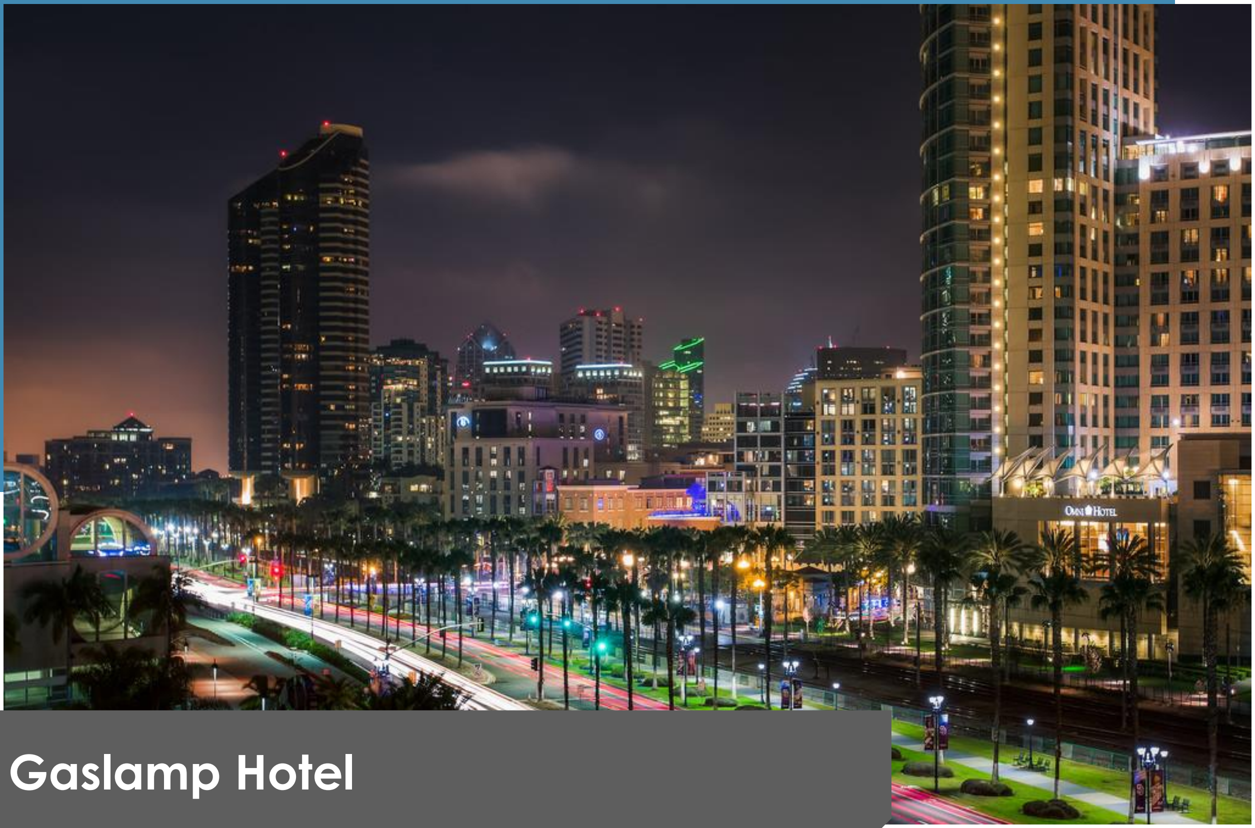
# Fire Protection/Life Safety Analysis



## Gaslamp Hotel

100 Center Way
San Diego, California

**FPE 596 Culminating Project**
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## Statement of Disclaimer

## Keywords

Hotel, Life Safety Analysis, Performance-based Analysis, FDS

# EXECUTIVE SUMMARY

The Gaslamp Hotel was analyzed for fire protection/life safety using two different methodologies; a prescriptive approach and a performance- based approach. Both considered the same features of the building.

The prescriptive analysis studied the variation of the building's fire protection/life safety components from those required by the applicable codes and standards. This analysis included building construction, fire resistance, fire suppression, fire detection, smoke control system, and egress systems.

The results of the analysis indicate that the building complies with the requirements of the applicable codes and standards, with three exceptions relating to occupant egress:

- The first-floor bar area: One exit is provided, however two are required. An additional exit through the restaurant is recommended.
- The 8th floor East and West Terrace areas: Only one exit from each space is provided, two are required. The use of horizontal exits along the east and west exterior walls are recommended. In addition, the east terrace requires the addition of a corridor and new exit door at the north end. The west horizontal exit can also be used to disperse pre-function occupants to the west.
- Eighth Floor Corridor 885: This is a dead end, which exceeds 20 feet in length. A door should be installed at the beginning of the corridor.

The performance-based approach included the evaluation of building occupant safety given two reasonable worst-case scenarios and two evacuation conditions.

The results of the time-based egress analysis indicate that occupants, both remote from and intimate with the fire origin, could safely egress the building prior to tenability conditions degrading to life threatening conditions. Despite the successful outcome of the analysis, a recommendation was made to add additional low-level exit signs with the intent of improving the inclination of occupants to egress through the corridors in low visibility conditions.

The structural analysis simulated the total burn out of the room of fire origin, which produced high temperatures for an extended period of time, 24 minutes. Two reasonable worst-case scenarios were considered.

The results of the first scenario indicate the increase in temperature of the reinforcing bars within the concrete floor slab did not cause a significant reduction in steel yield strength and that even at elevated temperatures the reinforced concrete floor slab could adequately support the applied load.

The results of the second scenario indicate that the reinforced concrete floor slab can still support the applied load, but only by a small margin. A recommendation is made to complete a higher order analysis to clarify the situation.

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# 1 INTRODUCTION

The Gaslamp Hotel, originally named the Water Front Tower, was constructed in the mid-late 1980s. Located in the Gaslamp District of the City of San Diego, the establishment is a favorite for business travelers.

The building recently underwent a major remodel, which included the change of franchise operator. Due to the extent of the work, the City of San Diego and the new hotel franchise required the building to be upgraded to the requirements of the 2016 edition of the California Building and Fire Codes.

The building is constructed of Type IA construction. This fully sprinklered building is 20 stories tall (no 13th floor), with a roof height of 180 feet (highest occupied floor 171 feet above grade), and thus considered a high-rise building. Total floor area is approximately 535,300 square feet.

Occupancy of the first floor includes entry, front desk, restaurant, kitchen, business center, and other hotel services. Floors 2-7 are utilized for automobile parking. In addition, a portion of the 7th floor is used for mechanical, laundry, and maintenance office space.

The 8th floor contains primarily assembly space consisting of small meeting rooms, the ballroom and space for necessary support functions (kitchen, mechanical, etc.). Floors 9-21 are guest room floors. The roof is unoccupied.

Representative photographs are shown in Figures 1-7. Floor plans can be found in Appendix A.

A fire protection/life safety analysis was performed for the Gaslamp Hotel. Two approaches were used, a prescriptive and a performance-based approach.

The prescriptive analysis investigates the building's compliance with the prescriptive requirements of the current edition of the applicable codes. However, the fire sprinkler, the secondary water supply, and the stairway pressurization systems were evaluated based upon the code adopted at the time of their original installation.

The performance-based approach evaluates the building's performance in two specially selected fire scenarios. Scientifically based performance objectives were developed upon which the building's performance was measured.

For liability reasons, the ownership of the building requested various details be modified such that any collusions drawn from this analysis would not be applicable to the actual building. This requested was honored.

Figure 1A: Building Aerial View

Figure 2: Building View from the South

Figure 3: First Floor Restaurant Area

Figure 4: Lobby Entrance

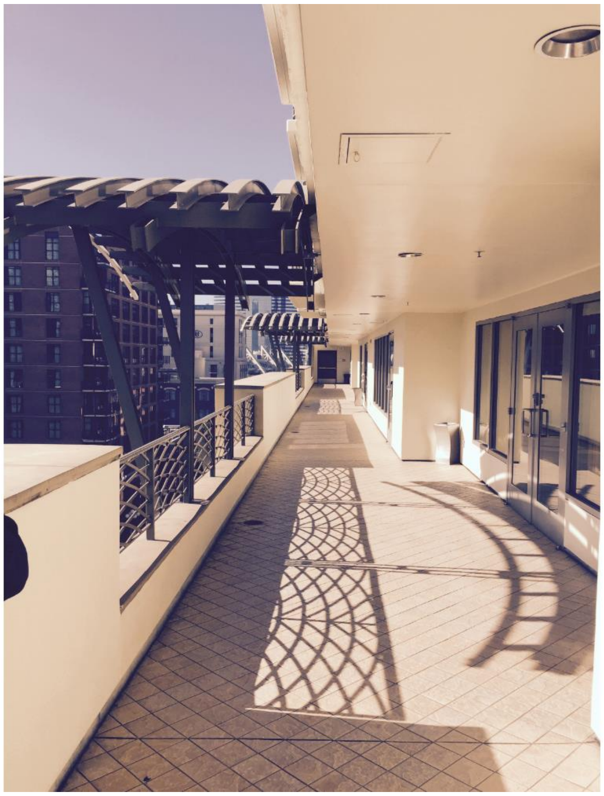

Figure 5: 8th Floor Gaslamp Terrace Area

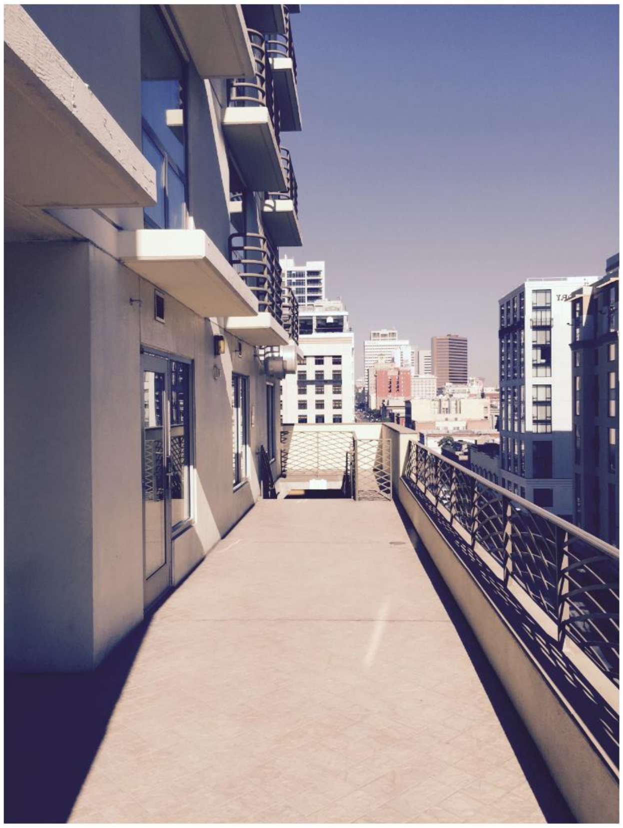

Figure 6: 8th Floor Employee Terrace Area

Figure 7: 8th Floor Typical Ballroom/Meeting Room

Figure 8: Typical Guestroom

# 2 APPLICABLE CODES AND STANDARDS

The following codes, standards, and other resources were used in the preparation of this report:

- California Building Code (CBC), 2016 Edition.
- California Fire Code (CFC), 2016 Edition.
- Uniform Building Code (UBC), 1979-1985 Editions.
- National Fire Protection Association (NFPA) 13, "Installation of Sprinkler Systems," 2016 Edition.
- National Fire Protection Association (NFPA) 13, "Installation of Sprinkler Systems," 1980 Edition.
- National Fire Protection Association (NFPA) 92, "Standard for Smoke Control Systems," 2012 Edition.
- National Fire Protection Association (NFPA) 72, "National Fire Alarm and Signaling Code," 2016 Edition.
- National Fire Protection Association (NFPA) 25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems," 2013 California Edition.
- National Fire Protection Association (NFPA) 101, "Life Safety Code," 2015 Edition.
- National Fire Protection Association Hand Book (NFPA HB), "Fire Protection Handbook," 20th Edition.
- Society of Fire Protection Engineers Handbook of Fire Protection Engineering (SFPE HB), 4th and 5th Editions.
- Numerous Papers and Literature as Referenced. See Reference section, Section 7.

# 3 PRESCRIPTIVE ANALYSIS

The following subsections summarize the fire protection/life safety features of the Gaslamp Hotel.

## 3.1 Passive Construction Elements

The Gaslamp Hotel is an example of Brutalism architecture, which was popular in the United States during the 1980's. Despite its apparently appropriate name, Brutalism is derived from the French term, beton brut, which translates to "rough concrete."[1] It is essentially based on shaped and molded forms of concrete, a thick, masonry variation of modernist architecture. Although unpopular today, this type of construction has excellent fire-resistant characteristics.

The required fire resistance ratings of key non-structural life safety elements are shown in Table 1. As previously noted, the building construction is Type IA. Construction material is poured in place reinforced concrete.

**Table 1: Construction Resistance Requirements**

| Element | Fire Resistance Rating | Reference (CBC) | Notes |
|---|---|---|---|
| Stair Enclosures (Connecting three floors or more) | 2-hour | CBC 713.4 | 4 |
| Exit Corridors (R-1 only) | 1-hour | Table 1020.1 | 2 |
| Elevator Shafts | 2-hour | CBC 713.4 | 2 |
| Other Shafts (Connecting three floors or more) | 1-hour | CBC 403.2.1.2 | Sprinklers at top and at alternate floor levels |

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[1] Paradis, Thomas, American Styles of Architecture, https://architecturestyles.org/

### 3.1.1 Fire Resistance Analysis

The fire resistance requirements for this Type IA building were evaluated using the 2016 edition of the CBC. Table 2 provides a summary of these requirements as well as the materials of construction. Based upon drawing review, and minimal site observation, the building complies with these CBC requirements.

Table 2: Fire Resistance Requirements

| Element | Required Fire Resistance Rating | Reference (CBC) | Construction Materials |
|---|---|---|---|
| Columns (Primary structural frame) | 3-hour | Table 601 | Poured in place, reinforced concrete, 12-36 inches thick (12 inches required Table 721.1 Min cover over reinforcing steel in accordance with Table 722.2.3. |
| Beams (Primary structural frame) | 3-hour | Table 601 | Poured in place, reinforced concrete, 12-30 inches thick (10 inches minimum required CRST ETN-B-1-16). Min cover over reinforcing steel in accordance with Table 722.2.3. |
| Floor, Ceiling Assemblies | 2-hour | Table 601 | Poured in place, reinforced concrete, 9-inches thick (5 inches required Table 7.21.1(3)). Min cover over reinforcing steel in accordance with Table 722.2.3. |
| Roof Assembly | 1½-hour | Table 601 | Same |
| Exterior Walls | Non-rated on south, east, and west sides of the building due to > 30 ft. yards. 3-hour on north side of the building | Table 602 | Poured in place, reinforced concrete, 8-inches thick (6.2 inches required Table 722.2.31). Min. cover over reinforcing steel in accordance with Table 722.2.3. |
| Exterior Wall Opening Protection | Non-rated on south, east, and west sides of the building. North side requires 1½-hour. |  | No openings provided in 3-hour north wall. |
| Interior Bearing Walls | 3-hour fire barrier,<br>Openings 3-hour | Table 601 | Poured in place, reinforced concrete, 12-30 inches thick (6.2 inches required Table 722.1.1(3)). Min. cover over reinforcing steel in accordance with Table 722.2.3. |
| Interior Non-bearing Walls and Partitions | Non-rated (unless required by other parts of the CBC) | Table 601 | Two-layers of 3/8 in. Type X gypsum board, UL assembly No. U-465. |
| Fire Resistant Assembly Joints (The building does not have a curtain wall system) | Tested in accordance with ASTM E1966 or UL 2079. Exterior wall joint rating is required only for north side of the building, as other sides are non-rated. | 715 | No documentation found. Destructive testing with replacement of joints required. |
| Fire Resistant Assembly Penetrations | Approved penetration fire stop system tested in accordance with ASTM E814 or UL 1479. | 714 | No documentation found. Replacement of fire stop systems required. |
| Stair Enclosures (Connecting three floors or more) | 2-hour fire barrier,<br>Openings 1½-hour. | 713.4 | Poured in place, reinforced concrete, 8-inches thick (5 inches required Table 721.1(3)). Min cover over reinforcing steel in accordance with Table 722.2.3. |
| Exit Corridors (R-1 Occupancy only, others non-rated) | 1-hour fire barrier, 20-minute door or opening protection. | Table 716.5,<br>Table 1020.1 | Two- layers of 3/8 in. Type X gypsum board, UL assembly No. U-465. |
| Elevator Shafts | 2-hour fire barrier,<br>Openings 1½-hour | 713.4 | Poured in place, reinforced concrete, 8-inches thick (5 inches required Table 7.21.1(3)). Min cover over reinforcing steel in accordance with Table 722.2.3. |
| Other Shafts (Connecting three floors or more) | 1-hour | 403.2.1.2 | Poured in place, reinforced concrete, 8-inches thick (3.5 inches required Table 721.1(3)). Min cover over reinforcing steel in accordance with Table 722.2.3. |

### 3.1.2 Interior Finish

The building complies with the interior finish requirements of the CBC as shown in Table 3. These requirements are based upon the assumption that the building is fully sprinklered.

Table 3: Interior Finish Requirements

| Occupancy | Stairs, Exit Passageways | Corridors | Rooms |
|---|---|---|---|
| A-2, A-3 | B | B | C |
| B, M, R-1 | B | C | C |
| F | C | C | C |
| S | C | C | C |

## 3.2 Smoke Control System

The building is provided with stairway and elevator hoistway pressurization. The design approach of both systems is to maintain a pressure differential of 0.05 inches of water column from inside of the shaft to surrounding areas. This pressure difference is intended to prevent smoke migration into the stair and elevator shafts thereby compromising tenability in the stairs and allowing smoke migration into other portions of the building.

System fan sizes are shown in Table 4. Fans are located upon the top of each shaft, providing only one injection point for the supply air. The current CBC requires multiple injection points to prevent the opening of an adjacent door from marginalizing the pressure differential. The legacy codes do not. The fan sizes are consistent with the general guideline of 800 cfm per floor.[2]

Until 1994, the City allowed vestibules to be excluded if a heliport was provided at the top of the building.[3] The building complies with these requirements, a heliport is provided and vestibules are not.

The system is activated upon sprinkler system water flow or system smoke detection activation. Alarm signals are sent to the EVACS panel and then to the mechanical control system. An alarm signal is then sent to the central station.

In addition, passive smoke control features, including auto and self-closing doors close upon activation of the EVACS. Smoke and fire dampers are closed upon activation of duct or system smoke detectors. The Sequence of Operation is shown in Appendix F.

Overall, the system does not comply with current requirements, but was allowed to remain in current condition because it apparently compiles with the requirements of the original code of record. For this analysis, it is considered acceptable.

Table 4: Stairway and Elevator Hoistway Pressurization System Fan Information

| Zone | Fan Size (supply) |
|---|---|
| Stair 1 | 14,500 cfm |
| Stair 2 | 16,800 cfm |
| Elevator Shafts 1-5 | 12,000 cfm |

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[2] Palenske, Garner, Aon Fire Protection, Comparisons of High-rise Building Supply Fan Capacities, 2009.

[3] San Diego Municipal Code, Pre-1994.

## 3.3 Water Supply System / Fire Flow Requirements

The building is supplied by the San Diego City water system. This system can be described as well gridded, with a system of pumps and pressure reducing valves strategically placed to maintain adequate pressure. The water system is considered reliable. Water supply data furnished by the City of San Diego hydraulic model is as follows:

- Static Pressure: 85 psi
- Residual pressure: 76 psi
- Flow: 1,335 gpm

The effective point of the test is on 7th Street between J and K Streets, which is on the east side of the building where the building's 6-inch fire protection connection is located. Since this data was developed by a hydraulic model, adjustments for seasonally pressure or flow fluctuations (i.e. safety factor) have been included in the data. A 6-inch Zurn Wilkin backflow prevention device is provided at the connection to the public water supply.

CBC Appendix B, Sections B104 and B105 provide the requirements for the fire flow needed for manual firefighting. Section B105.3 allows the fire flow for buildings equipped with an automatic sprinkler system to be based upon either the fire sprinkler demand, including hose allowance, or the area of the largest three successive floors, whichever is greater. Using the latter criterion, the fire area is 80,295 square feet (535,300 square feet/ 20 floors x 3 floors), resulting in a flow of 3,000 gpm at 20 psi. The largest fire sprinkler flow demand is 490 gpm (0.16 gpm/sq.ft. x 1,500 sq.ft. + 250 gpm hose allowance). Therefore, a fire flow of 3,000 gpm at 20 psi is required. Section B105 also requires minimum flow durations. The public water supply provides a reliable source thus, flow durations are assumed to be adequate. It should be noted that the required fire flow is greater than the flow provided by the water model. Discussions with City officials indicates that the slope of the water flow curve should remain constant up to at least 4,000 gpm.

The available pressure at a given flow can be calculated from the water test data provided by the City. Calculations are as follows[4]:

$R_2 = -((S-R_1)(Q_2/Q_1)1.85 - S)$

Given:

$Q_1$ = Flow at Point 1 =1,335 gpm

$Q_2$ = Flow at Point 2 =3,000 gpm

S = Static Pressure= 85 psi

$R_1$ = Residual Pressure at Point 1 = 76 psi

$R_2$ = Residual Pressure at Point 2 = 45 psi

Or solving for $Q_2$ at 20psi

$Q_2 = Q_1(S-R_2)/S-R_1)^{0.54}$

Given:

$R_2$ = Residual Pressure at Point 2 = 20 psi

$Q_2$ = 3,883 gpm

At 3,000 gpm, a pressure of 45 psi is available. Calculations also show the flow at 20 psi is 3,883 gpm. These flows and pressures are effective in the City main in 7th Street on the east side of the building. As shown by the calculations, adequate fire flow is provided by the City water system.

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[4] NFPA Fire Protection Handbook, page 1-101, 19th Edition.

## 3.4 Fire Suppression System

### 3.4.1 Automatic Sprinkler System

The building is protected by an automatic sprinkler system throughout. Quick response, ½-inch orifice, K=5.6 spray sprinklers are installed throughout the building, except in the parking garage areas, which are standard response. Sprinklers include recessed, pendant, and sidewall types (guest rooms and corridors). Sprinklers in the garage areas are corrosion resistant type. All sprinklers, with the exception of the sprinklers in the parking garage, were replaced during the 2000 building renovation. Design criteria by area is shown in Table 5. Hose stream allowance and water supply duration are shown in Table 6.

**Table 5: Sprinkler Design Criteria**

(NFPA 13, Section A5.2-5.3.1)[5]

| Floor | Occupancy | Hazard Classification | Design Criteria |
|---|---|---|---|
| 1 | Lobby, Restaurants, Assembly | Light Hazard | 0.10 gpm /sq.ft. for most remote 1,500 sq.ft.<br>(225 sq.ft. max. per sprinkler) |
| | Back of House and Storage | Ordinary I | 0.16 gpm/sq.ft. for the most remote 1,500 sq.ft<br>(130 sq.ft. max. per sprinkler) |
| | Retail (Sundry Shop) | Ordinary II | 0.21 gpm/sq.ft. for the room area (200 sq.ft. in size).<br>(130 sq.ft. max. per sprinkler) |
| 2-6 | Automobile Parking | Ordinary I | 0.16 gpm/sq.ft. for most remote 1,500 sq.ft.<br>(130 sq.ft. max. per sprinkler) |
| 7 | Automobile Parking | Ordinary 1 | 0.16 gpm/sq.ft. for most remote 1,500 sq.ft.<br>(130 sq.ft. max. per sprinkler.) |
| | Offices | Light Hazard | 0.10 gpm/sq.ft. for most remote 1,500 sq.ft.<br>(225 sq.ft. max. per sprinkler) |
| 8 | Assembly | Light Hazard | 0.10 gpm/sq.ft. for most remote 1,500 sq.ft.<br>(225 sq.ft. max. per sprinkler) |
| 9-12, 14-21 | Guest Rooms | Light Hazard | 0.10 gpm/sq.ft. for largest room<br>(225 sq.ft. max. per sprinkler) |
| | Corridors | Light Hazard | 0.10 gpm/sq.ft. for most remote 1,500 sq.ft.<br>(225 sq.ft. max. per sprinkler) |
| | Common areas, public assembly | Light Hazard | 0.10 gpm/sq.ft. for most remote 1,500 sq.ft.<br>(225 sq.ft. max. per sprinkler) |

**Table 6: Sprinkler Hose Allowance and Duration Requirements**

(NFPA 13, Table 11.2.3.1.2)[6]

| Occupancy | Inside Hose | Combined Inside/Outside Hose | Duration |
|---|---|---|---|
| Light Hazard | 100 gpm | 100 gpm | 30 minutes |
| Ordinary Hazard | 100 gpm | 250 gpm | 60 minutes |

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[5] 1980 edition of NFPA 13, as indicative of the criteria used during the original building design.

[6] Supervised sprinkler system, NFPA 13, Section 11.2.3.1.3.

### 3.4.2 Fire Pump, Secondary Water Supply, and Standpipe Systems

A 6-inch bulk main travels from the City connection through the first floor to the pump room and fills a 7,500-gallon atmospheric steel water storage tank. The tank level is maintained by a 6-inch modulating float valve located on the top of the tank. The tank feeds the fire pump, which supplies the fire sprinkler and standpipe systems. Schematic drawings of the systems are shown in Figures 8 and 9. The fire pump specifics are presented below.

- SPP Pumps, Model No. PCO5G, Serial No. USF-01-14-4504. U.L. listed, electric driven, spilt case centrifugal fire pump.
- Rated Capacity: 1,000 gpm
- Rated Net Pressure: 210 psi
- Net Pressure at 150% Capacity: 136 psi (65% of rated pressure)
- Rated Speed: 3,550 RPM
- Maximum Power: 227 bhp

The fire pump and water tank were installed when the building was originally built in the 1980s. The water tank was required by the Building Code (Uniform Building Code 1979-1985) to provide a secondary source of water in the event of a seismic event.

The criteria used during this period to determine the size of the water tank was the maximum sprinkler flow, plus 100 gpm hose stream allowance for a minimum of 30 minutes.[7] Therefore, the calculated minimum tank size is 10,200 gallons (340 gpm (0.16 gpm/sq.ft. x 1,500 sq. + 100-gpm hose allowance) x 30 minutes). However, in the 1980s the local interpretation of this requirement was that the secondary supply was only for the protection of the high-rise portion of the building containing residential or business occupancies.[8] These areas require light hazard protection. The size of the tank would then be 7,500 gallons (250 gpm (0.10 gpm/sq.ft. x 1,500 sq. + 100-gpm hose allowance) x 30 minutes)[9] as was found during the site visit.

A 6-inch modulating fill valve is provided to fill the tank as the fire pump is discharging. This arrangement is defined as a break tank assembly, which was developed by FM Global in the 1970s or ‘80s. Using this design approach, the sizing of the tank inlet piping and the capacity of the public water supply are required to meet the fire pump discharge at 150% capacity, which is 1,500 gpm.

The public water supply is capable of providing 1,500 gpm at 74 psi effective at the connection in 7th Street (same calculation method as Section 3.3). Considering the pressure loss of the backflow device (19 psi), and the friction loss in the 6-inch lateral to the building, and piping to the water tank, the public water supply is capable of providing the needed flow. The break tank arrangement, which supplements the somewhat dubious tank sizing methodology, provides the fire pump an adequate water supply to supply the fire sprinkler system indefinitely. Assuming of course, the City water system is not impaired by a seismic event. Considering all these factors, the fire pump and tank assembly arrangement is considered adequate for the building. Section 3.6 presents a hydraulic analysis of the adequacy of the fire pump to provide the specific demands of the automatic sprinkler and standpipes systems.

Class I Standpipes are located in Stairs 1, 2, 3, and 4. Hose valves, 2½ inches in diameter, are provided on each floor level of each standpipe. The sprinkler system is supplied by a combination standpipe located in Stair 2. Roof manifolds are provided for the standpipes located in Stairs 1 and 2 (Stairs 3 and 4 serve only Floors 8 and below). The pump is designed to provide a pressure of 65 psi at a flow of 250 gpm at each standpipe for a total flow of 1,000 gpm at the roof or highest standpipe outlet[10].

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[7] 1979-1985 UBC Section 1807

[8] City of San Diego policies based upon 1979-1882 UBC Section 1807 defining a high-rise building as only a R-1 or B Occupancy.

[9] In the mid-1990s the author requested a California State Fire Marshal (CSFM) opinion of this subject. As a result, the CSFM published the formal interpretation which states the pump and tank are required to be designed to protect all areas of a high-rise building, not just the portion above 75 feet from the fire department access point.

[10] 1979 Uniform Building Code Standard 38-3, Section 38.303, 2(B)

The fire department connection located on 7th Street connects to the standpipe on the first floor, downstream of the fire pump. Should the standpipe system be used for manual firefighting, additional pressure, flow, and supply duration is provided by fire department apparatus via connection to the nearest fire hydrant.

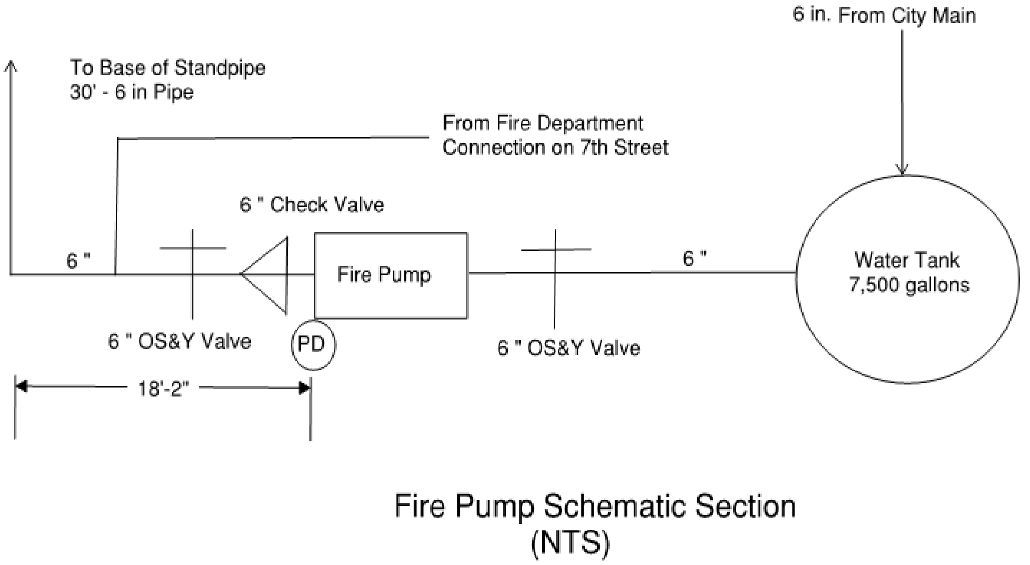

Figure 9: Fire Sprinkler Supply System

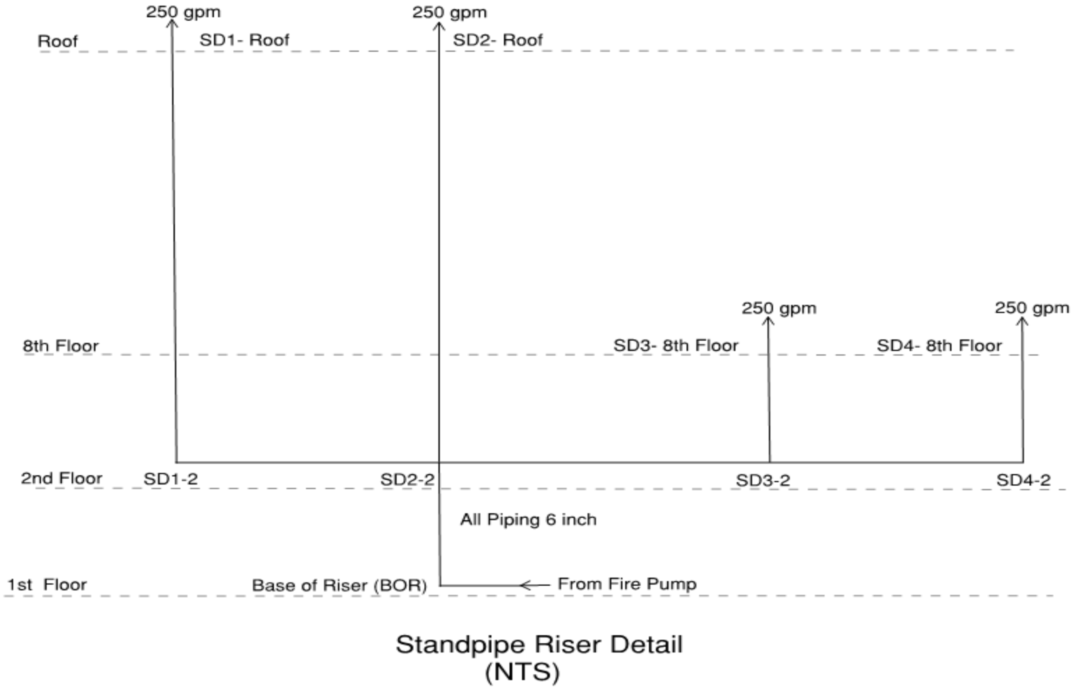

Figure 10: Standpipe System

### 3.4.3 Fire Suppression System Hydraulic Analysis

Plans of the fire protection systems for the building were not available. Basic schematic plans were prepared based upon information acquired by site survey (See Appendices B and C). These plans and calculations were used to evaluate the hydraulic adequacy of the fire protection systems.

The review of the architectural plans identified the most hydraulically demanding areas for the sprinkler system. Given the ceiling of the top floor of the building is approximately 180 feet from the ground floor where the fire pump is located, areas on this floor (21st floor) were considered the most hydraulically demanding due to the 78-psi loss for elevation gain. Three areas were evaluated on this floor; Guestrooms 2101 and 2105, and Room 2119/2120, which is the Club Lounge. The two guest rooms are typical in size of those found throughout the building. The Club Lounge is the largest non-residential room on the floor.

The automobile parking areas were considered as well. The required design criteria for the protection of these areas is the largest of the building, 0.16 gpm / sq.ft. for the most remote 1,500 sq.ft. However, the parking areas are located in the lower areas of the building, the highest level occurring on the 7th floor. Intuitively, due to their low elevation, these areas were not considered among the most hydraulically demanding.

This is proven by the approximation shown below:

- Sprinkler discharge: 0.16 gpm. / sq.ft. x 1,500 sq.ft. = 240 gpm
- Hose allowance: 250 gpm
- Total flow required at pump discharge: 490 psi
- Pressure required (without 7th floor piping network losses): 7 psi sprinkler discharge + 27 psi elevation loss = 34 psi
- Standpipe and friction loss from the base of the standpipe to the pump discharge: Assumed negligible.
- Fire pump discharge at 490 gpm = 240 psi, reduced to 175 psi due to potential pressure reducing valves.
- Available 7th floor sprinkler piping network friction loss: 175-34 psi = 141 psi

Given the large pressure available for 7th floor piping network losses, it was concluded that the fire pump system provides adequate flow and pressure for the parking areas.

The largest conference room on the 8th floor, Room 808/ 809/810, located the farthest distance from the sprinkler riser was evaluated. This space is the most hydraulically demanding of the light hazard areas of the building due to size and height within the building.

Hotel guest rooms are separated from each other and other areas by one-hour rated walls with 20-minute opening protection (doors). Because of this compartmentalization, the room design method was used as allowed by NFPA 13, Section 11.2.3.3. All the sprinklers within the individual rooms were calculated.

The same design approach was used in the analysis of the Club Lounge.

The 8th floor conference was calculated using the standard density area method. However, the remote area was reduced due to the use of quick response sprinklers as allowed by NFPA 13 Section 11.2.3.2.3. Starting with a base 1,500 sq.ft. design area, a 40% reduction was taken given the 9-foot ceiling height (NFPA 13 Figure 11.2.3.2.3.1). This resulted in a remote area of 900 sq.ft.

As presented in Tables 7 and 8, adequate flow and pressure is provided by the fire pump and water tank for the automatic sprinkler and standpipe systems. See Figure 10 for a graphic presentation of this data.

**Table 7: Automatic Sprinkler Design Analysis Summary**

| Floor/Area | Occupancy | Design Method/Criteria Used | Required Flow/Pressure at Pump Discharge | Provided Flow/Pressure at Pump Discharge[11] |
|---|---|---|---|---|
| 21st Floor<br>Room 2101 | Guest Room | Room design method 0.10 gpm/sq.ft. for all sprinklers within room. | 189 gpm/ 128 psi | 189 gpm/ 175 psi |
| 21st Floor<br>Room 2015 | Guest Room | Room design method 0.10 gpm/sq.ft. for all sprinklers within room | 190 gpm/ 119 psi | 190 gpm/ 175 psi |
| 21st Floor<br>Room 2119/2120 | Club Lounge | Room design method 0.10 gpm/sq.ft. for all sprinklers within room | 246 gpm/ 125 psi | 246 gpm/ 175 psi |
| 8th Floor<br>Room 808/809/810 | Conference Rooms | Standard density area method with quick response sprinkler area reduction.<br>0.10 gpm/sq.ft. for the most remote 900 sq.ft. | 237 gpm/ 85 psi | 237 gpm/ 175 psi |

**Table 8: Standpipe System Design Analysis Summary**

| Standpipe No. | Design Flow/Pressure | Required Standpipe Demand at Pump Discharge | Provided Standpipe Pressure/Flow at Pump Discharge |
|---|---|---|---|
| SP1 | 250 gpm/65 psi | | |
| SP2 | 250 gpm/65 psi | | |
| SP3 | 250 gpm/65 psi | | |
| SP4 | 250 gpm/65 psi | | |
| Total Standpipe System | 1000 gpm/65 psi | 1352 gpm/160 psi | 1352 gpm/160 psi |

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[11] Pressure reducing valves set at 175 psi are provided at the sprinkler pipe connection to the riser on all floors. In reality, the maximum pressure available at the standpipe sprinkler system connection at each floor is 175 psi.

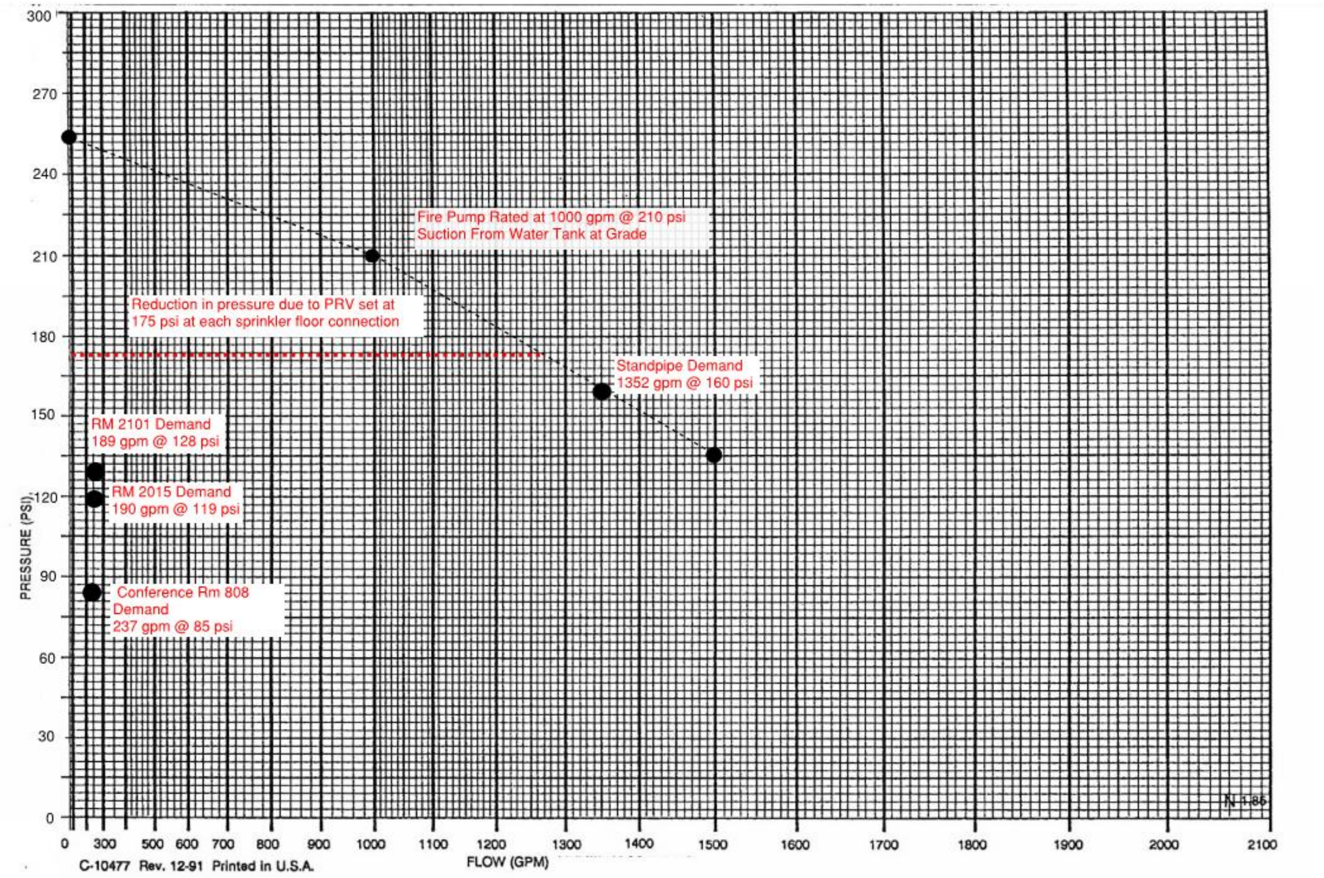

Figure 11: Fire Pumps Discharge vs Sprinkler Demand Requirements

### 3.4.4 Kitchen Fire Suppression System

The cooking areas of the kitchen are protected with a kitchen hood fire protection system. The system is a dry type and is activated automatically by fusible links locate over cooking devices or by manual pull as allowed by the CBC. The system is designed in accordance with the applicable standards.

### 3.4.5 System Inspection, Testing and Maintenance Requirements

NFPA 13 requires inspection, testing, and maintenance of fire sprinkler, standpipe, and fire pump/tank systems in accordance with the requirements of NFPA 25(California edition for this project) to provide at least the same level of performance and protection as designed. The owner or authorized representative bear the responsibility for completion of this program.

NFPA 25, Section 3.3.19 requires the service to be provided by a qualified State of California State Licensed C-16 contractor, a California State Fire Marshal Licensed A contractor, or a qualified owner's representative as permitted by Title 19.

Chapters 5-9 of NFPA 25 provides the minimum requirements for the inspection, testing, and maintenance of these systems. A detailed summary of inspection, testing, and maintenance scope and frequency is shown in Appendix D.

Review of the records for the programs shows that the Owner is following the requirements of NFPA 25. The inspections are completed by certified hotel staff and a State of California Licensed C16 sprinkler contractor. Repairs are made by the same contractor.

## 3.5 Fire Emergency Voice/Alarm Communication System

### 3.5.1 System Description

The original fire alarm system was recently replaced with a fire emergency voice/alarm communication system (EVACS) (CBC Section 907.5.2.2). The operation of any automatic fire or smoke detector, sprinkler waterflow device, or manual pull station will automatically sound an alert tone followed by voice instructions, which provide directions for occupant evacuation in accordance with the building's evacuation plan (CBC Section 907.5.2.2). Notification is zoned such that the fire floor, floor above, and floor below are notified simultaneously. The system also has the capability to broadcast live voice messages on a selective zone or all-call basis (CBC Section 907.5.2.2.2).

Drawings of the EVACS for the building were not available. Basic schematic drawings were prepared based upon information acquired by site survey. Drawings include the 8th floor, which is the home of the hotel's assembly space, and the 21st floor, which is a typical guest room floor. The location of the fire alarm control panel, inside the fire fighter control room on the first floor, is shown as well. The drawings are found in Appendix E.

All alarm, trouble, and supervisory signals received at the main FACP are sent off-site to a central monitoring station. The system is defined as a supervising station fire alarm system (NFPA 72, Section 3.3.282.). The sequence of operation for the system is shown in Appendix F.

The EVACS functions as an in-building Layer 1 Mass Notification System, which is defined as a means of notification of occupants by systems installed inside a building and controlled only by authorized users (NFPA 72, Section 24.3.8). The major difference between the EVACS and the mass notification system is the latter is designed based upon the findings of a risk analysis (NFPA 72, Section 24.3.11). The onsite risk analysis was reviewed and found to be adequate. The risk analysis is specific to the nature and anticipated risks of the facility. An emergency response plan was prepared (NFPA 72, Section 24.3.12). See Section 5.

Pathway survivability is a requirement for both EVACS and mass notification systems (NFPA 72, Section 24.3.13). The intent of this provision is to provide adequate protection of the system conductors such that fire exposure from within the building will not compromise system integrity. Because the occupant egress protocol requires only the fire floor, floor above, and floor below to evacuate in a fire condition, Level 2 or 3 pathway survivability is required (NFPA 72, Section 24.3.13.4.1). However, exception 1, allows Level 1 survivability when the notification zones are separated by less than 2-hour fire-rated construction. Level 1 survivability requires the building to be protected with a fire sprinkler system designed in accordance with the requirements of NFPA 13, and that all conductors are installed in metal raceways (NFPA 72, Section 12.4.2). Site inspection indicates the EVACS conductors are installed in metal raceways and, as previously presented in the fire sprinkler section, the building is properly sprinklered. Therefore, pathway survivability meets the requirements of NFPA 72.

The EVACS is controlled by an Edwards EST-3 fire alarm control panel (FACP). The FACP is located in Room 108, the fire fighter control room. The room is located adjacent to the main lobby of the building. The system supervises and controls initiating points such as detectors, manual fire alarm boxes, and input modules for monitoring other suppression systems and fire alarm equipment. Table 9 presents a summary of the fire alarm system notification and initiating devices installed in the building.

### 3.5.2 Initiation Devices

Smoke detection is provided:

- Above the FACP in the fire fighter control room (NFPA 72 Section 10.4.4)
- In each corridor serving guestrooms (CBC Section 907.2.8.2).
- At each door magnetically help open (CBC 907.3.3)
- In the elevator lobbies for elevator recall control functions (CBC Section 907.3.3, NFPA 72 Section 21.3.5).
- In each elevator machine rooms (CBC 907.2.13.1.1(1-2))
- In the main return air and exhaust plenums of each air-conditioning system having a capacity greater than 2,000 cfm and at each connection to a vertical duct or riser serving two or more stories from a return air duct or plenum of an air conditioning system. These are duct type smoke detectors (CBC 907.2.13.1.2(1-2).
- In guestrooms to provide local notification (CFC Section 907.2.11).
- Throughout the assembly space on the 8th floor. This was provided by the hotel's operator's fire protection requirements. The CBC does not require this.

The smoke detectors are Edwards Model SIGA2-PS Intelligent Photoelectric smoke detectors. These intelligent devices use an optical sensing chamber to detect smoke. The detector analyzes the sensor data to determine whether to initiate an alarm. The guestroom smoke detectors are provided with Edwards Model SIGA-AB4G sounder bases for local notification.

The maximum smoke detector spacing is 30 ft., and detectors are required to be located within 15 ft. of all walls. In addition, all points of the ceiling are required to have a detector within 0.7 times the listed spacing of the detector, 21 ft. (NFPA 72 Section 17.6.3.1.1). The system was found to comply with these requirements.

One manually activated initiating device (manual pull station) is provided adjacent to the FACP in the fire department control room (CFC Section 907.2). The pull station is located between 42 and 48 inches above the floor as required by the code (NFPA 72 Section 17.14.5).

Other initiating devices provided:

- Sprinkler water flow supervision devices
- Kitchen fire suppression system activation
- Addressable input modules are provided for monitoring the sprinkler system fire pump and control valves.

### 3.5.3 Notification Devices

The building is equipped with both audible and visual notification for all accessible public and common use areas (CBC Sections 907.5.2.1 and 907.5.2.3). Guestrooms are also provided with audible notification devices.

ADA complaint guest rooms are provided as required by the CBC. Of the 321 rooms in the facility, 20 are designated as ADA complaint and are provided with ADA complaint strobes (CBC Section 907.5.2.3.2). These guestrooms are located on the 11th, 15th, 18th, and 21st floors; there are five ADA-complaint rooms per floor. The guestrooms that were designated as accessible also included visual notification appliances activated by the building fire alarm system.

Activation of a guestroom smoke detector will sound a local alarm, activate the guestroom visual notification device, and send a supervisory alarm to the FACP.

The audible devices provided are designed to provide an average sound pressure level of 15 decibels above the average ambient noise level or 5 decibels above the maximum sound level having a duration of at least 60 seconds, whichever is greater (CBC 907.5.2.1.1). In addition, the maximum sound pressure level does not exceed 110 decibels at the minimum hearing distance from the audible device (CBC Section 907.5.2.1.2). In sleeping areas, the audibility is measured at pillow level.

The speakers are required to be located such that the bottoms of the devices are not less than 90 inches above the finished floor and a minimum of 6 inched below the ceiling (NFPA 72 18.4.8.1). The combination speaker strobe notification devices are required to be a minimum of 80 inches and maximum of 96 inches above the finished floor. In ceilings lower than 80 inches, the devices are allowed to be located within 6 inches of the ceiling (NFPA 72, Sections 18.5.5.1 and 18.5.5.2 respectively). The notification devices were found to comply with these requirements.

