprinkler Demand 616.9 GPM
- Hose Stream Demand 500 GPM
- Total Flow Demand 1116.9 GPM

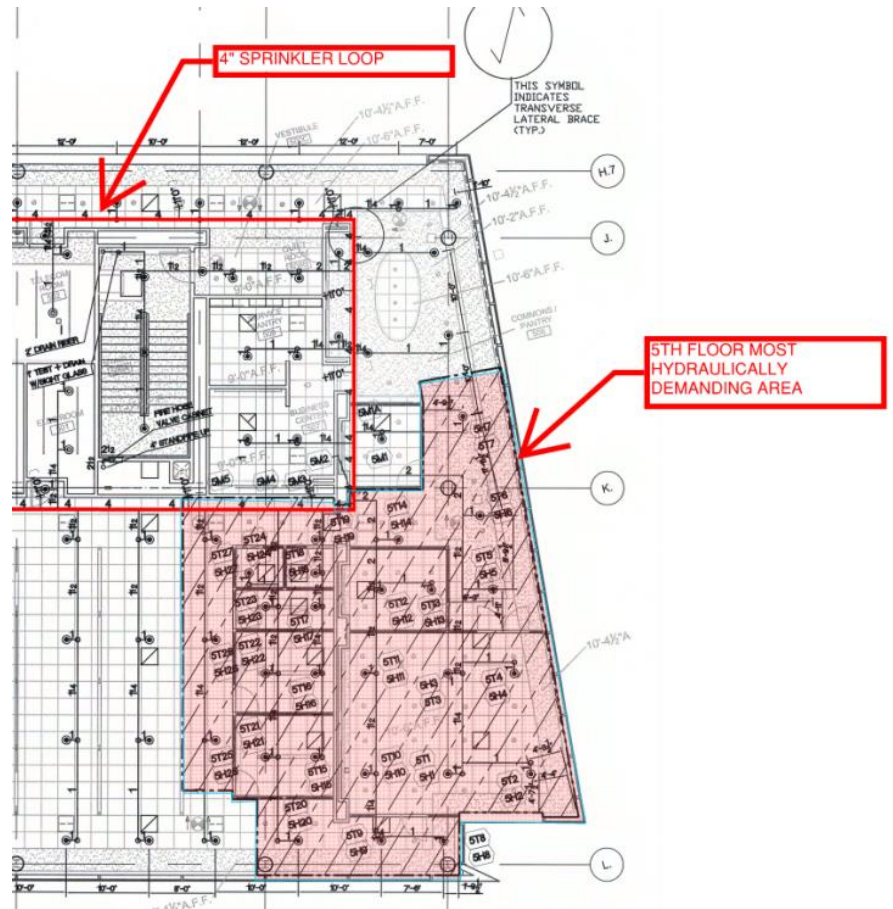


Figure 39: Wet – Most Hydraulically Demanding Area

Plotting the above information onto a Log 1.85 graph and including the existing site water supply curve, it is determined that the actual pressure and flow for the most remote and demanding portion of the system is less than the supply pressures and flows. An additional 10 psi safety factor was added to account for any fluctuations in the site system. In the image below, *Figure 37*, the blue line denotes the sprinkler demand, the red line represents the hose stream and the green line represents the site water supply.

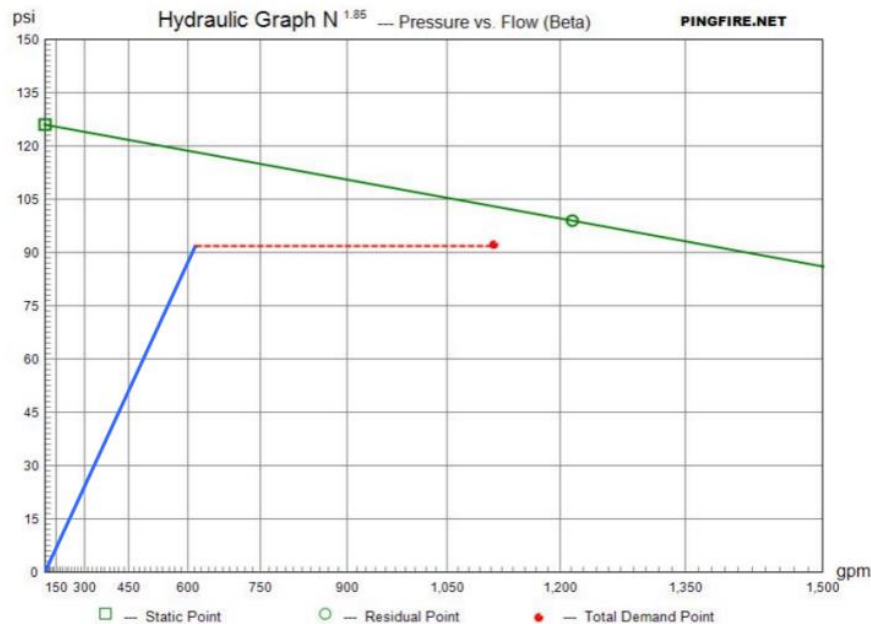


Figure 37: Wet – Water Supply Curve

ELEVATORS

The elevators within this building are all noncombustible electric/traction type; i.e. no hydraulics. The elevator cars comply with ANSI/ASME A17.1 requirements for construction. Therefore in accordance with NFPA 13 requirements for elevators, hoistways are not provided with sprinklers, neither at the top nor the bottom.

- NFPA 13 (2010) **8.15.5.2**: The sprinkler required at the bottom of the elevator hoistway by 8.15.5.1 shall not be required for enclosed, noncombustible elevator shafts that do not contain combustible hydraulic fluids.
- NFPA 13 (2010) **8.15.5.5**: The sprinkler required at the top of the elevator hoistway by 8.15.5.4 shall not be required where the hoistway for passenger elevators is noncombustible or limited-combustible and the car enclosure materials meet the requirements of ASME A17.1, Safety Code for Elevators and Escalators.

Sprinklers are provided in the elevator machine rooms; requiring power shutdown for the effected machine room and its associated hoistways prior to sprinkler discharge in accordance with ANSI/ASME A17.1 "Elevator Safety Code". No shut-off valves are required by NFPA 13 nor ANSI ASME A17.1 for the sprinklers protecting the elevator machine rooms.

- NFPA 13 (2010) **8.15.5.3**: Automatic sprinklers in elevator machine rooms or at the tops of hoistways shall be of ordinary-or intermediate-temperature rating.

RAISED FLOORS

The raised floor used for the Under Floor Air Distribution (UFAD) system is not sprinklered. All power wiring has been installed in conduits and any data/telecommunication cabling is "fire rated" cabling resulting in a noncombustible underfloor space.

- NFPA 13 (2010) **8.15.1.2.1**: Concealed spaces of noncombustible and limited-combustible construction with minimal combustible loading having no access shall not require sprinkler protection.

EXTERIOR LOADING DOCK

The truck loading area with exterior canopy covered platform located on the southwest corner of the building, *Figure 38*, is open to the outside and exposed to freezing conditions. Therefore, this area is protected with dry horizontal sidewall sprinklers connected to the interior wet sprinkler system.

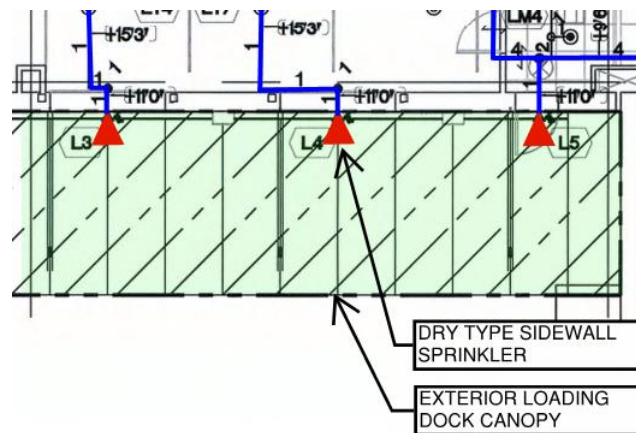


Figure 38: Loading Dock Sprinkler

PREACTION SPRINKLER SYSTEM

The main electrical equipment room on the first floor is provided with a single-interlock preaction system. In order to minimize the possibility of unwarranted operation or inadvertent water damage due to possible pipe leaks, this system was selected.

A single-interlock preaction sprinkler system is a "dry type" sprinkler system which has supervisory air applied to the piping. A detection system is provided in order to actuate the preaction valve and fill the system piping with water. Water will then be discharged when a sprinkler head operates. Both the detection system and the sprinkler system must operate or be damaged before water would be discharged. Damage to the sprinkler piping, alone, will only activate an alarm. The detection system must sense a fire and activate in order for the preaction valve to open, allowing water to start flowing into the piping.

DESIGN CRITERIA

The single-interlock preaction sprinkler system has been hydraulically designed by the fire protection contractor in accordance with the sprinkler design criteria: found in *Table 25* below:

Table 25: Preaction System Criteria

Preaction System Criteria				
Occupancy/Area	Design Density (GPM/SQ.FT)	Design Area (SQ. FT)	Area Per Sprinkler (SQ. FT)	Hose Stream (GPM)
Main Electrical Room	0.15	2000	130	500

SPRINKLER HEAD TYPE

The sprinklers used within the preaction protected area are standard response, upright heads as detailed in following table, *Table 26*. As this electrical space does not include an architectural ceiling, upright style heads are required in accordance with NFPA 13.

Table 26: Preaction Sprinkler Type

Area	Response	Type	Orifice (inches)	Temperature (F)
Electrical	Standard	Upright	0.5	286

HYDRAULIC CALCULATIONS

The required water demand for this preaction system has been calculated using hand calculations based on the Hazen-Williams formula. A complete hydraulic calculation of this system can be found in *Appendix K*.

Based on this calculation, the system's minimum demand information is as follows:

- Pressure Demand 33.5 PSIG
- Sprinkler Demand 126.4GPM
- Hose Stream Demand 500 GPM
- Total Flow Demand 626.4 GPM

ALARMS AND MONITORING

The means of detection for the single-interlock preaction system will be the heat detectors located in the main electrical room. The preaction system is also monitored for loss of air pressure i.e. activation of a sprinkler or pipe leaks. Compressed air is provided as the supervisory means for monitoring leaks or breaks in the preaction system piping. In the event of low air pressure in the system, a supervisory/trouble signal will be transmitted to the local preaction control panel.

HANGING AND BRACING

The hanging, bracing and restraints of the fire protection piping system have been designed and installed in accordance with NFPA 13, Chapter 9. The building has been classified as a seismic design category "b", therefore the sprinkler piping has also been installed to protect against earthquakes. A list of several used hangers and restraints can be found in *Appendix I*.

- NFPA 13 (2010) **9.3.1.1**: Where water-based fire protection systems are required to be protected against damage from earthquakes, the requirements of Section 9.3 shall apply, unless the requirements of 9.3.1.2 are met.

WET CHEMICAL SYSTEM

A wet chemical suppression system (Ansul) is provided in the kitchen area to combat kitchen related fires including grease, animal fats and oils. This system is located directly above the grill and stove area. Refer to *Figure 39* for the location of the Ansul system within the kitchen area on the western portion of the first floor.

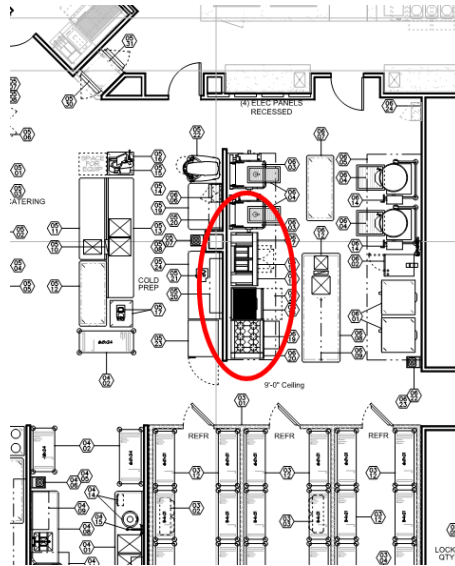


Figure 39: Ansul System Location

The wet chemical system, *Figure 40*, is comprised of a manual alarm box, nozzles, agent cylinder, alarm panel, gas shut off line and miscellaneous piping and detection cabling. Once a fusible link is broken or if the manual alarm box is pulled, the wet chemical agent will discharge directly over the cooking equipment and inside the exhaust duct. Simultaneously, the gas feeding the cooking equipment will be shut off immediately after operation.

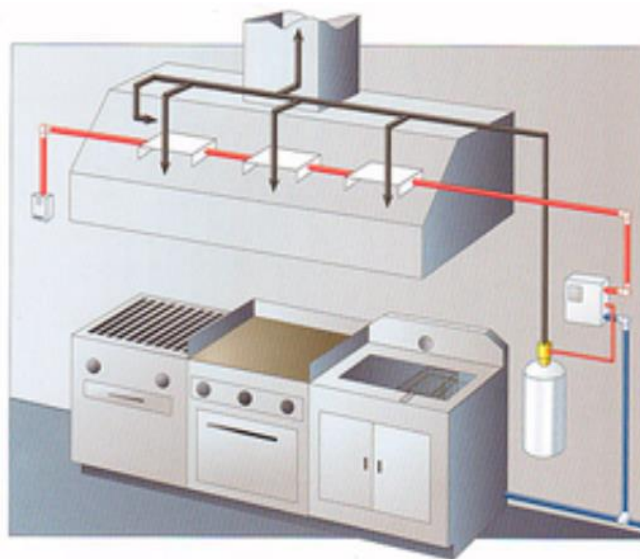


Figure 40: Typical Ansul System

FIRE EXTINGUISHERS

Portable fire extinguishers are provided throughout the building in accordance with NFPA 10 (2009). This building includes three different types of fire extinguishers which include Wet Chemical, Carbon Monoxide and multipurpose type.

- IBC (2069) **906**: Portable fire extinguishers shall be provided throughout the building in accordance with 2009 NFPA 10

WET CHEMICAL

The Wet Chemical extinguishers, *Figure 41*, can be found in the kitchen area to combat class K fire hazards.

- NFPA 10 (2009) **6.6.1**: Class K extinguishers shall be provided for hazards where there is a potential for fires involving combustible cooking media (vegetable or animal oils and fats).
- NFPA 10 (2009) **6.6.1**: Maximum travel distance shall not exceed 30 ft from the hazard to the extinguishers.



Figure 41: Wet Chemical Extinguisher

CARBON MONOXIDE



The CO extinguishers, *Figure 42*, are located in the main electrical room to combat class C fires of energized equipment.

- NFPA 10 (2009) **6.4.1**: Fire extinguishers with Class C ratings shall be required where energized electrical equipment can be encountered.

Figure 42: CO Fire Extinguisher

MULTI-PURPOSE DRY CHEMICAL

The multi-purpose dry chemical extinguishers, *Figure 43*, are found in all locations except otherwise noted in the above sections. These extinguishers are capable of extinguishing Class A, B and C fires.

- NFPA 10 (2010) **6.2.1.1**: Minimal sizes of fire extinguishers for the listed grades of hazards shall be provided on the basis of Table 6.2.1.1, except as modified by 6.2.1.3.1 and 6.2.1.4.



Figure 43: Multi-Purpose Extinguisher

INSPECTION, TESTING, AND MAINTENANCE

SPRINKLER SYSTEM

All inspections, testing and maintenance shall be in accordance with NFPA 25, Owner Standards, and local codes and regulations.

- NFPA 25 (2009) **4.1.1:** The property owner or designated representative shall be responsible for properly maintaining a water based fire protection system.

Refer to *Appendix L* for all items to be inspected, tested and maintained with the appropriate frequency as described by NFPA 25.

FIRE EXTINGUISHERS

INSPECTION

- NFPA 10 (2009) **7.2.1.1:** Fire extinguishers shall be manually inspected when initially placed in service.
- NFPA 10 (2009) **7.2.1.2:** Fire extinguishers shall be inspected either manually or by means of an electronic monitoring device/system at a minimum of 30-day intervals.

MAINTENANCE

- NFPA 10 (2009) **7.3.1.1:** Fire extinguishers shall be subjected to maintenance at intervals of not more than 1 year, at the time of hydrostatic test, or when specifically indicated by an inspection or electronic notification.

WET CHEMICAL SYSTEM

INSPECTION

- NFPA 17a (2009) **7.2:** On a monthly basis, inspection shall be conducted in accordance with the manufacturer's design, installation, and maintenance manual or the owner's manual.

TESTING

- NFPA 17a (2009) **7.3.3.4:** All wet chemical systems shall be tested, which shall include operation of the detection system signals and releasing devices, including manual stations and other associated equipment.

MAINTENANCE

- NFPA 17a (2009) **7.3.3:** At least semiannually and after any system activation, maintenance shall be conducted in accordance with the manufacturer's design, installation, and maintenance manual.

FIRE SUPPRESSION SYSTEMS SUMMARY

The fire suppression systems for the Monticello Office Building has been designed and installed in accordance with the applicable codes and standards. Utilizing the building owner's standards, the sprinkler system has been designed above and beyond the minimum requirements as detailed in NFPA 13. For example, the sprinkler design criteria have been increased for all spaces to closely match Factory Mutual Recommendations. All the fire extinguishers, fume hood system, site fire system, and standpipes have also been designed to provide the highest level of life safety for this building.

PERSCRIPTIVE ANALYSIS SUMMARY

The prescriptive analysis of the Monticello Office Building has shown that the building has been designed and installed in accordance with the applicable building codes and standards. Utilizing both the Life Safety Code (LSC) and the International Building Code (IBC) allowed for the most conservative approach to designing this building. All life safety components in this facility including the fire alarm systems, fire suppression systems, egress components and the structural fire protection has provided an environment in which the occupants are in a safe and protected enclosure which would allow the appropriate safe egress time during a fire event based on the prescriptive codes. To determine if the prescriptive codes truly provide this level of safety, the subsequent section will analyze the performance based design of this building.

Performance Based Analysis

The performance based-design analysis is a review of the fire protection features in a building using methods above and beyond the prescriptive codes to simulate fire scenarios and egress movement. These models are used to determine if the required safe egress time is less than the available safe egress time which is the time required to egress a building prior to untenable conditions. For this project, a combination of hand calculations and computer-based programs, Pathfinder and PyroSim, have been used to analyze the fire protection and egress features of the Monticello Office Building.

EMERGENCY MOVEMENT

The RSET is the amount of time it takes for the building to be fully evacuated. This process begins at the time a fire is ignited to the time when the building is completely empty of all occupants. The RSET is measured by adding the sum of the detection time, alarm (notification time), pre-evacuation time and the actual movement time.

STAGES OF EGRESS MOVEMENT:

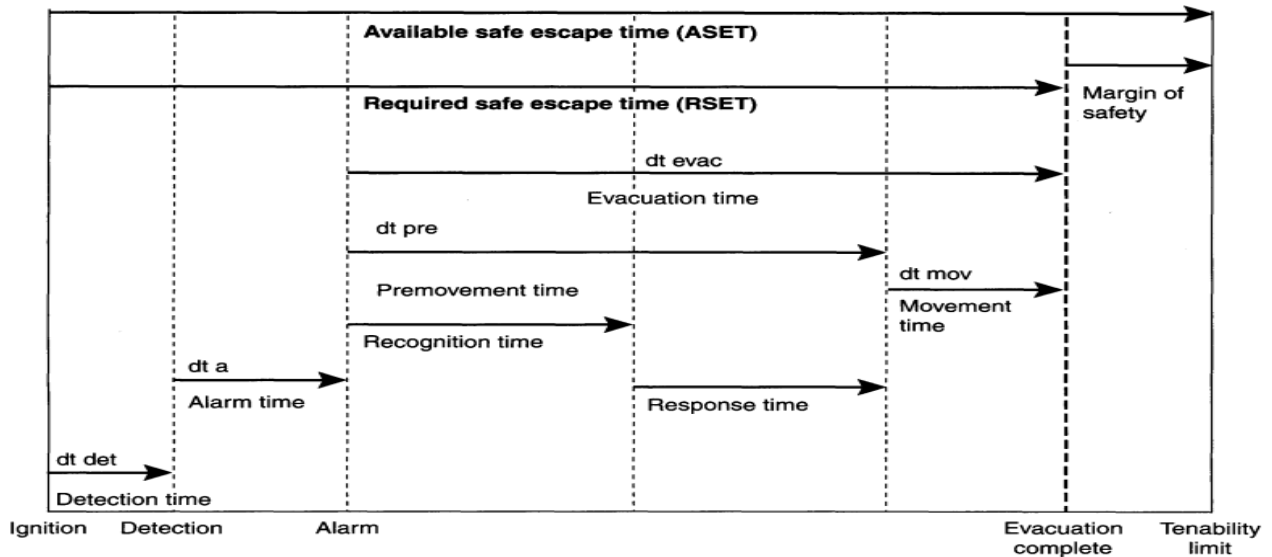


Figure 44: Egress Time Model (SFPE, Figure 3-12.1)

The above image, *Figure 44*, is the egress time model as it is described by the SFPE handbook.

DETECTION TIME

The time from the fire ignition to the point where an alarm sounds or people begin to sense cues i.e. smell of smoke or the sight of flames. This time will vary depending on the location of the fire in proximity to initiating devices, the fire characteristics, or the overall location of the fire. Detector Time can be calculated using the DETACT model as previously discussed in the fire alarm section of this report. Also, a fire dynamic simulation is able to estimate the detection time of various devices used in a fire scenario.

ALARM (NOTIFICATION) TIME

The time when a person identifies the alarm or cue until the time they decide to take action.

PRE-EVACUATION TIME

The time at which the occupant has decided to evacuate to the time they actually begin emergency egress out of the building. There are several factors that contributes to the time it takes for the occupants to begin the pre-movement phase of the evacuation process. The occupants will first detect the fire by either an audio, visual or physical cues such as the smell of smoke, the actuation of the fire alarm system or seeing smoke and or flames.

To determine a conservative value for this time, the SFPE handbook includes a table indicating various pre-movement times for a number of events. The closest comparison to the Monticello Office Building is described as a mid-rise office building, which provided an average alarm and pre-movement time of about 1.1 minutes. Refer to *Figure 45* below for a portion of this SFPE table.

Event Description	N	Min	1st Q	Median	3rd Q	Max	Mean	Factors
Mid-rise office building ⁹¹	161	0	0.5	0.9	1.4	<5	1.1	Unannounced drill, good alarm performance; fire wardens; cool day

Figure 45: Delay Times (SFPE, Table 3-12.2)

MOVEMENT TIME

The final stage of egress is movement which is the actual physical movement out of the building. The movement time for the Monticello Office Building has been determined using egress movement calculations and a computer-based egress simulation, called Pathfinder. A detailed review of these two methods can be found in the next sections.

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ACTIVATION ANALYSIS

The following section analyzes the activation time of both a sprinkler head and a ceiling mounted fire detector using the DETACT model. The DETACT model is computer-based program used to determine the actuation times of temperature dependent devices i.e. sprinklers and heat detectors, based on the Alpert's correlation for ceiling jet flows.

For this analysis a fire scenario was selected to determine the time in which the devices activate and the corresponding HRR of the fire. The fictional fire is assumed to be a slow growing fire that originates in a small wastebasket along a row of workstations on the third floor. It is also assumed for this application that heat detectors are located in the open work area. Refer to *Figure 46* for a schematic floor plan of this scenario.

Input Parameters:

- Ceiling Height = 3.2 meters
- Sprinkler Type = Recessed Pendant Sprinkler
- Sprinkler Temperature Rating = 68°C
- Sprinkler Radial Distance = 2.4 meters
- Heat Detector Radial Distance = 2.4 meters
- Sprinkler RTI = 50
- Heat Detector RTI = 2
- Fire Growth Coefficient = 0.003
- Ambient Temperature = 20 °C

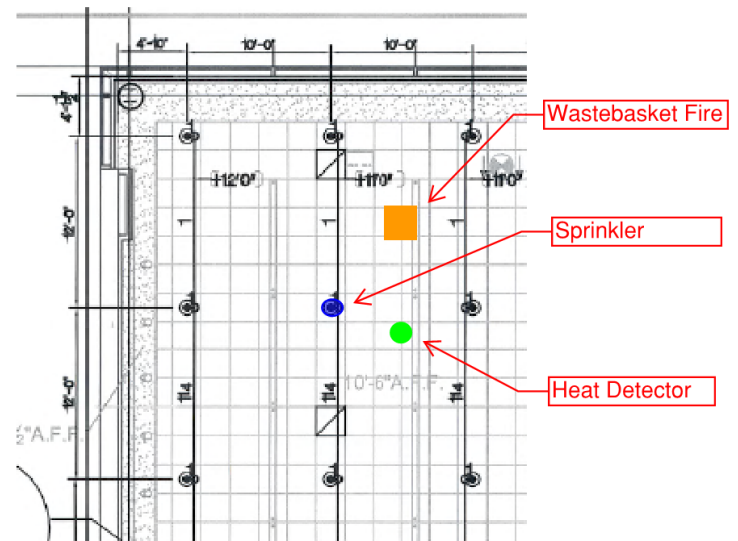


Figure 46: DETACT Fire Scenario

SPRINKLER ANALYSIS:

To determine the time in which a sprinkler would activate for this particular scenario, the following table, *Table 27*, illustrates the input and calculated results performed by the DETACT model using the information provided in the above section.

Table 27: DETACT – Sprinkler Activation

DETACT.XLS: Estimate of the response time of ceiling mounted fire detectors

INPUT PARAMETERS			CALCULATED PARAMETERS		
Calculation reset	1	0 or 1	R/H	0.75	-
Ceiling height (H)	3.2	m	W/H	12.5	-
Room width (W)	40	m	Temperature factor	0.36342	-
Radial distance (R)	2.4	m	Velocity factor	0.25418	-
Ambient temperature (To)	20	C	Calculation time (t)	501	s
Actuation temperature (Ta)	68	C	Fire HRR (Q)	753.003	kW
Rate of rise rating (ROR)	0	C/min	Gas temperature (Tg)	93.1557	C
Response time index (RTI)	50	(m-s) ^{1/2}	Gas velocity (Ug)	1.56926	m/s
Fire growth power (n)	2	-	ROR at detector	11.685	C/min
Fire growth coefficient (k)	0.003	kW/s ⁿ	Detector temp (Td)	85.5773	C
Fire location factor (kLF)	1	-	Detection trigger	94	500

The following graph, *Figure 47*, illustrates the gas temperature, detection temperature and the fire's heat release rate. It can be seen in the graph that the sprinkler temperature reaches the actuation temperature at approximately 420 seconds. At this time, the wastebasket fire heat release rate (HRR) is around 500 kW.

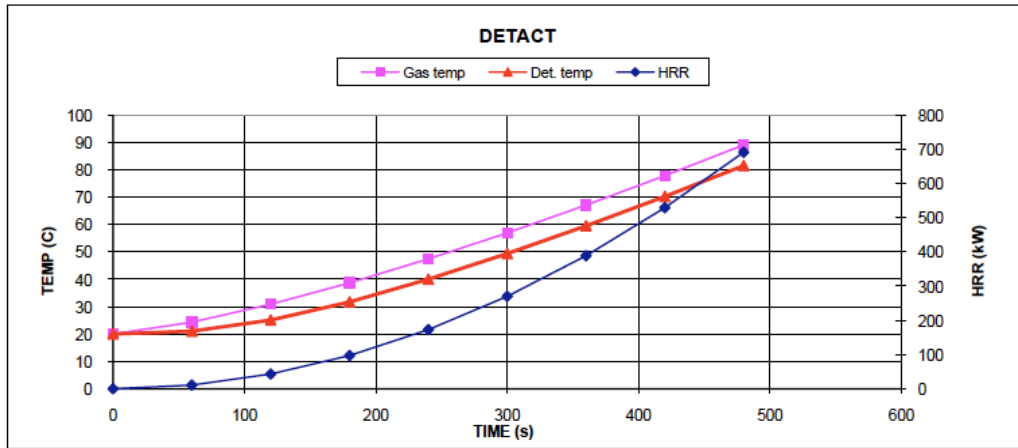


Figure 47: DETACT – Sprinkler Activation Graph

HEAT DETECTOR ANALYSIS:

Utilizing Table B.4.7.5.3 (*Table 28*) from NFPA 72, Temperature Rise for Detector Response, the temperature rise for average materials for a scattering type detector would be 21.1 C. Assuming that the ambient temperature of this space is 20 C, it is determined that the actuation temperature of the detector is 41.1C.

Table 28: Temperature Rise for Detector Response (NFPA 72, B.4.7.5.3)

Temperature Rise		
Material	Ionization Temperature Rise (C)	Scattering Temperature Rise (C)
Wood	13.9	41.7
Cotton	1.7	27.8
Polyurethane	7.2	7.2
PVC	7.2	7.2
Average	7.8	21.1

The Response time index (RTI) has also been assumed to be 2(m-s)^{1/2} for this application. The following table, *Table 29*, illustrates the input and calculated parameters for the DETACT model using the information provided above.

Table 29: DETACT – Heat Detector Activation

INPUT PARAMETERS			CALCULATED PARAMETERS		
Calculation reset	1	0 or 1	R/H	0.75	-
Ceiling height (H)	3.2	m	W/H	12.5	-
Room width (W)	40	m	Temperature factor	0.36342	-
Radial distance (R)	2.4	m	Velocity factor	0.25418	-
Ambient temperature (To)	20	C	Calculation time (t)	601	s
Actuation temperature (Ta)	41.1	C	Fire HRR (Q)	1083.6	kW
Rate of rise rating (ROR)	0	C/min	Gas temperature (Tg)	113.246	C
Response time index (RTI)	2	(m-s) ^{1/2}	Gas velocity (Ug)	1.77168	m/s
Fire growth power (n)	2	-	ROR at detector	12.4156	C/min
Fire growth coefficient (k)	0.003	kW/s ⁿ	Detector temp (Td)	113.142	C
Fire location factor (kLF)	1	-	Detection trigger	403	600

The following graph, *Figure 48*, illustrates the gas temperature, detection temperature and the fire’s heat release rate. It can be seen in the graph that the heat detector device temperature reaches its actuation temperature at approximately 220 seconds. At this time, the wastebasket fire HRR is around 150 kW

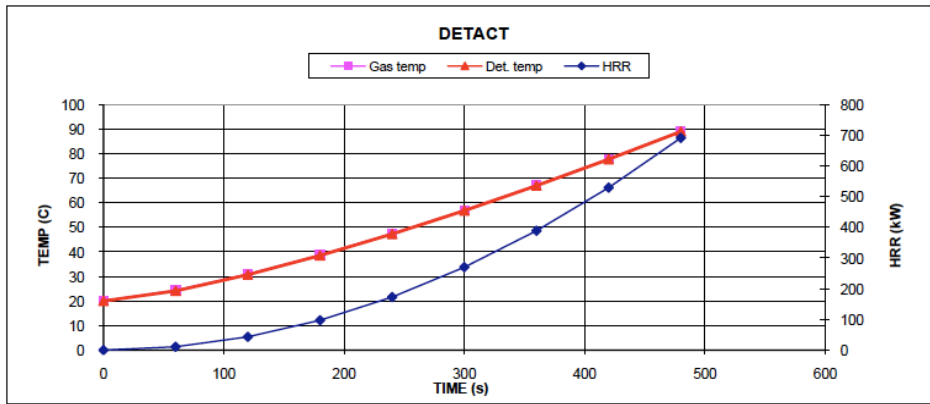


Figure 48: DETACT – Heat Detector Activation Graph

CALCULATED EVACUATION TIME

To determine the time it would take to fully evacuate the building, a calculation was performed using various equations detailed in the SFPE handbook. To perform this calculation, a number of assumptions must be made. These assumptions are as follows:

- Occupants utilize both exit stairways in optimum balance.
- Occupants start egress at the same time.
- The first floor occupants fully evacuate the building prior to the occupants on the floors above reaching the ground level.
- The pre-movement time as stated in the above section was used (1.1 minutes).

FLOW CAPACITY (STAIRWAY)

Effective Width of Stair = $60 - 12 = 48$ in (4ft)
 Maximum Specific Flow = 18.5
 Flow capacity = $18.5 * 4 = 74$ persons/min

FLOW CAPACITY (DOOR)

Effective Width of Door = $42 - 12 = 30$ in = (2.5ft)
 Maximum Specific Flow = 24/persons/min/ft effective width
 Flow Capacity = Effective Width of Door * Maximum Specific Flow = $24 * 2.5 = 60$ persons/min
 The exit doors are the most restrictive egress component.

SPEED OF MOVEMENT

Speed of movement (S) = $k - akD$

where:

$k = 212$ (Egress Constant, *Table 30*)
 $a = 2.86$ (Constant)
 $D = 0.175$ (Maximum Density of Stairway, *Figure 49*)

Table 30: Evacuation Speed (SFPE, Table 3-14.2)

Exit Route Element		k_1	k_2
Corridor, Aisle, Ramp, Doorway		275	1.40
Stairs			
Riser (in.)	Tread (in.)		
7.5	10	196	1.00
7.0	11	212	1.08
6.5	12	229	1.16
6.5	13	242	1.23

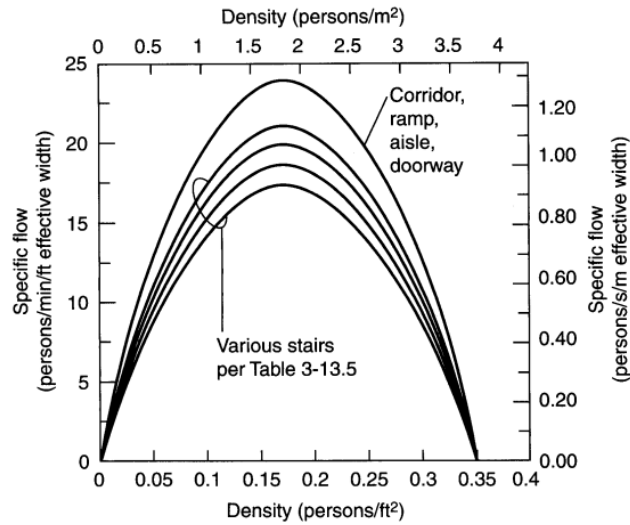


Figure 49: Specific Flows (SFPE, 3-14.5)

Speed of movement (S) = $212 - (2.86 * 212 * 0.175) = 106 \text{ ft/min}$

TRAVEL DISTANCE BETWEEN FLOORS

15 (height per floor) * 1.85 (conversion factor from SFPE Handbook Table 3-14.3) = 27.5ft

Addition of travel on landings = $2 * 10 = 20\text{ft}$

Total Travel distance per floor = $27.5 + 20 = 47.5\text{ft}$

Travel time = $47.5/106 = 0.44 \text{ min}$ (26 seconds)

ESTIMATED BUILDING EVACUATION:

Total Population above first floor = 1523

$(1523/60)/2 + 0.44 = 13 \text{ minutes}$

13 minutes + Pre movement time = 14.1 minutes

COMPUTER-BASED EGRESS

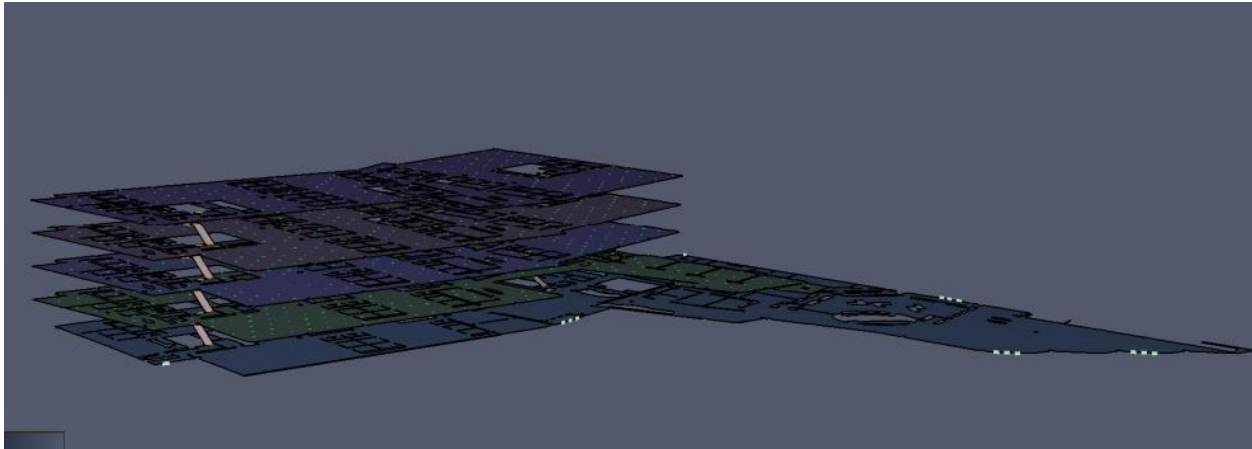


Figure 50: Pathfinder Model

Computer based egress models are tools used by fire protection engineers and architects to provide a detailed simulation of egress in a building. The computer based programs are relatively user friendly and provide realistic graphics to portray a close representation of the entire evacuation of a particular building. For this project, the program Pathfinder has been used to estimate the evacuation time of the building. The image above, *Figure 50*, is a rendering of the Pathfinder model. The assumptions used in this simulation are as follows:

- All occupants travel at the same speed.
- The first floor occupants fully evacuate the building prior to the occupants on the floors above reaching the ground level.
- Each floor includes the maximum number of occupants.
- All occupants start egress at the same time

The estimated evacuation time of the building according to the summary sheet, *Appendix O*, is 11 minutes. This time is slightly faster than the calculated time (13 minutes) provided in the previous section. Again, this does not include the pre-evacuation times addressed in the section above. Adding the pre-movement time of 1.1 minutes, the total egress time would be approximately 12.1 minutes.

The following images are several snapshots taken during the simulation. Within the first 30 seconds of the simulation, *Figure 51*, the majority of the occupants have made their way to the nearest exit per floor. Also, at this time, queuing at each entrance to the stairways is rapidly developing.

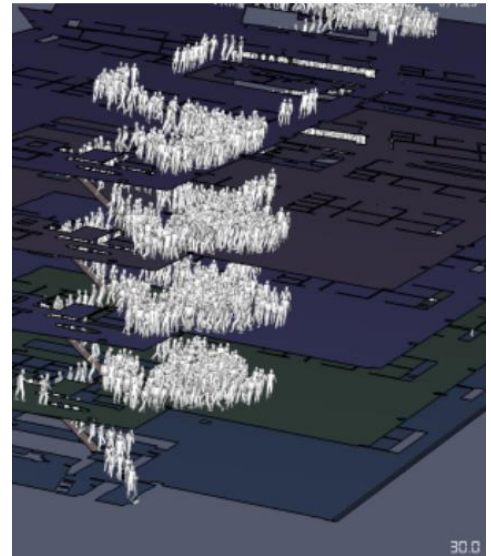


Figure 51: Pathfinder Model – East Stair (30 seconds)

A considerable amount of queuing can still be observed on the eastern stairwell in the building at 5 minutes into the simulation, *Figure 52*. The queuing can be contributed to a large volume of occupants attempting to egress through one corridor and door at the bottom of the stair enclosure. This back-up radiates through multiple floors, where the largest volume of occupants can be seen at the highest floor. The western side of the building also shows some queuing, however not as severe as the east side. This can be contributed to the multiple exits on the ground floor and the additional stair connecting the first and second floor in the atrium area.

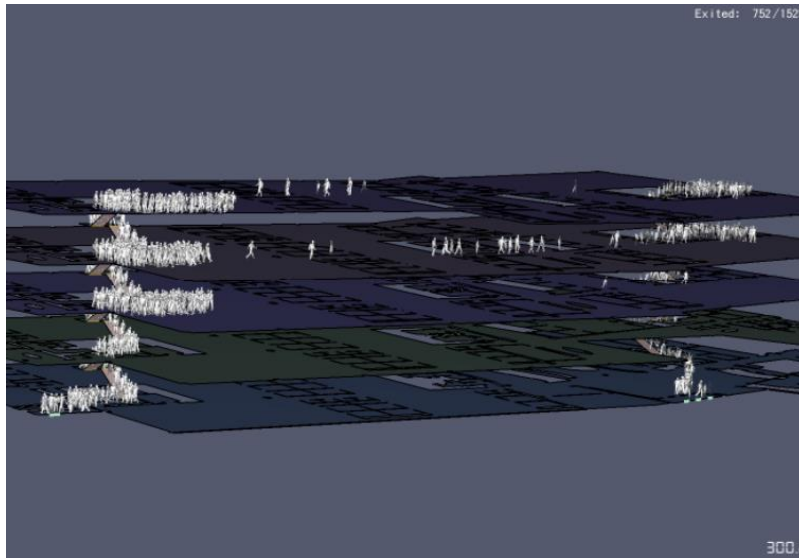


Figure 52: Pathfinder Model (300 seconds)

About 10 minutes into the simulation, *Figure 53*, it is observed that the western portion of the building had completely evacuated. Also, at this time, the eastern stairwell is filled with the remaining occupants in the building. Shortly, thereafter, at about 11 minutes, the building is completely empty.

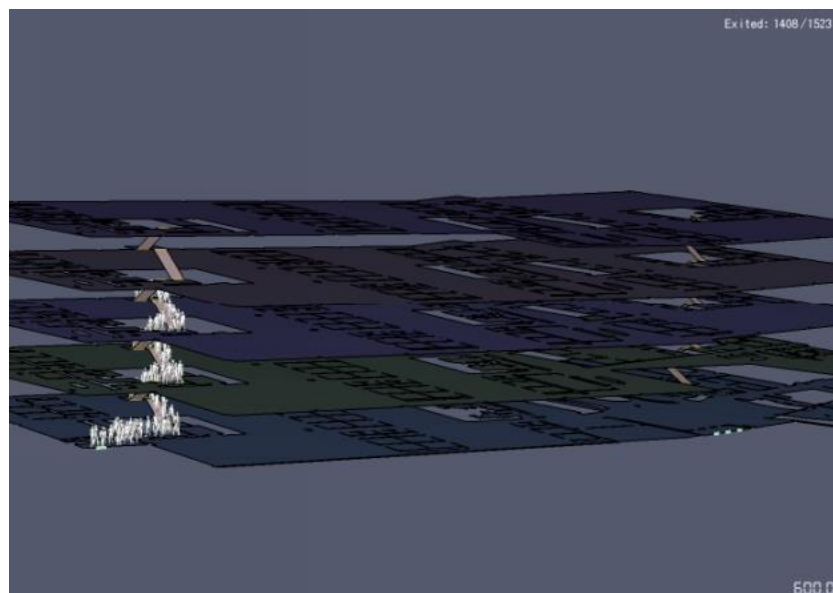


Figure 53: Pathfinder Model (600 seconds)

TENABILITY REQUIREMENTS

The time in which tenable conditions will occur is important to understand in order to determine the available safe egress time (ASET) an occupant has prior to incapacitation or death. To determine the appropriate tenable criteria, the following section details the maximum criteria that can exist within an enclosure before the conditions are deemed untenable. These values are then used to analyze the results from the PyroSim models in the subsequent sections.

VISIBILITY

The reduction of visibility during a fire event can be detrimental to an occupant's ability to safely egress. The lack of visibility in a space will greatly reduce a person's speed of movement and egress decisions including exit choices. Also, a person could be disoriented and confused as to where they are under low visibility conditions. As described in the SFPE Handbook, careful considerations of optical densities and extinction coefficients in relation to various walking speeds led to a conservative tenable criterion of a visible distance of no more than 10 m.

CARBON MONOXIDE CONCENTRATION

Asphyxiation by gasses omitted from a fire is another scenario that can cause incapacitation and/or death of an occupant. The two most widely omitted and dangerous gasses that could cause asphyxiation are carbon monoxide and hydrogen cyanide. Hydrogen cyanide may be released in fires that include nitrogen coating materials like polyurethane foams. Carbon Monoxide on the other hand is usually always present in a fire and the ingestions of CO into one's body results in a reduction of oxygen in the system resulting in an onset of a number of ailments including the possibility of death. The safe tenable limits that should be considered as described from the SFPE handbook are approximately 1000 ppm of CO and approximately 100 ppm of HCN. These values were used to determine the maximum concentrations that would not result in the loss of consciousness.

TEMPERATURE

The heat caused by a fire will cause incapacitation or death if the temperature within the enclosure reaches a level where a person is unable to survive. The heat from a fire can cause heat stroke, body surface burns and respiratory tract burns. For hyperthermia to set in, the SFPE handbook notes at approximately 120-80C (depending on the dryness of the air) for about 15 minutes could possibly raise the body temperature to unsafe levels. The lowest temperature that humid air can be ingested without incapacitation according to the SFPE Handbook is 60C (140F). Dry air has a higher temperature threshold; however, 60C should be used because fires will give off water during the combustion process so it can be assumed that the air will contain at least some humidity in it. Lastly, the temperature assumed to cause body surface burns due to conduction can be estimated at approximately 60C. Any temperatures below this value will cause discomfort. The overall tenable temperature that should be implemented in design fires is 60C before unsafe conditions are present.

MAXIMUM CRITERIA

- Visibility – 10 m
- CO Concentration – 1000 ppm
- Temperature – 60 C

FIRE SCENARIOS

Three fire scenarios have been selected for this building in order to determine if the Available Safe Egress Time (ASET) is sufficient to allow the building to be fully evacuated prior to unsafe conditions. To evaluate this, three (3) scenarios have been designed and simulated in a fire dynamic simulator (FDS) program called PyroSim. The results of each scenario have been evaluated based on the tenability limits presented in the previous section. All tenability limits are observed at 1.8 m above the finished floor (AFF). Where multiple floors are involved, both floors will be addressed.

FIRE SCENARIO A

OVERVIEW

A fire scenario has been designed on the first floor break room on the east side of the building. This area of the building is a particular concern due to the use of only one exterior exit door. In addition to this one exit door, the stair enclosure that connects the floors above discharges into a small corridor prior to the exterior door. It is assumed that if the door was open and a nearby fire had ignited, the conditions within the corridor may deteriorate rapidly to a point where egress from the stairs or from other parts of the east side of the first floor may be impossible. It is also assumed that the adjacent sprinklers are unable to contain the fire; resulting in two failure modes for this scenario. To address this possibility, a design fire using twelve (12) plastic chairs in two (2) stacks were placed in the small alcove directly adjacent to the corridor door. The following assumptions were made to perform this analysis:

- Chairs are made from polypropylene plastic material
- The adjacent egress door is propped open
- Sprinklers, heat detector and smoke detector are operational
- Sprinklers are unable to contain the fire resulting in a continuous rise of the HRR until the fire decay phase.
- Ambient temperature of the room is 20 C

The following image, *Figure 54*, is a representation of all components utilized in this simulation. The propped door leading into corridor is located directly west of the design fire location.

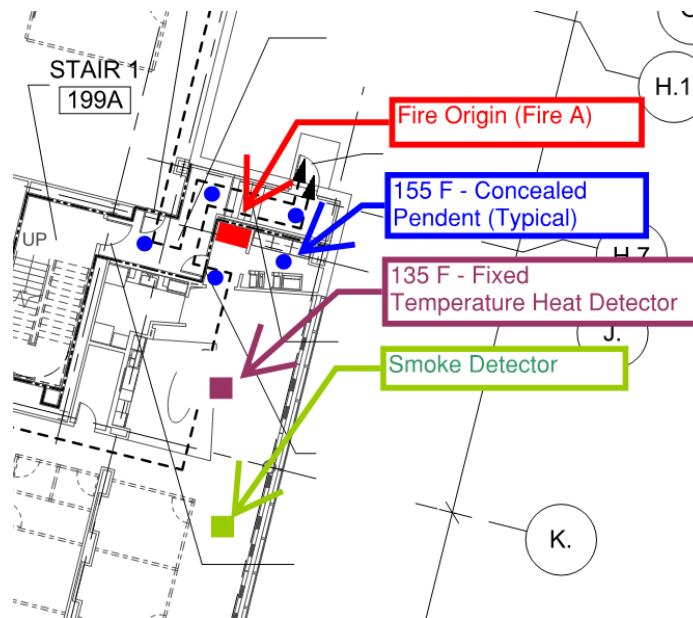


Figure 54: Design Fire A - Layout

FUEL SOURCE

Polypropylene chairs were selected for this simulation as these particular chair are commonly found in office breakroom areas. The chemical properties of polypropylene are as follows:

Polypropylene Properties (SFPE Handbook, Table 3-4.15)

- Carbon - 1
- Hydrogen - 1

The heat release rate (HRR) curve used to simulate a stacked chair fire was gathered from the SFPE handbook. The graph from the SFPE handbook, provided below in *Figure 55*, illustrates the HRRs of various configurations for stacked chairs. The graph shows that the largest tested fire was 2 stacks of 12 chairs; therefore, this configuration was used for this simulation. The values associated within the graph were later extrapolated and entered into the PyroSim program.

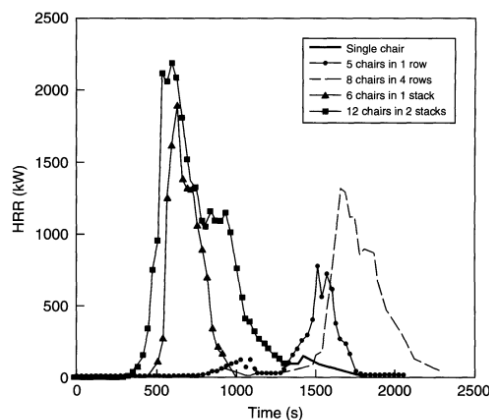


Figure 3-1.18. HRR of stackable chairs, polypropylene with steel frame, no padding.

Figure 55: Stacked Chair HRR

Byproducts were also required to be added in the PyroSim program to simulate the Carbon Monoxide concentrations and visibility throughout the smoke layer. Polypropylene, when burned, provides the following yields as described in the SFPE handbook, Table 3-4.16:

- CO Yield – 0.024
- Soot Yield - 0.059

PYROSIM

The PyroSim model was designed based on the existing characteristics of the break room and surrounding areas. Several sprinklers were added into the model based on their existing locations within the building. A heat detector and smoke detector were also added in the model to determine the activation times of each device. In addition to the HRR and the information stated above, the following parameters have been added to run the FDS simulation:

- Slice Files:
 - Visibility (1.8 m AFF)
 - Temperature (1.8 m AFF)
 - Carbon Monoxide volume fraction (1.8 m AFF)
- Mesh Cell Size: 0.125 m3
- Ambient temperature: 20 C
- Duration: 1200 seconds

The following image, *Figure 56*, is a rendering of the PyroSim model prior to the simulation. The blue dots denote the sprinkler head locations. The red dot denotes the heat detector and the green dot is the smoke detector.

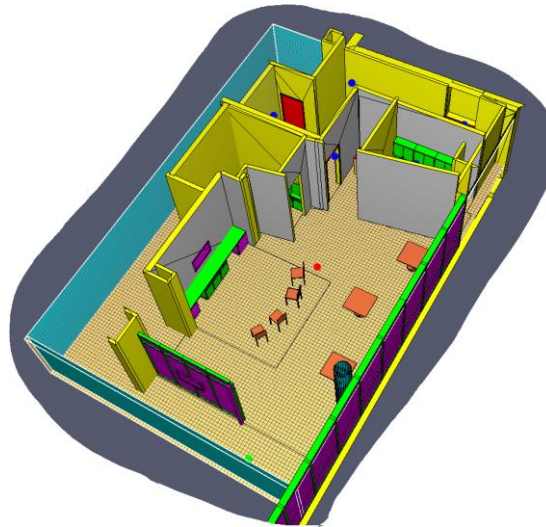


Figure 56: Design Fire A - PyroSim

DEVICE ACTIVATION

The first device to activate during this simulation was the smoke detector. The spot-type smoke detector sensed the presence of smoke at 313 seconds into the simulation. The figure below, *Figure 57*, is a rendering of the smoke production at the time of the smoke detector activation.

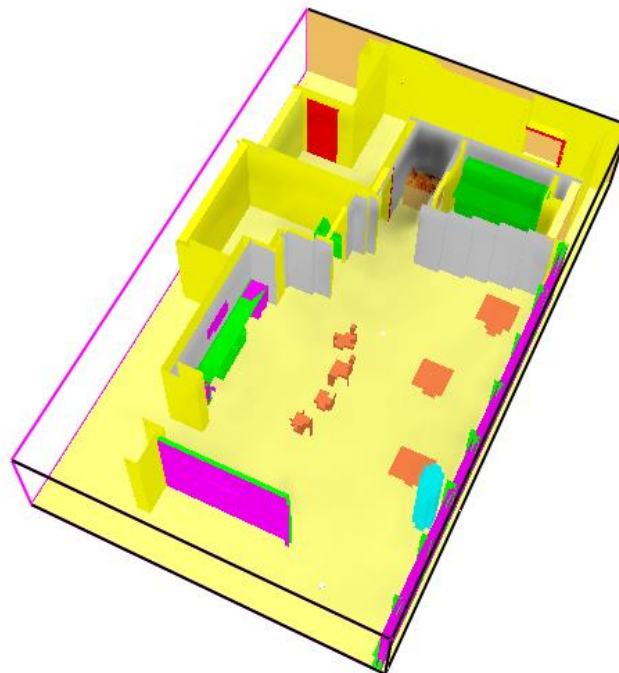


Figure 57: Design Fire A – Smoke Detector

Shortly after the smoke detector activates, the sprinkler directly adjacent to the stack of chairs begin to discharge water at approximately 400 seconds. Lastly, the heat detector activated at approximately 455 seconds. Refer to the image below, *Figure 58*, for a rendering of the smoke view model when the first sprinkler discharges.

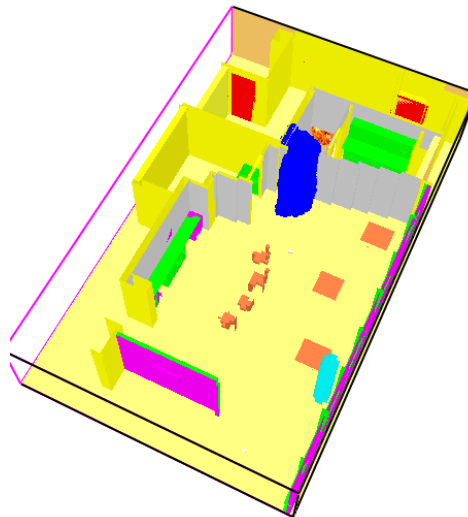


Figure 58: Design Fire A – Sprinkler Activation

VISIBILITY REVIEW

The visibility of the break room deteriorated much more rapidly than the adjacent corridor. However, the spaces directly outside of the break room, except for the corridor, open up to a large volume. This allows the smoke layer to travel the length of the open area prior to descending below 1.8 m above the finished floor (AFF). It was observed within the smoke view application, *Figure 59*, that the corridor began to fill with smoke and reduce the visibility to less than 10 m around 450 seconds.

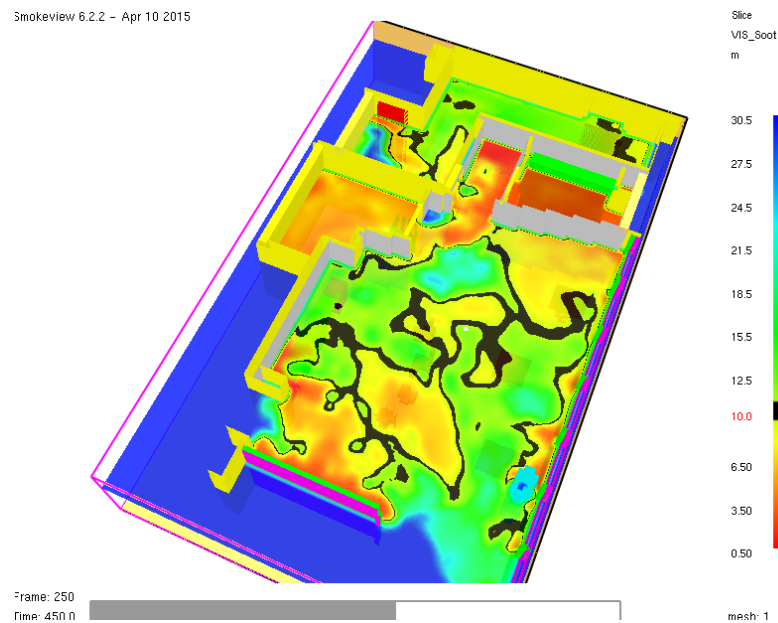


Figure 59: Design Fire A – Visibility (450s)

Several seconds after the tenability was reached in the corridor, the visibility within the corridor quickly deteriorated until zero visibility was established. This can be observed in the following image, *Figure 60*.

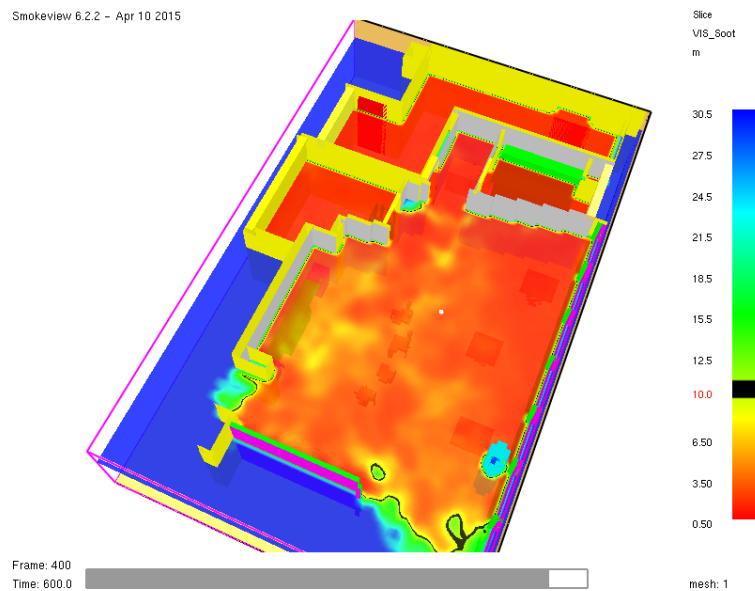


Figure 60: Design Fire A – Visibility (600s)

TEMPERATURE REVIEW

The temperature of the area was also evaluated for tenability. The highest temperatures were observed at 600 seconds. The following smoke view image shows that the temperatures within the enclosure do not exceed the maximum temperature of 60 C, except for the areas directly adjacent to the fire location. This low temperature can be contributed to the activation of the nearby sprinklers and the large open area to disperse the hot ceiling jet over a vast area.

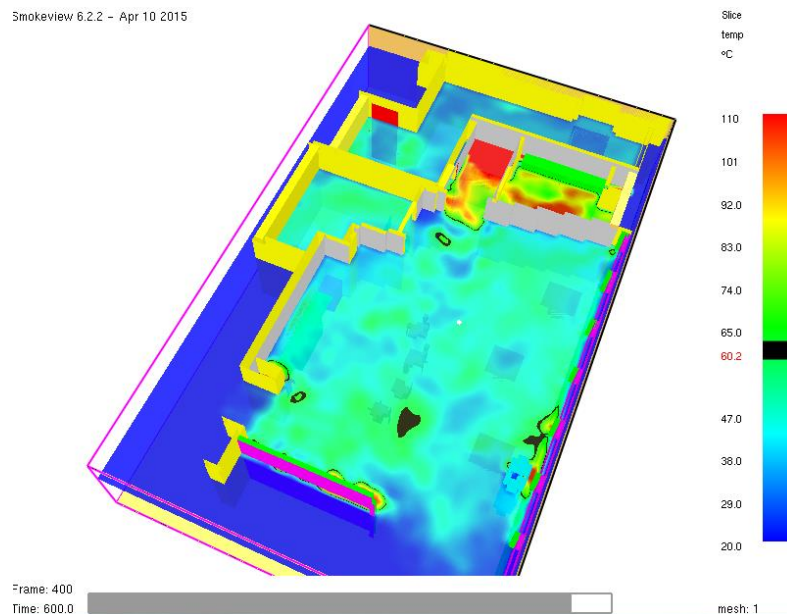


Figure 61: Design Fire A – Temperature (600s)

CO CONCENTRATION REVIEW

Lastly, the carbon monoxide levels were determined by the FDS model. It can be seen in *Figure 62* that the CO concentration never exceeds 500 ppm anywhere within the enclosure. This value is well below the maximum concentration of carbon monoxide that would cause incapacitation or death.

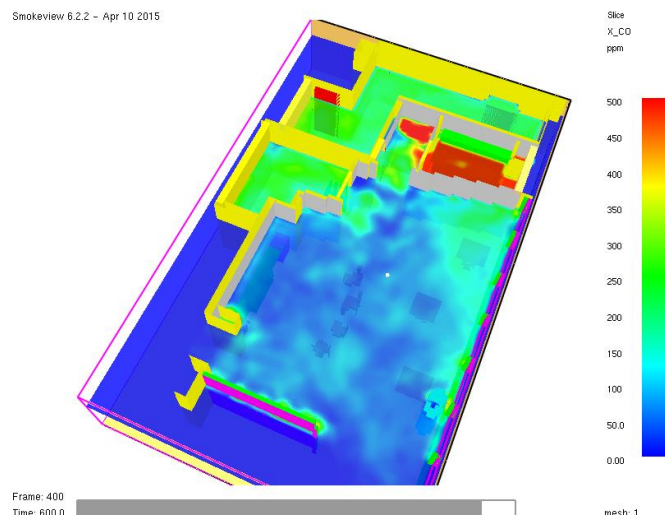


Figure 62: Design Fire A – CO Concentration (600s)

EGRESS ANALYSIS

The activation time of the first device occurred at 313 seconds after the ignition of the fuel source. At this time, occupants will be notified through the fire alarm system to begin the evacuation of the building. Adding the pre-evacuation time and the movement times that were determined in the Emergency Movement Section of this report, the calculated require safe egress time is approximately 17.3 minutes for the entire building. The conditions within the corridor space reach the untenable limits at 3.3 minutes, which is far less than the RSET. However, these untenable conditions are limited to the corridor and break room area only. At no point during the design fire simulation, the tenability limits were observed in the adjacent office space resulting in an acceptable egress performance.

FIRE SCENARIO B

OVERVIEW

The second fire scenario, Scenario B, has been designed in the atrium area of the building. The main entrance of the Monticello Office Building includes a small sitting area in the atrium located on the north side of the building. This area is a particular concern because if a fire is able to develop in this space, smoke can accumulate rapidly within the atrium enclosure. The building codes do not require a smoke control system for this particular application so there is no place for the smoke to go except down which may negatively affect the occupants that are attempting to evacuate the building. Another potential concern for this area is its proximity to the main entrance. A large fire may impede or block the main entrance of the building for egress, which can increase the RSET greatly. Typically, occupants will egress out of the same doors that they had used to enter and it is assumed that this main entry way is used by most occupants due to its proximity to the parking lot area. To address these concerns, a furniture fire was developed at the base of the first floor main stair utilizing a sofa and (2) chairs with similar materials. The following assumptions were made to perform this analysis:

- Sofa is wood framed with polyurethane foam
- Chairs are a wood frame with polyurethane foam
- Furniture ignites simultaneously
- The second floor door is closed
- Sprinklers and smoke detector are operational
- Sprinklers are able to contain the fire when activated
- Ambient temperature of the room is 20 C

The following image, *Figure 63*, is a representation of all components utilized in this simulation.

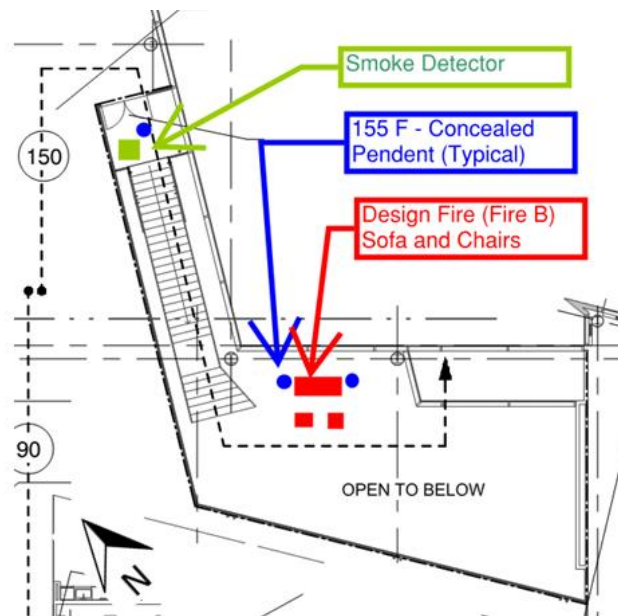


Figure 63: Design Fire B Layout

FUEL SOURCE

Polyurethane sofa and chairs were selected for this simulation. The chemical properties of flexible polyurethane foam are as follows:

Flexible Polyurethane Foam (SFPE Handbook, Table 3-4.15)

- Carbon - 1
- Hydrogen – 1.7
- Nitrogen – 0.08

The HRR of the sofa and chairs for this simulation has been gathered from the works of H. Kim and D. Lilley where they had collected the HRR of various pieces of furniture. The sofa and chair are made of the same materials and the associated HRR curves are shown in *Figures 64 and 65* below. The values associated within the graphs were later extrapolated and entered into the PyroSim program.

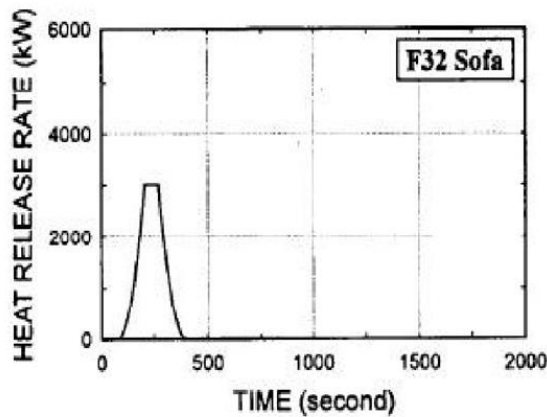


Figure 64: Sofa HRR

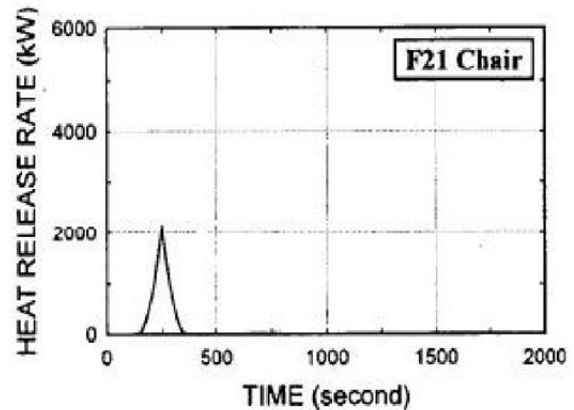


Figure 65: Chair HRR

Byproducts were also required to be added in the PyroSim program to simulate the Carbon Monoxide concentrations and visibility throughout the smoke layer. Flexible Polyurethane Foam, when burned, provides the following yields as described in the SFPE handbook, Table 3-4.16:

- CO Yield – 0.198
- Soot Yield - 0.042

PYROSIM

The PyroSim model was designed with the existing dimensions of the atrium and surrounding areas. Several sprinklers were added into the model based on their existing locations within the building. A smoke detector was also added in the model to determine the activation time. In addition to the HRR and the information stated above, the following items have been added to run the FDS simulation:

- Slice Files:
 - Visibility (1.8 m AFF, 1st and 2nd floor)
 - Temperature (1.8 m AFF, 1st and 2nd floor)
 - Carbon Monoxide volume fraction. (1.8 m AFF, 1st and 2nd floor)
- Ambient temperature: 20 C
- Duration: 750 seconds
- Mesh Size: 0.25 x 0.25 x 0.68

The following image, *Figure 66*, is a rendering of the PyroSim model prior to the simulation. The blue dots denote the sprinkler head locations and the green dot is the representation of the smoke detector. At the base of the stair and to the left of the main entrance vestibule, the sofa and two (2) chairs can be found.

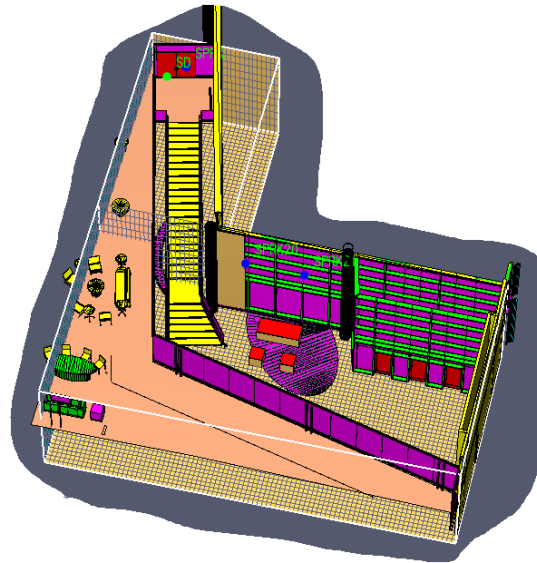


Figure 66: Design Fire B - PyroSim

DEVICE ACTIVATION

The smoke detector located at the main landing on the second floor was the first device to activate. It sensed the presence of smoke at approximately 116 seconds. The figure below, *Figure 67*, is a rendering of the smoke production at the time of the smoke detector activation. The sprinklers directly above the furniture activated shortly thereafter at 200 seconds. *Figure 68* represents the time in which each sprinkler activates. The sprinklers directly over the sofa are represented as SPRK 1 and SPRK 2, where, SPRK 1 is to the left of the sofa and SPRK 2 is located to the right side of the sofa.

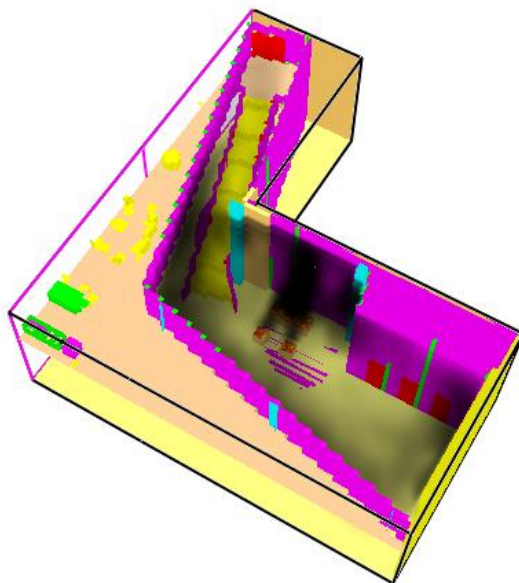


Figure 67: Design Fire B – Smoke Detector

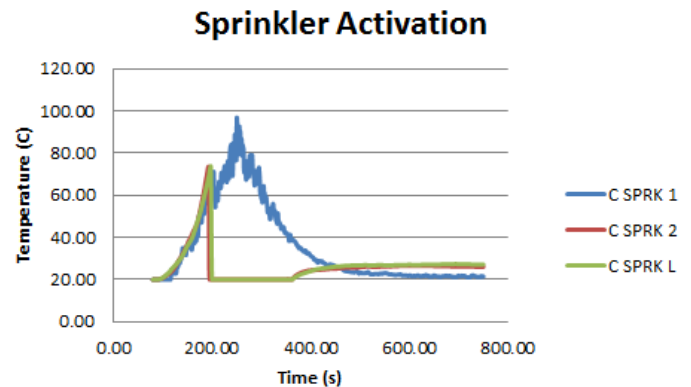


Figure 68: Design Fire B – Sprinkler Activation

The combined HRR of the chairs and sofa is detailed in the following figure, *Figure 69*. The maximum HRR of the furniture fire is approximately 6 MW.

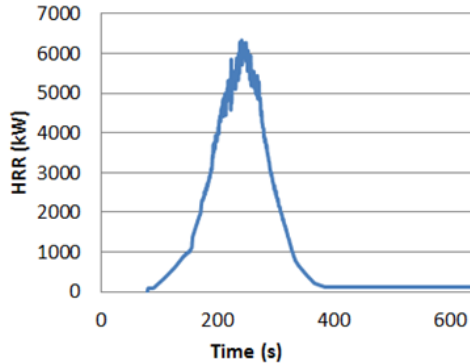


Figure 69: Design Fire B – Combined HRR

It is assumed that the sprinklers are able to contain the fire once they begin to discharge in this space. To account for this, the HRR is altered to account for the fire containment achieved by the sprinklers. To do this, the HRR was redeveloped to max out at the time in which the sprinklers activate (200s). After 200 seconds it is assumed that the HRR remains constant for the remainder of the simulation. Refer to *Figure 70* and *Figure 71* for the revised HRR due to the sprinkler activation. The PyroSim model was re-run to accommodate this modification.

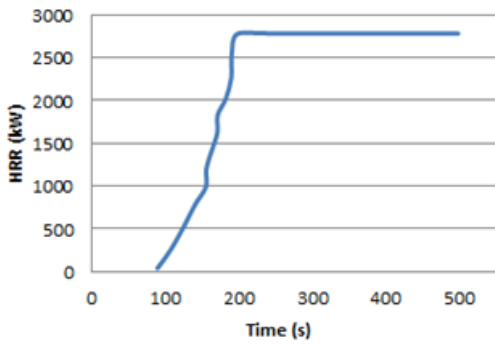


Figure 70: Design Fire B – Sofa HRR (Sprinkler)

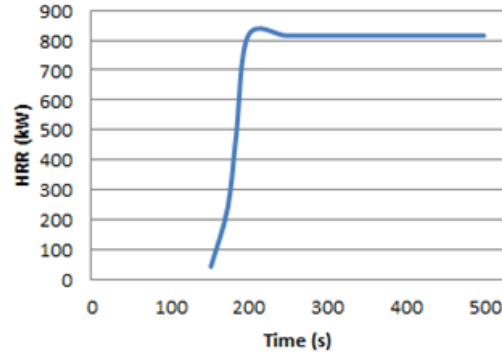


Figure 71: Design Fire B – Chair HRR (Sprinkler)

The updated simulation provided the following combined HRR curve, *Figure 72*. It can be observed that the max HRR (4 MW) is well below what was shown in the previous graph (6 MW).

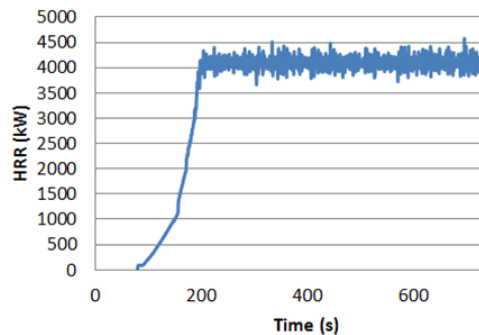


Figure 72: Design Fire B – Combined HRR (Sprinkler)

VISIBILITY REVIEW

The simulation was analyzed to determine how fast the smoke spread within the atrium and how the smoke level affected the visibility in this space. The first image, *Figure 73*, is a rendering of the smoke view model at the time where the second floor landing reached its maximum tenable limit for visibility (10 m at 1.8 AFF). At this time, 2.1 minutes, occupants would be unable to safely egress from the second floor through this stairway. The second image, *Figure 74*, is the representation of the 1st floor level at the end of the simulation (12.5 minutes). This image shows that the visibility does not drop below the 10m threshold, except directly adjacent to the fire.

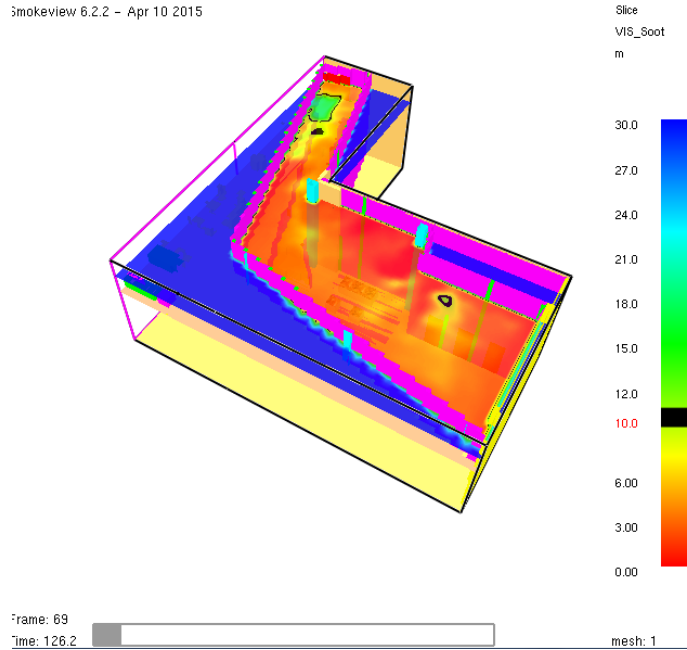


Figure 73: Design Fire B –2nd Floor Visibility (126s)

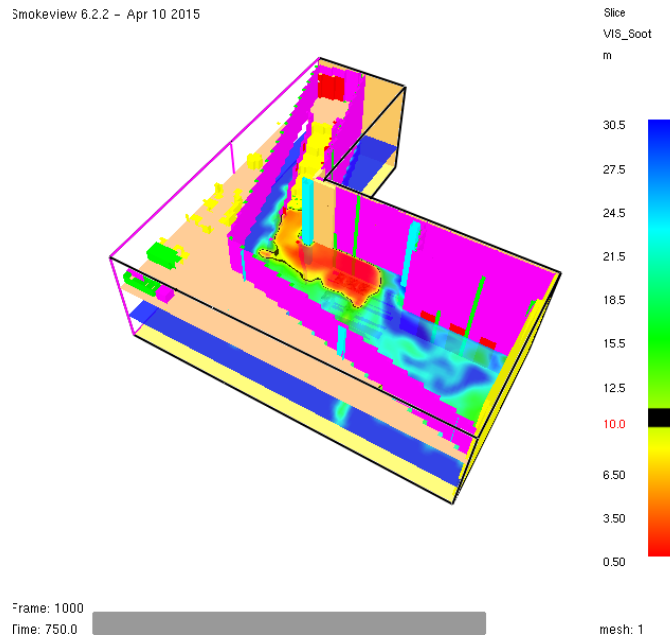


Figure 74: Design Fire B –1st Floor Visibility (750s)

TEMPERATURE REVIEW

The temperature of the area was also evaluated for tenability. The highest temperatures were observed at 12.5 minutes (750 seconds). The following smoke view image of the simulation shows the temperatures at 1.8 meters above the second floor landing. At this elevation, the temperatures do not exceed the maximum temperature of 60 C, except directly above the fire location.

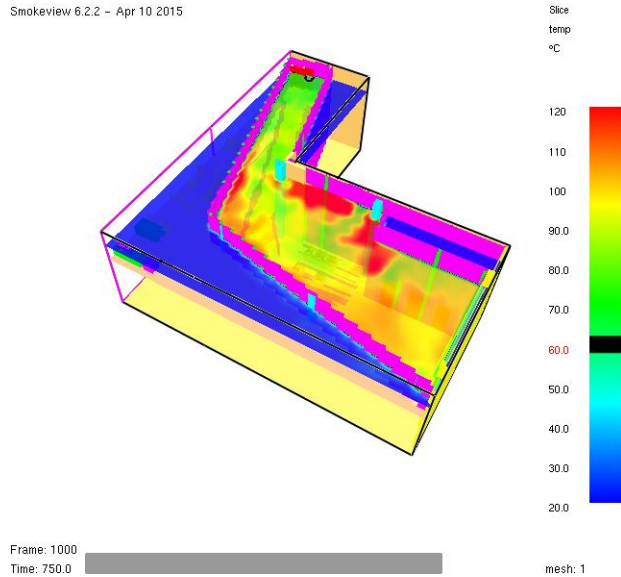


Figure 75: Design Fire B –Temperature (750s)

CO CONCENTRATION REVIEW

Lastly, the carbon monoxide levels were simulated for this scenario. It is observed in the following image, *Figure 76*, that the CO levels never exceed 400 ppm throughout the course of the simulation. As the maximum level of CO concentration is 1000 ppm, this area is considered to be acceptable based on these results.

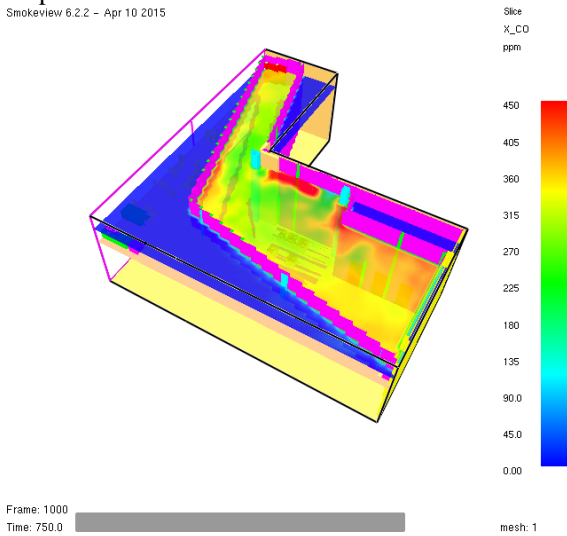


Figure 76: Design Fire B – CO concentration (750s)

EGRESS ANALYSIS

The activation time of the first device occurred at 116 seconds after the ignition of the fuel source. At this time, occupants will be notified through the fire alarm system to begin the evacuation of the building. Adding the pre-evacuation time and the movement times that were determined in the Emergency Movement Section of this report, the calculated required safe egress time is approximately 13 minutes for the entire building. The conditions within the atrium space reach the untenable limits for visibility at 126 seconds, which is far less than the RSET. However, these untenable conditions are limited to the second floor of the atrium area only. At no point during the design fire simulation, the tenability limits were observed at 1.8 m above the first floor except directly next to the fire location. It is assumed that occupants on the upper floor will see through the glass partition that the conditions in the atrium are deteriorating which would prevent occupants from attempting to egress through this main stair. These occupants would be able to use the two additional stairways on each floor to evacuate the building during this emergency. It is assumed that this would not affect the overall egress time of the building because the eastern stair is the most restrictive component within this building and would take the longest time to evacuate. Overall, the egress performance of the building is adequate for this scenario.

FIRE SCENARIO C

OVERVIEW

A fire scenario has also been developed in the kitchen area of this building. The intent of this scenario, Design Fire C, is to determine if an isolated fire in the kitchen space can spread untenable conditions into the adjacent server and dining spaces. To address this concern a pallet of fruit and berry baskets was placed next to the cooking equipment in the center of the kitchen. It is assumed that a grease fire on the grill area spreads rapidly onto the pallet, igniting the plastic containers. The following assumptions were made to perform this analysis:

- The ansul system is not operational
- Plastic containers are made out of Polyethylene terephthalate plastic
- Sprinklers are operational
- Sprinklers are able to contain the fire once activated.
- Ambient temperature of the room is 20 C

The following image, *Figure 77*, is a representation of all components utilized in this simulation.

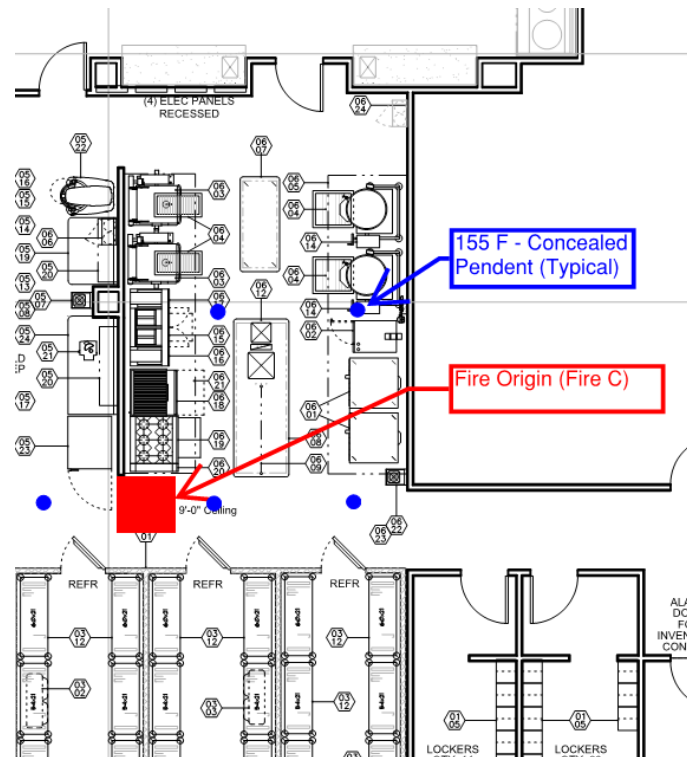


Figure 77: Design Fire C Layout

FUEL SOURCE

The fuel source for this design fire is the pallet of fruit and berry baskets. The plastic containers are assumed to be made out of Polyethylene terephthalate, therefore the chemical properties of this material is as follows:

Polyethylene terephthalate (PET) (SFPE Handbook, Table 3-4.15)

- Carbon – 1
- Hydrogen – 0.80
- Oxygen – 0.40

The heat release rate (HRR) curve used to simulate this fire was gathered from the SFPE handbook. This graph provided below in *Figure 78*, illustrates the HRRs of various sizes of the single pallet of fruit and berry baskets. The configuration with the largest observable HRR was Sample A, where the maximum HRR was 4923 kW as described in *Figure 79*. This pallet configuration and HRR was used for this simulation. To replicate this fire, the values associated within the graph were extrapolated and entered into the PyroSim program.

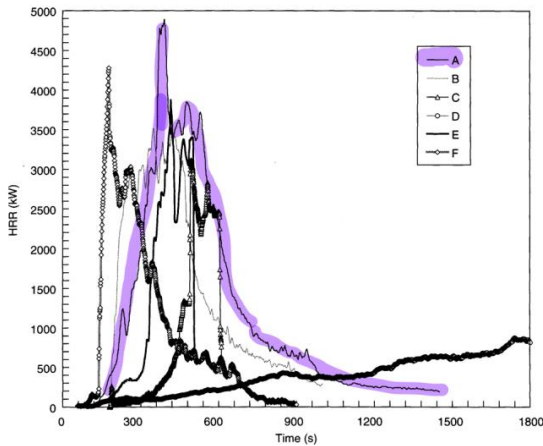


Figure 3-1.16. HRR of single-pallet loads of packaged fruit/berry baskets.

Figure 78: Pallet of Berry Baskets HRR

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

Figure 79: Pallet of Berry Baskets Criteria (SFPE, Table 3-1.2)

Byproducts were also required to be added into the PyroSim program to simulate the Carbon Monoxide concentrations and visibility throughout the smoke layer. Polyethylene terephthalate plastics, when burned, provide the following yields as described in the SFPE handbook, Table 3-4.16:

- CO Yield – 0.05
- Soot Yield - 0.053

PYROSIM

The PyroSim model was designed with the existing dimensions of the kitchen and surrounding areas. Several sprinklers were added into the model based on their existing locations within the building. In addition to the HRR and the information stated above, the following items have been added to run the FDS simulation:

- Slice Files:
 - Visibility (1.8 m AFF)
 - Temperature (1.8 m AFF)
 - Carbon Monoxide volume fraction. (1.8 m AFF)
- Ambient temperature: 20 C
- Duration: 2000 seconds
- Mesh Size: 0.25 x 0.25 x 0.25

The following image, *Figure 80*, is a rendering of the PyroSim model prior to the simulation. The blue dots denote the sprinkler head locations and the red square in the center of the image represents the pallet of fruit and berry baskets. The area located to the north of the image is the server space.

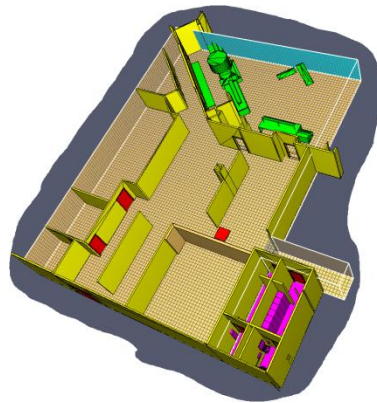


Figure 80: Design Fire C - PyroSim

DEVICE ACTIVATION

The two sprinklers located directly above the fire location activated almost simultaneously. It is observed in the following graph, *Figure 81*, that the sprinklers begin to discharge at approximately 200 seconds within this simulation.

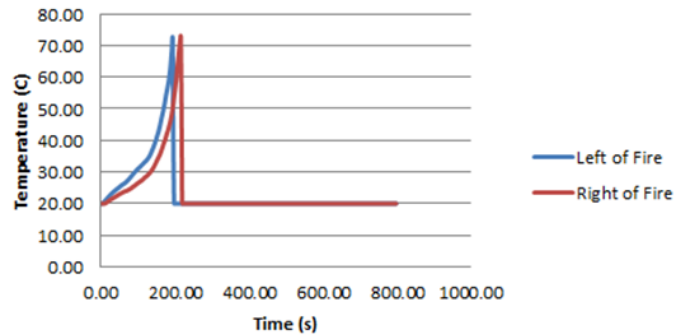


Figure 81: Design Fire C – Sprinkler Activation

It is assumed that the sprinklers are able to contain the fire once they begin to discharge in this space. To account for this, the HRR is altered to account for the fire containment achieved by the sprinklers. To do this, the HRR were redeveloped to max out at the time in which the sprinklers activate (200s). After 200 seconds it is assumed that the HRR remains constant for the remainder of the simulation. Refer to *Figure 82* for the revised HRR due to the sprinkler activation. The PyroSim model was re-run to accommodate this modification.

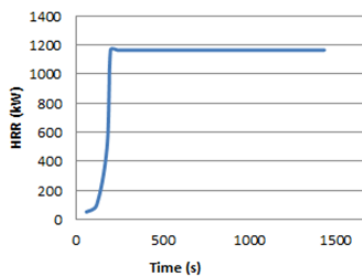


Figure 82: Design Fire C – Pallet of Berry Baskets HRR (Sprinkler)

VISIBILITY REVIEW

The simulation was analyzed to determine if the visibility 1.8m above the finished floor decreased below 10 m. In the smoke view model, it can be observed that the visibility in the kitchen area drops to 10 m at about 90 seconds into the simulation, *Figure 83*. Shortly after, at 300 seconds, *Figure 84*, the visibility in the kitchen drops to zero. It is also observed that the visibility in the server room remains constant at the ambient conditions except directly next to the kitchen door locations. The decreased visibility in this location is contributed to the smoke plume from the kitchen area spreading into the server space.

smokeview 6.2.2 - Apr 10 2015

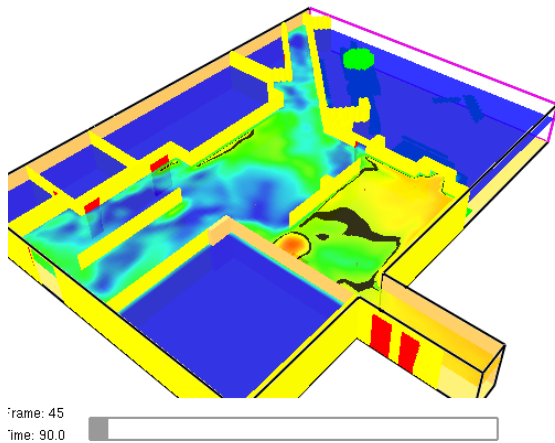


Figure 83: Design Fire C – Visibility (90s)

smokeview 6.2.2 - Apr 10 2015

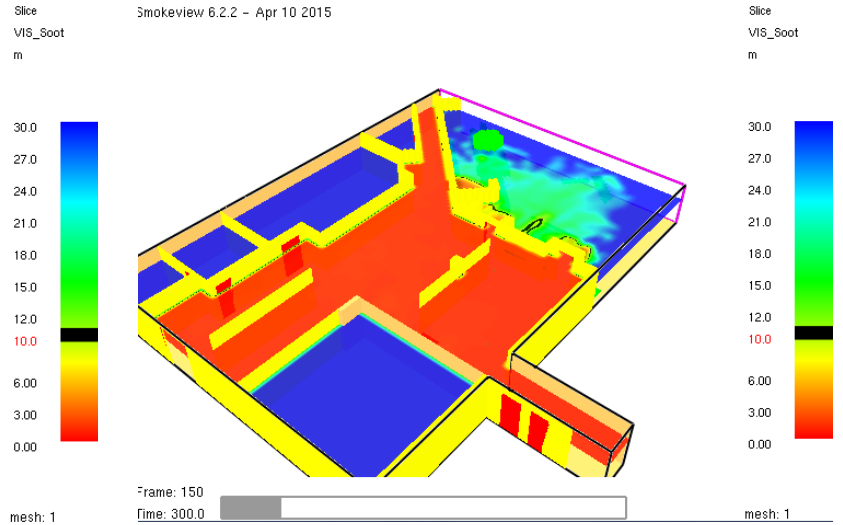


Figure 84: Design Fire C – Visibility (300s)

TEMPERATURE REVIEW

The temperature of the area was also evaluated for tenability. The temperature in the kitchen reached the maximum tenable limit, 60 C, within 3.3 minutes (200 seconds) which can be observed in the image below, *Figure 85*. The following smoke view image of the simulation shows the temperatures at 1.8 meters above the finished floor. However, the temperatures within the server space remained at the ambient temperatures throughout the entire duration for the simulation.

Smokeview 6.2.2 - Apr 10 2015

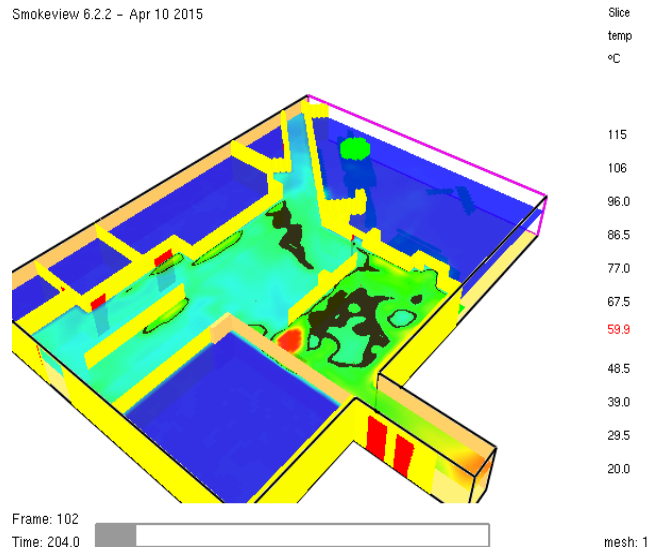


Figure 85: Design Fire C –Temperature (200 s)

CO CONCENTRATION REVIEW

Lastly, the carbon monoxide levels were analyzed for this scenario. It is observed in the following image, *Figure 86*, that the CO levels within the kitchen exceed 1000 ppm at about 400 seconds into the simulation. However, similar to temperature, the tenable conditions are limited to the kitchen area only.

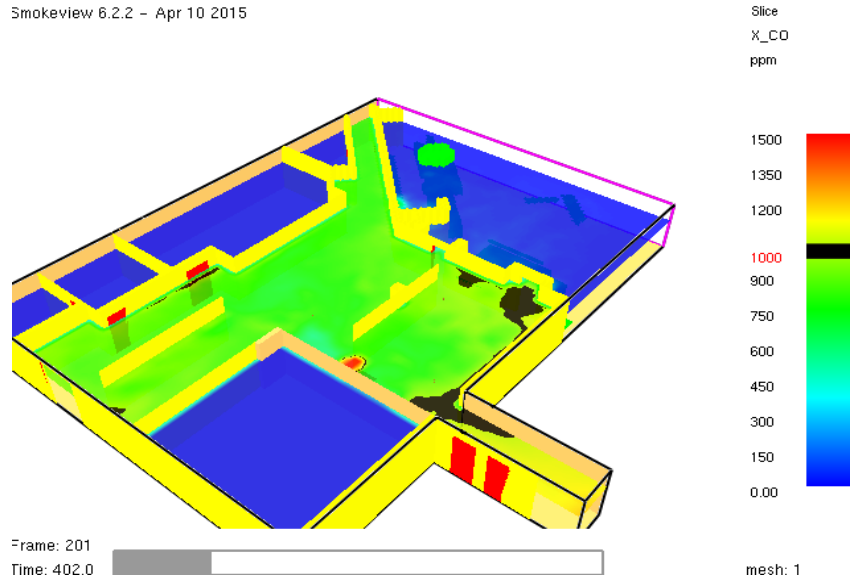


Figure 86: Design Fire C –CO Concentration (400 s)

EGRESS ANALYSIS

The activation time of the first device occurred at 200 seconds after the ignition of the fuel source. At this time, occupants will be notified through the fire alarm system to begin the evacuation of the building. Adding the pre-evacuation time and the movement times that were determined in the Emergency Movement Section of this report, the calculated require safe egress time is approximately 15.4 minutes for the entire building. The conditions within the kitchen space reach the untenable limits at 3.3 minutes, which is far less than the RSET. However, these untenable conditions are limited to the kitchen area only. At no point during the design fire simulation, the tenability limits were observed in the adjacent servery space resulting in an acceptable egress performance.

Summary and Recommendations

The Monticello Office Building is a modern office building with many ascetically pleasing architectural features which makes this building unique when compared to other structures with similar occupancies. This building has been designed in accordance with the prescriptive codes as originally mandated. In addition to meeting these codes, this building has been carefully designed and at parts over-designed to assure that it is a safe and functional building for its occupants. An example of an overdesigned feature is the sprinkler system where the sprinkler design criteria exceeds NFPA 13 minimum requirements.

The performance based analysis has proven that the building fire protection and egress features are more than sufficient to provide the occupants with adequate time to evacuate under an emergency situation. It was discovered in all fire scenarios that the untenable conditions were only observed in close proximity to the fire origin. The large open office spaces and the large dining area prevented the smoke and hot gas layer from descending to an elevation that may cause incapacitation and/or death to the occupants in the building. The biggest concern observed in the design fires was the blockage of the east corridor during Design Fire A. The inoperable exit would greatly increase the evacuation time of the building; however, as stated above, the untenable conditions were only observed near the fire location. Therefore, the occupants are able to egress through the remote exits on the west side of the building for this scenario.

Based on the results from the design fires performed for this building, several items are recommended to enhance the overall life safety of the building. The first recommendation is to provide door prop alarms on all doors that exit into an egress corridor. This would prevent doors from being accidentally or intentionally propped open which was the case for design fire A. Another recommendation for this building is to limit pallets to the loading dock areas only. Pallets with miscellaneous contents usually produce high heat release rate fires and limiting them to the loading dock may prevent large fires from developing towards the center of the building. It is also recommended that the building maintenance team and any other outside contractual maintenance companies keep up with the required Inspection Testing and Maintenance of all fire protection systems to assure that all life safety features are in normal operable working conditions.

References

IBC (2006) – International Building Code

Kim, Hyeong-Jin, and David Lilley. "Heat Release Rates of Burning Items in Fires." (2000). American Institute of Aeronautics and Astronautics.

NFPA 10 (2010) – Standard for Portable Fire Extinguishers, National Fire Protection Association

NFPA 13 (2010) - Standard for the Installation of Sprinkler Systems, National Fire Protection Association

NFPA14 (2010) - Standard for the Installation of Standpipe and Hose Systems, National Fire Protection Association

NFPA 24 (2010) – Standard for the Installation of Private Fire Service Mains, National Fire Protection Association

NFPA 25 (2010) - Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems.

NFPA 72 (2010) - National Fire Alarm and Signaling Code, National Fire Protection Association

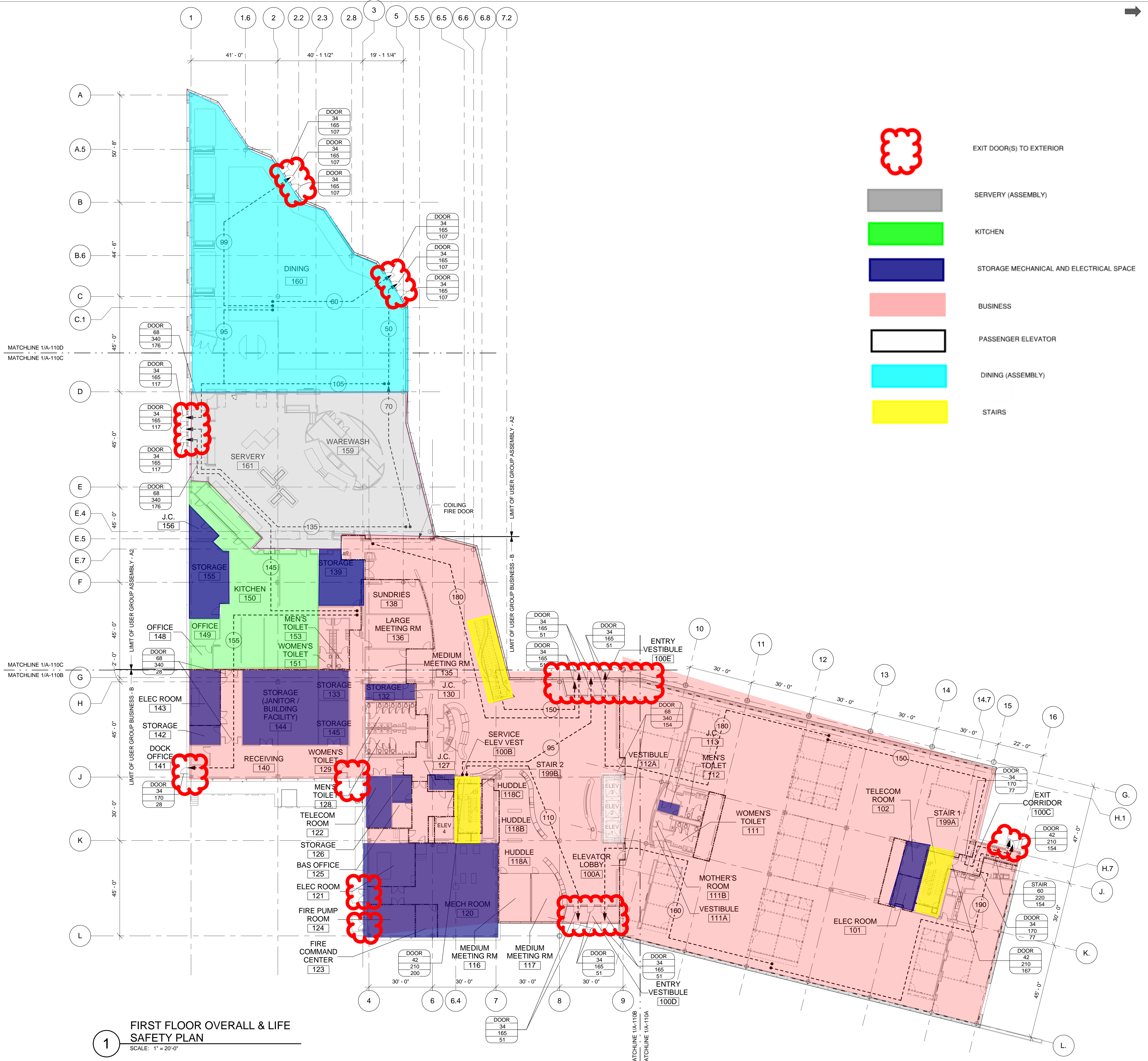
NFPA 101 (2009) – Life Safety Code

NFPA Fire Protection Handbook, 20th Edition, National Fire Protection Association

SFPE Handbook, Fourth edition. Society of Fire Protection Engineers

APPENDIX A

Occupancy and Exit Plans



LEGEND:

- INTERIOR PARTITION WALL
- 1 HR FIRE RATED WALL, CONFORMING TO - UL TEST #905
- 2 HR FIRE RATED WALL, CONFORMING TO - UL TEST #904
- EGRESS DOOR/STAIR CAPACITY: DOOR / STAIR PROVIDED WIDTH (INCHES) MAXIMUM ALLOWABLE LOAD ACTUAL LOAD
- EXIT ACCESS TRAVEL PATH (LONGEST TO EXIT) WITH TRAVEL DISTANCE (FEET)

GENERAL NOTES:

1. THE BUILDING USE GROUP IS BUSINESS - B THROUGHOUT, U.N.C.

EXIT DOOR(S) TO EXTERIOR (Red cloud symbol)

SERVERY (ASSEMBLY) (Grey)

KITCHEN (Green)

STORAGE MECHANICAL AND ELECTRICAL SPACE (Blue)

BUSINESS (Pink)

PASSENGER ELEVATOR (Black outline)

DINING (ASSEMBLY) (Cyan)

STAIRS (Yellow)

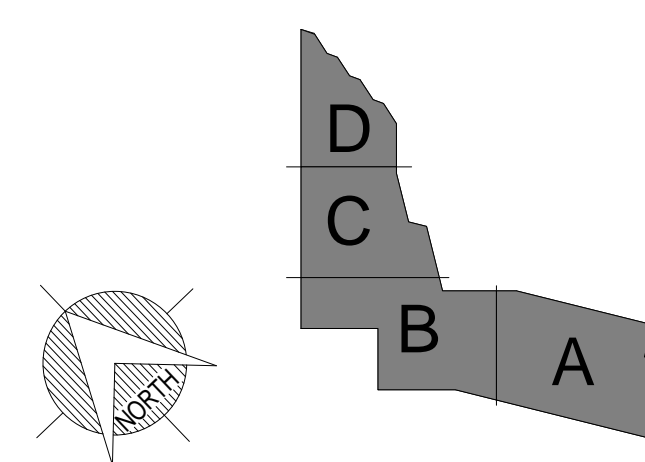
SEAL

A-012

M/F	BLDG	PROJ	DA	TYPE	LAST 0 REV

1ST FLOOR OVERALL & LIFE SAFETY PLAN
ARCHITECTURAL

PROJ NO	REVISION	RVSD	CHKD	APPD	DATE	PROJ NO	REVISION	RVSD	CHKD	APPD	DATE	STANDARDS	NO.	REFERENCE DRAWING TITLE	NO.	REFERENCE DRAWING TITLE	KEY PLAN			PROJECT SCALE	DATE
																			As indicated		