The horizontal spacing of the audible devices is required to be determined by calculation based upon this audibility performance criteria. The visual device horizontal spacing is required to be determined by the spacing criteria found in NFPA 72 Tables 18.5.5.4.1(a) and Figure 18.5.5.4.1(a) or Table 18.5.5.4.1(b). Appendix G shows a summary of calculated notification device spacing for selected areas, the 8th floor assembly space and the 21st floor, which is a typical guest room floor and other areas of the building.

The spacing of the audible and visual notification devices installed within the building were found to comply with the noted NFPA 72 requirements.

**Table 9: EVACS Initiation and Notification Device Summary**

| Product Name | Model Number | Function | Audible Characteristics | Visual Characteristics |
|---|---|---|---|---|
| Edwards Genesis G4 Series | G4RS2VM (Clear lenses) | Speaker/strobe | 80-89 dBa | 15-110 cd |
| Edwards Genesis G4 Series | G4FS2 | Speaker | 80-89 dBA | NA |
| Edwards Signature Series | SIGA2-PS | PS Intelligent Photoelectric smoke detector. Used in both common spaces and in guest rooms (local alarm) | NA | NA |
| Edwards Signature Series | Model SIGA-AB4G Sounder base | Provides audible signal for detectors located in the guest rooms. | | |
| Edwards 270 Series | 270 DPO Fire alarm station | Manual pull station initiates fire alarm system | NA | NA |
| Potter | VSR | Vane water flow switch | | |
| Potter | PCVS | Control valve supervisory switch | | |

Intelligibility of the EVACS is not required to be determined through quantitative methods (NFPA 72 Section 18.4.10.4). Standard practice in the city of San Diego, where the building is located, is to verify intelligibility during system acceptance testing. Brief testing of the fire alarm/emergency communication system was witnessed and the voice messages, both prerecorded and live where intelligible.

The design of the EVACS was reviewed to determine if the notification appliance circuits meet the maximum voltage drop criteria and that adequate backup power is provided. A maximum voltage drop of 10% was allowed by City of San Diego policy when the new EVACS was installed. Calculations shown in Table 10 confirm that the worst-case voltage drop is 8%, which complies with this requirement.

Standby power is required for the EVACS. The standby power supply is required to have a sufficient capacity to operate the system for 24 hours on standby condition (non-alarm) and 15 minutes in alarm condition (NFPA 72, Section 10.6.7.2.1.2). The required standby is 25.35 amp-hrs. See Appendix H for calculations. The provided standby power system is of adequate capacity.

**Table 10: Notification Circuit Voltage Drop Calculations**

| **Circuit No.** | **Speakers** | **Speaker Strobes** | **One-way Circuit Length (ft.)** | **Total Current (amps)** | **Voltage Drop (volts)** | **Voltage Drop %** |
|---|---|---|---|---|---|---|
| NAC 1 Typical Guestroom Floor* | 23 | 8 | 337 | 1.47 | 1.962 | 8.174 |
| NAC 2-1 8th Floor* | | 16 | 150 | 1.744 | 1.036 | 4.316 |
| NAC 2-2 8th Floor* | | 17 | 150 | 1.853 | 1.101 | 4.586 |
| *Assumed to be worst case | | | | | | |
| Input | | | | | | |
| Speaker Strobe Current Draw (15cd) (amps) | 0.109 | | | | | |
| Speaker Current Draw (80 dBA) (amps) | 0.026 | | | | | |
| Wire size(AWG) | 12 | | | | | |
| Wire Resistance (ohms/1000 ft.) | 1.98 | | | | | |
| Specific Voltage(VDC) | 24 | | | | | |

The fire alarm devices for monitoring the building sprinkler systems are located at the sprinkler risers and include supervision of all control valves, waterflow switches, and the electric driven fire pump.

### 3.5.4 System Documentation

NFPA 72, Section 7.2 requires that documentation be submitted upon completion of the system installation. The information is vital for the proper maintenance of the system and to document system components for use in future expansion or modification of the system. Table 11 shows an excerpt from NFPA 72, which lists the required documentation of all items.

**Table 11: System Documentation**

(NFPA 72, Section 7.2)

| Item | Description |
|---|---|
| (1) | *Written narrative providing intent and system description |
| (2) | Riser diagram |
| (3) | Floor plan layout showing locations of all devices, control equipment, and supervising station and sharing communications equipment with each sheet showing the following:<br>(a) Point of compass (north arrow)<br>(b) A graphic representation of the scale used<br>(c) Room use identification<br>(d) Building features that will affect the placement of initiating devices and notification appliances |
| (4) | Sequence of operation in either an input/output matrix or narrative form |
| (5) | Equipment technical data sheets |
| (6) | Manufacturers' published instructions, including operation and maintenance instructions |
| (7) | Batter capacity and de-rating calculations (where batteries are provided) |
| (8) | Voltage drop calculations for notification appliance circuits |
| (9) | Mounting height elevation for wall-mounted devices and appliances |
| (10) | Where occupant notification is required, minimum sound pressure levels that must be produced by the audible notification appliances in applicable covered areas |
| (11) | Pathway diagrams between the control unit and the supervising station and shared communications equipment |
| (12) | Completed record of completion in accordance with 7.5.6 and 7.8.2 |
| (13) | For software-based systems, a copy of site-specific software, including specific instructions on how to obtain the means of system and software access (password) |
| (14) | Record (as-built) drawings |
| (15) | Records, record retention, and record maintenance in accordance with Section 7.7 |
| (16) | Completed record of inspection and testing in accordance with 7.6.6 and 7.82 |

### 3.5.5 Record of Completion Documentation

NFPA 72, Section 7.66 (Item 12 from Table 11) requires a record of completion for the project. This document provides a detailed itemization of the system including the equipment installed, method of installation, and testing conformation. A statement that documents the system was designed and installed in accordance with NFPA 72 is also included. See Appendix I for the record of completion for the project.

### 3.5.6 System Inspection, Testing and Maintenance

Chapter 14 of NFPA 72 contain rigorous inspection, testing, and maintenance (ITM) requirements. These requirements are typically adopted by the various states for inclusion in their state building or fire codes. In this case, the 2016 California Fire Code adopts these requirements.

The purpose for the initial testing is to verify the system is in compliance with the design standards and is fully functional. The re-inspection of the system is to confirm changes to the system do not affect the system in a derogatory manner. Also, that the system is functional and reliable.

The responsibility of the ITM program belongs to the owner of the property or his designated representative. Records are required to be maintained which documents the specifics of the program. Representatives of the San Diego Fire Department, High-Rise Safety Division, inspect high-rise buildings on a yearly frequency. During these inspections, the records of the ITM are reviewed. Appendix J shows the requirements of NFPA 72 for ITM.

## 3.6 Secondary Power Systems

Adequate emergency power is provided by the diesel-powered generator or back-up batteries. The following systems are included:

- Exit signs and exit illumination*
- Elevator car lighting
- Fire alarm and supervisory systems *
- Fire detection and supervisory systems*
- Sprinkler alarm and supervisory systems*
- Emergency voice evacuation system (See Section 3.2)
- Elevators (one at a time each bank)
- Smoke-Control system
- Power for magnetic door hold open devices
- Kitchen exhaust hoods
- Fire pump

*These systems are typically provided with battery back-up.

## 3.7 Occupant Egress System

Two exits from each floor are provided by Stairs 1 and 2. The stairs are continuous from the roof to the ground floor where they transfer occupants into exit passages that terminate at the building exterior on the sidewalks along 6th and 7th Avenues respectively.

Stairs 3 and 4 provide additional exits for occupants of the 8th floor conference, meeting rooms or exterior terrace. Occupants from the 2nd through 7th floors have access to these stairs as well. Another stair, referenced as the Northwest Stair, provides egress from the 8th floor down to the 7th floor. Vestibules are not provided for any of the stairs.

A summary of occupants per floor vs exits required is shown in Table 12.

Table 12: Summary of Floor Occupancy and Required Number of Exits

| Floor No. | Occupants Per Floor | Floor Area (sf) | Required No. of Exits | Provided No. of Exits |
|---|---|---|---|---|
| 1 | 1015 | 26209 | 4 | 8 |
| 2 | 193 | 38976 | 2 | 4 |
| 3 | 193 | 38976 | 2 | 4 |
| 4 | 193 | 38976 | 2 | 4 |
| 5 | 193 | 38976 | 2 | 4 |
| 6 | 193 | 38976 | 2 | 4 |
| 7 | 185 | 37129 | 2 | 4 |
| 8 | 915 | 41206 | 3 | 5 |
| 9 | 113 | 19659 | 2 | 2 |
| 10 | 113 | 19659 | 2 | 2 |
| 11 | 113 | 19659 | 2 | 2 |
| 12 | 113 | 19659 | 2 | 2 |
| 14 | 113 | 19659 | 2 | 2 |
| 15 | 113 | 19659 | 2 | 2 |
| 16 | 113 | 19659 | 2 | 2 |
| 17 | 113 | 19659 | 2 | 2 |
| 18 | 113 | 19659 | 2 | 2 |
| 19 | 113 | 19659 | 2 | 2 |
| 20 | 113 | 19659 | 2 | 2 |
| 21 | 216 | 19629 | 2 | 2 |
| **Total** | 4624 | 535302 | | |

Applicable CBC occupant egress requirements are summarized as follows:

- Maximum travel distance- Group A, M, S-2, R-1= 250 feet (CBC Table 1017.2)
- Exit separation- 1/3 the diagonal dimension of the area/floor (CBC Section 1007.1.1)
- Common path of travel- A-2 or 3= 30 feet, B and R-1=75 feet (CBC Table 1006.2.1)
- Dead end corridors- A-2 or 3=20 feet maximum, Other occupancies =50 feet maximum (CBC Sections 1029.9.5 and 1020.4 respectively)
- Exit Signage placement- Exits and exit access doors shall be provided with exit signs readily visible from any direction of travel. In addition, signs are required to be placed such that no point in an exit access corridor or exit passageway is greater than 100 feet, or the listed viewing distance, whichever is less from the nearest exit sign (CBC Section 1013). Finally, low-level exit signs are required in hotel corridors of the building (CBC Section 1013.7).

### 3.7.1 Egress Analysis

All areas of the building, with the exception of the first floor bar area and the 8th floor, comply with the requirements of the CBC for egress. The number of exits required per floor, exit capacity from each floor, and from each space, travel distance, common path of travel, and exit separation are in accordance with CBC requirements. A summary of required exit width vs provided exit width on a per floor basis is shown in Table 13. Occupant egress plans are provided in Appendix K. Detailed calculations can be found in Appendix K.

The first-floor bar has an occupant load of 165 (31 occupants standing at the bar, 134 in the rest of the space). Two exits are required, one exit is provided. Another exit should be provided in the north bar area which would take occupants thru the restaurant and to one of the south exit doors.

The 8th floor has an occupant load that the floor egress system cannot support. See Appendix K and L for calculations. To resolve this, it is recommended that the horizontal exits be provided at the east and west walls as described below:

West Terrace area: This open-air area is used as access to the Northwest exit stair. It can also be used for assembly space. Unfortunately, this space has only one exit. The area could be interpreted as circulation from the pre-function area and not be required to be loaded. In addition, it is unlikely that this space and the pre-function will be loaded concurrently. However, the conservative approach that the space will be loaded was taken. In addition, the horizontal exit will be used to disperse occupant load from the pre-function area.

A horizontal exit at the building exterior wall is suggested to resolve this issue. This will allow 50% of the occupant load from the pre-function area (203 or 230 occupants) or the ballroom/conference room occupant load to egress west thru the horizontal exit. Once on the other side of the horizontal exit they are assumed to be in a safe area of refuge and do not egress from the building until escorted by authorize personnel. The exterior terrace is approximately 1,177 sq.ft., which can be used for the area of refuge for a maximum of 392 occupants (3 sf per occupant). In addition, as previously mentioned, the terrace itself has only one exit, the second required exit can be thru the horizontal exit to the east. The addition of a door which swings to the east will be required in the horizontal exit wall to accommodate 50% of the terrace occupant (40 occ.). There is ample space in the pre-function area for the area of refuge (120 sf. needed).

The horizontal exit wall is required to comply with the requirements for a fire barrier, with a minimum fire resistance rating of two- hours. The building floor is two- hour rated so the wall does not need to extend vertically thru the building. (CBC 1026.1) Openings in the horizontal exit wall are required to be 1½ hour rated. Doors are required to be self or automatic closing (CBC 716).

East Terrace area: This open-air area is used as a break area for employees. Unfortunately, only one exit is provided. To resolve this issue, a horizontal exit along the east exterior wall is recommended. In addition, a new door and corridor should be provided at the north portion of the terrace which will send occupants to Exit Stair No. 2. The other exit will be through the existing door into the employee lounge, which will be required to be reversed in swing. The employee lounge can provide the area of refuge (46 occupants at 3 sf. per occupant =138 sf.). This area is 1389 sf. Other requirements for the horizontal exit mirror those of the West Terrace area.

Eighth floor corridor 885 is a dead end which exceeds 20 feet in length. One solution is to provide a door at the beginning of the corridor (see egress drawings). Although frowned upon by jurisdictions, the door would prohibit occupants from accidentally going down the dead-end corridor to the end.

Table 13: Per Floor Occupant Exit Width Analysis*

| Floor | Exit Path | Total Occ. | Floor Area (sf) | Total Occ. Per Floor | Required Stair Entry Door Width (in.) | Provided Stair Entry Door Width (in.) | Required Stair Width (in.) | Provided Stair Width (in.) | Required Ground Level Exit Door Width (in.) | Provided Ground Level Exit Door Width (in.) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | From Floor | 1015 | 26209 | 1015 | NA | NA | NA | NA | 213 | 552 |
|  | From Bldg. |  |  |  |  |  | NA |  |  |  |
| 2-6 Typ. | From Floor | 193 | 38976 | 193 | 128 | 232 | 128 | 272 |  |  |
|  | From Bldg. | 193 |  | 193 |  |  | 128 | 272 | 128 | 272 |
| 7 | From Floor | 201 | 37129 | 201 | 128 | 232 | 128 | 272 |  |  |
|  | From Bldg. | 185 |  | 185 |  |  | 128 | 272 | 128 | 272 |
| 8 | From Floor | 915 | 41026 | 909 | 138 | 232 | 183 | 340 |  |  |
|  | From Bldg. | 915 |  | 909 |  |  | 183 | 272 | 138 | 272 |
| 9-12, 14-20 | From Floor | 113 | 19650 | 113 | 64 | 136 | 64 | 116 |  |  |
|  | From Bldg. | 113 |  | 113 |  |  | 64 | 116 | 64 | 116 |
| 21 | From Floor | 216 | 19629 | 216 | 64 | 136 | 64 | 116 |  |  |
|  | From Bldg. | 216 |  | 216 |  |  | 64 | 116 | 64 | 116 |

* See Appendix L for detailed calculations

## 3.8 Conclusion-Prescriptive Analysis

The prescriptive analysis studied the variation of the building's fire protection/life safety components from those required by the applicable codes and standards. The analysis included building construction, fire resistance, fire suppression, fire detection, smoke control system, and egress systems.

The results of the analysis indicate that the building complies with the requirements of the applicable codes and standards, with three exceptions relating to occupant egress:

- The first-floor bar area: One exit is provided, however two are required. An additional exit through the restaurant is recommended.
- The 8th floor East and West Terrace areas: Only one exit from each space is provided, two are required. The use of horizontal exits along the east and west exterior walls are recommended. In addition, the east terrace requires the addition of a corridor and new exit door at the north end. The west horizontal exit can also be used to disperse pre-function occupants to the west.
- Eighth Floor Corridor 885: This is a dead end, which exceeds 20 feet in length. A door should be installed at the beginning of the corridor.

In the next section of this report, a performance-based analysis will be completed. This involves the use of scientific analytical methods to evaluate the performance of the fire protection/life safety systems.

# 4 PERFORMANCE-BASED ANALYSIS

## 4.1 Goals and Objectives

The Life Safety Code is unique among the currently published building codes because a performance-based option is provided.[12] This option is outlined in Chapter 4, Section 4.4.2 and Chapter 5 of the code.

The primary goal of this approach is to provide an environment for the occupants that is reasonably safe from fire by the following means (Section 4.4.2):

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

The objectives to meet these goals are:

- Occupant protection - A structure shall be designed, constructed, and maintained to protect occupants who are not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place.
- Structural integrity - Structural integrity shall be maintained for the time needed to evacuate, relocate, or defend in place occupants who are not intimate with the initial fire development.
- System effectiveness - Systems utilized to achieve these goals shall be effective in mitigating the hazard or condition for which they are being used, shall be reliable, and shall be maintained to a level at which they were designed to operate.

The performance criterion for this approach is that any occupant who is not intimate with ignition shall not be exposed to instantaneous or cumulative untenable conditions (Section 5.2.2). Untenable conditions will be defined by the establishment of detailed performance criteria which is based upon well founded scientific principals or research.

## 4.2 Egress Analysis

### 4.2.1 Egress Calculations

Two evacuation conditions were analyzed:

- Condition 1-Global evacuation of the building
- Condition 2-Zoned evacuation of the fire floor, floor above, and floor below

Evacuation Condition 1 will be used later in this analysis to evaluate structural integrity. Evacuation Condition 2 is based upon the required City of San Diego EVACS sequence of operation and is commonly used by jurisdiction throughout the Western United States.[13]

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[12] The CBC does not offer a performance-based option. This can be achieved by use of the alternate materials and methods provisions of the CBC. Unfortunately, it is a discretionary decision of the building official to allow this approach.

[13] Author's experience

The hydraulic flow model methodology was used to establish the travel time for building occupants to move to a location of safety, which is defined as the building exterior or public way. This approach is considered a first order approximation. The following assumptions were made:

- All occupants start egress at the same time.
- The population will use all facilities in the optimum balance.
- The prime controlling factors will be either the enclosed stairs or the doors discharging from the stairs at ground level.
- The stairs have a code complying rise and run of 7 inches and 11 inches respectively.
- Cueing will occur; therefore, the specific flow of the evacuating occupants is equal to the maximum specific flow (Fs = Fsm).
- The four egress stairs are 68 inches wide.
- The four ground floor exit doors are 67 inches wide (the stairs were made wider at the floor to accommodate this).
- Exit boundary layer widths for both stairs and corridors = 6 inches each side (NFPA HB Table 4.2.4).
- Building size is 535,302 square feet.
- For Evacuation Condition 1, the total number of occupants, minus the first-floor occupants who egress directly to the outside, is 3609. For Evacuation Condition 2, the total number of occupants is 1229, which is the occupants from the fire floor, floor above and floor below.[14]

This analysis begins with the estimation of the flow capacity of the two controlling elements in the occupant flow, the stairways, and the ground floor stairway doors.

Estimation of stairway flow capacity:

The specific flow, Fs is defined as the flow of evacuating persons past a point in the exit route per unit time and unit effective width of the exit route. Since queuing will occur, Fs is assumed to Fsm, which is the maximum specific flow. For the stairs, the Fsm is 18.5 per/min/effective width (NFPA HB Table 4.2.8).

The effective width (We) is the width of the stairs minus the exit boundary widths on each side of the stair. The We for the stairs is 4.67 feet ((68 inches - (6 inches x 2))/12).

The calculated flow (Fc) = Fs x We (per/min).

For the stairway, Fc = 18.5 p/m/We X 4.67 ft. = 86.33 p/m

Estimation of stairway exit door flow capacity:

Fs= Fsm = 24.0 p/m/We. We for the door is 4.58 feet ((67 inches- (6 inches x 2))/12).

Fc= 24.0/p/m/We x 4.58 ft. = 110 p/m.

Since the flow capacity of the stairway is less than the flow capacity of the door, the flow is controlled by the stairway.

The Condition 1 building evacuation time is estimated to be 3609 p/4 exit stairs = 902.25 p / 86.33 p/m =10.45 or 11 minutes.

---

[14] The occupant loads of floors 7, 8, and 9 were used due to the high occupant load on the 8th floor.

The Condition 2 building evacuation time is estimated to be 1229 p/ 4 exit stairs = 307.25 p / 86.33 p/m =3.55 or 4 minutes. However, it can be assumed that smoke from the fire does not migrate vertically to the floor above or below. Therefore, only the occupants on the fire floor are exposed to smoke during evacuation. This exposure period begins when occupants leave their guestroom and continues until they enter the stairs. Once inside the stairs, tenability is maintained due to the operation of the stairway pressurization system.

Between a population density of 0.05 persons /ft² to 0.35 persons /ft² the relationship between speed and population density is assumed to be a linear function represented by the flowing equation[15] .

$S=k-akD$

Where:

S= Speed along the line of travel (ft. /min)

D= Population density (persons /ft²)

k= constant (275 for corridors)

a= 2.86 ft. /min.

Therefore:

D= 0.137 (persons /ft²) - 201 occupants/1469 ft² (for the exit corridor area)

S= 168 ft. / min.

Given a worst-case distance to the most remote stairway door of 220 ft., travel time to the stairway is approximately 2 minutes, which will be used for calculation of required egress time.

### 4.2.2 Fire Modeling Analysis

Fire Dynamic Simulator (FDS) was used to determine the time of smoke detector activation and sprinkler activation, two cues which initiate the egress process. In addition, modeling was used in the tenability analysis.

Developed at the National Institute of Standards and Technology (NIST), FDS is a computational fluid dynamics model of fire-driven fluid flow. FDS solves a form of the Navier-Stokes equations appropriate for low speed, thermally driven flow emphasizing smoke and heat transport from fires. [16]

Two fire scenarios were selected for this analysis:

Scenario 1: A fire within Guest Room 2101 on the 21st floor (typical guestroom) with the entry door shut. Occupants are assumed to be asleep at the time of fire ignition.

Scenario 2: Repeat of the first scenario, only with the entry door open.

Guestroom fire scenarios were obvious candidates given occupants can be in various states of awareness while in their guestrooms; including asleep, intoxicated, or otherwise distracted. Fire data supports this assumption, bedroom areas are the primary location of unconfined fires within hotels (28%).[17] Guestroom layout is in shown in Figure 11.

A fire within a meeting room or ballroom was also considered due to the potential for a high density of fuel and large occupant loads. After careful deliberation, the meeting scenario was eliminated.

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[15] SFPE HB 4th edition, page 3-379.

[16] FDS User's Guide, NIST Special Publication 1019, 6th edition, page 149.

[17] U.S. Fire Administration National Fire Incident Reporting System, 2005-2007.

Although the initial concerns are accurate, occupants attending events are generally alert and ample egress opportunities are provided. A fire in these spaces should be discovered early such that prompt egress could then ensue.

The design fire selected simulates a fire ignited within a guest room trash can that then ignites a mattress. The mattress is assumed to be unmodified flexible polyurethane foam covered with bedding material. Characteristics of the fire are based upon full-scale testing by NIST for the validation of the fire model Hazard I. [18]

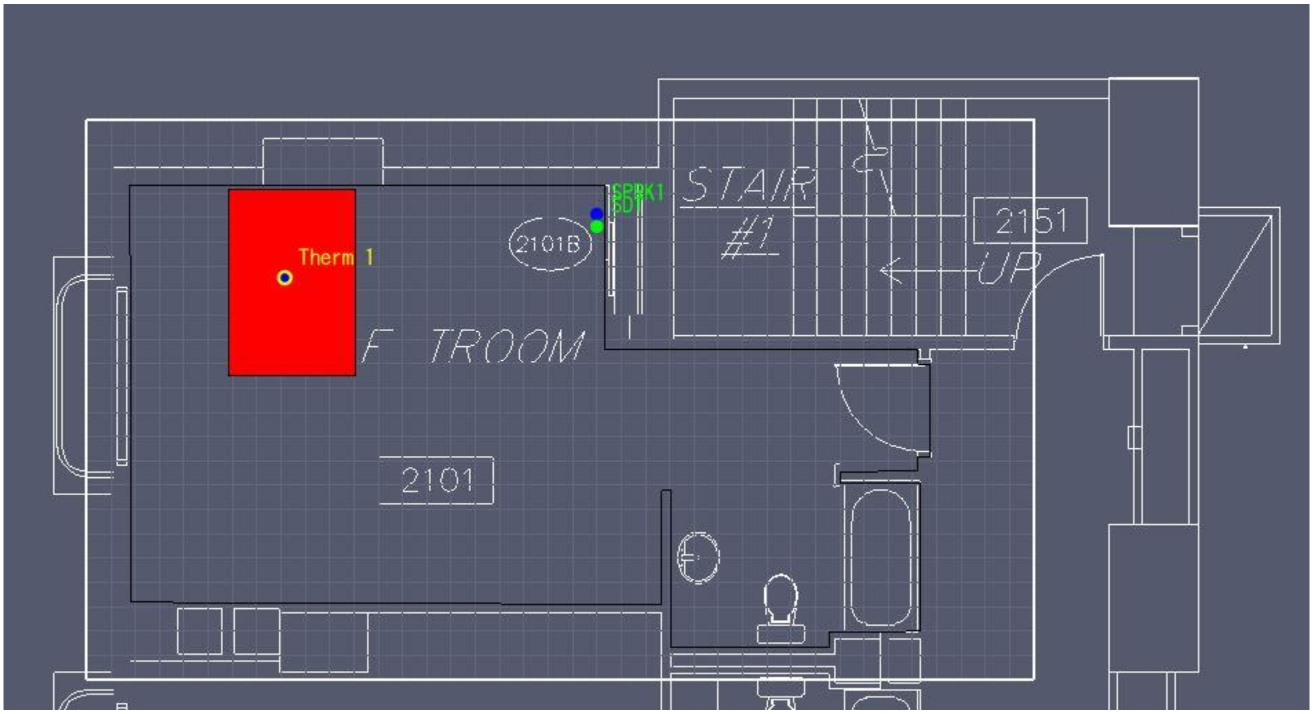

**Figure 11: Guestroom Layout**

Selection of this design fire is considered very conservative. Due to the high frequency of fires occurring in sleeping rooms, many involving fatalities, much work has been completed to modify the burning characteristics of mattresses. The Consumer Product Safety Commission (CPSC) published the updated version of the *Standard for the Flammability of Mattresses and Mattress Pads* (16 C.F.R. part 1632) in 2014. The intent of this standard was to reduce the unreasonable risk of property damage, burn injuries, and deaths from fire associated with mattresses and mattress pads when exposed to a smoldering ignition source, such as lit cigarette. [19] The performance requirement of this standard is a limitation of char length of the specimen to 2 inches. Pilot ignition is used to simulate a smoldering cigarette.

A more recent standard was published by the CPSC to address the ignition of mattresses by open flame. The igniter for the test is two gas burners intended to simulate burning bedclothes. Mattresses complying with CPSC *Standard for the Flammability (Open Flame) of Mattress Sets* (16 CFR 1633, March 15, 2006) will generate a smaller fire size with a slower growth rate, thus reducing the possibility of flashover occurring. [20] The performance standards used for this testing are a limitation of peak heat release rate to 200 kW within a 30-minute test and a total heat release of 15 MJ, for the first 10 minutes of the test.[21]

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[18] Kim, Hyeong-Jim and Lilley, David G., Heat Release Rates of Burning Items in Fires, AIAA 2000-0722. January 10, 2000.

[19] Consumer Product Safety Commission (CPSC), Standard for the Flammability of Mattresses and Mattress Pads (16 C.F.R. part 1632).

[20] Consumer Product Safety Commission (CPSC), Standard for the Flammability (Open Flame) of Mattress Sets (16 C.F.R. part 1633).

[21] IBID.

The use of the unmodified polyurethane mattress is a conservative assumption given the difference in heat release rates between the unmodified mattress and the CPCS complaint mattress (1577 kW vs 200kW, respectively).

To simulate a sprinkler-controlled fire, sprinkler activation time was predicted using FDS. Results showed that the sprinkler activation occurred at 70 seconds. After the point, fire growth was assumed to be constant for the remainder of the simulation. The heat release rate of the fire, design fire specifications, and sprinkler/smoke detector details are shown in Figure 12, Table 14, and Table 15 respectively.

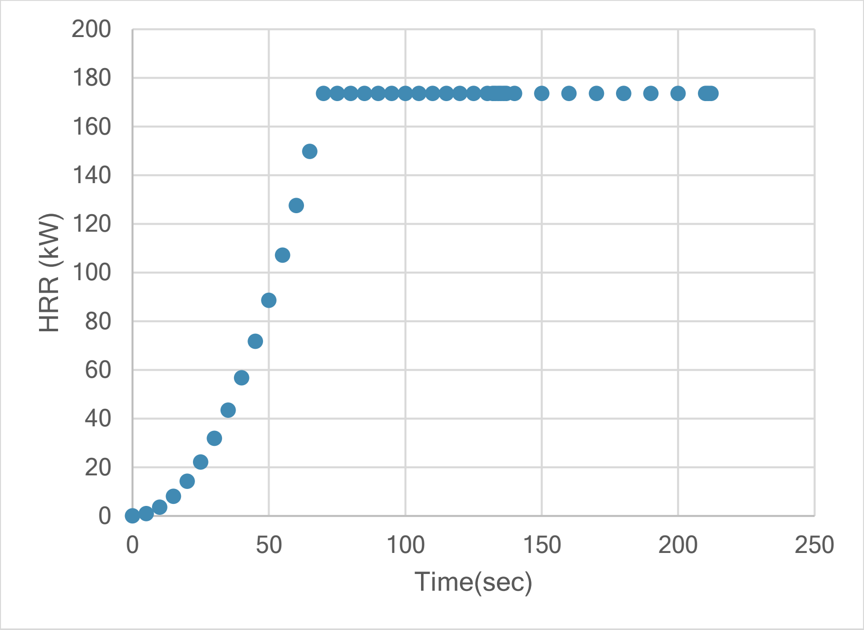

**Figure 12: Design Fire Heat Release Rate Curve**

**Table 14: Design Fire Specification**

| Fuel Description | Fire Characteristics | Ignition Method | Source of Data[22] |
|---|---|---|---|
| Mattress, Polyurethane foam with rayon ticking and bedding.<br>2.5 meters² | Fire growth constant = 0.035431 (kW/sec²)<br>Fire decay constant = 0.007687 (kW/ sec²)<br>Flexible Polyurethane foam material (Heat of combustion- 17.4 kJ/g)<br>Max HRR=1577.4 kW, HRR at sprinkler operation = 173 kW | Wastepaper Basket, 0.74 Kg | Mattress MAT001 |

**Table 15: Fire Sprinkler and Smoke Detector Details**

| Compartment | Device Type | Device Location | Ceiling Height (m) | RTI (m-s) ½ | Activation Temperature (°C) | Activation Obscuration (%/m) |
|---|---|---|---|---|---|---|
| Guest Room 2101 | Photoelectric smoke detector | See guestroom layout | 2.6 | NA | NA | 21 |
|  | Sidewall residential sprinkler, ½ in. orifice | See guestroom layout | 2.6 | 50 | 74 | NA |

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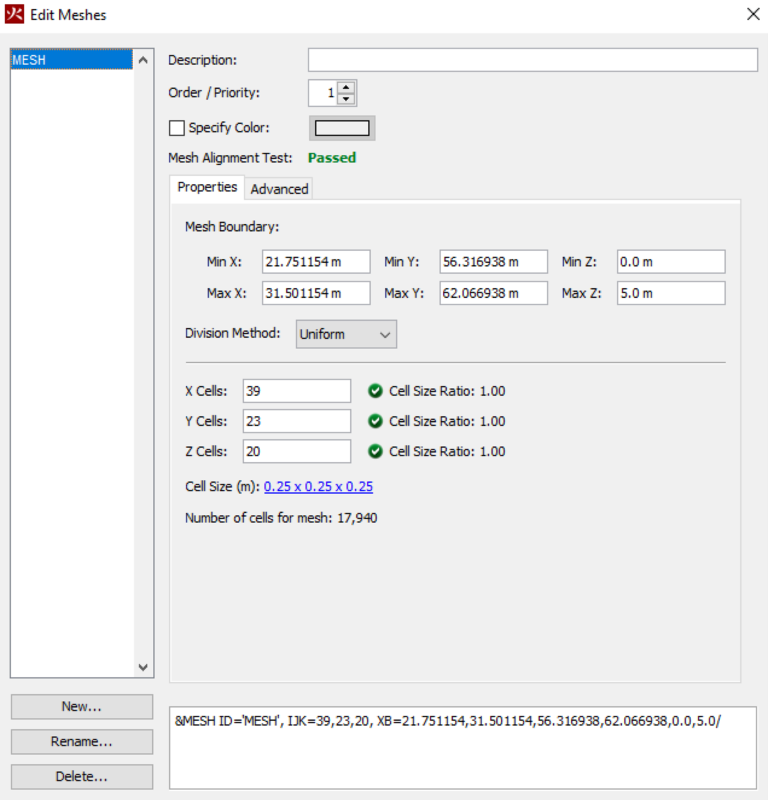
[22] Kim, Hyeong-Jim and Lilley, David G., Heat Release Rates of Burning Items in Fires, AIAA 2000-0722. January 10, 2000.

FDS uses the *simple chemistry model* to predict combustible. This model considers a single fuel species primarily consisting of carbon, hydrogen, and oxygen that reacts with oxygen to form water vapor, carbon dioxide, soot, and carbon monoxide.[23] The fuel reaction data used in the model is shown in Table 16. Fire product yield data is from Test GM 27, as measured in the ASTM E2058 fire apparatus. [24]

**Table 16: Design Fire Fuel Reaction Data**

| Reaction Fuel | Atom Count | Species | Yield [25] |
|---|---|---|---|
| Carbon | 1.0 | Carbon Monoxide | 0.042 |
| Hydrogen | 1.7 | Soot | 0.198 |
| Oxygen | 0.3 | | |
| Nitrogen | 0.08 | | |

FDS calculations are performed within a domain that is comprised or rectangular volumes know as mesh. The mesh is divided into rectangular cells. The resolution of the flow dynamics is dependent upon the cell size. The default cell size of 0.25m x 0.25m x 0.25m was used for this analysis. Using the NIST Cell Estimator tool the cell size used is between course and moderate size. This cell size was selected due to the large geometry of the model (entire hotel floor) which could potentially slow down the calculations. Figure 13 shows cell size input data.



Description:

Order / Priority: 1

☐ Specify Color:

Mesh Alignment Test: Passed

Mesh Boundary:

| | | | | | |
|---|---|---|---|---|---|
| Min X: | 21.751154 m | Min Y: | 56.316938 m | Min Z: | 0.0 m |
| Max X: | 31.501154 m | Max Y: | 62.066938 m | Max Z: | 5.0 m |

Division Method: Uniform

| | | |
|---|---|---|
| X Cells: | 39 | ✓ Cell Size Ratio: 1.00 |
| Y Cells: | 23 | ✓ Cell Size Ratio: 1.00 |
| Z Cells: | 20 | ✓ Cell Size Ratio: 1.00 |

Cell Size (m): 0.25 x 0.25 x 0.25

Number of cells for mesh: 17,940

```
&MESH ID='MESH', IJK=39,23,20, XB=21.751154,31.501154,56.316938,62.066938,0.0,5.0/
```

**Figure 13: Cell Size Input Data**

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[23] FDS User's Guide, NIST Special Publication 1019, 6th edition, page 149.
[24] SFPE Handbook Table 3-4.16, Footnote A.
[25] Fraction of fuel mass converted to the various species

FDS was used to measure the mass optical density to calculate the activation time of the smoke detector. The challenging aspect to analyzing smoke detector activation using the optical density method is selecting a prudent optical density alarm threshold. Due to the uncertainties in calculating the optical density alarm threshold, numerous fire testing programs have been completed. There is a wealth of data published on this subject. Work completed by Gottuk and Geimen was selected for determination of the optical density alarm threshold.[26] From this study, an alarm threshold of 0.14 OD/m (25 obscuration %/m) was selected. The testing results show that 86% of the photoelectric detectors alarmed for flaming fires and 83% for smoldering fires alarmed at this level.

The results of the fire modeling are shown in Table 17. Very little variation is seen between the two scenarios.

**Table 17: Fire Modeling Results**

| Scenario Number | Room Smoke Detector Activation Time (s) | HRR at Detector Activation (kW) | Sprinkler Activation Time (s) | HRR at Sprinkler Activation (kW) |
|---|---|---|---|---|
| 1 | 25 | 16 | 70 | 173 |
| 2 | 25 | 16 | 70 | 173 |

### 4.2.3 Time-based Egress Calculations

For occupant egress, the concept of required safe egress time (RSET) and available safe egress time (ASET) is used. RSET is the time needed for an occupant to safely egress from their location to a safe location where they are not threated by the effects of the fire. ASET is the time for the occupant to evacuate prior to conditions becoming untenable or life threating.

RSET is comprised of four main components (see Figure 13):[27]

- Time to notification
- Reaction time
- Pre-evacuation time
- Travel or movement time

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[26] Geiman, Justin A., and Gottuk, Daniel T., Alarm Thresholds for Smoke Detector Modeling, Fire Safety Science, 7th International Symposium.

[27] Mowrer & Rosenbaum, Fire Protection Handbook Information and Analysis for Fire Protection. Figure 3.11.4 Example Time Line for Evaluation of Available Versus Required Safe Egress Times, 2008.

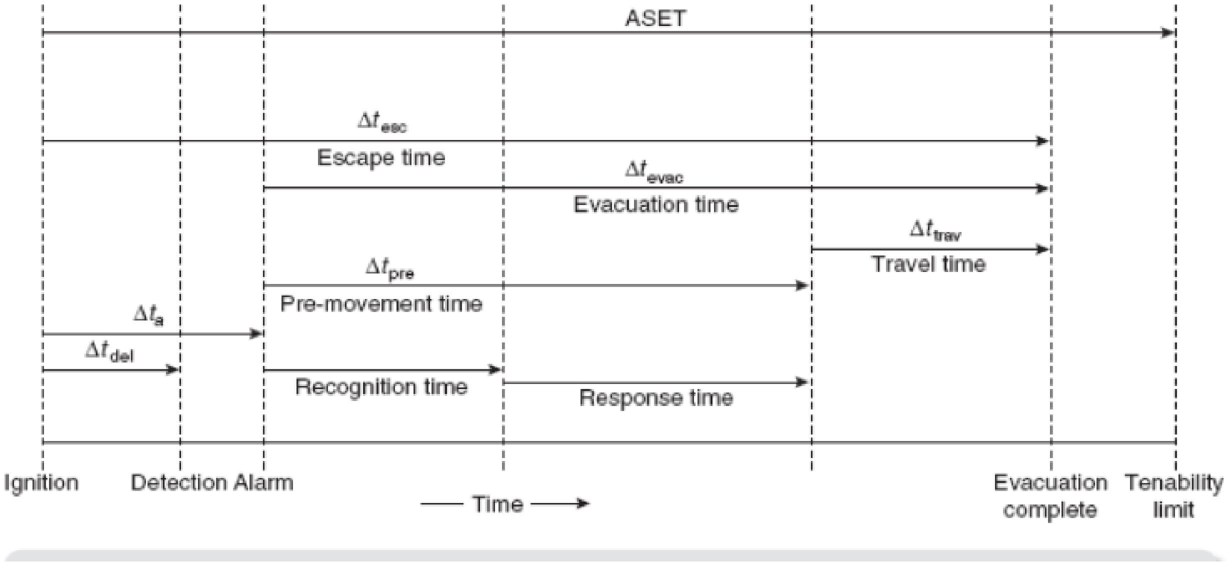

Figure 14: ASET vs RSET

The first three components can be grouped together into a general category of delay time, resulting in Evacuation time = Delay time + Travel time. These components, as applicable to this project, are discussed below.

The occupants of the hotel may consist of a diverse population. However, the hotel's brand caters to business travelers, who are assumed to be between the ages of 23-65 years old. The property is located within a historic district and thus tourists may also stay at the hotel. These two groups are generally considered ambulatory, so the egress analysis does not consider evacuation of disabled persons. Other provisions are made for this group, including specially designed rooms located in the lower hotel floors and elevator lobbies which may serve as areas of refuge, until responders arrive to provide evacuation assistance.

The time to notification is the period before occupants begin to sense the cues of the fire. As explained earlier, the Gaslamp Hotel has a modern EVACS, which includes system smoke detectors in the corridors and local smoke detectors in each guest room.

The time to notification is the period before occupants begin to sense the cues of the fire. Based upon the fire modeling analysis the local room smoke detector activates in 25 seconds from ignition, depending on fire location and characteristics. Activation of the first room fire sprinkler will result in a water flow alarm, which activates the building's fire alarm system. Based upon the fire modeling analysis the sprinkler will activate within 70 seconds from fire ignition.

Very early, within the initial fire development period, however, the occupants within the hotel room of fire origin may be exposed to variety of cues which signify a fire event. This can include smell, sight of flames, or sounds of glass breaking. Since the room occupants are likely intimate to the fire ignition (smoking cigarettes in bed, malicious activity, building device short circuit, etc.) the recognition of the fire event may occur promptly. It is assumed these occupants respond to local smoke detector activation and are out of the room within 60 seconds.

Quantification of when occupants not intimate with fire ignition will recognize a fire situation is very challenging given the lack of hard data to analyze. It is prudent to assume that the notification time is when building fire alarm system activates. Once a sprinkler activates, the flow switch sends a signal to the fire alarm panel. The flow switch is equipped with a delay, or retard feature, which can be programmed to delay the delivery of the alarm signal to the fire alarm panel. The purpose of this is to eliminate false alarms caused by fluctuations in water pressure. NFPA 72 Section 10.13.1 allows a maximum delay time of 90 seconds. Once the signal is received by the fire alarm panel, the building EVACS will activate flashing strobe lights and a pre-recorded message.

Given the first sprinkler activation at 70 seconds and the subsequent activation of the fire alarm system, the time to notification is assumed to be 160 seconds. For the Evacuation Condition 2, this would include notification of the occupants located on the fire floor, floor above. For Evacuation Condition 1 this would include all occupants of the building. The occupants of the guestroom of fire origin are assumed to have left the room much earlier, as previously discussed.

The reaction time is the time it takes occupants to perceive the fire cues or alarm signals and take action. It is expected the processing time would be limited within the room of fire origin, given the simplicity of the situation. However, occupants not intimate with fire ignition will need additional time to recognize the available clues.

Pre-evacuation is the time it takes the occupant to begin evacuation or seek refuge once the decision has been made to react. The occupants could exhibit a variety of behaviors, including packing their belongings, prior to exiting the room.

As previously stated, calculating the delay time until occupants react is very difficult. Work done by the British Standards Institute in 1997 provides a credible estimate that can be used for RSET calculations.[28] As shown in Figure 14, for hotel occupancies, given a voice evacuation system is provided, a delay time of 4 minutes is estimated.

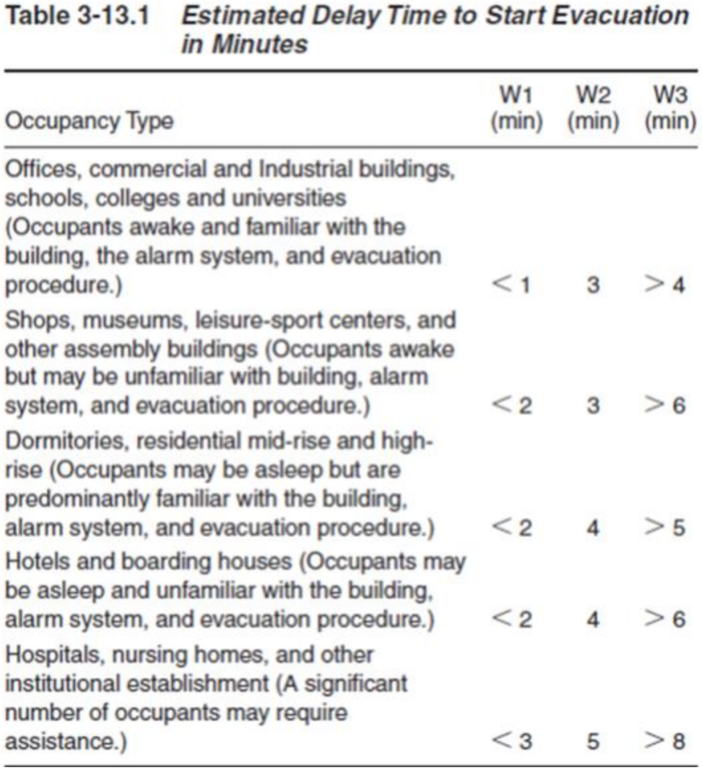

**Table 3-13.1** ***Estimated Delay Time to Start Evacuation in Minutes***

| Occupancy Type | W1 (min) | W2 (min) | W3 (min) |
|---|---|---|---|
| Offices, commercial and Industrial buildings, schools, colleges and universities (Occupants awake and familiar with the building, the alarm system, and evacuation procedure.) | < 1 | 3 | > 4 |
| Shops, museums, leisure-sport centers, and other assembly buildings (Occupants awake but may be unfamiliar with building, alarm system, and evacuation procedure.) | < 2 | 3 | > 6 |
| Dormitories, residential mid-rise and high-rise (Occupants may be asleep but are predominantly familiar with the building, alarm system, and evacuation procedure.) | < 2 | 4 | > 5 |
| Hotels and boarding houses (Occupants may be asleep and unfamiliar with the building, alarm system, and evacuation procedure.) | < 2 | 4 | > 6 |
| Hospitals, nursing homes, and other institutional establishment (A significant number of occupants may require assistance.) | < 3 | 5 | > 8 |

Figure 15: Delay Time Estimation

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[28] British Standard Institute, DD London 1997. Fire Safety Engineering in Buildings, Part 1, Guide to the Application of Fire Safety Principals, Table 21.

The RSET for each evacuation condition is shown in Tables 18 and 19.

**Table 18: RSET Calculations Evacuation Condition 1 - Global Evacuation**

| Time Increments | Calculated Time (min) | Notes |
|---|---|---|
| Time to notification | 2.6 | Sprinkler activation plus alarm signal delay |
| Delay to start of evacuation | 4 | Defining this as reaction and pre-evac time (i.e. time to notification is added separately) From British Standards Institute, 1997 work. |
| Travel time | 11 | |
| Subtotal | 17.5 | |
| Safety Factor (1.5) | 8.75 | Engineering judgement, considered CBC Section 909.4.6 |
| RSET | 26.25≈ 26 | |

**Table 19: RSET Calculations Evacuation Condition 2 - Zoned Evacuation of Fire Floor, Floor Above, and Floor Below**

| Time Increments | Calculated Time (min) | Notes |
|---|---|---|
| Time to notification | 2.6 | Sprinkler activation plus alarm signal delay |
| Delay to start of evacuation | 4 | Defining this as reaction and pre-evac time (i.e. time to notification is added separately) From British Standards Institute, 1997 work. |
| Travel time | 2 | |
| Subtotal | 8.5 | |
| Safety Factor (1.5) | 4.25 | Engineering judgement, considered CBC Section 909.4.6 |
| RSET | 12.75≈13 | |

#### 4.2.3.1 Limitations

The science of occupant behavior and egress characteristics is still developing. The broad range of variables that affect occupant behavior and egress ability is staggering and can differ greatly depending on numerous factors. For example, occupants in one region of the United States may have lower overall physical fitness due to eating habits, exercise opportunities, etc. than groups in other areas. One would conclude that movement times for the former group would then be slower that the latter group. However, the criteria found in various sources commonly used to calculate egress times are not categorized to this level.

Work completed by Gwynne showed that the maximum specific flow rates for stairs found in various sources are generally optimistic[29]. In other words, occupants may travel through stairs much slower than thought.

In addition to the variability of the various factors which affect occupant behavior and egress, these factors are potentially ever changing. Education, situational awareness, and other factors are generationally variable. The behavior of a population from the mid-1970s may not behave the same as a similar group in 2017.

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[29] Gwynne, Steven, et al, Fire Safety Journal 44, 2009, Questioning the Linear Relationship Between Door Width and Achievable Flow Rate.

All this information should be considered when preparing a performance-based egress analysis. Engineering judgement should be used to develop and apply adequate safety factors which can compensate for the uncertainties of occupant behavior and egress.

A safety factor of 1.5 was used in the analysis based upon the requirements of the California Building Code, and engineering judgement.

### 4.2.4 Tenability Analysis

To evaluate the conditions created by the fire at a point in time, and how these conditions will affect occupant evacuation, a tenability analysis is completed. This process allows one to thoughtfully establish thresholds beyond which occupants will not be safe during their evacuation from the building. Once these limits were set, FDS is used to calculate the experimental conditions which will result from a given fire scenario. From this evaluation, ASET or available safe egress time is determined.

Conditions to be considered include:

- Time to incapacitation due to the effects of asphyxiant gases
- Time to incapacitation due to heat exposure
- Time when optical density is significantly impaired such that egress efficiency is lost

The most common asphyxiant gases produced by fires are carbon monoxide (CO) and Hydrogen Cyanide (HCN). Review of fire fatality data suggests that CO exposure may be the major ultimate cause of death in most fires where serious burns are not present.[30]

CO affects victims by replacing the oxygen carried by hemoglobin in the blood. The two form a substance known as carboxyhemoglobin (COHb) which hinders oxygen absorption and ultimately causes death due to asphyxiation. The results of several studies are presented below:

- In a study of fire victims, 54% of the fatalities were found to have COHb levels in excess of 50%, which is considered a lethal level, and 69% of the fatalities were found to have COHb levels in excess of 30%, which is considered to be an incapacitating level.[31]
- Data from accidental exposures and low-level experimental human exposures indicate that loss of consciousness can occur at COHb levels of 30% to 40%.[32]
- The first effects in human subjects, which normally consisted of headaches, occurred at COHb levels of 15% to 20%, but at these levels, there were only minor deficits in behavioral performance.[33]

From this data, it is prudent to establish a level of 30% COHb as threshold for incapacitation (due to the loss of consciousness).