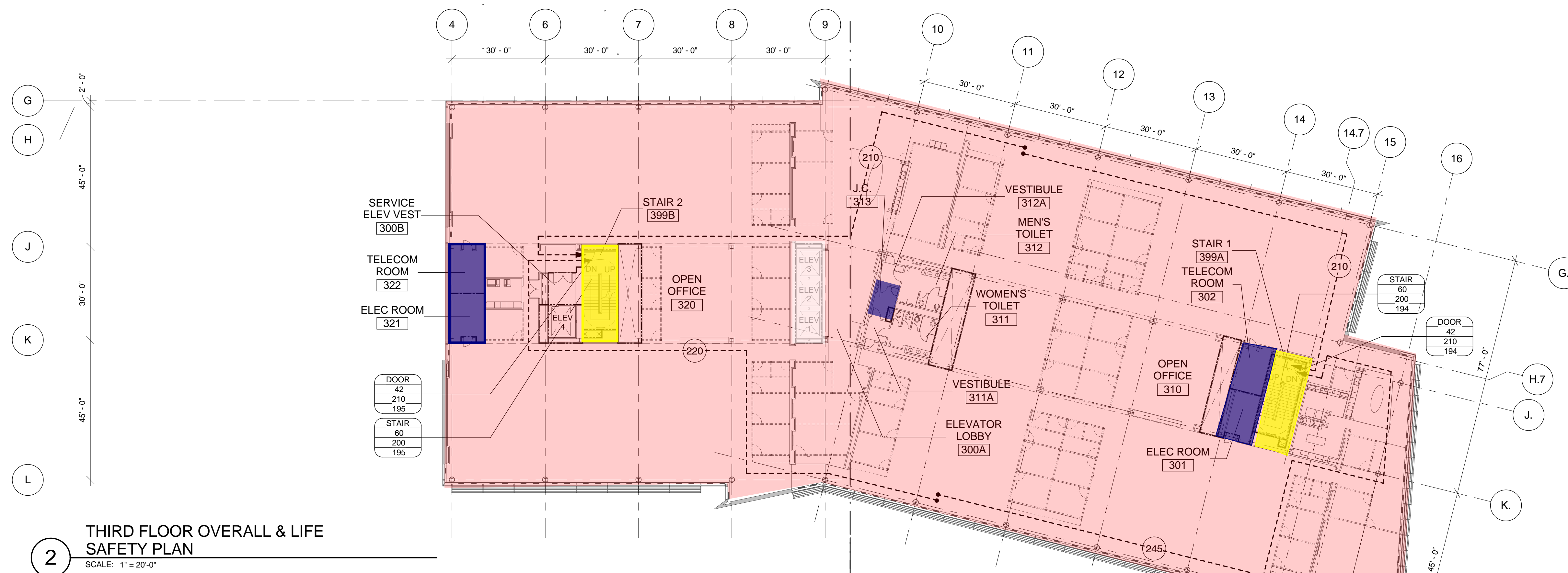


PROJECT SCALE: As indicated

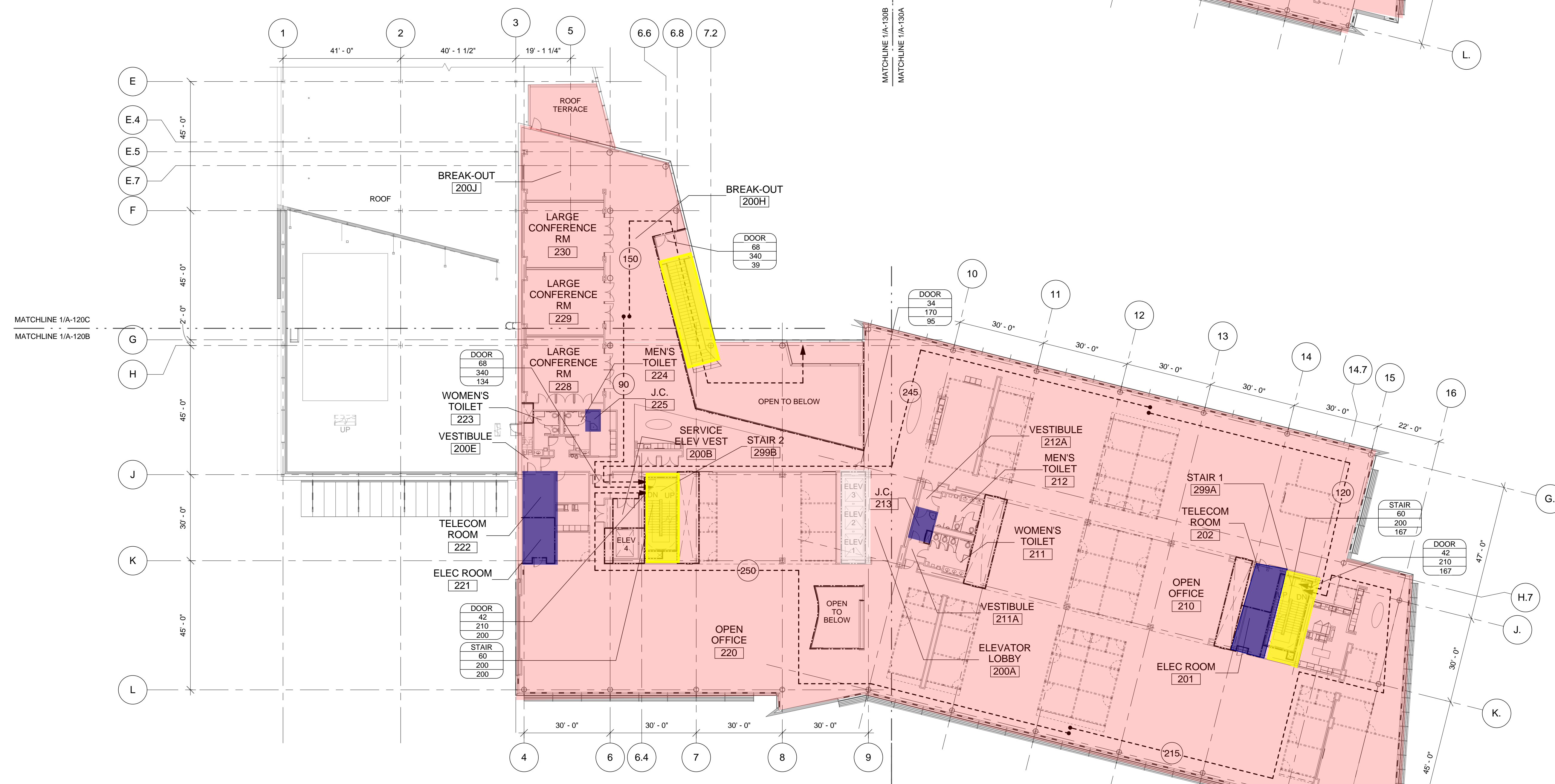
CHECKED: _____

APPROVED-DESIGN RELEASE: _____

APPROVED-CONSTR. RELEASE: _____



2 THIRD FLOOR OVERALL & LIFE SAFETY PLAN
SCALE: 1" = 20'-0"



1 SECOND FLOOR OVERALL & LIFE SAFETY PLAN
SCALE: 1" = 20'-0"

SEAL

A-013

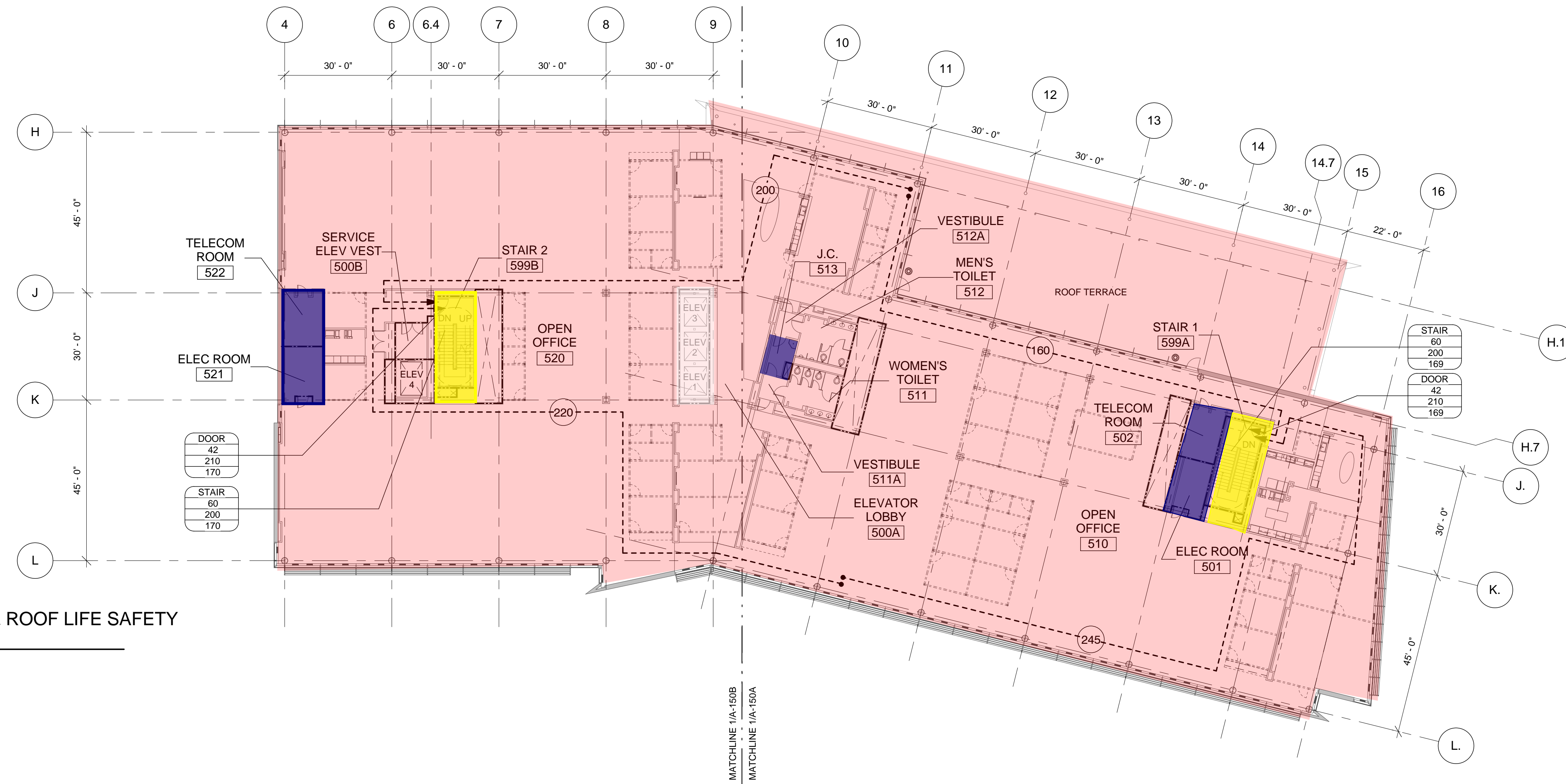
M/F	BLDG	PROJ	DA	TYPE	LAST 0 REV

2ND & 3RD FLR. OVERALL & LIFE SAFETY PLAN
ARCHITECTURAL

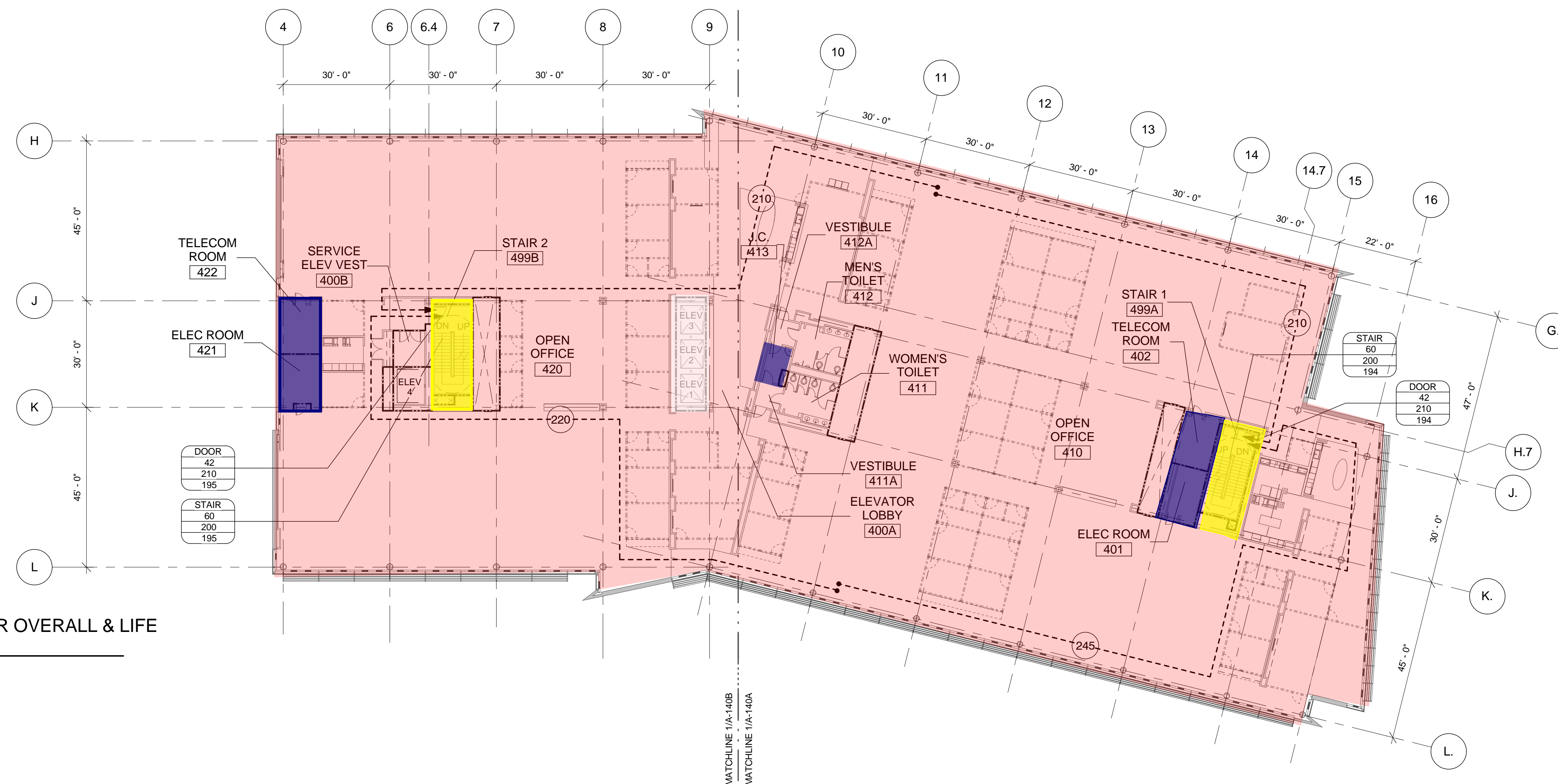
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KEY PLAN

PROJECT SCALE DRAWN CHECKED APPROVED-DESIGN RELEASE APPROVED-CONSTR. RELEASE DATE



2 FIFTH FLOOR & ROOF LIFE SAFETY PLAN
SCALE: 1" = 20'-0"



1 FOURTH FLOOR OVERALL & LIFE SAFETY PLAN
SCALE: 1" = 20'-0"

- LEGEND:**
- ===== INTERIOR PARTITION WALL
 - 1 HR FIRE RATED WALL, CONFORMING TO - UL TEST #1035
 - 2 HR FIRE RATED WALL, CONFORMING TO - UL TEST #904
 - XXXX DOOR / STAIR EGRESS DOOR/STAIR CAPACITY: PROVIDED WIDTH (INCHES) MAXIMUM ALLOWABLE LOAD ACTUAL LOAD
 - XX--- EXIT ACCESS TRAVEL PATH (LONGEST TO EXIT) WITH TRAVEL DISTANCE (FEET)

GENERAL NOTES:
1. THE BUILDING USE GROUP IS BUSINESS - B THROUGHOUT. U.N.O.

SEAL					
M/F	BLDG	PROJ	DA	TYPE	LAST REV
					0
4TH & 5TH FLR. OVERALL & LIFE SAFETY PLAN					
ARCHITECTURAL					

PROJ NO	REVISION	RVSD	CHKD	APPD	DATE	PROJ NO	REVISION	RVSD	CHKD	APPD	DATE	STANDARDS	NO.	REFERENCE DRAWING TITLE	NO.	REFERENCE DRAWING TITLE

KEY PLAN

PROJECT SCALE: As indicated DATE: _____

DRAWN: _____

CHECKED: _____

APPROVED-DESIGN RELEASE: _____

APPROVED-CONSTR. RELEASE: _____

APPENDIX B

Life Safety Plans – Exit Signs



LEGEND:

- INTERIOR PARTITION WALL
- 1 HR FIRE RATED WALL, CONFORMING TO - UL TEST #1000
- 2 HR FIRE RATED WALL, CONFORMING TO - UL TEST #1004
- EGRESS DOOR/STAIR CAPACITY: DOOR / STAIR PROVIDED WIDTH (INCHES) MAXIMUM ALLOWABLE LOAD ACTUAL LOAD
- EXIT ACCESS TRAVEL PATH (LONGEST TO EXIT) WITH TRAVEL DISTANCE (FEET)

GENERAL NOTES:
 1. THE BUILDING USE GROUP IS BUSINESS - B THROUGHOUT, U.N.C.

1 FIRST FLOOR OVERALL & LIFE SAFETY PLAN
 SCALE: 1" = 20'-0"

SEAL

A-012

M/F	BLDG	PROJ	DA	TYPE	LAST	REV
					0	

1ST FLOOR OVERALL & LIFE SAFETY PLAN
 ARCHITECTURAL

PROJ NO	REVISION	RVSD	CHKD	APPD	DATE	PROJ NO	REVISION	RVSD	CHKD	APPD	DATE	STANDARDS	NO.	REFERENCE DRAWING TITLE	NO.	REFERENCE DRAWING TITLE

KEY PLAN

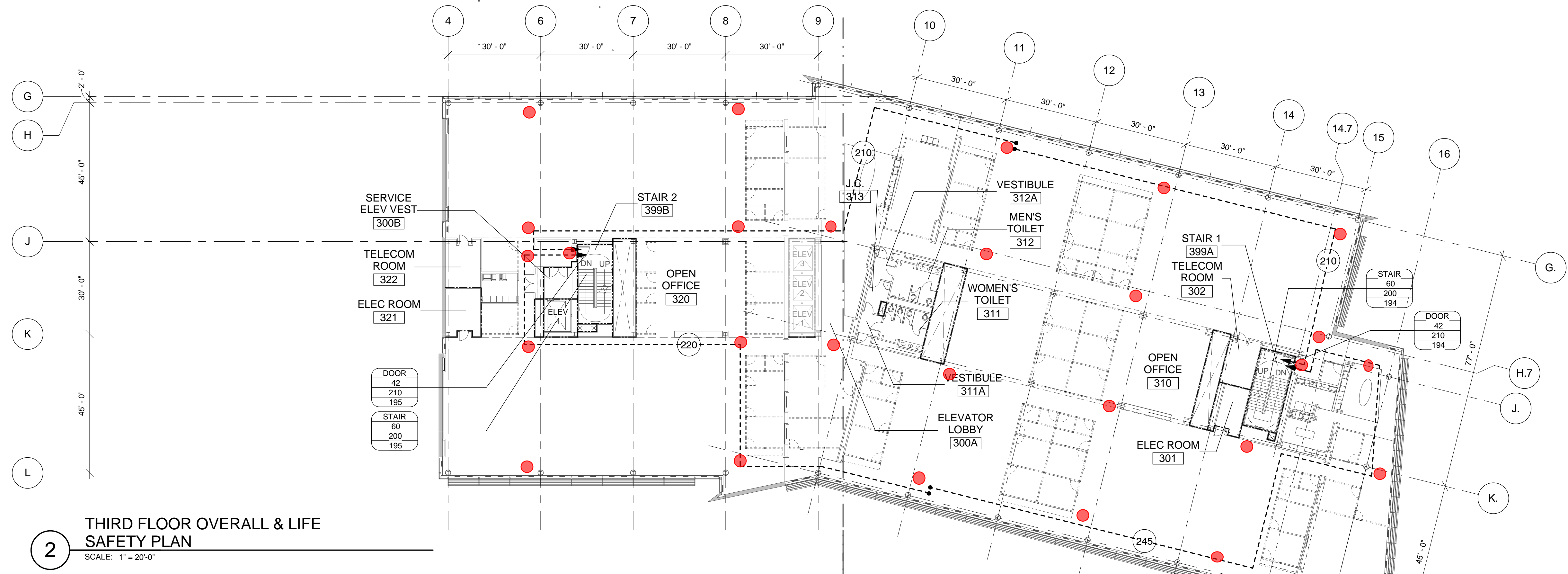
PROJECT SCALE
 As indicated

DATE

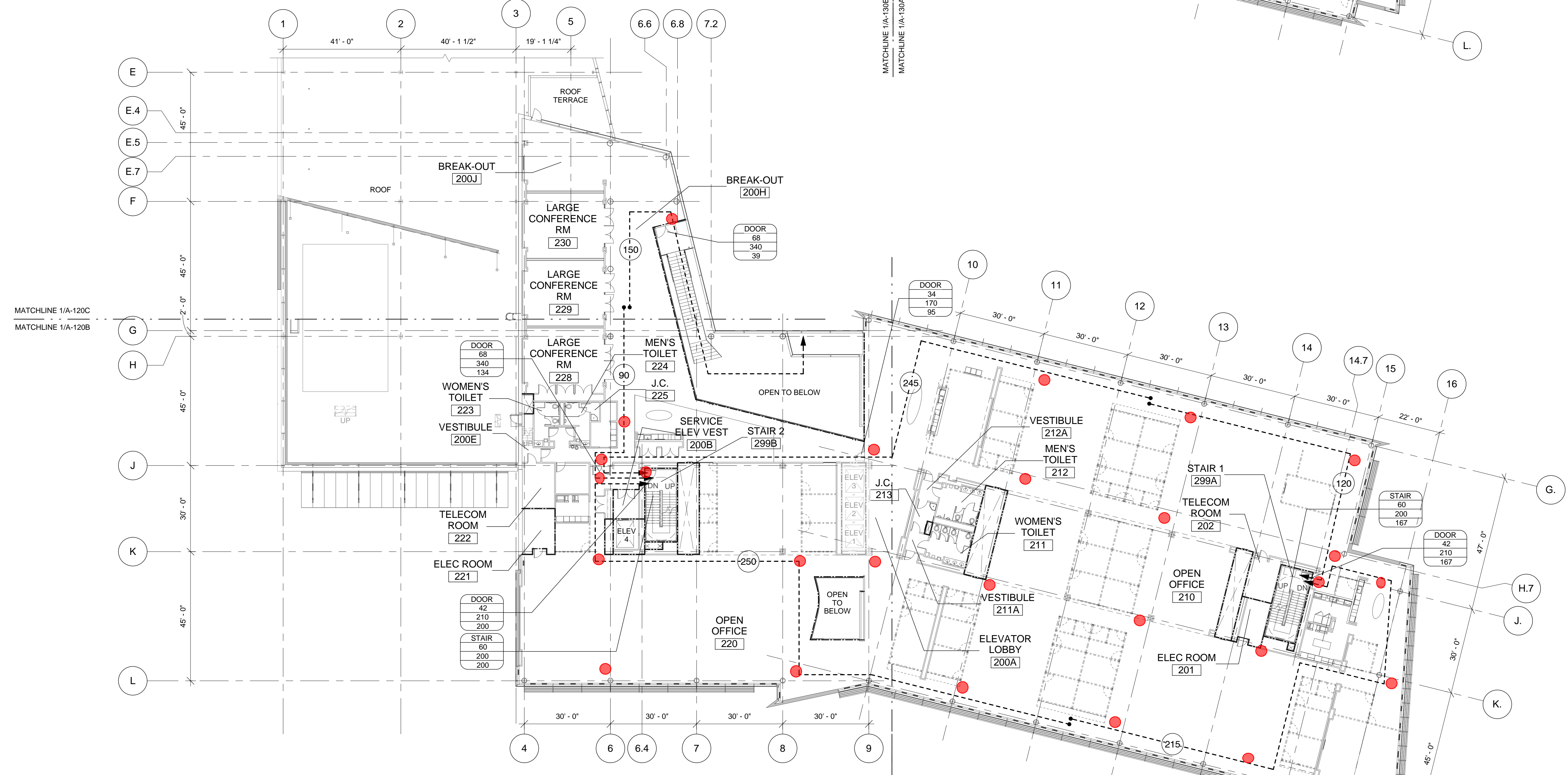
CHECKED

APPROVED-DESIGN RELEASE

APPROVED-CONSTR. RELEASE



2 THIRD FLOOR OVERALL & LIFE SAFETY PLAN
SCALE: 1" = 20'-0"



1 SECOND FLOOR OVERALL & LIFE SAFETY PLAN
SCALE: 1" = 20'-0"

LEGEND:

- INTERIOR PARTITION WALL
- 1 HR FIRE RATED WALL, CONFORMING TO - UL TEST #1935
- 2 HR FIRE RATED WALL, CONFORMING TO - UL TEST #1904
- EGRESS DOOR/STAIR CAPACITY:
DOOR / STAIR PROVIDED WIDTH (INCHES)
MAXIMUM ALLOWABLE LOAD
ACTUAL LOAD
- EXIT ACCESS TRAVEL PATH (LONGEST TO EXIT) WITH TRAVEL DISTANCE (FEET)

GENERAL NOTES:

- THE BUILDING USE GROUP IS BUSINESS - B THROUGHOUT, U.N.O.

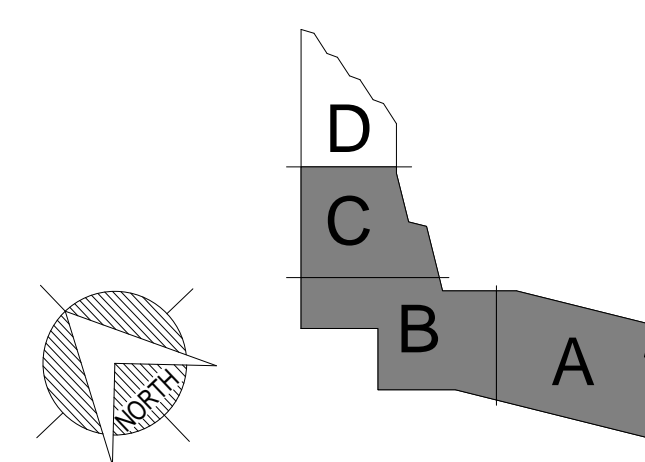
SEAL

A-013

M/F	BLDG	PROJ	DA	TYPE	LAST 0 REV
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2ND & 3RD FLR. OVERALL & LIFE SAFETY PLAN
ARCHITECTURAL

PROJ NO	REVISION	RVSD	CHKD	APPD	DATE	PROJ NO	REVISION	RVSD	CHKD	APPD	DATE	STANDARDS	NO.	REFERENCE DRAWING TITLE	NO.	REFERENCE DRAWING TITLE	KEY PLAN	PROJECT SCALE	DATE



APPROVED- CONSTR. RELEASE	DATE
------------------------------	------

APPENDIX C

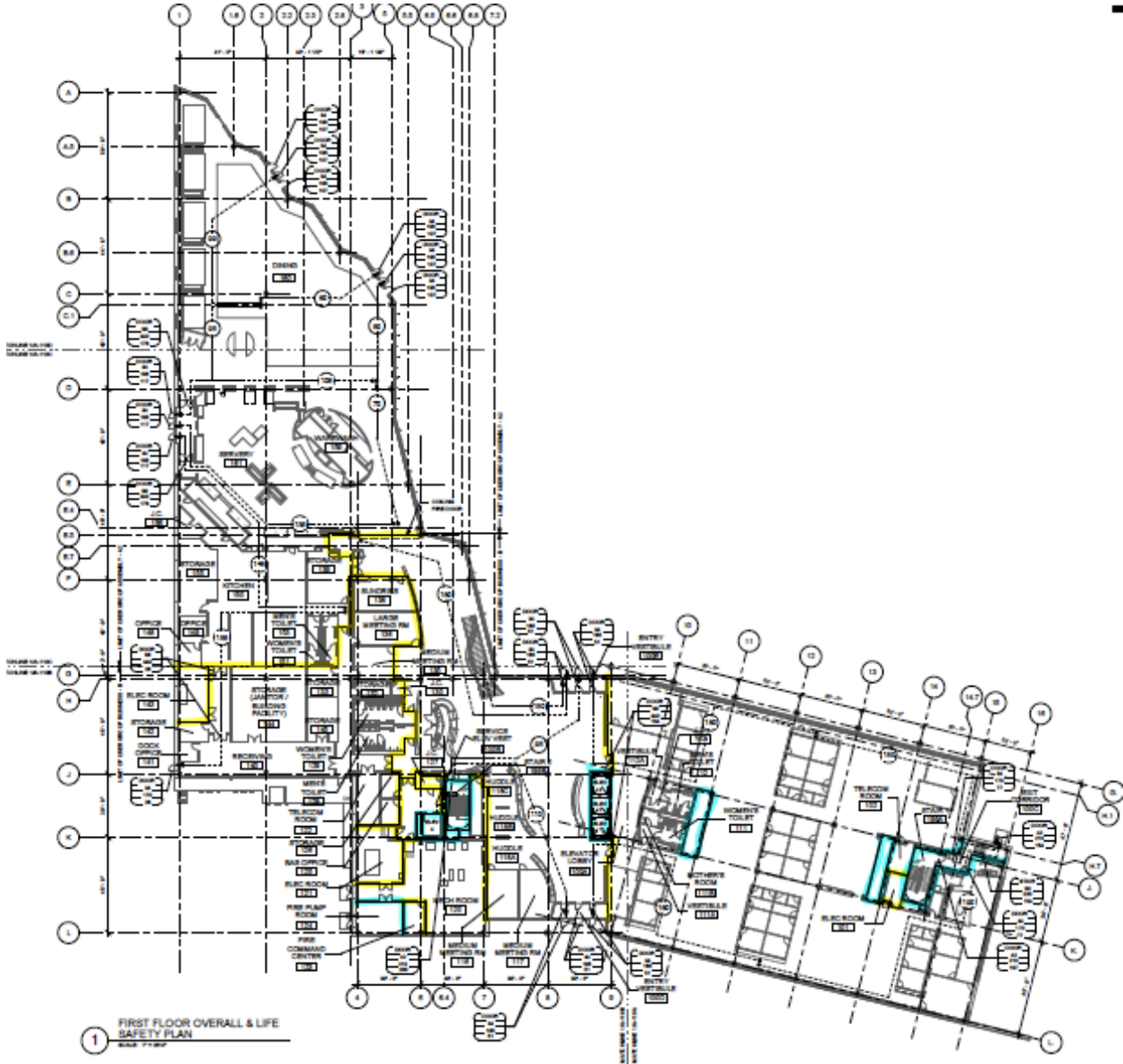
Interior Fire Rated Walls

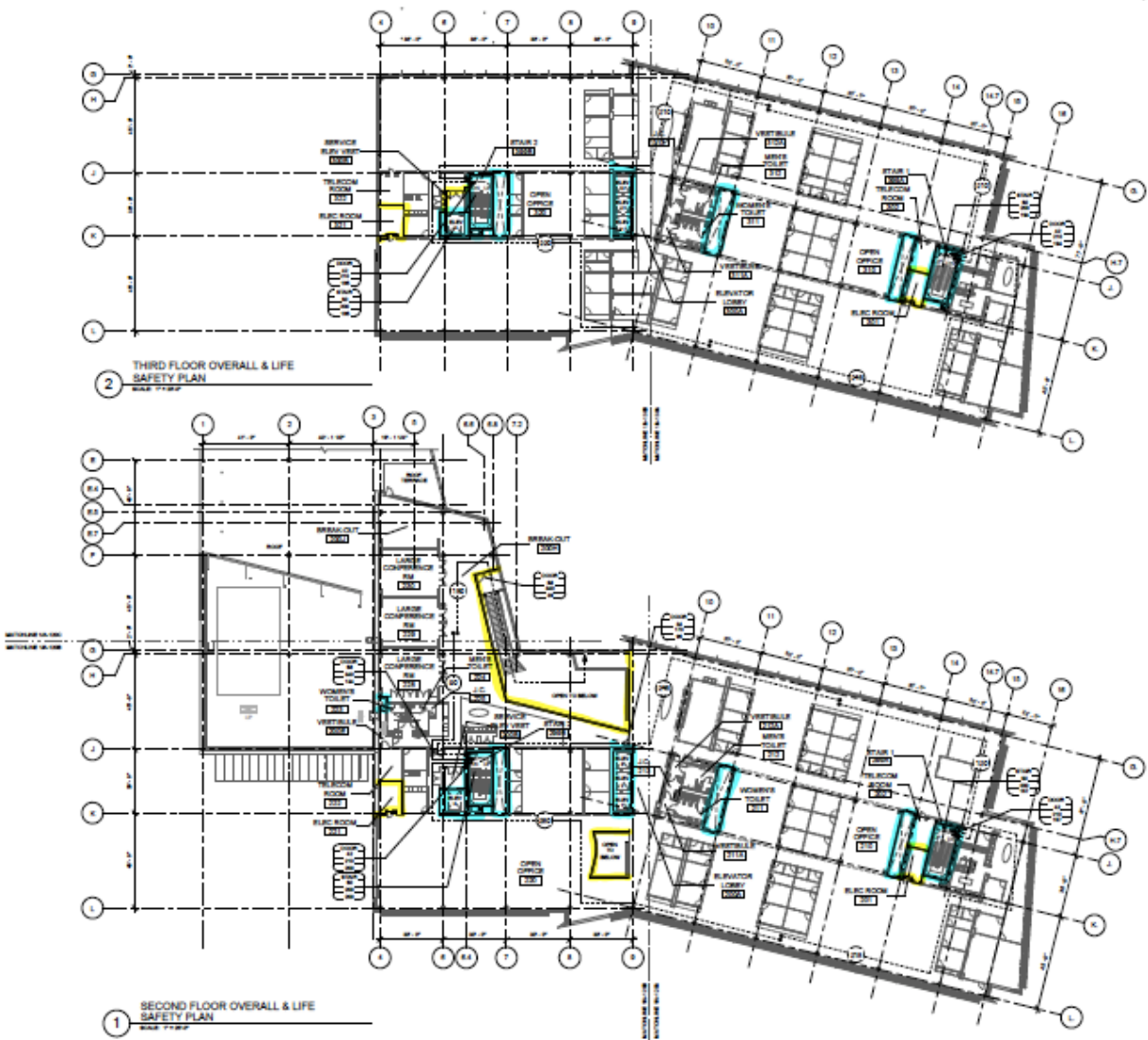
Interior Fire Rated Walls

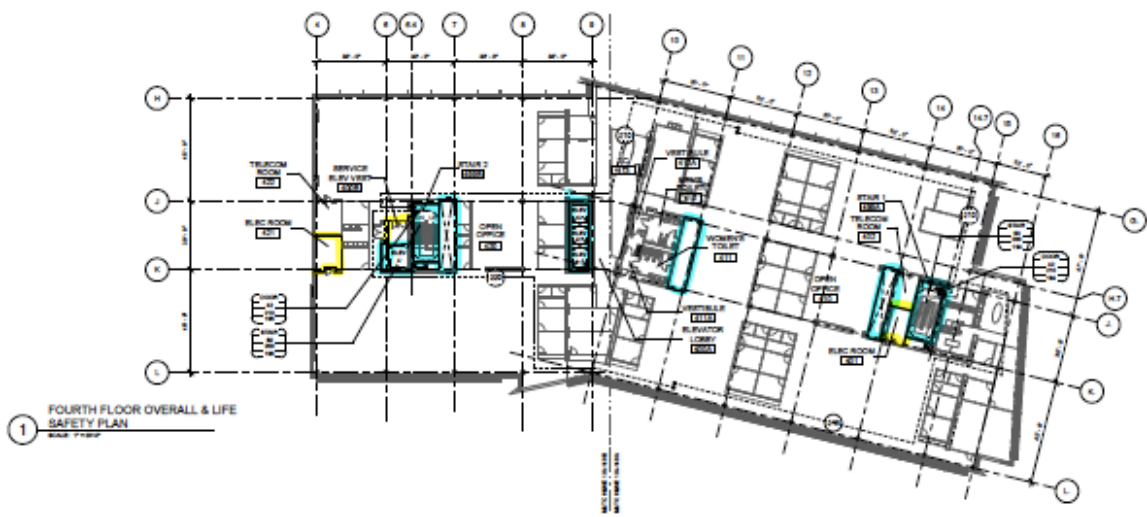
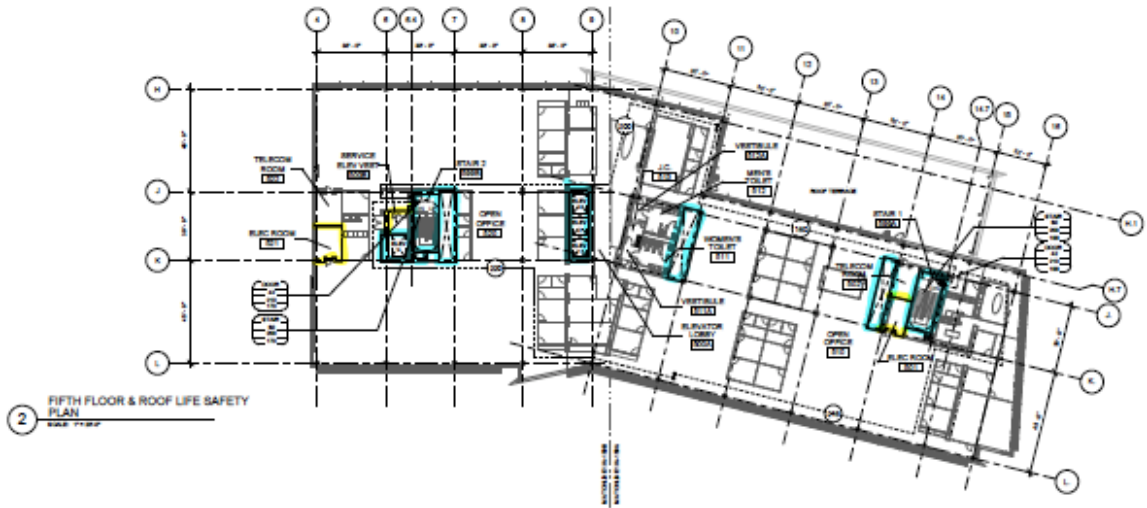
Legend

Yellow = 1 Hour

Blue = 2 Hour



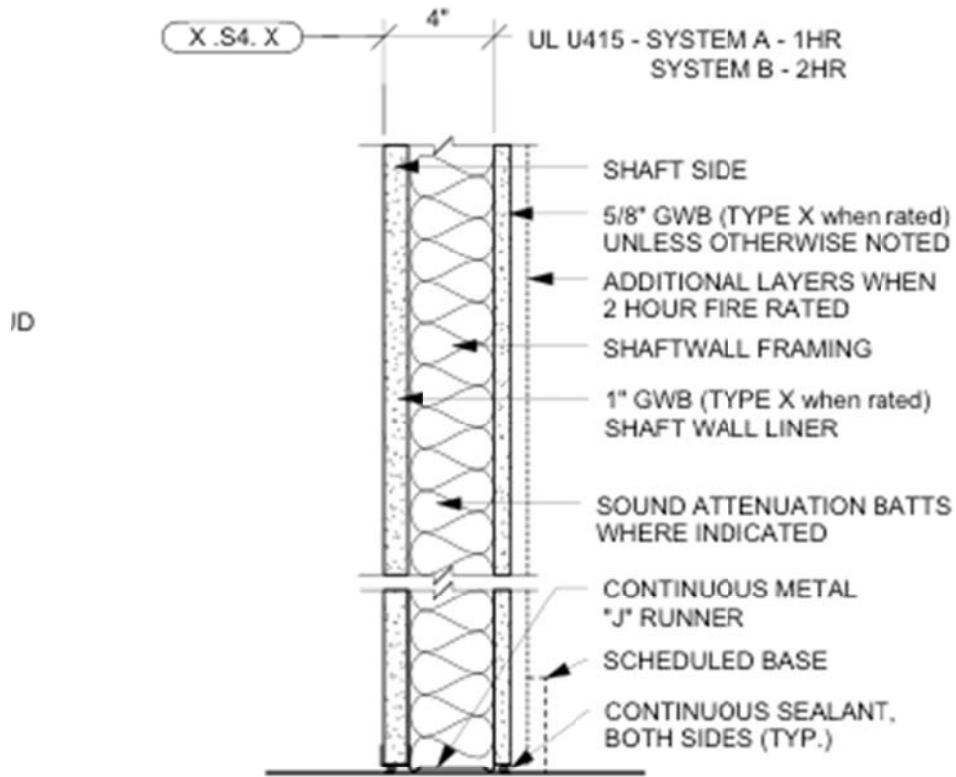




APPENDIX D

Partition Details

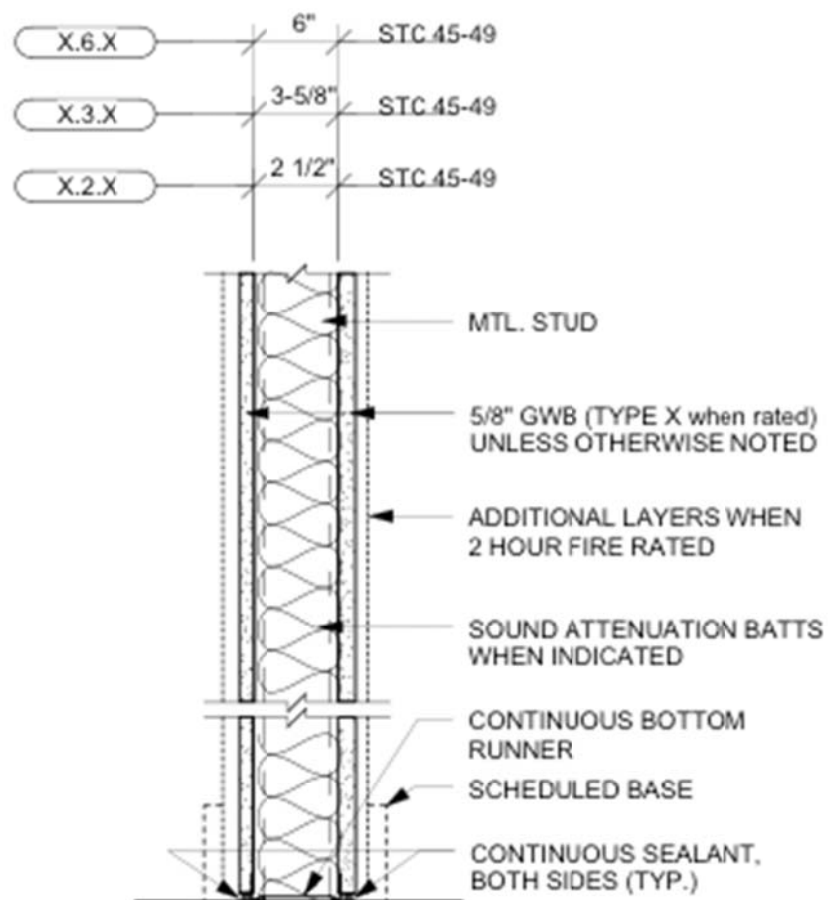
Partition Details



4

SHAFTWALL PARTITION

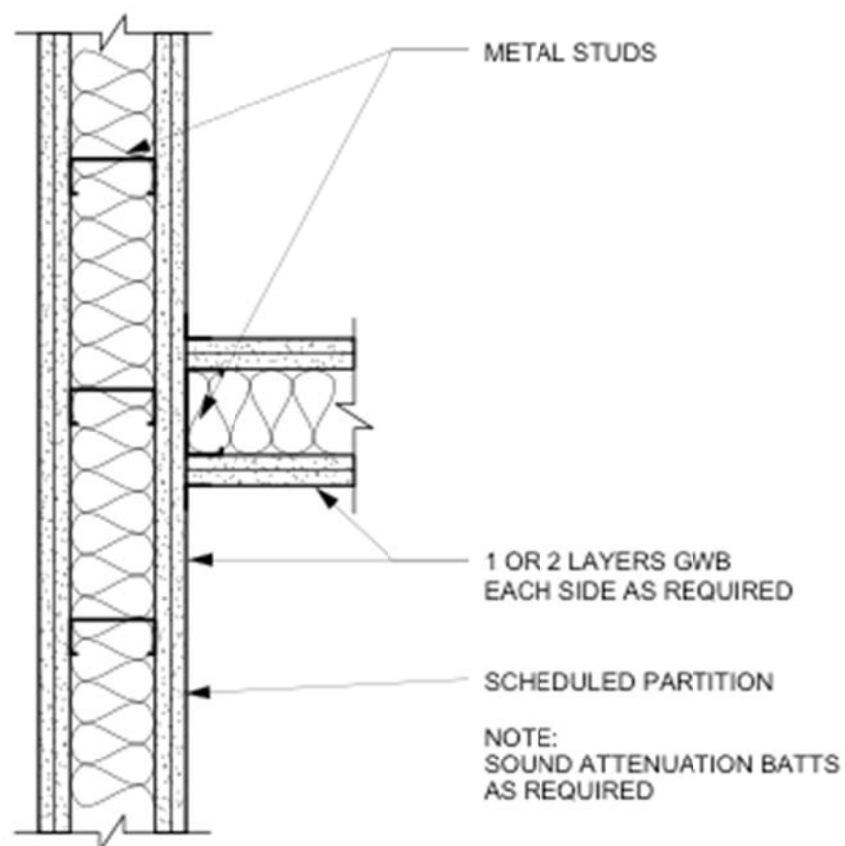
SCALE: 1 1/2" = 1'-0"



3

GWB PARTITION ON MTL STUDS

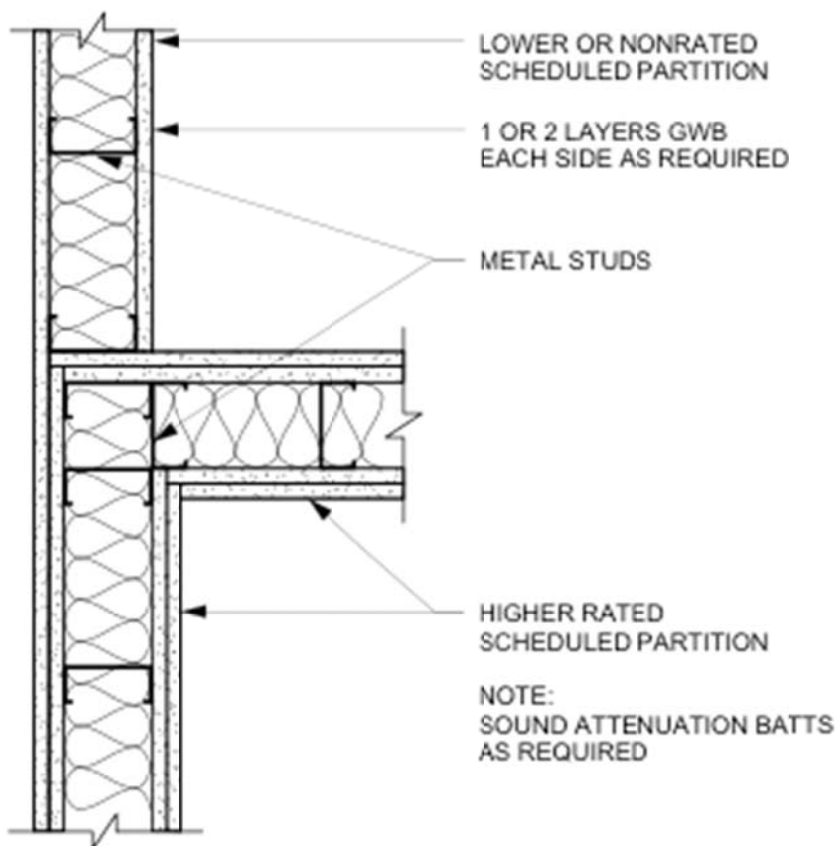
SCALE: 1 1/2" = 1'-0"



7

"T" INTERSECTION - EQUAL RATINGS

SCALE: 1 1/2" = 1'-0"



6

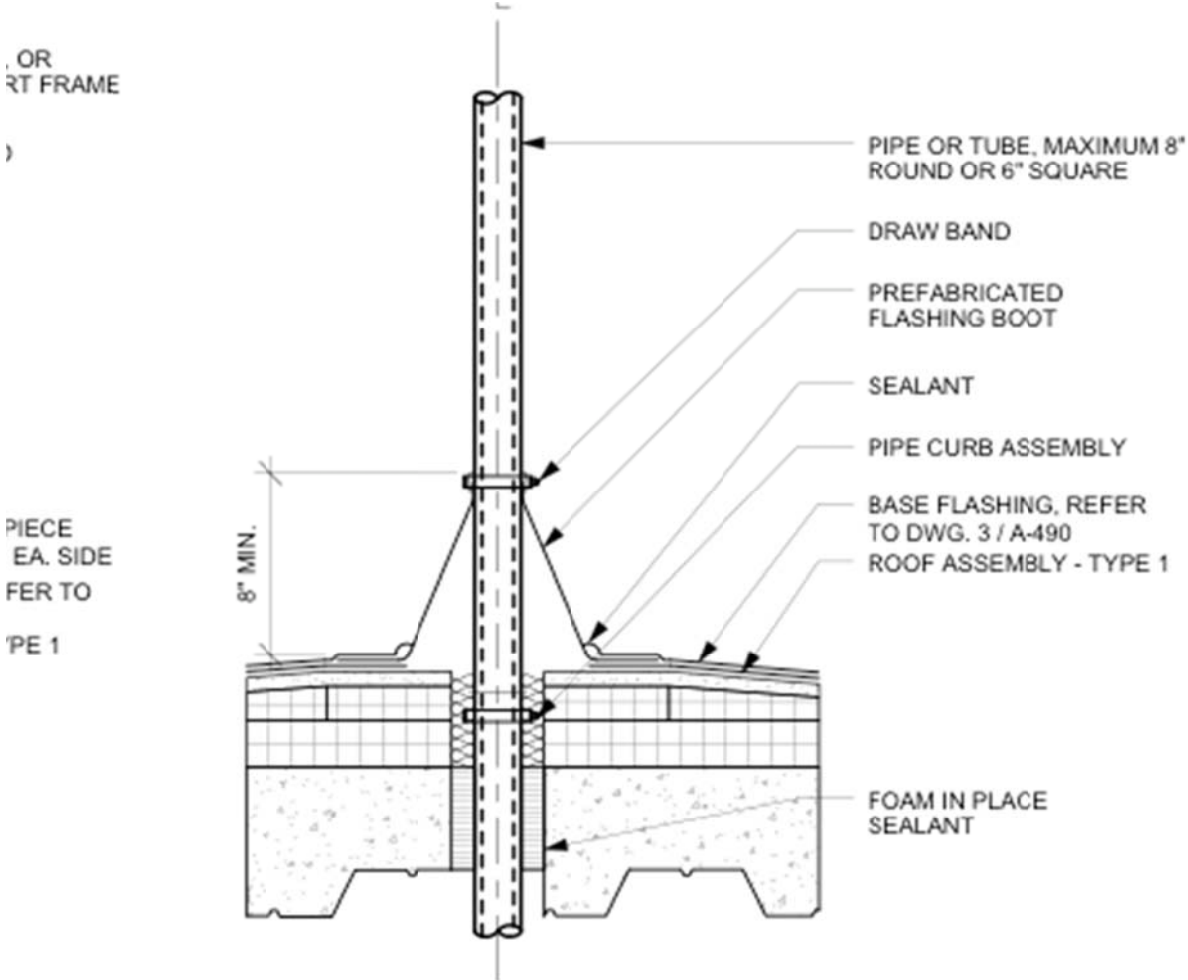
"T" INTERSECTION - UNEQUAL RATINGS

SCALE: 1 1/2" = 1'-0"

APPENDIX E

Penetration Details

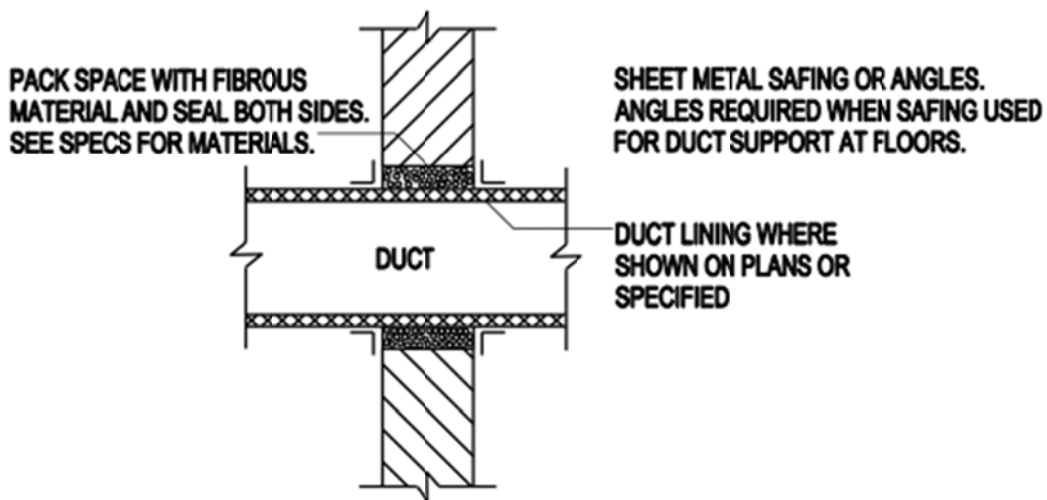
Penetration Details



8

SMALL PIPE OR TUBE PENETRATION

SCALE: 1 1/2" = 1'-0"



NOTES:

1. WHERE FIRE, SMOKE, OR COMBINATION FIRE/SMOKE DAMPERS ARE REQUIRED, INSTALLATION WILL BE PER DAMPER MANUFACTURER'S REQUIREMENTS.
2. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATIONS.

2 TYPICAL INTERIOR WALL
OR FLOOR SLAB PENETRATIONS

APPENDIX F

Fire Alarm Drawings

DESCRIPTION	DATE
REVISIONS	

General Notes:

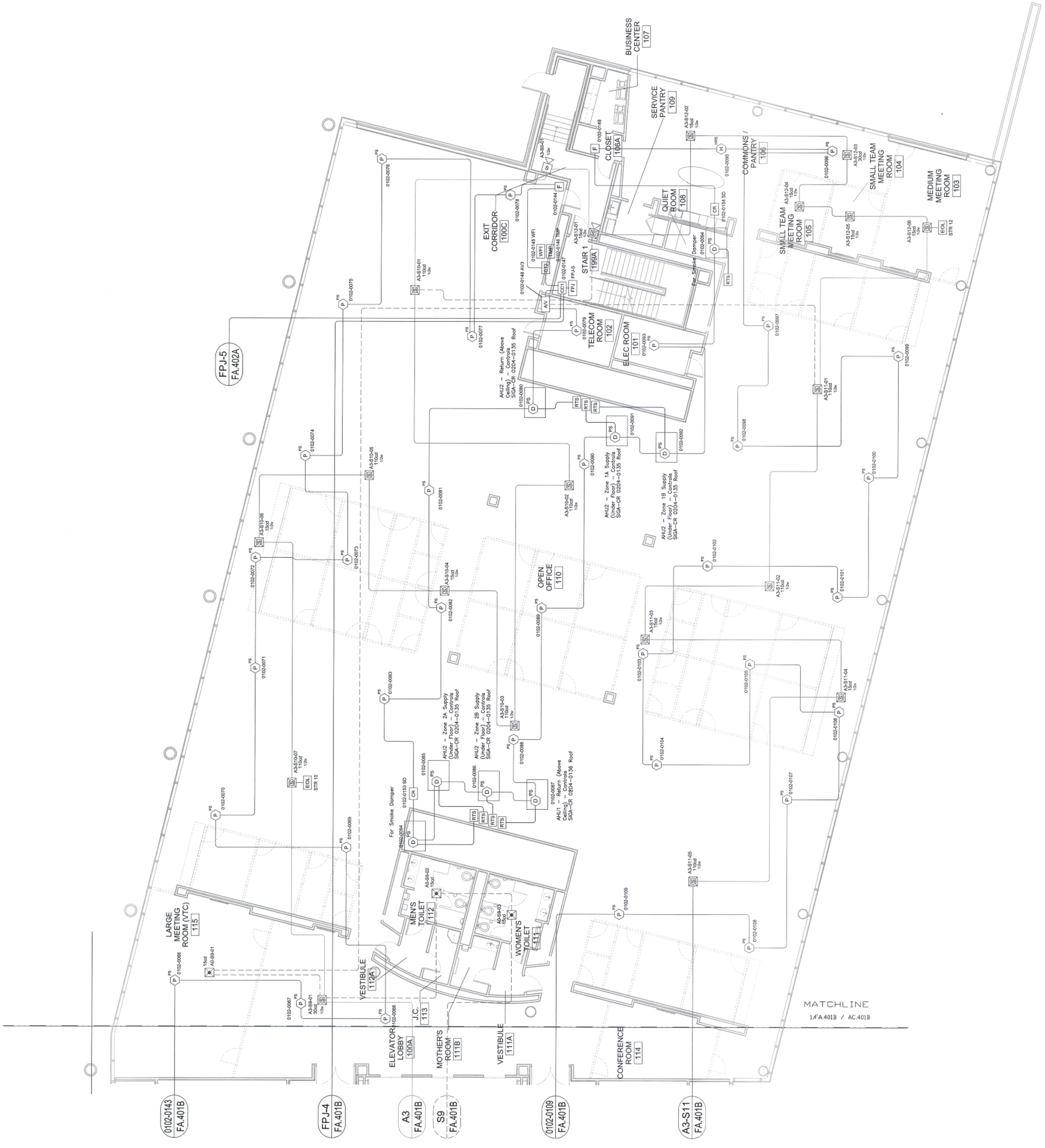
1. Open Fire wiring, for fire alarm, will be used where allowable by code.

Sheet Notes:

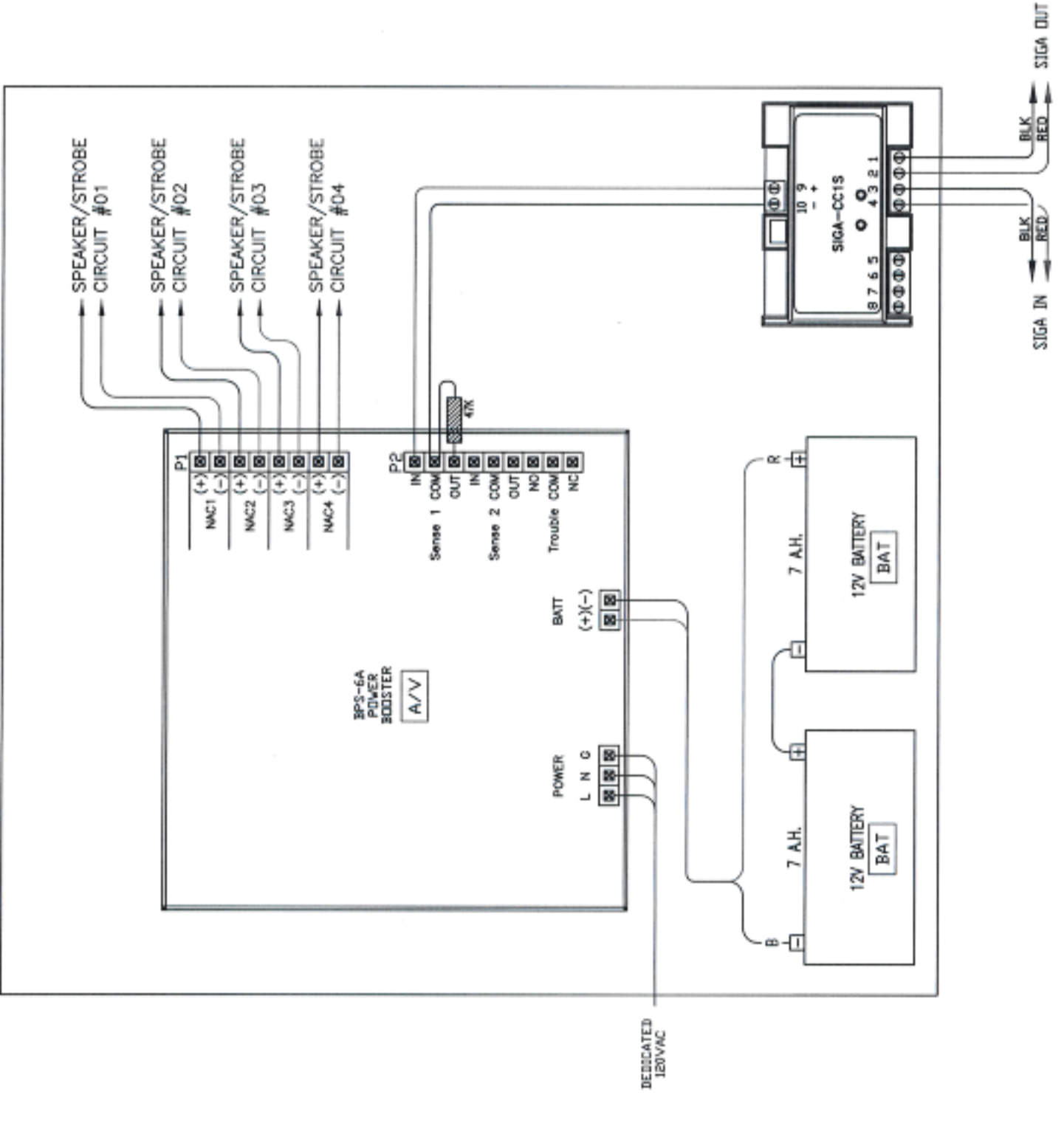
1. All speakers will be tapped at 1/2 watt, unless otherwise noted on the drawings.
2. A minimum of 2 speaker circuits shall be provided on each typical office floor. Additional circuits shall be provided on non-typical floors as necessary to meet the specified loading requirements of the specifications.
3. Sirobe circuiting shall be based on an 80% circuit capacity but shall not exceed 10 strobes per circuit except where noted on enclosed prints.
4. Addressable "SIGA" circuits shall be cabled, configured, and programmed as Class "A" circuits.
5. All new cabling shall be Megger tested as outlined in the contract documents. This testing shall occur prior to the devices being installed.
6. Device Addressing shall depict node, slot, and address as it will be shown on the EST3 LCD display's.
7. Wall Mounted notification devices shall be white on all floors. Devices that require surface backboxes will be provided by the Life Safety contractor.

Cabling Notes:

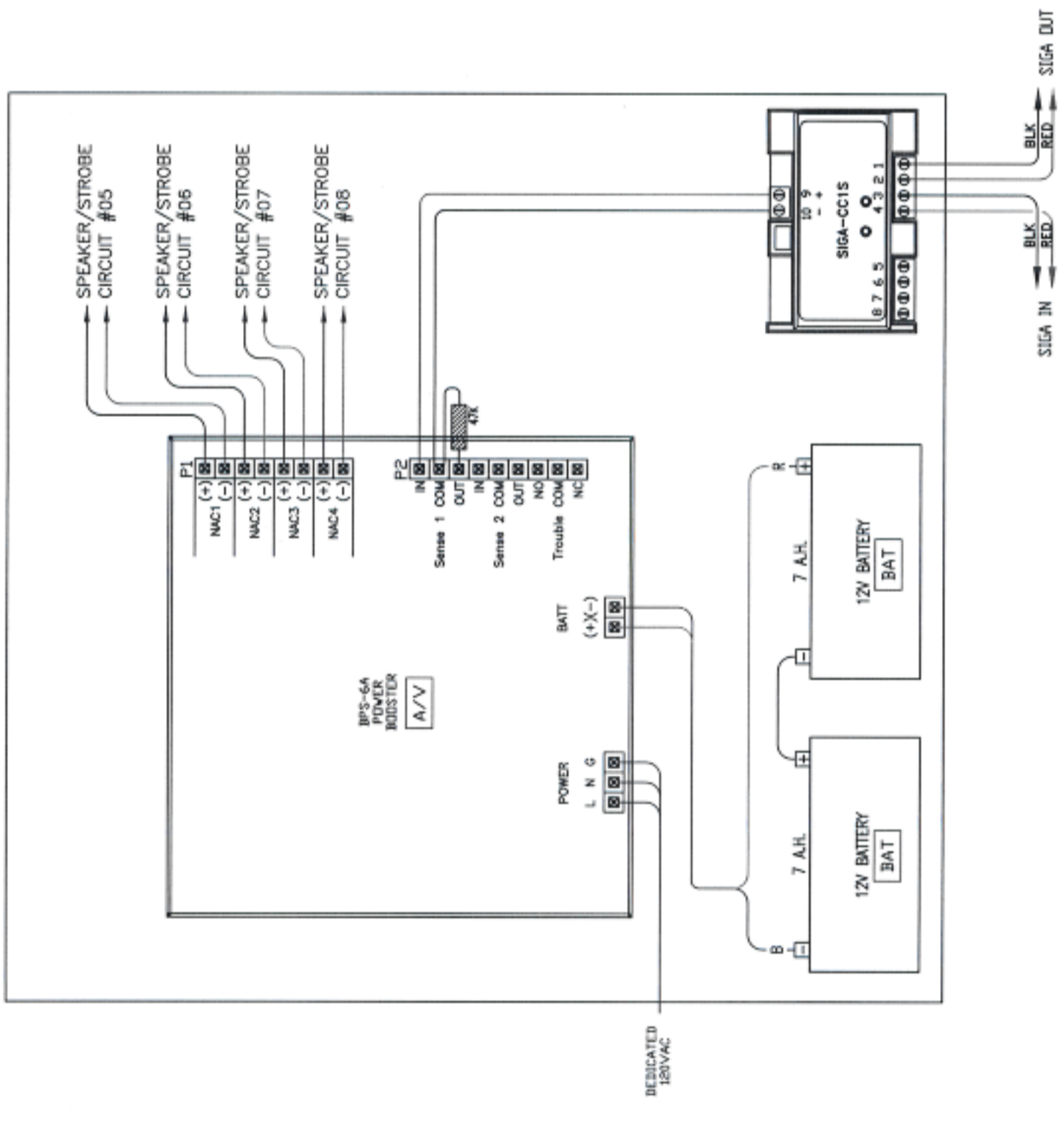
- Dashed Line (Purple) - Sirobe Only
- Solid Green Line - Audio Only
- Solid Purple Line - Audio / Sirobe Ckt
- Solid Red Line - Data Loop
- Solid Brown Line - Fire Phone
- Solid Blue - Annunciator / Network



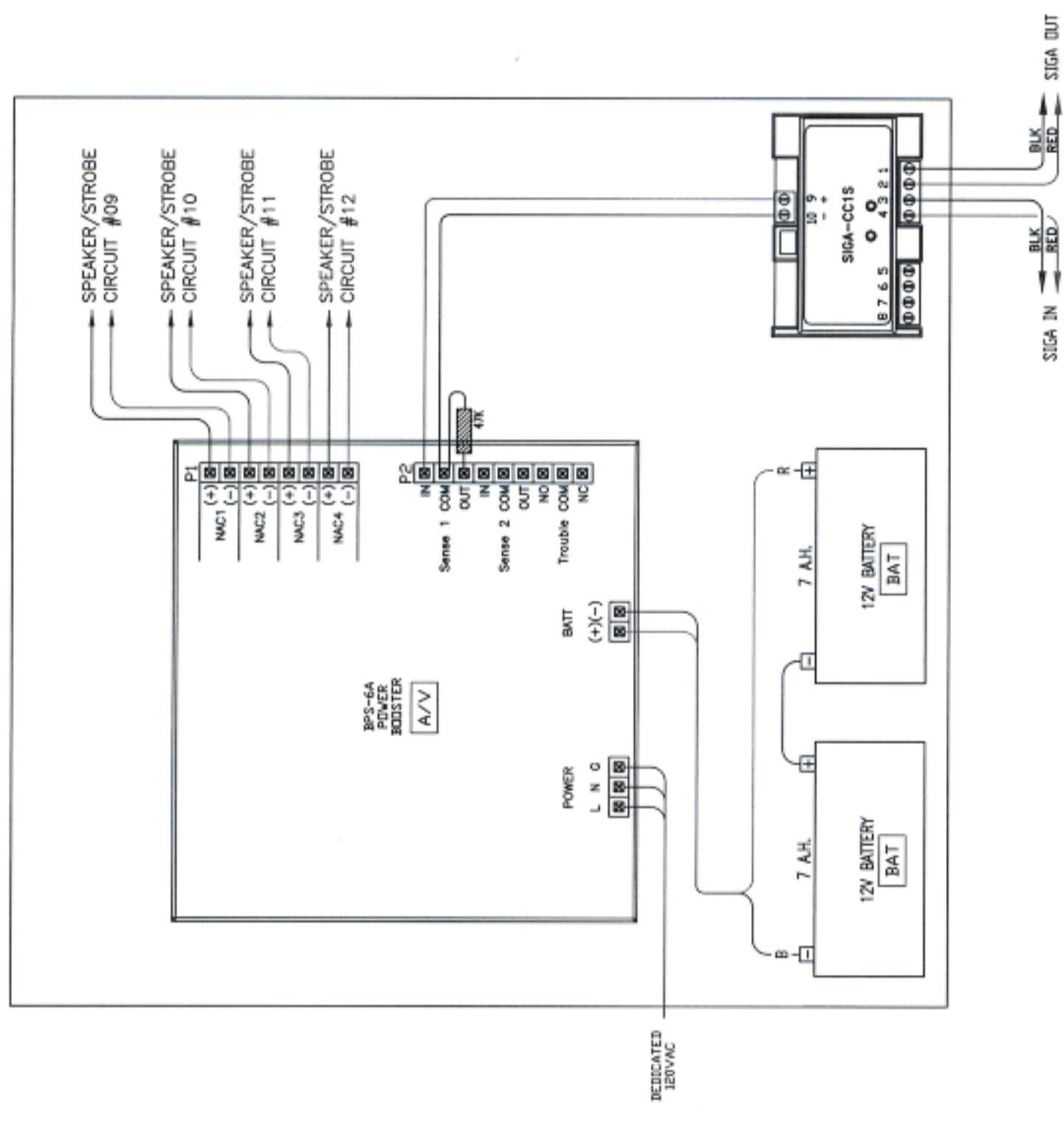
POWER BOOSTER #1
1ST FLOOR TELECOM RM. 102



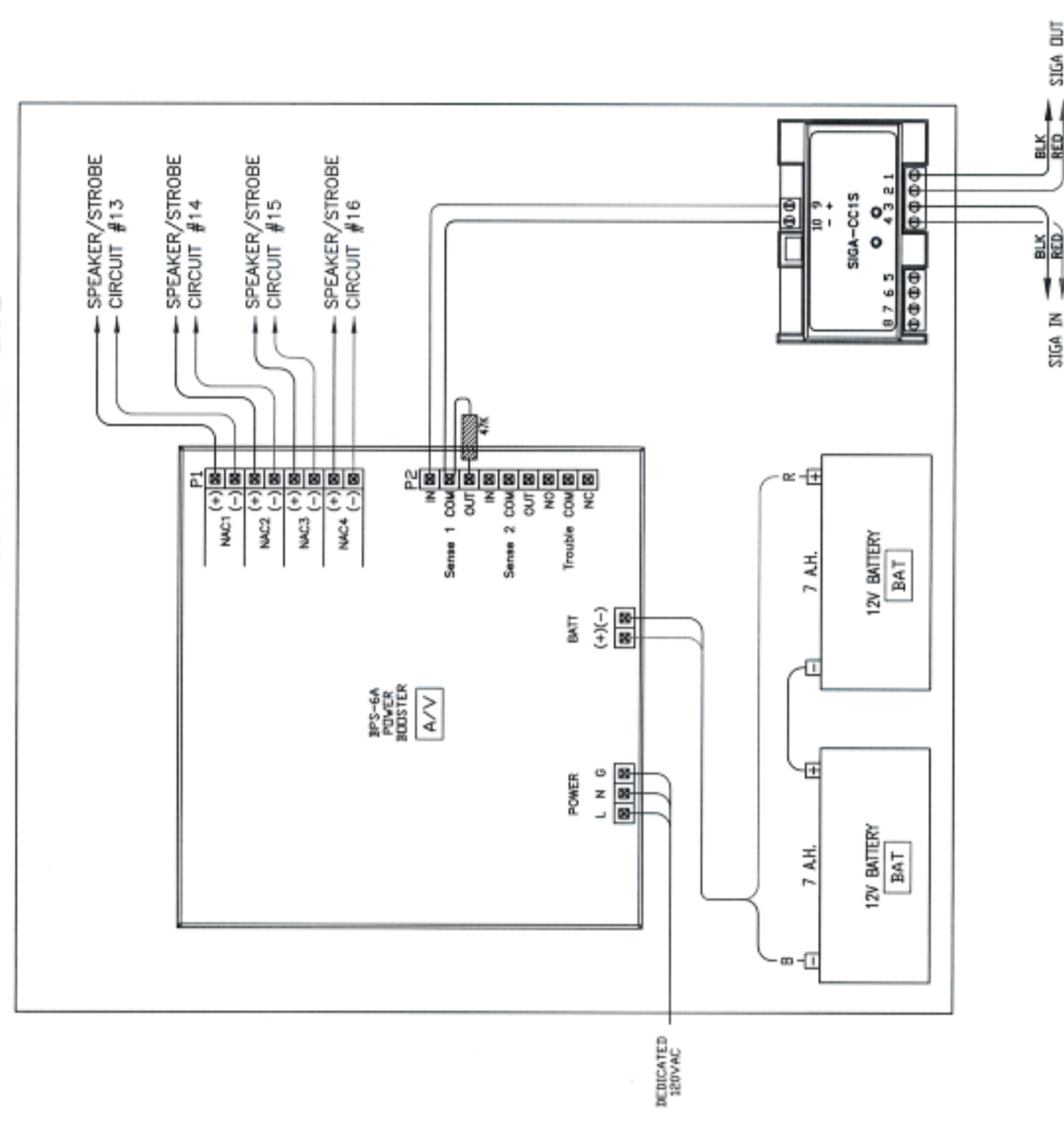
POWER BOOSTER #2
1ST FLOOR TELECOM RM. 102



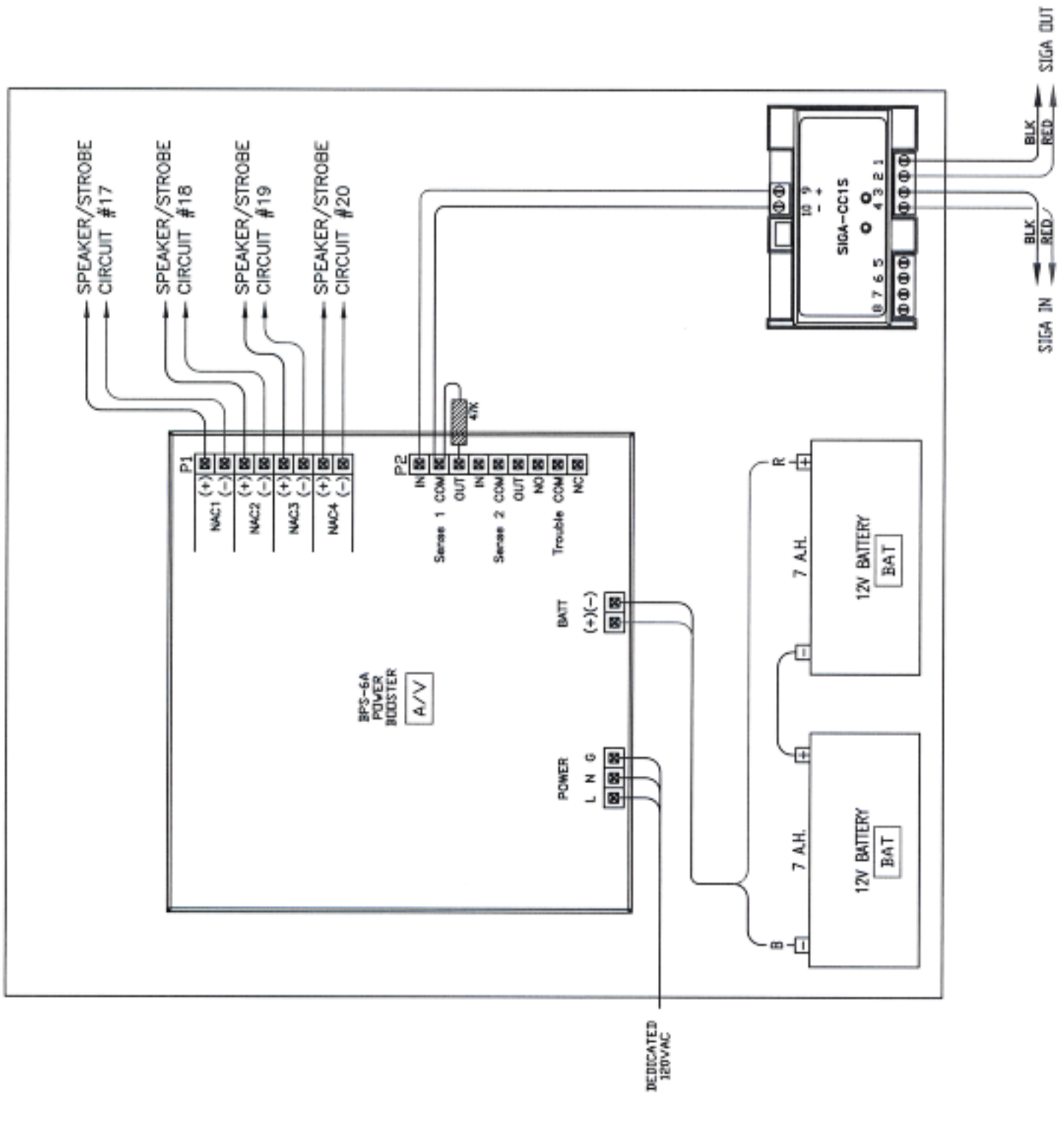
POWER BOOSTER #3
1ST FLOOR TELECOM RM. 122



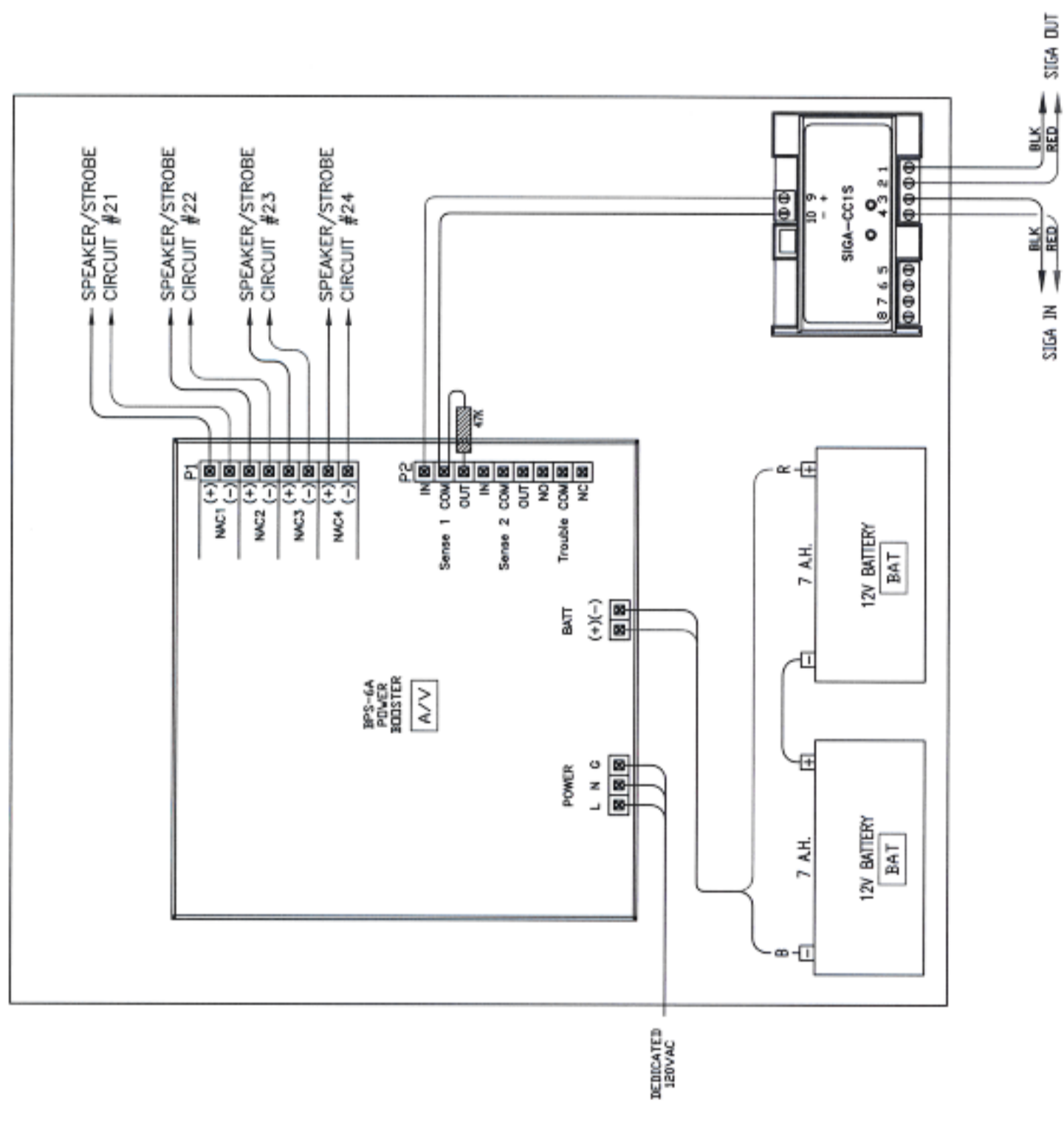
POWER BOOSTER #4
2ND FLOOR TELECOM RM. 202



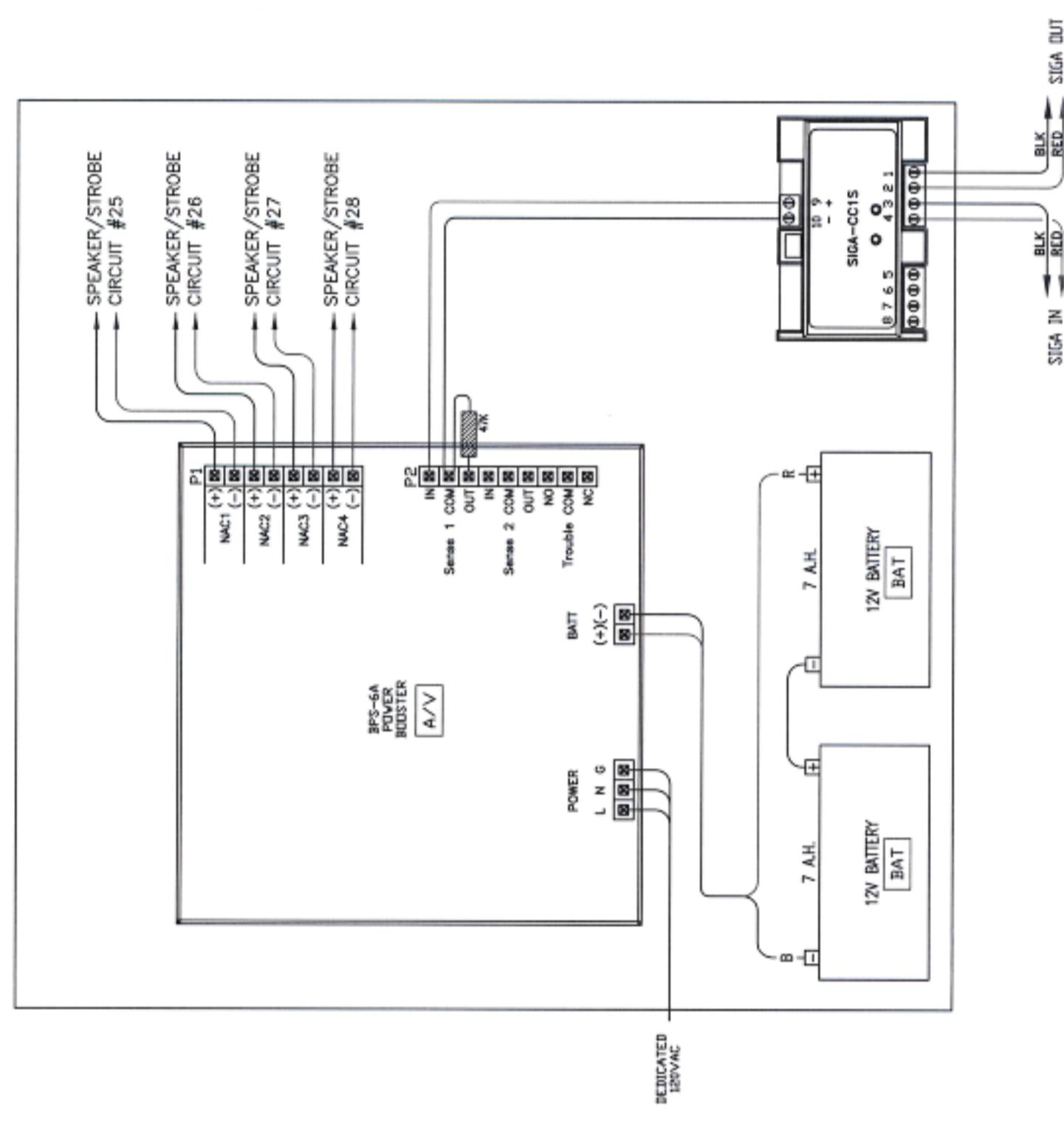
POWER BOOSTER #5
2ND FLOOR TELECOM RM. 222



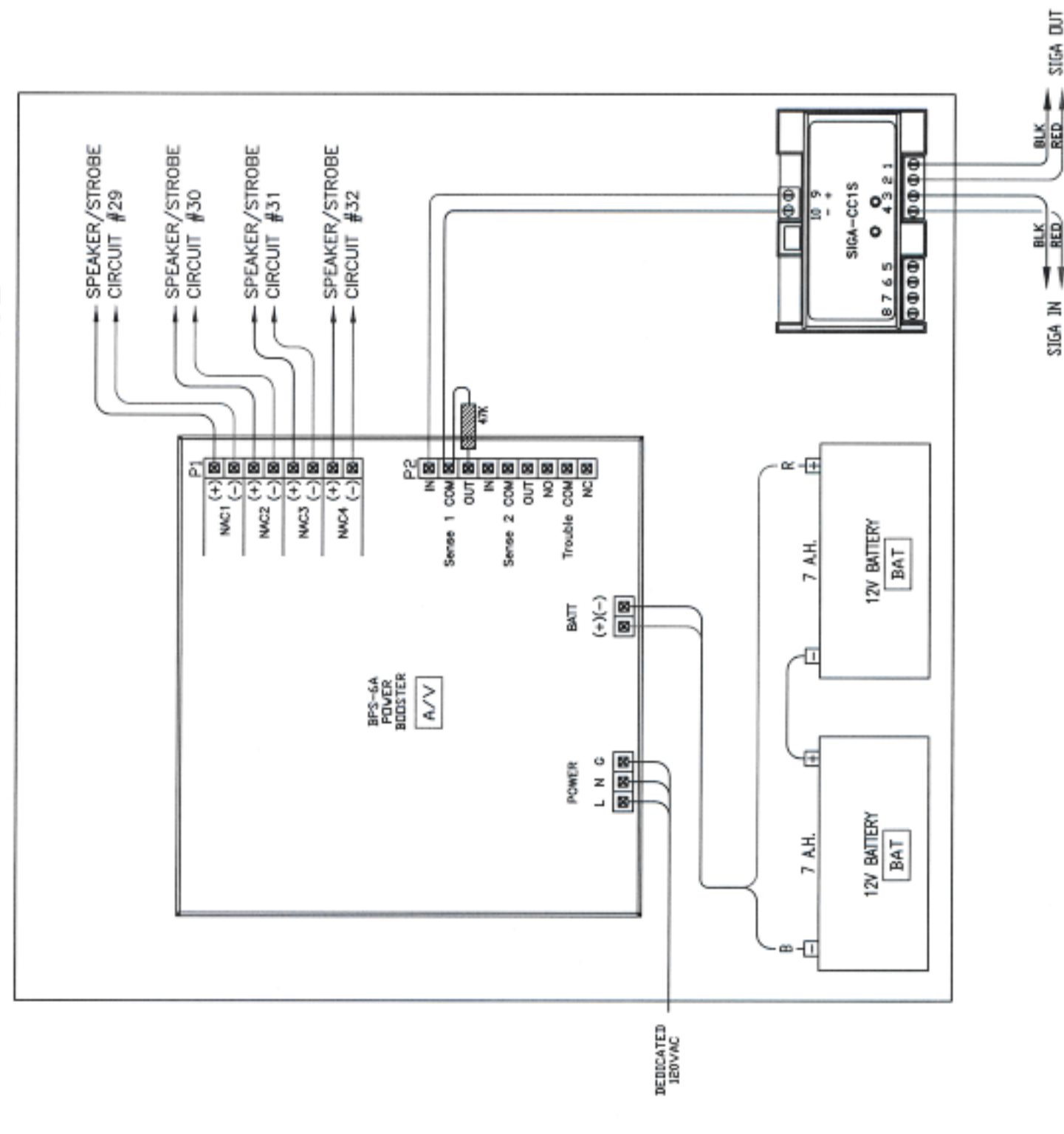
POWER BOOSTER #6
3RD FLOOR TELECOM RM. 302



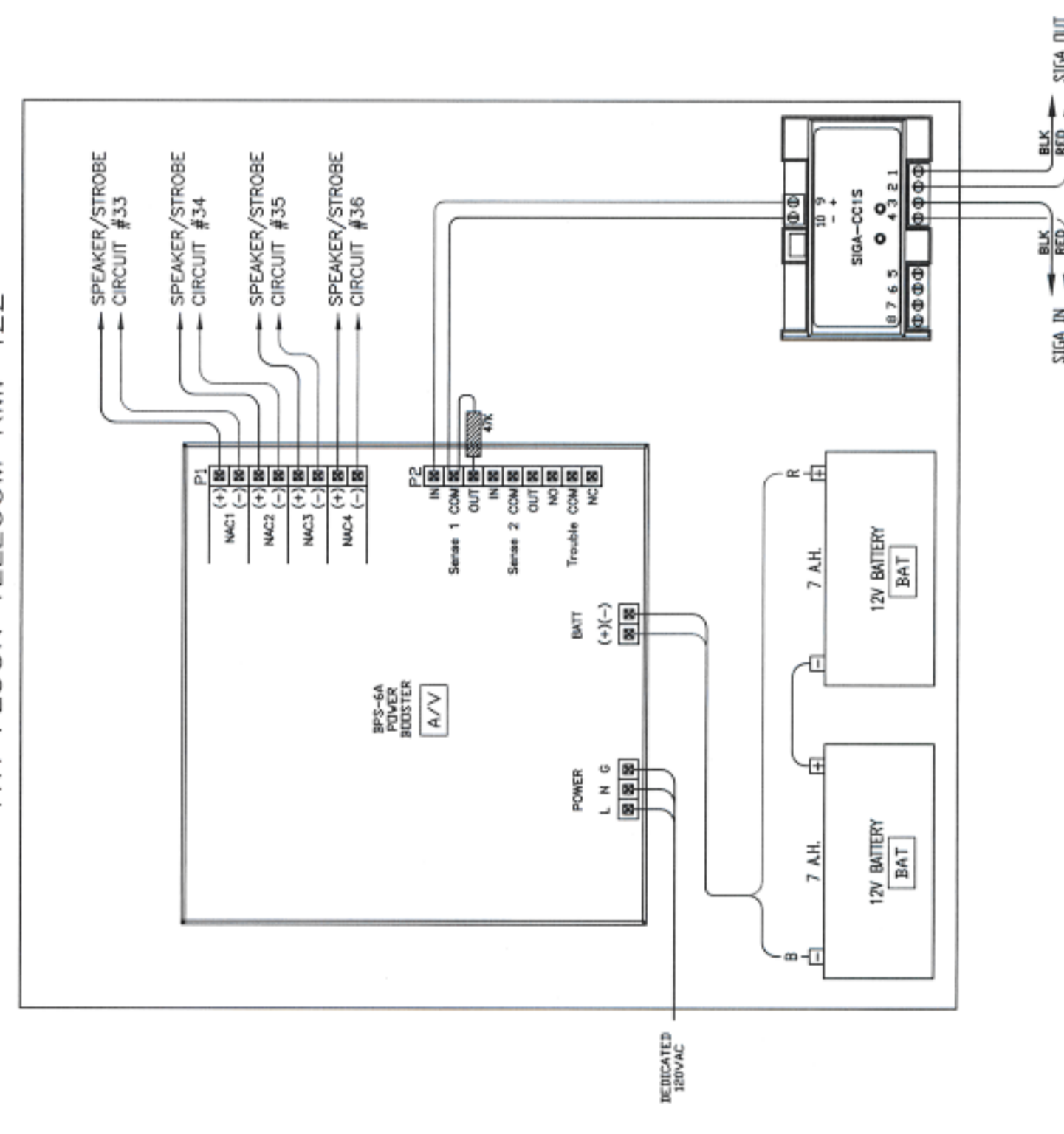
POWER BOOSTER #7
3RD FLOOR TELECOM RM. 322



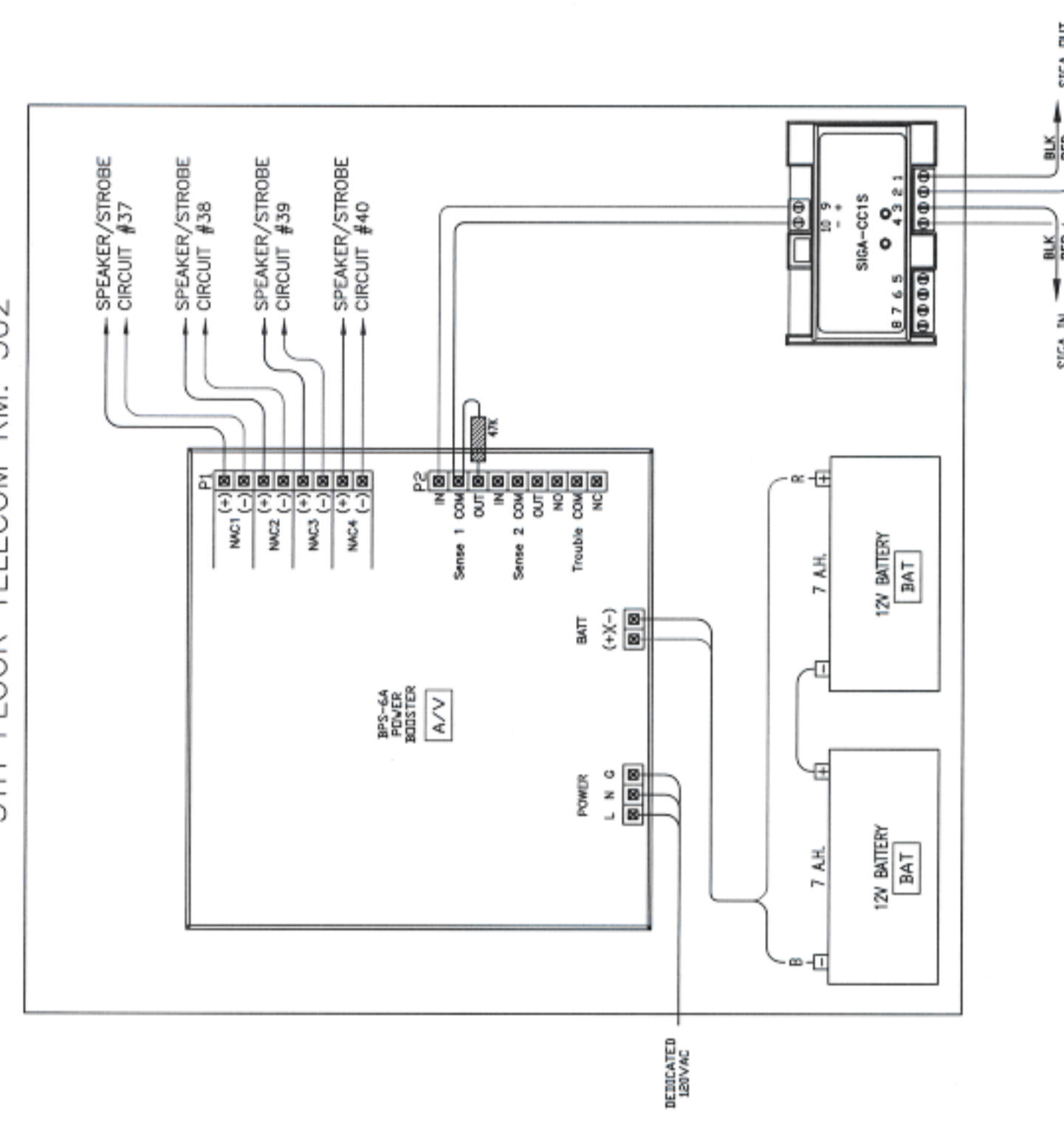
POWER BOOSTER #8
4TH FLOOR TELECOM RM. 402



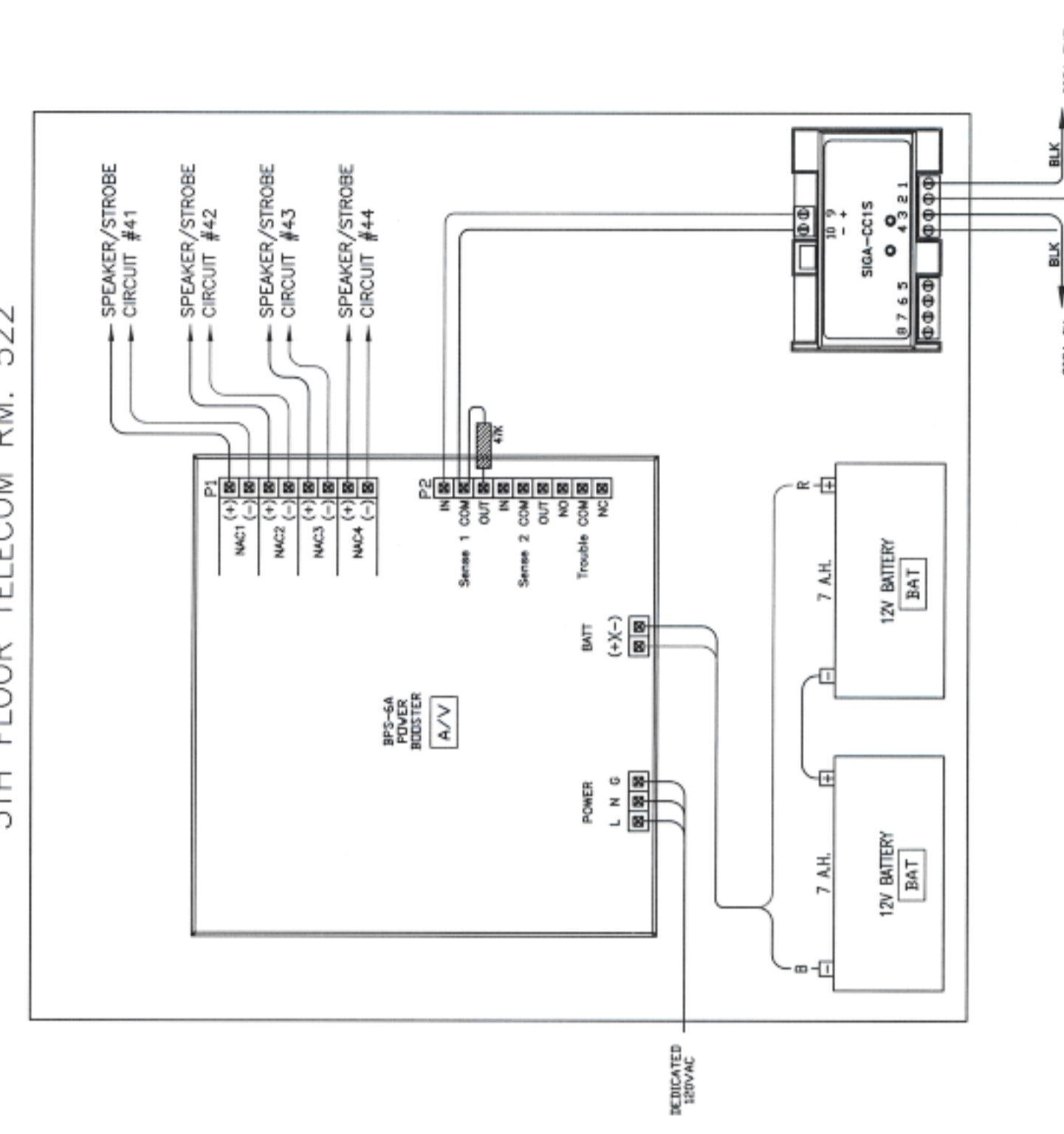
POWER BOOSTER #9
4TH FLOOR TELECOM RM. 422



POWER BOOSTER #10
5TH FLOOR TELECOM RM. 502



POWER BOOSTER #11
5TH FLOOR TELECOM RM. 522



REVISIONS

Table with columns for revision number, description, and date.

General Notes:
1. Open wiring, for fire alarm, will be used where allowable by code.

Sheet Notes:
1. All speakers will be tapped at 1/2 watt, unless otherwise noted on the drawings.

2. A minimum of 2 speaker circuits shall be provided on each typical office floor. Additional circuits shall be provided on non-typical floors as necessary to meet the specified loading requirements of the specifications.

3. Strobe circuiting shall be based on an 80% circuit capacity but shall not exceed 10 strobes per circuit except where noted on enclosed prints.

4. Addressable "SIGA" circuits shall be Class "A" circuits.

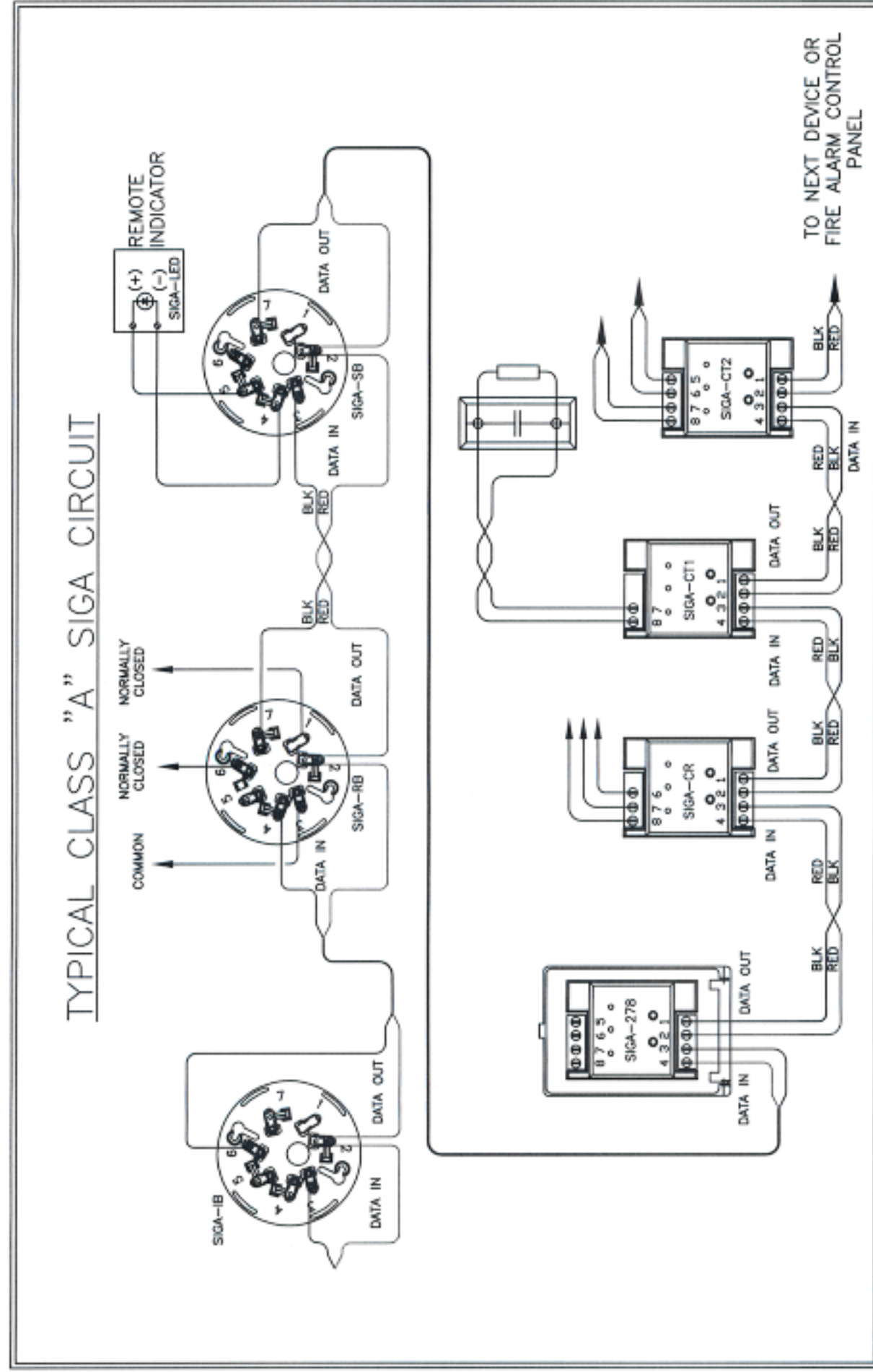
5. All new cabling shall be Megger tested as outlined in the contract documents. This testing shall occur prior to the devices being installed.

6. Device Addressing shall depict node, slot, and address as it will be shown on the EST3 LCD display's.

7. Wall Mounted notification devices shall be white on all floors. Devices that require surface backboxes will be provided by the Life Safety contractor.

Cabling Notes:
Dashed Line (Purple) - Strobe Only
Solid Green Line - Audio Only
Solid Purple Line - Audio / Strobe Ckt
Solid Red Line - Data Loop

Fire Alarm
Power Supply Termination



GENERAL NOTES:

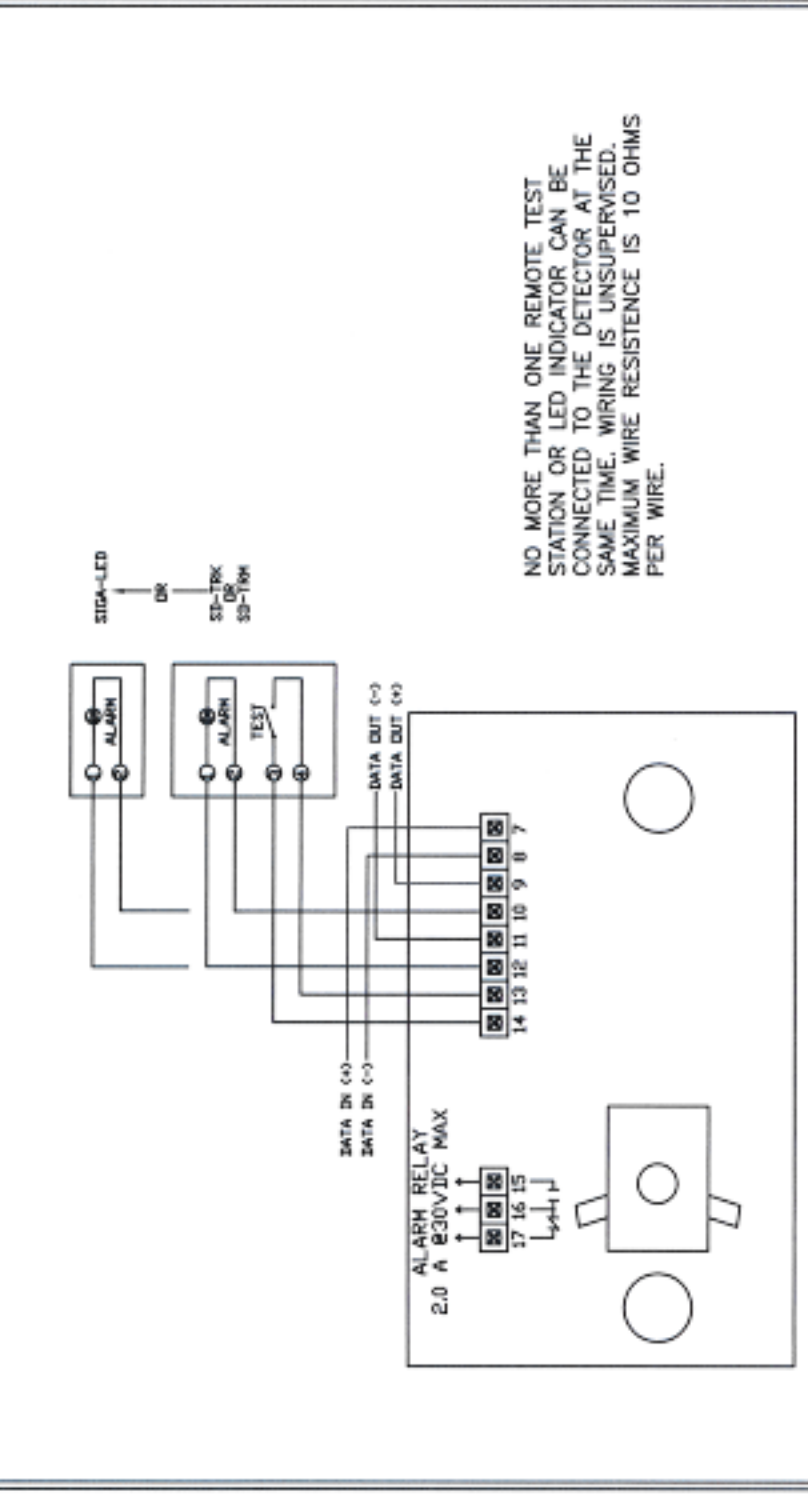
1. INCOMING AND OUTGOING CABLES MUST BE WIRED AS INDICATED BETWEEN THE POSITIVE WIRE (RED OR WHITE) AND CONDUIT GROUND. THE TAP CONFIGURATION IS NOT ALLOWED IN CLASS "A" CONFIGURATIONS.