Unlike CO, which is absorbed into the blood stream relatively slowly, hydrogen cyanide affects victims much quicker. Because one of the early symptoms of hydrogen cyanide is hyperventilation, the rate of uptake of species increases greatly. Limited data on human exposure to concentrations of 100 ppm indicates that incapacitation occurs after 20 minutes, and at concentrations of 180 ppm, incapacitation occurs after only two minutes.[34]

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[30] SFPE Handbook, 5th edition, page 2220.
[31] SFPE Handbook, 5th edition, page 2334.
[32] SFPE Handbook, 5th edition, page 2347.
[33] SFPE Handbook, 5th edition, page 2331.
[34] SFPE Handbook, 5th edition, page 2222.

The analysis of this hazard is problematic because fuel composition data for hydrogen cyanide production is not readily available. Therefore, an evaluation of hydrogen cyanide concentrations was not performed for this project. The effect of other asphyxiant gases and irritants produced by the fire were considered minor for the purposes of this analysis as well.

The consequences of exposure to heat is another factor to consider when completing a tenability analysis. Radiant heat exposure can affect occupants who are intimate to the fire origin. The effects of this exposure include pain, redness, and burns. Figure 15 summarizes the limits of tenability from heat exposure. Heat exposure seems unlikely given the building is fully sprinklered. However, a limiting heat flux of approximately 2.5 kW/m², was selected.[35]

Exposure to convective heat is also important to consider. Potential consequences of such exposure include heat stroke (Hyperthermia), skin burns, and respiratory tract burns. It is assumed that convection heat exposure could occur when guestroom occupants are traveling down the corridor to the stair enclosure due to smoke that has migrated out of the room of origin via an open door. Using a maximum unimpeded flow speed of 168 ft. /min.[36], and a travel distance of 220 feet, results in travel time of 1 minute. Adding a safety factor of 2, a travel time of two minutes is estimated. Therefore, a two-minute exposure to a dry air temperature of 160° F will be used as the limiting convection heat exposure criteria.

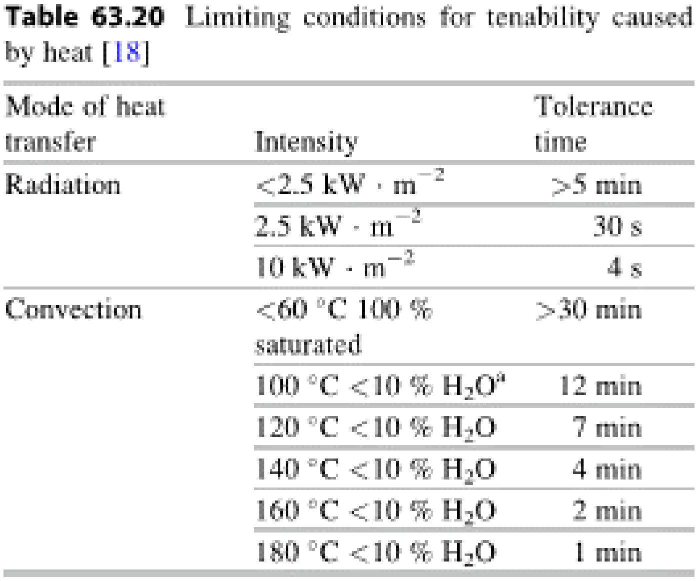

**Table 63.20** Limiting conditions for tenability caused by heat [18]

| Mode of heat transfer | Intensity | Tolerance time |
|---|---|---|
| Radiation | $<2.5\ \mathrm{kW \cdot m^{-2}}$ | >5 min |
| | $2.5\ \mathrm{kW \cdot m^{-2}}$ | 30 s |
| | $10\ \mathrm{kW \cdot m^{-2}}$ | 4 s |
| Convection | <60 °C 100 % saturated | >30 min |
| | 100 °C <10 % $H_2O^a$ | 12 min |
| | 120 °C <10 % $H_2O$ | 7 min |
| | 140 °C <10 % $H_2O$ | 4 min |
| | 160 °C <10 % $H_2O$ | 2 min |
| | 180 °C <10 % $H_2O$ | 1 min |

**Figure 16: Limiting Conditions for Tenability Caused by Heat** [37]

Visibility is an important consideration when predicting occupant fire behavior. Studies indicate that occupants will move through smoke to evacuate a fire condition. Occupant movement thru smoke can occur when visibility is in the range of 3-4 meters.[38] It is recognized that some percentage of occupants will change direction and retreat in reduced visibility situations. Studies show that approximately 30% of occupants turned back rather than travel through low visibility conditions.[39] The average visibility at which people retreat was 3 meters.[40] Based upon this information, a 3-meter visibility criterion will be used.

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[35] SFPE Handbook, Table 4.2.7.

[36] IBID.

[37] SFPE Handbook of Fire Protection Engineering, 5th Edition, Table 63.20.

[38] J.L. Bryan, Smoke as a Determinant of Human Behavior in Fire Situation, National Bureau of Standards, Washington, D.C., 1977. SFPE Guide to Human Behavior in Fire, Second edition, pages 46-47. Conversations with Dan O'Connor, Chair, SFPE Task Group on Human Behavior in Fire

[39] IBID

[40] IBID

In summary, the tenability criteria that was selected is shown below.

**Table 20: Tenability Criteria**

| Criteria | Limit |
|---|---|
| Carbon Monoxide | 30% COHb |
| Visibility | 3 meters |
| Radiant Heat Flux | 2.5 kW/m$^2$ |
| Temperature | 160°C (320°F) air < 10% H2O for 2 minutes |

FDS modeling is used to establish the actual conditions which occupants were exposed to as they evacuate. This data was analyzed and ultimately compared to the previously established tenability criteria.

If occupants can evacuate the building prior to conditions become untenable (ASET>RSET) the egress system will be meet the performance criterion established, that any occupant who is not intimate with ignition will not be exposed to instantaneous or cumulative untenable conditions. Then the egress system meets the requirements of the Life Safety Code. Since this building is in a jurisdiction which uses the CBC, the analysis would be submitted for approval as an alternate design approach.

#### 4.2.4.1 Tenability Analysis Results

Figure 16A presents a rendering of the fire floor. Guestroom 2101, the room of fire origin, is shown in the upper left corner of the rendering. The corridor evaluated in the model is also shown. Conditions were evaluated at 1.82 meters (6 ft.) above the floor level. Figures 16-25 show slice file renderings of various conditions. Note that only the results for Evacuation Condition 2 – Zoned Evacuation of the fire floor, floor above, and floor below, are presented. Evacuation Condition 1 – Global Evacuation of the building is used for the structural analysis, which is described later in this report.

Figures 17, 20, and 25 show the CO levels within the guestroom and the fire floor corridor at various times. The CO data was converted to percentage COHb for comparison to the tenability limit sent. From experimental human exposure testing, Steward derived the following equation, which was used to calculate %COHb from CO data:[41]

$\%COHb = (3.317 \times 10^{-5})\ (ppm\ CO)^{1.036}\ (RMV)(t)$

Where:

ppm CO= CO concentration(ppm)
RMV= Volume of air breathed(L/min)
T= exposure time(minutes)

An RMV number of 25 liters/min was used, which is based upon lite walking during egress.[42]

COHb calculations are presented in Table 21. Values are below the established performance criteria.

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[41] SFPE Handbook, 4th edition, page 2-116.
[42] IBID.

Table 21: %COHb Calculations

| Scenario | Location | Exposure Time (mins) | RMV (L/min) | CO Mole/mole | CO (ppm) | COHb (%) |
|---|---|---|---|---|---|---|
| 1-Door closed | Guest Room | 1 | 25 | 0.00031 | 310 | 0.32 |
| 2-Door open | Guest Room | 1 | 25 | 0.00016 | 160 | 0.16 |
| 2-Door open | Fire Floor Corridor | 2 | 25 | 0.00022 | 220 | 0.44 |
| 2-Door open | Fire Floor Corridor | 2 | 25 | 0.00061 | 610 | 1.27 |

The overall results of the modeling effort are shown in Table 22. The results show that the occupants within the guestroom of origin will safely egress the guestrooms prior to loss of tenability, regardless of the door position, ASET>RSET. Egress of these occupants is considered reasonably safe.

The results also show that the fire floor corridor losses visibility at 205 secs (see Figure 22). Using the calculated RSET value of 780 secs., ASET <RSET, and therefore conditions are considered unsafe.

Occupants above or below the fire floor are protected by passive construction and therefore unaffected.

Table 22: Modeling Results-Evacuation[43]

| Scenario | Location | Guest RM Door Position | Visibility (m) | COHb % | Temp (C) | RSET (secs) | ASET (secs) | Pass/Fail |
|---|---|---|---|---|---|---|---|---|
| **Number 1** | Guest Room | Closed | 3@60s | 8@60 s | 71@97 s | 60 | 60 | P |
| | Fire floor corridor | | Unaffected | Unaffected | Unaffected | Unaffected | Unaffected | P |
| | Floor above or below | | Unaffected | Unaffected | Unaffected | Unaffected | Unaffected | P |
| **Number 2** | Guest Room | Open | 3@60 s | 2.28@60 s | 71@110 s | 60 | 60 | P |
| | Fire floor corridor | | 3@250 s | 2.4 @ 800 s | 42@800 s | 780 | 205 | P (See discussion) |
| | Floor above or below | | Unaffected | Unaffected | Unaffected | Unaffected | Unaffected | P |

## 4.2.5 Discussion/Conclusion

Most complex issues are clouded by an abundance of complication. The visibility criteria used is based upon the opinions of a group of well recognized human behavioral scientists. [44] However, in this case there is more information to consider.

The guestroom occupants will be entering the corridor at approximately 390 secs. (time to notification plus delay to start of evacuation) and make their way towards the stair enclosure. Visibility at this point will be less than 3 meters. They continue in the corridor for 120 seconds and then enter the stair enclosure where conditions are tenable.

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[43] Only results for Evacuation Condition 2- Zoned evacuation of the fire floor, floor above, and floor below are shown.

[44] SFPE Guide to Human Behavior in Fire, Second edition

As noted previously, the visibility performance criteria used is based upon data that suggests 30% of the occupants will retreat when visibility decreases to 3 meters, at 1.82 meters above the floor.

Human behavior studies have shown that the presence of others can influence behavior and decision making.[45] Informational social influence, as it is called, is when people observe the behavior of others and possibility follow that behavior.[46] Informational social influence has been demonstrated in the herding behavior which can occurs during exit choice.[47] During the evacuation of the fire floor, approximately 200 people will exit their guestrooms to investigate conditions or egress to the exit. From the research presented, 70% of the occupants will continue through the low visibility condition to the exit. Social influence could increase that percentage.

Familiarity with the exit route also may influence occupants to travel through low visibility conditions. Research shows occupants tend to exit the building through familiar routes, the same routes they entered the building thru.[48] Other than using the elevator vs stairs to travel vertically in the building, the Gaslamp Hotel ingress and egress systems are the same. The use of the exit system in non-emergency conditions will provide occupants with some level of familiarity should emergency evacuation be required.

The visibility tenability limit is measured at 1.82 meters (6 feet), which is assumed to be above the head level of most occupants. Visibility is improved below this level which may motivate occupants to duck below the smoke layer to egress the floor.

Conservative assumptions have been made regarding design related issues. The design fire heat release rate is assumed to stay constant after sprinkler operation when in most cases the heat release will decrease or the fire will be extinguished. As a result, smoke production would be decreased and visibility would be improved from that modeled.[49] The delay in fire alarm activation due to sprinkler water flow has been maximized at 90 seconds. This further delays the start of egress.

Based upon the above narrative, it is determined that the occupants on the fire floor can safely exit through the corridor to reach the stairway despite the reduced visibility. Given temperature and toxicity are not within harmful levels, safe egress can be accomplished. The occupants will be provided with an environment that is reasonably safe from the fire event. The primary goal of the performance-based analysis is then accomplished. The results also show that the occupants of the guestroom of fire origin should exit their room prior to conditions becoming untenable. This assumes the occupants are ambulatory when the fire event occurs.

Despite the convection of the above statements, a minor addition to fire protection/life safety features of the building is suggested. Additional low-level exit signs should be added to the guestroom corridors to provide enhanced directional clues during occupant egress. The signs should be spaced at 6 meters along the corridor walls. Other installation requirements of CBC Section 1013.7, regarding low-level exit signs, should be followed as well.

---

[45] G. Proulx, “Occupant Behavior and Evacuation,” National Research Council Canada, Ottawa, Canada, 2001

[46] D. Nilsson and A. Johansson, “Social influence during the initial phase of a fire evacuation- Analysis of evacuation experiments in a cinema theater,” Fire Safety Journal, vol 44, no.1, pp 71-79, 2009.

[47] B. Lantane and J.M. Darley, “Group Inhibition of Bystander Intervention in Emergencies,” Journal of Personality and Social Psychology, vol.10, no.3, pp 215-221, 1968.

[48] SFPE Guide to Human Behavior in Fire, Second edition 2019, page 16

[49] M. Ahrens, U.S Experience with Sprinklers, NFPA, July 2017, Fact Sheet-Research

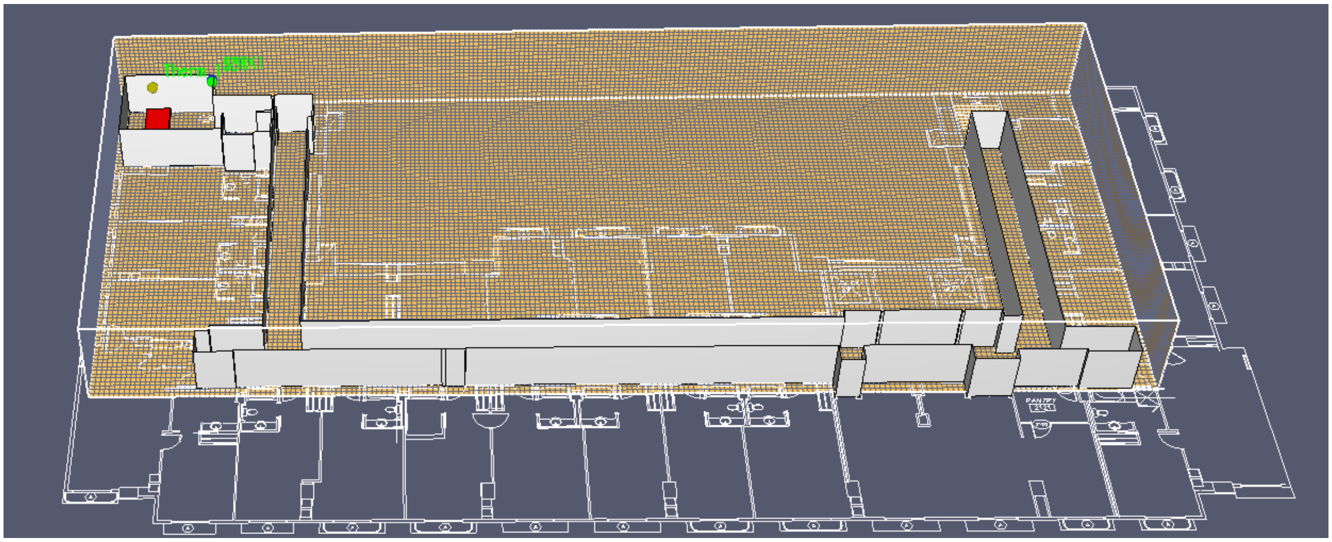


Figure 17: FDS Modeling Orientation

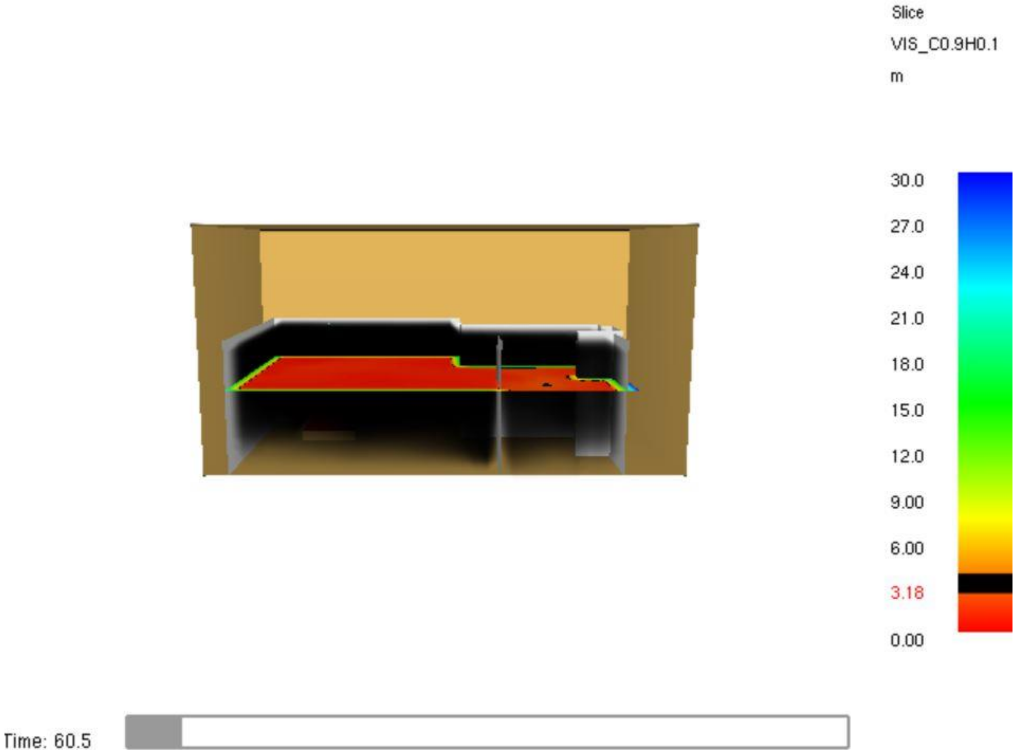


Figure 18: Guestroom Door Closed - Guestroom Visibility

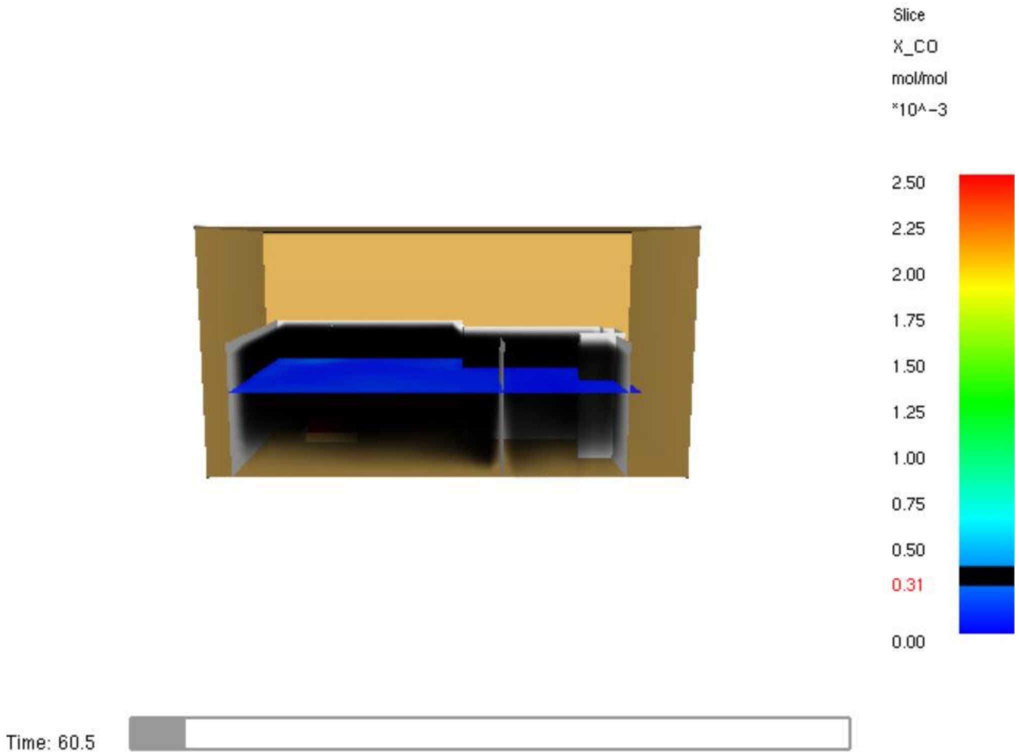


Figure 19: Guestroom Door Closed - Guestroom Co%

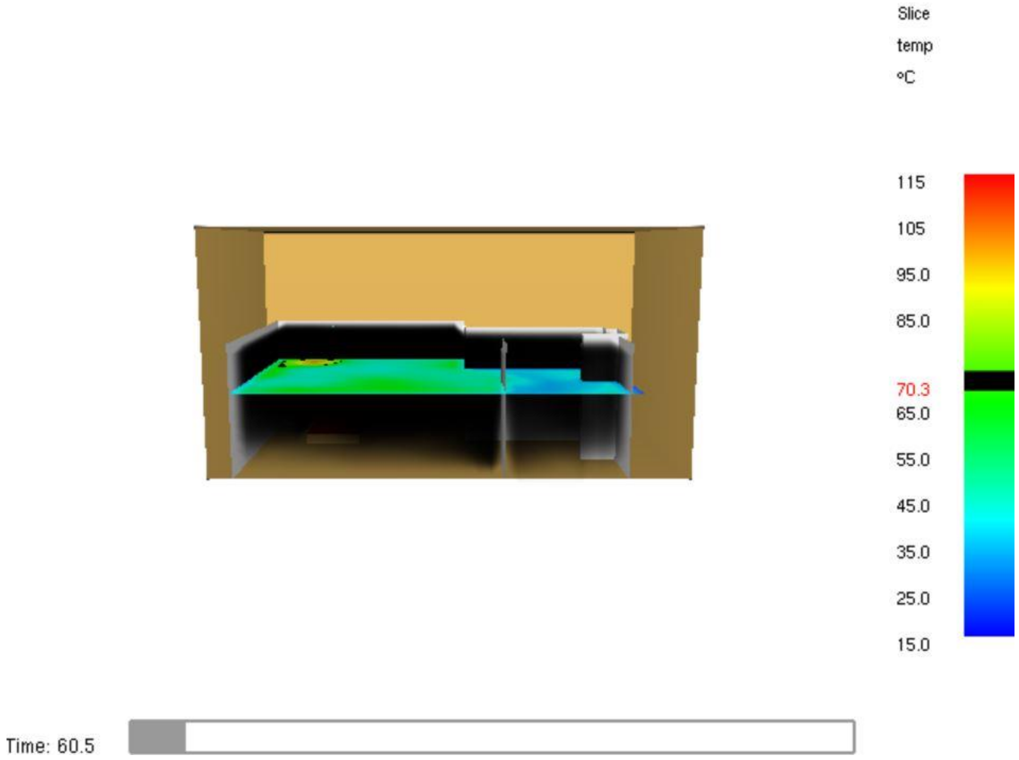


Figure 20: Guestroom Door Closed Temperature

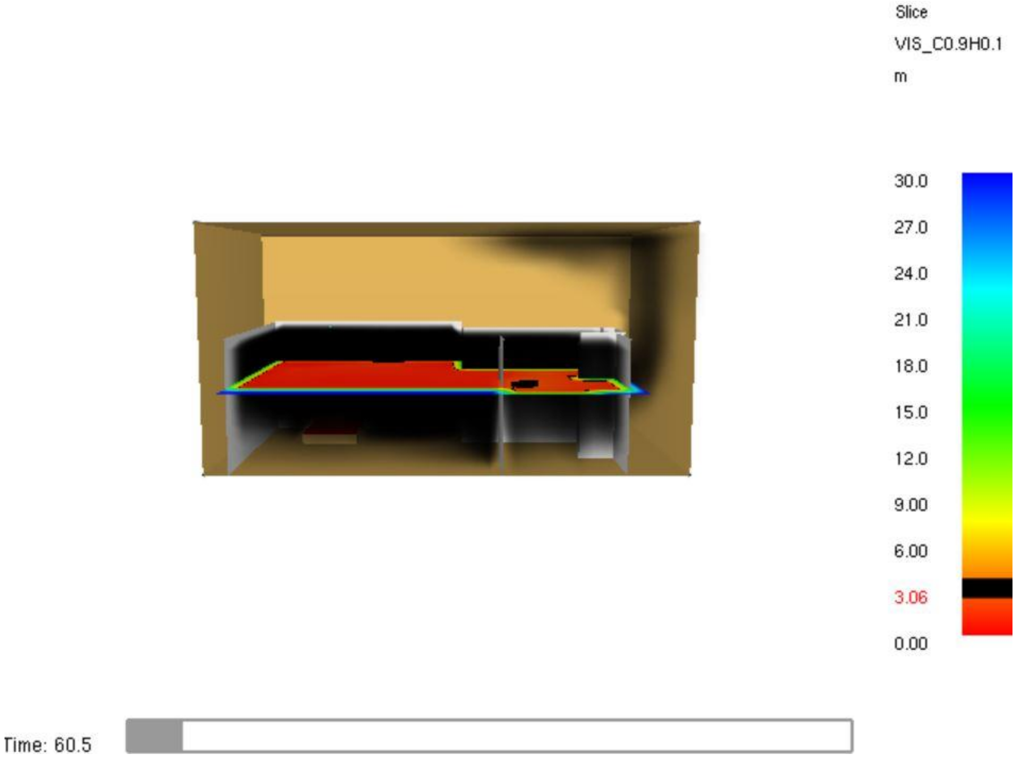


Figure 21: Guestroom Door Open - Guestroom Visibility

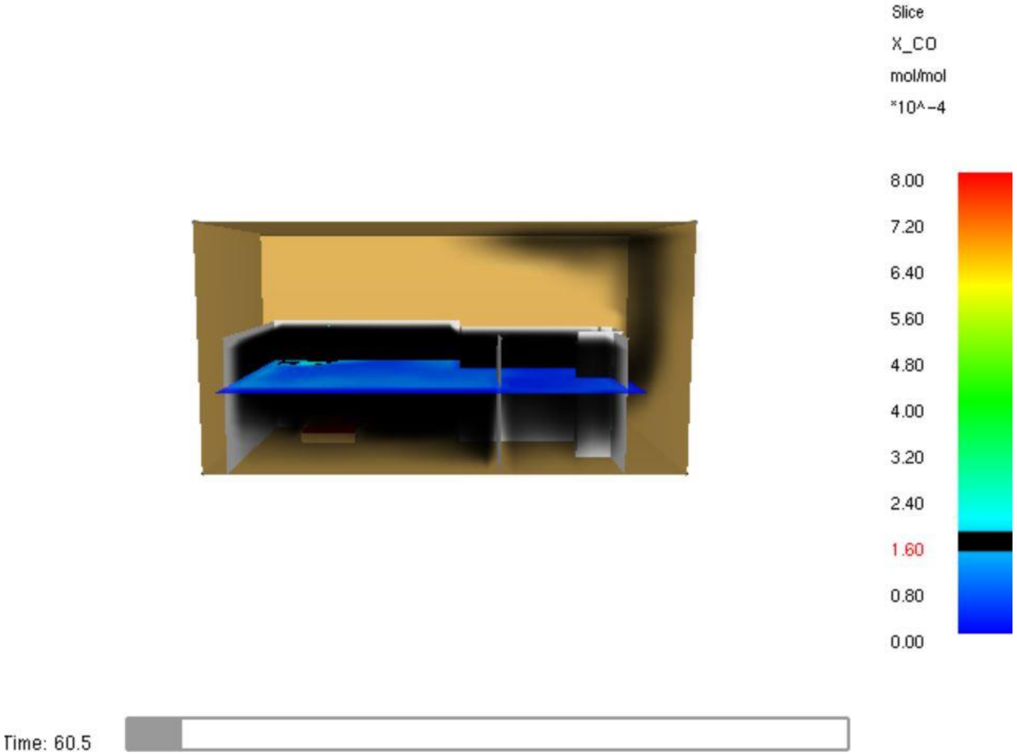


Figure 22: Guestroom Door Open - Guestroom C0%

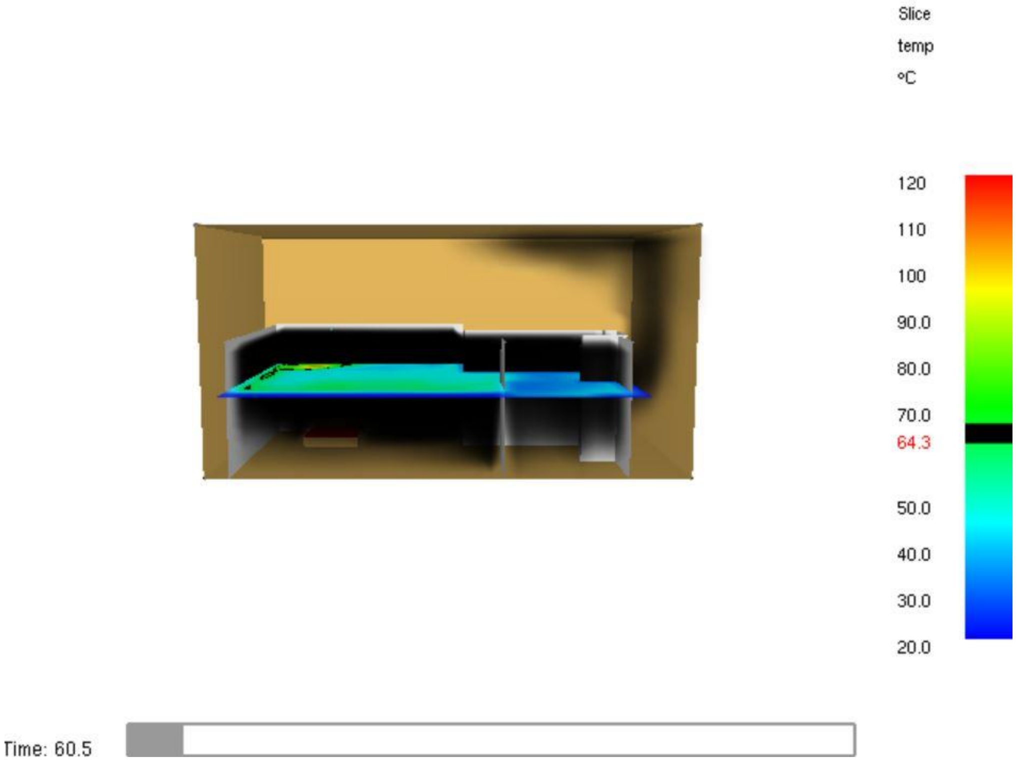


Figure 23: Guestroom Door Open - Guestroom Temperature

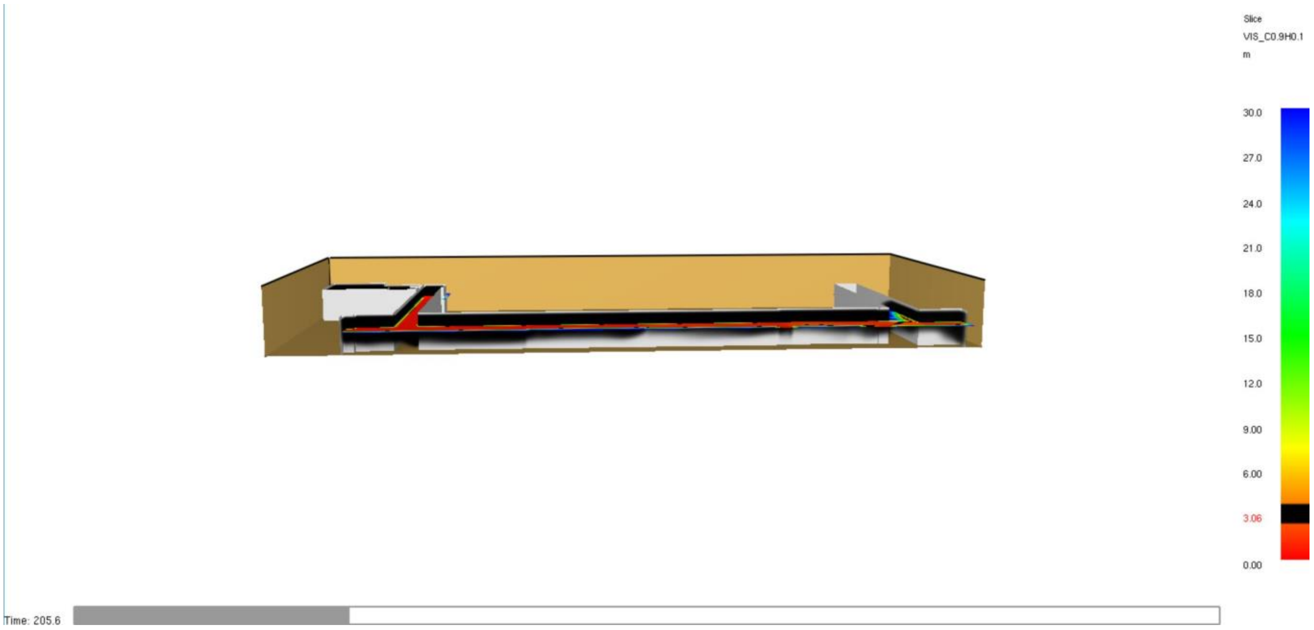


Figure 24: Guestroom Door Open - Fire Floor Visibility Lost @ 205 secs

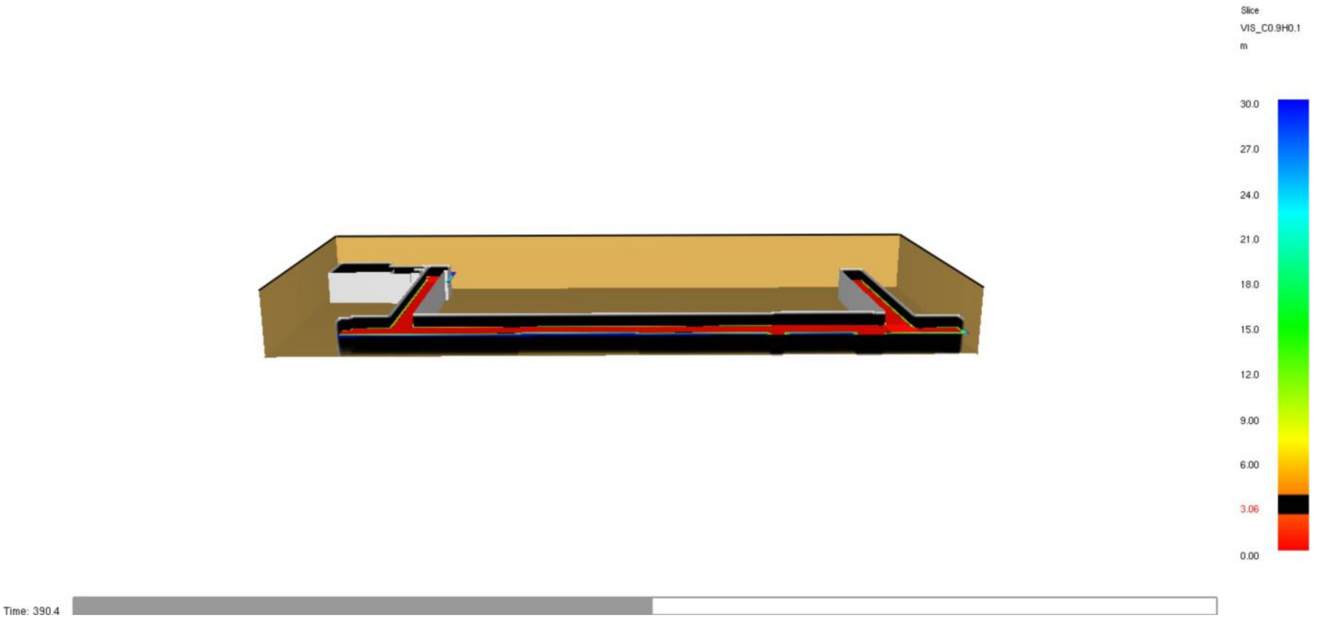


Figure 25: Guestroom Door Open - Fire Floor Visibility @ 390 seconds

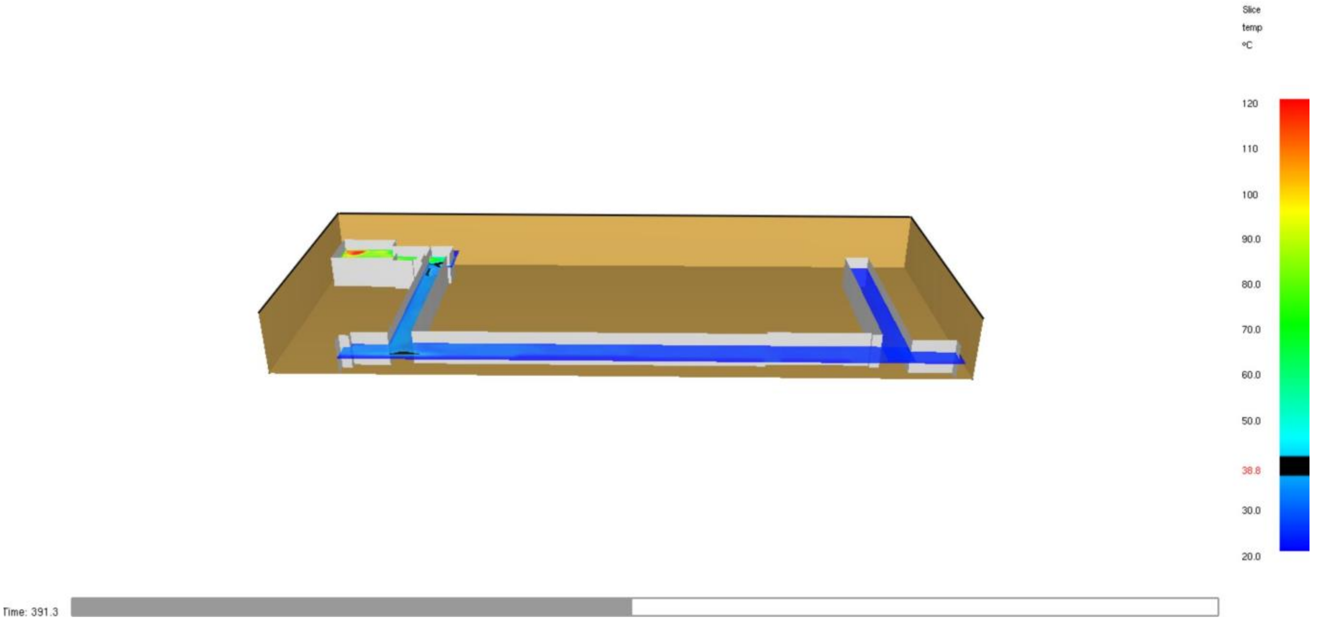


Figure 26: Guestroom Door Open - Fire Floor Temperature @ 390 secs

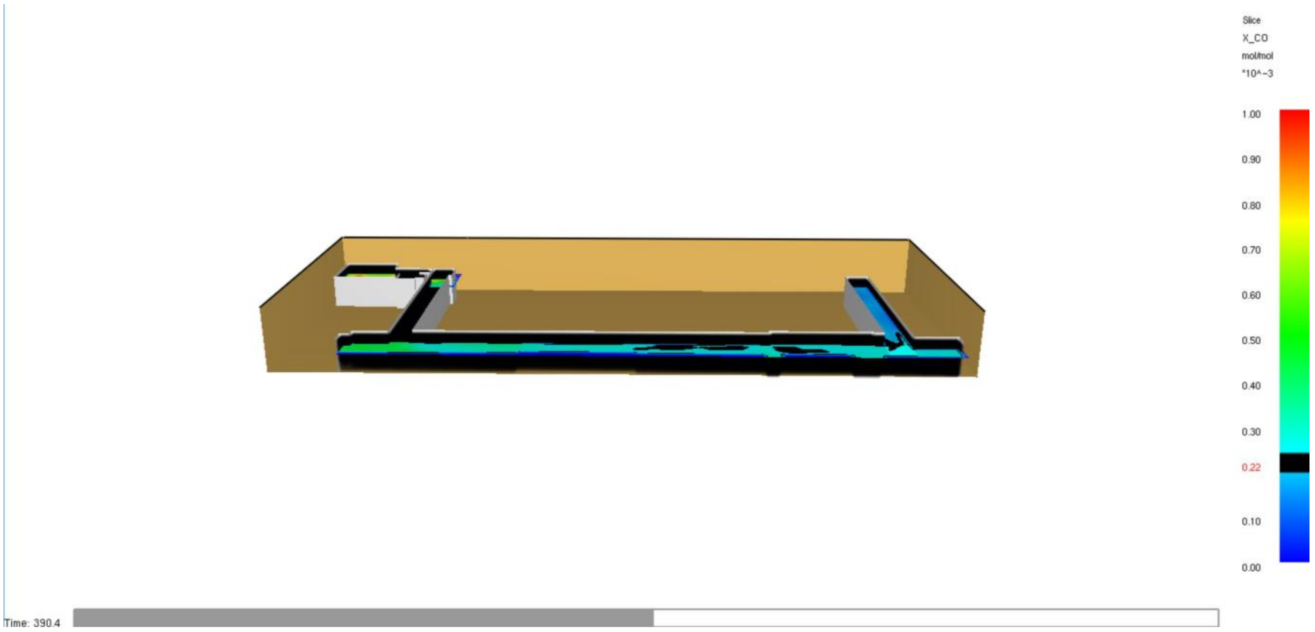


Figure 27: Guestroom Door Open - Fire Floor CO% @ 390 secs

## 4.3 Structural Fire Protection

### 4.3.1 Fire Strategy

Whether intended by the architect or not, the noncombustible nature of the building's construction is the foundation of the structural fire safety strategy. The primary goal is for the building to maintain structural stability through the burn out phase (complete consumption of the contents with the room of fire origin). The intent is to provide ample time for building evacuation and fire fighter operations.

An estimate of required safe egress time (RSET) is 26 minutes, as presented in Table 18, found within Section 4.2.3, Time-based Egress Calculations. Firefighting operations are expected to take more time. Standard response time in the downtown area is 6 minutes from notification. It is assumed fire department suppression activities could begin within 30 minutes from notification.

Maintaining structural stability is accomplished through the use of noncombustible building elements; the floors, ceilings, structural system, and walls are poured in place reinforced concrete. The passive elements of the fire safety strategy are shown on the composite life safety plans, Appendix M. See Appendix M for available structural drawings.

Supplemental protection is provided by the building's fire sprinkler system. During the time at which the building was designed, fire sprinklers were considered only a property protection safeguard. Today, because of the invention of the quick response sprinkler, sprinklers have the ability to activate during the early stages of fire development, thereby limiting fire spread and reducing smoke production rates. The sprinkler system works in conjunction with the building construction to limit the fire to the room of origin, which is a primary goal of the fire safety strategy.

Providing early notification and maintaining tenability during occupant evacuation is another important component of the fire safety strategy. The fire alarm system provides early notification of the fire event.

The structural fire safety strategy of the building can be summarized as multiple elements working together to provide safety to occupants and responding fire personnel. Additional details of the active elements of the strategy are found in the fire sprinkler and fire alarm sections of this report.

#### 4.3.1.1 Design Fire Analysis

An analysis of the structural system's ability to resist the impact of thermal exposure was completed. Construction type of the building is reinforced concrete, so a concrete floor/ceiling assembly was analyzed for each condition. The analysis included calculation of the maximum temperature within the room of fire origin followed by establishment of the fire duration. The resulting data was used to predict the temperature of the reinforcing bars within the concrete slab. The heat transfer boundary conditions were calculated by using the finite difference method.

The Thomas plot approach was used to calculate maximum ceiling temperatures. The following equation developed by Law in 1983 also was used: [50]

$T_{max} = 6000(1-e^{-0.1\Omega}) / \sqrt{\Omega}$

$T_{max}$= Maximum compartment temperature

$\Omega = (A_t - A_v) / (A_v\sqrt{H_v})$

$A_t$= Surface area of the compartment

$A_v$= Area of the vent

$H_v$ = Height of the top of the vent

---

[50] Law, M. A Basis for the Design of Fire Protection Building Structures, The Structural Engineer, February 1983.

Time to burn out, which is defined as the time for complete combustion of the fuel within the compartment of fire origin, was calculated to establish the fire duration. Fuel load density data was selected from work completed by Chen.[51] See Tables 23 and 24.

$Tb = M_f / R$

$Tb$ = Time to burn out

$M_f$ = Mass of fuel (MJ/m²)

= Fuel load density/ $\Delta h_c$

$\Delta h_c$ =heat of combustion of the fuel (MJ/kg)

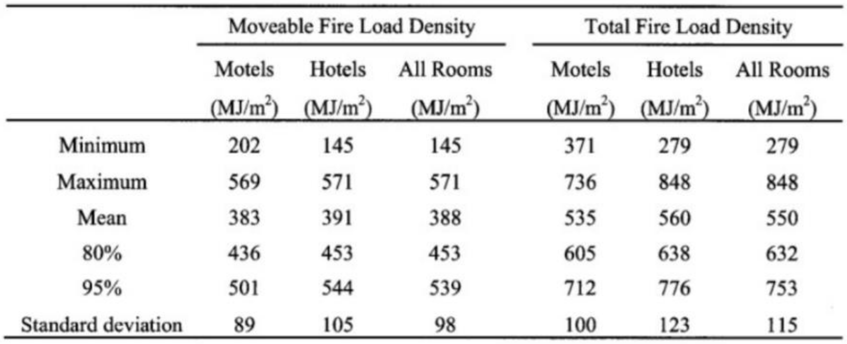
$R= 0.1A_o \sqrt{} H_o$

$A_o$ = Area of the opening

$H_o$ = Height of the opening

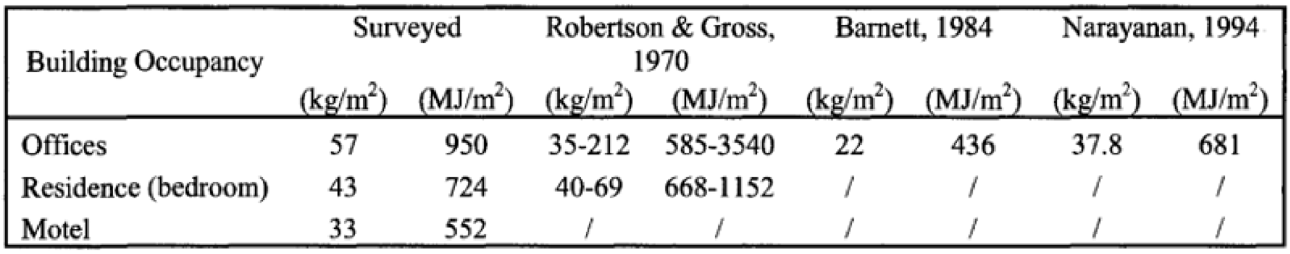
The finite difference method was used to calculate the temperature of the steel reinforcing bar based upon the exposure created by the compartment ceiling temperatures.

**Table 23: Fuel Load Densities**



| | Moveable Fire Load Density | | | Total Fire Load Density | | |
|---|---|---|---|---|---|---|
| | Motels (MJ/m²) | Hotels (MJ/m²) | All Rooms (MJ/m²) | Motels (MJ/m²) | Hotels (MJ/m²) | All Rooms (MJ/m²) |
| Minimum | 202 | 145 | 145 | 371 | 279 | 279 |
| Maximum | 569 | 571 | 571 | 736 | 848 | 848 |
| Mean | 383 | 391 | 388 | 535 | 560 | 550 |
| 80% | 436 | 453 | 453 | 605 | 638 | 632 |
| 95% | 501 | 544 | 539 | 712 | 776 | 753 |
| Standard deviation | 89 | 105 | 98 | 100 | 123 | 115 |

**Table 24 Fuel Load Densities**



| Building Occupancy | Surveyed | | Robertson & Gross, 1970 | | Barnett, 1984 | | Narayanan, 1994 | |
|---|---|---|---|---|---|---|---|---|
| | (kg/m²) | (MJ/m²) | (kg/m²) | (MJ/m²) | (kg/m²) | (MJ/m²) | (kg/m²) | (MJ/m²) |
| Offices | 57 | 950 | 35-212 | 585-3540 | 22 | 436 | 37.8 | 681 |
| Residence (bedroom) | 43 | 724 | 40-69 | 668-1152 | / | / | / | / |
| Motel | 33 | 552 | / | / | / | / | / | / |

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[51] Chen, Zhengrong, Design Fires for Hotels and Motels, Thesis Ottawa-Carleton Institute for Civil Engineering.

Three fire scenarios were analyzed as described below. The guestroom fire scenario was selected because fire data shows that bedroom areas are the primary location of unconfined fires within hotels (28%). [52] The meeting room scenario were selected due to the potential for a high density of combustibles. Compartment Dimensions are shown in Table 25.

Scenario 1: A fire within Guest Room 2101 on the 21st floor (typical guestroom). The fuel load density selected was 560 MJ/m² from Chen's work. It was assumed fire sprinklers did not operate.