2. TONE GENERATOR SHOULD BE CONNECTED TO THE FIRE ALARM CONTROL PANEL.

ROUGH-IN INFORMATION:

SIGA-IB	1 GANG BOX, OR 4'X1'-1/2" DEEP, OR 4'X1'-1/2" DEEP SQUARE BOX WITH 1 GANG COVER.
SIGA-CC1	2 GANG BOX 2-1/2" DEEP, OR 4'X1'-1/2" DEEP SQUARE BOX WITH 2 GANG COVERS AND SIGA-MP MOUNTING PLATES.
SIGA-CC2	2 GANG BOX 2-1/2" DEEP, OR 4'X1'-1/2" DEEP SQUARE BOX WITH 2 GANG COVERS AND SIGA-MP MOUNTING PLATES.
SIGA-DTS	4'X1'-1/2" DEEP SQUARE BOX.
SIGA-UM	4'X1'-1/2" DEEP SQUARE BOX.

TYPICAL SIGNATURE SUPERDUCT SMOKE CONFIGURATION



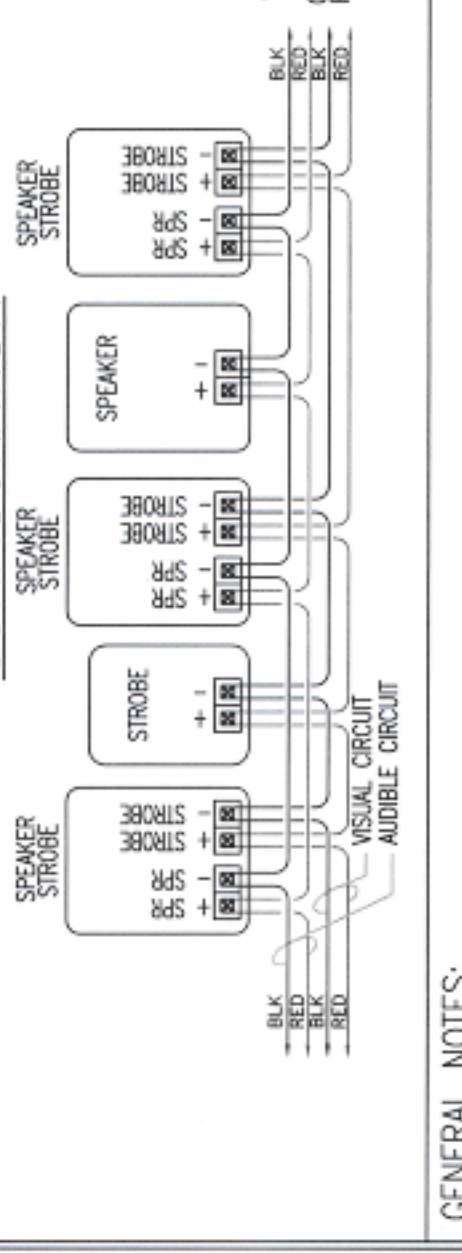
GENERAL NOTES:

INSTALL IN ACCORDANCE WITH INSTALLATION SHEET # 85001-0584

ROUGH-IN INFORMATION:

SD-TRK	REMOTE TEST STATION	INDOOR FLUSH MOUNT AT 6' A.F.F.
SIGA-LED	REMOTE TEST STATION	INDOOR FLUSH MOUNT AT 6' A.F.F.

TYPICAL SPEAKER/STROBE CIRCUIT CONFIGURATION

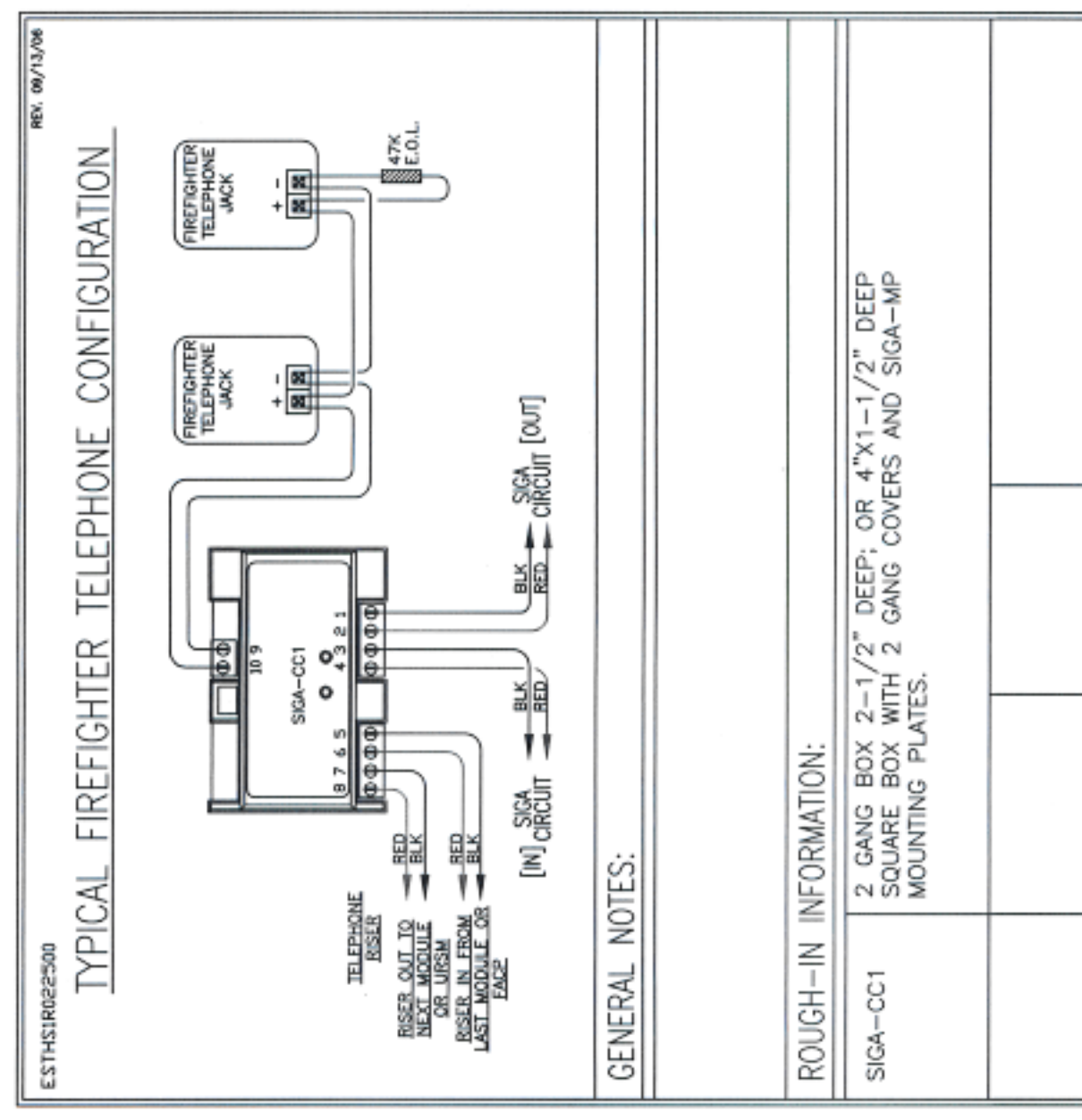


GENERAL NOTES:

ADA MOUNTING HEIGHT: 48 INCHES ABOVE FLOOR OR 6 INCHES BELOW CEILING (WHICH EVER IS LOWER). VERIFY ALL BOX SIZES & TYPES PRIOR TO ROUGH-IN. REFERENCE FLOOR PLANS FOR SPEAKER TAP SETTINGS

ROUGH-IN INFORMATION: GENESIS SERIES

CA SERIES	SPEAKER AND STROBE	INDOOR FLUSH MOUNT AT 6' A.F.F.
CC SERIES	HORN AND STROBE	INDOOR SURFACE MOUNT AT 6' A.F.F.

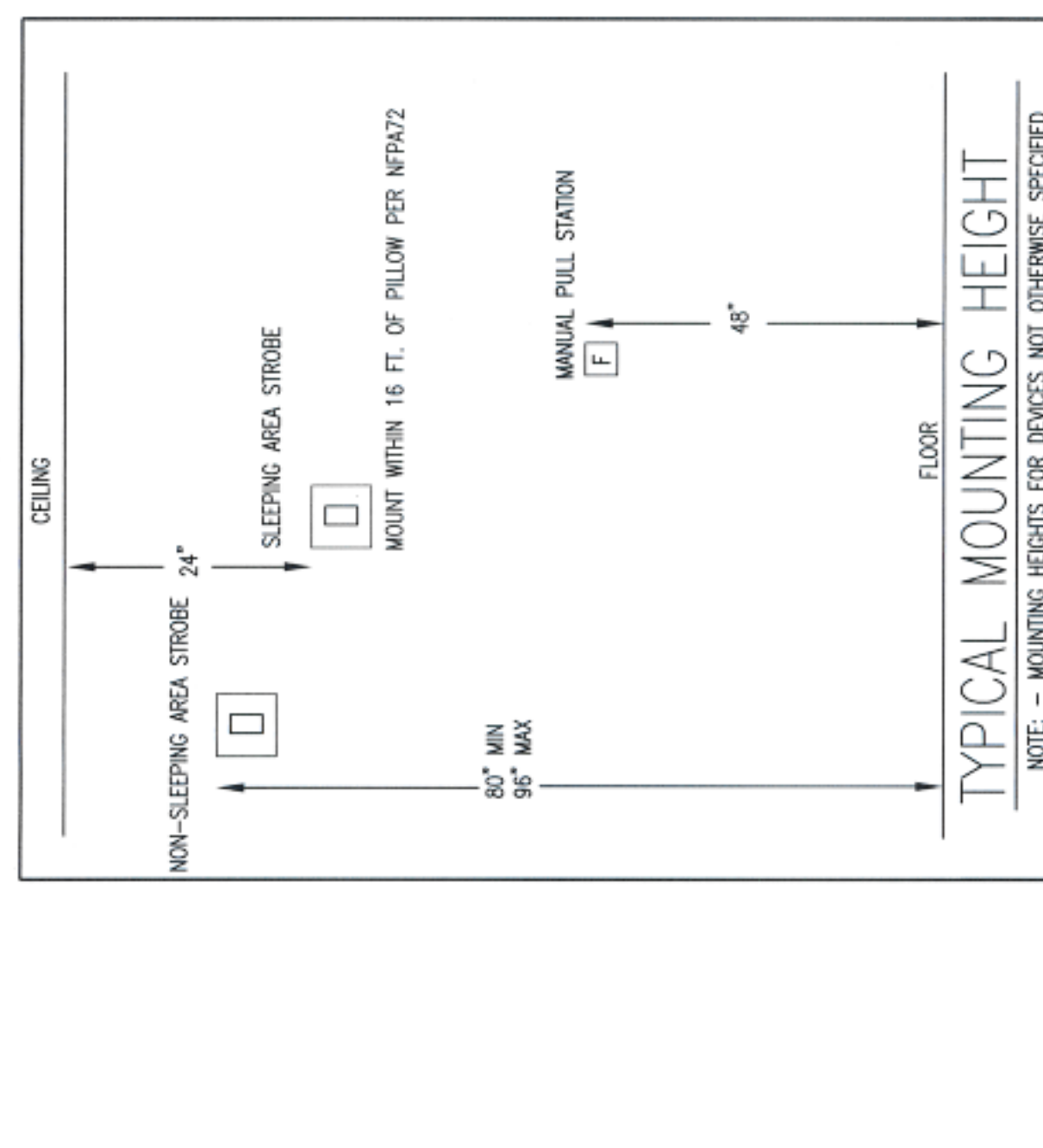


GENERAL NOTES:

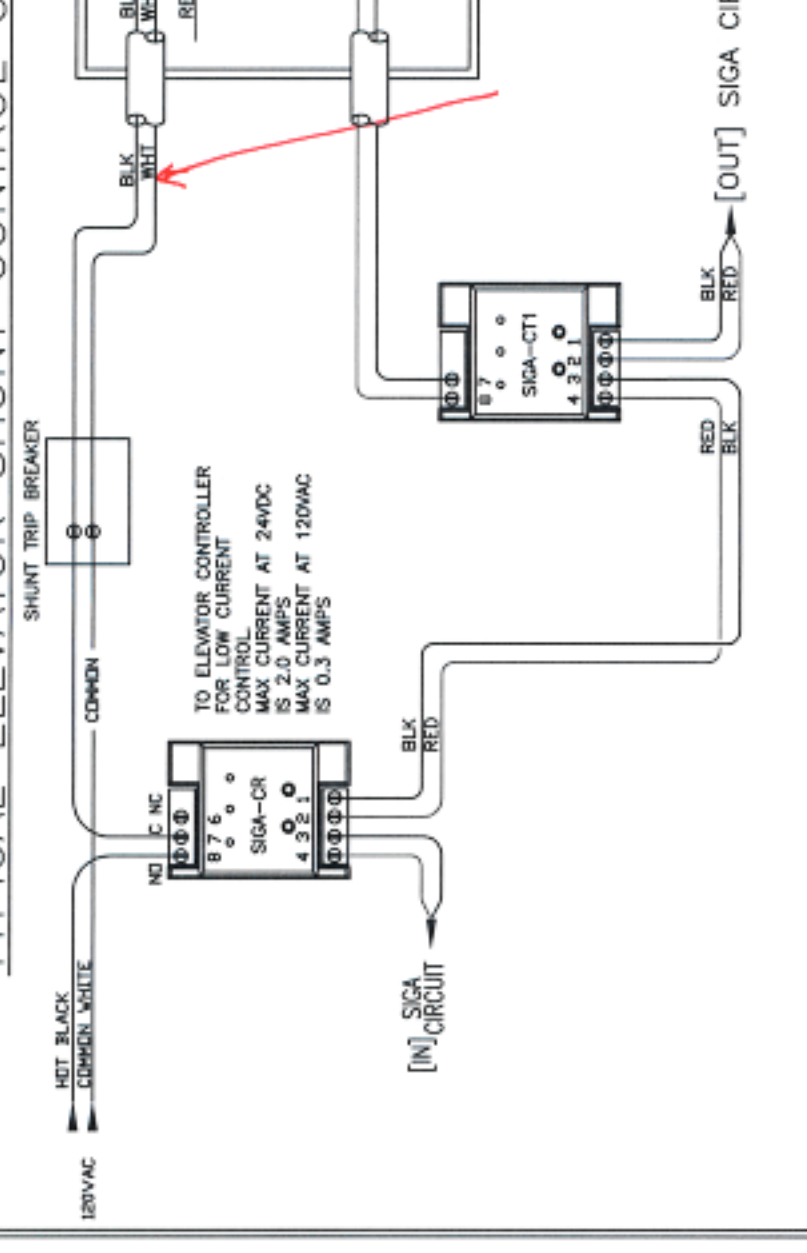
1. INCOMING AND OUTGOING CABLES MUST BE WIRED AS INDICATED BETWEEN THE POSITIVE WIRE (RED OR WHITE) AND CONDUIT GROUND. THE TAP CONFIGURATION IS NOT ALLOWED IN CLASS "A" CONFIGURATIONS.

ROUGH-IN INFORMATION:

SIGA-CC1	2 GANG BOX 2-1/2" DEEP, OR 4'X1'-1/2" DEEP SQUARE BOX WITH 2 GANG COVERS AND SIGA-MP MOUNTING PLATES.
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TYPICAL ELEVATOR SHUNT CONTROL CONFIGURATION

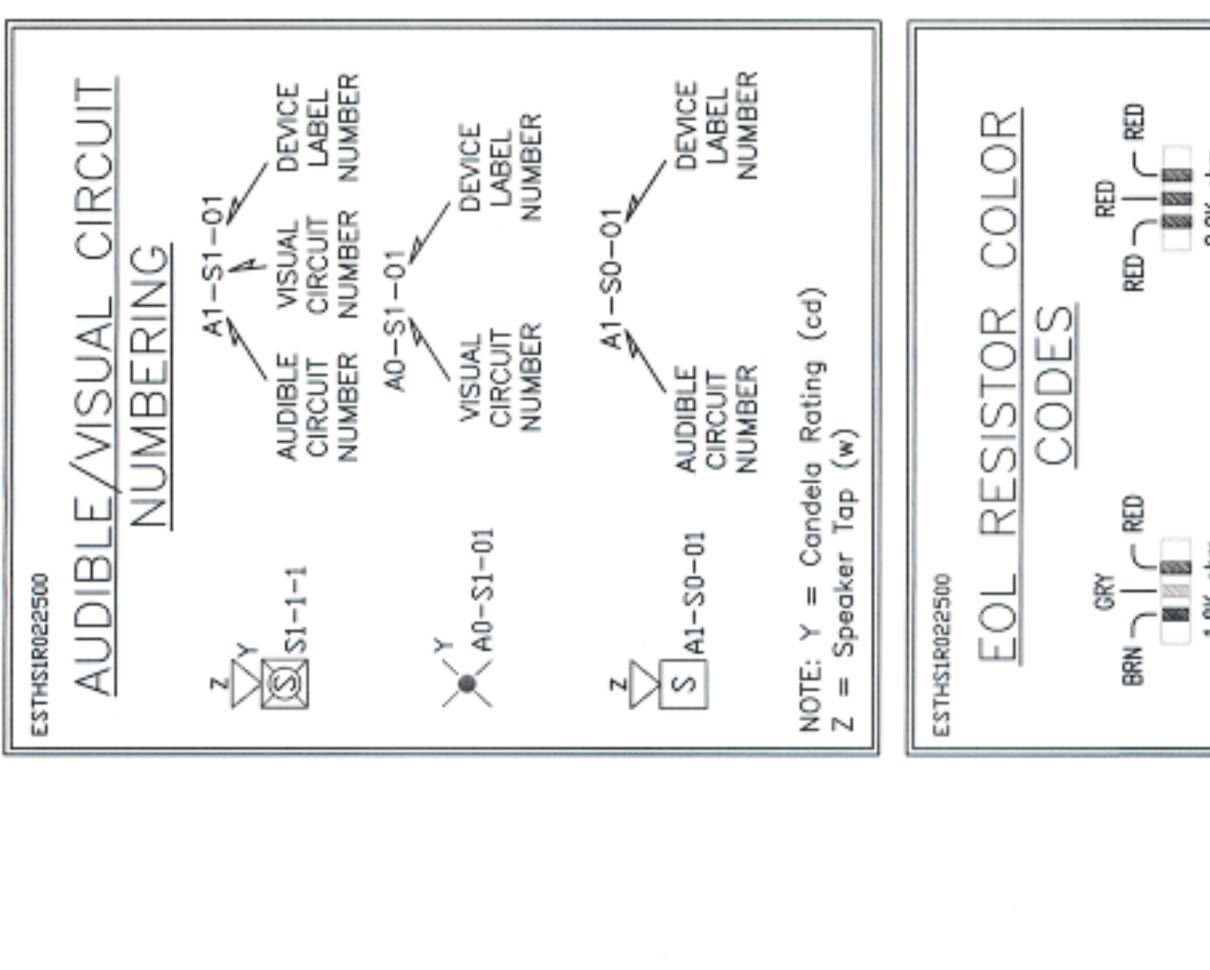


GENERAL NOTES:

USED FOR 120VAC CONTROL ON SHUNT CONTROL

ROUGH-IN INFORMATION:

SIGA-CR	1 GANG BOX 2-1/2" DEEP, OR 4'X1'-1/2" DEEP SQUARE BOX WITH 1 GANG COVER
PAM-1	4'X1'-1/2" DEEP SQUARE BOX.



GENERAL NOTES:

1. WRITING CLARITY MUST BE MAINTAINED WHEN THE ADDRESSING INFORMATION IS USED AS "NEGATIVE" AND THE RED OR WHITE WIRE IS TO BE USED AS "POSITIVE".

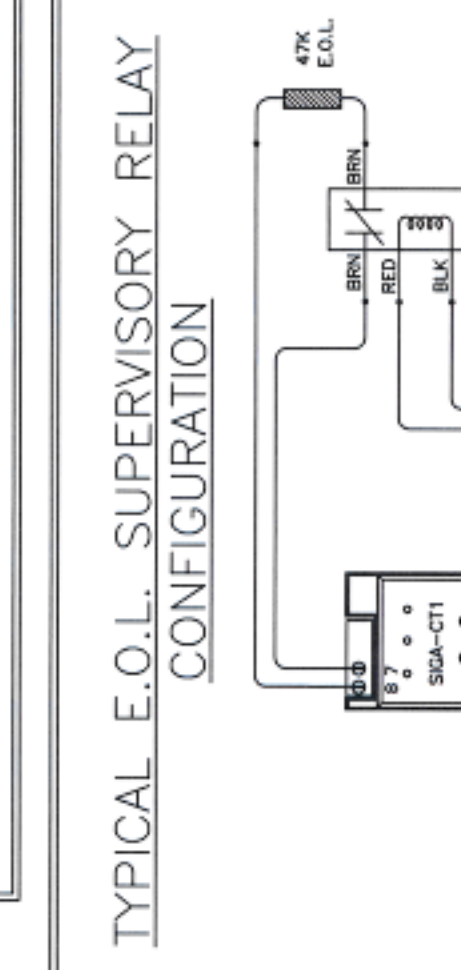
2. WHEN WIRING ADDRESSABLE DEVICES, THE "IN" AND "OUT" SHOWN ON TYPICAL WIRING DIAGRAMS MUST BE FOLLOWED. THE ADDRESSABLE LOOP OF SIGA CABLE FROM THE PANEL CONNECTS TO THE "IN" TERMINALS, AND THE LOOP IN THE FIELD CONNECTS TO THE "OUT" TERMINALS.

CABLE TYPE DEFINITIONS

LABEL	TYPE	CABLE REQUIREMENT
A/V CIRCUIT	AUDIBLE/VISUAL	#14 GAUGE TWISTED PAIR CABLE
A CIRCUIT	AUDIBLE (SPEAKERS)	#16 GAUGE TWISTED PAIR CABLE
V CIRCUIT	AUDIBLE (HORNS, BELLS, CHIMES)	#16 GAUGE TWISTED PAIR CABLE
BA CIRCUIT	BOOSTER ACTIVATION	#14 GAUGE TWISTED PAIR CABLE
AL CIRCUIT	ADDRESSABLE LOOP	#16 GAUGE TWISTED PAIR CABLE

EOL RESISTOR CODES

BRN	0	RED	1	ORG	2
GRN	3	RED	4	ORG	5
WHT	6	RED	7	ORG	8
BLK	9	RED	0	ORG	1



GENERAL NOTES:

LOCATE ADDRESSABLE MODULE IN AN ACCESSIBLE AREA THAT IS NOT SUBJECT TO AMBIENT TEMPERATURES OF OVER 100 DEGREES, OR HIGH HUMIDITY.

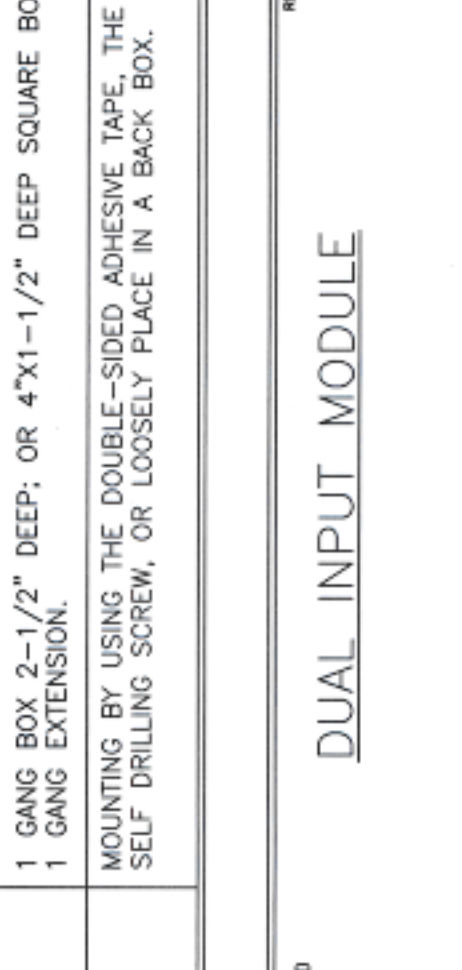
ROUGH-IN INFORMATION:

SIGA-CT1	1 GANG BOX 2-1/2" DEEP, OR 4'X1'-1/2" DEEP SQUARE BOX WITH 1 GANG COVER
204-12/24V	4'X1'-1/2" DEEP SQUARE BOX.



ROUGH-IN INFORMATION:

SIGA-CR	1 GANG BOX 2-1/2" DEEP, OR 4'X1'-1/2" DEEP SQUARE BOX WITH 1 GANG EXTENSION.
PAM-1	MOUNTING BY USING THE DOUBLE-SIDED ADHESIVE TAPE, THE SELF DRILLING SCREW, OR LOOSELY PLACE IN A BACK BOX.



ROUGH-IN INFORMATION:

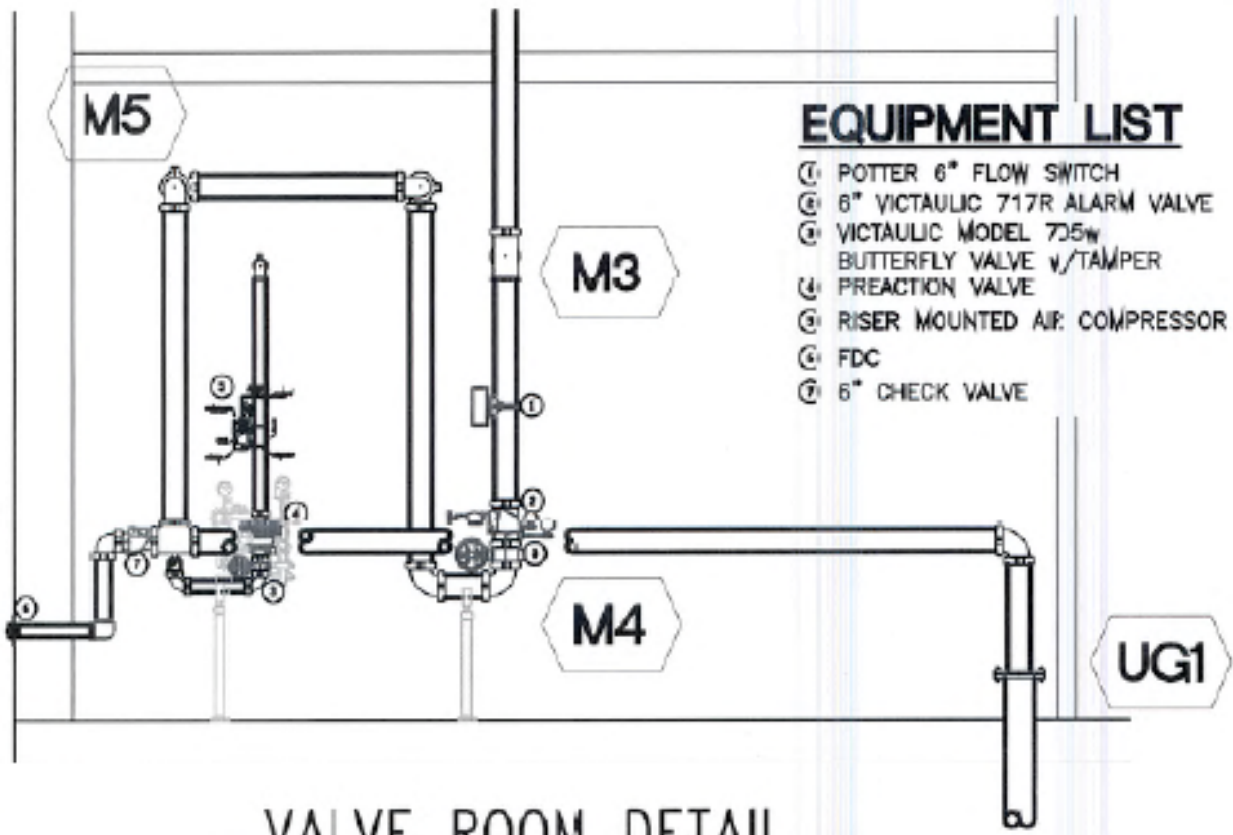
SIGA-CT2	1 GANG BOX 2-1/2" DEEP, OR 4'X1'-1/2" DEEP SQUARE BOX WITH 1 GANG COVER.
----------	--

RESULT OR ACTION

CHANNEL	RESULT OR ACTION
1	SMOKE DETECTOR
2	HEAT DETECTOR
3	DUCT SMOKE DETECTOR
4	SPRINKLER MONITORING
5	FIRE PUMP MONITORING
6	MANUAL PULL STATION
7	ANSUL HOOD MONITORING
8	STROBE POWER DISCONNECT
9	ELEVATOR RECALL SIGNAL
10	ELEVATOR RECALL SIGNAL (ALARM FLOOR ONLY)
11	STROBE POWER DISCONNECT
12	STROBE POWER DISCONNECT
13	STROBE POWER DISCONNECT
14	STROBE POWER DISCONNECT
15	STROBE POWER DISCONNECT
16	STROBE POWER DISCONNECT
17	STROBE POWER DISCONNECT
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19	STROBE POWER DISCONNECT
20	STROBE POWER DISCONNECT
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48	STROBE POWER DISCONNECT
49	STROBE POWER DISCONNECT
50	STROBE POWER DISCONNECT

APPENDIX G

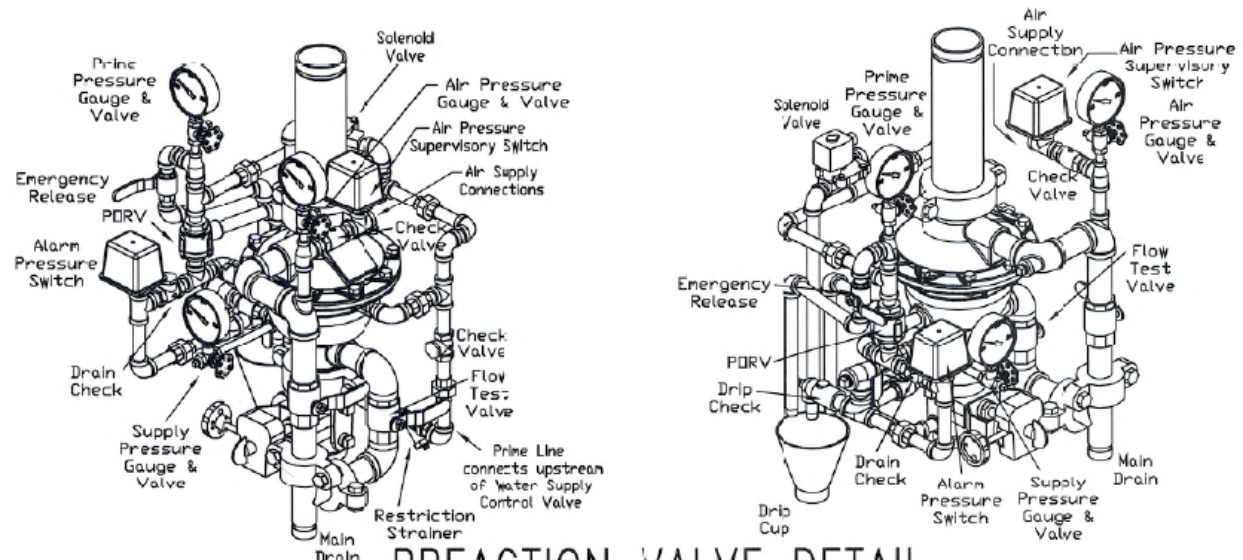
Valve Data Sheets and Details



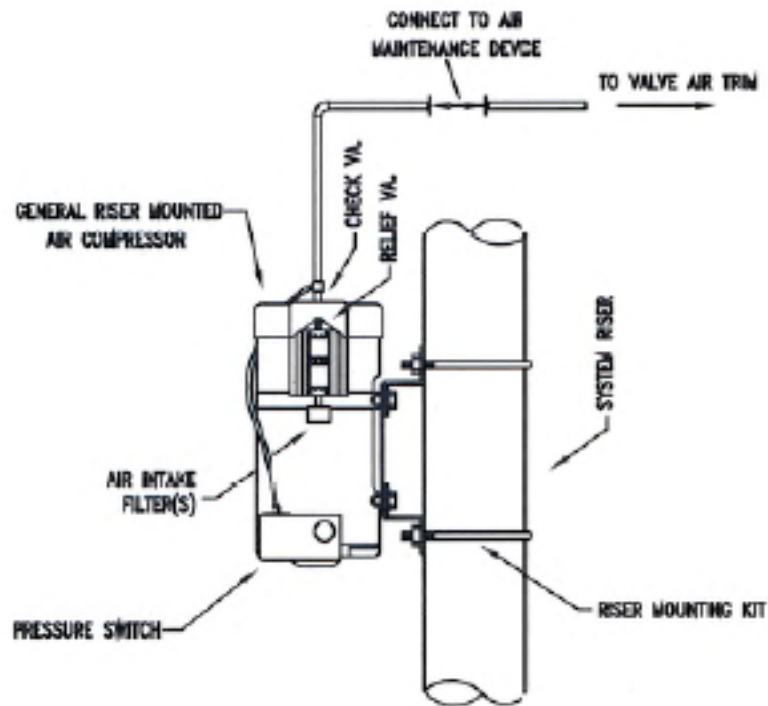
EQUIPMENT LIST

- ① POTTER 6" FLOW SWITCH
- ② 6" VICTAULIC 717R ALARM VALVE
- ③ VICTAULIC MODEL 725w BUTTERFLY VALVE w/TAMPER
- ④ PREACTION VALVE
- ⑤ RISER MOUNTED AIR COMPRESSOR
- ⑥ FDC
- ⑦ 6" CHECK VALVE

VALVE ROOM DETAIL
NO SCALE



PREACTION VALVE DETAIL
NO SCALE



RISER MOUNTED AIR COMPRESSOR SCHEMATIC
NO SCALE



The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058

Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

1. DESCRIPTION

The Viking Model J-1 Alarm Check Valve serves as a check valve by trapping pressurized water above the clapper and preventing reverse flow from sprinkler piping.

The valve is designed to initiate an alarm during a sustained flow of water (such as the flow required by an open sprinkler) by operating an optional water motor alarm and/or alarm pressure switch. The valve is made suitable for use on variable pressure water supplies by adding the optional retard chamber to the standard trim.

Features

- Ductile iron body for less weight and extra strength.
- Rubber-faced clapper hinged to access cover for quick removal and easy servicing.
- All moving parts can be serviced without removing the valve from the installed position.
- With the cover/clapper assembly removed, clapper rubber replacement requires removal of only one screw.
- External by-pass trim to minimize clapper movement and false alarm.
- Trim allows installation of optional non-interruptible pressure switch to activate an electric alarm panel and/or remote alarm.
- Can be installed on constant or variable pressure water supplies.
- Can be installed vertically or horizontally, with access cover facing up.
- Valve housing tapped for inlet and outlet pressure gauges, alarm devices, and system main drain.
- Trim includes alarm test valve for testing alarms without reducing system pressure.



2. LISTINGS AND APPROVALS



UL Listed - Guide VPLX
cUL Listed



FM Approved - Waterflow Alarm Valves

NYC Department of Buildings - MEA 89-92-E Vol. XI



LPCB



VDS - DN80 - G 4960086, DN100 - G 4960087, DN150 - G 4960088, DN200 - G 4960089



CE Certified: Standard EN-12259-2, EC-certificate of conformity 0532-CPD-2010

Viking Technical Data may be found on
The Viking Corporation's Web site at
<http://www.vikinggroupinc.com>.
The Web site may include a more recent
edition of this Technical Data Page.

3. TECHNICAL DATA

Specifications

Friction Loss - Refer to Table 1

Pressure Rating - 250 psi (17.2 bar) water working pressure.

Factory tested hydrostatically to 500 psi (34.5 bar).

The valve may be hydrostatically tested at 300 psi (20.7 bar) and/or 50 psi (3.4 bar) above the normal water working pressure, for limited periods of time (two hours), for the purpose of acceptance by the AHJ. If air testing is required, do not exceed 40 psi (2.8 bar) air pressure.

Material Standards

Refer to Table 1

Ordering Information

The valve is listed and/or approved with specific trim for use up to 250 psi (17.2 bar). No substitutions or omissions, in part or in full, are allowed. Additional accessories to the standard trim packages are required for a complete system meeting the requirements of the applicable rules and codes. See appropriate technical data for additional information.

Part Numbers - Refer to Table 1

Accessories -

- a. Retard Chamber: Required when the J-1 Alarm Check Valve is installed on systems with a variable pressure water supply to minimize unwanted (false) alarms.
- b. Water Motor Alarm: The J-1 Alarm Check Valve is designed to operate a mechanical alarm during a sustained flow of water (such as the flow required by an open sprinkler). Refer to the water motor alarm technical data.



TECHNICAL DATA

2" MODEL G-2000P PREACTION WITH ELECTRIC RELEASE

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058

Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

1. DESCRIPTION

The 2" Model G-2000P Preaction System with Electric Release can be used as a Single Interlock Preaction System with Electric Release, or as a Double Interlock Preaction System with Electric/Pneu-Letric Release. These preaction systems are commonly used where it is important to control accidental water discharge due to inadvertent damage to the sprinkler piping. The small profile, lightweight, pilot operated Viking G-2000P Valve comes complete as shown in Figure 8. This pilot operated externally reset valve also includes an internal check diaphragm, which eliminates the need for a separate check valve being installed in the system riser.

A. Viking Supervised Single-Interlocked Electric Release Preaction Systems Utilizing the Viking G-2000P Valve

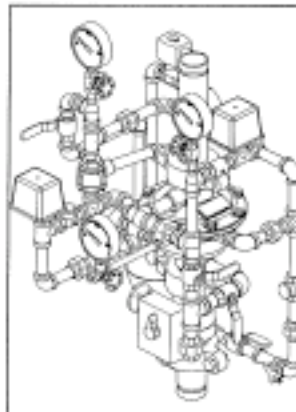
The system piping is pressurized with air or nitrogen as required by NFPA 13 for supervisory purposes only. Viking recommends a minimum of 15 to 20 psi (1.0 to 1.4 bar) for supervisory air pressure. This feature serves to prevent undetected leaks on the system piping network. If the system piping or a sprinkler is damaged, the supervisory pressure is reduced and a "low air" supervisory alarm is activated.

Electrically released preaction systems require a 24 VDC normally closed electric solenoid valve controlled by an approved release control panel with compatible detection system. In fire conditions, when the detection system operates, the system control panel energizes the solenoid valve open. When the solenoid opens, the priming water is relieved from the internal prime chamber assembly. The prime chamber assembly collapses, and water passes through the G-2000P Valve and internal check diaphragm to the system piping network. The entire sprinkler system fills with water. The sprinkler piping will remain filled with water until a sprinkler operates.

B. Viking Supervised Double-Interlocked Electric/Pneu-Letric Release Preaction Systems Utilizing the Viking G-2000P Valve.

The system piping is pressurized with air or nitrogen to serve both as a means of supervising the integrity of the piping network and as one portion of the system release operation. This feature serves to prevent undetected leaks on the system piping network. If the system piping or a sprinkler is damaged, the supervisory pressure is reduced and a "low air" supervisory alarm is activated.

The 24 VDC normally closed electric solenoid and an additional "low air" alarm switch are connected to a compatible release control panel and compatible detection devices. The release control panel is programmed so that a signal from both a release device and the low air alarm switch must be received before the solenoid is allowed to open. The air pressure switch has two independently operating connections. The high side is wired as a low air supervisory switch, and the low side is wired as low air alarm. In fire conditions, a detection device and the low air alarm switch must operate in order to open the solenoid valve. When the solenoid opens, priming water is relieved from the G-2000P Valve's internal prime chamber assembly. The prime chamber assembly is forced open by the system water supply and water passes through the G-2000P Valve and internal check diaphragm to the system piping network. The entire sprinkler system fills with water.



2. LISTING AND APPROVALS

dULus Listed - VLFT (Single Interlock) VLJH (Double Interlock)
FM Approved - Preaction Sprinkler Systems

3. TECHNICAL DATA

Specifications:

Pressure Rating: 250 PSI (17.2 Bar) Water Working Pressure
Factory Hydrostatically Tested to: 500 psi (34.5 bar)

Friction Loss (Given in feet of Schedule 40 pipe based on Hazen & Williams formula; C=120):

G-2000P Valve - 8.5'
10" Section of Pipe - 1'
Water Supply Control Valve: 1.9'

Cv Factor: 115.6

Valve Color: Black

Material Specifications:

Refer to Figure 11

$$Q = C_v \sqrt{\Delta P}$$

Q = Flow
Cv = Flow Factor (GPM/1 PSI ΔP)
ΔP = Pressure Loss through Valve

Viking Technical Data may be found on
The Viking Corporation's Web site at
<http://www.vikinggroupinc.com>.
The Web site may include a more recent
edition of this Technical Data Page.

APPENDIX H

Sprinkler Summary

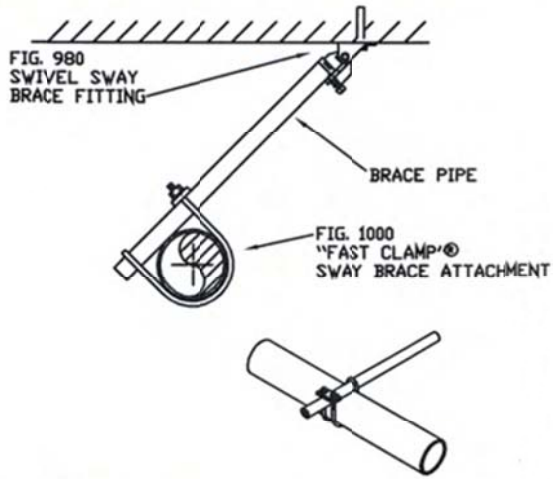
Sprinklers: Sprinkler types that are provided for the various spaces within the building are located below:


Occupancy/ Area	Response Classification	Style	Finish	Orifice (in.)	Temp (°F)	Mfr./ Model (Basis of Design)
General Office/ Common Areas	Quick	Recessed Pendent	Chrome	0.5	165	Viking/ Microfast VK302
Storage Rooms (Max. Storage height = 12 ft.)	Standard	Upright	Brass	11/32	286	Viking/ Micromatic VK200
Mechanical/ Electrical Rooms	Standard	Upright	Brass	0.5	286	Viking/ Micromatic VK100
Any Shell-out Space	Standard	Upright	Brass	0.5	165	Viking/ Micromatic VK100
Loading Dock Canopies	Standard	Horz. Dry Sidewall	Chrome	0.5	165	Viking/ Std Dry Horz. Sidewall VK156
Other areas without ceilings	Quick	Upright	Brass	0.5	165	Viking/ Microfast VK300

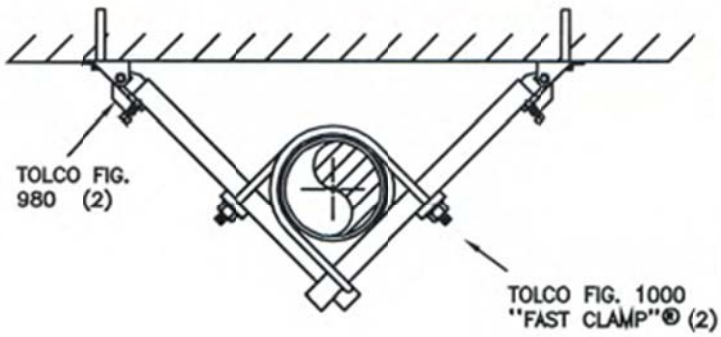
APPENDIX I

Sprinkler Hanger Details

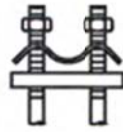
Hanging and Bracing



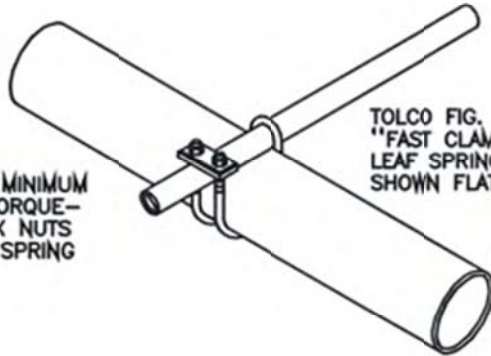
 LATERAL EARTHQUAKE BRACE
BRACE PIPE THREADED ONE END



 FAST CLAMP RISER BRACE



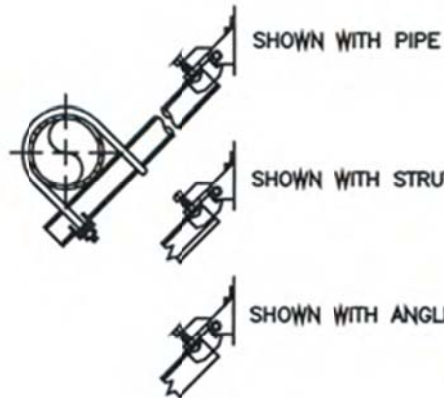
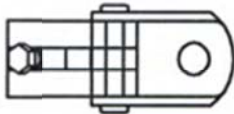
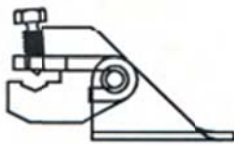
LEAF SPRING
CONFIGURATION AND
ORIENTATION BEFORE
NUTS ARE TIGHTENED



TOLCO FIG. 1000
"FAST CLAMP" © w/
LEAF SPRING
SHOWN FLAT

TO ASSURE MINIMUM
REQUIRED TORQUE—
TIGHTEN HEX NUTS
UNTIL LEAF SPRING
IS FLAT


 FIG. 1000 LATERAL EARTHQUAKE BRACE
LEAF SPRING CONFIGURATION

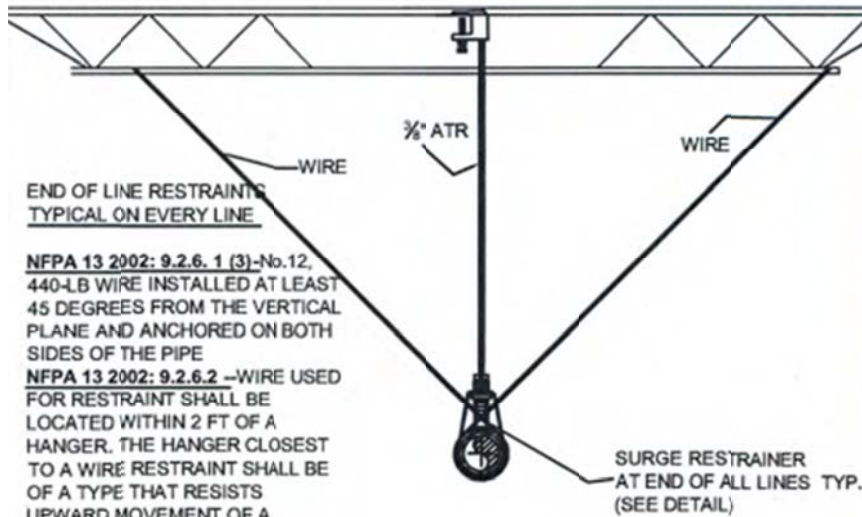


SHOWN WITH PIPE

SHOWN WITH STRUT

SHOWN WITH ANGLE

 FIG. 980 - UNIVERSAL SWIVEL SWAY BRACE ATTACHMENT



END OF LINE RESTRAINTS
TYPICAL ON EVERY LINE

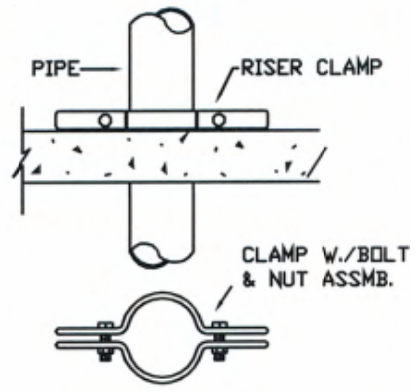
NFPA 13 2002: 9.2.6. 1 (3)-No.12,
440-LB WIRE INSTALLED AT LEAST
45 DEGREES FROM THE VERTICAL
PLANE AND ANCHORED ON BOTH
SIDES OF THE PIPE

NFPA 13 2002: 9.2.6.2 --WIRE USED
FOR RESTRAINT SHALL BE
LOCATED WITHIN 2 FT OF A
HANGER. THE HANGER CLOSEST
TO A WIRE RESTRAINT SHALL BE
OF A TYPE THAT RESISTS
UPWARD MOVEMENT OF A
BRANCH LINE.

NFPA 13 2002: 9.2.6. 3- THE END
SPRINKLER ON A LINE SHALL BE
RESTRAINED AGAINST EXCESSIVE
VERTICAL AND LATERAL
MOVEMENT

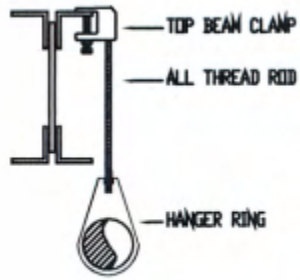
SURGE RESTRAINER
AT END OF ALL LINES TYP.
(SEE DETAIL)

END OF LINE RESTRAINTS
(N.T.S.)



RISER CLAMP

NO SCALE



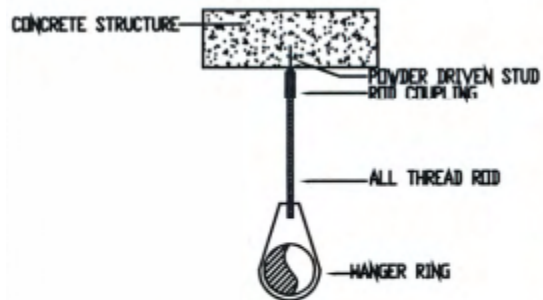
HANGER NO. 1

NO SCALE



HANGER NO. 2 (SHORTY)

NO SCALE



HANGER NO. 3C

NO SCALE



Adjustable Swivel Ring, Tapped Per NFPA Standard Submittal Sheet

SIZE RANGE: 1/2" through 8"

MATERIAL: Carbon steel

FINISH: Galvanized

SERVICE: Recommended for suspension of non-insulated stationary pipe line.

MAXIMUM TEMPERATURE: 650° F

APPROVALS: Complies with Federal Specification A-A-1192A (Type 10), WW-H-171-E (Type 10) and MSS-SP-69 (Type 10), UL, ULC Listed and FM Approved (Sizes 1/2" - 8").

FEATURES:

- Threads are countersunk so that they cannot become burred or damaged.
- Knurled swivel nut provides vertical adjustment after piping is in place.
- Captured swivel nut in the 1/2" through 3" sizes.



APPROVED
For Listing/Approval Details and Limitations visit our Web Site www.anvilstar.com or contact an Anvil®/AnvilStar™ Sales Representative.



FIG. 69

Pipe Size	Max Load	Weight	Rod Size A	B	C	F
in.	lbs.	lbs.	in.	in.	in.	in.
1/2	300	0.10	3/8	2 1/2	2	1 1/2
3/4		0.10		2 1/2	1 1/2	1 1/2
1		0.10		2 1/2	1 1/2	1
1 1/4		0.10		2 1/2	1 1/2	3/4
1 1/2		0.10		2 1/2	1 1/2	
2		525		0.11	1/2	3 1/2
2 1/2	0.20		4	2 1/2		1 1/2
3	0.20		4 1/2	2 1/2		1 1/2
4	0.30		4 1/2	2 1/2		1 1/2
5	1,000	0.54	5/8	5 1/2	4 1/2	2 1/2
6		0.65		6 1/2	5 1/2	
8		1.00		8	7	2 1/2

Refer to the Pipe Hanger Catalog for Additional Parts available on Anvil's Web Site www.anvilinf.com

PROJECT INFORMATION:		APPROVAL STAMP:
Project: undefined	Date: undefined	
Architect / Engineer: undefined	Phone: undefined	
Contractor: undefined		
Address: undefined		
Notes 1: undefined		
Notes 2: undefined		

Anvil® Pipe Hangers & Supports
REV: 06.09.05-002

For the latest UL/ULC Listed and FM Approved pressure ratings, versus pipe schedule, go to www.anvilstar.com or contact your local AnvilStar representative





SIZE RANGE: 3/8" and 1/2"

MATERIAL: Malleable/Ductile iron body, hardened steel cup point set screw and locknut.

FINISH: Plain or Galvanized

SERVICE: Recommended for use under roof installations with bar joint type construction, or for attachment to the top flange of structural shapes where the vertical hanger rod is required to be offset from the edge of the flange and where the thickness of joints or flange does not exceed 1 1/2".

APPROVALS: Complies with Federal Specification A-A-1192A (Type 19) WW-H-171-E (Type 19) and MSS-SP-69 (Type 19), UL Listed and FM Approved.

HOW TO SIZE: Size of clamp is determined by size of rod to be used.

INSTALLATION: Follow maximum recommended set screw torque values per MSS-SP-69. (See tables on See "Maximum Recommended Applied Torques" on page 212.)

FEATURES:

- Provides clamping to bar joints which are directly under roof installations.
- Provides for vertical hanger rod installed offset from the edge of the beam flange.
- Malleable iron body assures full thread engagement of rod.