Scenario 2: A fire within Guest Room 2101 on the 21st floor (typical guestroom). In this case, however it was assumed that a seismic event damaged the bottom of the concrete slab such that the steel reinforcing bars were exposed (direct exposure to the hot gas layer). The fuel load density selected was 560 MJ/m² from Chen. It was assumed fire sprinklers did not operate.

**Table 25: Compartment Dimensions**

| Room Name | Room Area | Room Dimensions | Ceiling Height |
|---|---|---|---|
| Guest Room 2101 | 23.6 m | 4.29 m x 5.49 m | 2.97 m |

The results of this analysis are presented in Table 26. Detailed calculations are provided in Appendix N.

**Table 26: Thermal Calculation Results**

| Scenario Number | $T_b$ (Mins) | $T_{max}$ (°C) | Max. Reinforcing Steel Temperature (°C) |
|---|---|---|---|
| No. 1 | 23.6 | 800 | 225 |
| No. 2 | Same | Same | 800 |

#### 4.3.1.2 Structural Fire Analysis

The performance objective is applied load ($U^*_{fire}$) during the fire must be less than or equal to the capacity of the structural element during the fire ($R_{fire}$), or shown in equation form:

$$U^*_{fire} \leq \phi R_{fire}$$

For the structural systems analyzed for this project, the moment created by the prescribed loading produced the maximum stress. Therefore, only moment calculations were completed. The statement for this relation can be written as:

$$M_u \leq \phi M_n$$

Where:

$\phi$ = Strength reduction factor (0.90)
$M_n$ = Load capability (moment)
$M_u$ = Applied load (moment)

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[52] U.S. Fire Administration National Fire Incident Reporting System, 2005-2007.

### 4.3.1.3 Failure Analysis

The loading on the reinforced concrete slab was calculated as follows:

$M= w\ l^2/8$

Where:

M = moment (kip-ft)
W= Distributed loading (pound/lf)
l= Length of the span (ft)

The loading was calculate using a load fire reduction design of 1.2D x 0.5 L

Where:

D= Dead Load (pound/lf)
L= Live Load (pound/lf)

CBC requirements for live load criteria were used. For the hotel guest rooms L= 40 psf. Dead load criteria were difficult to quantify, however 15 psf for partitions was added to the weight of the concrete slab (112.5 $p/ft^2$) for a total dead load of 127.5 p/lf.

W= 1.2D x 0.5 L
= 1.2 x 127.5 +0.5 x 40 p/sf x 1ft (slab width) = 173 p/lf for the guest rooms.

For the meeting room a dead load of 127.5 p/sf and a live load of 100 p/sf and slab width of 1lf, results in:

W= 1.2 x 127.5 p/sf+ 0.5 x100p/sf x 1ft= 203 p/ lf

The applied load to the slab is then

$M= w\ l^2/8$
= 173p/lf $(28\ ft)^2/8$ = 16.954 k-ft for the guest rooms and

= 203 p/lf $((28\ ft)^2/28$ = 19.89 k-ft for the meeting room

The moment capacity of the slab during fire conditions was calculated as follows:

$M_{nf}= A_s\ f_y\ (d-a/2)/0.85f_cb$

$M_{nf=}$ Load capability during fire (k-ft)

$A_s$ = Area of steel ($in^2$)

$f_y$ = Modulus of elasticity of steel(kips)

d = Effect depth of the cross section of the slab (in)

a = Stress block depth (in)

$= A_sf_y/0.85*f'_cb$

$f'_{c\,=}$ Yield strength of concrete (kips)

b= Width (in)

Results are shown in Table 27. In Scenario 1, the reinforced concrete slab had ample strength to support the applied load during fire conditions.

In Scenario 2, which included exposed reinforcing bar, the slab was near maximum capacity. However, concrete temperatures exceeded 500 °C from the bottom of the slab to a thickness of 0.0285 inches. Concrete with temperatures above 500 °C is assumed not to contribute to the load bearing capacity of the slab, while the rest of the slab retains its original strength. The 500 °C Isotherm Calculation Method was used to calculate the new slab dimension D. Then the new moment capacity of the slab was calculated. The slab is not capable of supporting the applied loads.

See Appendix N for spreadsheet calculations.

**Table 27: Structural Analysis Results**

| Scenario Number | Applied Load Mu (k-ft) | Load Capacity ϕMn(k-ft) |
|---|---|---|
| No. 1 | 16.95 | 99.0 |
| No. 2 | 16.95 | 18.0 |
| No. 2 500 °C Isotherm Calculation Method | 16.95 | 15.6 |

#### 4.3.1.4 Discussion/Conclusion

The reinforced concrete slab performed exceptional except when damaged and the reinforcing bars were exposed to the hot gas layer. Increasing the thickness is potential solution. However, given this is an existing occupied hotel that solution is impractical. It is suggested a higher order of analysis be performed to confirm results.

## 4.4 Conclusion- Performance-based Analysis

A performance-based analysis was completed for the Gaslamp Hotel building. The analysis included the evaluation of building occupant safety given two reasonable worst-case scenarios; a fire located in a typical guestroom with limited ventilation (entry door closed), and a repeat of the first scenario with improved ventilation (entry door open). Two evacuation conditions were considered; global egress of the entire building and zoned egress of the fire floor, floor above, and floor below. The former was used in the structural analysis to predict conditions resulting from a total burnout of the room of fire origin. The latter, a more contemporary evacuation condition, was used in the time-based egress analysis.

The results of the time-based egress analysis showed that occupants both remote from and intimate with the fire origin could safely egress the building prior to tenability conditions degrading to life threatening conditions. Visibility within the guestroom corridors degraded prior to the other two tenability criteria, temperature and toxicity. Despite the successful outcome of the analysis, a recommendation is made to add additional low-level exit signs at a spacing of 6 meters within the hotel guest room corridors with intent of improving the inclination for occupants to egress through the corridors in low visibility conditions.

The structural analysis simulated the total burn out of the room of fire origin which produced high temperatures within the compartment of fire origin for an extended period of time, 24 minutes. Two reasonable worst-case case scenarios were considered; the total burn out of the room of origin, and a repeat of the first scenario assuming steel reinforcing bars were exposed to the hot gas layer due to a seismic event. In both cases the fire sprinklers were assumed to be impaired.

The results of the first scenario showed the increase in temperature of the reinforcing bars did not cause a significant reduction in steel yield strength and that even at elevated temperatures the reinforced concrete floor slab could still adequately support the applied loads.

The results of the second scenario indicated that the reinforced concrete floor slab could not support the applied loads, but only by a small margin. A higher order analysis is recommended to clarify the situation.

The fire suppression and detection systems upon which this analysis is based are maintained as required by the applicable standards and thus should performed as designed, which satisfies another objective of the performance-based design.

# 5 FIRE SAFETY MANAGEMENT PLAN

The purpose of this Fire Safety Management Plan (FSMP) is to establish procedures required by the CBC for pre-fire planning and occupant evacuation. The plan is also designed to provide information to emergency services about the nature of the emergency so that a safe and effective response may be initiated. A FSMP was drafted to fortify the hotel's preset plan. See Appendix P.

# 6 PROJECT CONCLUSION AND RECOMMENDATIONS

The Gaslamp Hotel was analyzed for fire protection/life safety using two different methodologies; a prescriptive approach and a performance- based approach. Both considered the same features of the building, but through different lenses.

The prescriptive analysis studied the variation of the building's fire protection/life safety components from those required by the applicable codes and standards. This analysis included building construction, fire suppression, fire detection, smoke control system, and egress systems.

The results of the analysis indicate that the building complies with the requirements of the applicable codes and standards, with three exceptions relating to occupant egress:

- The 1st floor bar area: One exit is provided, two are required. An additional exit through the restaurant is recommended.
- The 8th floor East and West Terrace areas: Only one exit from each space is provided, two are required. The use of horizontal exits along the east and west exterior walls is recommended. In addition, the east terrace requires the addition of a corridor and new exit door at the north end. The west horizontal exit can also be used to disperse pre-function occupants to the west.
- Eighth floor Corridor 885: This dead end exceeds 20 feet in length. A door should be installed at the beginning of the corridor.

The performance-based approach included the evaluation of building occupant safety given two reasonable worst-case scenarios and two evacuation conditions.

The results of the time-based egress analysis indicate that occupants, both remote from and intimate with the fire origin, could safely egress the building prior to tenability conditions degrading to life threatening conditions. Despite the successful outcome of the analysis, a recommendation is made to add additional low-level exit signs with the intent of improving the inclination for occupants to egress through the corridors in low visibility conditions.

The structural analysis simulated the total burn out of the room of fire origin which produced high temperatures within the compartment of fire origin for an extended period of time, 24 minutes. Two reasonable worst-case case scenarios were considered.

The results of the first scenario indicate the increase in temperature of the reinforcing bars did not cause a significant reduction in steel yield strength and that even at elevated temperatures the reinforced concrete floor slab could still adequately support the applied loads.

The results of the second scenario indicated that the reinforced concrete floor slab could not support the applied loads, but only by a small margin. A recommendation is made to complete a higher order analysis to clarify the situation.

**Respectfully submitted:**

Gar A Palenske

**Garner A. Palenske, P.E.**

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12. G. Proulx, *Occupant Behavior and Evacuation*, National Research Council Canada, Ottawa, Canada, 2001.
13. Geiman, Justin A., and Gottuk, Daniel T., Alarm Thresholds for Smoke Detector Modeling, Fire Safety Science, 7th International Symposium.
14. Gwynne, Steven, et al, *Questioning the Linear Relationship between Door Width and Achievable Flow Rate*, Fire Safety Journal 44, 2009.
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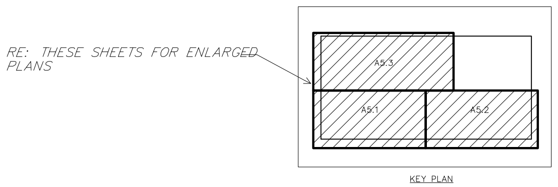
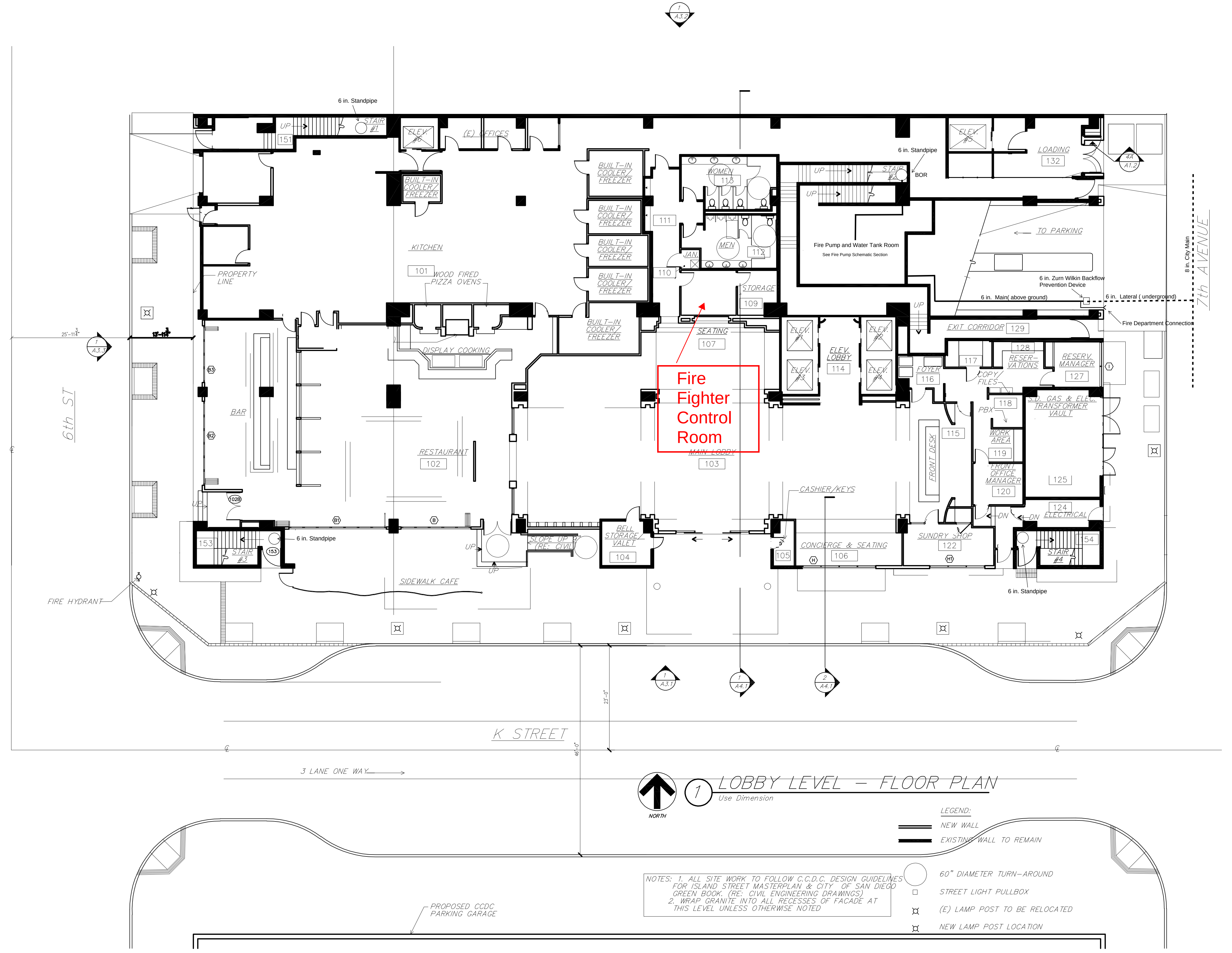
17. Law, M., *A Basis for the Design of Fire Protection Building Structures*, the Structural Engineer, February 1983.
18. Mowrer & Rosenbaum, *Fire Protection Handbook Information and Analysis for Fire Protection*, Figure 3.11.4 Example Time Line for Evaluation of Available Versus Required Safe Egress Times, 2008.
19. NFPA Fire Protection Handbook, page 1-101, 19th Edition.
20. Paradis, Thomas, American Styles of Architecture. https://architecturestyles.org/
21. Pressure reducing valves set at 175 psi are provided at the sprinkler pipe connection to the riser on all floors. In reality, the maximum pressure available at the standpipe sprinkler system connection at each floor is 175 psi.
22. San Diego Municipal Code, Pre-1994.
23. SFPE Guide to Human Behavior in Fire, Second Edition 2019, page 16.
24. SFPE Handbook of Fire Protection Engineering, 5th Edition, Table 63.20.
25. SFPE Handbook Table 3-4.16, Footnote A.
26. SFPE Handbook, 4th edition, page 2-116.
27. SFPE Handbook, 5th edition, page 2220.
28. SFPE Handbook, 5th edition, page 2222.
29. SFPE Handbook, 5th edition, page 2331.
30. SFPE Handbook, 5th edition, page 2334.
31. SFPE Handbook, 5th edition, page 2347.
32. SFPE Handbook, Table 4.2.7.
33. SFPE HB 4th Edition, page 3-379.
34. Supervised Sprinkler System, NFPA 13, Section 11.2.3.1.3.
35. U.S. Fire Administration National Fire Incident Reporting System, 2005-2007.

# 8 APPENDICES

# APPENDIX A - FLOOR PLANS





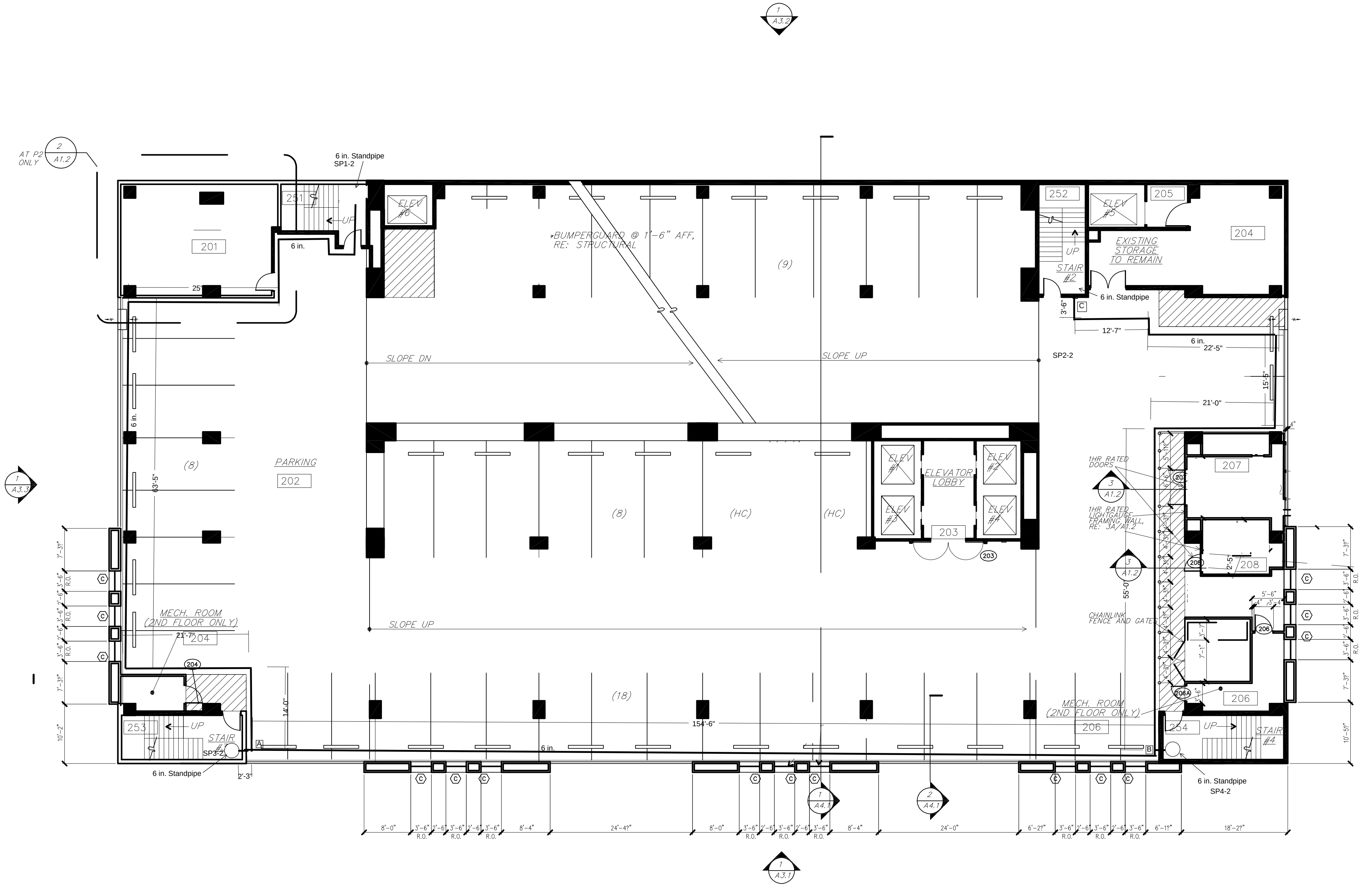
## 1 LOBBY LEVEL — FLOOR PLAN

Use Dimension

NOTES: 1. ALL SITE WORK TO FOLLOW C.C.D.C. DESIGN GUIDELINES FOR ISLAND STREET MASTERPLAN & CITY OF SAN DIEGO GREEN BOOK. (RE: CIVIL ENGINEERING DRAWINGS)
2. WRAP GRANITE INTO ALL RECESSES OF FACADE AT THIS LEVEL UNLESS OTHERWISE NOTED

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| ○ | 60" DIAMETER TURN-AROUND |
| □ | STREET LIGHT PULLBOX |
| ¤ | (E) LAMP POST TO BE RELOCATED |
| ¤ | NEW LAMP POST LOCATION |



## 1 TYPICAL PARKING LEVELS 2ND-6TH

Use Dimension

NOTE: MECHANICAL EQUIPMENT SPACES AT NORTH EAST AND SOUTHEAST CORNERS VARY FROM ONE PARKING LEVEL TO THE OTHER.

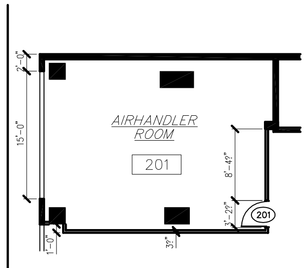
LEGEND:

═ NEW WALL

▬ EXISTING WALL TO REMAIN

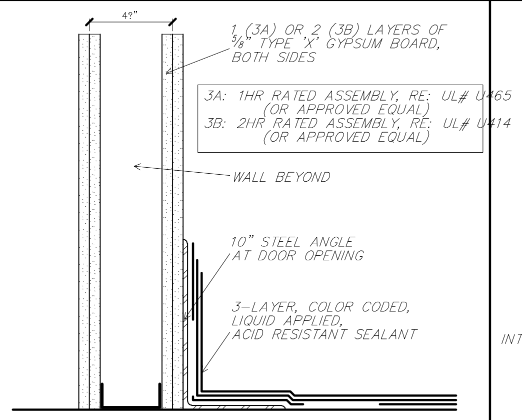
○ 60" DIAMETER TURN-AROUND

NORTH



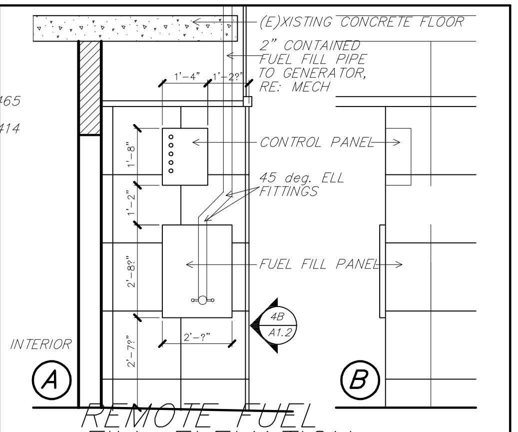
## 2 CORNER AT P2

?" = 1'-0"



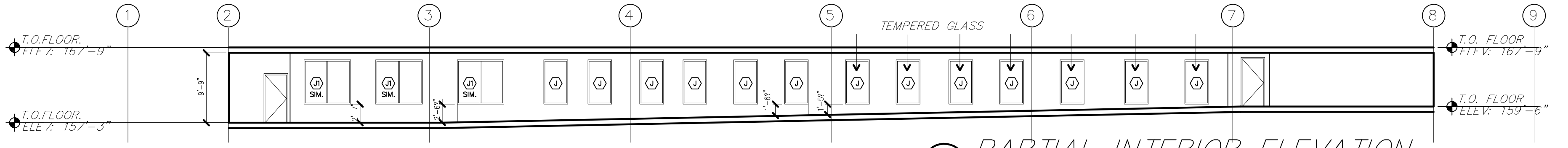
## 3 THRESHOLD DETAIL

3" = 1'-0"



## 4 REMOTE FUEL FILL ELEVATION

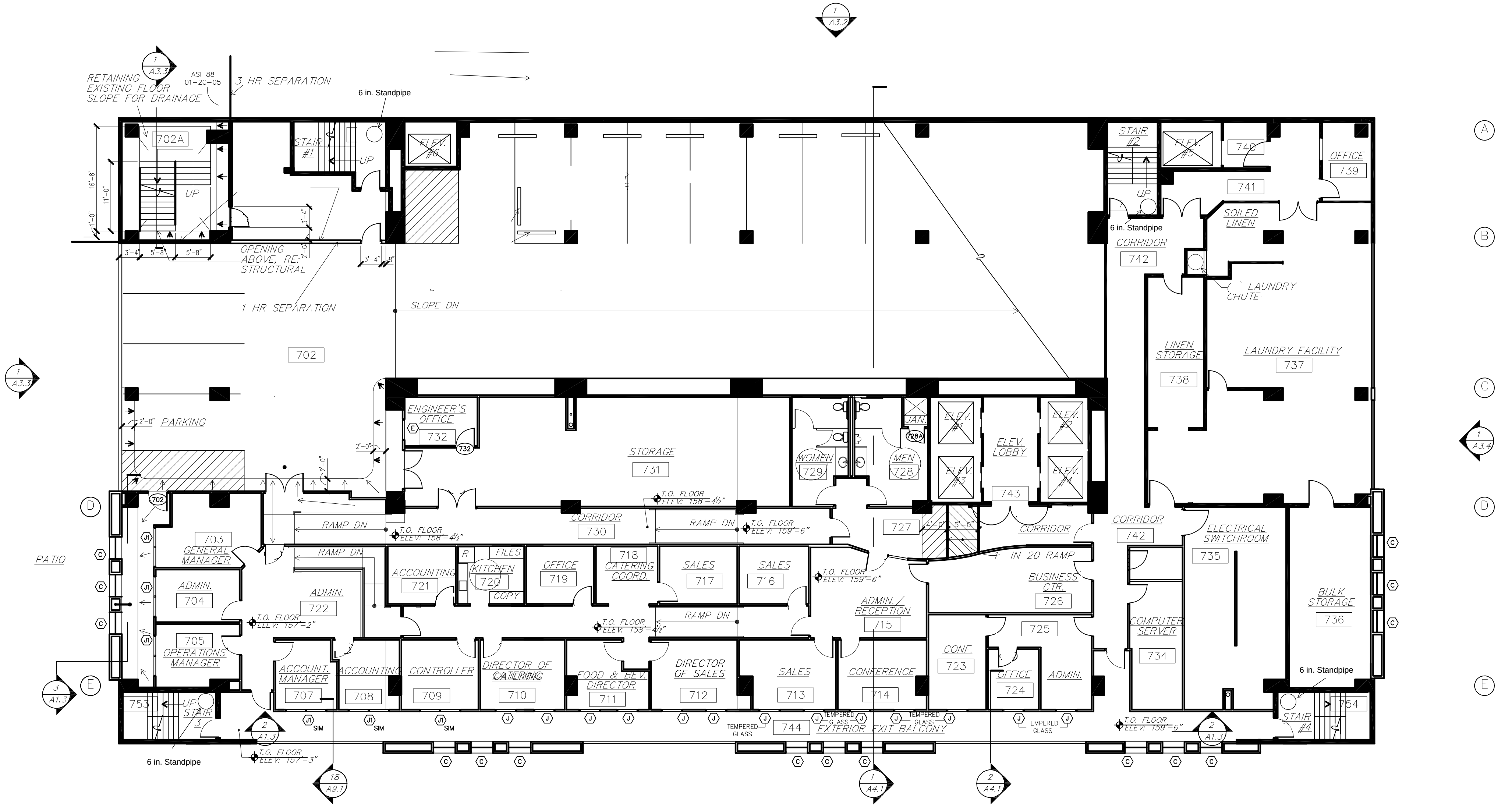
?" = 1'-0"

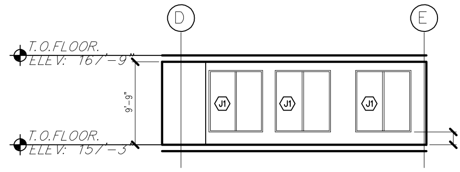


## 2 PARTIAL INTERIOR ELEVATION

?" = 1'-0"

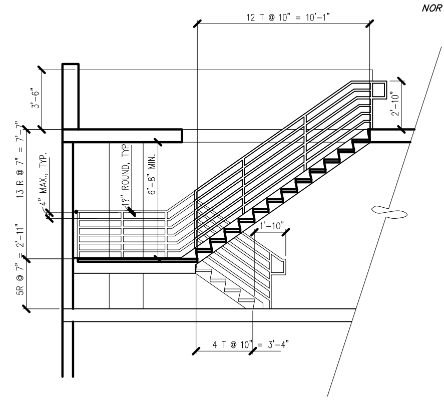
RE: 1/A1.3





NORTH

1
A3.1



## 4 STAIR SECTION/ELEVATION

?" = 1'-0"

RE: 1/A1.3; STRUCT.

## 1 SEVENTH FLOOR – PROPOSED PLAN

Use Dimension

EXISTING OVERALL PARKING COUNT:

277 TOTAL PARKING STALLS
34 ACCESSIBLE PARKING STALLS
15 EXISTING STALLS, INCLUDING 2 ACCESSIBLE, LOST.

PROPOSED PARKING COUNT REDUCTION:

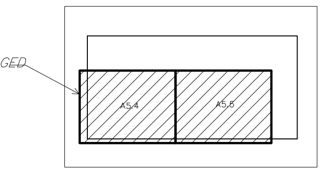
18 EXISTING STALLS, INCLUDING 2 ACCESSIBLE, LOST.

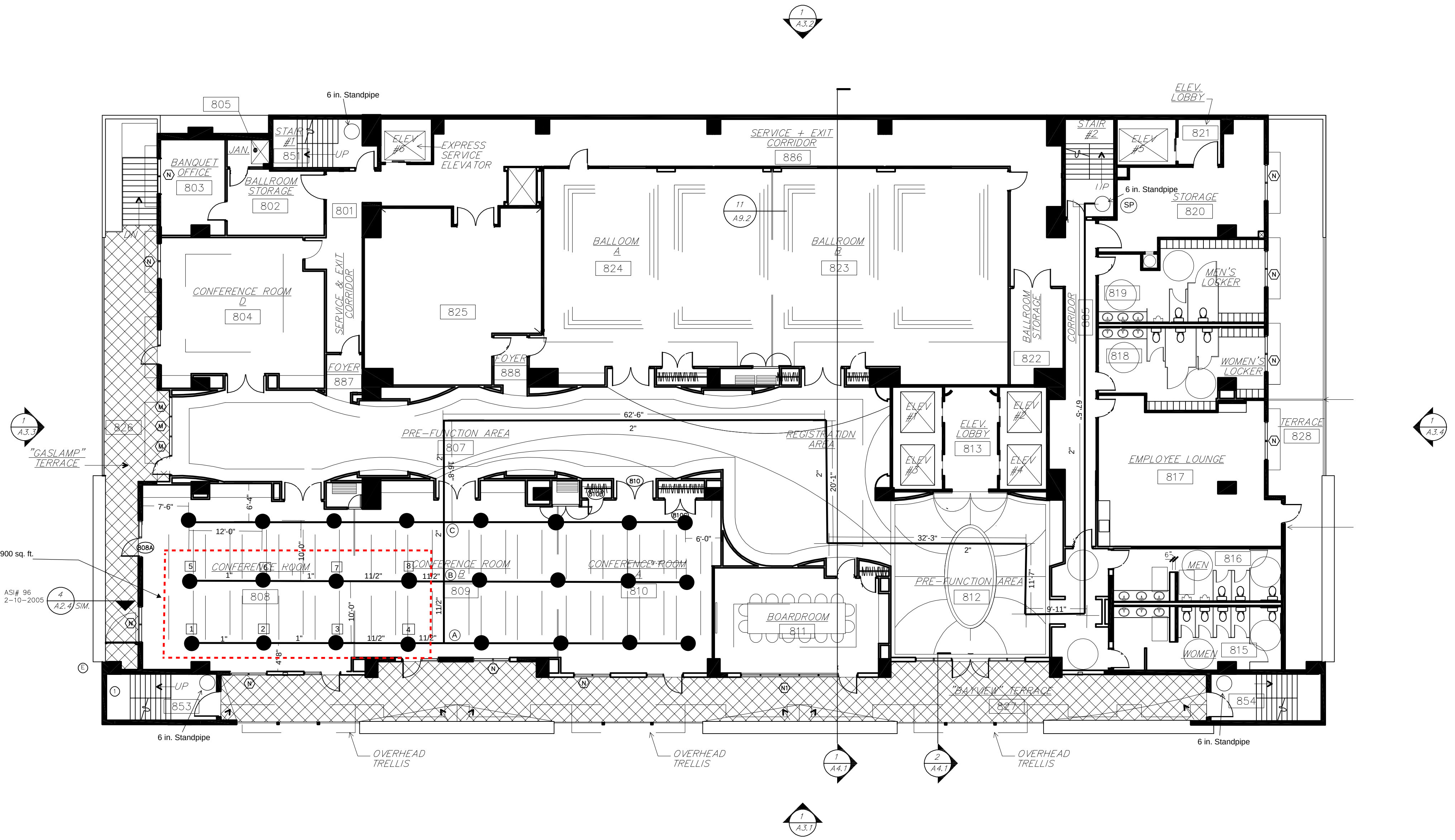
LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| ○ | 60" DIAMETER TURN–AROUND |

KEY PLAN

RE: THESE SHEETS FOR ENLARGED PLANS





Room 808/809/810
Design Density: 0.10 gpm/sq. ft. for most remote 900 sq. ft.
(Quick response sprinkler reduction)
Requiring 237 gpm @ 85 psi
at fire pump discharge

| Sprinkler Legend | |
|---|---|
| Standard spray sprinkler<br>165 degree rated, quick response, pendent | ● |
| Extended coverage side wall sprinkler<br>165 degree rated, quick response<br>Tyco Model TY3332 used as example | ▷ |

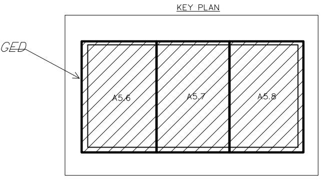
NORTH

# 1 EIGHTH FLOOR (CONFERENCE LEVEL) – PROPOSED PLAN

Use Dimension

LEGEND:

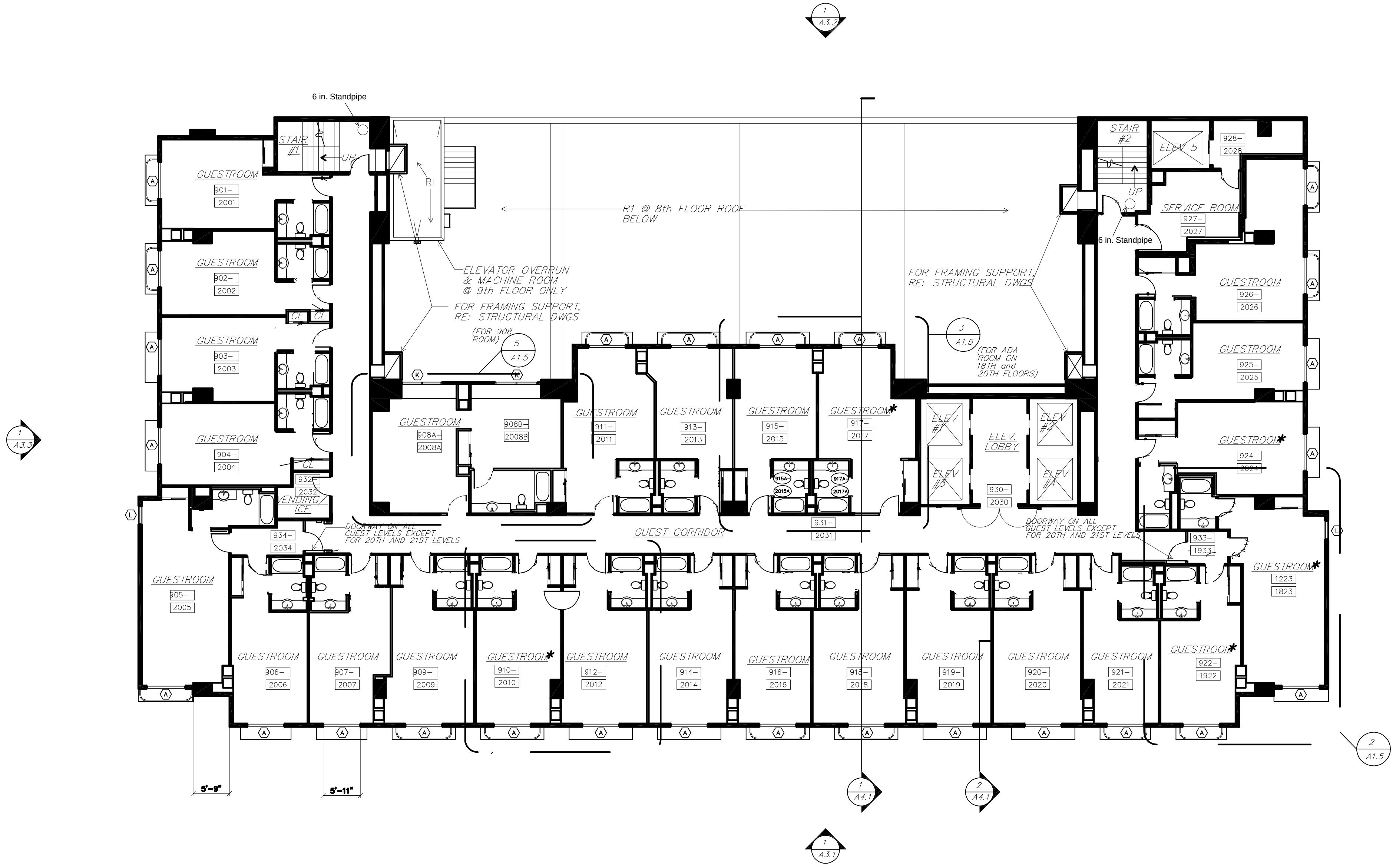
| | |
|---|---|
| ═ | NEW WALL – MINIMUM 54 STC RATING (1 HR RATED) |
| ▬ | EXISTING WALL TD REMAIN |
| ○ | 60" DIAMETER TURN–AROUND |

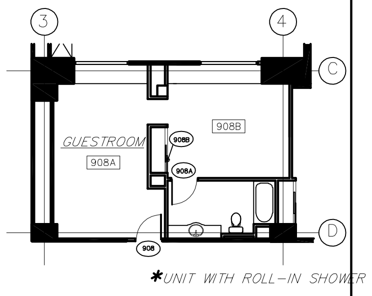


RE: THESE SHEETS FOR ENLARGED PLANS

A1.4

13 MAY 2004



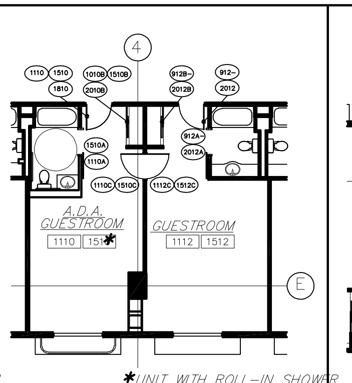


*UNIT WITH ROLL-IN SHOWER

ALSO SEE 2/A5.9

## GUESTROOM 908

9" = 1'-0" RE: 1/A1.5

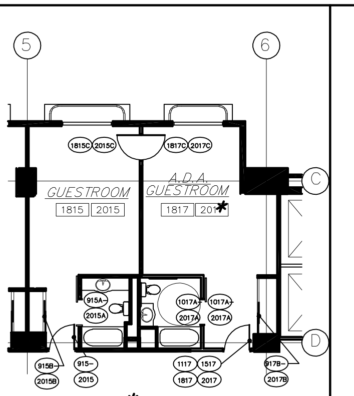


*UNIT WITH ROLL-IN SHOWER

ALSO SEE 3/A5.10

## ADA GUESTROOMS

9" = 1'-0" RE: 1/A1.5

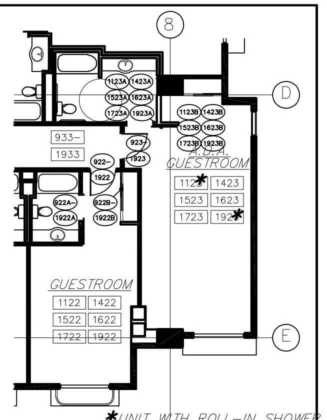


*UNIT WITH ROLL-IN SHOWER

ALSO SEE 2/A5.10

## ADA GUESTROOMS

9" = 1'-0" RE: 1/A1.5



*UNIT WITH ROLL-IN SHOWER
ALSO SEE 2/A5.11

## ADA GUESTROOMS

9" = 1'-0" RE: 1/A1.5

NORTH

# TYPICAL GUESTROOM FLOOR PLAN (9th–12th & 14th–20thFLOORS)

Use Dimension

NOTE: THERE IS NO 13th FLOOR

NOTE 1: GUESTROOM LAYOUTS BASED ON ORIGINAL CONSTRUCTION DOCUMENTS. SPACES HAVE NOT BEEN CONFIRMED BY RECENT OBSERVATION.

NOTE 2: NUMBER OF GUESTROOMS: 321 PLUS CLUB LEVEL LOUNGE

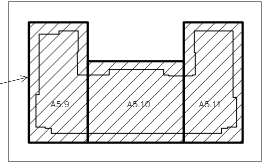
NOTE 3: ADA COMPLIANT GUESTROOMS LOCATED ON ELEVENTH, FIFTEENTH, EIGHTEENTH, AND TWENTY–FIRST FLOORS.

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| * | ROOMS WITH VISUAL ALARMS ON SELECT LEVELS (SEE SHEET A0.0) |
| ○ | 60" DIAMETER TURN–AROUND |

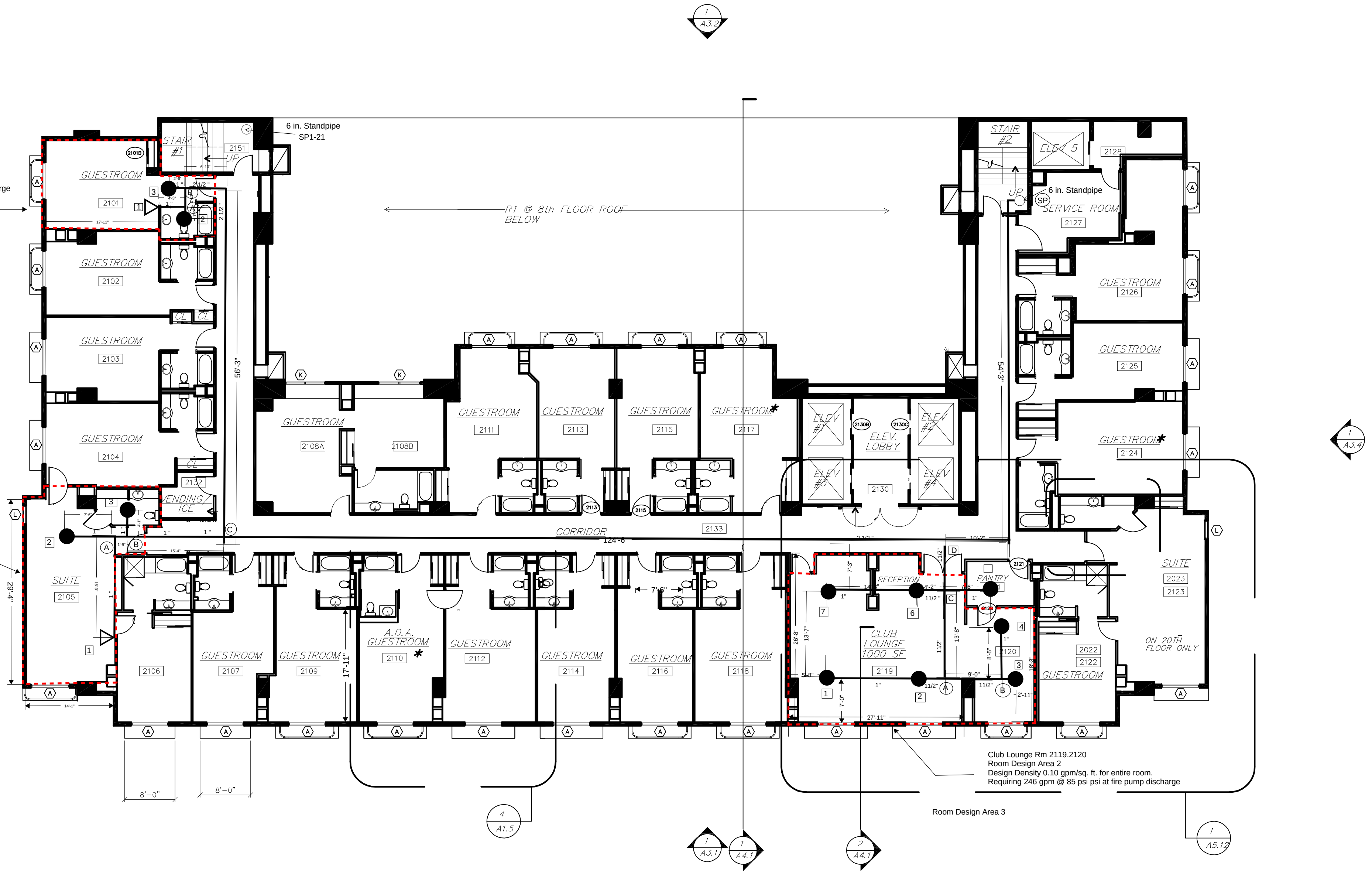
RE: THESE SHEETS FOR ENLARGED PLANS

KEY PLAN



A1.5

NORTH



Room 2101
Room Design Area 1
Design Density: 0.10 gpm/sq. ft. for entire room.
Requiring 189 gpm @ 128 psi at fire pump discharge

Room 2015
Room Design Area 2
Design Density: 0.10 gpm/sq. ft. for entire room.
Requiring 190 gpm @ 128 psi at fire pump discharge

Club Lounge Rm 2119.2120
Room Design Area 2
Design Density 0.10 gpm/sq. ft. for entire room.
Requiring 246 gpm @ 85 psi psi at fire pump discharge

Room Design Area 3

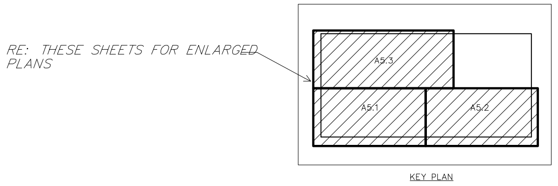
| Sprinkler Legend | |
|---|---|
| Standard spray sprinkler<br>165 degree rated, quick response, pendent | ● |
| Extended coverage side wall sprinkler<br>165 degree rated, quick response<br>Tyco Model TY3332 used as example | ▷ |

NORTH

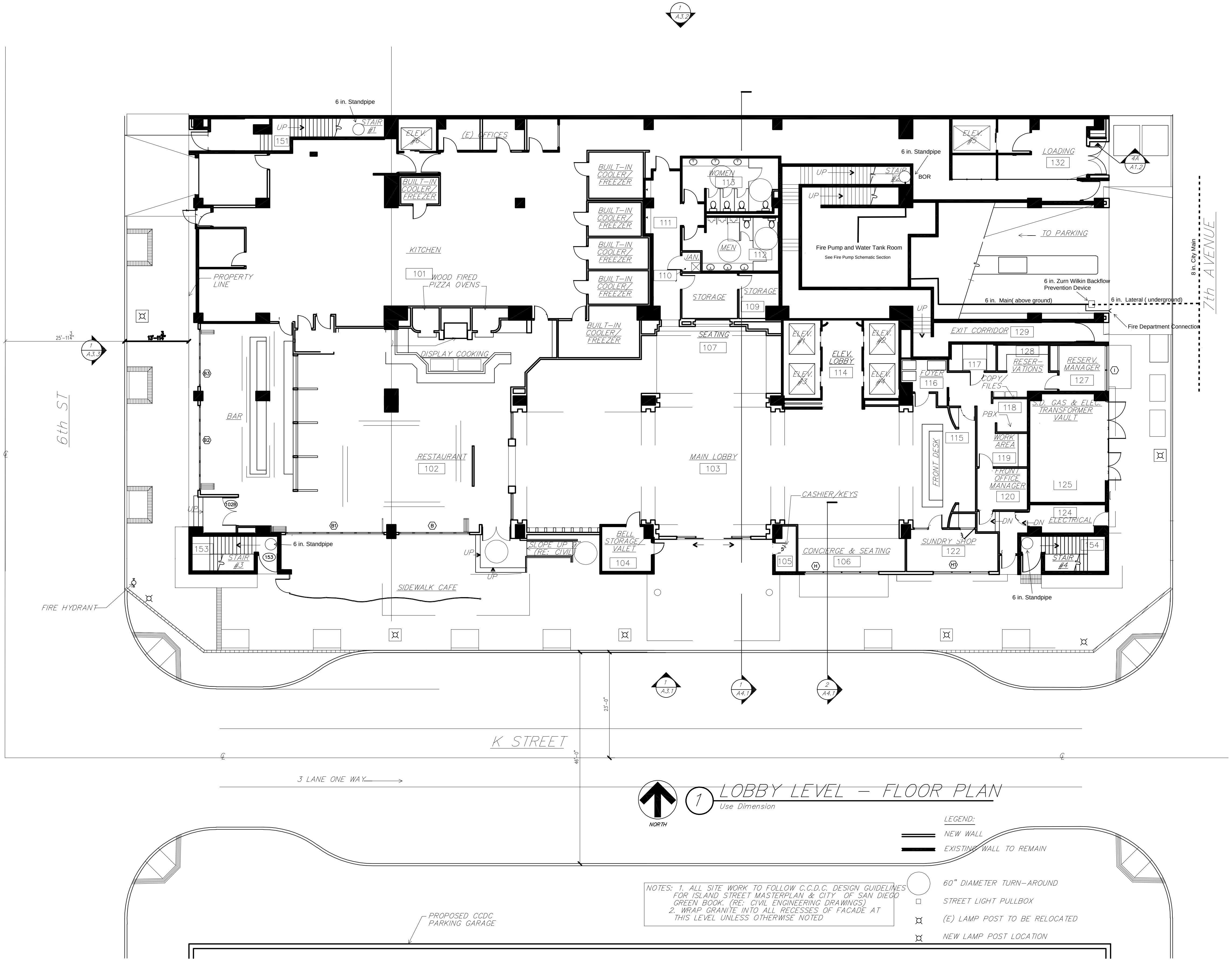
# 1 CLUB LEVEL (21st FLOOR)

Use Dimension

# APPENDIX B - FIRE PROTECTION SYSTEM PLANS



KEY PLAN



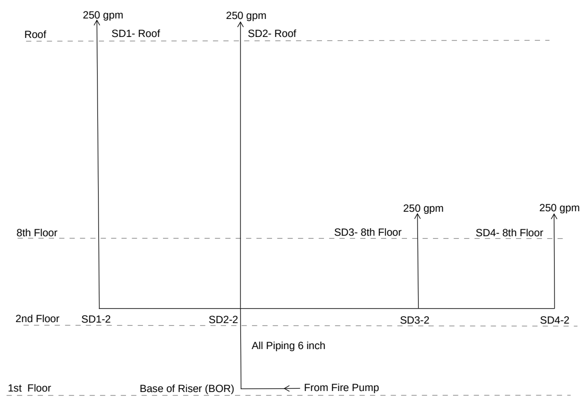
# 1 LOBBY LEVEL - FLOOR PLAN

Use Dimension

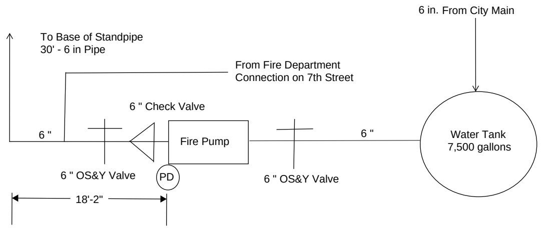
NOTES: 1. ALL SITE WORK TO FOLLOW C.C.D.C. DESIGN GUIDELINES FOR ISLAND STREET MASTERPLAN & CITY OF SAN DIEGO GREEN BOOK. (RE: CIVIL ENGINEERING DRAWINGS)
2. WRAP GRANITE INTO ALL RECESSES OF FACADE AT THIS LEVEL UNLESS OTHERWISE NOTED

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| ○ | 60" DIAMETER TURN-AROUND |
| □ | STREET LIGHT PULLBOX |
| ¤ | (E) LAMP POST TO BE RELOCATED |
| ¤ | NEW LAMP POST LOCATION |

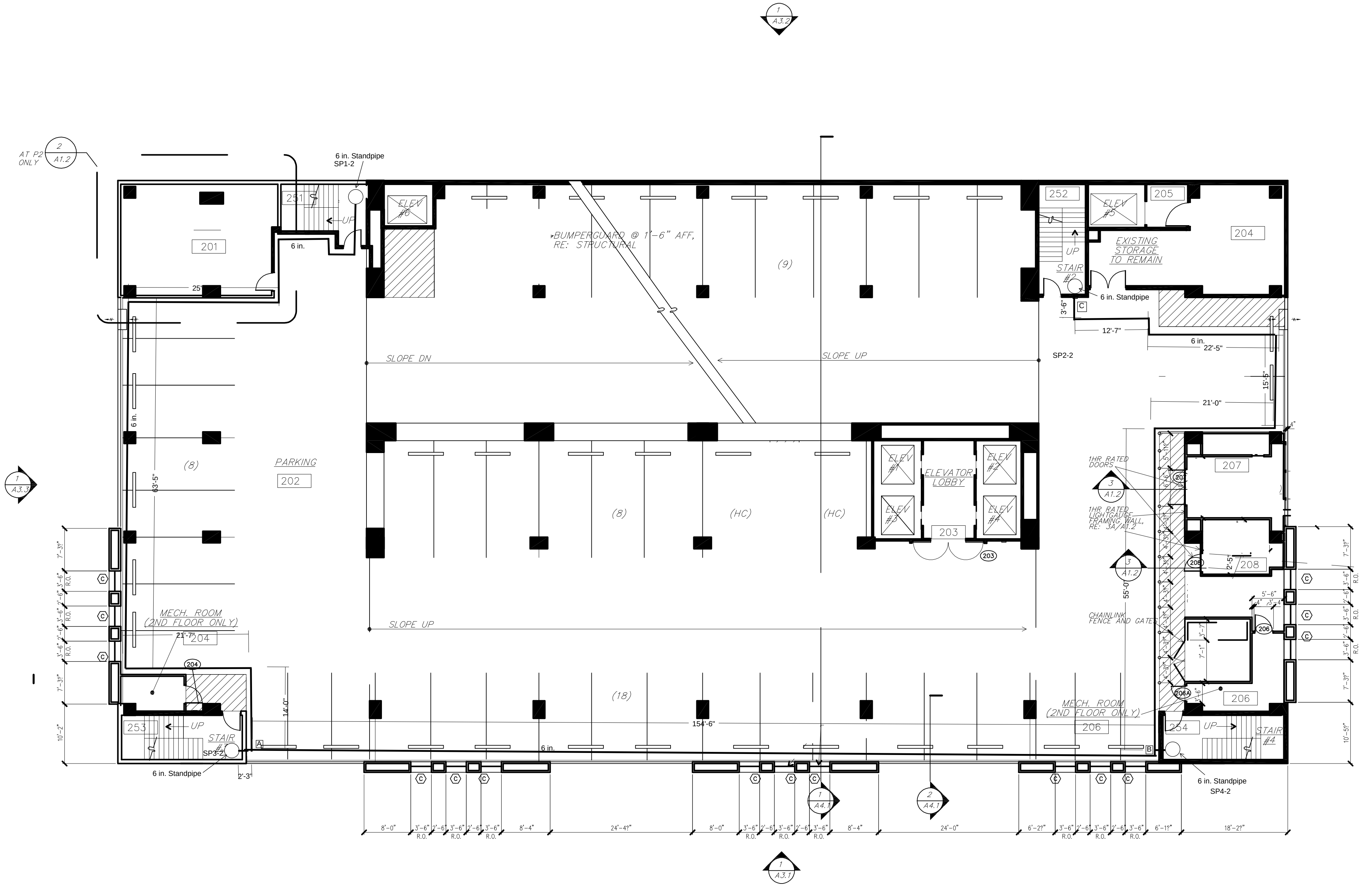


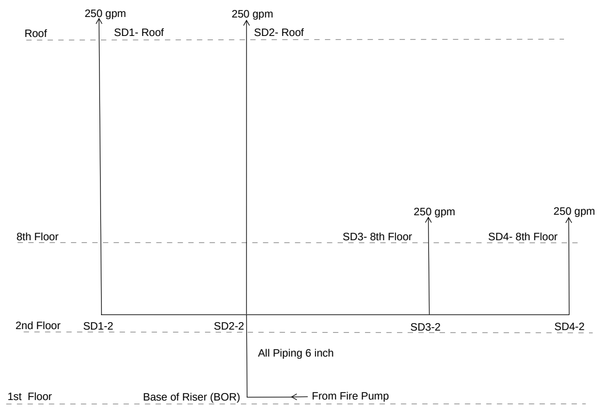
Standpipe Riser Detail
(NTS)



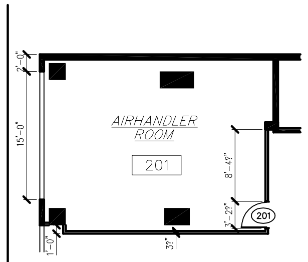
Fire Pump Schematic Section
(NTS)

A1.1

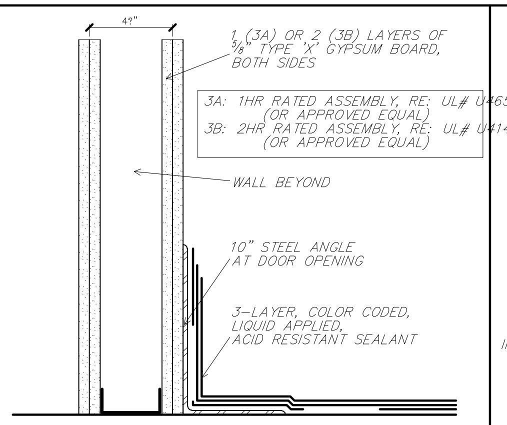




Standpipe Riser Detail
(NTS)



## 2 CORNER AT P2
?" = 1'-0"



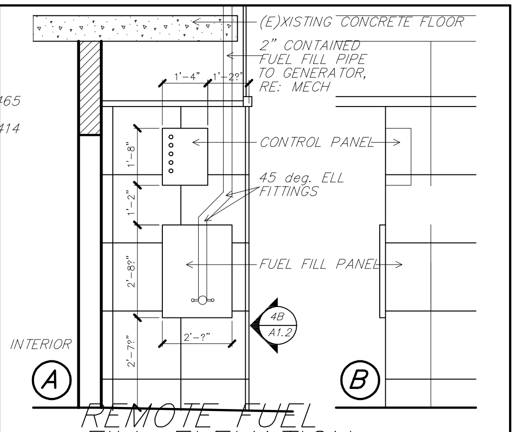
1 (3A) OR 2 (3B) LAYERS OF 5/8" TYPE "X" GYPSUM BOARD, BOTH SIDES

3A: 1HR RATED ASSEMBLY, RE: UL# U465 (OR APPROVED EQUAL)
3B: 2HR RATED ASSEMBLY, RE: UL# U414 (OR APPROVED EQUAL)

10" STEEL ANGLE AT DOOR OPENING

3-LAYER, COLOR CODED, LIQUID APPLIED, ACID RESISTANT SEALANT

## 3 THRESHOLD DETAIL
3" = 1'-0"



(E)XISTING CONCRETE FLOOR

2" CONTAINED FUEL FILL PIPE TO GENERATOR, RE: MECH

## 4 REMOTE FUEL FILL ELEVATION
?" = 1'-0"

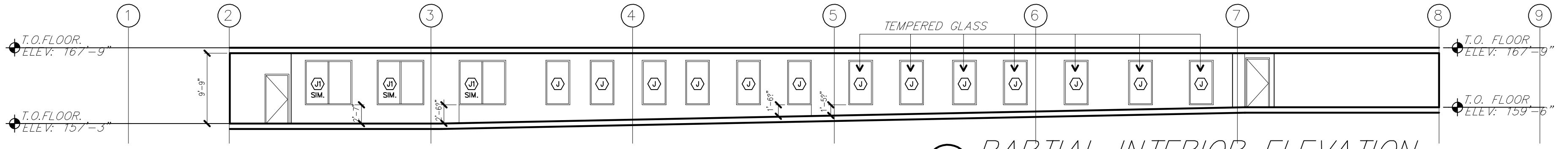
## 1 TYPICAL PARKING LEVELS 2ND-6TH
Use Dimension

NOTE: MECHANICAL EQUIPMENT SPACES AT NORTH EAST AND SOUTHEAST CORNERS VARY FROM ONE PARKING LEVEL TO THE OTHER.

LEGEND:
- NEW WALL
- EXISTING WALL TO REMAIN
- ○ 60" DIAMETER TURN-AROUND

NORTH

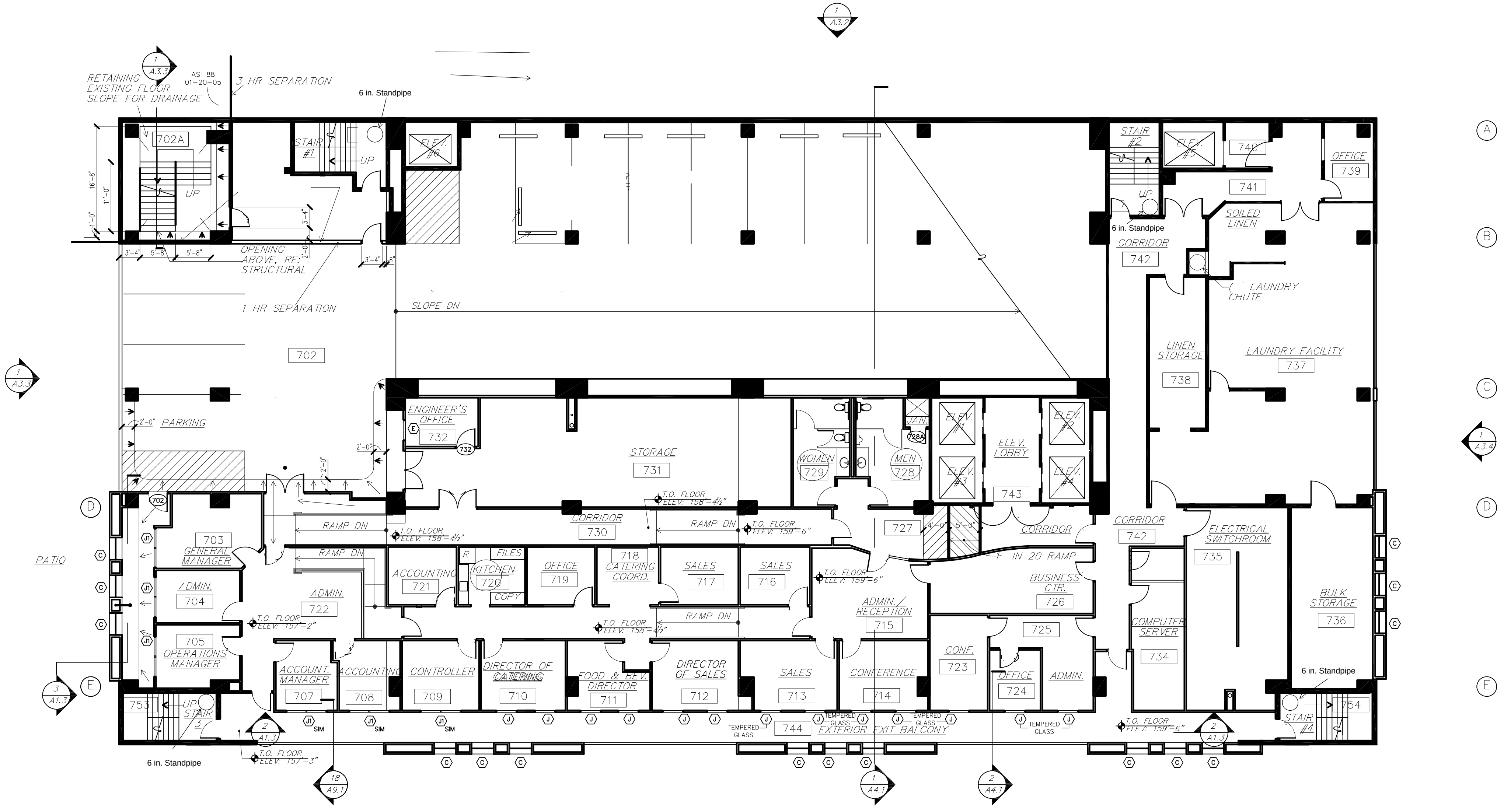
A1.2

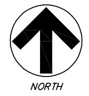


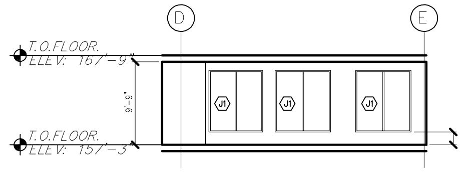
## 2 PARTIAL INTERIOR ELEVATION

?" = 1'-0"

RE: 1/A1.3







## 1 SEVENTH FLOOR – PROPOSED PLAN

Use Dimension

EXISTING OVERALL PARKING COUNT:

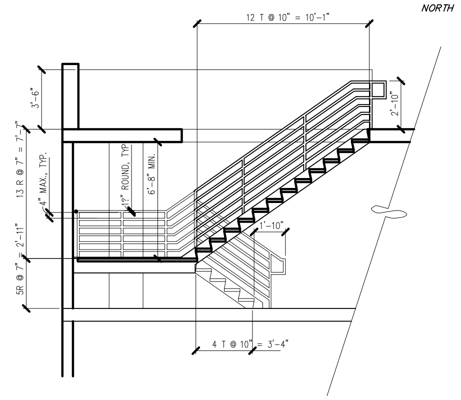
277 TOTAL PARKING STALLS
34 ACCESSIBLE PARKING STALLS
15 EXISTING STALLS, INCLUDING 2 ACCESSIBLE, LOST.

PROPOSED PARKING COUNT REDUCTION:

18 EXISTING STALLS, INCLUDING 2 ACCESSIBLE, LOST.

LEGEND:

═ NEW WALL
▬ EXISTING WALL TO REMAIN
○ 60" DIAMETER TURN-AROUND

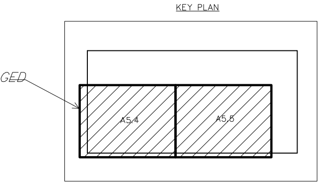


## 4 STAIR SECTION/ELEVATION

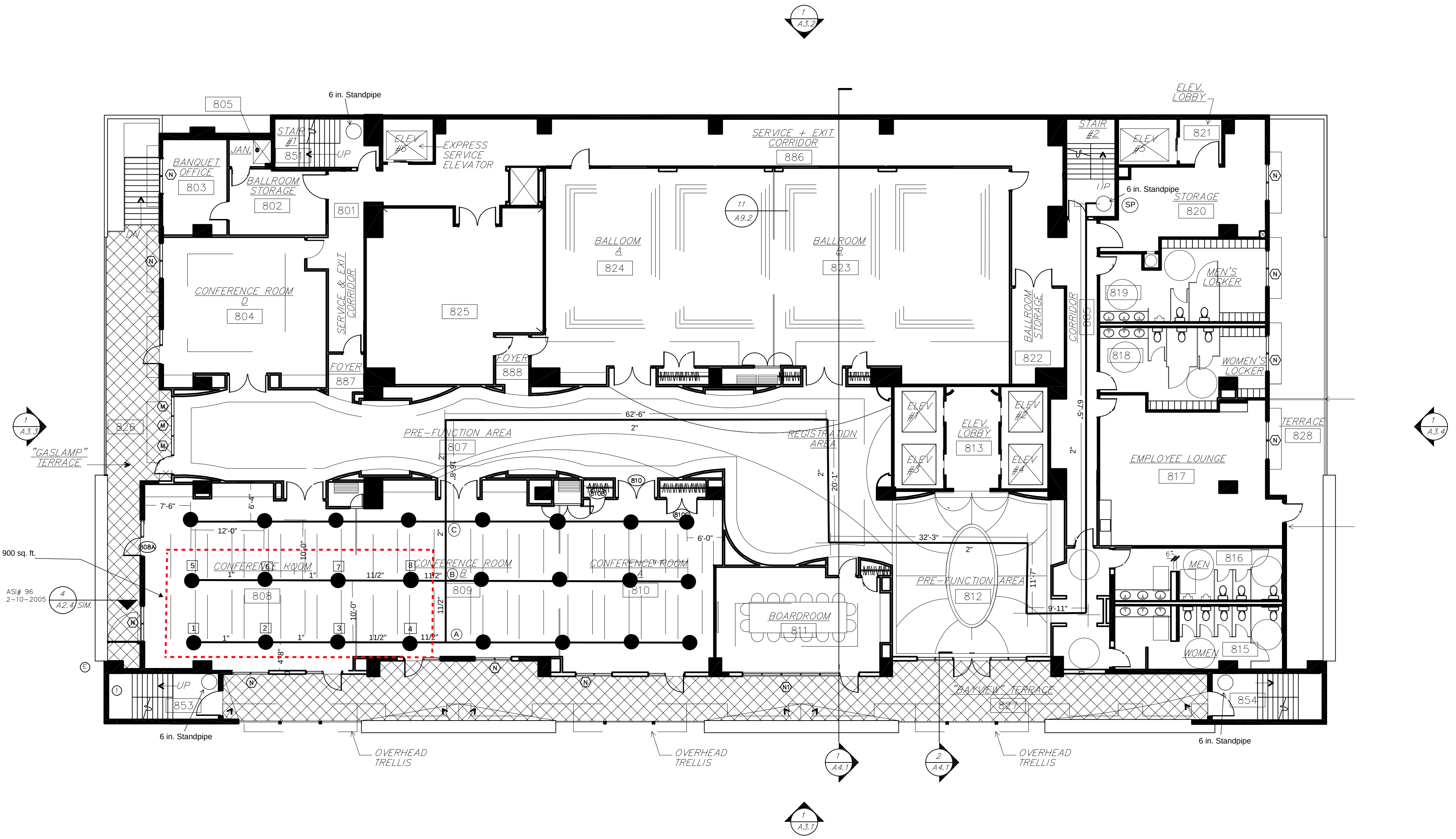
?" = 1'-0"

RE: 1/A1.3; STRUCT.

RE: THESE SHEETS FOR ENLARGED PLANS



Room 808/809/810
Design Density: 0.10 gpm/sq. ft. for most remote 900 sq. ft.
(Quick response sprinkler reduction)
Requiring 237 gpm @ 85 psi
at fire pump discharge



| Sprinkler Legend | |
|---|---|
| Standard spray sprinkler<br>165 degree rated, quick response, pendent | ● |
| Extended coverage side wall sprinkler<br>165 degree rated, quick response<br>Tyco Model TY3332 used as example | ▷ |

NORTH

## 1 EIGHTH FLOOR (CONFERENCE LEVEL) – PROPOSED PLAN

Use Dimension

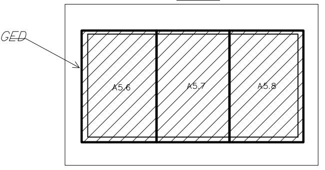
LEGEND:

NEW WALL – MINIMUM 54 STC RATING (1 HR RATED)

EXISTING WALL TD REMAIN

60" DIAMETER TURN–AROUND

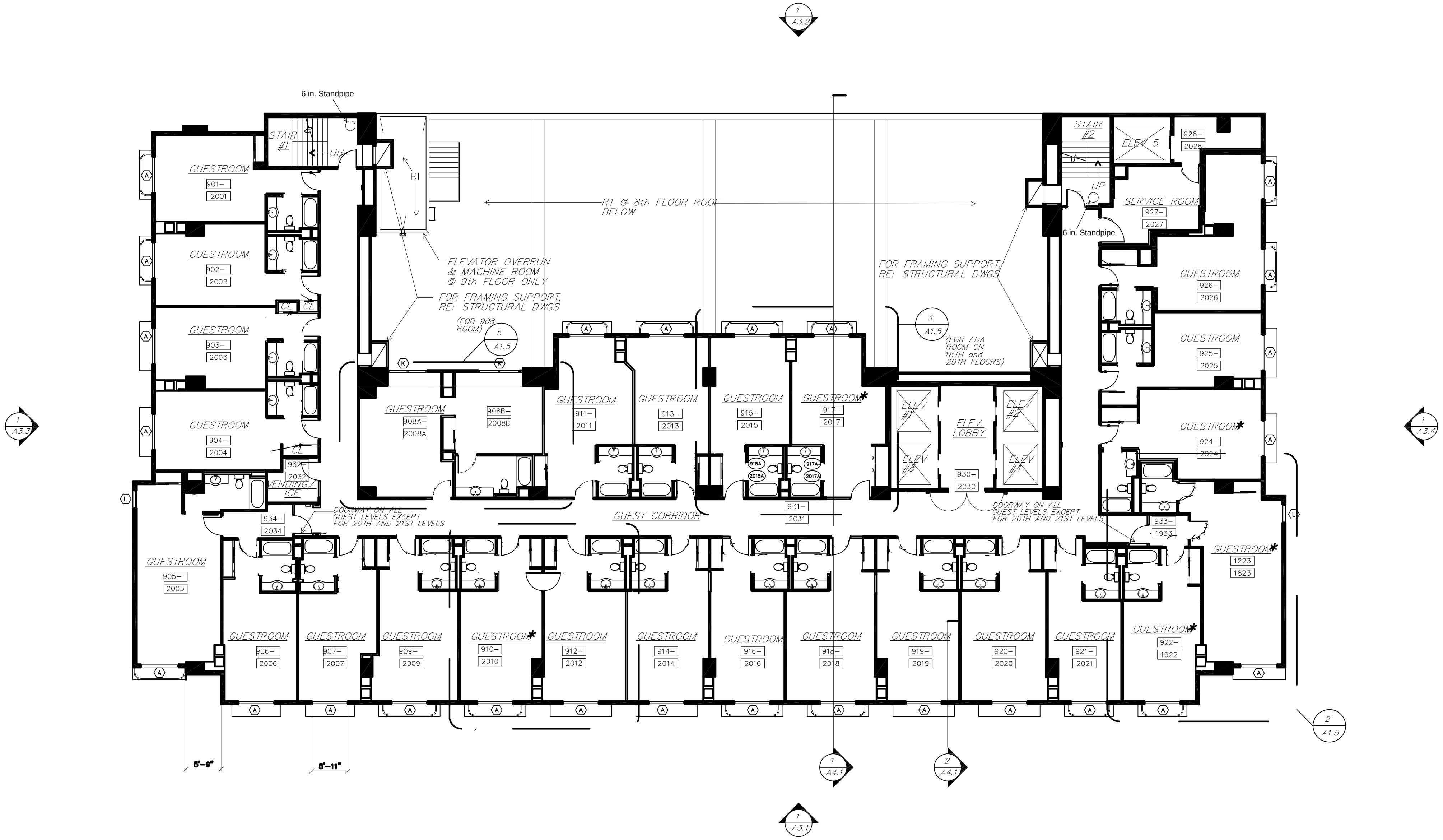
KEY PLAN

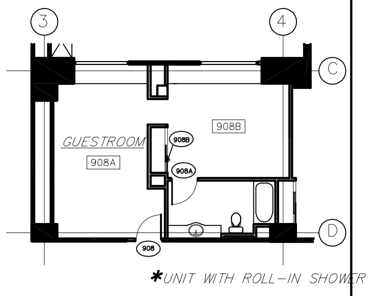


RE: THESE SHEETS FOR ENLARGED PLANS

A1.4

13 MAY 2004



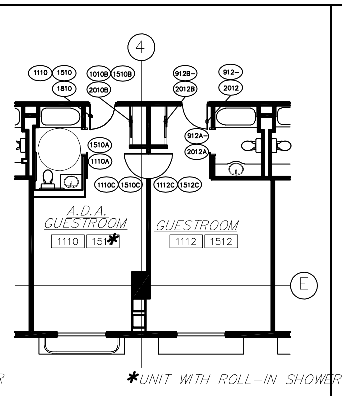


*UNIT WITH ROLL-IN SHOWER

ALSO SEE 2/A5.9

### GUESTROOM 908

?" = 1'-0" RE: 1/A1.5

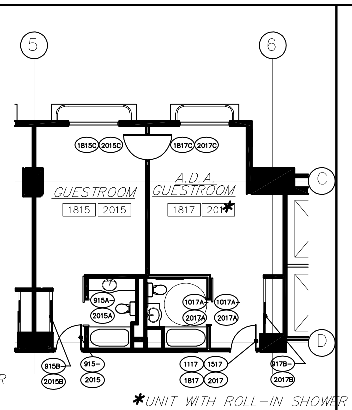


*UNIT WITH ROLL-IN SHOWER

ALSO SEE 3/A5.10

### ADA GUESTROOMS

?" = 1'-0" RE: 1/A1.5

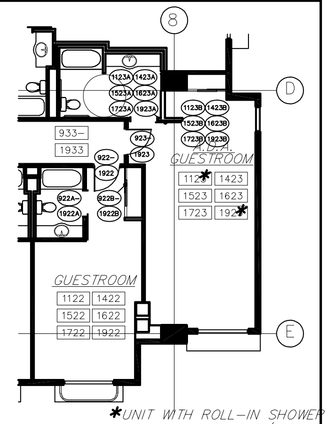


*UNIT WITH ROLL-IN SHOWER

ALSO SEE 2/A5.10

### ADA GUESTROOMS

?" = 1'-0" RE: 1/A1.5



*UNIT WITH ROLL-IN SHOWER
ALSO SEE 2/A5.11

### ADA GUESTROOMS

?" = 1'-0" RE: 1/A1.5

# TYPICAL GUESTROOM FLOOR PLAN (9th–12th & 14th–20thFLOORS)

Use Dimension

NOTE: THERE IS NO 13th FLOOR

NOTE 1: GUESTROOM LAYOUTS BASED ON ORIGINAL CONSTRUCTION DOCUMENTS. SPACES HAVE NOT BEEN CONFIRMED BY RECENT OBSERVATION.

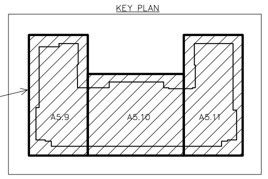
NOTE 2: NUMBER OF GUESTROOMS: 321 PLUS CLUB LEVEL LOUNGE

NOTE 3: ADA COMPLIANT GUESTROOMS LOCATED ON ELEVENTH, FIFTEENTH, EIGHTEENTH, AND TWENTY–FIRST FLOORS.

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| * | ROOMS WITH VISUAL ALARMS ON SELECT LEVELS (SEE SHEET A0.0) |
| ○ | 60" DIAMETER TURN–AROUND |

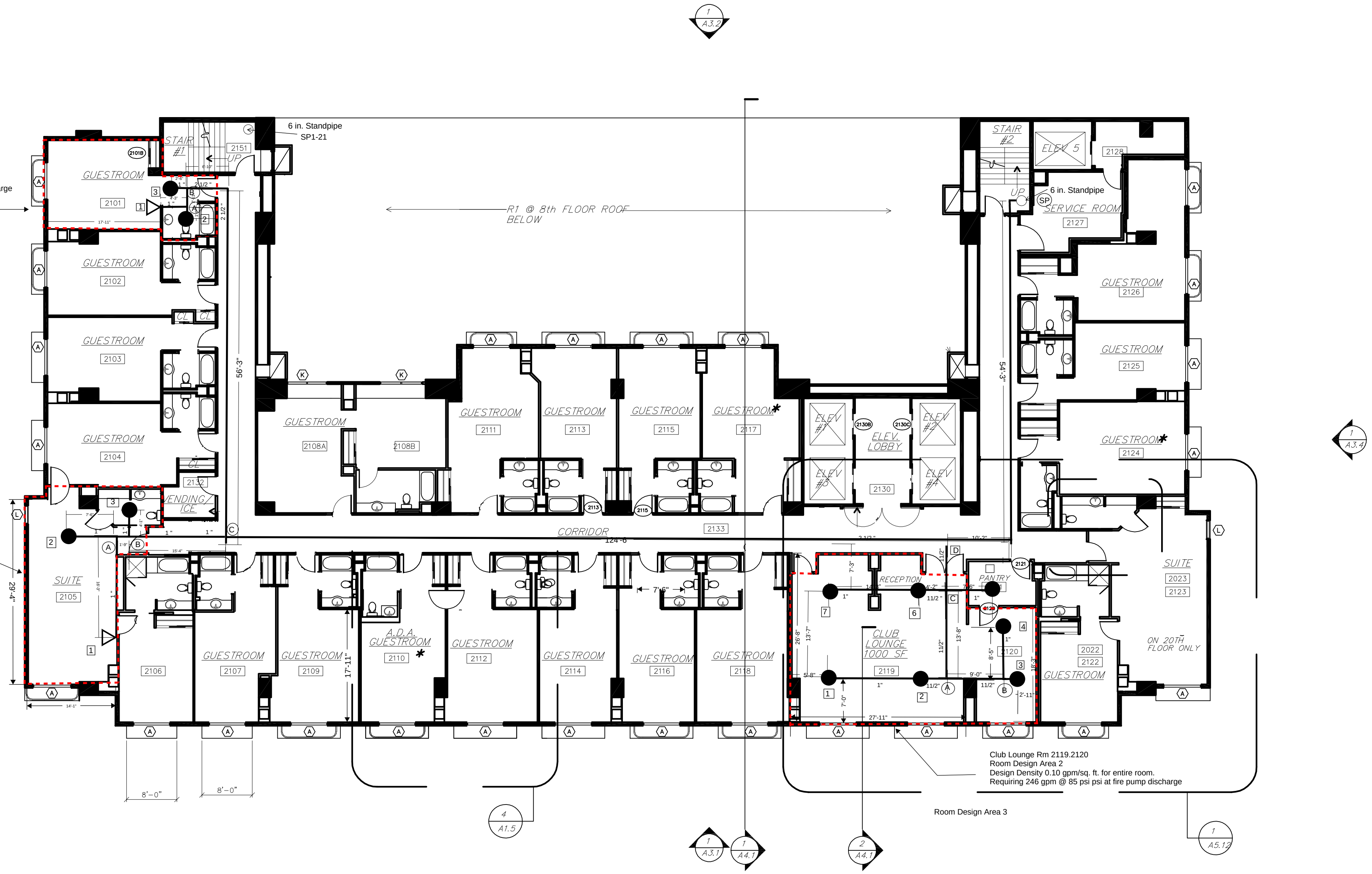
RE: THESE SHEETS FOR ENLARGED PLANS



A1.5

Room 2101
Room Design Area 1
Design Density: 0.10 gpm/sq. ft. for entire room.
Requiring 189 gpm @ 128 psi at fire pump discharge

Room 2015
Room Design Area 2
Design Density: 0.10 gpm/sq. ft. for entire room.
Requiring 190 gpm @ 128 psi at fire pump discharge



Club Lounge Rm 2119.2120
Room Design Area 2
Design Density 0.10 gpm/sq. ft. for entire room.
Requiring 246 gpm @ 85 psi psi at fire pump discharge

Room Design Area 3

| Sprinkler Legend | |
|---|---|
| Standard spray sprinkler<br>165 degree rated, quick response, pendent | ● |
| Extended coverage side wall sprinkler<br>165 degree rated, quick response<br>Tyco Model TY3332 used as example | ▷ |

NORTH

## 1 CLUB LEVEL (21st FLOOR)

Use Dimension

A1.6

# APPENDIX C - FIRE PROTECTION SYSTEM HYDRAULIC CALCULATIONS

## Standpipe Hydraulic Calculations

| Step No. | Nozzle Ident and Location | Flow in gpm | | Pipe size | Pipe Fittings and Devices | Equivalent Pipe Length | | Friction loss (psi/ft) | | Pressure Summary | | Normal Pressure | | Notes | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SP1-Roof to SP1-2 | q | | 6.065 | | L | 162 | C= | 120 | Pt | 65.0 | Pt | | | |
| | | | | | | F | | | | Pe | 70.1 | Pv | | 159.8 | =8.8+4.3+2.6 + 8.3+ 10.8 +25.8+ 63.5+ 21.8 +14 |
| | | Q | 250.0 | | | T | 162 | pf | 0.00271 | Pf | 0.4 | Pn | | | |
| | | | | | | | | | | | | | | | |
| 1 | SP1-2 to A | q | | 6.065 | 1-T | L | 159.8 | C= | 120 | Pt | 135.6 | Pt | | | |
| | | | | | 8-E | F | 142 | | | Pe | | Pv | | 159.8 | =8.8+4.3+2.6 + 8.3+ 10.8 +25.8+ 63.5+ 21.8 +14 |
| | | Q | 250.0 | | | T | 301.8 | pf | 0.003 | Pf | 0.8 | Pn | | | |
| | | | | | | | | | | Pt | 136.4 | | | | |
| | | | | | | | | | | | | | | | |
| 2 | SP3-2 ( balance 250 gpm to 136.4 psi) | q | 362.00 | 6.065 | 1T | L | 2.3 | C= | 120 | Pt | 136.4 | Pt | | | k= q/p0.5 |
| | q= 31x 136.4(0.5)=362 | | | | | F | 30 | | | Pe | 0.0 | Pv | k= | 31 | p = 65 +0.4 = 65 psi, q= 250 solve for K = 250*65(0.5)= 31 |
| | | Q | 612.0 | | | T | 32.3 | pf | 0.014 | Pf | 0.5 | Pn | | | |
| 3 | A to B | q | | 6.065 | | L | 158.6 | C= | 120 | Pt | 136.4 | Pt | | 158.6 | 313.1 |
| | | | | | 1E | F | 14 | | | Pe | | Pv | | | |
| | | Q | 612.0 | | | T | 172.6 | pf | 0.014 | Pf | 2.4 | Pn | | | |
| 4 | SP4-2 ( balance 250 to 138.8) | q | 365.3 | 6.065 | | L | | C= | 120 | Pt | 138.8 | Pt | k= | 31 | |
| | q= 31x 138.8(0.5)= 365.3 | | | | | F | | | | Pe | | Pv | | | |
| | | Q | 977.3 | | | T | 0 | pf | 0.034 | Pf | | Pn | | | |
| 5 | B to C | q | | 6.065 | | L | 130.35 | C= | 120 | Pt | 138.8 | Pt | | 130.35 | 130.35 |
| | | | | | 6E | F | 98 | | | Pe | | Pv | | | |
| | | Q | 977.3 | | | T | 228.35 | pf | 0.034 | Pf | 7.7 | Pn | | | |
| 6 | SP2-2 balance 250 to 146.1 | q | 374.6 | 6.065 | | L | | C= | 120 | Pt | 146.5 | Pt | | | |
| | q= 31 x 146 (0.5)= | | | | | F | | | | Pe | | Pv | | | |
| | | Q | 1351.9 | | | T | 0 | pf | 0.061 | Pf | 0.0 | Pn | k= | 31 | |
| 7 | | | | | | F | | | | Pt | 146.5 | Pv | | | |
| | | | | | | T | | pf | | Pf | | Pn | | | |
| | SP2-2 to BOR | q | | 6.065 | | L | 9 | C= | 120 | Pt | 146.5 | Pt | | | |
| | | | | | 1E | F | 49 | | | Pe | 4.0 | Pv | | | |
| | | Q | 1351.9 | | 1OS&Y, 1CV | T | 58 | pf | 0.061 | Pf | 3.6 | Pn | | | |
| 8 | BOR to PD | | | 6.065 | | L | 48.2 | C= | 120.000 | Pt | 154.1 | | | | Main pipe to riser |
| | | | | | 1T | F | 49 | | | Pe | | | | | |
| | | Q | 1351.9 | | | T | 97.2 | pf | 0.061 | Pf | 6.0 | | | | |
| 9 | PD | q | | | | L | | C= | 120 | Pt | 160.1 | Pt | | | |
| | | | | | | F | | | | Pe | | Pv | | | |
| | | Q | | | | T | | pf | | Pf | | Pn | | | |

Conference Room 808 Hydraulic Calculations

| Step No. | Nozzle Ident and Location | Flow in gpm | | Pipe size | Pipe Fittings and Devices | Equivalent Pipe Length | | Friction loss (psi/ft) | | Pressure Summary | | Spacing sf | K | density(gpm/sf) | Q | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | q | | 1.049 | | L | 12 | C= | 120 | Pt | 7.0 | 120 | 5.6 | 0.10 | 14.8 | 7.00 |
| | | | | | | F | | | | Pe | | | | | | |
| | | Q | 14.7 | | | T | 12 | pf | 0.074 | Pf | 0.9 | Find ke for drop | Assume 1 "x 1 ' drop at each sprinkler | | | |
| 2 | 2 | q | 15.7 | 1.049 | | L | 12 | C= | 120 | Pt | 7.9 | pf= | 0.07 | 7.07 | | |
| | | | | | | F | | | | Pe | | p t for drop= 7+ 0.07= 7.07, Q=k(p)0.5 | | | | |
| | | Q | 30.4 | | | T | 12 | pf | 0.283 | Pf | 3.4 | solve for ke | 5.56 | Q adjusted | 14.7 | |
| 3 | 3 | q | 18.8 | 1.61 | | L | 12 | C= | 120 | Pt | 11.3 | | | | | |
| | | | | | | F | | | | Pe | | | | | | |
| | | Q | 49.2 | | | T | 12 | pf | 0.086 | Pf | 1.0 | | | | | |
| 4 | 4 | q | 19.6 | 1.61 | 1T | L | 6 | C= | 120 | Pt | 12.3 | | | | | |
| | | | | | | F | 8 | | | Pe | | | | | | |
| | | Q | 68.9 | | | T | 14 | pf | 0.159 | Pf | 2.2 | | | | | |
| 5 | A | q | 0.0 | 1.61 | | L | 10 | C= | 120 | Pt | 14.5 | Ke = | 17.15 | | | |
| | | | | | | F | | | | Pe | | | | | | |
| | | Q | 68.9 | | | T | 10 | pf | 0.159 | Pf | 1.6 | | | | | |
| 6 | B | q | 68.9 | 2.067 | | L | 10 | C= | 120 | Pt | 16.1 | QB= | 68.87 | | | |
| | | | | | | F | | | | Pe | | | | | | |
| | | Q | 137.7 | | | T | 10 | pf | 0.170 | Pf | 1.7 | | | | | |
| 7 | C to SP | q | | 2.067 | | L | 177.7 | C= | 120 | Pt | 17.8 | | | | | |
| | | | | | 7-E | F | 35 | | | Pe | | | | | | |
| | | Q | 137.7 | | | T | 212.7 | pf | 0.170 | Pf | 36.1 | | | | | |
| 8 | 2 SP to BOR | q | | 6.065 | | L | 72 | C= | 120 | Pt | 54.0 | | sch 40 | 20 floors x 9 Ft | | |
| | | | | | | F | | | | Pe | 31.2 | 72ft X 0.433 psi/ft = | | | | |
| | | Q | 137.7 | | | T | 72 | pf | 0.0008985 | Pf | 0.0647 | | | | | |
| 9 | 3 BOR to PD | q | | 6.065 | | L | 48.2 | C= | 120 | Pt | 85.2 | | | | | |
| | | | | | 1E | F | 49 | | | Pe | | | | | | |
| | | Q | 137.7 | | 1OS&Y, 1CV | T | 97.2 | pf | 0.0008985 | Pf | 0.09 | | | | | |
| 10 | PD | q | 100.0 | | | | | | | Pt | 85.3 | add hose 100 gpm | | | | |
| | | Q | 237.7 | | | | | | | | | | | | | |

Room 2101 Fire Sprinkler Hydraulic Calculations

| Step No. | Nozzle Ident and Location | | Flow in gpm | | Pipe size | Pipe Fittings and Devices | Equivalent Pipe Length | | Friction loss (psi/ft) | | Pressure Summary | | spacing sf | k | density(gpm/sf) | Q | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | Sprinkler 1 | q | | 1.049 | | L | 4.25 | C = | 120 | Pt | 26.8 | 120 | 5.6 | | 29 | 26.82 |
| | | | | | | 1T | F | 5 | | | Pe | | | | | | |
| | | | Q | 29.0 | | | T | 9.25 | pf | 0.259 | Pf | 2.4 | | | | | |
| | A | | | | | | | | | | Pt | 29.2 | | | | | |
| | | | | | | | | | | | | | | | | | |
| 2 | | Sprinkler 2 | q | 22.5 | 1.049 | | L | 1.75 | C = | 120 | Pt | 16.1 | 225 | 5.6 | 0.10 | 22.5 | 16.14 |
| | | | | | | | F | | | | Pe | | | | | | |
| | | | Q | 22.5 | | | T | 1.75 | pf | 0.162 | Pf | 0.3 | | | | | |
| | | | q | | 1.049 | | L | 13 | C = | 120 | Pt | 16.4 | 120 | 5.6 | 0.15 | 18 | 10.33 |
| | | | | | | | F | | | | Pe | | | | | | |
| | | | Q | 0.0 | | | T | 13 | pf | 0.000 | Pf | 0.0 | Ke | 5.55 | | | |
| | | Balance Sp 2 @A | q | 30.0 | | | | | | | | 29.2 | | 5.6 | | | |
| 3 | A-B | | q | 29.0 | 1.61 | | L | 2.9 | C = | 120 | Pt | 29.2 | 225 | 5.6 | 0.10 | 22.5 | 16.14 |
| | | | | | | 1T | F | 8 | | | Pe | | | | | | |
| | | | Q | 59.0 | | | T | 10.9 | pf | 0.120 | Pf | 1.3 | | | | | |
| | | | q | | | | L | | C = | | Pt | 30.5 | 225 | 5.6 | 0.10 | 22.5 | 16.14 |
| | | | | | | | F | | | | Pe | | | | | | |
| | | | Q | | | | T | | pf | | Pf | | | | | | |
| 4 | | Sprinkler 3 | q | | 1.049 | | L | 2.5 | C = | 120 | Pt | 16.1 | 225 | 5.6 | 0.10 | 22.5 | 16.14 |
| | | | | | | | F | | | | Pe | | | | | | |
| | | | Q | 22.5 | | | T | 2.5 | pf | 0.162 | Pf | 0.4 | | | | | |
| | | | | | | | F | | | | Pt | 16.5 | | | | | |
| | | | | | | | T | | pf | | Pf | | | | | | |
| 5 | | Balance Sp 3 @B | q | 30.1 | 1.049 | | L | | C = | 120 | Pt | 29.6 | Ke | 5.53 | | | |
| | | | | | | | F | | | | Pe | | | | | | |
| | | | Q | 89.1 | | | T | | pf | | Pf | | | | | | |

Room 2101 Fire Sprinkler Hydraulic Calculations

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | | B to SP | | | 2.469 | | L | 241.83 | | 120.000 | Pt | 29.6 | 241.83 | 6.83 | 56.25 | 125 | 54.25 |
| | | | | | | 6E | F | 52 | | | Pe | 6.0 | | | | | |
| | | | | 89.1 | | 1 BFV | T | 293.83 | pf | 0.032 | Pf | 9.4 | | | | | |
| | | | | | | | | | | | Pt | 45.0 | | | | | |
| 7 | | SP to BOR | q | | 6.065 | | L | 171 | C = | 120 | Pt | 45.0 | 19 floors x 9 Ft | | | | |
| | | | | | | | F | | | | Pe | 74.0 | | | | | |
| | | | Q | 89.1 | | | T | 171 | pf | 0.0004014 | Pf | 0.1 | | | | | |
| 8 | | BOR to PD | q | | 6.065 | | L | 48.2 | C = | 120 | Pt | 119.1 | | | | | |
| | | | | | | 1E | F | 49 | | | Pe | 9.0 | | | | | |
| | | | Q | 89.1 | | 1OS&Y , 1CV | T | 97.2 | pf | 0.0004014 | Pf | 0.04 | | | | | |
| 9 | | PD | q | 100.0 | | | L | | C = | | Pt | 128.1 | add hose | | Table 11.2.3.1.2 | | |
| | | | Q | 189.1 | | | | | | | | | allowance | | | | |

# Room 2105 Hydraulic Calculations

| Nozzle Ident and Location | | Flow in gpm | | Pipe size | Pipe Fittings and Devices | Equivalent Pipe Length | | Friction loss (psi/ft) | | Pressure Summary( psi) | | | Spacing sf | k | Density (gpm/sf) | Q | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sprinkler 1 | q | | 1.049 | | L | 16 | C= | 120 | Pt | 26.8 | Extended coverage sidewall | 120 | 5.6 | | 29 | 26.82 |
| | | | | | 1T | F | 5 | | | Pe | | TY3332 | | | | | |
| | | Q | 29.0 | | | T | 21 | pf | 0.259 | Pf | 5.4 | | | | | | |
| A | | | | | | | | | | Pt | 32.3 | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | Sprinkler 2 | q | 22.5 | 1.049 | | L | 1.75 | C= | 120 | Pt | 16.1 | | 225 | 5.6 | 0.10 | 22.5 | 16.14 |
| | | | | | | F | | | | Pe | | | | | | | |
| | | Q | 22.5 | | | T | 1.75 | pf | 0.162 | Pf | 0.3 | | | | | | |
| | | q | | 1.049 | | L | 13 | C= | 120 | Pt | 16.4 | | 120 | 5.6 | 0.15 | 18 | 10.33 |
| | | | | | | F | | | | Pe | | | | | | | |
| | | Q | 0.0 | | | T | 13 | pf | 0.000 | Pf | 0.0 | | Ke | 5.55 | | | |
| | Balance Sp 2 @A | q | 31.5 | | | | | | | | 32.3 | | | 5.6 | | | |
| A-B | | q | 29.0 | 1.61 | | L | 1.9 | C= | 120 | Pt | 32.3 | | 225 | 5.6 | 0.10 | 22.5 | 16.14 |
| | | | | | 1T | F | 8 | | | Pe | | | | | | | |
| | | Q | 60.5 | | | T | 9.9 | pf | 0.125 | Pf | 1.2 | | | | | | |
| | | q | | | | L | | C= | 120 | Pt | 33.5 | | 225 | 5.6 | 0.10 | 22.5 | 16.14 |
| | | | | | | F | | | | Pe | | | | | | | |
| | | Q | | | | T | | pf | | Pf | | | | | | | |
| | Sprinkler 3 | q | | 1.049 | | L | 4 | C= | 120 | Pt | 16.1 | | 225 | 5.6 | 0.10 | 22.5 | 16.14 |
| | | | | | | F | | | | Pe | | | | | | | |
| | | Q | 22.5 | | | T | 4 | pf | 0.162 | Pf | 0.6 | | | | | | |
| | | | | | | F | | | | Pt | 16.8 | | | | | | |
| | | | | | | T | | pf | | Pf | | | | | | | |
| | Balance Sp 3 @B | q | 29.9 | 1.049 | | L | | C= | 120 | Pt | 29.6 | | Ke | 5.49 | | | |
| | | | | | | F | | | | Pe | | | | | | | |
| | | Q | 90.4 | | | T | | pf | | Pf | | | | | | | |
| | B to C | | | 1.049 | | L | 15.25 | | 120.000 | Pt | 29.6 | Main pipe to riser | 241.83 | 6.83 | 56.25 | 124.5 | 54.25 |
| | | | | | 1T | F | 5 | | | | | | | | | | |
| | | Q | 90.4 | | | T | 20.25 | pf | 2.120 | Pf | 42.9 | | | | | | |
| | | | | | | | | | | Pt | 72.5 | | | | | | |
| | C to SP | | | 2.469 | | L | 180.75 | | 120.000 | Pt | 29.6 | Main pipe to riser | 180.75 | | 56.25 | 124.5 | |
| | | | | | 4E | F | 20 | | | | | | | | | | |
| | | Q | 90.4 | | | T | 200.75 | pf | 0.033 | Pf | 6.6 | | | | | | |
| | | | | | | | | | | Pt | 36.2 | | | | | | |