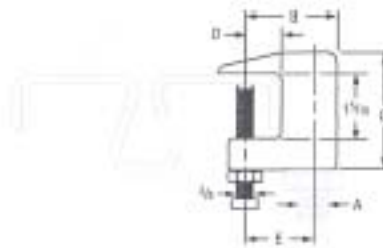
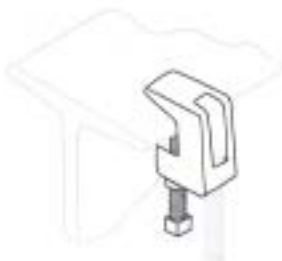


FIG. 94

Rod Size A	Max Load ■	Weight	B	C	D	E	F
in.	lbs.	lbs.	in.	in.	in.	in.	in.
3/8	1,200	0.46	1 1/2	2 1/2	3/4	1 1/2	1
1/2	1,600	0.82	1 1/2	2 1/2	3/4	1 1/2	1 1/4

■ Maximum temperature of 450° F

Refer to the Pipe Hanger Catalog for Additional Parts available on Anvil's Web Site www.anvilinc.com

PROJECT INFORMATION:		APPROVAL STAMP:
Project: undefined		
Date: undefined	Phone: undefined	
Architect / Engineer: undefined		
Contractor: undefined		
Address: undefined		
Notes 1: undefined		
Notes 2: undefined		

Anvil® Pipe Hangers & Supports
rev. 06/09/06/07

For the latest UL/ULC Listed and FM Approved pressure ratings, versus pipe schedule, go to www.anvilstar.com or contact your local AnvilStar representative





Extension Pipe or Riser Clamp

Submission Sheet

SIZE RANGE: 3/4" through 24"

MATERIAL: Carbon steel

FINISH: Plain, Galvanized or Epoxy coated

SERVICE: For support of stationary steel pipe risers, cast iron pipe or conduit.
This product is not intended for use with hanger rods. For this application refer to Fig. 40 Riser Clamp, page PH-35.

MAXIMUM TEMPERATURE: Plain 650° F, Galvanized and Epoxy 450° F

APPROVALS: Complies with Federal Specification A-A-1192A (Type B) WW-H-171-E (Type B) and MSS-SP-69 (Type B), UL, ULCC Listed (Sizes 1/2" - 6")

INSTALLATION: Clamp is fitted and bolted preferably below a coupling or welded lap on steel pipe. Bolt torques should be per industry standards (See "Maximum Recommended Applied Torques" on page 212). Clamp is designed for standard steel pipe O.D. and this must be considered in sizing the riser for other types of piping.



For Listing/Approval Details and Limitations visit our Web Site www.anvilint.com or contact an Anvil/AnvilStar™ Sales Representative.

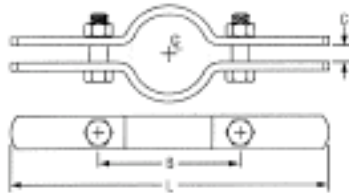


FIG. 261

Pipe Size In.	Max Load lbs.	Weight lbs.	L in.	B in.	C in.	Bolt Dia. in.
3/4	220	1.1	8 1/2	2 1/2	3 1/2	3/8
1		1.1		3 1/2		
1 1/4	250	1.6	10	3 1/2	3 1/2	3/8
1 1/2		1.6		4 1/2		
2	300	1.7	10 1/4	4 1/2	3 1/2	3/8
2 1/2	400	1.9	11 1/4	4 1/2	3 1/2	3/8
3	500	1.9	11 1/4	5 1/2	3 1/2	3/8
3 1/2	600	2.3	12 1/4	6 1/2		
4	750	2.4		7	3 1/2	3/8
5	1,500	3.6	12 1/4	8		
6	1,600	4.0	14 1/4	9	3 1/2	3/8
8	2,500	7.6	18 1/2	12		
10		11.1	28 1/4	13 1/4	3 1/2	3/8
12	2,700	16.5	22 1/4	15 1/4		
14		17.7	24	17 1/4	3 1/2	3/8
16	30.4	26	19 1/4			
18	2,900	33.8	28	21 1/4	3 1/2	3/8
20		35.0	30	23 1/4		
24	3,200	82.0	36 1/4	30	1	3/4

Refer to the Pipe Hanger Catalog for Additional Parts available on Anvil's Web Site www.anvilint.com

PROJECT INFORMATION:		APPROVAL STAMP:
Project: undefined		
Date: undefined	Phone: undefined	
Architect / Engineer: undefined		
Contractor: undefined		
Address: undefined		
Notes 1: undefined		
Notes 2: undefined		

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REV. 04.09.06-006

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APPENDIX J

Hydraulic Calculation (5th Floor)

Computer Based Hydraulic Calculation (5th floor)

Refer to Appendix N for Contractor Shop Drawing including all nodes, sprinklers, pipe locations, pipe lengths, and pipe diameters.

MATER SUPPLY DATA

SOURCE NODE TAG	STATIC PRESS. (PSI)	RESID. PRESS. (PSI)	FLOW @ (GPM)	AVAIL. PRESS. (PSI)	TOTAL @ DEMAND (GPM)	REQ'D PRESS. (PSI)
SRC	128.0	99.0	1216.0	112.5	866.9	91.7

AGGREGATE FLOW ANALYSIS:

TOTAL FLOW AT SOURCE	866.9 GPM
TOTAL HOSE STREAM ALLOWANCE AT SOURCE	100.0 GPM
OTHER HOSE STREAM ALLOWANCES	150.0 GPM
TOTAL DISCHARGE FROM ACTIVE SPRINKLERS	616.9 GPM

NODE ANALYSIS DATA

NODE TAG	ELEVATION (FT)	NODE TYPE	PRESSURE (PSI)	DISCHARGE (GPM)
5H1	237.5	K= 5.60	13.4	20.5
5H2	237.5	K= 5.60	12.1	19.5
5H3	237.5	K= 5.60	14.4	21.3
5H4	237.5	K= 5.60	13.6	20.6
5H5	237.2	K= 5.60	16.5	22.7
5H6	237.2	K= 5.60	19.5	24.7
5H7	237.2	K= 5.60	22.5	26.6
5H8	237.5	K= 5.60	13.5	20.6
5H9	237.5	K= 5.60	13.4	20.5
5H10	237.5	K= 5.60	14.6	21.4
5H11	237.5	K= 5.60	16.1	22.5
5H12	237.5	K= 5.60	18.1	23.9
5H13	237.5	K= 5.60	17.2	23.2
5H14	237.5	K= 5.60	19.0	24.4
5H15	237.5	K= 5.60	15.6	22.1
5H16	237.5	K= 5.60	16.5	22.8
5H17	237.5	K= 5.60	17.7	23.5
5H18	237.5	K= 5.60	18.2	23.9
5H19	237.5	K= 5.60	19.2	24.6
5H20	237.5	K= 5.60	13.8	20.8
5H21	237.5	K= 5.60	14.8	21.5
5H22	237.5	K= 5.60	16.0	22.4
5H23	237.5	K= 5.60	17.1	23.1
5H24	237.5	K= 5.60	16.9	23.0
5H25	237.5	K= 5.60	20.2	25.2
5H26	237.5	K= 5.60	20.7	25.5
5H27	237.5	K= 5.60	21.7	26.1
5T1	238.0	- - - -	14.4	- - -
5T2	238.0	- - - -	14.6	- - -
5T3	238.0	- - - -	15.9	- - -
5T4	238.0	- - - -	16.1	- - -
5T5	238.0	- - - -	18.0	- - -
5T6	238.0	- - - -	21.0	- - -
5T7	238.0	- - - -	25.6	- - -
5T8	238.0	- - - -	13.6	- - -
5T9	238.0	- - - -	14.6	- - -

NODE ANALYSIS DATA					
NODE	TAG	ELEVATION (FT)	NODE TYPE	PRESSURE (PSI)	DISCHARGE (GPM)
ST10		238.0	- - - -	16.1	- - -
ST11		238.0	- - - -	17.7	- - -
ST12		238.0	- - - -	20.0	- - -
ST13		238.0	- - - -	20.3	- - -
ST14		238.0	- - - -	21.1	- - -
ST15		238.0	- - - -	16.6	- - -
ST16		238.0	- - - -	18.1	- - -
ST17		238.0	- - - -	19.3	- - -
ST18		238.0	- - - -	20.0	- - -
ST19		238.0	- - - -	21.1	- - -
ST20		238.0	- - - -	14.9	- - -
ST21		238.0	- - - -	16.3	- - -
ST22		238.0	- - - -	17.7	- - -
ST23		238.0	- - - -	10.8	- - -
ST24		238.0	- - - -	19.5	- - -
ST25		238.0	- - - -	22.2	- - -
ST26		238.0	- - - -	22.8	- - -
ST27		238.0	- - - -	23.9	- - -
SM1		238.0	- - - -	26.0	- - -
SM1A		238.0	- - - -	26.1	- - -
SM2		238.0	- - - -	26.0	- - -
SM3		238.0	- - - -	26.0	- - -
SM4		238.0	- - - -	26.0	- - -
SM5		238.0	- - - -	26.2	- - -
SM6		238.0	- - - -	29.5	- - -
SM7		238.0	- - - -	29.5	- - -
SM8		238.0	- - - -	32.9	- - -
SM9		238.0	- - - -	33.0	- - -
SMT		238.0	- - - -	36.2	- - -
SPC		234.5	- - - -	44.9	- - -
SPC1		234.5	HOSE STREAM	50.5	150.0
BR2		179.0	- - - -	75.9	- - -
M1		179.0	- - - -	76.0	- - -
M2		179.0	- - - -	78.2	- - -
M3		179.0	- - - -	80.3	- - -
M4		170.5	- - - -	85.2	- - -
M5		179.0	- - - -	83.1	- - -
UG1		169.0	- - - -	88.3	- - -
SRC		163.7	SOURCE	91.7	766.9

PIPE DATA

PIPE TAG		ELEV. (FT)	NOZ. (K)	PT (PSI)	DISC. (GPM)	Q (GPM)	DIA (IN)	LENGTH	PRESS.	
END NODES	VEL (FPS)					HW (C) FL/FT	(FT)	SUM. (PSI)		
Pipe: 1						-20.5	1.049 PL	2.75	PF	1.2
SH1	237.5	5.6	13.4	20.5	7.6	120 FTG	3E	PE	-0.2	
ST1	238.0	0.0	14.4	0.0		0.136 TL	8.75	PV		
Pipe: 2						-19.5	1.049 PL	10.58	PF	2.7
SH2	237.5	5.6	12.1	19.5	7.2	120 FTG	3ET	PE	-0.2	
ST2	238.0	0.0	14.6	0.0		0.124 TL	21.58	PV		
Pipe: 3						-21.3	1.049 PL	2.75	PF	1.7
SH3	237.5	5.6	14.4	21.3	7.9	120 FTG	2ET	PE	-0.2	
ST3	238.0	0.0	15.9	0.0		0.146 TL	11.75	PV		
Pipe: 4						-20.6	1.049 PL	8.58	PF	2.7
SH4	237.5	5.6	13.6	20.6	7.7	120 FTG	3ET	PE	-0.2	
ST4	238.0	0.0	16.1	0.0		0.138 TL	19.58	PV		
Pipe: 5						-22.7	1.049 PL	4.41	PF	1.9
SH5	237.2	5.6	16.5	22.7	8.4	120 FTG	ET	PE	-0.4	
ST5	238.0	0.0	18.0	0.0		0.165 TL	11.41	PV		
Pipe: 6						-24.7	1.049 PL	2.75	PF	1.9
SH6	237.2	5.6	19.5	24.7	9.2	120 FTG	ET	PE	-0.4	
ST6	238.0	0.0	21.0	0.0		0.193 TL	9.75	PV		
Pipe: 7						-26.6	1.049 PL	11.58	PF	3.4
SH7	237.2	5.6	22.5	26.6	9.9	120 FTG	2E	PE	-0.4	
ST7	238.0	0.0	25.6	0.0		0.220 TL	15.58	PV		
Pipe: 8						-20.6	1.049 PL	0.50	PF	0.3
SH8	237.5	5.6	13.5	20.6	7.6	120 FTG	E	PE	-0.2	
ST8	238.0	0.0	13.6	0.0		0.137 TL	2.50	PV		
Pipe: 9						-20.5	1.049 PL	1.50	PF	1.4
SH9	237.5	5.6	13.4	20.5	7.6	120 FTG	2ET	PE	-0.2	
ST9	238.0	0.0	14.6	0.0		0.136 TL	10.50	PV		
Pipe: 10						-21.4	1.049 PL	2.33	PF	1.7
SH10	237.5	5.6	14.6	21.4	8.0	120 FTG	2ET	PE	-0.2	
ST10	238.0	0.0	16.1	0.0		0.148 TL	11.33	PV		
Pipe: 11						-22.5	1.049 PL	2.33	PF	1.8
SH11	237.5	5.6	16.1	22.5	8.3	120 FTG	2ET	PE	-0.2	
ST11	238.0	0.0	17.7	0.0		0.161 TL	11.33	PV		
Pipe: 12						-23.9	1.049 PL	2.66	PF	2.1
SH12	237.5	5.6	18.1	23.9	8.9	120 FTG	2ET	PE	-0.2	
ST12	238.0	0.0	20.0	0.0		0.180 TL	11.66	PV		
Pipe: 13						-23.2	1.049 PL	8.50	PF	3.3
SH13	237.5	5.6	17.2	23.2	8.6	120 FTG	3ET	PE	-0.2	
ST13	238.0	0.0	20.3	0.0		0.172 TL	19.50	PV		

PIPE TAG	END	ELEV.	NOZ.	PT	DISC.	Q (GPM)	DIA (IN)	LENGTH	PRESS.
NODES	(FT)	(K)	(PSI)	(GPM)	VEL (FPS)	HW (C)	(FT)	SUM.	
						PL/FT		(PSI)	
Pipe: 14						-24.4	1.049 PL	3.66	PF 2.4
SH14	237.5	5.6	19.0	24.4	9.1	120 FTG	2ET	PE -0.2	
ST14	238.0	0.0	21.1	0.0		0.188 TL	12.66	PV	
Pipe: 15						-22.1	1.049 PL	1.83	PF 1.2
SH15	237.5	5.6	15.6	22.1	8.2	120 FTG	3E	PE -0.2	
ST15	238.0	0.0	16.6	0.0		0.156 TL	7.83	PV	
Pipe: 16						-22.8	1.049 PL	1.83	PF 1.8
SH16	237.5	5.6	16.5	22.8	8.5	120 FTG	2ET	PE -0.2	
ST16	238.0	0.0	18.1	0.0		0.166 TL	10.83	PV	
Pipe: 17						-23.5	1.049 PL	1.83	PF 1.9
SH17	237.5	5.6	17.7	23.5	8.7	120 FTG	2ET	PE -0.2	
ST17	238.0	0.0	19.3	0.0		0.176 TL	10.83	PV	
Pipe: 18						-23.9	1.049 PL	1.83	PF 2.0
SH18	237.5	5.6	18.2	23.9	8.9	120 FTG	2ET	PE -0.2	
ST18	238.0	0.0	20.0	0.0		0.181 TL	10.83	PV	
Pipe: 19						-24.6	1.049 PL	1.83	PF 2.1
SH19	237.5	5.6	19.2	24.6	9.1	120 FTG	2ET	PE -0.2	
ST19	238.0	0.0	21.1	0.0		0.190 TL	10.83	PV	
Pipe: 20						-20.8	1.049 PL	3.50	PF 1.3
SH20	237.5	5.6	13.8	20.8	7.7	120 FTG	3E	PE -0.2	
ST20	238.0	0.0	14.9	0.0		0.140 TL	9.50	PV	
Pipe: 21						-21.5	1.049 PL	2.50	PF 1.7
SH21	237.5	5.6	14.8	21.5	8.0	120 FTG	2ET	PE -0.2	
ST21	238.0	0.0	16.3	0.0		0.149 TL	11.50	PV	
Pipe: 22						-22.4	1.049 PL	2.50	PF 1.8
SH22	237.5	5.6	16.0	22.4	8.3	120 FTG	2ET	PE -0.2	
ST22	238.0	0.0	17.7	0.0		0.161 TL	11.50	PV	
Pipe: 23						-23.1	1.049 PL	2.50	PF 2.0
SH23	237.5	5.6	17.1	23.1	8.6	120 FTG	2ET	PE -0.2	
ST23	238.0	0.0	18.8	0.0		0.170 TL	11.50	PV	
Pipe: 24						-23.0	1.049 PL	5.83	PF 2.8
SH24	237.5	5.6	16.9	23.0	8.5	120 FTG	3ET	PE -0.2	
ST24	238.0	0.0	19.5	0.0		0.168 TL	16.83	PV	
Pipe: 25						-25.2	1.049 PL	2.33	PF 2.3
SH25	237.5	5.6	20.2	25.2	9.3	120 FTG	2ET	PE -0.2	
ST25	238.0	0.0	22.2	0.0		0.199 TL	11.33	PV	
Pipe: 26						-25.5	1.049 PL	2.33	PF 2.3
SH26	237.5	5.6	20.7	25.5	9.5	120 FTG	2ET	PE -0.2	
ST26	238.0	0.0	22.8	0.0		0.204 TL	11.33	PV	

PIPE TAG	END	ELEV.	NOZ.	PT	DISC.	Q (GPM)	DIA (IN)	LENGTH	PRESS.	SUM.
NODES	(FT)	(K)	(PSI)	(GPM)		VEL (FPS)	HM (C)	(FT)	(PSI)	(PSI)
Pipe: 27										
SH27	237.5	5.6	21.7	26.1	9.7	-26.1	1.049 PL	2.33	PF	2.4
ST27	238.0	0.0	23.9	0.0		120 FTG	2ET		PE	-0.2
						0.213 TL	11.33		PV	
Pipe: 28										
ST1	238.0	0.0	14.4	0.0	7.6	-20.5	1.049 PL	1.33	PF	0.2
ST2	238.0	0.0	14.6	0.0		120 FTG	----		PE	0.0
						0.136 TL	1.33		PV	
Pipe: 29										
ST2	238.0	0.0	14.6	0.0	8.6	-40.0	1.380 PL	10.66	PF	1.3
ST3	238.0	0.0	15.9	0.0		120 FTG	----		PE	0.0
						0.123 TL	10.66		PV	
Pipe: 30										
ST3	238.0	0.0	15.9	0.0	9.7	-61.3	1.610 PL	1.33	PF	0.2
ST4	238.0	0.0	16.1	0.0		120 FTG	----		PE	0.0
						0.128 TL	1.33		PV	
Pipe: 31										
ST4	238.0	0.0	16.1	0.0	12.9	-81.9	1.610 PL	8.75	PF	1.9
ST5	238.0	0.0	18.0	0.0		120 FTG	----		PE	0.0
						0.219 TL	8.75		PV	
Pipe: 32										
ST5	238.0	0.0	18.0	0.0	16.5	-104.7	1.610 PL	8.75	PF	3.0
ST6	238.0	0.0	21.0	0.0		120 FTG	----		PE	0.0
						0.345 TL	8.75		PV	
Pipe: 33										
ST6	238.0	0.0	21.0	0.0	12.4	-129.4	2.067 PL	17.83	PF	5.0
SM1	238.0	0.0	26.0	0.0		120 FTG	ET		PE	0.0
						0.151 TL	32.83		PV	
Pipe: 34										
ST7	238.0	0.0	25.6	0.0	5.7	-26.6	1.380 PL	3.33	PF	0.5
SM1A	238.0	0.0	26.1	0.0		120 FTG	T		PE	0.0
						0.058 TL	9.33		PV	
Pipe: 35										
ST8	238.0	0.0	13.6	0.0	7.6	-20.6	1.049 PL	7.50	PF	1.0
ST9	238.0	0.0	14.6	0.0		120 FTG	----		PE	0.0
						0.137 TL	7.50		PV	
Pipe: 36										
ST9	238.0	0.0	14.6	0.0	8.8	-41.1	1.380 PL	8.16	PF	1.4
ST10	238.0	0.0	16.1	0.0		120 FTG	E		PE	0.0
						0.130 TL	11.16		PV	
Pipe: 37										
ST10	238.0	0.0	16.1	0.0	9.8	-62.5	1.610 PL	12.00	PF	1.6
ST11	238.0	0.0	17.7	0.0		120 FTG	----		PE	0.0
						0.133 TL	12.00		PV	
Pipe: 38										
ST11	238.0	0.0	17.7	0.0	13.4	-85.0	1.610 PL	10.00	PF	2.3
ST12	238.0	0.0	20.0	0.0		120 FTG	----		PE	0.0
						0.235 TL	10.00		PV	
Pipe: 39										
ST12	238.0	0.0	20.0	0.0	17.1	-108.8	1.610 PL	0.83	PF	0.3
ST13	238.0	0.0	20.3	0.0		120 FTG	----		PE	0.0
						0.371 TL	0.83		PV	

PIPE TAG	END	ELEV.	NOZ.	PT	DISC.	Q (GPM)	DIA (IN)	LENGTH	PRESS.
NODES	(FT)	(K)	(PSI)	(GPM)	VEL (FPS)	HW (C)	FL/FT	(FT)	SUM.
									(PSI)
Pipe: 40									
5T13	238.0	0.0	20.3	0.0	12.6	2.067	PL	5.16	PF 0.8
5T14	238.0	0.0	21.1	0.0		120	FTG	----	PE 0.0
						0.157	TL	5.16	PV
Pipe: 41									
5T14	238.0	0.0	21.1	0.0	15.0	2.067	PL	7.41	PF 4.8
5M2	238.0	0.0	26.0	0.0		120	FTG		ET PE 0.0
						0.215	TL	22.41	PV
Pipe: 42									
5T15	238.0	0.0	16.6	0.0	8.2	1.049	PL	10.00	PF 1.6
5T16	238.0	0.0	18.1	0.0		120	FTG	----	PE 0.0
						0.156	TL	10.00	PV
Pipe: 43									
5T16	238.0	0.0	18.1	0.0	9.6	1.380	PL	8.00	PF 1.2
5T17	238.0	0.0	19.3	0.0		120	FTG	----	PE 0.0
						0.153	TL	8.00	PV
Pipe: 44									
5T17	238.0	0.0	19.3	0.0	10.8	1.610	PL	4.00	PF 0.6
5T18	238.0	0.0	20.0	0.0		120	FTG	----	PE 0.0
						0.157	TL	4.00	PV
Pipe: 45									
5T18	238.0	0.0	20.0	0.0	14.5	1.610	PL	4.00	PF 1.1
5T19	238.0	0.0	21.1	0.0		120	FTG	----	PE 0.0
						0.274	TL	4.00	PV
Pipe: 46									
5T19	238.0	0.0	21.1	0.0	18.4	1.610	PL	3.58	PF 4.9
5M3	238.0	0.0	26.0	0.0		120	FTG		T PE 0.0
						0.423	TL	11.58	PV
Pipe: 47									
5T20	238.0	0.0	14.9	0.0	7.7	1.049	PL	10.00	PF 1.4
5T21	238.0	0.0	16.3	0.0		120	FTG	----	PE 0.0
						0.140	TL	10.00	PV
Pipe: 48									
5T21	238.0	0.0	16.3	0.0	9.1	1.380	PL	10.00	PF 1.4
5T22	238.0	0.0	17.7	0.0		120	FTG	----	PE 0.0
						0.137	TL	10.00	PV
Pipe: 49									
5T22	238.0	0.0	17.7	0.0	10.2	1.610	PL	8.00	PF 1.1
5T23	238.0	0.0	18.8	0.0		120	FTG	----	PE 0.0
						0.142	TL	8.00	PV
Pipe: 50									
5T23	238.0	0.0	18.8	0.0	13.9	1.610	PL	2.66	PF 0.7
5T24	238.0	0.0	19.5	0.0		120	FTG	----	PE 0.0
						0.250	TL	2.66	PV
Pipe: 51									
5T24	238.0	0.0	19.5	0.0	17.5	1.610	PL	9.00	PF 6.5
5M4	238.0	0.0	26.0	0.0		120	FTG		T PE 0.0
						0.384	TL	17.00	PV
Pipe: 52									
5T25	238.0	0.0	22.2	0.0	5.4	1.380	PL	12.00	PF 0.6
5T26	238.0	0.0	22.8	0.0		120	FTG	----	PE 0.0
						0.052	TL	12.00	PV

PIPE TAG	RND	ELEV.	NOZ.	PT	DISC.	Q (GPM)	DIA (IN)	LENGTH	PRESS.
NODES	(FT)	(K)	(PSI)	(GPM)	VRL (FPS)	HM (C)	(FT)	SUM.	
						FL/PT		(PSI)	
Pipe: 53									
ST26	238.0	0.0	22.8	0.0	8.0	1.610 PL	12.00	PF	1.1
ST27	238.0	0.0	23.9	0.0		120 FTG	----	PE	0.0
						0.090 TL	12.00	PV	
Pipe: 54									
ST27	238.0	0.0	23.9	0.0	12.1	1.610 PL	3.58	PF	2.3
SM5	238.0	0.0	26.2	0.0		120 FTG	T	PE	0.0
						0.194 TL	11.58	PV	
Pipe: 55									
SM1	238.0	0.0	26.0	0.0	3.4	4.026 PL	3.00	PF	0.0
SM2	238.0	0.0	26.0	0.0		120 FTG	----	PE	0.0
						0.006 TL	3.00	PV	
Pipe: 56									
SM2	238.0	0.0	26.0	0.0	0.5	4.026 PL	4.83	PF	0.0
SM3	238.0	0.0	26.0	0.0		120 FTG	E	PE	0.0
						0.000 TL	11.63	PV	
Pipe: 57									
SM3	238.0	0.0	26.0	0.0	3.5	4.026 PL	5.33	PF	0.0
SM4	238.0	0.0	26.0	0.0		120 FTG	----	PE	0.0
						0.007 TL	5.33	PV	
Pipe: 58									
SM4	238.0	0.0	26.0	0.0	6.3	4.026 PL	8.83	PF	0.2
SM5	238.0	0.0	26.2	0.0		120 FTG	----	PE	0.0
						0.020 TL	8.83	PV	
Pipe: 59									
SM5	238.0	0.0	26.2	0.0	8.2	4.026 PL	78.66	PF	3.3
SM6	238.0	0.0	29.5	0.0		120 FTG	ET	PE	0.0
						0.032 TL	101.46	PV	
Pipe: 59A									
SM6	238.0	0.0	29.5	0.0	7.9	4.026 PL	100.41	PF	3.5
SM8	238.0	0.0	32.9	0.0		120 FTG	2E	PE	0.0
						0.030 TL	114.01	PV	
Pipe: 59B									
SM8	238.0	0.0	32.9	0.0	7.3	4.026 PL	110.25	PF	3.2
SM7	238.0	0.0	36.2	0.0		120 FTG	2E	PE	0.0
						0.026 TL	123.85	PV	
Pipe: 59C									
SM1A	238.0	0.0	26.1	0.0	7.3	4.026 PL	121.08	PF	3.4
SM7	238.0	0.0	29.5	0.0		120 FTG	E	PE	0.0
						0.026 TL	127.88	PV	
Pipe: 59D									
SM7	238.0	0.0	29.5	0.0	7.6	4.026 PL	109.00	PF	3.5
SM9	238.0	0.0	33.0	0.0		120 FTG	2E	PE	0.0
						0.028 TL	122.60	PV	
Pipe: 59E									
SM9	238.0	0.0	33.0	0.0	8.3	4.026 PL	84.33	PF	3.2
SM7	238.0	0.0	36.2	0.0		120 FTG	2E	PE	0.0
						0.033 TL	97.93	PV	
Pipe: 59F									
SM6	238.0	0.0	29.5	0.0	0.3	4.026 PL	36.66	PF	0.0
SM7	238.0	0.0	29.5	0.0		120 FTG	2E2T	PE	0.0
						0.000 TL	82.26	PV	

PIPE TAG	END	ELEV.	NOZ.	PT	DISC.	Q(GPM)	DIA(IN)	LENGTH	PRESS.	
NODES	(FT)	(K)	(PSI)	(GPM)	VEL(FPS)	HW(C)	PL/FT	(FT)	SUM.	(PSI)
Pipe: 59G										
5M8	238.0	0.0	32.9	0.0	0.6	-24.6	4.026 PL	38.66	PF	0.0
5M9	238.0	0.0	33.0	0.0			120 FTG	282T	PE	0.0
							0.000 TL	84.26	PV	
Pipe: 60										
5M1	238.0	0.0	26.0	0.0	6.7	-264.7	4.026 PL	5.16	PF	0.1
5M1A	238.0	0.0	26.1	0.0			120 FTG	----	PE	0.0
							0.022 TL	5.16	PV	
Pipe: 61										
5MT	238.0	0.0	36.2	0.0	15.5	-616.9	4.026 PL	39.08	PF	7.3
5FC	234.5	0.0	44.9	0.0			120 FTG	28T	PE	1.5
							0.106 TL	68.68	PV	
Pipe: 62										
5FC	234.5	0.0	44.9	0.0	15.5	-616.9	4.026 PL	2.16	PF	5.5
5PCL	234.5	H.S.	50.5	150.0			120 FTG	TCB	PE	0.0
							0.106 TL	52.16	PV	
Pipe: 63										
5PCL	234.5	H.S.	50.5	150.0	8.5	-766.9	6.065 PL	56.41	PF	1.4
BR2	179.0	0.0	75.9	0.0			120 FTG	E	PE	24.0
							0.022 TL	66.41	PV	
Pipe: 64										
BR2	179.0	0.0	75.9	0.0	8.5	-766.9	6.065 PL	4.00	PF	0.1
M1	179.0	0.0	76.0	0.0			120 FTG	----	PE	0.0
							0.022 TL	4.00	PV	
Pipe: 65										
M1	179.0	0.0	76.0	0.0	8.5	-766.9	6.065 PL	31.50	PF	2.1
M2	179.0	0.0	78.2	0.0			120 FTG	RTC	PE	0.0
							0.022 TL	98.50	PV	
Pipe: 66										
M2	179.0	0.0	78.2	0.0	8.5	-766.9	6.065 PL	69.08	PF	2.1
M3	179.0	0.0	80.3	0.0			120 FTG	3E	PE	0.0
							0.022 TL	99.08	PV	
Pipe: 67										
M3	179.0	0.0	80.3	0.0	8.5	-766.9	6.065 PL	8.46	PF	1.3
M4	170.5	0.0	85.2	0.0			120 FTG	RCB	PE	3.7
							0.022 TL	58.46	PV	
Pipe: 68										
M4	170.5	0.0	85.2	0.0	8.5	-766.9	6.065 PL	16.41	PF	1.5
M5	179.0	0.0	83.1	0.0			120 FTG	38T	PE	-3.7
							0.022 TL	71.41	PV	
Pipe: 69										
M5	179.0	0.0	83.1	0.0	8.5	-766.9	6.065 PL	40.33	PF	0.9
UG1	169.0	0.0	88.3	0.0			120 FTG	----	PE	4.3
							0.022 TL	40.33	PV	
Pipe: 70										
UG1	169.0	0.0	88.3	0.0	4.5	-766.9	8.390 PL	177.00	PF	1.1
SRC	163.7	SRCS	91.7	(N/A)			140 FTG	R2T	PE	2.3
							0.003 TL	328.00	PV	

NOTES (HASS):

- (1) Calculations were performed by the HASS 8.1 computer program under license no. 38091471 granted by
 HRS Systems, Inc.
 200 South Public Square
 Petersburg, TN 37144
 (931) 659-9760
- (2) The system has been calculated to provide an average imbalance at each node of 0.001 gpm and a maximum imbalance at any node of 0.077 gpm.
- (3) Total pressure at each node is used in balancing the system. Maximum water velocity is 18.4 ft/sec at pipe 46.
- (4) Items listed in bold print on the cover sheet

 are automatically transferred from the calculation report.

(5) PIPE FITTINGS TABLE

Pipe Table Name: STANDARD.PIP

PAGE: A MATERIAL: S40 HWC: 120

Diameter (in)	Equivalent Fitting Lengths in Feet								
	E Ell	T Tee	L LngEll	C ChkVlv	B BfyVlv	G GatVlv	A AlmChk	D DPVlv	N NPTee

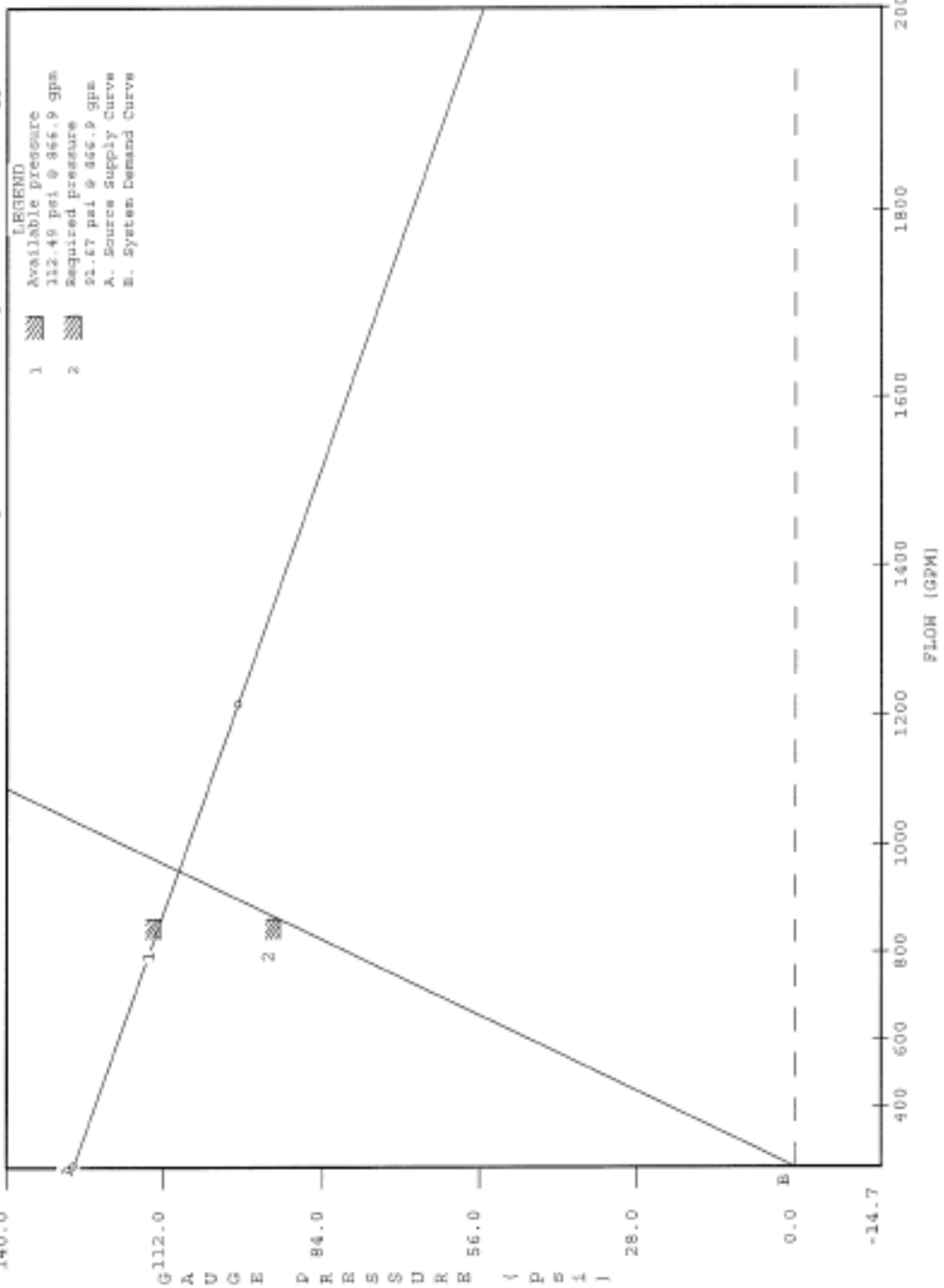
	F								
	P45Ell								
1.049	2.00	5.00	2.00	5.00	4.00	1.00	10.00	10.00	5.00
	1.00								
1.380	3.00	6.00	2.00	7.00	4.00	1.00	10.00	10.00	6.00
	1.50								
1.610	4.00	8.00	2.00	9.00	4.00	1.00	10.00	10.00	8.00
	2.00								
2.067	5.00	10.00	3.00	11.00	5.00	1.00	10.00	10.00	10.00
	2.50								
4.026	6.00	16.00	5.00	22.00	12.00	2.00	20.00	10.00	16.00
	3.40								
6.065	10.00	25.00	7.50	32.00	8.00	3.00	28.00	19.00	25.00
	3.50								

PAGE: D MATERIAL: DIRON HWC: 140

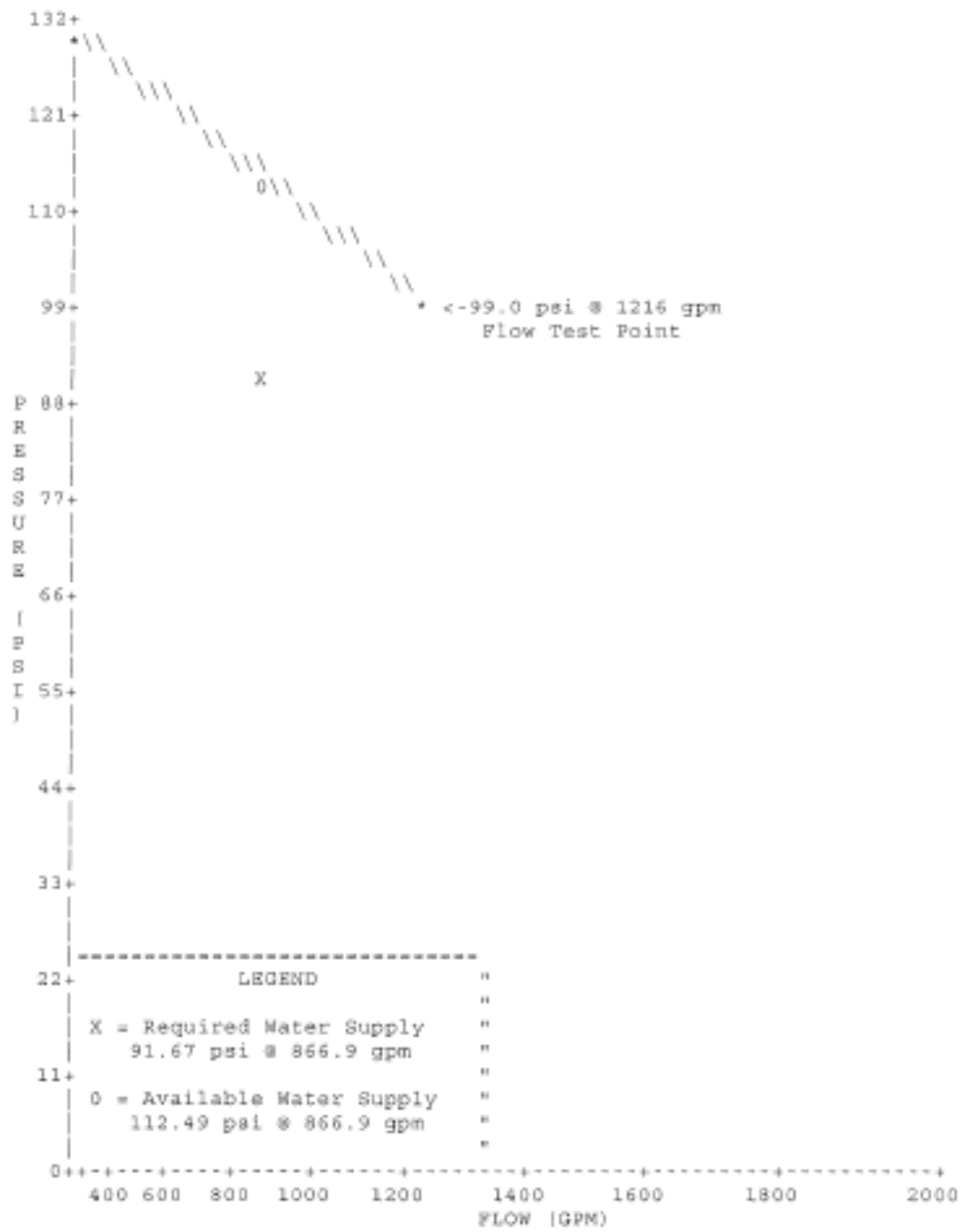
Diameter (in)	Equivalent Fitting Lengths in Feet								
	E Ell	T Tee	L LngEll	C ChkVlv	B BfyVlv	G GatVlv	N NPTee	F P45Ell	
8.390	31.00	60.00	22.00	78.00	21.00	7.00	0.00	0.00	

WATER SUPPLY ANALYSIS

Static: 128.00 psi Resid: 99.00 psi Flow: 1216.0 gpm



WATER SUPPLY CURVE



APPENDIX K

Hydraulic Calculation (1st Floor)

Refer to Appendix I for Contractor Shop Drawing including all nodes, sprinklers, pipe locations, pipe lengths, and pipe diameters.

HYDRAULIC CALCULATIONS

CONTRACT NAME FPE 523 Project Building (Reaction) SHEET 1 OF 1

NOZZLE IDENT. AND LOCATION	FLOW IN GPM	PIPE SIZE	PIPE FITTINGS AND DEVICES	EQUIV. PIPE LENGTH	FRICTION LOSS PSI/FT	PRESSURE SUMMARY	NORMAL PRESSURE	NOTES
PH2 PT1	q	1.049	E	L 4	C=100	Pt 12.12	Pt	K=5.6 Q = A _s × dash 130 × .15 = 19.5 gpm
			F	1		Pe	Pv	
	Q 19.5		T	5	.17	Pf 0.85	Pn	
	q			L	C=100	Pt 12.97	Pt	K _{eq} = Q ÷ √P 19.5 ÷ √12.97 = 5.4
			F			Pe	Pv	
	Q		T			Pf	Pn	
PH1 PT1	Q 19.5	1.049	E	L 9.5	C=100	Pt 13	Pt	K _{eq} = 5.4
			F	1		Pe	Pv	
	Q 19.5		T	10.5	.173	Pf 1.82	Pn	
PT1 PM1	Q 20.9	1.380	2T	L .75	.176	Pt 14.82	Pt	Q = K _{eq} × √P 5.4 × √14.82 = 20.9 P _e = .433 × .75 = .3
			F	12		Pe .3	Pv	
	Q 40.4		T	12.75		Pf 2.24	Pn	
PM1 PM2	Q 0	1.61		L 10	.083	Pt 17.36	Pt	K _{eq} @PM1 = 9.69
			F			Pe	Pv	
	Q 40.4		T	10		Pf .83	Pn	
PM2 PM3	Q 41.33	1.61		L 10	.306	Pt 18.19	Pt	
			F			Pe	Pv	
	Q 81.73		T	10		Pf 3.06	Pn	
PM3 PTV	Q 44.67	2.067	3E	L 18.75	.203	Pt 21.25	Pt	
			F	15		Pe	Pv	
	Q 26.4		T	33.75		Pf 6.85	Pn	
PTV PBV	q	2.067	E	L 7.25	.203	Pt 28.1	Pt	
			B	F 20		Pe 3.03	Pv	
	Q 126.4		D	T 27.25		Pf 5.53	Pn	
PBV M5	q	4.026	2E	L 9.75	C=120	Pt 36.66	Pt	
			F	20	Pe -3.5	Pv		
	Q 126.4		T	27.75	Pf .179	Pn		
M5 UG1	q	6.065	2E	L 40	C=120	Pt 33.34	Pt	
			F	95	Pe	Pv		
	Q 126.4		T	85	Pf .085	Pn		
UG1 SRC	q	8.343	E	L 177	C=140	Pt 33.43	Pt	Hose = 500 gpm
			F	151	Pe	Pv		
	Q 126.4		T	328	Pf .032	Pn		
						Pt 33.46		



American Fire Sprinkler Association
12750 Main Drive, Suite 350, Dallas, Texas 75241
Tele: 214-348-2500
Fax: 214-343-8399
www.afsprinkler.org

Required Flow: 626.4 gpm @ 33.5 psi
+ Pressure

APPENDIX L

Sprinkler NFPA 25

NFPA 25 Inspection Testing and Maintenance Summary for Sprinkler and Standpipe System

Table 5.1.1.2 Summary of Sprinkler System Inspection, Testing, and Maintenance

Item	Frequency	Reference
Inspection		
Gauges (dry, preaction, and deluge systems)	Weekly/monthly	5.2.4.2, 5.2.4.3, 5.2.4.4
Control valves		Table 13.1
Waterflow alarm devices	Quarterly	5.2.5
Valve supervisory alarm devices	Quarterly	5.2.5
Supervisory signal devices (except valve supervisory switches)	Quarterly	5.2.5
Gauges (wet pipe systems)	Monthly	5.2.4.1
Hydraulic nameplate	Quarterly	5.2.6
Buildings	Annually (prior to freezing weather)	4.1.1.1
Hanger/seismic bracing	Annually	5.2.3
Pipe and fittings	Annually	5.2.2
Sprinklers	Annually	5.2.1
Spare sprinklers	Annually	5.2.1.4
Information sign	Annually	5.2.6.1
Fire department connections		Table 13.1
Valves (all types)		Table 13.1
Obstruction, internal inspection of piping	5 years	14.2
Test		
Waterflow alarm devices		
Mechanical devices	Quarterly	5.3.3.1
Vane and pressure switch type devices	Semiannually	5.3.3.2
Valves supervisory alarm devices		Table 13.1
Supervisory signal devices (except valve supervisory switches)		Table 13.1
Main drain		Table 13.1
Antifreeze solution	Annually	5.3.4
Gauges	5 years	5.3.2
Sprinklers — extra high temperature	5 years	5.3.1.1.1.4
Sprinklers — fast response	At 20 years and every 10 years thereafter	5.3.1.1.1.3
Sprinklers	At 50 years and every 10 years thereafter	5.3.1.1.1
Sprinklers	At 75 years and every 5 years thereafter	5.3.1.1.1.5
Sprinklers — dry	At 10 years and every 10 years thereafter	5.3.1.1.1.6
Maintenance		
Valves (all types)		Table 13.1
Low-point drains (dry pipe system)		13.4.4.3.2
Sprinklers and automatic spray nozzles protecting commercial cooking equipment and ventilation systems	Annually	5.4.1.9
Investigation		
Obstruction		14.3

Table 6.1.1.2 Summary of Standpipe and Hose Systems Inspection, Testing, and Maintenance

Item	Frequency	Reference
Inspection		
Control valves		Table 13.1
Pressure regulating devices		Table 13.1
Piping	Annually	6.2.1
Hose connections		Table 13.1
Cabinet	Annually	NFPA 1962
Gauges	Weekly	6.2.2
Hose	Annually	NFPA 1962
Hose storage device	Annually	NFPA 1962
Hose nozzle	Annually and after each use	NFPA 1962
Hydraulic design information sign	Annually	6.2.3
Test		
Waterflow alarm devices		Table 13.1
Valve supervisory alarm devices		Table 13.1
Supervisory signal devices (except valve supervisory switches)		Table 13.1
Hose storage device	Annually	NFPA 1962
Hose	5 years/3 years	NFPA 1962
Pressure control valve		Table 13.1
Pressure reducing valve		Table 13.1
Hydrostatic test	5 years	6.3.2
Flow test	5 years	6.3.1
Main drain test		Table 13.1
Maintenance		
Hose connections	Annually	Table 6.1.2
Valves (all types)	Annually/as needed	Table 13.1

Note: Strikethroughs represent items not part of project building.

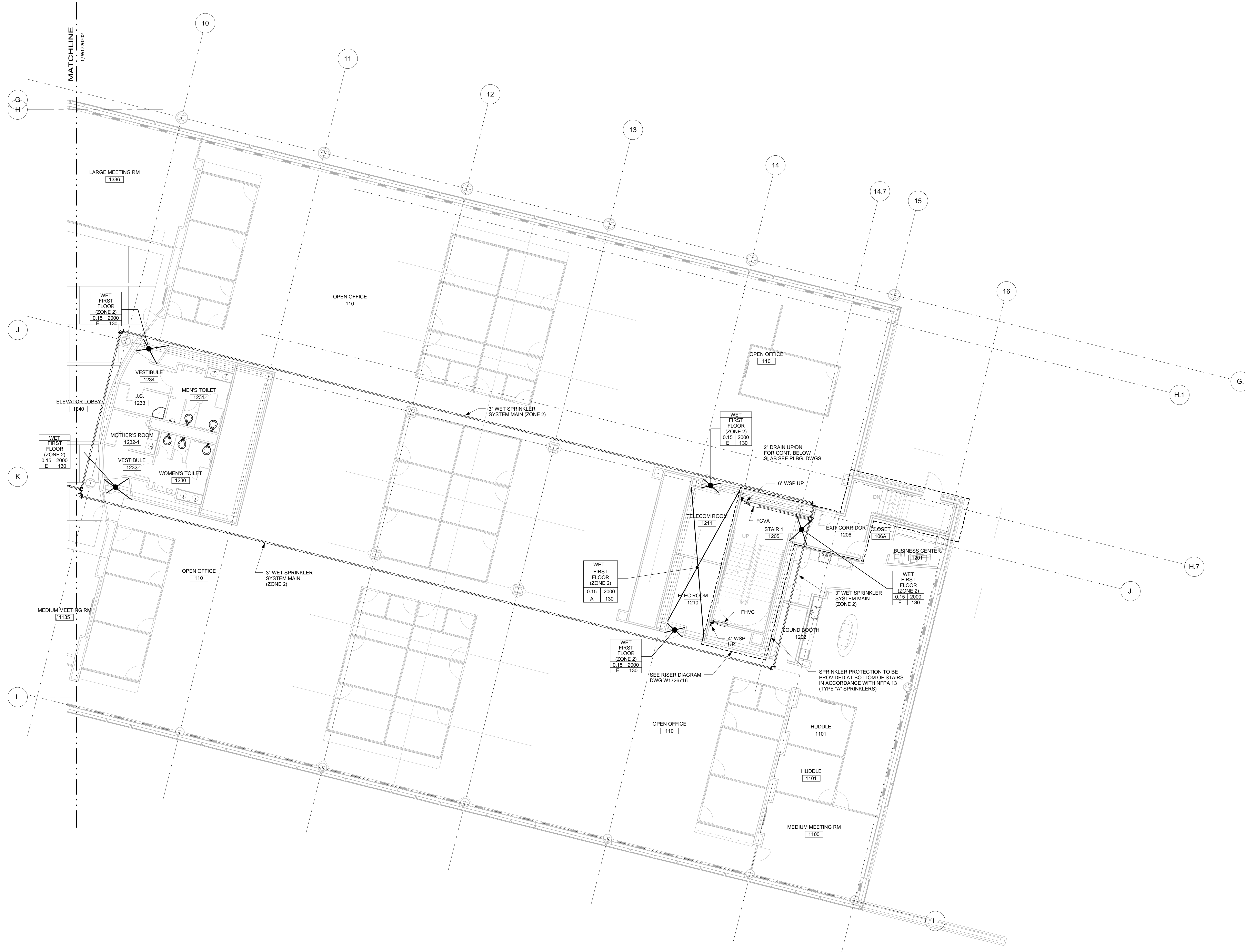
APPENDIX M

Engineer Sprinkler Plans

NOTES

- SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
- SEE DRAWING W1726717 FOR GENERAL NOTES AND DETAILS.
- ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

WET
FIRST FLOOR (ZONE 2)
0.15 2000
B 130
- COORDINATE SPRINKLER PIPING LOCATION WITH ARCHITECTURAL REFLECTED CEILING PLAN.

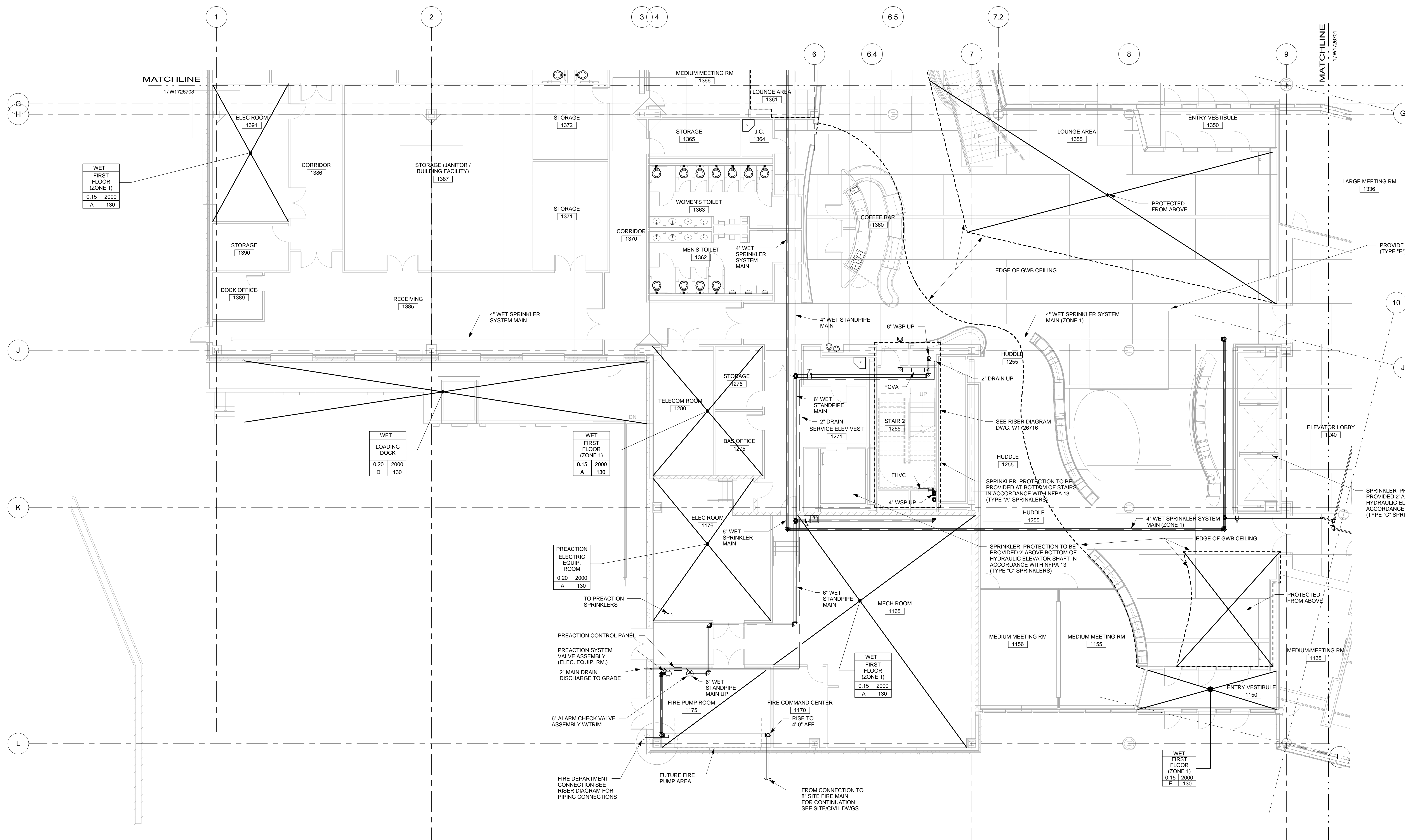


FIRST FLOOR - PART A

NOTES

- SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
- SEE DRAWING W1726717 FOR GENERAL NOTES AND DETAILS.
- ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

WET FLOOR (ZONE 1)	0.15	2000
A	130	
B	130	
- COORDINATE SPRINKLER PIPING LOCATION WITH ARCHITECTURAL REFLECTED CEILING PLAN.