Room 2105 Hydraulic Calculations

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SP to BOR | q | | 6.065 | | L | 171 | C= | 120 | Pt | 36.2 | sch 40 | 20 flrs x 9 Ft | | | | |
| | | | | | | F | | | | Pe | 74.0 | | | | | | |
| | | Q | 90.4 | | | T | 171 | pf | 0.0004123 | Pf | 0.1 | | | | | | |
| | BOR to PD | q | | 6.065 | | L | 48.2 | C= | 120 | Pt | 110.3 | | | | | | |
| | | | | | 1E | F | 49 | | | Pe | 9.0 | | | | | | |
| | | Q | 90.4 | | 1OS&Y, 1CV | T | 97.2 | pf | 0.0004123 | Pf | 0.04 | | | | | | |
| | PD | q | 100.0 | | | L | | C= | 120 | Pt | 119.3 | | hose allowance | | Table 11.2.3.1.2 | | |
| | | Q | 190.4 | | | | | | | | | | | | | | |

Room 2119/2120 Hydraulic Calculations

| Step No. | Nozzle Ident and Location | | Flow in gpm | | Pipe size | Pipe Fittings and Devices | Equivalent Pipe Length | | Friction loss (psi/ft) | | Pressure Summary | | Notes | Spacing sf | k | Density(gpm/sf) | Q | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | Sprinkler 1 | q | | 1.049 | | L | 14.7 | C= | 120 | Pt | 16.1 | 225 x 0.10 = 22.5 | 225 | 5.6 | 0.10 | 22.5 | 16.14 |
| | | | | | | | F | | | | Pe | | | | | | | |
| | | | Q | 22.5 | | | T | 14.7 | pf | 0.162 | Pf | 2.4 | | | | | | |
| | | | | | | | | | | | Pt | 18.5 | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| 2 | | Sprinkler 2 | q | 24.1 | 1.61 | 1t | L | 4.2 | C= | 120 | Pt | 18.5 | | 225 | 5.6 | 0.10 | 22.5 | 18.50 |
| | | | | | | | F | 5 | | | Pe | | | | | | | |
| | | | Q | 46.6 | | | T | 9.2 | pf | 0.077 | Pf | 0.7 | | | | | | |
| 3 | | A | q | | | | L | 4.2 | C= | 120 | Pt | 19.2 | | 120 | 5.6 | 0.15 | 18 | 10.33 |
| | | | | | | | F | | | | Pe | | | | | | | |
| | | | Q | 46.6 | | | T | 4.2 | pf | | Pf | 0.0 | | Ke | 10.63 | | | |
| | | Balance @A | q | 46.6 | | | | | | | Pt | 19.2 | | | 5.6 | | | |
| 4 | | Sprinkler 4 | q | | 1.048 | | L | 8.4 | C= | 120 | Pt | 16.1 | | 225 | 5.6 | 0.10 | 22.5 | 16.14 |
| | | | | | | 1T | F | 8 | | | Pe | | | | | | | |
| | | | Q | 22.5 | | | T | 16.4 | pf | 0.163 | Pf | 2.7 | | | | | | |
| 5 | | B | q | | | | L | | C= | | Pt | 18.8 | | 225 | 5.6 | 0.10 | 22.5 | 16.14 |
| | | | | | | | F | | | | Pe | | | | | | | |
| | | | Q | 22.5 | | | T | | pf | | Pf | 18.8 | | | | | | |
| 6 | | Sprinkler 3 | q | | 1.049 | | L | 2.5 | C= | 120 | Pt | 16.1 | | 225 | 5.6 | 0.10 | 22.5 | 16.14 |
| | | | | | | | F | | | | Pe | | | | | | | |
| | | | Q | 22.5 | | | T | 2.5 | pf | 0.162 | Pf | 0.4 | | | | | | |
| 7 | | B | | | | | F | | | | Pt | 16.5 | | Ke | 5.53 | | | |
| | | | | | | | T | | pf | | Pf | | | | | | | |
| | | Balance Sp 3 @B | q | 24.0 | | | L | | C= | 120 | Pt | 18.8 | | Ke | 5.53 | | | |
| | | | | | | | F | | | | Pe | | | | | | | |
| | | | Q | 46.5 | | | T | | pf | | Pf | | | | | | | |
| 8 | | B to A | | | 1.61 | | L | 9 | C= | 120.000 | Pt | 18.8 | Main pipe to riser | 241.83 | 6.83 | 56.25 | 124.5 | 54.25 |
| | | | | | | 1T | F | 8 | | | Pe | | | | | | | |
| | | | Q | 46.5 | | | T | 17 | pf | 0.077 | Pf | 1.3 | | | | | | |
| 9 | | Balance Sp1/2 BranchLine at A | q | 47.7 | | | L | | C= | 120 | Pt | 20.1 | | Ke | 10.63 | | 46.2 | 19.20 |
| | | | | | | | F | | | | Pe | | | | | | | |
| | | | Q | 94.2 | | | T | | pf | | Pf | | | | | | | |
| 10 | | A to C | | | 1.61 | | L | 13.7 | C= | 120.000 | Pt | 20.1 | Main pipe to riser | 241.83 | 6.83 | 56.25 | 124.5 | 54.25 |
| | | | | | | | F | | | | Pe | | | | | | | |
| | | | Q | 94.2 | | | T | 13.7 | pf | 0.284 | Pf | 3.9 | | | | | | |
| | | Balance Branchline 6/7 | | 52.1 | | | | | | | Pt | 24.0 | | | | | | |
| | | | | | | | | | | | | | | Ke | 10.63 | | | |
| | | | | | | | F | | | | Pe | | | | | | | |
| | | | Q | 146.2 | | | T | | pf | | Pf | | | | | | | |
| 11 | | C to D | q | | 1.61 | | L | 7.25 | C= | 120 | Pt | 24.0 | | | | | | |
| | | | | | | 1T | F | 10 | | | Pe | | | | | | | |
| | | | Q | 146.2 | | | T | 17.25 | pf | 0.641 | Pf | 11.1 | | | | | | |
| 12 | | D to SP | q | | 2.469 | 3E | L | 64.41 | C= | 120 | Pt | 35.0 | | 64.41 | 10.16 | 54.25 | | |

Room 2119/2120 Hydraulic Calculations

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | F | 18 | | | Pe | | | | | | | |
| | | | Q | 146.2 | | | T | 82.41 | pf | 0.080 | Pf | 6.6 | | | | | | |
| 13 | SP to BOR | | q | | 6.065 | | L | 171 | C= | 120 | Pt | 6.6 | sch 40 | 20 flrs x 9 Ft | | | | |
| | | | | | | | F | | | | Pe | 74.0 | | | | | | |
| | | | Q | 146.2 | | | T | 171 | pf | 0.0010036 | Pf | 0.2 | | | | | | |
| 14 | BOR to PD | | q | | 6.065 | 1E 1OS&Y, 1CV | L | 48.2 | C= | 120 | Pt | 80.8 | | | | | | |
| | | | | | | | F | 49 | | | Pe | 9.0 | | | | | | |
| | | | Q | 146.2 | | | T | 97.2 | pf | 0.0010036 | Pf | 0.10 | | | | | | |
| | | PD | q | 100.0 | | | L | | C= | | Pt | 89.9 | | add hose | | Table 11.2.3.1.2 | | |
| | | | Q | 246.2 | | | | | | | | | | | | | | |

# APPENDIX D – FIRE SUPPRESSION SYSTEM INSPECTION, TESTING, AND MAINTENANCE REQUIREMENTS

NFPA 25, Section 3.3.19 requires the service to be provided by a qualified State of California State Licensed C-16 contractor, a California State Fire Marshal Licensed A contractor, or a qualified owner's representative as permitted by Title 19.

Chapters 5-9 of NFPA 25 provides the minimum requirements for the inspection, testing, and maintenance of these systems. A brief overview of the requirements for the various components follows. A detailed summary of inspection, testing, and maintenance scope and frequency is shown in Tables 7-10.

### 1.1.1 Sprinkler Inspection

(NFPA 25, Section 5.2.1)
Sprinkler are required to be inspected from the floor level annually. Sprinklers in concealed spaces where access is provided are required to be inspected very five years. Sprinklers installed in inaccessible spaces are not required to be inspected. Sprinklers which show any signs of leakage, corrosion, physical damage, loss of glass bulb liquid, or that have been painted require replacement. Stock, equipment, or other materials closer to the sprinkler is required to be moved.

The supply of spare sprinkler is required to be inspected and additional sprinklers added if the type or quantity is deficient. A sprinkler wrench for each type of sprinkler is also to be verified.

### 1.1.2 Pipe and Fittings

(NFPA 25, Section 5.2.2)
Sprinkler pipe and fittings installed under an exposed ceiling is required to be inspected annually from the floor. This equipment is required to be in good working order and free of mechanical damage, leakage, or corrosion. The piping is not allowed to support other materials.

Pipe and fittings installed in concealed spaces where access is provided are required to be inspected a maximum of every five years using the same guidelines. Sprinkler pipe and fittings installed in inaccessible spaces are not required to be inspected.

### 1.1.3 Hangers, Seismic Bracing, and Gauges

(NFPA 25, Sections 5.2.3 and 5.2.4)
Hangers and bracing are required to be inspected for damage or attachment instability annually. Gauges are required to be inspected quarterly to verify they are in functional and in good working order.

### 1.1.4 Waterflow Alarm and Supervisory Devices

(NFPA 25, Section 5.2.5)
These devices are required to be functionally tested annually. The system's audible device is required to activate within 90 seconds of the opening of the inspector's drain.

### 1.1.5 Hydraulic Design Information Placard

(NFPA 25, Section 5.2.6)
The placard is required to be inspected to verify secure attachment on a quarterly basis.

### 1.1.6 Sprinkler Testing

(NFPA 25, Section 5.3.1)

Sprinklers which reach a specific age, 20 -50 years, are required to be tested to confirm proper functionality. A specific sample size is provided to a nationally recognized for the testing. Generally, not less than 4 sprinklers, or 1% of the number of sprinklers of a specific type are required to be tested. Sprinklers manufactured prior to 1920 are required to be replaced.

Gauges are required to be recalibrated or replaced every five years.

### 1.1.7 Sprinkler Maintenance

(NFPA 25, Section 5.4)

Replacement sprinklers are required to be the proper style, K factor, deflector type, and orifice size. Only new sprinklers are allowed to be used for replacement.

**Table 1: NFPA 25 Fire Sprinkler Inspection, Testing, and Maintenance Requirements**

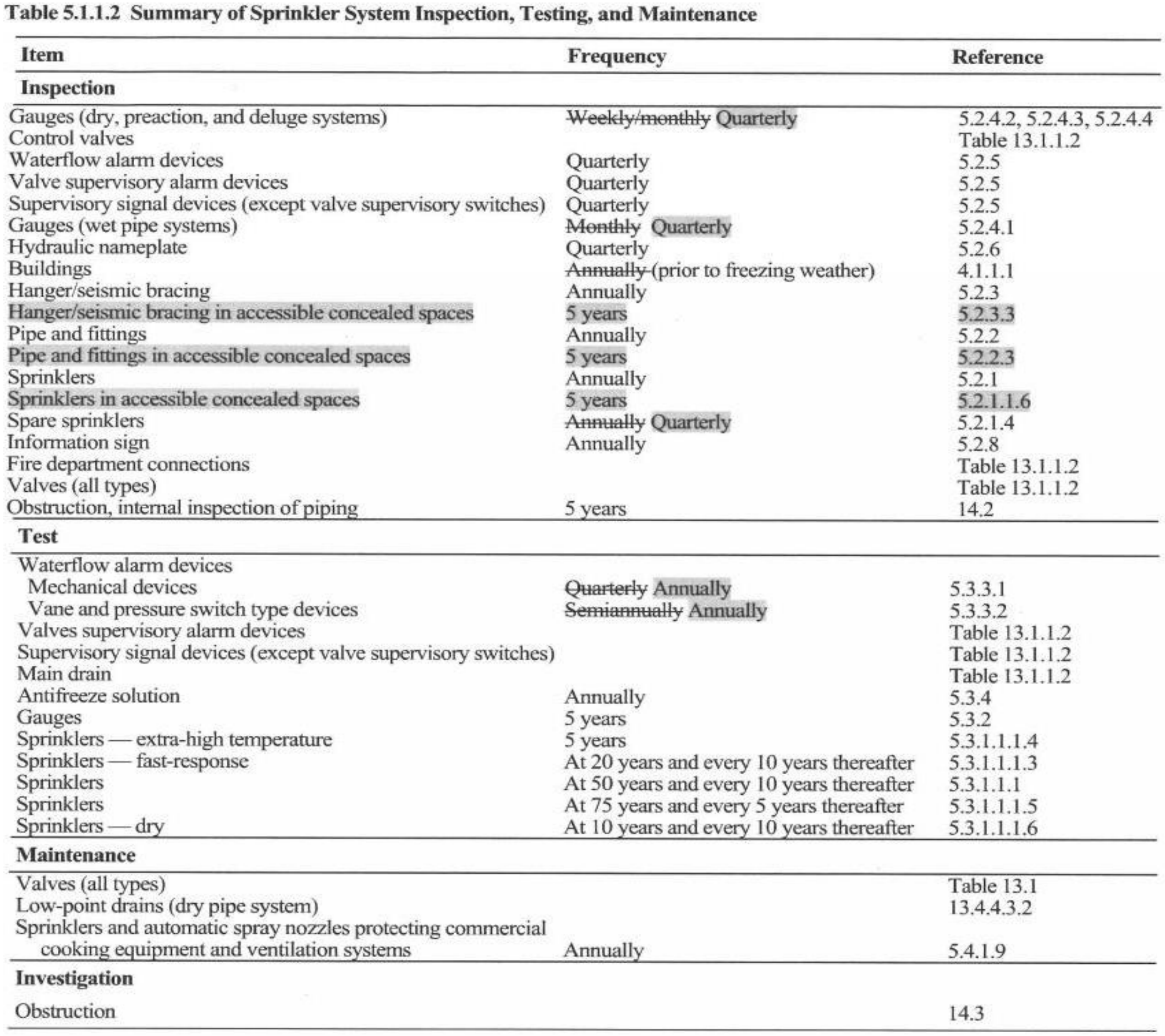


**Table 5.1.1.2 Summary of Sprinkler System Inspection, Testing, and Maintenance**

| Item | Frequency | Reference |
|---|---|---|
| **Inspection** | | |
| Gauges (dry, preaction, and deluge systems) | ~~Weekly/monthly~~ Quarterly | 5.2.4.2, 5.2.4.3, 5.2.4.4 |
| Control valves | | Table 13.1.1.2 |
| Waterflow alarm devices | Quarterly | 5.2.5 |
| Valve supervisory alarm devices | Quarterly | 5.2.5 |
| Supervisory signal devices (except valve supervisory switches) | Quarterly | 5.2.5 |
| Gauges (wet pipe systems) | ~~Monthly~~ Quarterly | 5.2.4.1 |
| Hydraulic nameplate | Quarterly | 5.2.6 |
| Buildings | ~~Annually~~ (prior to freezing weather) | 4.1.1.1 |
| Hanger/seismic bracing | Annually | 5.2.3 |
| Hanger/seismic bracing in accessible concealed spaces | 5 years | 5.2.3.3 |
| Pipe and fittings | Annually | 5.2.2 |
| Pipe and fittings in accessible concealed spaces | 5 years | 5.2.2.3 |
| Sprinklers | Annually | 5.2.1 |
| Sprinklers in accessible concealed spaces | 5 years | 5.2.1.1.6 |
| Spare sprinklers | ~~Annually~~ Quarterly | 5.2.1.4 |
| Information sign | Annually | 5.2.8 |
| Fire department connections | | Table 13.1.1.2 |
| Valves (all types) | | Table 13.1.1.2 |
| Obstruction, internal inspection of piping | 5 years | 14.2 |
| **Test** | | |
| Waterflow alarm devices | | |
| Mechanical devices | ~~Quarterly~~ Annually | 5.3.3.1 |
| Vane and pressure switch type devices | ~~Semiannually~~ Annually | 5.3.3.2 |
| Valves supervisory alarm devices | | Table 13.1.1.2 |
| Supervisory signal devices (except valve supervisory switches) | | Table 13.1.1.2 |
| Main drain | | Table 13.1.1.2 |
| Antifreeze solution | Annually | 5.3.4 |
| Gauges | 5 years | 5.3.2 |
| Sprinklers — extra-high 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 |

### 1.1.8 Standpipe System Inspection

(NFPA 25, Section 6.1)
Components of the standpipe system are required to be visually inspected annually. Standpipe systems are required to be flow tested every five years. The testing is required to verify that the system can still provide the required design and flow.

Gauges and waterflow alarm supervisory devices are required to be tested at the same frequency as such devices attached to sprinkler systems.

**Table 2: NFPA 25 Standpipe and Hose System Inspection, Testing, and Maintenance Requirements**

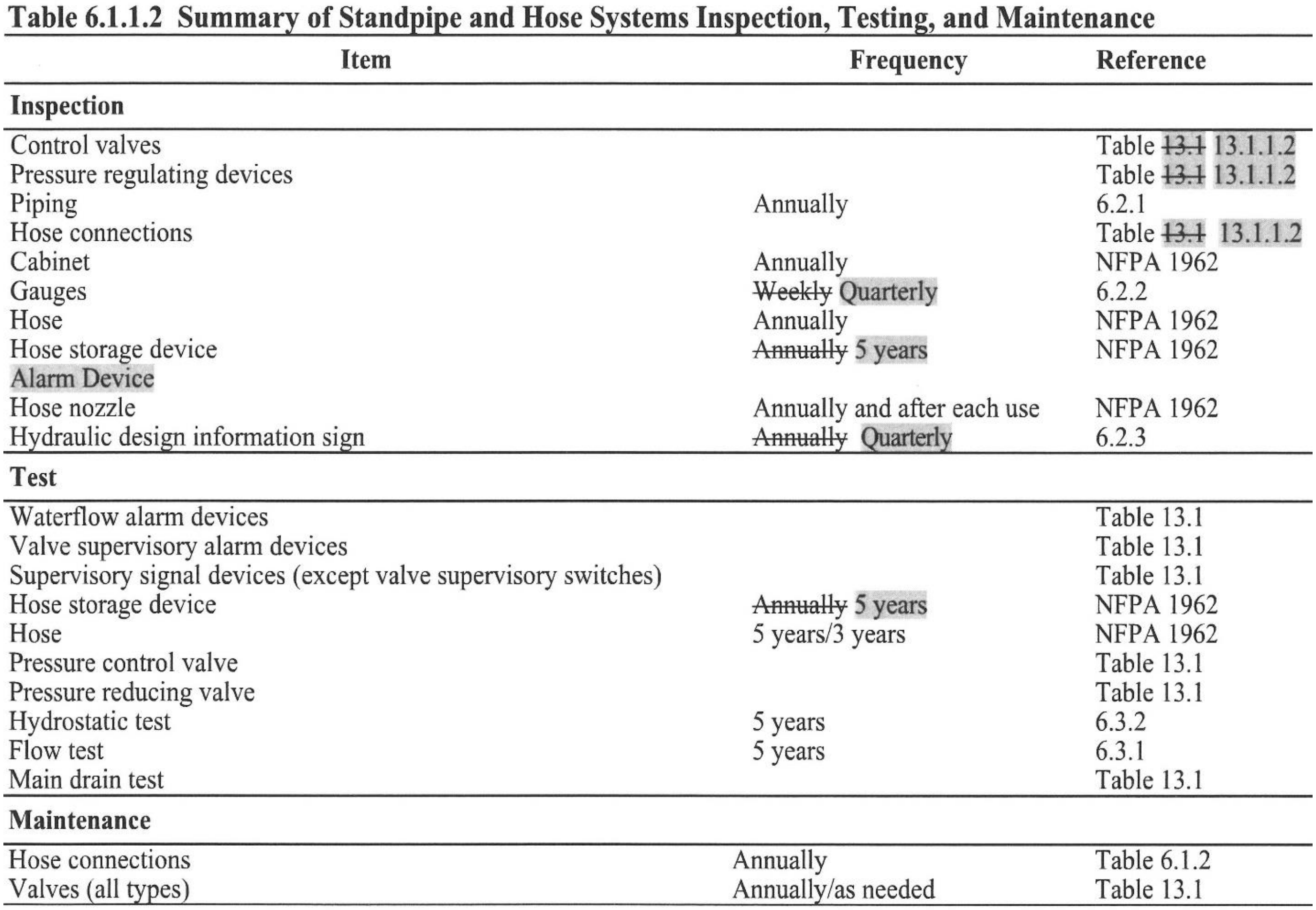


**Table 6.1.1.2 Summary of Standpipe and Hose Systems Inspection, Testing, and Maintenance**

| Item | Frequency | Reference |
|---|---|---|
| **Inspection** | | |
| Control valves | | Table ~~13.1~~ 13.1.1.2 |
| Pressure regulating devices | | Table ~~13.1~~ 13.1.1.2 |
| Piping | Annually | 6.2.1 |
| Hose connections | | Table ~~13.1~~ 13.1.1.2 |
| Cabinet | Annually | NFPA 1962 |
| Gauges | ~~Weekly~~ Quarterly | 6.2.2 |
| Hose | Annually | NFPA 1962 |
| Hose storage device | ~~Annually~~ 5 years | NFPA 1962 |
| Alarm Device | | |
| Hose nozzle | Annually and after each use | NFPA 1962 |
| Hydraulic design information sign | ~~Annually~~ Quarterly | 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~~ 5 years | 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 |

### 1.1.9 Fire Pump Inspection

(NFPA 25, Section 8.2)
Visual inspections are required to be performed weekly for diesel engine driven pumps and monthly for electric motor driven pumps.

### 1.1.10 Fire Pump Testing

(NFPA 25, Section 8.3)
Diesel engine driven pumps are required to be operated weekly. Electric motor driven pumps are required to be operated monthly. No flow condition tests are required to be conducted. The fire pumps

are required to be tested for automatic start up. Diesel engine driven pumps are required to run for a minimum of 30 minutes. Electric motor driven pumps a minimum of 10 minutes. A comprehensive review of the fire pump system components is required to be completed during these tests.

Fire pumps are required to be flow tested yearly. Flow and pressure reading are required to made at churn, rated and 150% flow capacity.

**Table 3: NFPA 25 Fire Pump System Inspection, Testing, and Maintenance Requirements**

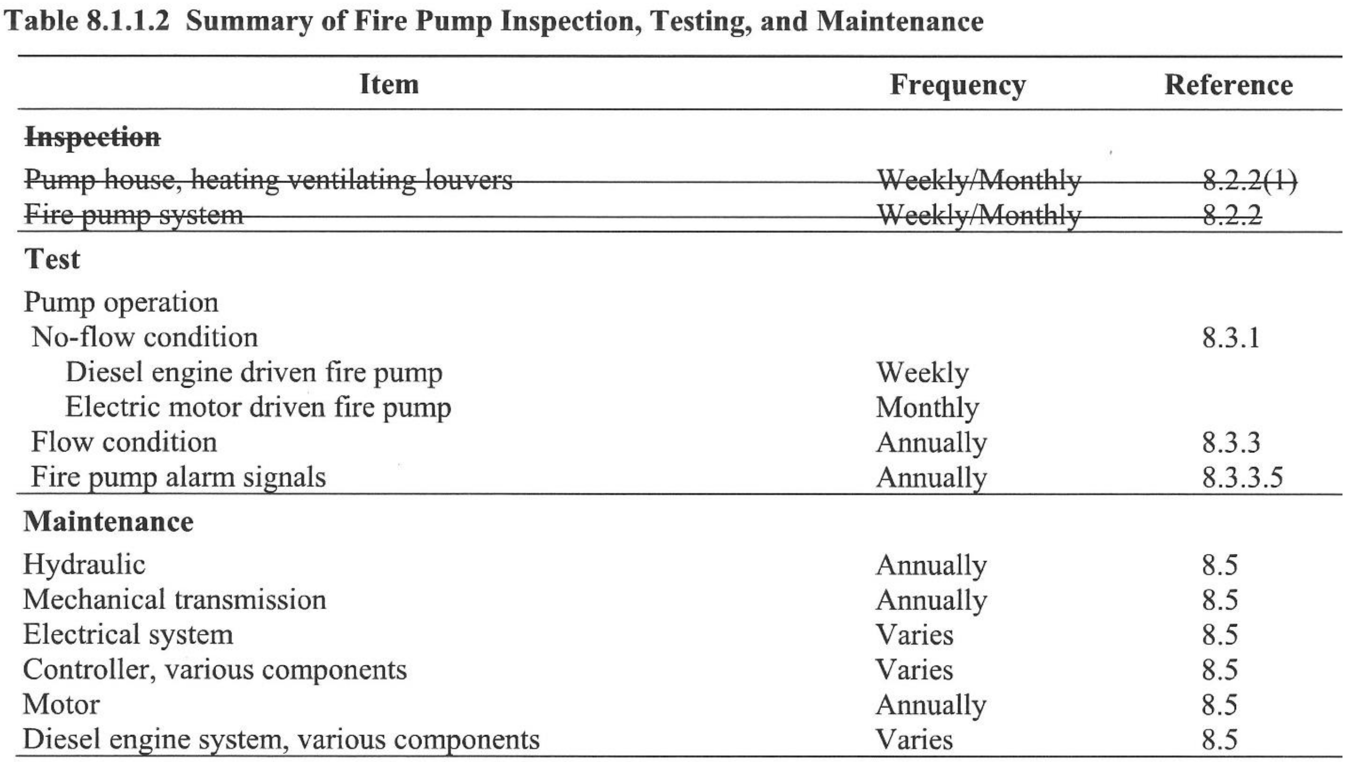


**Table 8.1.1.2 Summary of Fire Pump Inspection, Testing, and Maintenance**

| Item | Frequency | Reference |
|---|---|---|
| ~~**Inspection**~~ | | |
| ~~Pump house, heating ventilating louvers~~ | ~~Weekly/Monthly~~ | ~~8.2.2(1)~~ |
| ~~Fire pump system~~ | ~~Weekly/Monthly~~ | ~~8.2.2~~ |
| **Test** | | |
| Pump operation | | |
| No-flow condition | | 8.3.1 |
| Diesel engine driven fire pump | Weekly | |
| Electric motor driven fire pump | Monthly | |
| Flow condition | Annually | 8.3.3 |
| Fire pump alarm signals | Annually | 8.3.3.5 |
| **Maintenance** | | |
| Hydraulic | Annually | 8.5 |
| Mechanical transmission | Annually | 8.5 |
| Electrical system | Varies | 8.5 |
| Controller, various components | Varies | 8.5 |
| Motor | Annually | 8.5 |
| Diesel engine system, various components | Varies | 8.5 |

### 1.1.11 Water Tank Inspection

(NFPA 25, Section 8.3)

Water tanks are required to be inspected quarterly. This includes inspection of the water level alarms, exterior of the tank, and tank supports. The interior of steel water tanks without corrosion protection are required to be inspected every 5 years.

**Table 4: NFPA 25 Water Storage Tank System Inspection, Testing, and Maintenance Requirements**

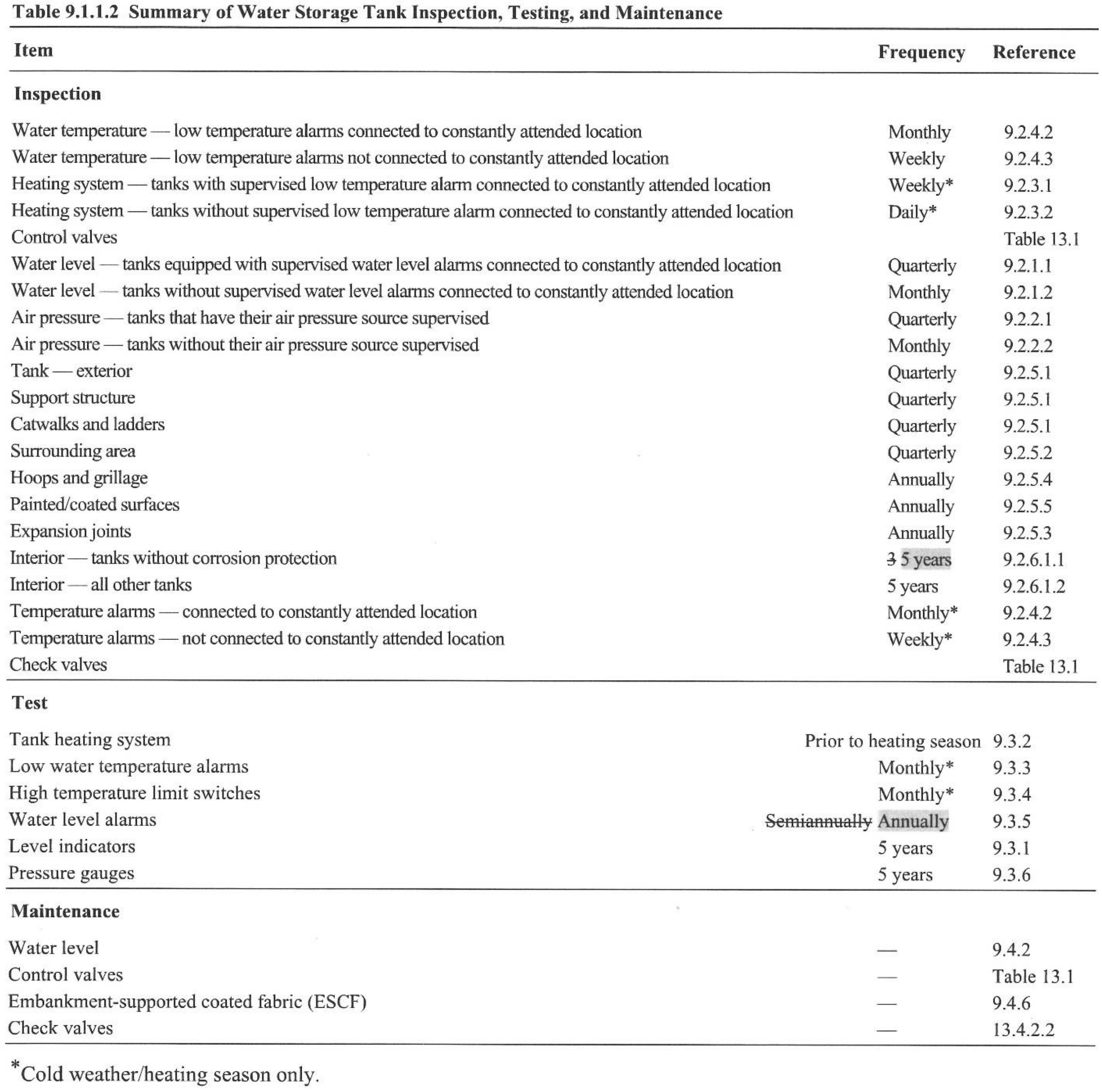


Table 9.1.1.2 Summary of Water Storage Tank Inspection, Testing, and Maintenance

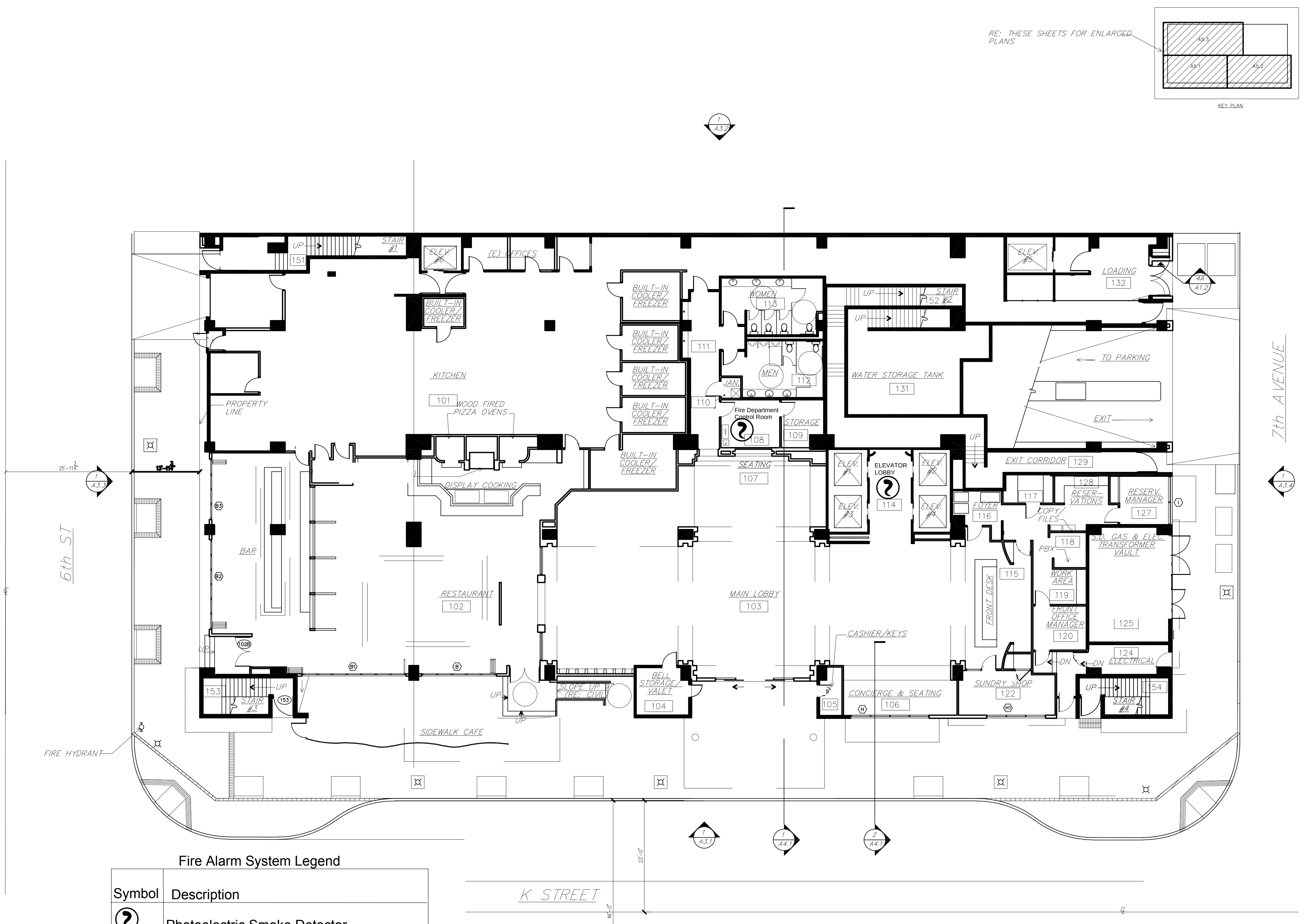
| Item | Frequency | Reference |
|---|---|---|
| **Inspection** | | |
| Water temperature — low temperature alarms connected to constantly attended location | Monthly | 9.2.4.2 |
| Water temperature — low temperature alarms not connected to constantly attended location | Weekly | 9.2.4.3 |
| Heating system — tanks with supervised low temperature alarm connected to constantly attended location | Weekly* | 9.2.3.1 |
| Heating system — tanks without supervised low temperature alarm connected to constantly attended location | Daily* | 9.2.3.2 |
| Control valves | | Table 13.1 |
| Water level — tanks equipped with supervised water level alarms connected to constantly attended location | Quarterly | 9.2.1.1 |
| Water level — tanks without supervised water level alarms connected to constantly attended location | Monthly | 9.2.1.2 |
| Air pressure — tanks that have their air pressure source supervised | Quarterly | 9.2.2.1 |
| Air pressure — tanks without their air pressure source supervised | Monthly | 9.2.2.2 |
| Tank — exterior | Quarterly | 9.2.5.1 |
| Support structure | Quarterly | 9.2.5.1 |
| Catwalks and ladders | Quarterly | 9.2.5.1 |
| Surrounding area | Quarterly | 9.2.5.2 |
| Hoops and grillage | Annually | 9.2.5.4 |
| Painted/coated surfaces | Annually | 9.2.5.5 |
| Expansion joints | Annually | 9.2.5.3 |
| Interior — tanks without corrosion protection | ~~3~~ 5 years | 9.2.6.1.1 |
| Interior — all other tanks | 5 years | 9.2.6.1.2 |
| Temperature alarms — connected to constantly attended location | Monthly* | 9.2.4.2 |
| Temperature alarms — not connected to constantly attended location | Weekly* | 9.2.4.3 |
| Check valves | | Table 13.1 |
| **Test** | | |
| Tank heating system | Prior to heating season | 9.3.2 |
| Low water temperature alarms | Monthly* | 9.3.3 |
| High temperature limit switches | Monthly* | 9.3.4 |
| Water level alarms | ~~Semiannually~~ Annually | 9.3.5 |
| Level indicators | 5 years | 9.3.1 |
| Pressure gauges | 5 years | 9.3.6 |
| **Maintenance** | | |
| Water level | — | 9.4.2 |
| Control valves | — | Table 13.1 |
| Embankment-supported coated fabric (ESCF) | — | 9.4.6 |
| Check valves | — | 13.4.2.2 |

*Cold weather/heating season only.

### 1.1.12 Facility Inspection, Testing, and Maintenance Programs

Review of the records for the programs shows that the Owner is following the requirements of NFPA 25. The inspections are completed by certified hotel staff and a State of California licensed C16 sprinkler contractor. Repairs are made by the same contractor.

# APPENDIX E – EVACS FLOOR PLANS



## 1 LOBBY LEVEL – FLOOR PLAN

Use Dimension

NORTH

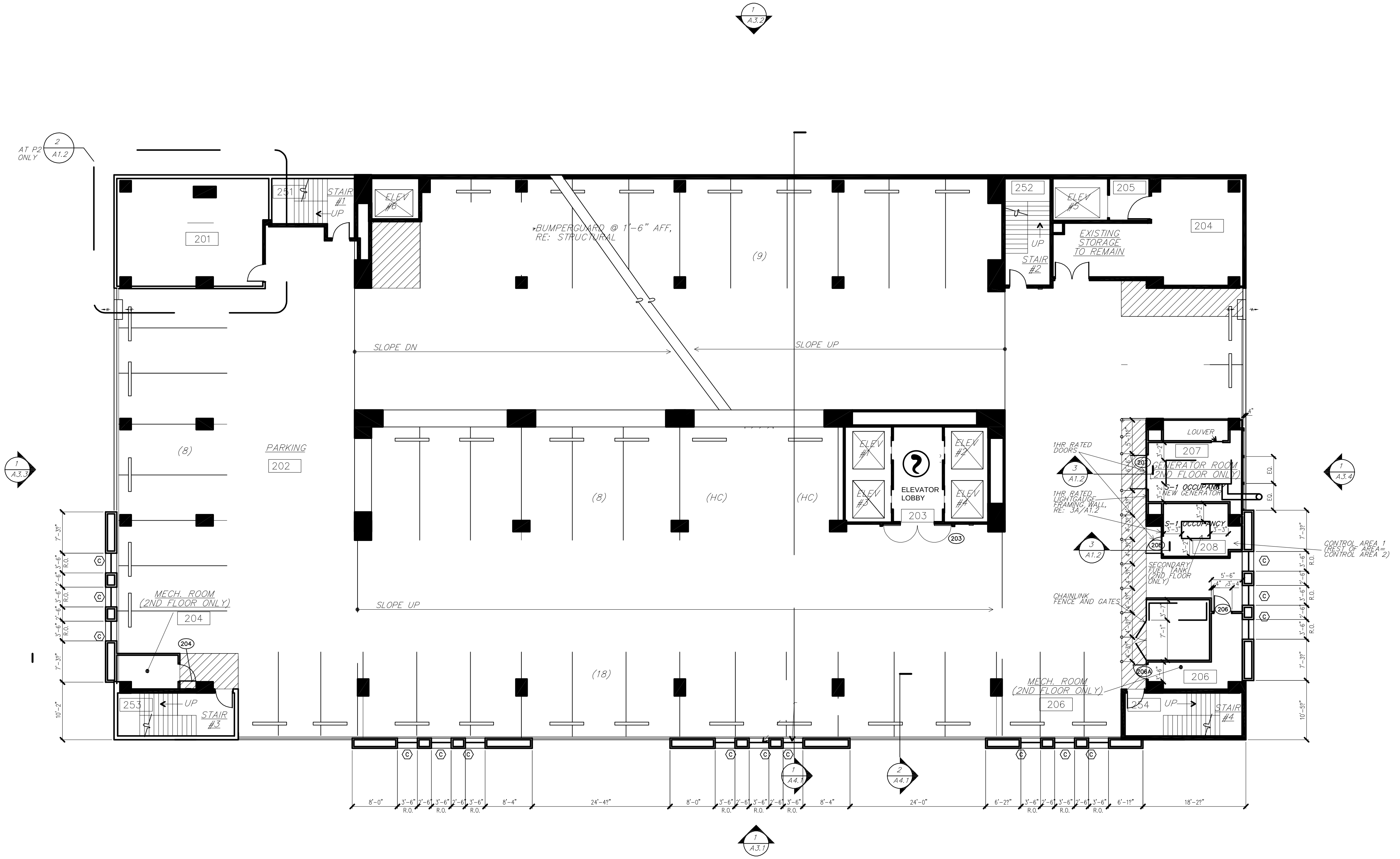
Fire Alarm System Legend

| Symbol | Description |
|---|---|
| ? | Photoelectric Smoke Detector |
| ?SB | Guest Room Photoelectric Smoke Detector with Sounder Base |
| ▽ | Speaker |
| CD ▼ X ☒ | Speaker Strobe |
| FACP | Fire Alarm Control Panel |
| P | Manual Pull Station |

LEGEND:

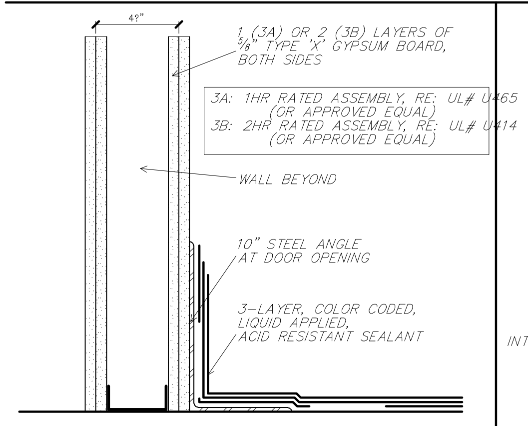
| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| ○ | 60" DIAMETER TURN-AROUND |
| □ | STREET LIGHT PULLBOX |
| ☒ | (E) LAMP POST TO BE RELOCATED |
| ☒ | NEW LAMP POST LOCATION |

NOTES: 1. ALL SITE WORK TO FOLLOW C.C.D.C. DESIGN GUIDELINES FOR ISLAND STREET MASTERPLAN & CITY OF SAN DIEGO GREEN BOOK. (RE: CIVIL ENGINEERING DRAWINGS)
2. WRAP GRANITE INTO ALL RECESSES OF FACADE AT THIS LEVEL UNLESS OTHERWISE NOTED



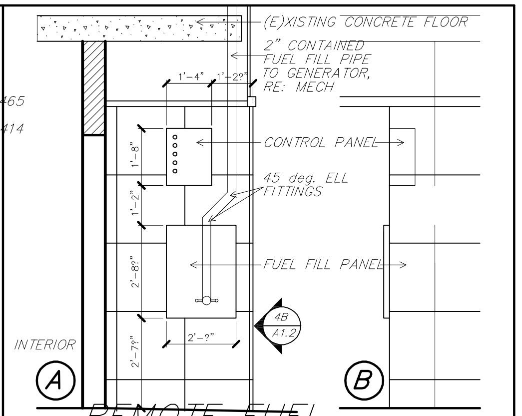
Fire Alarm System Legend

| Symbol | Description |
|---|---|
| Ⓢ | Photoelectric Smoke Detector |
| ⓈSB | Guest Room Photoelectric Smoke Detector with Sounder Base |
| ▽□ | Speaker |
| CD▼X ☒ | Speaker Strobe |
| FACP | Fire Alarm Control Panel |
| P | Manual Pull Station |



③ THRESHOLD DETAIL

3" = 1'-0"



④ REMOTE FUEL FILL ELEVATION

?" = 1'-0"

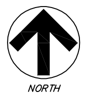
① TYPICAL PARKING LEVELS 2ND-6TH

Use Dimension

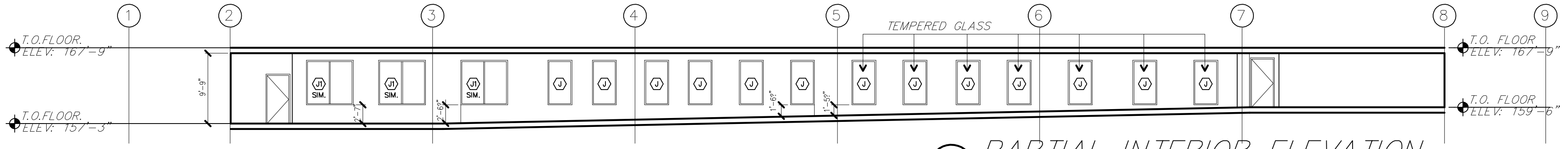
NOTE: MECHANICAL EQUIPMENT SPACES AT NORTH EAST AND SOUTHEAST CORNERS VARY FROM ONE PARKING LEVEL TO THE OTHER.

LEGEND:

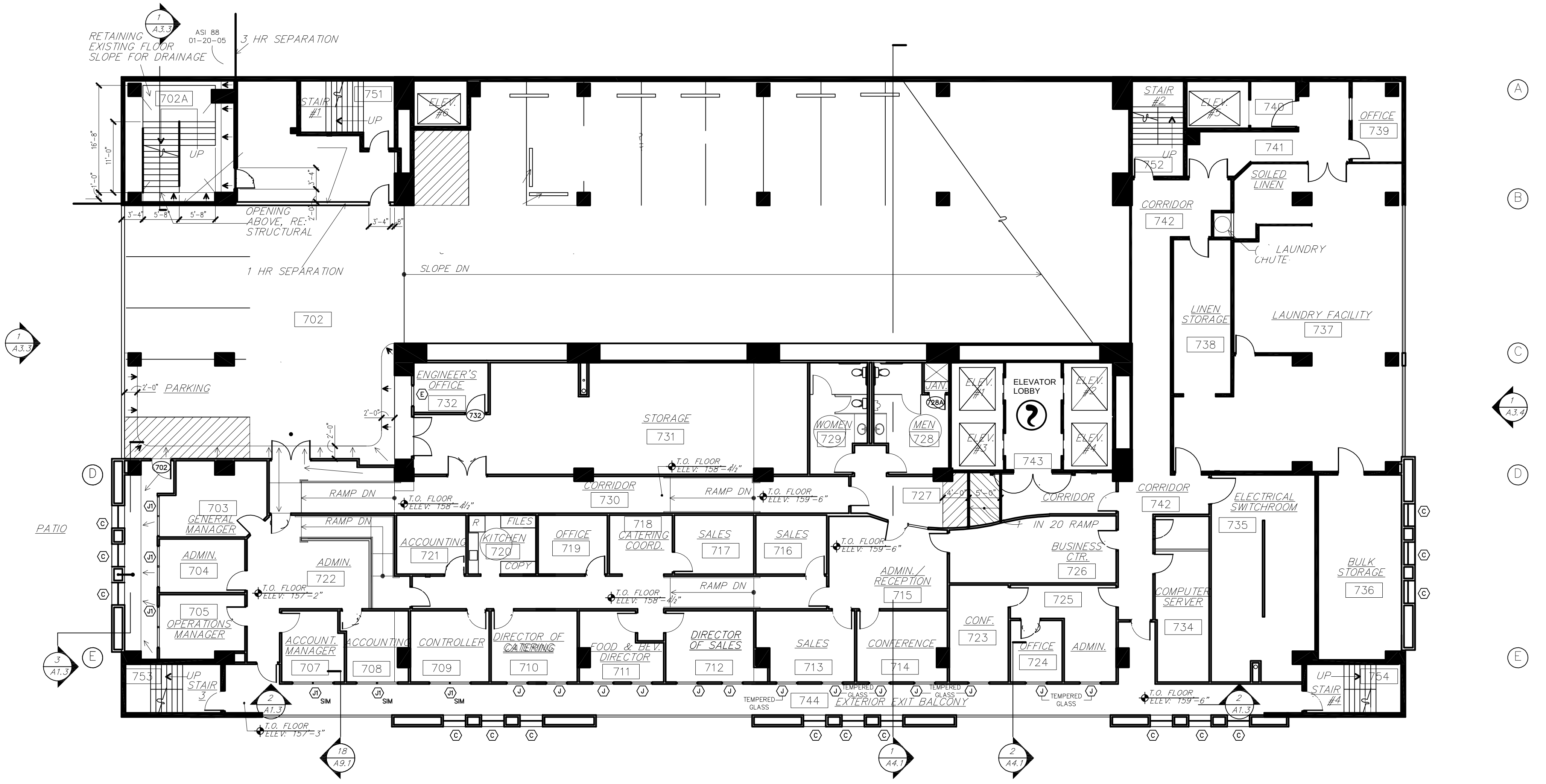
| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| ○ | 60" DIAMETER TURN-AROUND |

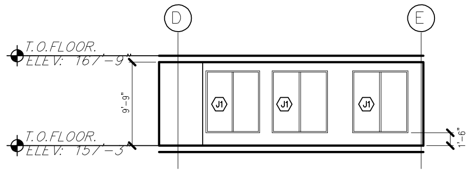


A1.2



## 2 PARTIAL INTERIOR ELEVATION
?" = 1'-0"
RE: 1/A1.3





## 1 SEVENTH FLOOR – PROPOSED PLAN
Use Dimension

EXISTING OVERALL PARKING COUNT:

277 TOTAL PARKING STALLS
34 ACCESSIBLE PARKING STALLS
15 EXISTING STALLS, INCLUDING 2 ACCESSIBLE, LOST.

PROPOSED PARKING COUNT REDUCTION:

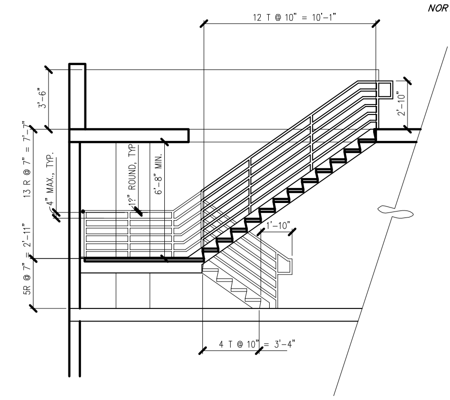
18 EXISTING STALLS, INCLUDING 2 ACCESSIBLE, LOST.