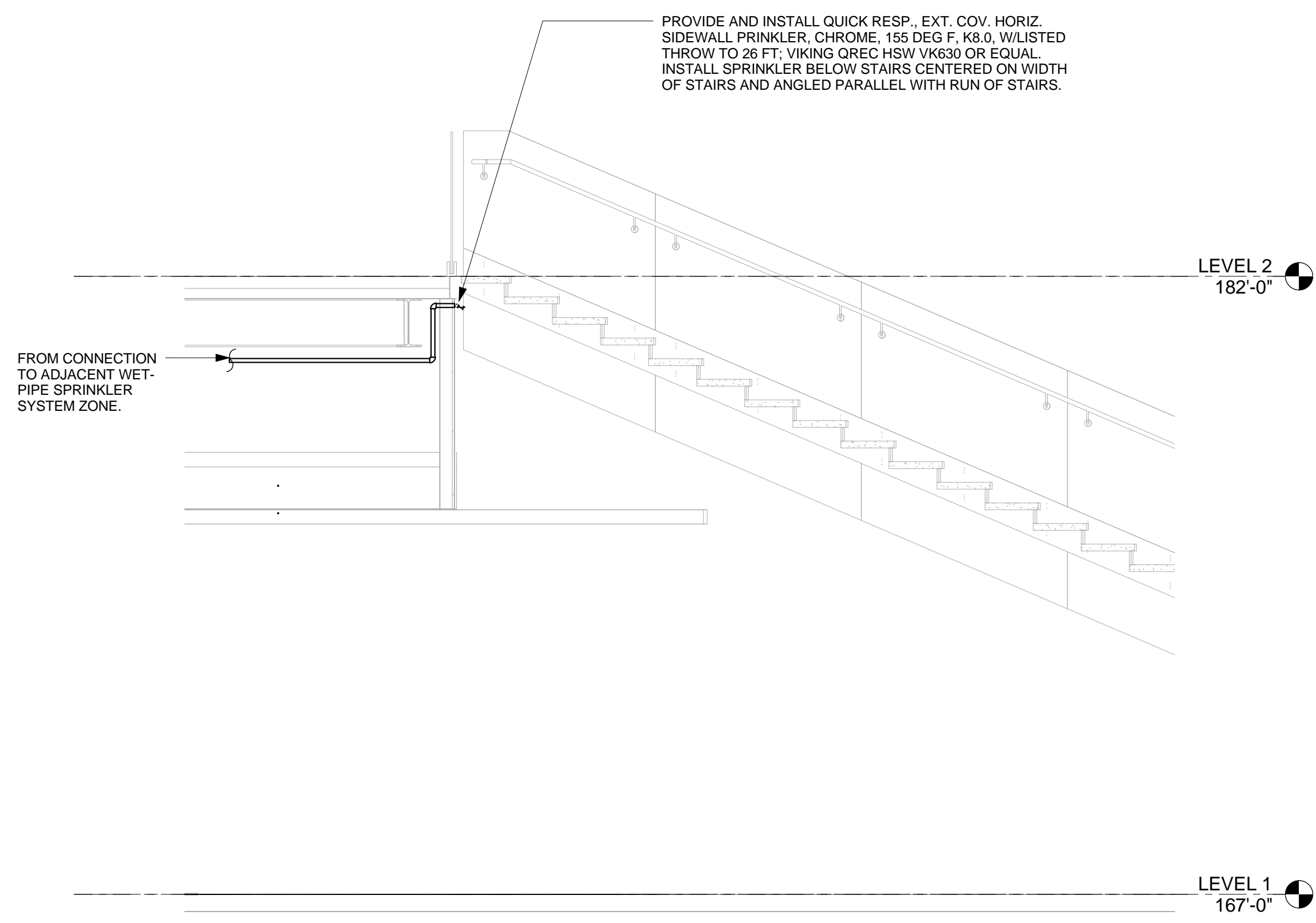
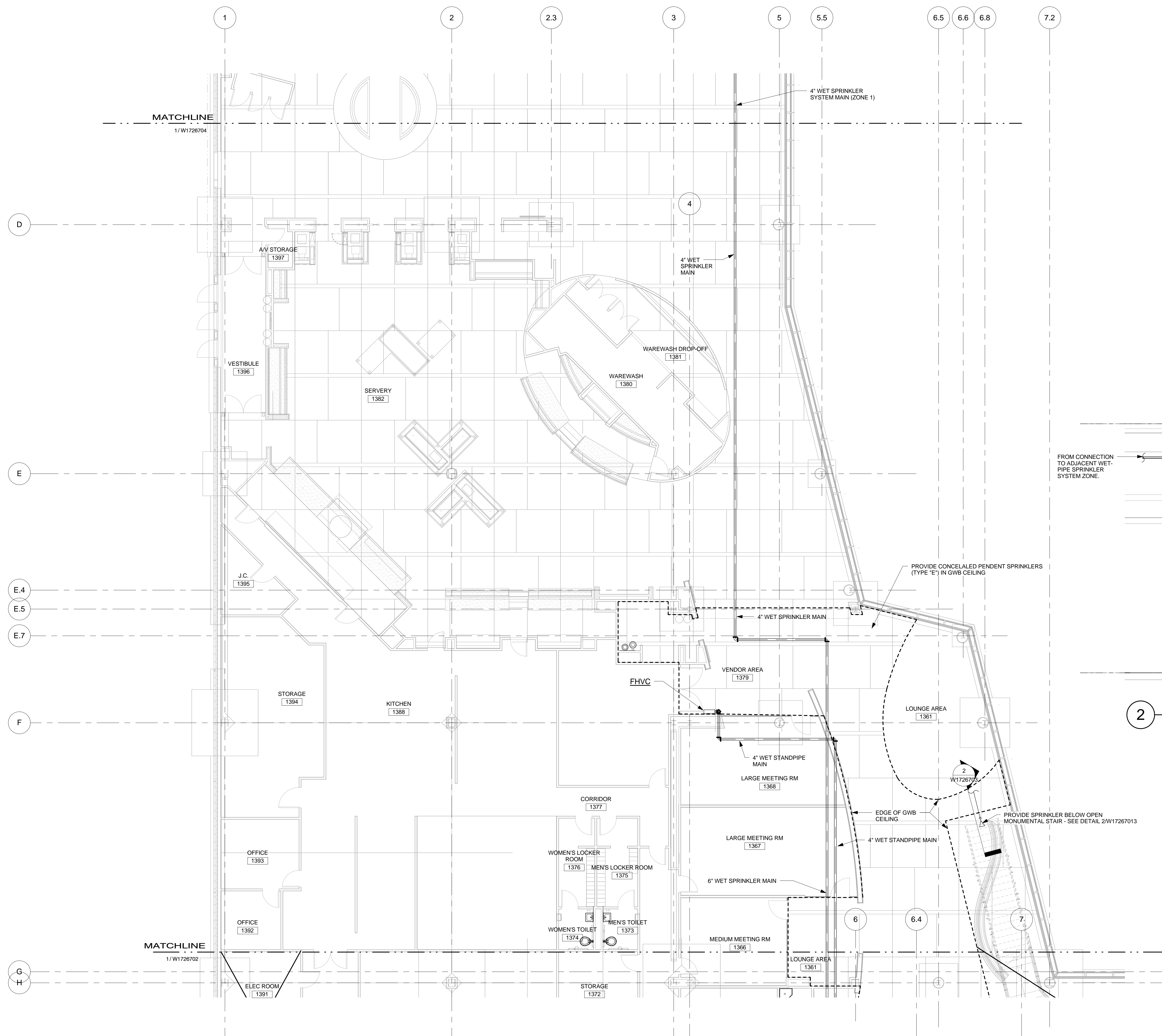


FIRST FLOOR - PART B

NOTES

- SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
- SEE DRAWING W1726717 FOR GENERAL NOTES AND DETAILS.
- ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

FLOOR	ZONE	SPACING	TYPE
FIRST FLOOR	(ZONE 2)	0.15	2000
B			130
- COORDINATE SPRINKLER PIPING LOCATION WITH ARCHITECTURAL REFLECTED CEILING PLAN.

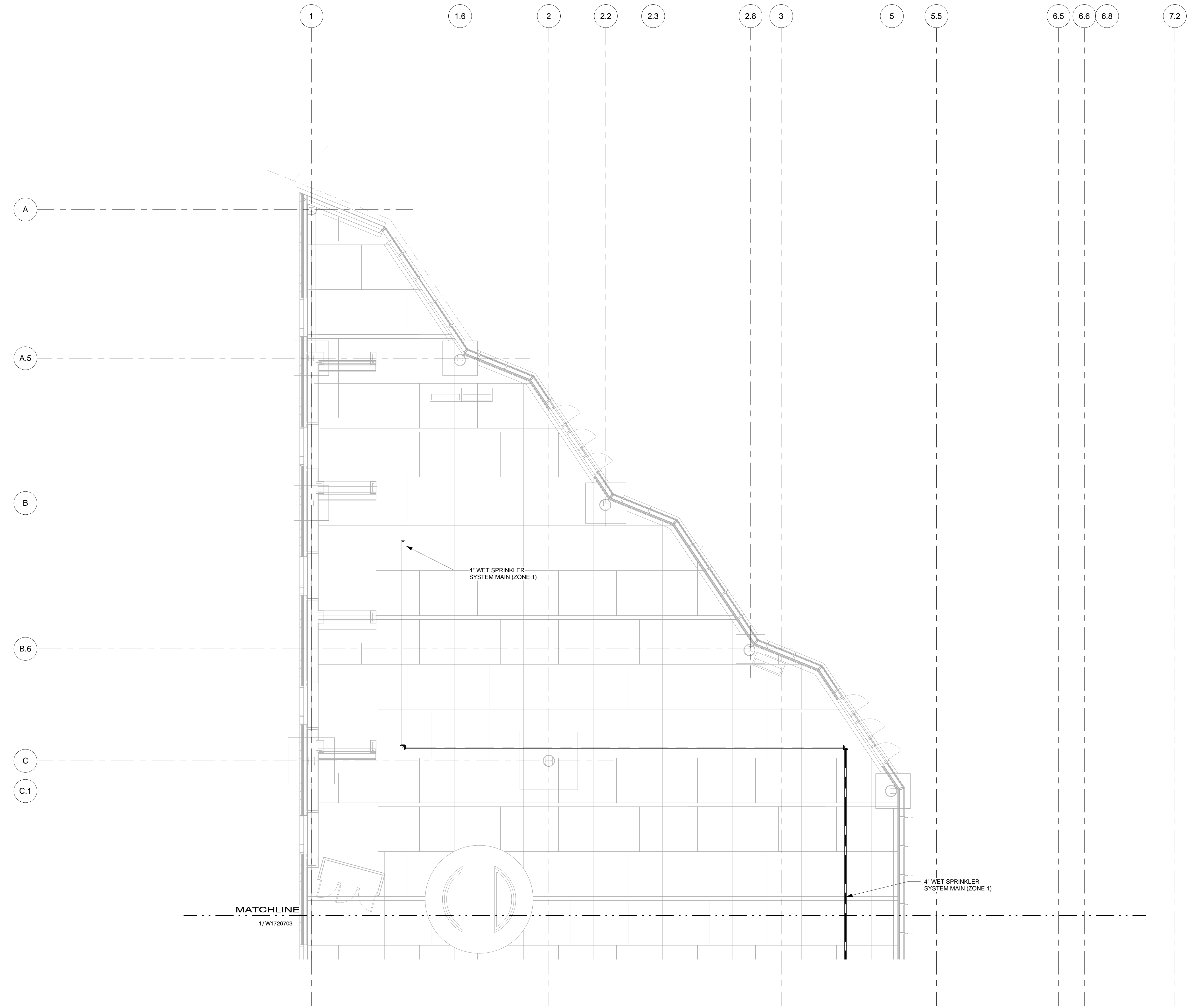


2 SPRINKLER PROTECTION BELOW OPEN MONUMENTAL STAIR
SCALE: 3/8" = 1'-0"

NOTES

1. SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
2. SEE DRAWING W1726716 FOR GENERAL NOTES AND DETAILS.
3. ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

WET	
FIRST FLOOR (ZONE 2)	
0.15	2000
B	130
4. COORDINATE SPRINKLER PIPING LOCATION WITH ARCHITECTURAL REFLECTED CEILING PLAN.



MATCHLINE
1/W1726703

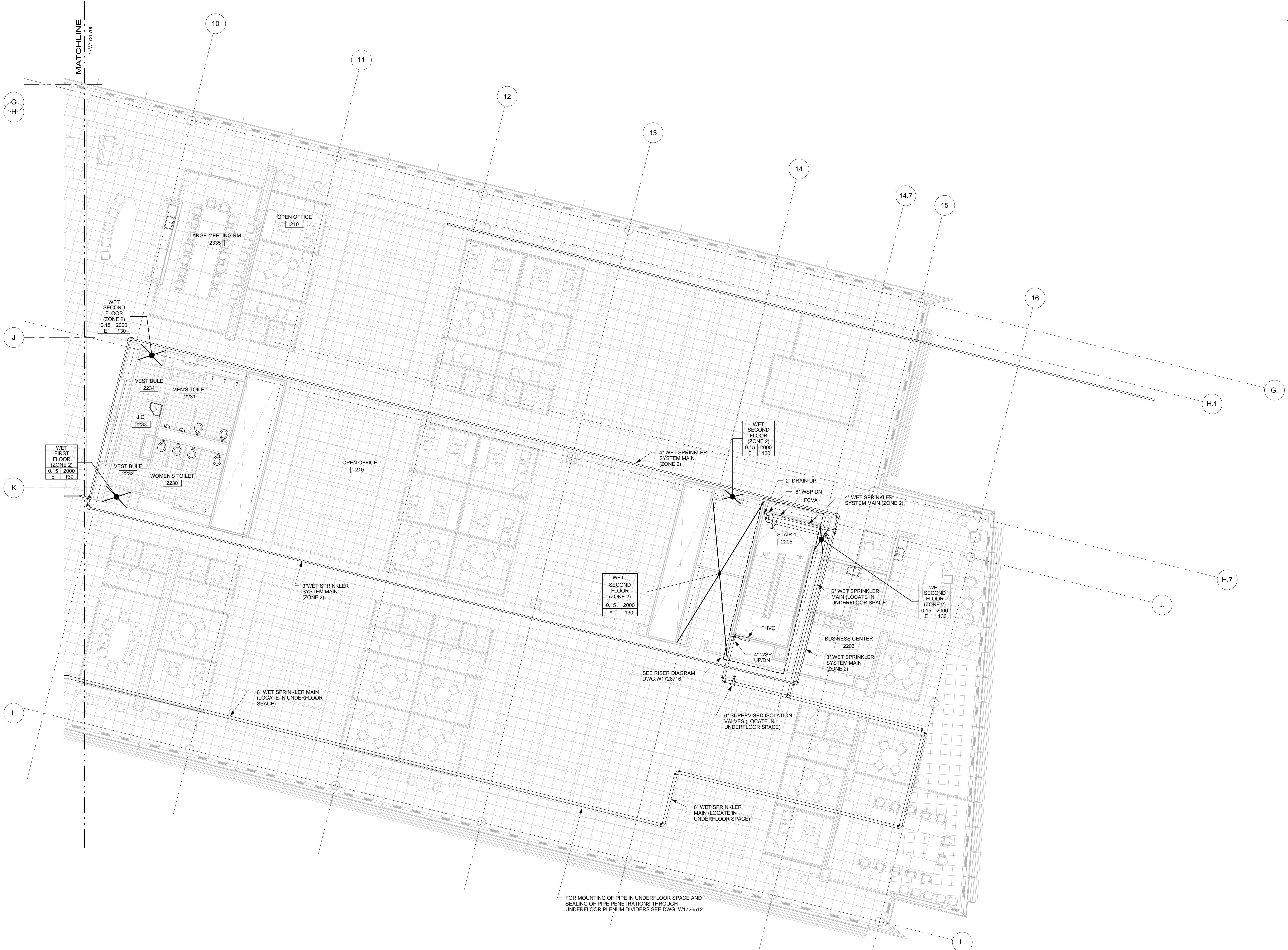
4" WET SPRINKLER SYSTEM MAIN (ZONE 1)

4" WET SPRINKLER SYSTEM MAIN (ZONE 1)

NOTES

- 1. SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
- 2. SEE DRAWING W1726717 FOR GENERAL NOTES AND DETAILS.
- 3. ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

WET
SECOND FLOOR (ZONE 2)
0.15 2000
B 130

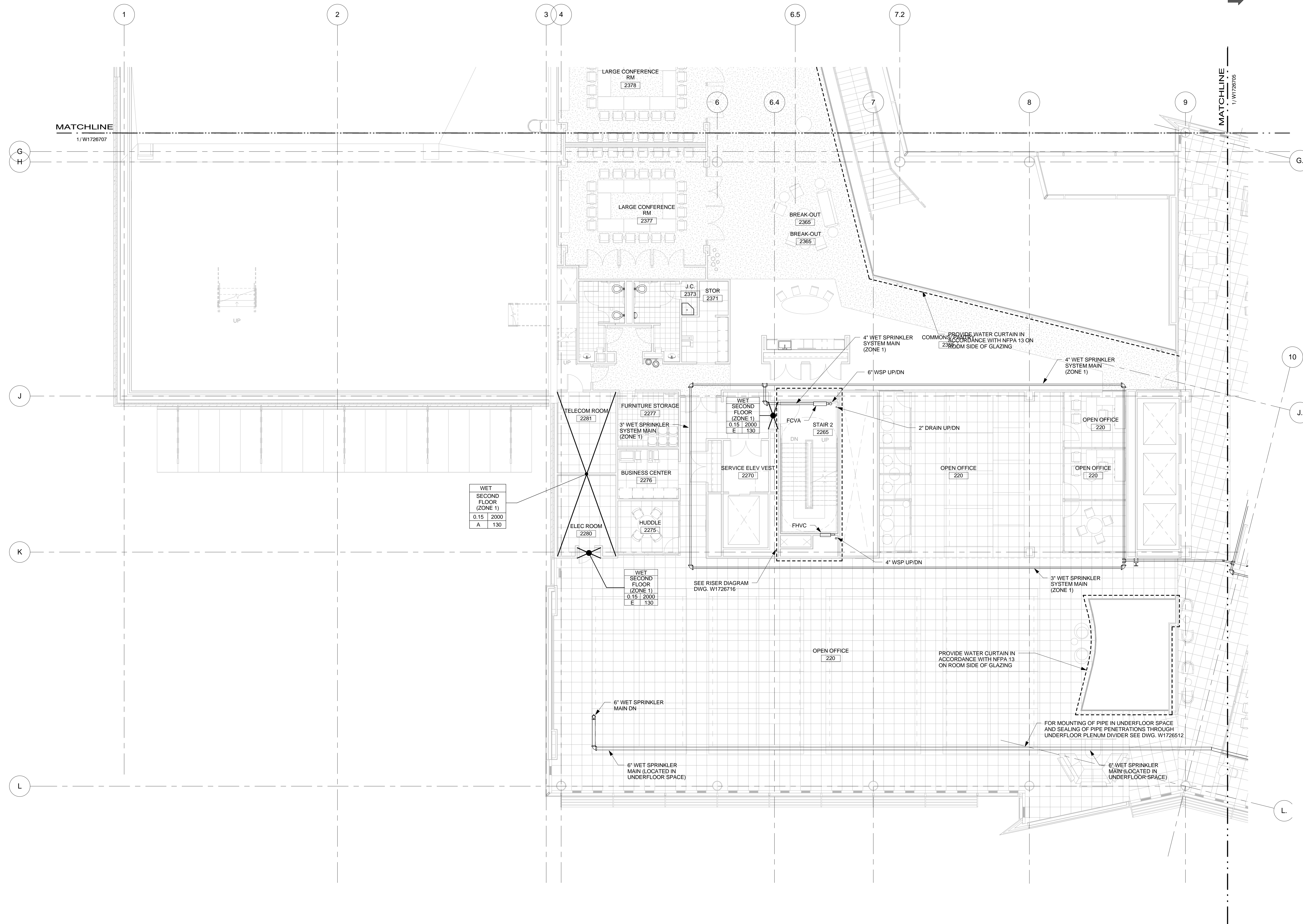


FOR MOUNTING OF PIPE IN UNDERFLOOR SPACE AND SEALING OF PIPE PENETRATIONS THROUGH UNDERFLOOR PLENUM DIVIDERS SEE DWG. W1726512

NOTES

1. SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
2. SEE DRAWING W1726717 FOR GENERAL NOTES AND DETAILS.
3. ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

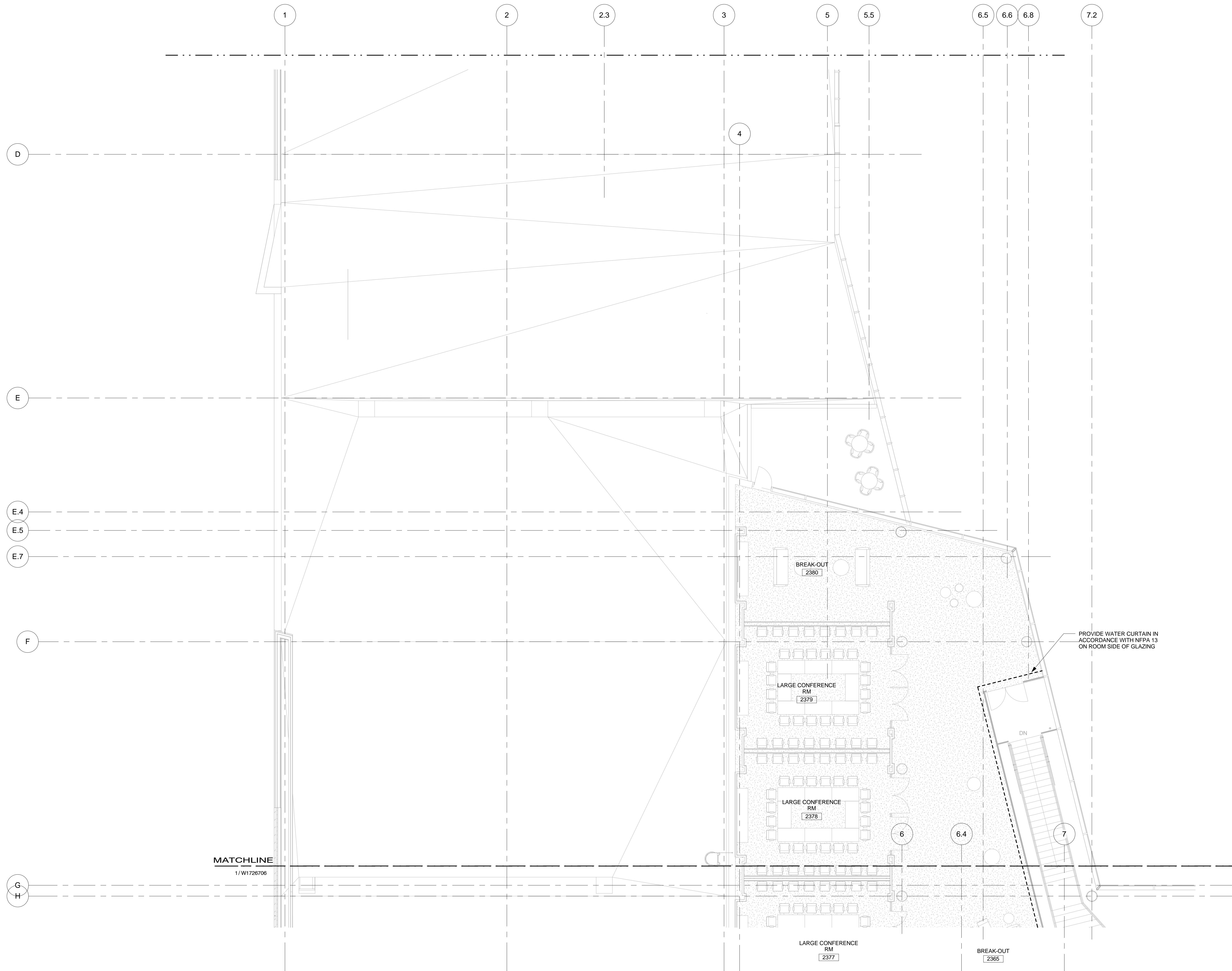
WET SECOND FLOOR (ZONE 1)	
0.15	2000
B	130



NOTES

- 1. SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
- 2. SEE DRAWING W1726717 FOR GENERAL NOTES AND DETAILS.
- 3. ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

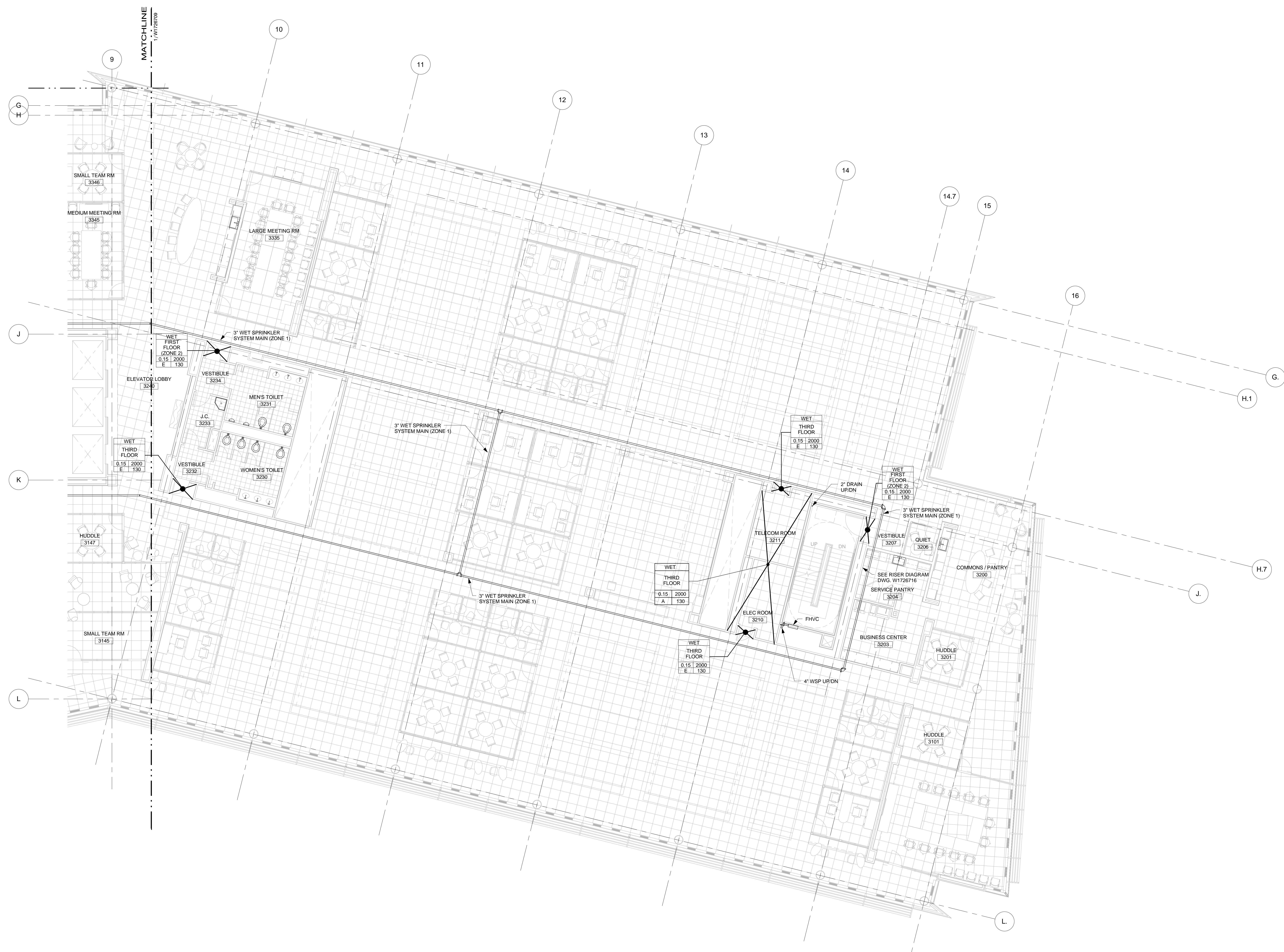
WET
SECOND FLOOR (ZONE 2)
0.15 2000
B 130



NOTES

- 1. SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
- 2. SEE DRAWINGS W1726717 FOR GENERAL NOTES AND DETAILS.
- 3. ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

WET
THIRD FLOOR
0.15 2000
B 130

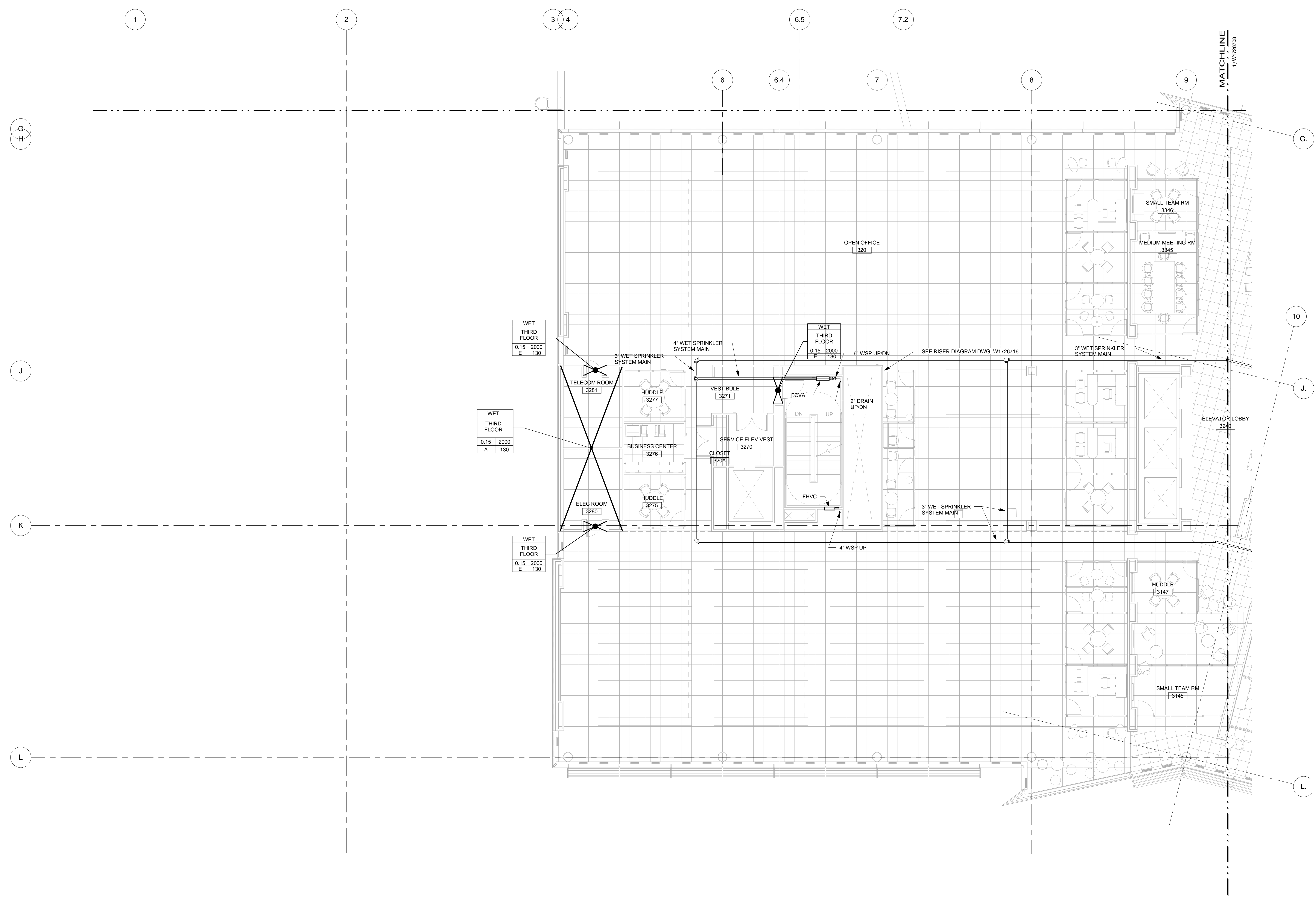


THIRD FLOOR - PART A

NOTES

- 1. SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
- 2. SEE DRAWING W1726717 FOR GENERAL NOTES AND DETAILS.
- 3. ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

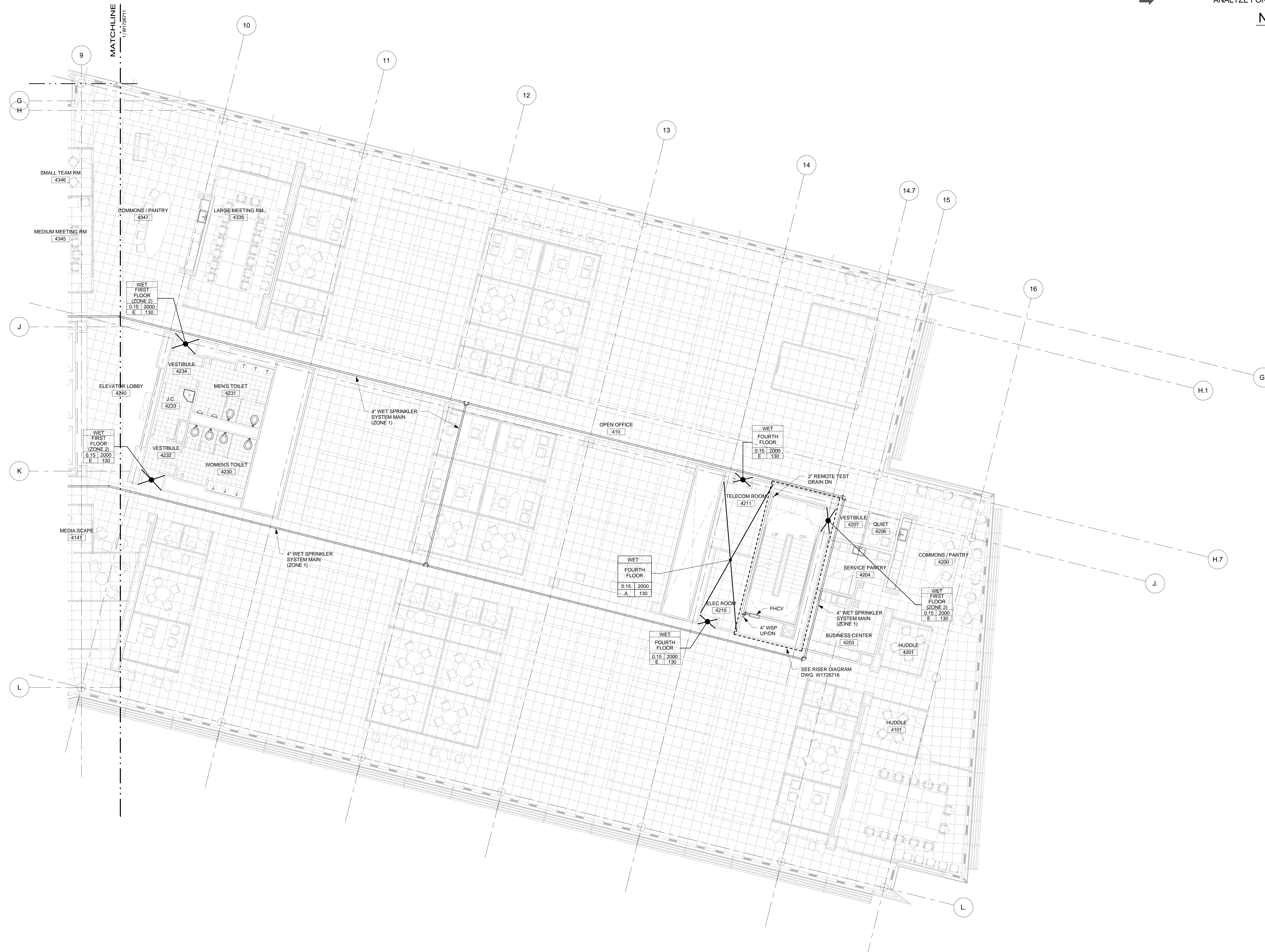
WET
THIRD FLOOR
0.15 2000
B 130



NOTES

- 1. SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
- 2. SEE DRAWING W1726717 FOR GENERAL NOTES AND DETAILS.
- 3. ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

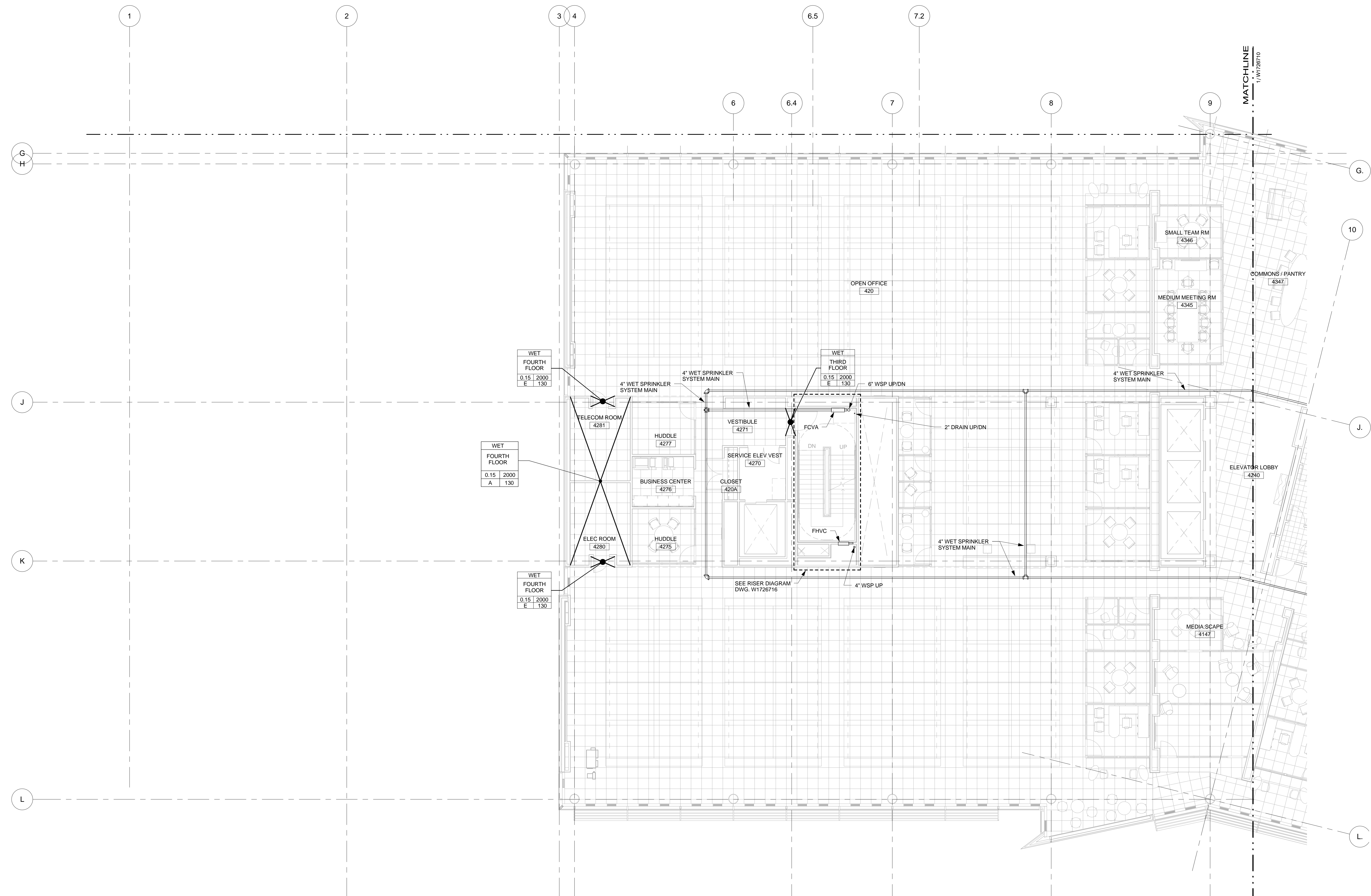
WET
FOURTH FLR
0.15 2000
B 130



NOTES

- 1. SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
- 2. SEE DRAWINGS W1726717 FOR GENERAL NOTES AND DETAILS.
- 3. ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

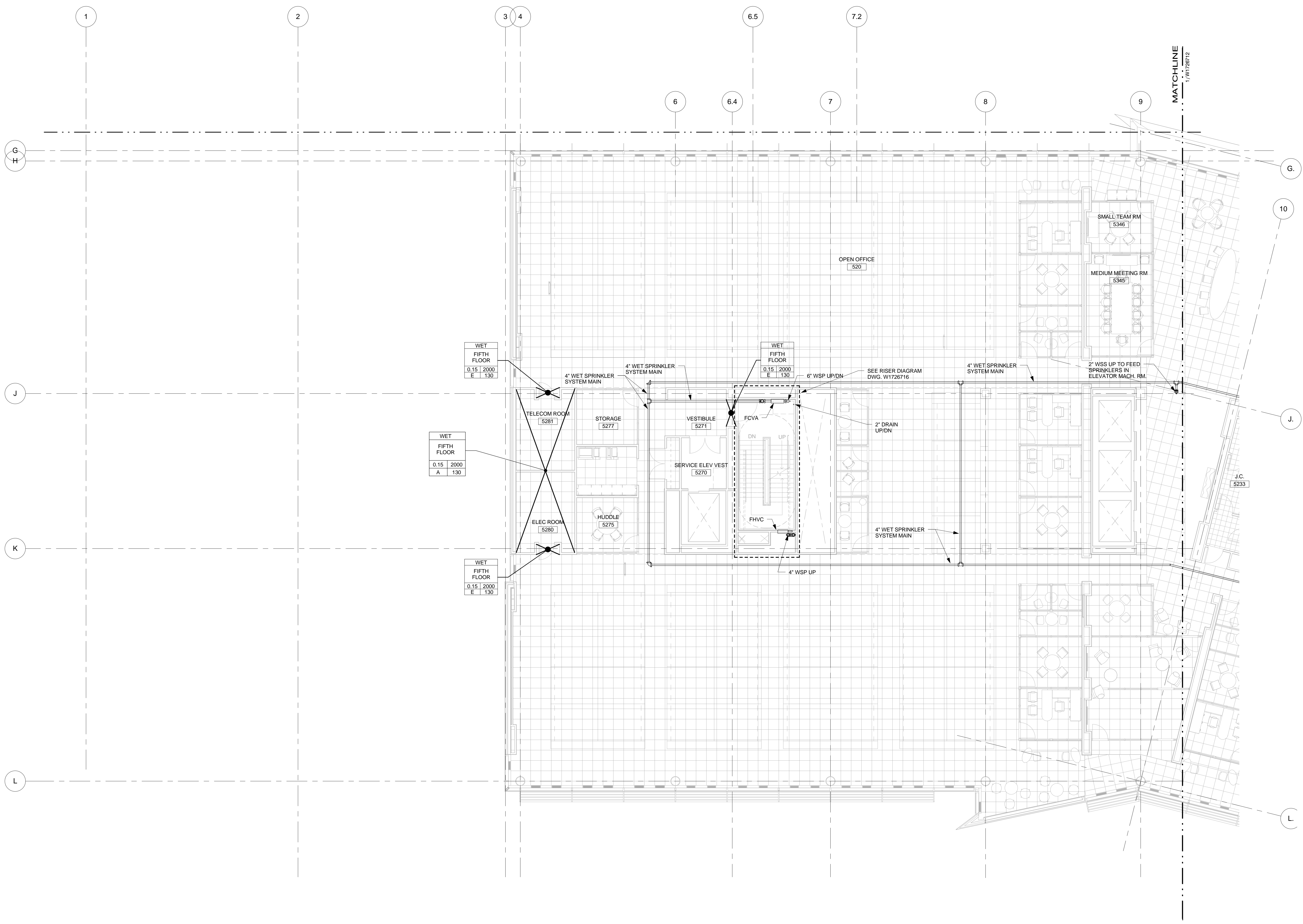
WET
FOURTH FLR
0.15 2000
B 130



NOTES

- 1. SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
- 2. SEE DRAWING W1726717 FOR GENERAL NOTES AND DETAILS.
- 3. ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

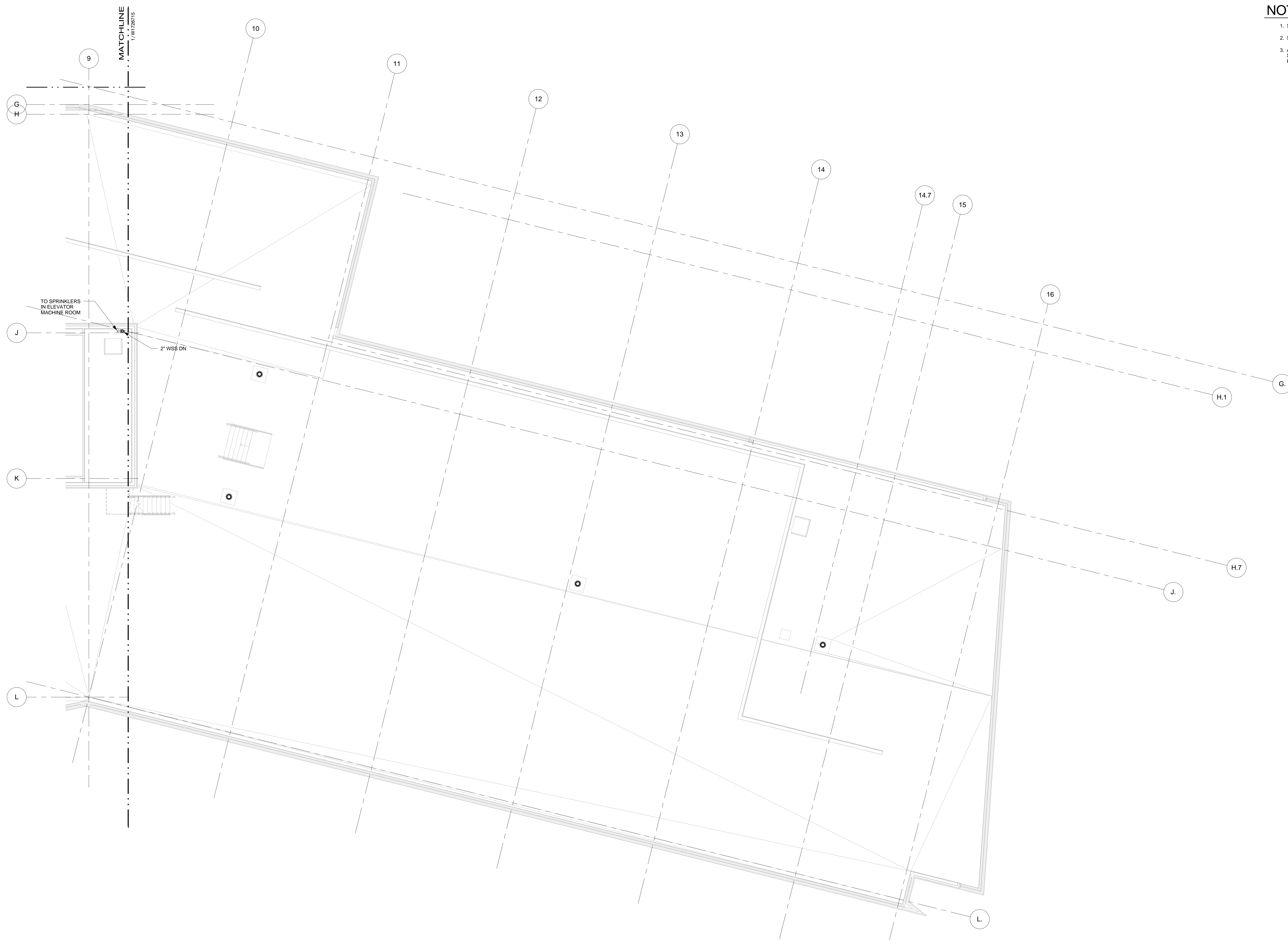
WET
FIFTH FLOOR
0.15 2000
B 130



NOTES

- 1. SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
- 2. SEE DRAWING W1726717 FOR GENERAL NOTES AND DETAILS.
- 3. ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

WET	
ROOF PLAN	
0.15	2000
B	130

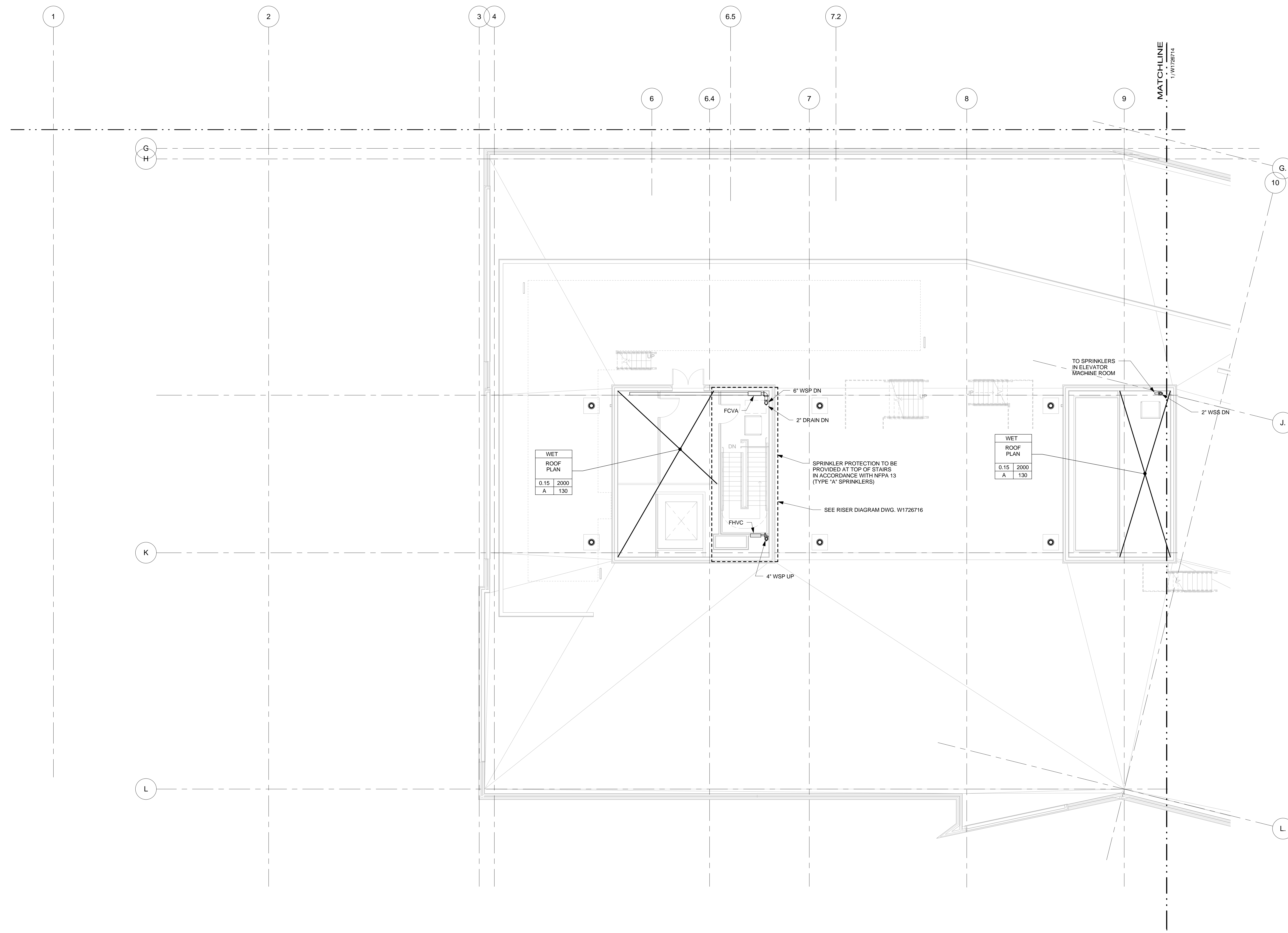


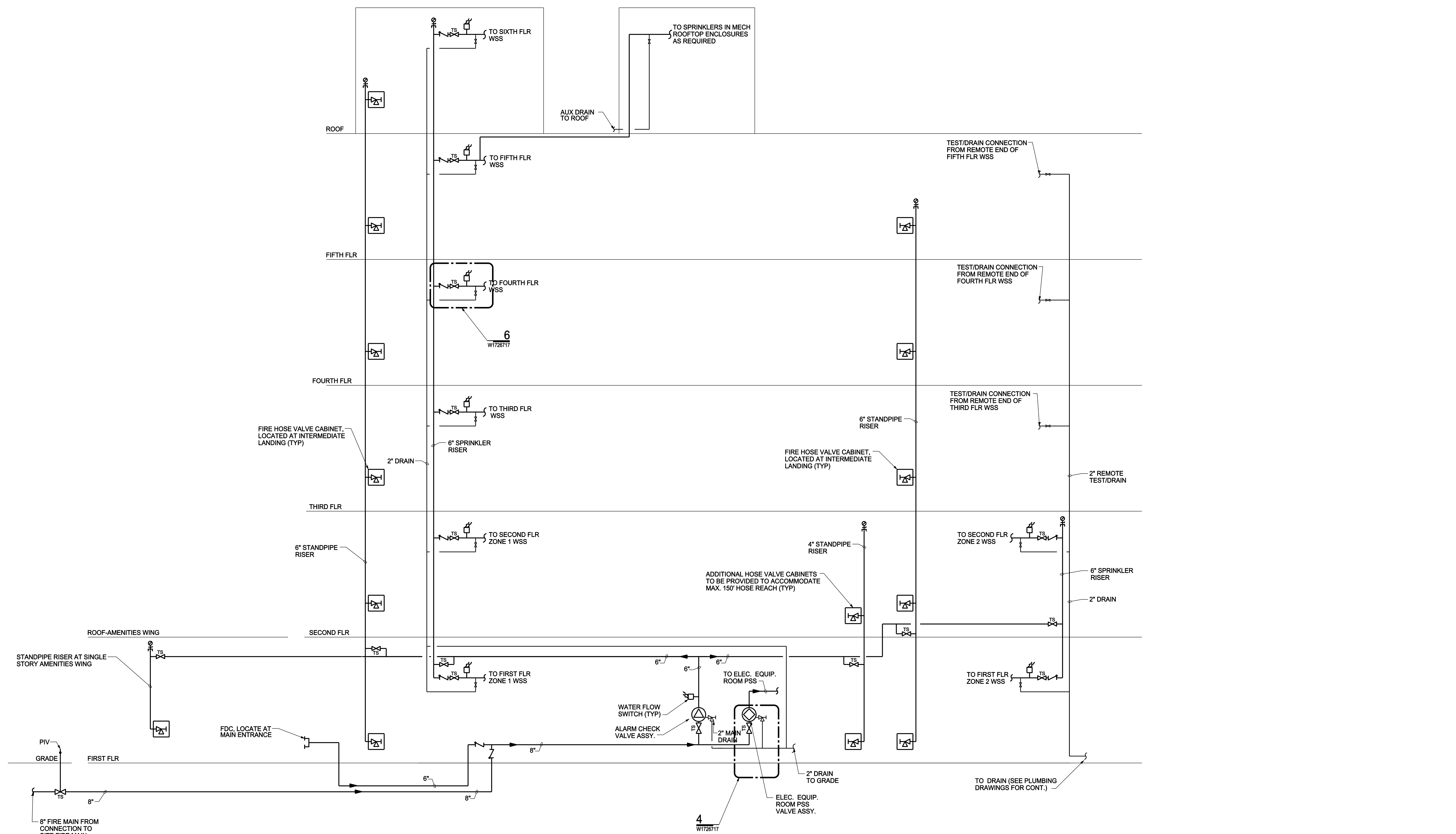
ROOF - PART A

NOTES

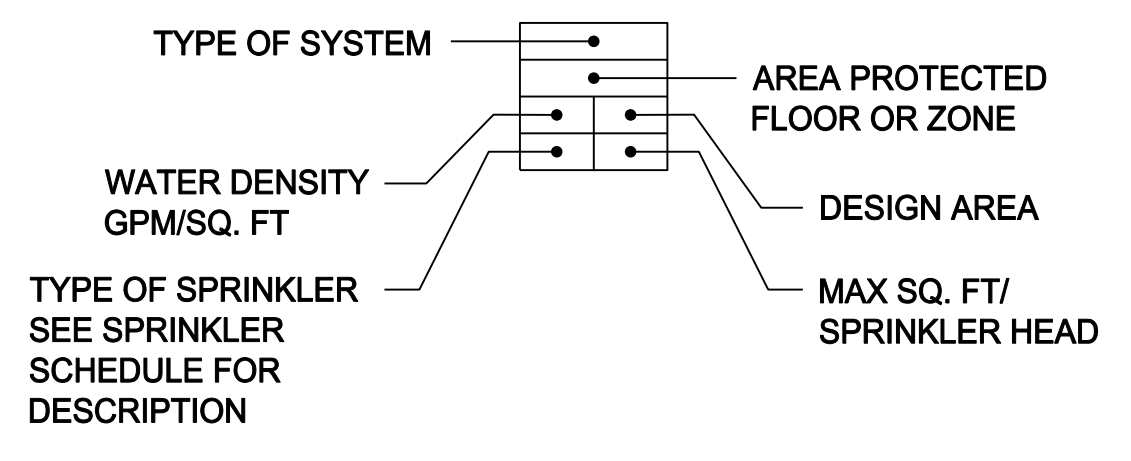
- 1. SEE DRAWINGS W1726435 & W1726436 FOR SYMBOLS AND ABBREVIATIONS.
- 2. SEE DRAWING W1726717 FOR GENERAL NOTES AND DETAILS.
- 3. ALL SPACES ON THIS SHEET ARE TO BE PROVIDED WITH AUTOMATIC SPRINKLER PROTECTION DESIGNED IN ACCORDANCE WITH THE FOLLOWING CRITERIA, EXCEPT AS OTHERWISE NOTED.