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| ○ | 60" DIAMETER TURN–AROUND |

### Fire Alarm System Legend

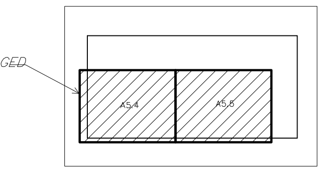
| Symbol | Description |
|---|---|
| ? | Photoelectric Smoke Detector |
| ?SB | Guest Room Photoelectric Smoke Detector with Sounder Base |
| ▽ | Speaker |
| CD ▼ X ☒ | Speaker Strobe |
| FACP | Fire Alarm Control Panel |
| P | Manual Pull Station |



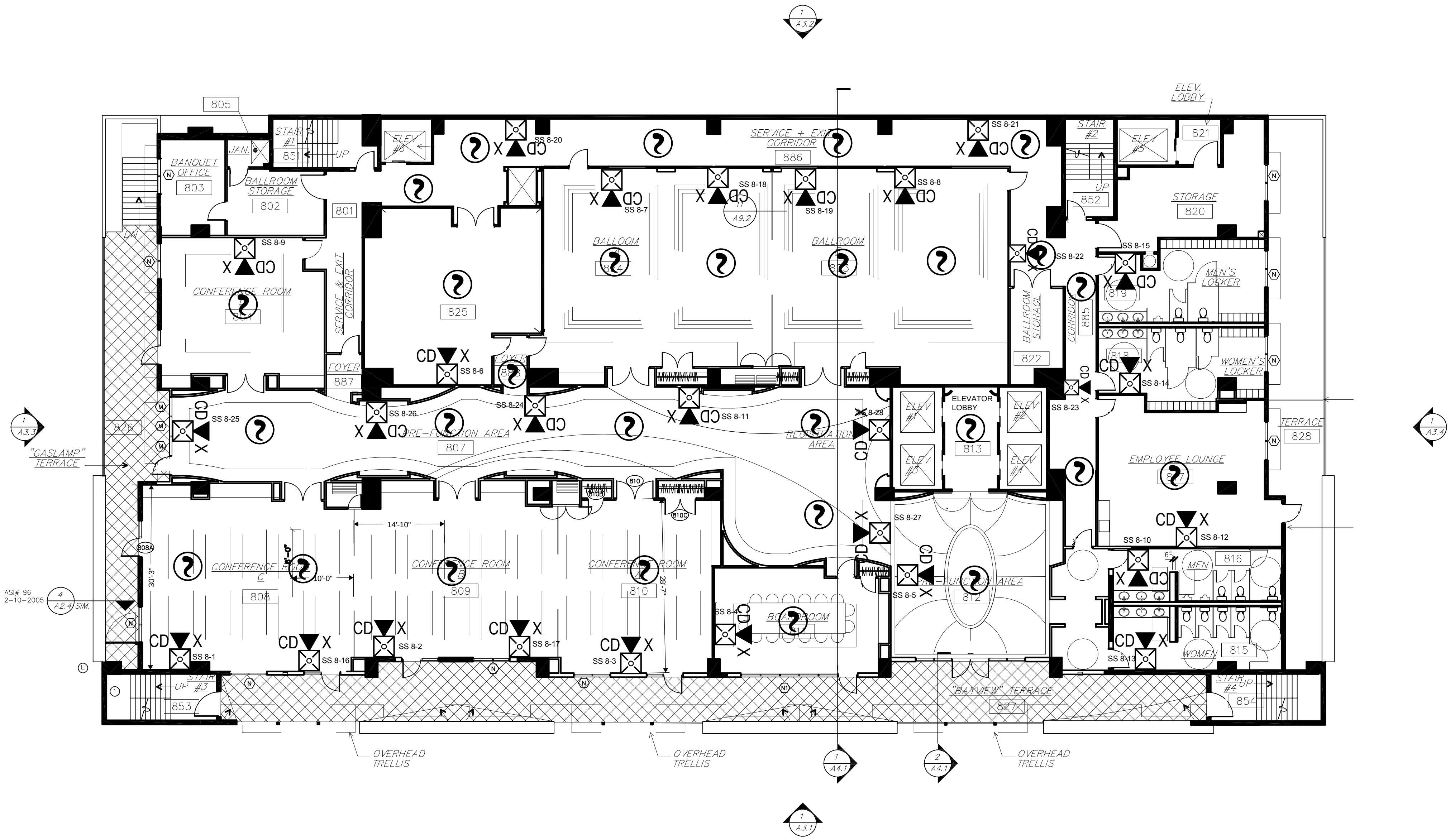
## 4 STAIR SECTION/ELEVATION
?" = 1'-0"
RE: 1/A1.3; STRUCT.

RE: THESE SHEETS FOR ENLARGED PLANS

KEY PLAN



A1.3



## Fire Alarm System Legend

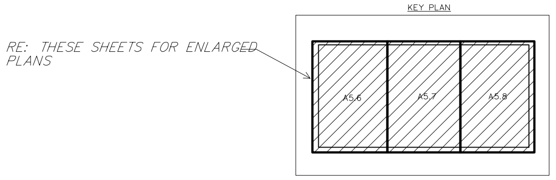
| Symbol | Description |
|---|---|
| ? | Photoelectric Smoke Detector |
| ?SB | Guest Room Photoelectric Smoke Detector with Sounder Base |
| ▽ | Speaker |
| CD▼X | Speaker Strobe |
| FACP | Fire Alarm Control Panel |
| P | Manual Pull Station |

NORTH

## 1 EIGHTH FLOOR (CONFERENCE LEVEL) – PROPOSED PLAN

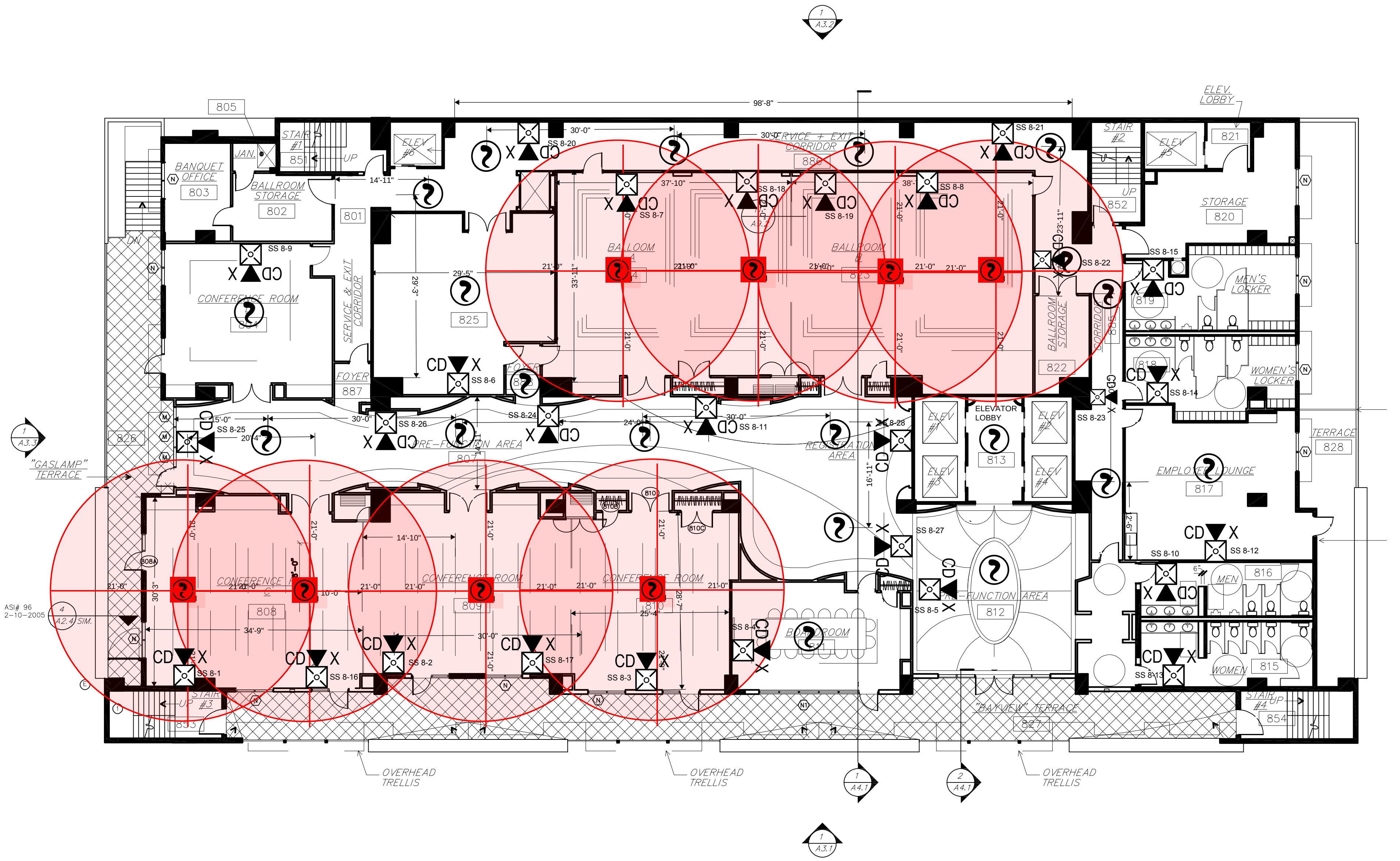
Use Dimension

See Sheet A1.4A for Dimensions and Detector Coverage Overlay



A1.4

13 MAY 2004



Fire Alarm System Legend

| Symbol | Description |
|---|---|
| ? | Photoelectric Smoke Detector |
| ?SB | Guest Room Photoelectric Smoke Detector with Sounder Base |
| ▽ | Speaker |
| CD ▼ X | Speaker Strobe |
| FACP | Fire Alarm Control Panel |
| P | Manual Pull Station |

NORTH

## 1 EIGHTH FLOOR (CONFERENCE LEVEL) –Dimensions and Detector Coverage Overlay

Use Dimension

LEGEND:

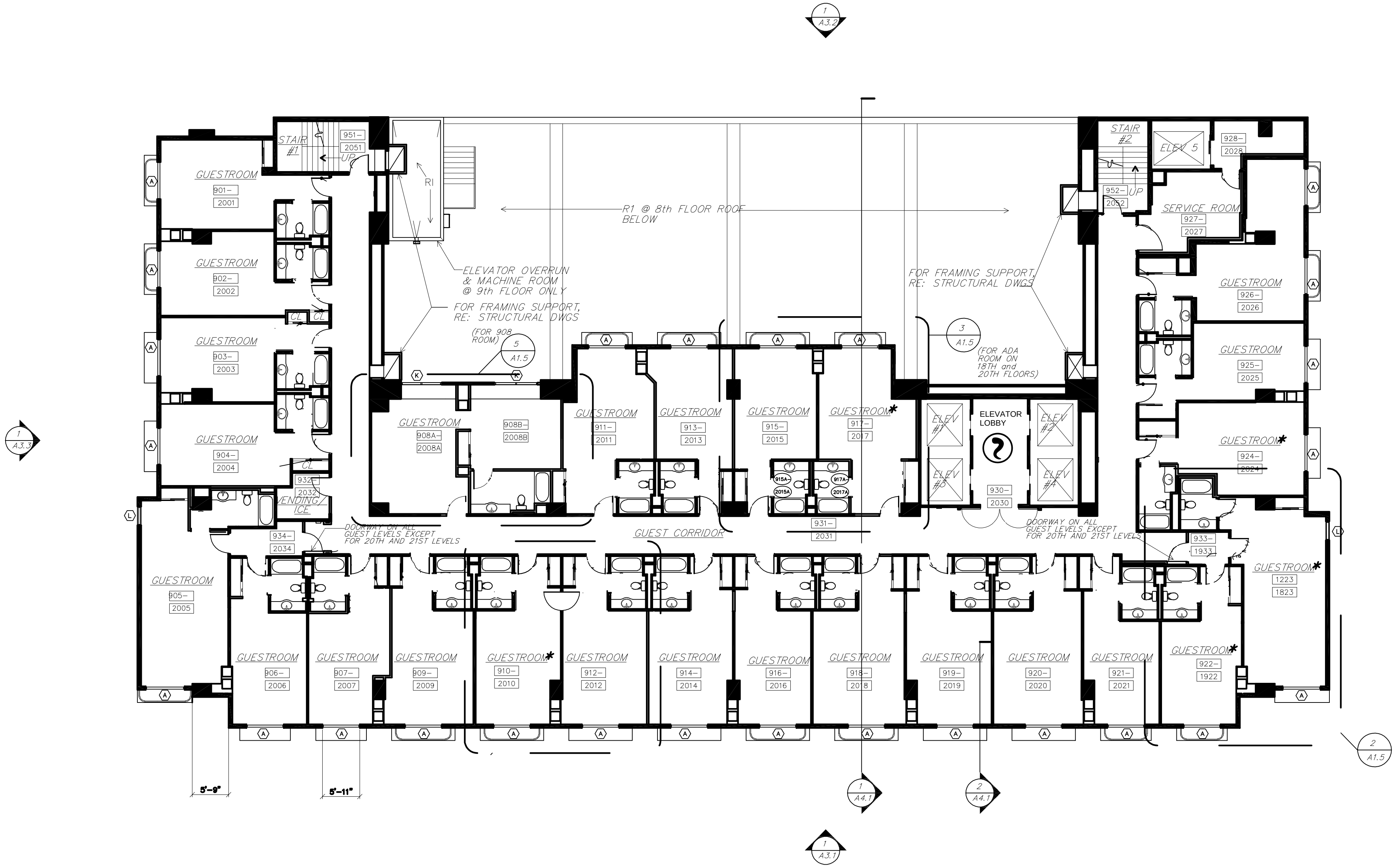
NEW WALL – MINIMUM 54 STC RATING (1 HR RATED)

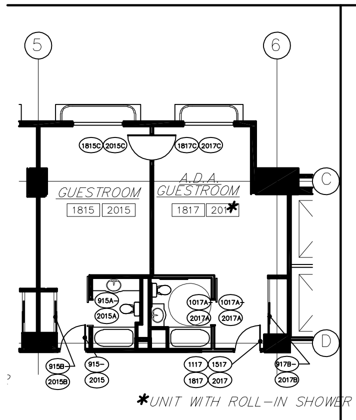
EXISTING WALL TO REMAIN

60" DIAMETER TURN-AROUND

A1.4A

13 MAY 2004



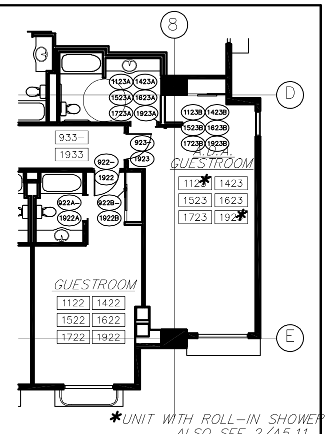


*UNIT WITH ROLL–IN SHOWER

ALSO SEE 2/A5.10

## ADA GUESTROOMS

?" = 1'–0"  RE: 1/A1.5



*UNIT WITH ROLL–IN SHOWER
ALSO SEE 2/A5.11

## ADA GUESTROOMS

?" = 1'–0"  RE: 1/A1.5

### Fire Alarm System Legend

| Symbol | Description |
|---|---|
| ? | Photoelectric Smoke Detector |
| ?SB | Guest Room Photoelectric Smoke Detector with Sounder Base |
| ▽ | Speaker |
| CD ▼ X | Speaker Strobe |
| FACP | Fire Alarm Control Panel |
| P | Manual Pull Station |

## TYPICAL GUESTROOM FLOOR PLAN (9th–12th & 14th–20thFLOORS)

Use Dimension

NOTE: THERE IS NO 13th FLOOR

NOTE 1: GUESTROOM LAYOUTS BASED ON ORIGINAL CONSTRUCTION DOCUMENTS. SPACES HAVE NOT BEEN CONFIRMED BY RECENT OBSERVATION.

NOTE 2: NUMBER OF GUESTROOMS: 321 PLUS CLUB LEVEL LOUNGE

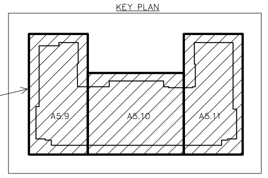
NOTE 3: ADA COMPLIANT GUESTROOMS LOCATED ON ELEVENTH, FIFTEENTH, EIGHTEENTH, AND TWENTY–FIRST FLOORS.

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| * | ROOMS WITH VISUAL ALARMS ON SELECT LEVELS (SEE SHEET A0.0) |
| ○ | 60" DIAMETER TURN–AROUND |

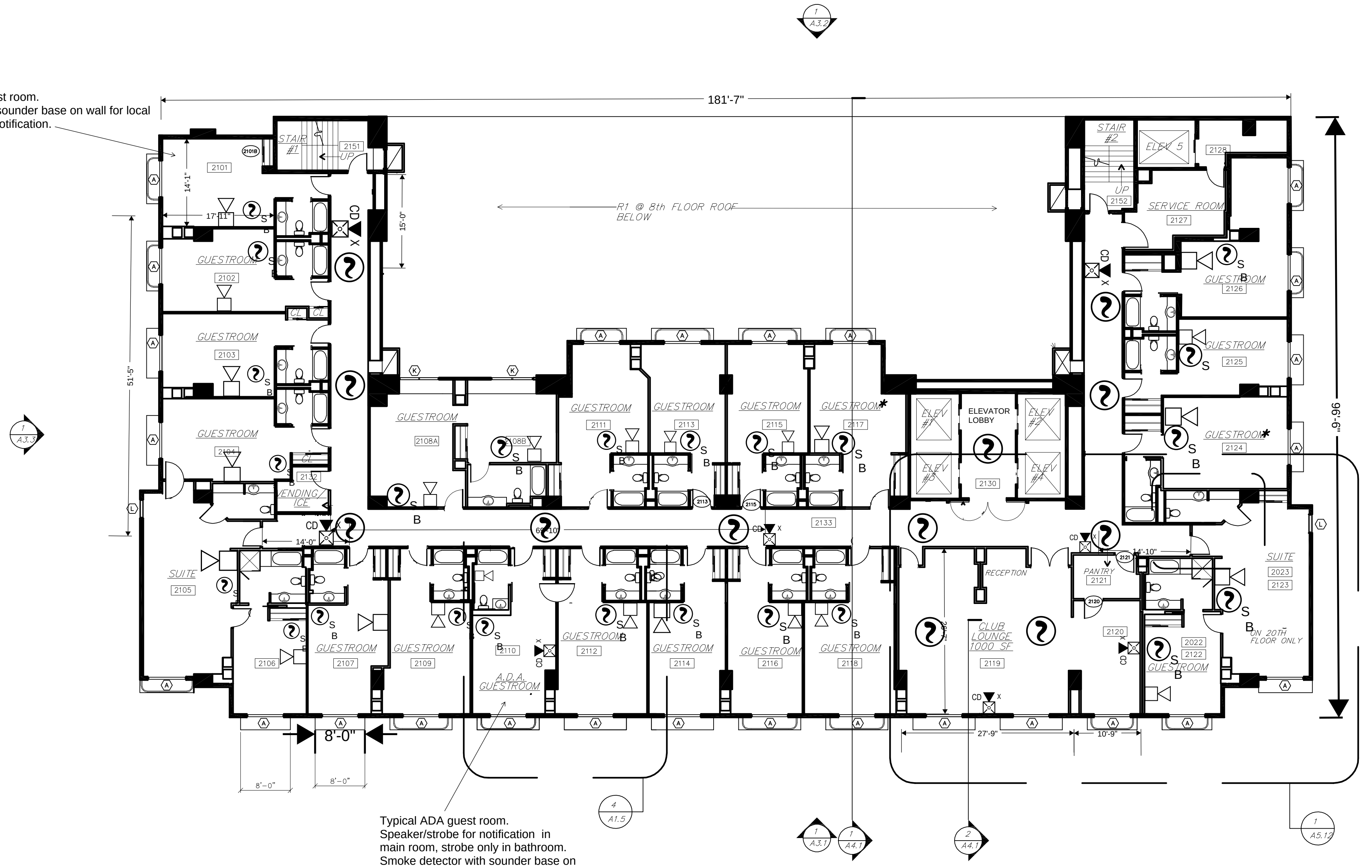
RE: THESE SHEETS FOR ENLARGED PLANS

KEY PLAN



NORTH

A1.5



Typical non-ADA guest room.
Smoke detector with sounder base on wall for local notification, horn for notification.

Typical ADA guest room.
Speaker/strobe for notification in main room, strobe only in bathroom.
Smoke detector with sounder base on wall for local notification.

## Fire Alarm System Legend

| Symbol | Description |
|---|---|
| ? | Photoelectric Smoke Detector |
| ? SB | Guest Room Photoelectric Smoke Detector with Sounder Base |
| ▽ | Speaker |
| CD ▼ X ☒ | Speaker Strobe |
| FACP | Fire Alarm Control Panel |
| P | Manual Pull Station |

NORTH

## 1 CLUB LEVEL (21st FLOOR)

Use Dimension

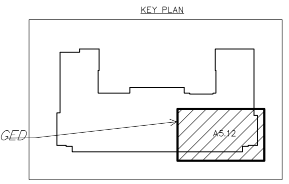
NOTE 1: GUESTROOM LAYOUTS BASED ON ORIGINAL CONSTRUCTION DRAWINGS. SPACES HAVE NOT BEEN CONFIRMED BY RECENT OBSERVATION.

NOTE 2: NUMBER OF GUESTROOMS: 321 PLUS CLUB LEVEL LOUNGE

NOTE 3: NEW ADA COMPLIANT GUESTROOM NOT SHOWN

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| * | ROOMS WITH VISUAL ALARMS ON SELECT LEVELS (SEE SHEET A0.0) |
| ○ | 60" DIAMETER TURN–AROUND |



RE: THESE SHEET FOR ENLARGED PLANS

# APPENDIX F – SEQUENCE OF OPERATION

|  | **Manual Pull Station** | **Elevator Lobby Smoke Detector** | **Elevator Machine Room Smoke Detector** | **Elevator Machine Room Heat Detector** | **Area Smoke Detectors** | **Duct Smoke Detectors** | **Elevator Shaft Smoke/Heat Detectors** | **Sprinkler Waterflow Switch** | **Sprinkler Valve Tamper Switch** |
|---|---|---|---|---|---|---|---|---|---|
| **Annunciate At Fire Control Room** | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| **Annunciate At 24 Hour Attended Remote Location** | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| **Activate Audible and Visual Alarm Signals On Floor Of Alarm, Floor above, and Floor Below** | YES | YES | YES | YES | YES | YES | YES | YES | NO |
| **Shut Down All Air Handling On Floor of Alarm** | YES | YES | YES | YES | YES | YES | NO | YES | NO |
| **Close All Smoke/Fire Dampers On Floor of Alarm** | YES | YES | YES | YES | YES | YES | NO | YES | NO |
| **Release A7:K13All Motorized And Electro-Magnetically Held Doors On Floor of Alarm** | YES | YES | YES | YES | YES | YES | NO | YES | NO |
| **Recall All Elevators Serving Floor Of Alarm** | NO | YES | YES | YES | NO | NO | YES | NO | NO |
| **Activate Elevator Shunt Trip** | NO | NO | NO | YES | NO | NO | NO | NO | NO |
| **Release All Stair Shaft Door Locks In Building** | YES | YES | YES | YES | YES | YES | YES | YES | NO |
| **Activate All Stair Shaft Pressurization In Building** | YES | YES | YES | YES | YES | YES | YES | YES | NO |

# APPENDIX G – SELECTED NOTIFICATION DEVICE CALCULATIONS

| Location | Size | Device | Audibility Criteria * | Visibility* |
|---|---|---|---|---|
| Typical Non-ADA Guest Room<br>(21st Floor) | 17 ft. 11 in. x 14 ft. 6 in.<br>(260 sq. ft.) | Speaker | Greater of 15 dB over ambient or 5 dB above max. sound level having a duration of at least 60 seconds measured at pillow level (Sec. 18.4.5) Bedroom ambient sound level 35 dBA (Table 18.4.3) + 15 dB = 50 dBA. Distance from device to pillow= 6 feet, so 50 dBA rated device is required. Square wave required. 80 dBA, ¼ W provided (smallest capacity device). | Not required |
| Typical ADA Guest Room<br>(21st Floor) | 15 ft. 10 in. x 12 ft. 2 in.<br>(192 sq. ft.) | Speaker /strobe in main space, strobe in bathroom | Same calculation =50 dBA rated device required. Square wave required. 80 dBA, ¼ W provided (smallest capacity device). | Use 20 ft. x 20 ft. spacing. 15 cd strobe required and provided in main area. Strobe only required in bathroom, 15cd (Table 18.5.4.1(a)) and ADDAG. |
| Typical corridor | Less than 20 ft. wide | Speaker /strobe | Greater of 15 dB over ambient or 5 dB above max. sound level having a duration of at least 60 seconds measured at 5 ft. above the floor (Sec. 18.4.3.1) Corridor ambient sound level 35 dBA (Residential Table18.4.3) + 15 dB = 50 dBA. Worst case speaker spacing 70 ft. 6 dBA x 3 =18 dBA. 50 dBA+ 18 dBa= 68 dBA. 80 dBA, ¼ W provided (smallest capacity device). | Strobes to be located no greater than 15 ft. from the end of the corridor and no greater than 100 ft. between devices. Minimum 15 cd device required and provided. (Section 18.5.5.5) |
| Club Lounge<br>21st floor | 27 ft. 9 in. x 26 ft. 7 in. + 10 ft. 9 in. x 26 ft. 7 in.<br>(1075 sq. ft.) |  | Greater of 15 dB over ambient or 5 dB above max. sound level having a duration of at least 60 seconds measured at 5 ft. above the floor (Sec. 18.4.3.1) Room ambient sound level 55 dBA (Assembly Table18.4.3) + 15 dB = 70 dBA. Worst case speaker spacing 27 ft. 6 dBA loss = 55 dBA+ 6 dBa= 61 dBA. Use 2- 80 dBA, ¼ W provided (smallest capacity device). | Use 2- 30 ft. x 30 ft. spacing. 15 cd strobe required and provided. (Table 18.5.4.1(a)) |

* Section references are to NFPA 72

# APPENDIX H - STANDBY POWER CALCULATIONS

| Description | Standby Current Per Unit (amps) | Qty | Total Standby Current (amps) | Alarm Current Per Unit (amps) | Qty | Total System Alarm Current (amps) |
|---|---|---|---|---|---|---|
| FACP | 0.145 | 1 | 0.145 | 0.155 | 1.00 | 0.16 |
| Smoke Detectors | 0.000070 | 480 | 0.03 | 0.06000 | 480.00 | 28.80 |
| Speaker | 0.00 | 276 | 0.00 | 0.09 | 276.00 | 24.84 |
| Speaker Strobes | 0.00 | 360 | 0.00 | 0.096 | 360.00 | 34.56 |
| Duct Detectors | 0.0006 | 100 | 0.0600 | 0.1000 | 100.00 | 10.00 |
| Relays | 0.0015 | 200 | 0.30 | 0.00 |  | 0.00 |
| Total System Standby Current (amps) | 0.54 |  |  |  |  |  |
| Total System Alarm Current (amps) | 98.36 |  |  |  |  |  |
| Required Standby Capacity (amp-hrs.) | 12.93 |  |  |  |  |  |
| Required Alarm Capacity (amp-hrs.) | 8.20 |  |  |  |  |  |
| Total Required Capacity (amp-hrs.) | 21.12 |  |  |  |  |  |
| Required Battery Capacity (amp-hrs.) | 25.35 |  |  |  |  |  |
| Inputs |  |  |  |  |  |  |
| Required Standby Time (hrs.) | 24.00 |  |  |  |  |  |
| Requires alarm time (minutes) | 5.00 |  |  |  |  |  |
| Safety Factor | 1.20 |  |  |  |  |  |
| Device Count |  |  |  |  |  |  |
| Area | Speakers | Speaker/ Strobe | Smoke Detectors |  |  |  |
| Guestroom Floors (12) | 276 | 96 | 444 |  |  |  |
| 8th floor | 0 | 33 | 26 |  |  |  |
| Typical Floors 1-7(7) |  | 231 | 10 |  |  |  |
| Total Devices | 276 | 360 | 480 |  |  |  |

# APPENDIX I – EVACS RECORD OF COMPLETION

## FIRE ALARM AND EMERGENCY COMMUNICATION SYSTEM RECORD OF COMPLETION

*To be completed by the system installation contractor at the time of system acceptance and approval.*
*It shall be permitted to modify this form as needed to provide a more complete and/or clear record.*
*Insert N/A in all unused lines.*
*Attach additional sheets, data, or calculations as necessary to provide a complete record.*

### 1. PROPERTY INFORMATION

Name of property: Gaslamp Hotel

Address: 100 Schirmer Way

Description of property: 21 story hotel

Occupancy type: R-1

Name of property representative: Joe Smith

Address: same

Phone: 858-671-2345 Fax: E-mail:

Authority having jurisdiction over this property:

Phone: San Diego Fire Dept. Fax: E-mail: ggreen@ sdfire .com

### 2. INSTALLATION, SERVICE, AND TESTING CONTRACTOR INFORMATION

Installation contractor for this equipment: Unknown

Address:

License or certification number:

Phone: Fax: E-mail:

Service organization for this equipment:

Address:

License or certification number:

Phone: Fax: E-mail:

A contract for test and inspection in accordance with NFPA standards is in effect as of:

Contracted testing company:

Address:

Phone: Fax: E-mail:

Contract expires: Contract number: Frequency of routine inspections:

### 3. DESCRIPTION OF SYSTEM OR SERVICE

☐ Fire alarm system (nonvoice)

☒ Fire alarm with in-building fire emergency voice alarm communication system (EVACS)

☐ Mass notification system (MNS)

☐ Combination system, with the following components:

☐ Fire alarm ☐ EVACS ☐ MNS ☐ Two-way, in-building, emergency communication system

☐ Other (specify):

## 3. DESCRIPTION OF SYSTEM OR SERVICE *(continued)*

*NFPA 72* edition: Additional description of system(s):

**3.1 Control Unit**

Manufacturer: Edwards Model number: EST-3

**3.2 Mass Notification System** ☒ This system does not incorporate an MNS

**3.2.1 System Type:**

☐ In-building MNS—combination

☐ In-building MNS—stand-alone ☐ Wide-area MNS ☐ Distributed recipient MNS

☐ Other (specify):

**3.2.2 System Features:**

☐ Combination fire alarm/MNS ☐ MNS autonomous control unit ☐ Wide-area MNS to regional national alerting interface

☐ Local operating console (LOC) ☐ Direct recipient MNS (DRMNS) ☐ Wide-area MNS to DRMNS interface

☐ Wide-area MNS to high-power speaker array (HPSA) interface ☐ In-building MNS to wide-area MNS interface

☐ Other (specify):

**3.3 System Documentation**

☒ An owner's manual, a copy of the manufacturer's instructions, a written sequence of operation, and a copy of the numbered record drawings are stored on site. Location: In fire control room

**3.4 System Software** ☒ This system does not have alterable site-specific software.

Operating system (executive) software revision level:

Site-specific software revision date: Revision completed by:

☐ A copy of the site-specific software is stored on site. Location:

**3.5 Off-Premises Signal Transmission** ☐ This system does not have off-premises transmission.

Name of organization receiving alarm signals with phone numbers:

Alarm: ADP Phone: 800-777-888-999

Supervisory: ADP Phone: same

Trouble: ADP Phone: same

Entity to which alarms are retransmitted: ADP Phone: same

Method of retransmission: Both wireless and by telephone

If Chapter 26, specify the means of transmission from the protected premises to the supervising station:

Both wireless and by telephon

If Chapter 27, specify the type of auxiliary alarm system: ☐ Local energy ☐ Shunt ☐ Wired ☐ Wireless

## 4. CIRCUITS AND PATHWAYS

### 4.1 Signaling Line Pathways

### 4.1.1 Pathways Class Designations and Survivability

Pathways class: ______ Survivability level: ______ Quantity: ______
*(See NFPA 72, Sections 12.3 and 12.4)*

### 4.1.2 Pathways Utilizing Two or More Media

Quantity: ______ Description: ______

### 4.1.3 Device Power Pathways

☒ No separate power pathways from the signaling line pathway

☐ Power pathways are separate but of the same pathway classification as the signaling line pathway

☐ Power pathways are separate and different classification from the signaling line pathway

### 4.1.4 Isolation Modules

Quantity: unknown

### 4.2 Alarm Initiating Device Pathways

### 4.2.1 Pathways Class Designations and Survivability

Pathways class: unknown Survivability level: Level 1 Quantity: unknown
*(See NFPA 72, Sections 12.3 and 12.4)*

### 4.2.2 Pathways Utilizing Two or More Media

Quantity: ______ Description: ______

### 4.2.3 Device Power Pathways

☒ No separate power pathways from the initiating device pathway

☐ Power pathways are separate but of the same pathway classification as the initiating device pathway

☐ Power pathways are separate and different classification from the initiating device pathway

### 4.3 Non-Voice Audible System Pathways

### 4.3.1 Pathways Class Designations and Survivability

Pathways class: unknown Survivability level: level 1 Quantity: unknown
*(See NFPA 72, Sections 12.3 and 12.4)*

### 4.3.2 Pathways Utilizing Two or More Media

Quantity: unknown Description: ______

### 4.3.3 Appliance Power Pathways

☐ No separate power pathways from the notification appliance pathway

☐ Power pathways are separate but of the same pathway classification as the notification appliance pathway

☐ Power pathways are separate and different classification from the notification appliance pathway

## 5. ALARM INITIATING DEVICES

### 5.1 Manual Initiating Devices

**5.1.1 Manual Fire Alarm Boxes** ☐ This system does not have manual fire alarm boxes.

Type and number of devices: Addressable: 1 Conventional: ____ Coded: ____ Transmitter: ____

Other (specify): ____

**5.1.2 Other Alarm Boxes** ☒ This system does not have other alarm boxes.

Description: ____

Type and number of devices: Addressable: ____ Conventional: ____ Coded: ____ Transmitter: ____

Other (specify): ____

### 5.2 Automatic Initiating Devices

**5.2.1 Smoke Detectors** ☐ This system does not have smoke detectors.

Type and number of devices: Addressable: 300 Conventional: ____

Other (specify): ____

Type of coverage: ☐ Complete area ☐ Partial area ☐ Nonrequired partial area

Other (specify): complete in guest room corridors and on 8th floor

Type of smoke detector sensing technology: ☒ Ionization ☐ Photoelectric ☐ Multicriteria ☐ Aspirating ☐ Beam

Other (specify): ____

**5.2.2 Duct Smoke Detectors** ☐ This system does not have alarm-causing duct smoke detectors.

Type and number of devices: Addressable: ? Conventional: ____

Other (specify): unknown

Type of coverage: ____

Type of smoke detector sensing technology: ☒ Ionization ☐ Photoelectric ☐ Aspirating ☐ Beam

**5.2.3 Radiant Energy (Flame) Detectors** ☒ This system does not have radiant energy detectors.

Type and number of devices: Addressable: ____ Conventional: ____

Other (specify): ____

Type of coverage: ____

**5.2.4 Gas Detectors** ☒ This system does not have gas detectors.

Type of detector(s): ____

Number of devices: Addressable: ____ Conventional: ____

Type of coverage: ____

**5.2.5 Heat Detectors** ☒ This system does not have heat detectors.

Type and number of devices: Addressable: ____ Conventional: ____

Type of coverage: ☐ Complete area ☐ Partial area ☐ Nonrequired partial area ☐ Linear ☐ Spot

Type of heat detector sensing technology: ☐ Fixed temperature ☐ Rate-of-rise ☐ Rate compensated

## 5. ALARM INITIATING DEVICES *(continued)*

### 5.2.6 Addressable Monitoring Modules
☐ This system does not have monitoring modules.

Number of devices: unknown

### 5.2.7 Waterflow Alarm Devices
☐ This system does not have waterflow alarm devices.

Type and number of devices: Addressable: 23 Conventional: ___ Coded: ___ Transmitter: ___

### 5.2.8 Alarm Verification
☐ This system does not incorporate alarm verification.

Number of devices subject to alarm verification: unknown Alarm verification set for ___ seconds

### 5.2.9 Presignal
☒ This system does not incorporate pre-signal.

Number of devices subject to presignal: ___

Describe presignal functions: ___

### 5.2.10 Positive Alarm Sequence (PAS)
☐ This system does not incorporate PAS.

Describe PAS: unknown

### 5.2.11 Other Initiating Devices
☐ This system does not have other initiating devices.

Describe: ___

## 6. SUPERVISORY SIGNAL-INITIATING DEVICES

### 6.1 Sprinkler System Supervisory Devices
☐ This system does not have sprinkler supervisory devices.

Type and number of devices: Addressable: 23 Conventional: ___ Coded: ___ Transmitter: ___

Other (specify): ___

### 6.2 Fire Pump Description and Supervisory Devices
☐ This system does not have a fire pump.

Type fire pump: ☐ Electric pump ☐ Engine

Type and number of devices: Addressable: 3 Conventional: ___ Coded: ___ Transmitter: ___

Other (specify): ___

### 6.2.1 Fire Pump Functions Supervised

☒ Power ☒ Running ☒ Phase reversal ☐ Selector switch not in auto ☒ Engine or control panel trouble ☒ Low fuel

Other (specify): ___

### 6.3 Duct Smoke Detectors (DSDs)
☐ This system does not have DSDs causing supervisory signals.

Type and number of devices: Addressable: ? Conventional: ___

Other (specify): unknown

Type of coverage: ___

Type of smoke detector sensing technology: ☐ Ionization ☐ Photoelectric ☐ Aspirating ☐ Beam

### 6.4 Other Supervisory Devices
☒ This system does not have other supervisory devices.

Describe: ___

## 7. MONITORED SYSTEMS

### 7.1 Engine-Driven Generator

☐ This system does not have a generator.

### 7.1.1 Generator Functions Supervised

☒ Engine or control panel trouble ☒ Generator running ☒ Selector switch not in auto ☐ Low fuel

☐ Other (specify):

### 7.2 Special Hazard Suppression Systems

☐ This system does not monitor special hazard systems.

Description of special hazard system(s): kitchen hood systems

### 7.3 Other Monitoring Systems

☒ This system does not monitor other systems.

Description of special hazard system(s):

## 8. ANNUNCIATORS

☐ This system does not have annunciators.

### 8.1 Location and Description of Annunciators

Location 1: only main panel in the fire fighter's control room

Location 2:

Location 3:

## 9. ALARM NOTIFICATION APPLIANCES

### 9.1 In-Building Fire Emergency Voice Alarm Communication System

☐ This system does not have an EVACS.

Number of single voice alarm channels: unknown Number of multiple voice alarm channels:

Number of speakers: 340 Number of speaker circuits: unknown

Location of amplification and sound-processing equipment:

Location of paging microphone stations:

Location 1: fire fighter's control room

Location 2:

Location 3:

### 9.2 Nonvoice Notification Appliances

☐ This system does not have nonvoice notification appliances.

Horns: 200 With visible: 100 Bells: With visible:

Chimes: none With visible:

Visible only: 100 Other (describe):

### 9.3 Notification Appliance Power Extender Panels

☒ This system does not have power extender panels.

Quantity:

Locations:

## 10. MASS NOTIFICATION CONTROLS, APPLIANCES, AND CIRCUITS

☒ This system does not have an MNS.

### 10.1 MNS Local Operating Consoles

Location 1:

Location 2:

Location 3:

### 10.2 High-Power Speaker Arrays

Number of HPSA speaker initiation zones:

Location 1:

Location 2:

Location 3:

### 10.3 Mass Notification Devices

Combination fire alarm/MNS visible appliances: MNS-only visible appliances:

Textual signs: Other (describe):

Supervision class:

### 10.3.1 Special Hazard Notification

☐ This system does not have special suppression predischarge notification.

☐ MNS systems DO NOT override notification appliances required to provide special suppression predischarge notification.

## 11. TWO-WAY EMERGENCY COMMUNICATION SYSTEMS

### 11.1 Telephone System

☐ This system does not have a two-way telephone system.

Number of telephone jacks installed: 21 Number of warden stations installed:

Number of telephone handsets stored on site: 23

Type of telephone system installed: ☒ Electrically powered ☐ Sound powered

### 11.2 Two-Way Radio Communications Enhancement System

☐ This system does not have a two-way radio communications enhancement system.

Percentage of area covered by two-way radio service: Critical areas: % General building areas: %

Amplification component locations:

Inbound signal strength: dBm Outbound signal strength: dBm

Donor antenna isolation is: dB above the signal booster gain

Radio frequencies covered:

Radio system monitor panel location:

## 11. TWO-WAY EMERGENCY COMMUNICATION SYSTEMS *(continued)*

### 11.3 Area of Refuge (Area of Rescue Assistance) Emergency Communications Systems

☐ This system does not have an area of refuge (area of rescue assistance) emergency communications system.

Number of stations: Location of central control point:

Days and hours when central control point is attended:

Location of alternate control point:

Days and hours when alternate control point is attended:

### 11.4 Elevator Emergency Communications Systems

☒ This system does not have an elevator emergency communications system.

Number of elevators with stations: Location of central control point:

Days and hours when central control point is attended:

Location of alternate control point:

Days and hours when alternate control point is attended:

### 11.5 Other Two-Way Communication Systems

Describe:

## 12. CONTROL FUNCTIONS

This system activates the following control fuctions:

☒ Hold-open door releasing devices ☒ Smoke management ☐ HVAC shutdown ☒ F/S dampers

☐ Door unlocking ☒ Elevator recall ☐ Fuel source shutdown ☒ Extinguishing agent release

☒ Elevator shunt trip ☐ Mass notification system override of fire alarm notification appliances

Other (specify):

### 12.1 Addressable Control Modules

☐ This system does not have control modules.

Number of devices: unknown

Other (specify):

## 13. SYSTEM POWER

### 13.1 Control Unit

### 13.1.1 Primary Power

Input voltage of control panel: 120 v Control panel amps: unknown

Overcurrent protection: Type: unknown Amps:

Location (of primary supply panel board):

Disconnecting means location:

### 13.1.2 Engine-Driven Generator

☐ This system does not have a generator.

Location of generator: roof

Location of fuel storage: ground floor Type of fuel: diesel

## 13. SYSTEM POWER *(continued)*

### 13.1.3 Uninterruptible Power System
☒ This system does not have a UPS.

Equipment powered by a UPS system:

Location of UPS system:

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): In alarm mode (minutes):

### 13.1.4 Batteries

Location: On each floor Type: unknown Nominal voltage: Amp/hour rating:

Calculated capacity of batteries to drive the system:

In standby mode (hours): 24 hours In alarm mode (minutes): 15 minutes

☐ Batteries are marked with date of manufacture ☐ Battery calculations are attached

### 13.2 In-Building Fire Emergency Voice Alarm Communication System or Mass Notification System

☐ This system does not have an EVACS or MNS system.

### 13.2.1 Primary Power

Input voltage of EVACS or MNS panel: 120 v EVACS or MNS panel amps: unknown

Overcurrent protection: Type: unknown Amps:

Location (of primary supply panel board): first floor utility room

Disconnecting means location: same

### 13.2.2 Engine-Driven Generator
☐ This system does not have a generator.

Location of generator: same as fire alarm system

Location of fuel storage: Type of fuel:

### 13.2.3 Uninterruptible Power System
☒ This system does not have a UPS.

Equipment powered by a UPS system:

Location of UPS system:

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): In alarm mode (minutes):

### 13.2.4 Batteries

Location: see fire alarm system Type: Nominal voltage: Amp/hour rating:

Calculated capacity of batteries to drive the system:

In standby mode (hours): In alarm mode (minutes):

☐ Batteries are marked with date of manufacture ☐ Battery calculations are attached

## 13. SYSTEM POWER *(continued)*

**13.3 Notification Appliance Power Extender Panels** ☐ This system does not have power extender panels.

**13.3.1 Primary Power**

Input voltage of power extender panel(s): unknown Power extender panel amps:

Overcurrent protection: Type: Amps:

Location (of primary supply panel board):

Disconnecting means location:

**13.3.2 Engine-Driven Generator** ☐ This system does not have a generator.

Location of generator: see fire alarm system

Location of fuel storage: Type of fuel:

**13.3.3 Uninterruptible Power System** ☒ This system does not have a UPS.

Equipment powered by a UPS system:

Location of UPS system:

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): In alarm mode (minutes):

**13.3.4 Batteries**

Location: unknown Type: Nominal voltage: Amp/hour rating:

Calculated capacity of batteries to drive the system:

In standby mode (hours): In alarm mode (minutes):

☐ Batteries are marked with date of manufacture ☐ Battery calculations are attached

## 14. RECORD OF SYSTEM INSTALLATION

*Fill out after all installation is complete and wiring has been checked for opens, shorts, ground faults, and improper branching, but before conducting operational acceptance tests.*

This is a: ☐ New system ☒ Modification to an existing system Permit number: x1122

The system has been installed in accordance with the following requirements: (Note any or all that apply.)

☒ *NFPA 72*, Edition:

☒ *NFPA 70, National Electrical Code*, Article 760, Edition:

☒ Manufacturer's published instructions

Other (specify):

System deviations from referenced NFPA standards: none

Signed: X Printed name: Garner Palenske Date: 6/11/18

Organization: Palenske Alarm Title: Field worker Phone: 858-713-2492

## 15. RECORD OF SYSTEM OPERATIONAL ACCEPTANCE TEST

☐ New system

*All operational features and functions of this system were tested by, or in the presence of, the signer shown below, on the date shown below, and were found to be operating properly in accordance with the requirements for the following:*

☒ Modifications to an existing system

*All newly modified operational features and functions of the system were tested by, or in the presence of, the signer shown below, on the date shown below, and were found to be operating properly in accordance with the requirements of the following:*

☒ *NFPA 72*, Edition:

☒ *NFPA 70, National Electrical Code,* Article 760, Edition:

☒ Manufacturer’s published instructions

Other (specify):

☐ Individual device testing documentation [Inspection and Testing Form (Figure 14.6.2.4) is attached]

Signed: X Printed name: Garner Palenske Date: 6.11.18

Organization: Palenske Alarm Title: Field Guy Phone: 858-713-2492

## 16. CERTIFICATIONS AND APPROVALS

### 16.1 System Installation Contractor:

This system, as specified herein, has been installed and tested according to all NFPA standards cited herein.

Signed: unknown Printed name: Date:

Organization: Title: Phone:

### 16.2 System Service Contractor:

The undersigned has a service contract for this system in effect as of the date shown below.

Signed: unknown Printed name: Date:

Organization: Title: Phone:

### 16.3 Supervising Station:

This system, as specified herein, will be monitored according to all NFPA standards cited herein.

Signed: X Printed name: Mr. Jones Date: 6.11.18

Organization: ADP Title: Supervisor Phone: 800- 7778880

## 16. CERTIFICATIONS AND APPROVALS *(continued)*

### 16.4 Property or Owner Representative:

I accept this system as having been installed and tested to its specifications and all NFPA standards cited herein.

Signed: x
Printed name: Mr. Smith
Date: 6.11.18
Organization: Schirmer Hotels
Title: President
Phone: 800- 538-4292

### 16.5 Authority Having Jurisdiction:

I have witnessed a satisfactory acceptance test of this system and find it to be installed and operating properly in accordance with its approved plans and specifications, with its approved sequence of operations, and with all NFPA standards cited herein.

Signed: not signed
Printed name:
Date:
Organization:
Title:
Phone:

# APPENDIX J - EVACS INSPECTION, TESTING, AND MAINTENANCE REQUIREMENTS

## Chapter 13 Reserved

## Chapter 14 Inspection, Testing, and Maintenance

### 14.1 Application.

**14.1.1** The inspection, testing, and maintenance of systems, their initiating devices, and notification appliances shall comply with the requirements of this chapter.

**14.1.2** The inspection, testing, and maintenance of single- and multiple-station smoke and heat alarms and household fire alarm systems shall comply with the requirements of this chapter.

**14.1.3** Procedures that are required by other parties and that exceed the requirements of this chapter shall be permitted.