WET
ROOF PLAN
0.15 2000
A 130





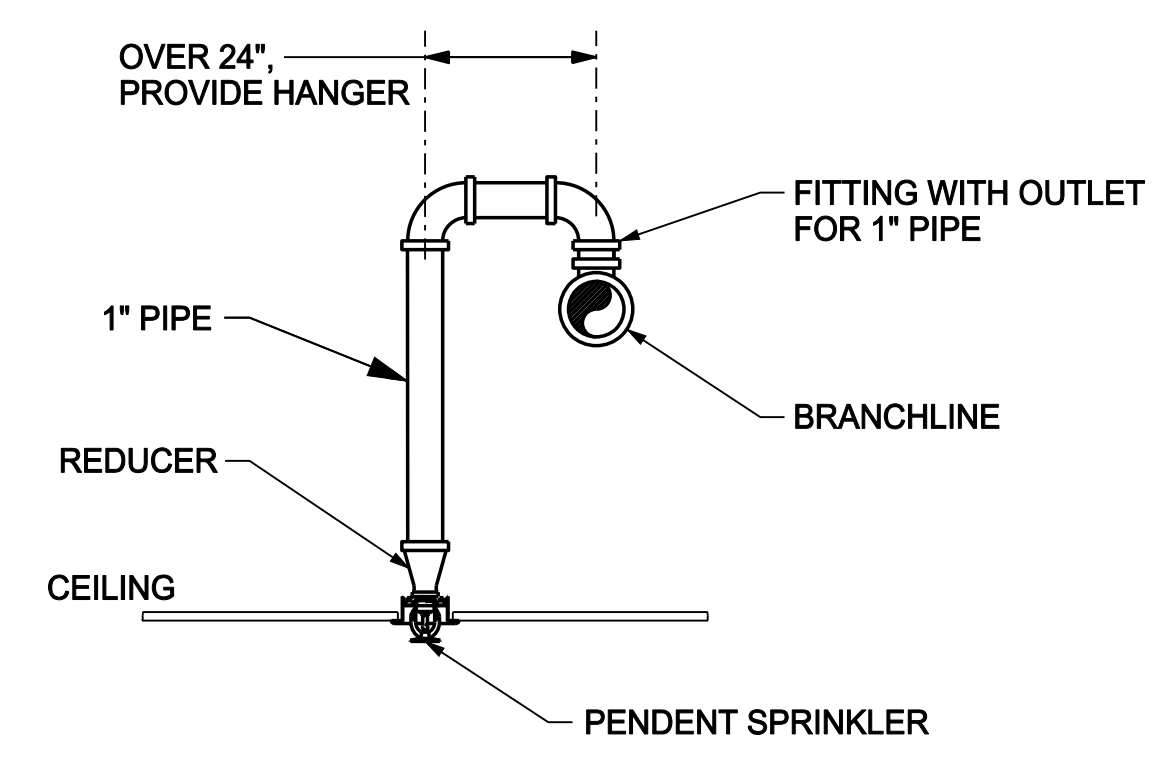
1 STANDPIPE/SPRINKLER SYSTEM RISERS DIAGRAM
N.T.S.



1 SPRINKLER SYSTEM DESIGN CRITERIA
N.T.S.

TYPE	DESCRIPTION	FINISH
A	PENDENT OR UPRIGHT, STANDARD RESPONSE	BRASS
B	RECESSED PENDENT, QUICK RESPONSE	CHROME
C	HORIZ. SIDEWALL, STANDARD RESPONSE	BRASS
D	CONCEALED PENDENT, QUICK RESPONSE	TEFLON COATED CORROSION RESISTANT
E	RECESSED PENDENT, QUICK RESPONSE	WHITE

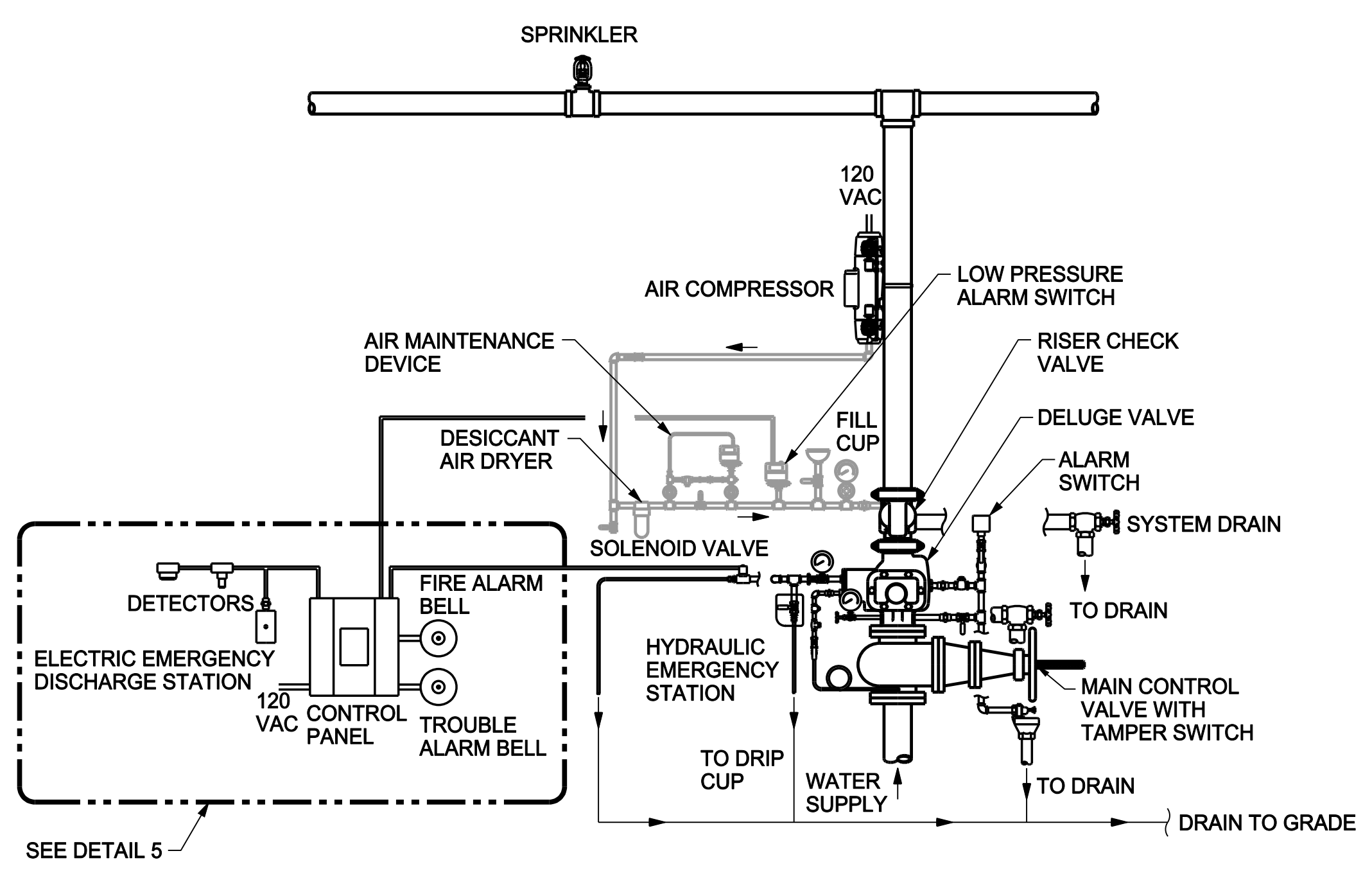
2 SPRINKLER SCHEDULE
N.T.S.



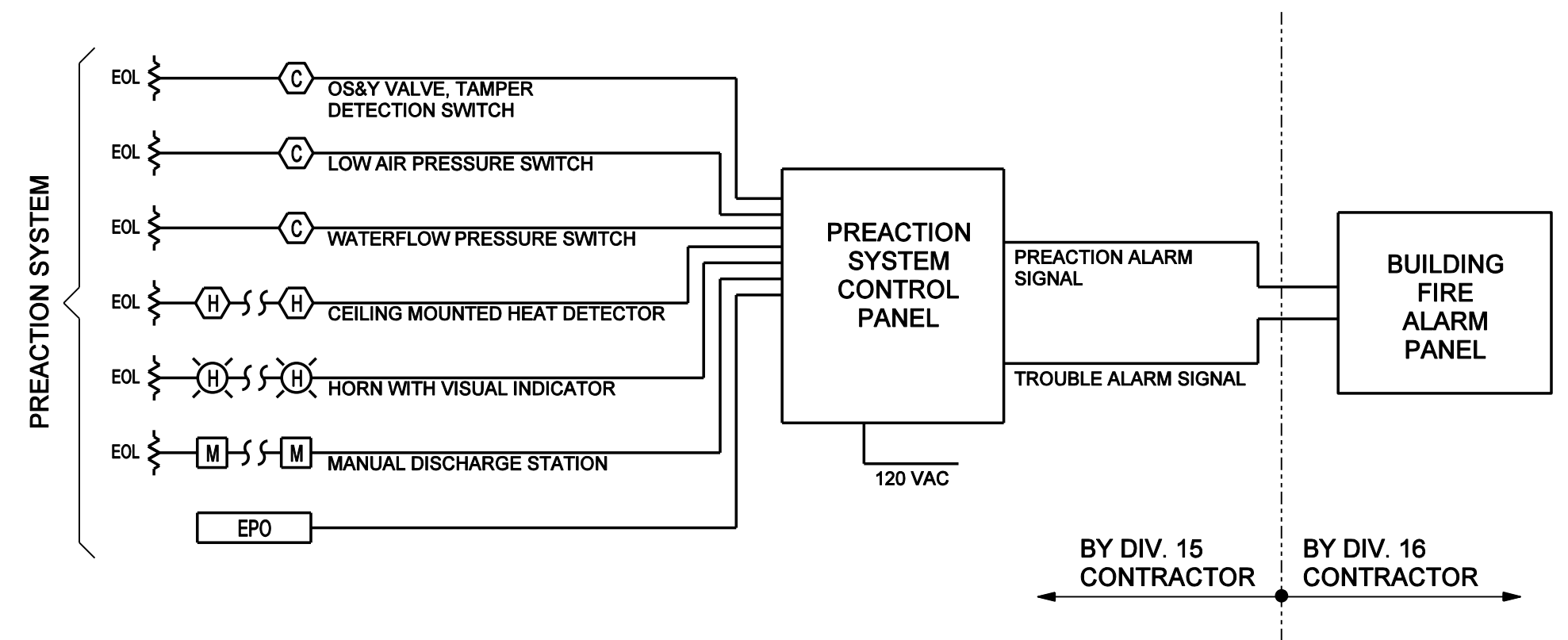
3 RETURN BEND ARRANGEMENT-PENDENT SPRINKLER
N.T.S.

GENERAL NOTES:

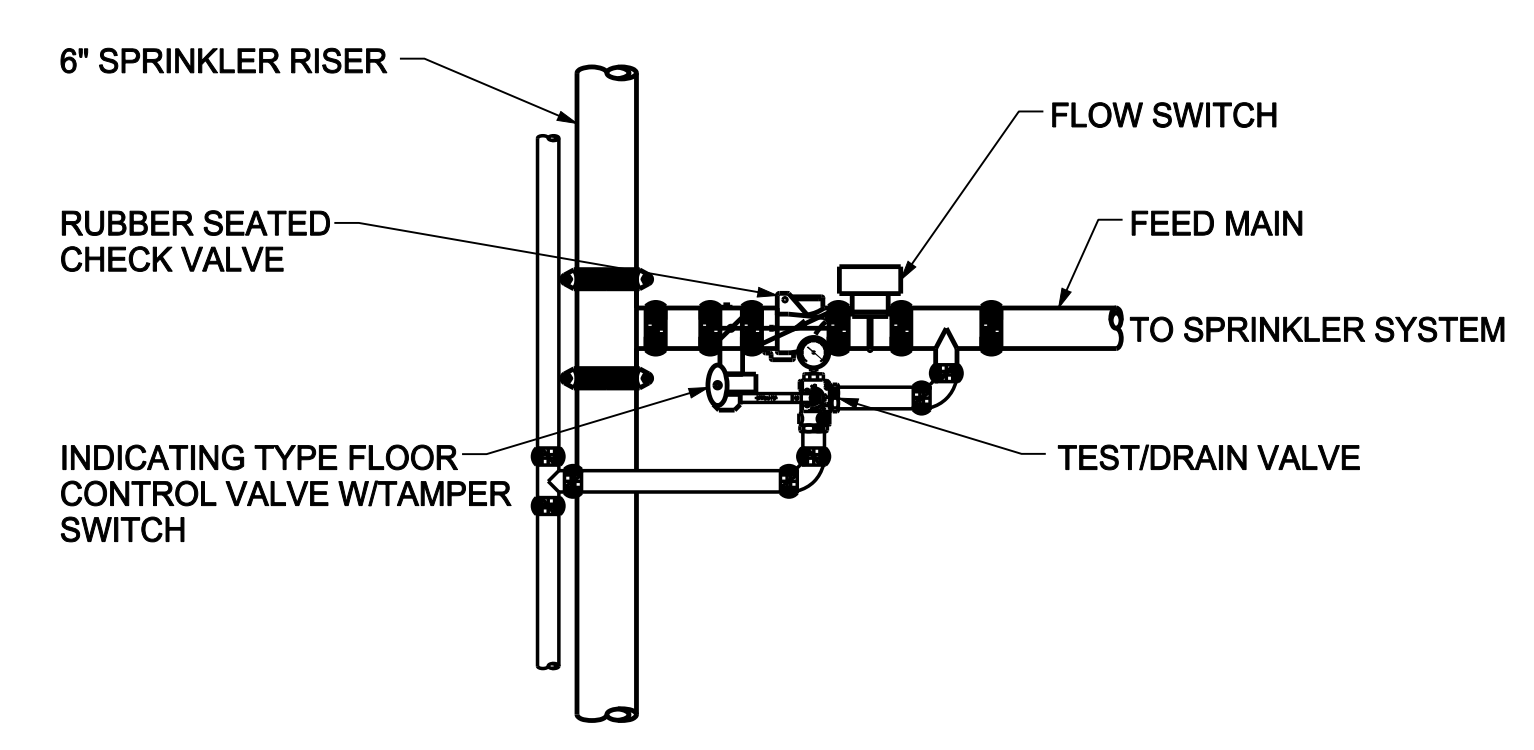
- ALL WORK TO BE PERFORMED, DESIGNED AND INSTALLED IN ACCORDANCE WITH ALL REFERENCED CODES, STANDARDS AND REGULATIONS.
- COORDINATE THE INSTALLATION OF PIPING AND EQUIPMENT WITH ALL TRADES AND DRAWINGS PRIOR TO COMMENCING INSTALLATION; NO ADDITIONAL COST TO THE OWNER WILL BE ALLOWED IF ATTRIBUTED TO A FAILURE TO COORDINATE.
- ALL DROPS TO MORE THEN ONE SPRINKLER HEAD AND ALL CHANGES IN PIPING ELEVATIONS THAT CREATE TRAPPED PIPING SECTIONS SHALL BE PROVIDED WITH AUXILIARY DRAINS PER NFPA 13.
- THE CONTRACTOR SHALL ACQUIRE OR PERFORM A NEW (LESS THAN 1 YR. OLD) HYDRANT FLOW TEST AT THIS SITE. IN ACCORDANCE WITH NFPA 13. THE RESULTS OF THIS TEST SHALL BE USED IN THE FINAL SPRINKLER SYSTEM HYDRAULIC CALCULATIONS.
- CONTRACTOR SHALL PROVIDE AN INSPECTORS TEST CONNECTION AT THE HYDRAULICALLY MOST REMOTE PORTION OF EACH SPRINKLER SYSTEM. TEST CONNECTIONS SHALL BE LOCATED BETWEEN 6 AND 7 FT. AFF AND SHALL BE PIPED TO THE OUTSIDE OF THE BUILDING TO AN AREA WHERE THE VALVES MAY BE OPENED FOR A SUFFICIENT TIME TO ASSURE A PROPER TEST WITHOUT CAUSING WATER DAMAGE.
- CONTRACTOR SHALL PROVIDE CONCRETE SPLASH BLOCKS AT THE DISCHARGE POINTS OF THE TEST CONNECTIONS, MAIN DRAINS, AUXILIARY DRAINS, AND BALL DRIP SUCH THAT THE PROBABILITY OF WATER DAMAGE IS MINIMIZED.
- ALL PENETRATIONS THROUGH DESIGNATED FIRE RATED WALLS, CEILINGS, AND FLOOR SLABS SHALL BE PROPERLY SEALED WITH AN APPROVED AND LISTED FIRE STOPPING MATERIAL. ALL PENETRATIONS IN DESIGNATED SMOKE-TIGHT WALLS, CEILINGS AND FLOOR SLABS SHALL BE PROPERLY SEALED TO RESIST THE PASSAGE OF SMOKE. SEE SPEC SECTION 07270.
- SPRINKLERS SHALL BE INSTALLED UNDER DUCTS, DECKS, GRATINGS, PIPING AND OTHER OBSTRUCTIONS OVER 4 FT. WIDE IN ACCORDANCE WITH NFPA 13.
- WHERE OBSTRUCTIONS TO SPRINKLER DISCHARGE EXIST, SPRINKLERS SHALL BE LOCATED WITH RESPECT TO THESE OBSTRUCTIONS IN ACCORDANCE WITH NFPA 13.



4 SCHEMATIC - PREACTION VALVE ASSEMBLY
N.T.S.



5 PREACTION CONTROL PANEL DIAGRAM
N.T.S.

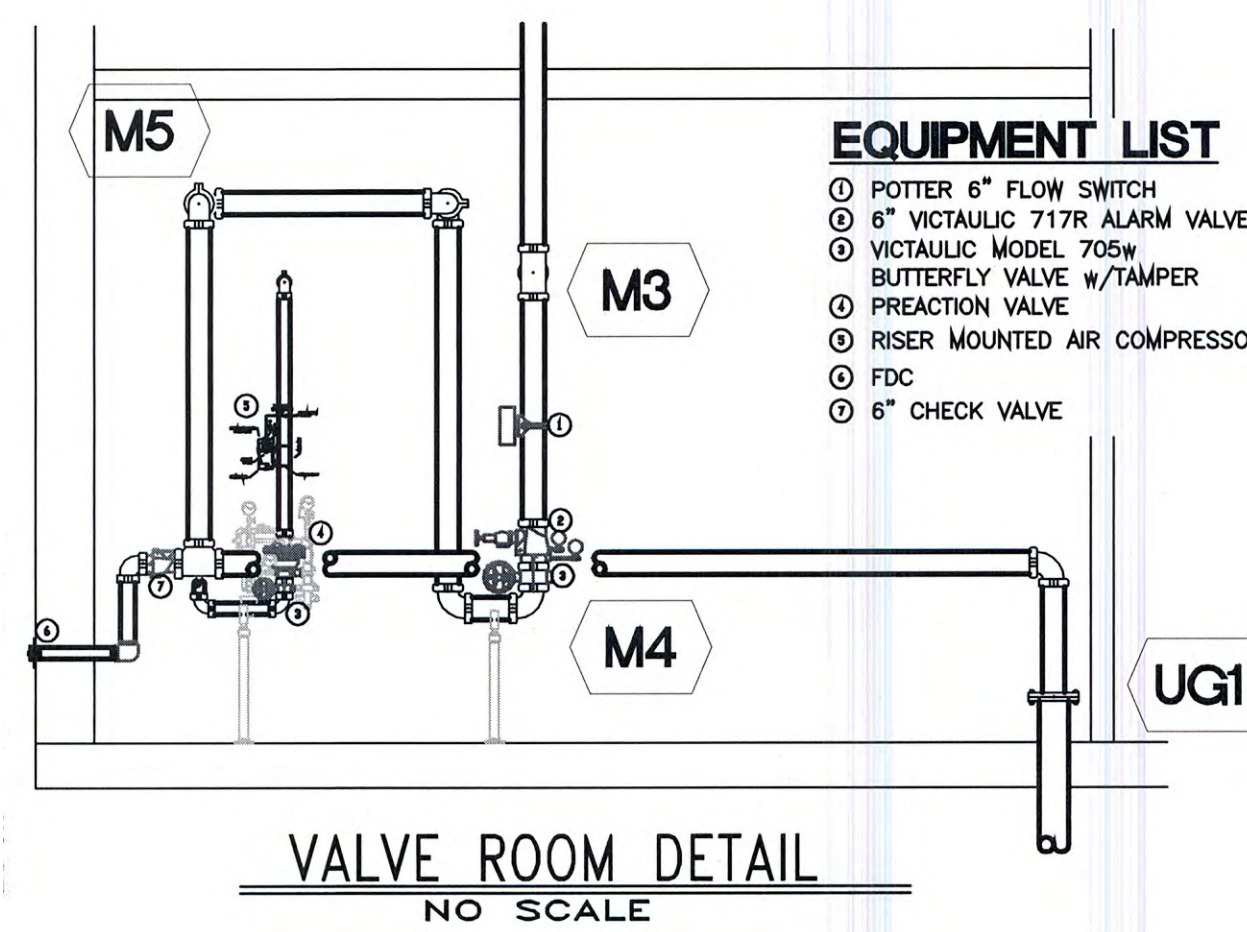
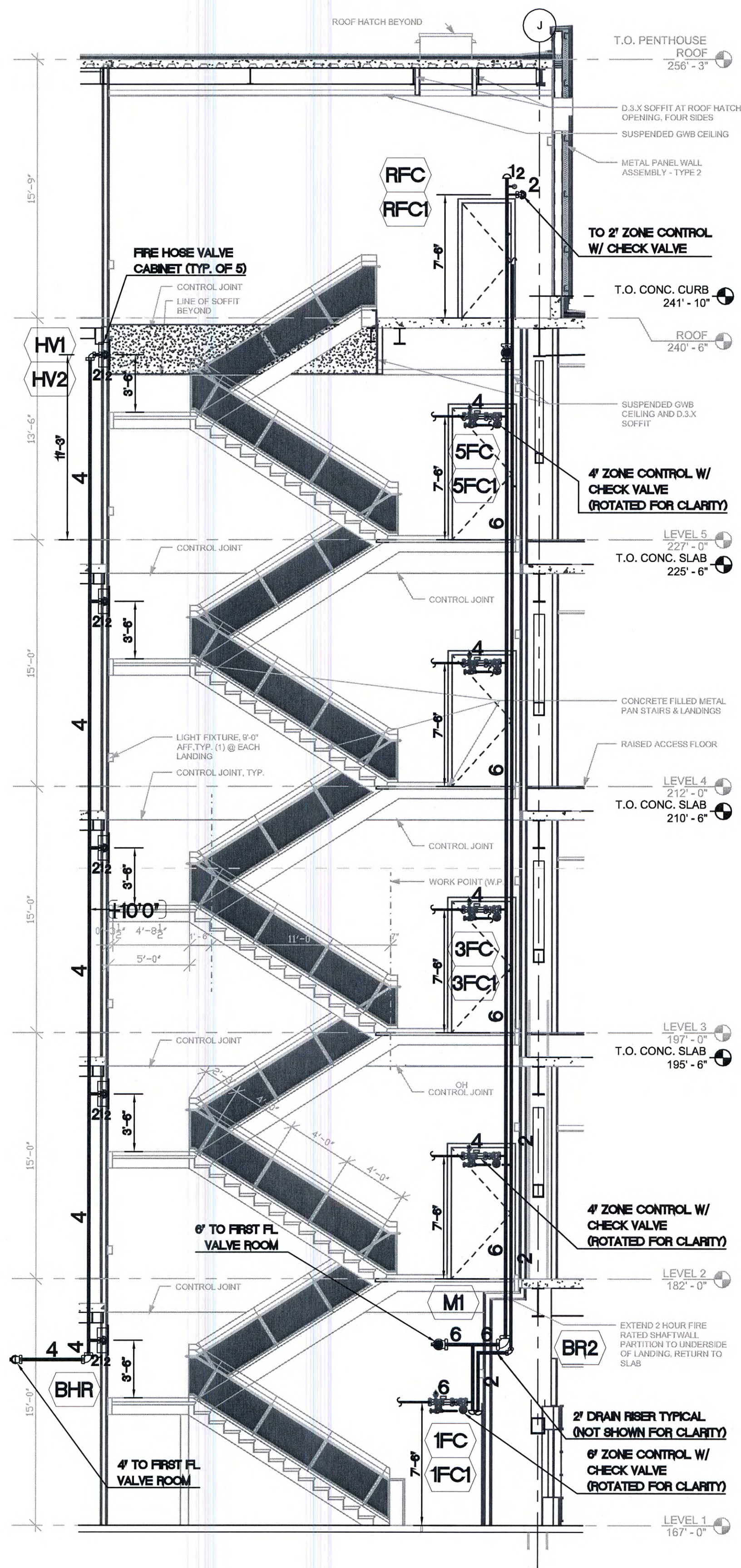


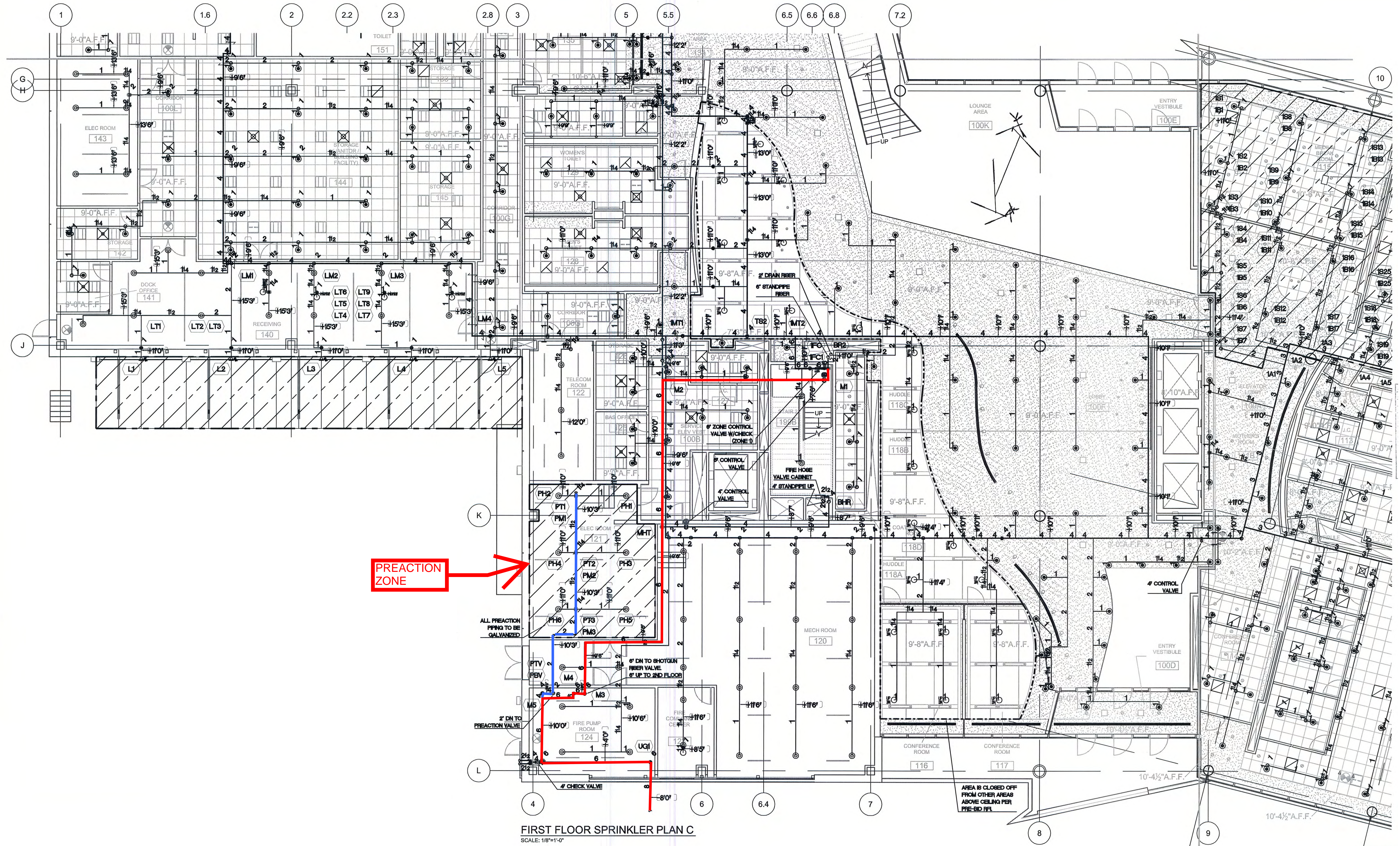
7 SPRINKLER SYSTEM FLOOR CONTROL VALVE AND DRAIN RISER ASSEMBLY
N.T.S.

A
B
C
D
E
F
G
H
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J
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L
M
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X

APPENDIX N

Contractor Sprinkler Plans





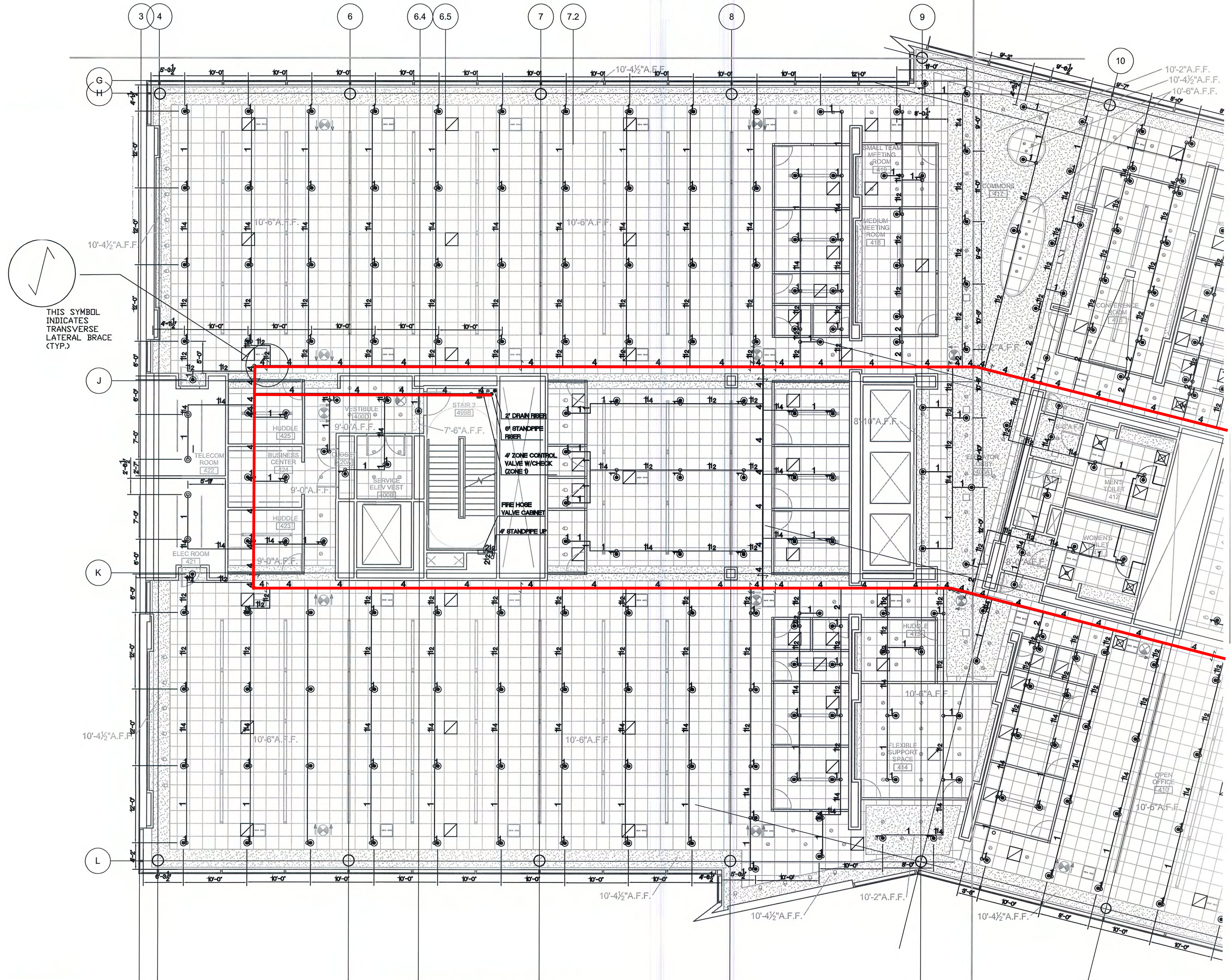
PREACTION ZONE

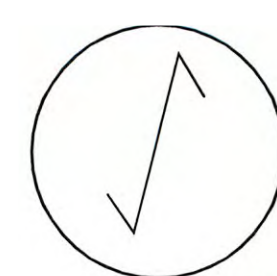
ALL PREACTION PIPING TO BE GALVANIZED

2" DN TO PREACTION VALVE

FIRST FLOOR SPRINKLER PLAN C
SCALE: 1/8"=1'-0"

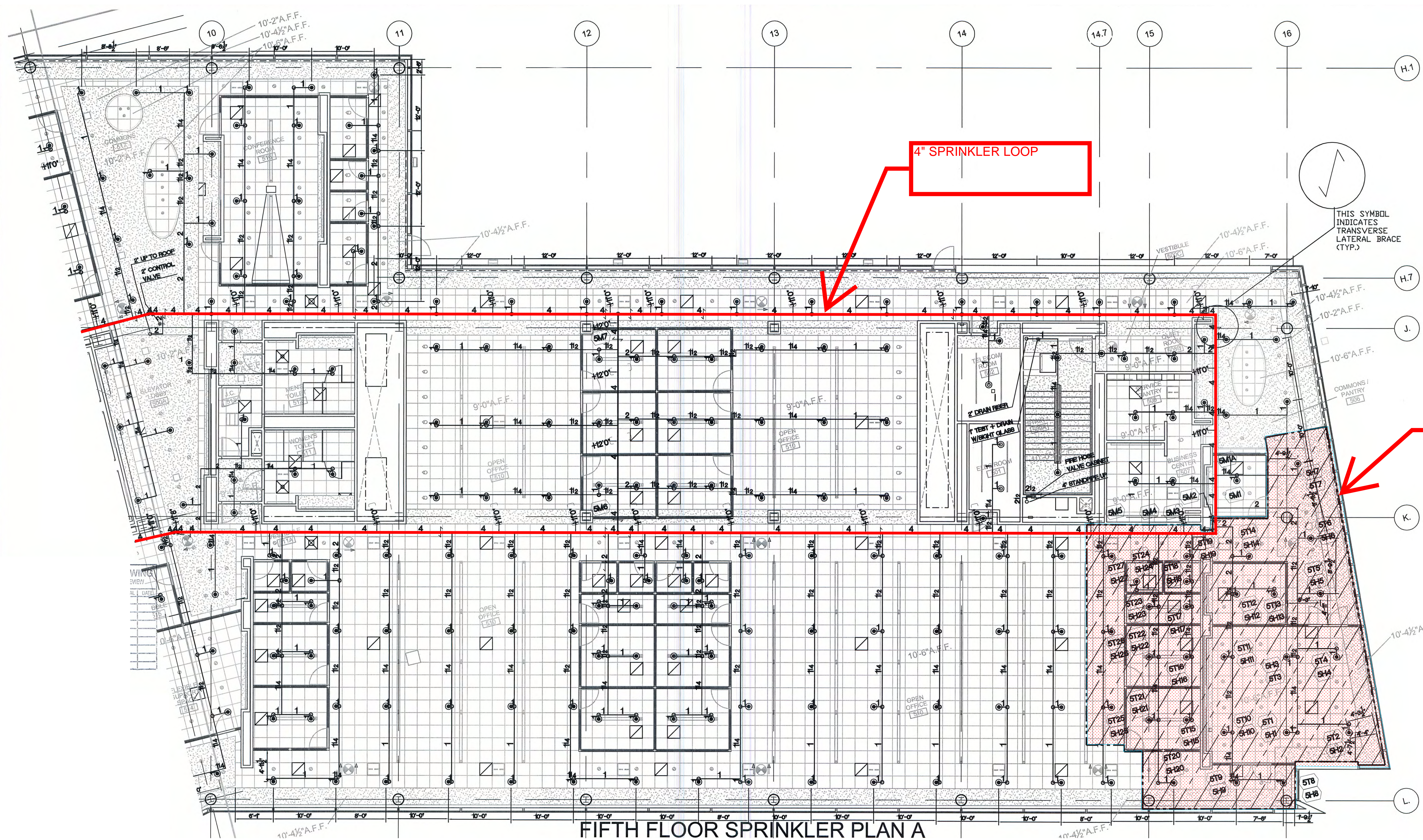
AREA IS CLOSED OFF FROM OTHER AREAS ABOVE CEILING PER PRE-BID RFI



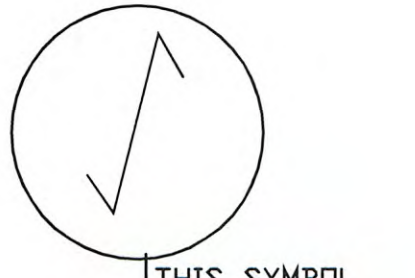


 THIS SYMBOL INDICATES TRANSVERSE LATERAL BRACE (TYP.)

FOURTH FLOOR SPRINKLER PLAN B
 SCALE: 1/8"=1'-0"



4" SPRINKLER LOOP



THIS SYMBOL INDICATES TRANSVERSE LATERAL BRACE (TYP.)

5TH FLOOR MOST HYDRAULICALLY DEMANDING AREA

FIFTH FLOOR SPRINKLER PLAN A

APPENDIX O

Pathfinder Summary Sheet

Final Project_summary

SUMMARYSUMMARY***SUMMARY***SUMMARY***SUMMARY***

Simulation: Final Project
 Version: 2014.2.0818
 Mode: Steering
 Total Occupants: 1523
 Exit Times (s):
 Min: 26.8
 Max: 698.4
 Average: 312.6
 StdDev: 181.9

[Components] All: 88
 [Components] Doors: 51
 Triangles: 18160
 Startup Time: 0.3s
 CPU Time: 347.6s

ROOM/DOOR	FIRST IN (s)	LAST OUT (s)	TOTAL USE (pers)	FLOW AVG. (pers/s)
Floor 0.0 ft->Room00	0.0	0.0	0	
Floor 0.0 ft->Room01	0.0	0.0	0	
Floor 0.0 ft->Room02	0.0	0.0	0	
Floor 0.0 ft->Room03	0.0	0.0	0	
Floor 0.0 ft->Room031	0.0	0.0	0	
Floor 0.0 ft->Room04	0.0	0.0	0	
Floor 0.0 ft->Door00	26.8	698.4	804	1.20
Floor 0.0 ft->Door01	27.2	536.1	502	0.99
Floor 0.0 ft->Door02	42.9	532.4	172	0.35
Floor 0.0 ft->Door03	52.8	117.8	44	0.68
Floor 0.0 ft->Door04	0.0	0.0	0	
Floor 0.0 ft->Door05	0.0	0.0	0	
Floor 0.0 ft->Door06	0.0	0.0	0	
Floor 0.0 ft->Door07	0.0	0.0	0	
Floor 0.0 ft->Door08	0.0	0.0	0	
Floor 0.0 ft->Door09	0.0	0.0	0	
Floor 0.0 ft->Door10	0.0	0.0	0	
Floor 0.0 ft->Door11	0.0	0.0	0	
Floor 0.0 ft->Door12	0.0	0.0	0	
Floor 0.0 ft->Door13	0.0	0.0	0	
Floor 0.0 ft->Door14	73.9	73.9	1	
Floor 0.0 ft->Door15	0.0	0.0	0	
Floor 0.0 ft->Door16	0.0	0.0	0	
Floor 0.0 ft->Room07	12.8	698.4	1523	
Floor 0.0 ft->Room12	8.3	659.6	804	
Floor 0.0 ft->Room13	5.5	503.1	605	
Floor 0.0 ft->Stair01	7.9	510.7	605	
Stair01 door 1	12.8	510.7	605	1.22
Stair01 door 2	7.9	503.1	605	1.22
Floor 0.0 ft->Stair02	11.3	664.6	804	
Stair02 door 1	15.5	664.6	804	1.24
Stair02 door 2	11.3	659.6	804	1.24
Floor 0.0 ft->Stair03	1.3	91.2	114	
Stair03 door 1	1.3	77.4	114	1.50
Stair03 door 2	15.1	91.2	114	1.50
Floor 0.0 ft->Stair04	1.1	496.4	605	
Stair04 door 1	1.1	490.1	605	1.24
Stair04 door 2	5.5	496.4	605	1.23
Floor 0.0 ft->Stair05	3.8	651.6	804	
Stair05 door 1	3.8	644.8	804	1.25
Stair05 door 2	8.3	651.6	804	1.25
Floor 15.0 ft->Room11	0.0	644.8	1523	
Floor 15.0 ft->Room16	0.0	631.5	626	
Floor 15.0 ft->Room17	0.0	473.7	505	
Floor 15.0 ft->Stair06	0.0	480.2	509	
Stair06 door 1	1.1	480.2	509	1.06
Stair06 door 2	1.7	473.7	505	1.07
Floor 15.0 ft->Stair07	0.0	469.0	504	
Stair07 door 1	2.8	464.5	498	1.08
Stair07 door 2	0.8	469.0	504	1.08
Floor 15.0 ft->Stair08	0.0	637.5	632	
Stair08 door 1	0.7	637.5	632	0.99
Stair08 door 2	1.8	631.5	626	0.99
Floor 15.0 ft->Stair09	0.0	626.4	625	
Stair09 door 1	2.3	617.2	619	1.01
Stair09 door 2	1.1	626.4	625	1.00
Floor 30.0 ft->Room15	0.0	617.2	1117	

Final Project_summary

Floor 30.0 ft->Room22	0.0	0.0	0	
Floor 30.0 ft->Room23	0.0	605.3	402	
Floor 30.0 ft->Room24	0.0	455.8	340	
Floor 30.0 ft->Stair10	0.0	460.6	347	
Stair10 door 1	1.1	460.6	347	0.76
Stair10 door 2	1.8	455.8	340	0.75
Floor 30.0 ft->Stair11	0.0	610.1	408	
Stair11 door 1	0.7	610.1	408	0.67
Stair11 door 2	1.8	605.3	402	0.67
Floor 30.0 ft->Stair12	0.0	601.3	401	
Stair12 door 1	2.5	593.1	395	0.67
Stair12 door 2	0.7	601.3	401	0.67
Floor 30.0 ft->Stair13	0.0	451.1	339	
Stair13 door 1	2.8	446.5	333	0.75
Stair13 door 2	0.3	451.1	339	0.75
Floor 45.0 ft->Room18	0.0	593.1	728	
Floor 45.0 ft->Room26	0.0	434.3	138	
Floor 45.0 ft->Room27	0.0	561.6	214	
Floor 45.0 ft->Stair14	0.0	438.8	143	
Stair14 door 1	1.1	438.8	143	0.33
Stair14 door 2	1.9	434.3	138	0.32
Floor 45.0 ft->Stair16	0.0	577.4	220	
Stair16 door 1	1.1	577.4	220	0.38
Stair16 door 2	1.8	561.6	214	0.38
Floor 45.0 ft->Stair18	0.0	427.6	137	
Stair18 door 1	3.5	415.8	131	0.32
Stair18 door 2	0.3	427.6	137	0.32
Floor 45.0 ft->Stair19	0.0	547.3	213	
Stair19 door 1	5.9	535.0	208	0.39
Stair19 door 2	1.1	547.3	213	0.39
Floor 60.0 ft->Room28	0.0	535.0	339	

APPENDIX P

FDS Design Fire A

Fire.A.fds
Generated by PyroSim - Version 2015.2.0604
Apr 20, 2016 10:09:00 AM

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MONODISPERSE=.TRUE.,
AGE=60.0,
SAMPLING_FACTOR=1/

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FUEL='REAC_FUEL',
FORMULA='C3H6',
CO_YIELD=0.024,
SOOT_YIELD=0.059/

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PARTICLE_VELOCITY=5.0,
SPRAY_ANGLE=60.0,75.0/

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QUANTITY='CHAMBER OBSCURATION',
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BETA_E=-1.0,
ALPHA_C=1.0,
BETA_C=-0.8/

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&OBST XB=65.4007,66.4007,-38.0388,-37.4182,0,0,1.0, SURF_ID='INERT'/ Obstruction
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&TAIL /

APPENDIX Q

FDS Design Fire B

Fire.B3.fds

Generated by PyroSim - Version 2015.2.0604

Apr 20, 2016 10:15:12 AM

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SAMPLING_FACTOR=1/

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FUEL='REAC_FUEL',
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H=1.7,
O=0.3,
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CO_YIELD=0.042,
SOOT_YIELD=0.198/

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&TAIL /

APPENDIX R

FDS Design Fire C

Fire.C.2.fds
Generated by PyroSim - Version 2015.2.0604
Apr 20, 2016 10:16:20 AM

&HEAD CHID='Fire_C_2/'
&TIME T_END=2000.0/
&DUMP RENDER_FILE='Fire_C_2.ge1', DT_RESTART=300.0/

&MESH ID='MESH', IJK=75,105,11, XB=-47.6353,-28.8853,-9.69992,16.5501,0.0,2.75/
&MESH ID='MESH01', IJK=24,7,11, XB=-28.8853,-22.8853,-2.44992,-0.699925,0.0,2.75/

&SPEC ID='WATER VAPOR'/

&PART ID='Water',
SPEC_ID='WATER VAPOR',
DIAMETER=500.0,
MONODISPERSE=.TRUE.,
AGE=60.0,
SAMPLING_FACTOR=1/

&REAC ID='PET',
FUEL='REAC_FUEL',
FORMULA='C10H8O4',
CO_YIELD=0.05,
SOOT_YIELD=0.053/

&PROP ID='Default_Water Spray',
QUANTITY='SPRINKLER LINK TEMPERATURE',
ACTIVATION_TEMPERATURE=74.0,
PART_ID='Water',
FLOW_RATE=26.0,
PARTICLE_VELOCITY=5.0,
SPRAY_ANGLE=60.0,75.0/

&PROP ID='Water Spray',
PART_ID='Water',
FLOW_RATE=26.0,
PARTICLE_VELOCITY=5.0,
SPRAY_ANGLE=60.0,75.0/

&DEVIC ID='SPRK', PROP_ID='Default_Water Spray', XYZ=-36.3853,-0.949925,2.7/
&DEVIC ID='SPRK01', PROP_ID='Water Spray', XYZ=-32.8853,-0.949925,2.7, QUANTITY='TEMPERATURE', SETPOINT=68.0/
&DEVIC ID='SPRK02', PROP_ID='Water Spray', XYZ=-30.1353,-0.949925,2.7, QUANTITY='TEMPERATURE', SETPOINT=68.0/
&DEVIC ID='SPRK03', PROP_ID='Water Spray', XYZ=-32.8853,3.30008,2.75, QUANTITY='TEMPERATURE', SETPOINT=68.0/
&DEVIC ID='SPRK04', PROP_ID='Water Spray', XYZ=-30.1353,3.30008,2.75, QUANTITY='TEMPERATURE', SETPOINT=68.0/
&SURF ID='Burner',
COLOR='RED',
HRRPUA=1164.0,
RAMP_Q='Burner_RAMP_Q'/
&RAMP ID='Burner_RAMP_Q', T=60.0, F=0.04/
&RAMP ID='Burner_RAMP_Q', T=120.0, F=0.09/
&RAMP ID='Burner_RAMP_Q', T=180.0, F=0.43/
&RAMP ID='Burner_RAMP_Q', T=200.0, F=1.0/
&RAMP ID='Burner_RAMP_Q', T=1440.0, F=1.0/

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&OBST XB=-47.6353,-43.1353,-9.69992,-9.69992,0.0,2.75, COLOR='YELLOW', SURF_ID='INERT'/ AcDbPolyFaceMesh - 9EA8
&OBST XB=-28.8853,-28.8853,-7.44992,-7.19992,0.0,2.75, COLOR='YELLOW', SURF_ID='INERT'/ AcDbPolyFaceMesh - 1C39D
&OBST XB=-34.6353,-34.6353,3.05008,5.30008,0.0,2.75, COLOR='YELLOW', SURF_ID='INERT'/ AcDbPolyFaceMesh - 1C3D5
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&OBST XB=-43.3853,-43.1353,-1.94992,-1.94992,0.0,2.25, COLOR='YELLOW', SURF_ID='INERT'/ AcDbPolyFaceMesh - 1C4F5
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&OBST XB=-36.6353,-29.1353,-2.44992,-2.44992,0.0,2.75, SURF_ID='INERT'/ Obstruction

&VENT SURF_ID='OPEN', XB=-28.8853,-28.8853,-0.699925,16.5501,0.0,2.75/ Mesh Vent: MESH [XMAX]
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&VENT SURF_ID='OPEN', XB=-47.6353,-28.8853,16.5501,16.5501,0.0,2.75/ Mesh Vent: MESH [YMAX]
&VENT SURF_ID='Burner', XB=-34.3853,-33.3853,-1.44992,-0.449925,0.1624,0.1624/ Vent

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&SLCF QUANTITY='VOLUME FRACTION', SPEC_ID='CARBON MONOXIDE', PBZ=1.8/
&SLCF QUANTITY='VISIBILITY', PBZ=1.8/
&SLCF QUANTITY='VISIBILITY', PBX=-31.2/
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&TAIL /