**14.1.4** The requirements of this chapter shall apply to both new and existing systems.

**14.1.5** The requirements of Chapter 7 shall apply where referenced in Chapter 14.

### 14.2 General.

**14.2.1 Purpose.**

**14.2.1.1*** The purpose for initial and reacceptance inspections is to ensure compliance with approved design documents and to ensure installation in accordance with this Code and other required installation standards.

**14.2.1.2*** The purpose for initial and reacceptance tests of fire alarm and signaling systems is to ensure system operation in accordance with the design documents.

**14.2.1.3*** The purpose for periodic inspections is to assure that obvious damages or changes that might affect the system operability are visually identified.

**14.2.1.4*** The purpose for periodic testing is to statistically assure operational reliability.

**14.2.2 Performance.**

**14.2.2.1 Performance Verification.** To ensure operational integrity, the system shall have an inspection, testing, and maintenance program.

**14.2.2.1.1** Inspection, testing, and maintenance programs shall satisfy the requirements of this Code and conform to the equipment manufacturer's published instructions.

**14.2.2.1.2** Inspection, testing, and maintenance programs shall verify correct operation of the system.

**14.2.2.2 Impairments/Deficiencies.**

**14.2.2.2.1** The requirements of Section 10.20 shall be applicable when a system is impaired.

**14.2.2.2.2** System deficiencies shall be corrected.

**14.2.2.2.3** If a deficiency is not corrected at the conclusion of system inspection, testing, or maintenance, the system owner or the owner's designated representative shall be informed of the impairment in writing within 24 hours.

**14.2.2.2.4** In the event that any equipment is observed to be part of a recall program, the system owner or the system owner's designated representative shall be notified in writing.

**14.2.3 Responsibilities.**

**14.2.3.1*** The property or building or system owner or the owner's designated representative shall be responsible for inspection, testing, and maintenance of the system and for alterations or additions to this system.

**14.2.3.2** Where the property owner is not the occupant, the property owner shall be permitted to delegate the authority and responsibility for inspecting, testing, and maintaining the fire protection systems to the occupant, management firm, or managing individual through specific provisions in the lease, written use agreement, or management contract.

**14.2.3.3** Inspection, testing, or maintenance shall be permitted to be done by the building or system owner or a person or organization other than the building or system owner if conducted under a written contract.

**14.2.3.4** Where the building or system owner has delegated any responsibilities for inspection, testing, or maintenance, a copy of the written delegation required by 14.2.3.3 shall be provided to the authority having jurisdiction upon request.

**14.2.3.5** Testing and maintenance of central station service systems shall be performed under the contractual arrangements specified in 26.3.3.

**14.2.3.6* Service Personnel Qualifications and Experience.** Service personnel shall be qualified and experienced in accordance with the requirements of 10.5.3.

**14.2.4* Notification.**

**14.2.4.1** Before proceeding with any testing, all persons and facilities receiving alarm, supervisory, or trouble signals and all building occupants shall be notified of the testing to prevent unnecessary response.

**14.2.4.2** At the conclusion of testing, those previously notified (and others, as necessary) shall be notified that testing has been concluded.

**14.2.4.3** The owner or the owner's designated representative and service personnel shall coordinate system testing to prevent interruption of critical building systems or equipment.

**14.2.5 System Documentation.** Prior to system maintenance or testing, the record of completion and any information required by Chapter 7 regarding the system and system alterations, including specifications, wiring diagrams, and floor plans, shall be provided by the owner or a designated representative to the service personnel upon request.

**14.2.5.1** The provided documentation shall include the current revisions of all fire alarm software and the revisions of software of any systems with which the fire alarm software interfaces.

**14.2.5.2** The revisions of fire alarm software, and the revisions of the software in the systems with which the fire alarm software interfaces, shall be verified for compatibility in accordance with the requirements of 23.2.2.1.1.

**14.2.6 Releasing Systems.** Requirements pertinent to testing the fire alarm systems initiating fire suppression system releasing functions shall be covered by 14.2.6.1 through 14.2.6.6.

**14.2.6.1** Testing personnel shall be qualified and experienced in the specific arrangement and operation of a suppression system(s) and a releasing function(s) and shall be cognizant of the hazards associated with inadvertent system discharge.

**14.2.6.2** Occupant notification shall be required whenever a fire alarm system configured for releasing service is being serviced or tested.

**14.2.6.3** Discharge testing of suppression systems shall not be required by this Code.

**14.2.6.4** Suppression systems shall be secured from inadvertent actuation, including disconnection of releasing solenoids or electric actuators, closing of valves, other actions, or combinations thereof, for the specific system, for the duration of the fire alarm system testing.

**14.2.6.5** Testing shall include verification that the releasing circuits and components energized or actuated by the fire alarm system are electrically monitored for integrity and operate as intended on alarm.

**14.2.6.6** Suppression systems and releasing components shall be returned to their functional operating condition upon completion of system testing.

**14.2.7 Interface Equipment and Emergency Control Functions.**

**14.2.7.1*** Testing personnel shall be qualified and experienced in the arrangement and operation of interface equipment and emergency control functions.

**14.2.7.2** Testing shall be accomplished in accordance with Table 14.4.3.2.

**14.2.8 Automated Testing.**

**14.2.8.1** Automated testing arrangements that provide equivalent means of testing devices to those specified in Table 14.4.3.2 at a frequency at least equivalent to those specified in Table 14.4.3.2 shall be permitted to be used to comply with the requirements of this chapter.

**14.2.8.2** Failure of a device on an automated test shall result in an audible and visual trouble signal.

**14.2.9* Performance-Based Inspection and Testing.** As an alternate means of compliance, subject to the authority having jurisdiction, components and systems shall be permitted to be inspected and tested under a performance-based program.

**14.2.10* Test Plan.**

**14.2.10.1** A test plan shall be written to clearly establish the scope of the testing for the fire alarm or signaling system.

**14.2.10.2** The test plan and results shall be documented with the testing records.

**14.3 Inspection.**

**14.3.1*** Unless otherwise permitted by 14.3.2, visual inspections shall be performed in accordance with the schedules in Table 14.3.1 or more often if required by the authority having jurisdiction.

**Table 14.3.1 Visual Inspection**

| Component | Initial Acceptance | Periodic Frequency | Method | Reference |
|---|---|---|---|---|
| 1. All equipment | X | Annual | Ensure there are no changes that affect equipment performance. Inspect for building modifications, occupancy changes, changes in environmental conditions, device location, physical obstructions, device orientation, physical damage, and degree of cleanliness. | 14.3.4 |
| 2. Control equipment: | | | | |
| (a) Fire alarm systems monitored for alarm, supervisory, and trouble signals | | | Verify a system normal condition. | |
| (1) Fuses | X | Annual | | |
| (2) Interfaced equipment | X | Annual | | |
| (3) Lamps and LEDs | X | Annual | | |
| (4) Primary (main) power supply | X | Annual | | |
| (5) Trouble signals | X | Semiannual | | |
| (b) Fire alarm systems unmonitored for alarm, supervisory, and trouble signals | | | Verify a system normal condition. | |
| (1) Fuses | X | Weekly | | |
| (2) Interfaced equipment | X | Weekly | | |
| (3) Lamps and LEDs | X | Weekly | | |
| (4) Primary (main) power supply | X | Weekly | | |
| (5) Trouble signals | X | Weekly | | |

**Table 14.3.1** *Continued*

| Component | Initial Acceptance | Periodic Frequency | Method | Reference |
|---|---|---|---|---|
| 3. Reserved | | | | |
| 4. Supervising station alarm systems — transmitters | | | Verify location, physical condition, and a system normal condition. | |
| (a) Digital alarm communicator transmitter (DACT) | X | Annual | | |
| (b) Digital alarm radio transmitter (DART) | X | Annual | | |
| (c) McCulloh | X | Annual | | |
| (d) Radio alarm transmitter (RAT) | X | Annual | | |
| (e) All other types of communicators | X | Annual | | |
| 5. In-building fire emergency voice/alarm communications equipment | X | Semiannual | Verify location and condition. | |
| 6. Reserved | | | | |
| 7. Reserved | | | | |
| 8. Reserved | | | | |
| 9. Batteries | | | Inspect for corrosion or leakage. Verify tightness of connections. Verify marking of the month/year of manufacture (all types). | 10.6.10 |
| (a) Lead-acid | X | Monthly | Visually inspect electrolyte level. | |
| (b) Nickel-cadmium | X | Semiannual | | |
| (c) Primary (dry cell) | X | Monthly | | |
| (d) Sealed lead-acid | X | Semiannual | | |
| 10. Reserved | | | | |
| 11. Remote annunciators | X | Semiannual | Verify location and condition. | |
| 12. Notification appliance circuit power extenders | X | Annual | Verify proper fuse ratings, if any. Verify that lamps and LEDs indicate normal operating status of the equipment. | 10.6 |
| 13. Remote power supplies | X | Annual | Verify proper fuse ratings, if any. Verify that lamps and LEDs indicate normal operating status of the equipment. | 10.6 |
| 14. Transient suppressors | X | Semiannual | Verify location and condition. | |
| 15. Reserved | | | | |
| 16. Fiber-optic cable connections | X | Annual | Verify location and condition. | |
| 17. Initiating devices | | | Verify location and condition (all devices). | |
| (a) Air sampling | | | | |
| (1) General | X | Semiannual | Verify that in-line filters, if any, are clean. | 17.7.3.6 |
| (2) Sampling system piping and sampling ports | X | N/A | Verify that sampling system piping and fittings are installed properly, appear airtight, and are permanently fixed. Confirm that sampling pipe is conspicuously identified. Verify that sample ports or points are not obstructed. | 17.7.3.6 |

*(continues)*

**Table 14.3.1** *Continued*

| Component | Initial Acceptance | Periodic Frequency | Method | Reference |
|---|---|---|---|---|
| (b) Duct detectors | | | | |
| (1) General | X | Semiannual | Verify that detector is rigidly mounted. Confirm that no penetrations in a return air duct exist in the vicinity of the detector. Confirm the detector is installed so as to sample the airstream at the proper location in the duct. | 17.7.5.5 |
| (2) Sampling tube | X | Annual | Verify proper orientation. Confirm the sampling tube protrudes into the duct in accordance with system design. | 17.7.5.5 |
| (c) Electromechanical releasing devices | X | Semiannual | | |
| (d) Fire extinguishing system(s) or suppression system(s) switches | X | Semiannual | | |
| (e) Manual fire alarm boxes | X | Semiannual | | |
| (f) Heat detectors | X | Semiannual | | |
| (g) Radiant energy fire detectors | X | Quarterly | Verify no point requiring detection is obstructed or outside the detector's field of view. | 17.8 |
| (h) Video image smoke and fire detectors | X | Quarterly | Verify no point requiring detection is obstructed or outside the detector's field of view. | 17.7.7;<br>17.11.5 |
| (i) Smoke detectors (excluding one- and two-family dwellings) | X | Semiannual | | |
| (j) Projected beam smoke detectors | X | Semiannual | Verify beam path is unobstructed. | |
| (k) Supervisory signal devices | X | Quarterly | | |
| (l) Waterflow devices | X | Quarterly | | |
| 18. Reserved | | | | |
| 19. Combination systems | | | Verify location and condition (all types). | |
| (a) Fire extinguisher electronic monitoring device/systems | X | Semiannual | | |
| (b) Carbon monoxide detectors/systems | X | Semiannual | | |
| 20. Fire alarm control interface and emergency control function interface | X | Semiannual | Verify location and condition. | |
| 21. Guard's tour equipment | X | Semiannual | Verify location and condition. | |
| 22. Notification appliances | | | Verify location and condition (all appliances). | |
| (a) Audible appliances | X | Semiannual | | |
| (b) Audible textual notification appliances | X | Semiannual | | |
| (c) Visible appliances | | | | |
| (1) General | X | Semiannual | | 18.5.5 |
| (2) Candela rating | X | N/A | Verify that the candela rating marking agrees with the approved drawings. | 18.5.5 |
| 23. Exit marking audible notification appliances | X | Semiannual | Verify location and condition. | |

**Table 14.3.1** ***Continued***

| Component | Initial Acceptance | Periodic Frequency | Method | Reference |
|---|---|---|---|---|
| 24. Reserved | | | | |
| 25. Area of refuge two-way communication system | X | Annual | Verify location and condition. | |
| 26. Reserved | | | | |
| 27. Supervising station alarm systems — receivers | | | | |
| (a) Signal receipt | X | Daily | Verify receipt of signal. | |
| (b) Receivers | X | Annual | Verify location and normal condition. | |
| 28. Public emergency alarm reporting system transmission equipment | | | Verify location and condition. | |
| (a) Publicly accessible alarm box | X | Semiannual | | |
| (b) Auxiliary box | X | Annual | | |
| (c) Master box | | | | |
| (1) Manual operation | X | Semiannual | | |
| (2) Auxiliary operation | X | Annual | | |
| 29. Reserved | | | | |
| 30. Mass notification system | | | | |
| (a) Monitored for integrity | | | Verify a system normal condition. | |
| (1) Control equipment | | | | |
| (i) Fuses | X | Annual | | |
| (ii) Interfaces | X | Annual | | |
| (iii) Lamps/LED | X | Annual | | |
| (iv) Primary (main) power supply | X | Annual | | |
| (2) Secondary power batteries | X | Annual | | |
| (3) Initiating devices | X | Annual | | |
| (4) Notification appliances | X | Annual | | |
| (b) Not monitored for integrity; installed prior to adoption of the 2010 edition | | | Verify a system normal condition. | |
| (1) Control equipment | | | | |
| (i) Fuses | X | Semiannual | | |
| (ii) Interfaces | X | Semiannual | | |
| (iii) Lamps/LED | X | Semiannual | | |
| (iv) Primary (main) power supply | X | Semiannual | | |
| (2) Secondary power batteries | X | Semiannual | | |
| (3) Initiating devices | X | Semiannual | | |
| (4) Notification appliances | X | Semiannual | | |
| (c) Antenna | X | Annual | Verify location and condition. | |
| (d) Transceivers | X | Annual | Verify location and condition. | |

Note: N/A = not applicable, no minimum requirement established.

**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 shutdowns if approved by the authority havingjurisdiction.

**14.3.3** Extended intervals shall not exceed 18 months.

**14.3.4** Initial and reacceptance inspections shall be made to ensure compliance with approved design documents and to ensure installation in accordance with this Code and other required installation standards.

**14.3.5** Periodic visual inspections in accordance with Table 14.3.1 shall be made to assure that there are no changes that affect equipment performance.

### 14.4 Testing.

### 14.4.1 Initial Acceptance Testing.

**14.4.1.1** All new systems shall be inspected and tested in accordance with the requirements of Chapter 14.

**14.4.1.2** The authority having jurisdiction shall be notified prior to the initial acceptance test.

### 14.4.2* Reacceptance Testing.

**14.4.2.1** When an initiating device, notification appliance, or control relay is added, it shall be functionally tested.

**14.4.2.2** When an initiating device, notification appliance, or control relay is deleted, another device, appliance, or control relay on the circuit shall be operated.

**14.4.2.3** When modifications or repairs to control equipment hardware are made, the control equipment shall be tested in accordance with Table 14.4.3.2, items 2(a) and 2(d).

**14.4.2.4** When changes are made to site-specific software, the following shall apply:

(1) All functions known to be affected by the change, or identified by a means that indicates changes, shall be 100 percent tested.
(2) In addition, 10 percent of initiating devices that are not directly affected by the change, up to a maximum of 50 devices, also shall be tested and correct system operation shall be verified.
(3) A revised record of completion in accordance with 7.5.6 shall be prepared to reflect these changes.

**14.4.2.5** Changes to the system executive software shall require a 10 percent functional test of the system, including a test of at least one device on each input and output circuit to verify critical system functions such as notification appliances, control functions, and off-premises reporting.

### 14.4.3* Test Methods.

**14.4.3.1*** At the request of the authority having jurisdiction, the central station facility installation shall be inspected for complete information regarding the central station system, including specifications, wiring diagrams, and floor plans that have been submitted for approval prior to installation of equipment and wiring.

**14.4.3.2*** Systems and associated equipment shall be tested according to Table 14.4.3.2.

**Table 14.4.3.2 Testing**

| Component | Initial Acceptance | Periodic Frequency | Method |
|---|---|---|---|
| 1. All equipment | X | | See Table 14.3.1. |
| 2. Control equipment and transponder | | | |
| (a) Functions | X | Annually | Verify correct receipt of alarm, supervisory, and trouble signals (inputs); operation of evacuation signals and auxiliary functions (outputs); circuit supervision, including detection of open circuits and ground faults; and power supply supervision for detection of loss of ac power and disconnection of secondary batteries. |
| (b) Fuses | X | Annually | Verify rating and supervision. |
| (c) Interfaced equipment | X | Annually | Verify integrity of single or multiple circuits providing interface between two or more control units. Test interfaced equipment connections by operating or simulating operation of the equipment being supervised. Verify signals required to be transmitted at the control unit. |
| (d) Lamps and LEDs | X | Annually | Illuminate lamps and LEDs. |
| (e) Primary (main) power supply | X | Annually | Test under maximum load, including all alarm appliances requiring simultaneous operation. Test redundant power supplies separately. |
| 3. Fire alarm control unit trouble signals | | | |
| (a) Audible and visual | X | Annually | Verify operation of control unit trouble signals. Verify ring-back feature for systems using a trouble-silencing switch that requires resetting. |
| (b) Disconnect switches | X | Annually | If control unit has disconnect or isolating switches, verify performance of intended function of each switch. Verify receipt of trouble signal when a supervised function is disconnected. |
| (c) Ground-fault monitoring circuit | X | Annually | If the system has a ground detection feature, verify the occurrence of ground-fault indication whenever any installation conductor is grounded. |
| (d) Transmission of signals to off-premises location | X | Annually | Actuate an initiating device and verify receipt of alarm signal at the off-premises location.<br>Create a trouble condition and verify receipt of a trouble signal at the off-premises location.<br>Actuate a supervisory device and verify receipt of a supervisory signal at the off-premises location. If a transmission carrier is capable of operation under a single- or multiple-fault condition, activate an initiating device during such fault condition and verify receipt of an alarm signal and a trouble signal at the off-premises location. |

**Table 14.4.3.2** *Continued*

| Component | Initial Acceptance | Periodic Frequency | Method |
|---|---|---|---|
| 4. Supervising station alarm systems — transmission equipment | | | |
| (a) All equipment | X | Annually | [a]Test all system functions and features in accordance with the equipment manufacturer's published instructions for correct operation in conformance with the applicable sections of Chapter 26.<br>Except for DACT, actuate initiating device and verify receipt of the correct initiating device signal at the supervising station within 90 seconds. Upon completion of the test, restore the system to its functional operating condition.<br>If test jacks are used, conduct the first and last tests without the use of the test jack. |
| (b) Digital alarm communicator transmitter (DACT) | X | Annually | Except for DACTs installed prior to adoption of the 2013 edition of NFPA 72 that are connected to a telephone line (number) that is also supervised for adverse conditions by a derived local channel, ensure connection of the DACT to two separate means of transmission.<br>Test DACT for line seizure capability by initiating a signal while using the telephone line (primary line for DACTs using two telephone lines) for a telephone call. Ensure that the call is interrupted and that the communicator connects to the digital alarm receiver. Verify receipt of the correct signal at the supervising station. Verify each transmission attempt is completed within 90 seconds from going off-hook to on-hook.<br>Disconnect the telephone line (primary line for DACTs using two telephone lines) from the DACT. Verify indication of the DACT trouble signal occurs at the premises fire alarm control unit within 4 minutes of detection of the fault. Verify receipt of the telephone line trouble signal at the supervising station. Restore the telephone line (primary line for DACTs using two telephone lines), reset the fire alarm control unit, and verify that the telephone line fault trouble signal returns to normal. Verify that the supervising station receives the restoral signal from the DACT.<br>Disconnect the secondary means of transmission from the DACT. Verify indication of the DACT trouble signal occurs at the premises fire alarm control unit within 4 minutes of detection of the fault. Verify receipt of the secondary means trouble signal at the supervising station. Restore the secondary means of transmission, reset the fire alarm control unit, and verify that the trouble signal returns to normal. Verify that the supervising station receives the restoral signal from the secondary transmitter.<br>Cause the DACT to transmit a signal to the DACR while a fault in the telephone line (number) (primary line for DACTs using two telephone lines) is simulated. Verify utilization of the secondary communication path by the DACT to complete the transmission to the DACR. |
| (c) Digital alarm radio transmitter (DART) | X | Annually | Disconnect the primary telephone line. Verify transmission of a trouble signal to the supervising station by the DART occurs within 4 minutes. |
| (d) McCulloh transmitter | X | Annually | Actuate initiating device. Verify production of not less than three complete rounds of not less than three signal impulses each by the McCulloh transmitter.<br>If end-to-end metallic continuity is present and with a balanced circuit, cause each of the following four transmission channel fault conditions in turn, and verify receipt of correct signals at the supervising station:<br>(1) Open<br>(2) Ground<br>(3) Wire-to-wire short<br>(4) Open and ground<br>If end-to-end metallic continuity is not present and with a properly balanced circuit, cause each of the following three transmission channel fault conditions in turn, and verify receipt of correct signals at the supervising station:<br>(1) Open<br>(2) Ground<br>(3) Wire-to-wire short |

(continues)

**Table 14.4.3.2** *Continued*

| Component | Initial Acceptance | Periodic Frequency | Method |
|---|---|---|---|
| (e) Radio alarm transmitter (RAT) | X | Annually | Cause a fault between elements of the transmitting equipment. Verify indication of the fault at the protected premises, or transmission of trouble signal to the supervising station. |
| (f) Performance-based technologies | X | Annually | Perform tests to ensure the monitoring of integrity of the transmission technology and technology path.<br>Where shared communications equipment is used as permitted by 26.6.3.1.14, provided secondary (standby) power sources shall be tested in accordance with Table 14.4.3.2, item 7, 8, or 9, as applicable.<br>Where a single communications path is used, disconnect the communication path. Manually initiate an alarm signal transmission or allow the check-in (handshake) signal to be transmitted automatically.[b] Verify the premises unit annunciates the failure within 200 seconds of the transmission failure. Restore the communication path.<br>Where multiple communication paths are used, disconnect both communication paths. Manually initiate an alarm signal transmission. Verify the premises control unit annunciates the failure within 200 seconds of the transmission failure. Restore both communication paths. |
| 5. Emergency communications equipment | | | |
| (a) Amplifier/tone generators | X | Annually | Verify correct switching and operation of backup equipment. |
| (b) Call-in signal silence | X | Annually | Operate/function and verify receipt of correct visual and audible signals at control unit. |
| (c) Off-hook indicator (ring down) | X | Annually | Install phone set or remove phone from hook and verify receipt of signal at control unit. |
| (d) Phone jacks | X | Annually | Visually inspect phone jack and initiate communications path through jack. |
| (e) Phone set | X | Annually | Activate each phone set and verify correct operation. |
| (f) System performance | X | Annually | Operate the system with a minimum of any five handsets simultaneously. Verify voice quality and clarity. |
| 6. Engine-driven generator | X | Monthly | If an engine-driven generator dedicated to the system is used as a required power source, verify operation of the generator in accordance with NFPA 110 by the building owner. |
| 7. Secondary (standby) power supply[c] | X | Annually | Disconnect all primary (main) power supplies and verify the occurrence of required trouble indication for loss of primary power. Measure or verify the system's standby and alarm current demand and verify the ability of batteries to meet standby and alarm requirements using manufacturer's data. Operate general alarm systems a minimum of 5 minutes and emergency voice communications systems for a minimum of 15 minutes. Reconnect primary (main) power supply at end of test. |
| 8. Uninterruptible power supply (UPS) | X | Annually | If a UPS system dedicated to the system is used as a required power source, verify by the building owner operation of the UPS system in accordance with NFPA 111. |
| 9. Battery tests | | | Prior to conducting any battery testing, verify by the person conducting the test, that all system software stored in volatile memory is protected from loss. |
| (a) Lead-acid type | | | |
| (1) Battery replacement | X | Annually | Replace batteries in accordance with the recommendations of the alarm equipment manufacturer or when the recharged battery voltage or current falls below the manufacturer's recommendations. |
| (2) Charger test | X | Annually | With the batteries fully charged and connected to the charger, measure the voltage across the batteries with a voltmeter. Verify the voltage is 2.30 volts per cell ±0.02 volts at 77°F (25°C) or as specified by the equipment manufacturer. |
| (3) Discharge test | X | Annually | With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery. |
| (4) Load voltage test | X | Semiannually | With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery. Verify the battery does not fall below 2.05 volts per cell under load. |

**Table 14.4.3.2** ***Continued***

| Component | Initial Acceptance | Periodic Frequency | Method |
|---|---|---|---|
| (5) Specific gravity | X | Semiannually | Measure as required the specific gravity of the liquid in the pilot cell or all of the cells. Verify the specific gravity is within the range specified by the manufacturer. Although the specified specific gravity varies from manufacturer to manufacturer, a range of 1.205–1.220 is typical for regular lead-acid batteries, while 1.240–1.260 is typical for high-performance batteries. Do not use a hydrometer that shows only a pass or fail condition of the battery and does not indicate the specific gravity, because such a reading does not give a true indication of the battery condition. |
| (b) Nickel-cadmium type | | | |
| (1) Battery replacement | X | Annually | Replace batteries in accordance with the recommendations of the alarm equipment manufacturer or when the recharged battery voltage or current falls below the manufacturer's recommendations. |
| (2) Charger test[d] | X | Annually | With the batteries fully charged and connected to the charger, place an ampere meter in series with the battery under charge. Verify the charging current is in accordance with the manufacturer's recommendations for the type of battery used. In the absence of specific information, use 1/30 to 1/25 of the battery rating. |
| (3) Discharge test | X | Annually | With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery. |
| (4) Load voltage test | X | Semiannually | With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery. Verify the float voltage for the entire battery is 1.42 volts per cell, nominal, under load. If possible, measure cells individually. |
| (c) Sealed lead-acid type | | | |
| (1) Battery replacement | X | Annually | Replace batteries in accordance with the recommendations of the alarm equipment manufacturer or when the recharged battery voltage or current falls below the manufacturer's recommendations. |
| (2) Charger test | X | Annually | With the batteries fully charged and connected to the charger, measure the voltage across the batteries with a voltmeter. Verify the voltage is 2.30 volts per cell ±0.02 volts at 77°F (25°C) or as specified by the equipment manufacturer. |
| (3) Discharge test | X | Annually | With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery. |
| (4) Load voltage test | X | Semiannually | Verify the battery performs under load, in accordance with the battery manufacturer's specifications. |
| 10. Public emergency alarm reporting system — wired system | X | Daily | Manual tests of the power supply for public reporting circuits shall be made and recorded at least once during each 24-hour period. Such tests shall include the following:<br>(1) Current strength of each circuit. Changes in current of any circuit exceeding 10 percent shall be investigated immediately.<br>(2) Voltage across terminals of each circuit inside of terminals of protective devices. Changes in voltage of any circuit exceeding 10 percent shall be investigated immediately.<br>(3)[e] Voltage between ground and circuits. If this test shows a reading in excess of 50 percent of that shown in the test specified in (2), the trouble shall be immediately located and cleared. Readings in excess of 25 percent shall be given early attention. These readings shall be taken with a calibrated voltmeter of not more than 100 ohms resistance per volt. Systems in which each circuit is supplied by an independent current source (Forms 3 and 4) require tests between ground and each side of each circuit. Common current source systems (Form 2) require voltage tests between ground and each terminal of each battery and other current source. |

*(continues)*

**Table 14.4.3.2** *Continued*

| Component | Initial Acceptance | Periodic Frequency | Method |
|---|---|---|---|
| | | | (4) Ground current reading shall be permitted in lieu of (3). If this method of testing is used, all grounds showing a current reading in excess of 5 percent of the supplied line current shall be given immediate attention.<br>(5) Voltage across terminals of common battery on switchboard side of fuses.<br>(6) Voltage between common battery terminals and ground. Abnormal ground readings shall be investigated immediately.<br>Tests specified in (5) and (6) shall apply only to those systems using a common battery. If more than one common battery is used, each common battery shall be tested. |
| 11. Remote annunciators | X | Annually | Verify the correct operation and identification of annunciators. If provided, verify the correct operation of annunciator under a fault condition. |
| 12. Reserved | | | |
| 13. Reserved | | | |
| 14. Reserved | | | |
| 15. Conductors — metallic | | | |
| (a) Stray voltage | X | N/A | Test all installation conductors with a volt/ohmmeter to verify that there are no stray (unwanted) voltages between installation conductors or between installation conductors and ground. Verify the maximum allowable stray voltage does not exceed 1 volt ac/dc, unless a different threshold is specified in the published manufacturer's instructions for the installed equipment. |
| (b) Ground faults | X | N/A | Test all installation conductors, other than those intentionally and permanently grounded, for isolation from ground per the installed equipment manufacturer's published instructions. |
| (c) Short-circuit faults | X | N/A | Test all installation conductors, other than those intentionally connected together, for conductor-to-conductor isolation per the published manufacturer's instructions for the installed equipment. Also test these same circuits conductor-to-ground. |
| (d) Loop resistance | X | N/A | With each initiating and indicating circuit installation conductor pair short-circuited at the far end, measure and record the resistance of each circuit. Verify that the loop resistance does not exceed the limits specified in the published manufacturer's instructions for the installed equipment. |
| (e) Circuit integrity | X | N/A | For initial and reacceptance testing, confirm the introduction of a fault in any circuit monitored for integrity results in a trouble indication at the fire alarm control unit. Open one connection at not less than 10 percent of the initiating devices, notification appliances and controlled devices on every initiating device circuit, notification appliance circuit, and signaling line circuit. Confirm all circuits perform as indicated in Sections 23.5, 23.6, and 23.7. |
| | N/A | Annually | For periodic testing, test each initiating device circuit, notification appliance circuit, and signaling line circuit for correct indication at the control unit. Confirm all circuits perform as indicated in Sections 23.5, 23.6, and 23.7. |
| 16. Conductors — nonmetallic | | | |
| (a) Fiber optics | X | N/A | Test the fiber-optic transmission line by the use of an optical power meter or by an optical time domain reflectometer used to measure the relative power loss of the line. Test result data must meet or exceed ANSI/TIA 568-C.3, *Optical Fiber Cabling Components Standard,* related to fiber-optic lines and connection/splice losses and the control unit manufacturer's published specifications. |
| (b) Circuit integrity | X | N/A | For initial and reacceptance testing, confirm the introduction of a fault in any circuit monitored for integrity results in a trouble indication at the fire alarm control unit. Open one connection at not less than 10 percent of the initiating devices, notification appliances, and controlled devices on every initiating device circuit, notification appliance circuit, and signaling line circuit. Confirm all circuits perform as indicated in Sections 23.5, 23.6, and 23.7. |
| | N/A | Annually | For periodic testing, test each initiating device circuit, notification appliance circuit, and signaling line circuit for correct indication at the control unit. Confirm all circuits perform as indicated in Sections 23.5, 23.6, and 23.7. |

**Table 14.4.3.2** ***Continued***

| Component | Initial Acceptance | Periodic Frequency | Method |
|---|---|---|---|
| 17. Initiating devices[f] | | | |
| (a) Electromechanical releasing device | | | |
| (1) Nonrestorable-type link | X | Annually | Verify correct operation by removal of the fusible link and operation of the associated device. Lubricate any moving parts as necessary. |
| (2) Restorable-type link[g] | X | Annually | Verify correct operation by removal of the fusible link and operation of the associated device. Lubricate any moving parts as necessary. |
| (b) Fire extinguishing system(s) or suppression system(s) alarm switch | X | Annually | Operate the switch mechanically or electrically and verify receipt of signal by the fire alarm control unit. |
| (c) Fire–gas and other detectors | X | Annually | Test fire–gas detectors and other fire detectors as prescribed by the manufacturer and as necessary for the application. |
| (d) Heat detectors | | | |
| (1) Fixed-temperature, rate-of-rise, rate of compensation, restorable line, spot type (excluding pneumatic tube type) | X | Annually (see 14.4.4.5) | Perform heat test with a listed and labeled heat source or in accordance with the manufacturer's published instructions. Assure that the test method for the installed equipment does not damage the nonrestorable fixed-temperature element of a combination rate-of-rise/fixed-temperature element detector. |
| (2) Fixed-temperature, nonrestorable line type | X | Annually | Do not perform heat test. Test functionality mechanically and electrically. Measure and record loop resistance. Investigate changes from acceptance test. |
| (3) Fixed-temperature, nonrestorable spot type | X | See Method | After 15 years from initial installation, replace all devices or have 2 detectors per 100 laboratory tested. Replace the 2 detectors with new devices. If a failure occurs on any of the detectors removed, remove and test additional detectors to determine either a general problem involving faulty detectors or a localized problem involving 1 or 2 defective detectors.<br>If detectors are tested instead of replaced, repeat tests at intervals of 5 years. |
| (4) Nonrestorable (general) | X | Annually | Do not perform heat tests. Test functionality mechanically and electrically. |
| (5) Restorable line type, pneumatic tube only | X | Annually | Perform heat tests (where test chambers are in circuit), with a listed and labeled heat source or in accordance with the manufacturer's published instructions of the detector or conduct a test with pressure pump. |
| (6) Single- and multiple-station heat alarms | X | Annually | Conduct functional tests according to manufacturer's published instructions. Do not test nonrestorable heat detectors with heat. |
| (e) Manual fire alarm boxes | X | Annually | Operate manual fire alarm boxes per the manufacturer's published instructions. Test both key-operated presignal and general alarm manual fire alarm boxes. |
| (f) Radiant energy fire detectors | X | Semiannually | Test flame detectors and spark/ember detectors in accordance with the manufacturer's published instructions to determine that each detector is operative.<br>Determine flame detector and spark/ember detector sensitivity using any of the following:<br>(1) Calibrated test method<br>(2) Manufacturer's calibrated sensitivity test instrument<br>(3) Listed control unit arranged for the purpose<br>(4) Other approved calibrated sensitivity test method that is directly proportional to the input signal from a fire, consistent with the detector listing or approval<br>If designed to be field adjustable, replace detectors found to be outside of the approved range of sensitivity or adjust to bring them into the approved range.<br>Do not determine flame detector and spark/ember detector sensitivity using a light source that administers an unmeasured quantity of radiation at an undefined distance from the detector. |
| (g) Smoke detectors — functional test | | | |
| (1) In other than one- and two-family dwellings, system detectors | X | Annually | [h]Test smoke detectors in place to ensure smoke entry into the sensing chamber and an alarm response. Use smoke or a listed and labeled product acceptable to the manufacturer or in accordance with their published instructions. Other methods listed in the manufacturer's published instructions that ensure smoke entry from the protected area, through the vents, into the sensing chamber can be used. |

*(continues)*

**Table 14.4.3.2** *Continued*

| Component | Initial Acceptance | Periodic Frequency | Method |
|---|---|---|---|
| (2) Single- and multiple-station smoke alarms connected to protected premises systems | X | Annually | Perform a functional test on all single- and multiple-station smoke alarms connected to a protected premises fire alarm system by putting the smoke alarm into an alarm condition and verifying that the protected premises system receives a supervisory signal and does not cause a fire alarm signal. |
| (3) System smoke detectors used in one- and two-family dwellings | X | Annually | Conduct functional tests according to manufacturer's published instructions. |
| (4) Air sampling | X | Annually | Test with smoke or a listed and labeled product acceptable to the manufacturer or in accordance with their published instructions. Test from the end sampling port or point on each pipe run. Verify airflow through all other ports or points. |
| (5) Duct type | X | Annually | In addition to the testing required in Table 14.4.3.2(g)(1) and Table 14.4.3.2(h), test duct smoke detectors that use sampling tubes to ensure that they will properly sample the airstream in the duct using a method acceptable to the manufacturer or in accordance with their published instructions. |
| (6) Projected beam type | X | Annually | Test the detector by introducing smoke, other aerosol, or an optical filter into the beam path. |
| (7) Smoke detector with built-in thermal element | X | Annually | Operate both portions of the detector independently as described for the respective devices. |
| (8) Smoke detectors with control output functions | X | Annually | Verify that the control capability remains operable even if all of the initiating devices connected to the same initiating device circuit or signaling line circuit are in an alarm state. |
| (h) Smoke detectors — sensitivity testing | | | |
| In other than one- and two-family dwellings, system detectors | N/A | See 14.4.4.3 | Perform any of the following tests to ensure that each smoke detector is within its listed and marked sensitivity range:<br>(1) Calibrated test method<br>(2) Manufacturer's calibrated sensitivity test instrument<br>(3) Listed control equipment arranged for the purpose<br>(4) Smoke detector/control unit arrangement whereby the detector causes a signal at the control unit when its sensitivity is outside its listed sensitivity range<br>(5) Other calibrated sensitivity test method approved by the authority having jurisdiction |
| (i) Carbon monoxide detectors/carbon monoxide alarms for the purposes of fire detection | X | Annually | Test the devices in place to ensure CO entry to the sensing chamber by introduction through the vents, to the sensing chamber of listed and labeled product acceptable to the manufacturer or in accordance with their published instructions. |
| (j) Initiating devices, supervisory | | | |
| (1) Control valve switch | X | Semiannual | Operate valve and verify signal receipt to be within the first two revolutions of the handwheel or within one-fifth of the travel distance, or per the manufacturer's published instructions. |
| (2) High- or low-air pressure switch | X | Annually | Operate switch and verify receipt of signal is obtained where the required pressure is increased or decreased a maximum 10 psi (70 kPa) from the required pressure level. |
| (3) Room temperature switch | X | Annually | Operate switch and verify receipt of signal to indicate the decrease in room temperature to 40°F (4.4°C) and its restoration to above 40°F (4.4°C). |
| (4) Water level switch | X | Annually | Operate switch and verify receipt of signal indicating the water level raised or lowered a maximum 3 in. (70 mm) from the required level within a pressure tank, or a maximum 12 in. (300 mm) from the required level of a nonpressure tank. Also verify its restoral to required level. |
| (5) Water temperature switch | X | Annually | Operate switch and verify receipt of signal to indicate the decrease in water temperature to 40°F (4.4°C) and its restoration to above 40°F (4.4°C). |
| (k) Mechanical, electrosonic, or pressure-type waterflow device | X | Semiannually | Water shall be flowed through an inspector's test connection indicating the flow of water equal to that from a single sprinkler of the smallest orifice size installed in the system for wet-pipe systems, or an alarm test bypass connection for dry-pipe, pre-action, or deluge systems in accordance with NFPA 25. |

**Table 14.4.3.2** ***Continued***

| Component | Initial Acceptance | Periodic Frequency | Method |
|---|---|---|---|
| (l) Multi-sensor fire detector or multi-criteria fire detector or combination fire detector | X | Annually | Test each of the detection principles present within the detector (e.g., smoke/heat/CO, etc.) independently for the specific detection principle, regardless of the configuration status at the time of testing. Also test each detector in accordance with the published manufacturer's instructions.<br>Test individual sensors together if the technology allows individual sensor responses to be verified.<br>Perform tests as described for the respective devices by introduction of the physical phenomena to the sensing chamber of element. An electronic check (magnets, analog values, etc.) is not sufficient to comply with this requirement.<br>Verify by using the detector manufacturer's published instructions that the test gas used will not impair the operation of either sensing chamber of a multisensor, multicriteria, or combination fire detector.<br>Confirm the result of each sensor test through indication at the detector or control unit.<br>Where individual sensors cannot be tested individually, test the primary sensor.[j]<br>Record all tests and results. |
| 18. Special hazard equipment | | | |
| (a) Abort switch (dead-man type) | X | Annually | Operate abort switch and verify correct sequence and operation. |
| (b) Abort switch (recycle type) | X | Annually | Operate abort switch and verify development of correct matrix with each sensor operated. |
| (c) Abort switch (special type) | X | Annually | Operate abort switch and verify correct sequence and operation in accordance with authority having jurisdiction. Observe sequencing as specified on as-built drawings or in system owner's manual. |
| (d) Cross-zone detection circuit | X | Annually | Operate one sensor or detector on each zone. Verify occurrence of correct sequence with operation of first zone and then with operation of second zone. |
| (e) Matrix-type circuit | X | Annually | Operate all sensors in system. Verify development of correct matrix with each sensor operated. |
| (f) Release solenoid circuit[k] | X | Annually | Verify operation of solenoid. |
| (g) Squibb release circuit | X | Annually | Use AGI flashbulb or other test light approved by the manufacturer. Verify operation of flashbulb or light. |
| (h) Verified, sequential, or counting zone circuit | X | Annually | Operate required sensors at a minimum of four locations in circuit. Verify correct sequence with both the first and second detector in alarm. |
| (i) All above devices or circuits or combinations thereof | X | Annually | Verify supervision of circuits by creating an open circuit. |
| 19. Combination systems | | | |
| (a) Fire extinguisher electronic monitoring device/system | X | Annually | Test communication between the device connecting the fire extinguisher electronic monitoring device/system and the fire alarm control unit to ensure proper signals are received at the fire alarm control unit and remote annunciator(s) if applicable. |
| (b) Carbon monoxide[l] device/system | X | Annually | Test communication between the device connecting the carbon monoxide device/system and the fire alarm control unit to ensure proper signals are received at the fire alarm control unit and remote annunciator(s) if applicable. |
| 20. Interface equipment[m] | X | See 14.4.4.4 | Test interface equipment connections by operating or simulating the equipment being supervised. Verify signals required to be transmitted are received at the control unit. Test frequency for interface equipment is the same as the frequency required by the applicable NFPA standard(s) for the equipment being supervised. |
| 21. Guard's tour equipment | X | Annually | Test the device in accordance with the manufacturer's published instructions. |
| 22. Alarm notification appliances | | | |
| (a) Audible[n] | X | N/A | For initial and reacceptance testing, measure sound pressure levels for signals with a sound level meter meeting ANSI S1.4a, *Specifications for Sound Level Meters,* Type 2 requirements. Measure sound pressure levels throughout the protected area to confirm that they are in compliance with Chapter 18. Set the sound level meter in accordance with ANSI S3.41, *American National Standard Audible Evacuation Signal,* using the time-weighted characteristic F (FAST). |

*(continues)*

**Table 14.4.3.2** *Continued*

| Component | Initial Acceptance | Periodic Frequency | Method |
|---|---|---|---|
| | N/A | Annually | [o]For periodic testing, verify the operation of the notification appliances. |
| (b) Audible textual notification appliances (speakers and other appliances to convey voice messages) | X | N/A | For initial and reacceptance testing, measure sound pressure levels for signals with a sound level meter meeting ANSI S1.4a, *Specifications for Sound Level Meters*, Type 2 requirements. Measure sound pressure levels throughout the protected area to confirm that they are in compliance with Chapter 18. Set the sound level meter in accordance with ANSI S3.41, *American National Standard Audible Evacuation Signal*, using the time-weighted characteristic F (FAST).<br>Verify audible information to be distinguishable and understandable and in compliance with 14.4.11. |
| | N/A | Annually | [o]For periodic testing, verify the operation of the notification appliances. |
| (c) Visible | X | N/A | Perform initial and reacceptance testing in accordance with the manufacturer's published instructions. Verify appliance locations to be per approved layout and confirm that no floor plan changes affect the approved layout. Verify that the candela rating marking agrees with the approved drawing. Confirm that each appliance flashes. |
| | N/A | Annually | For periodic testing, verify that each appliance flashes. |
| 23. Exit marking audible notification appliance | X | Annually | Perform tests in accordance with manufacturer's published instructions. |
| 24. Emergency control functions[p] | X | Annually | For initial, reacceptance, and periodic testing, verify emergency control function interface device activation. Where an emergency control function interface device is disabled or disconnected during initiating device testing, verify that the disabled or disconnected emergency control function interface device has been properly restored. |
| 25. Area of refuge two-way communication system | X | Annually | Use the manufacturer's published instructions and the as-built drawings provided by the system supplier to verify correct operation after the initial testing phase has been performed by the supplier or by the supplier's designated representative.<br>Test the two-way communication system to verify operation and receipt of visual and audible signals at the transmitting unit and the receiving unit, respectively.<br>Operate systems with more than five stations with a minimum of five stations operating simultaneously.<br>Verify voice quality and clarity.<br>Verify directions for the use of the two-way communication system, instructions for summoning assistance via the two-way communication system, and written identification of the location is posted adjacent to the two-way communication system.<br>Verify that all remote stations are readily accessible.<br>Verify the timed automatic communications capability to connect with a constantly attended monitoring location per 24.5.3.4. |
| 26. Special procedures | | | |
| (a) Alarm verification | X | Annually | Verify time delay and alarm response for smoke detector circuits identified as having alarm verification. |
| (b) Multiplex systems | X | Annually | Verify communications between sending and receiving units under both primary and secondary power.<br>Verify communications between sending and receiving units under open-circuit and short-circuit trouble conditions.<br>Verify communications between sending and receiving units in all directions where multiple communications pathways are provided.<br>If redundant central control equipment is provided, verify switchover and all required functions and operations of secondary control equipment.<br>Verify all system functions and features in accordance with manufacturer's published instructions. |
| 27. Supervising station alarm systems — receiving equipment | | | |
| (a) All equipment | X | Monthly | Perform tests on all system functions and features in accordance with the equipment manufacturer's published instructions for correct operation in conformance with the applicable sections of Chapter 26.<br>Actuate initiating device and verify receipt of the correct initiating device signal at the supervising station within 90 seconds. Upon completion of the test, restore the system to its functional operating condition. |

**Table 14.4.3.2** ***Continued***

| Component | Initial Acceptance | Periodic Frequency | Method |
|---|---|---|---|
| | | | If test jacks are used, perform the first and last tests without the use of the test jack. |
| (b) Digital alarm communicator receiver (DACR) | X | Monthly | Disconnect each transmission means in turn from the DACR, and verify audible and visual annunciation of a trouble signal in the supervising station.<br>Cause a signal to be transmitted on each individual incoming DACR line (path) at least once every 6 hours (24 hours for DACTs installed prior to adoption of the 2013 edition of *NFPA 72*). Verify receipt of these signals. |
| (c) Digital alarm radio receiver (DARR) | X | Monthly | Cause the following conditions of all DARRs on all subsidiary and repeater station receiving equipment. Verify receipt at the supervising station of correct signals for each of the following conditions:<br>(1) AC power failure of the radio equipment<br>(2) Receiver malfunction<br>(3) Antenna and interconnecting cable failure<br>(4) Indication of automatic switchover of the DARR<br>(5) Data transmission line failure between the DARR and the supervising or subsidiary station |
| (d) McCulloh systems | X | Monthly | Test and record the current on each circuit at each supervising and subsidiary station under the following conditions:<br>(1) During functional operation<br>(2) On each side of the circuit with the receiving equipment conditioned for an open circuit<br>Cause a single break or ground condition on each transmission channel. If such a fault prevents the functioning of the circuit, verify receipt of a trouble signal.<br>Cause each of the following conditions at each of the supervising or subsidiary stations and all repeater station radio transmitting and receiving equipment; verify receipt of correct signals at the supervising station:<br>(1) RF transmitter in use (radiating)<br>(2) AC power failure supplying the radio equipment<br>(3) RF receiver malfunction<br>(4) Indication of automatic switchover |
| (e) Radio alarm supervising station receiver (RASSR) and radio alarm repeater station receiver (RARSR) | X | Monthly | Cause each of the following conditions at each of the supervising or subsidiary stations and all repeater station radio transmitting and receiving equipment; verify receipt of correct signals at the supervising station:<br>(1) AC power failure supplying the radio equipment<br>(2) RF receiver malfunction<br>(3) Indication of automatic switchover, if applicable |
| (f) Private microwave radio systems | X | Monthly | Cause each of the following conditions at each of the supervising or subsidiary stations and all repeater station radio transmitting and receiving equipment; verify receipt of correct signals at the supervising station:<br>(1) RF transmitter in use (radiating)<br>(2) AC power failure supplying the radio equipment<br>(3) RF receiver malfunction<br>(4) Indication of automatic switchover |
| (g) Performance-based technologies | X | Monthly | Perform tests to ensure the monitoring of integrity of the transmission technology and technology path.<br>Where a single communications path is used, disconnect the communication path. Verify that failure of the path is annunciated at the supervising station within 60 minutes of the failure (within 5 minutes for communication equipment installed prior to adoption of the 2013 edition of *NFPA 72*). Restore the communication path.<br>Where multiple communication paths are used, disconnect both communication paths and confirm that failure of the path is annunciated at the supervising station within not more than 6 hours of the failure (within 24 hours for communication equipment installed prior to adoption of the 2013 edition of *NFPA 72*). Restore both communication paths. |

*(continues)*

**Table 14.4.3.2** ***Continued***

| Component | Initial Acceptance | Periodic Frequency | Method |
|---|---|---|---|
| 28. Public emergency alarm reporting system transmission equipment | | | |
| (a) Publicly accessible alarm box | X | Semiannually | Actuate publicly accessible initiating device(s) and verify receipt of not less than three complete rounds of signal impulses. Perform this test under normal circuit conditions. If the device is equipped for open circuit operation (ground return), test it in this condition as one of the semiannual tests. |
| (b) Auxiliary box | X | Annually | Test each initiating circuit of the auxiliary box by actuation of a protected premises initiating device connected to that circuit. Verify receipt of not less than three complete rounds of signal impulses. |
| (c) Master box | | | |
| (1) Manual operation | X | Semiannually | Perform the tests prescribed for 28(a). |
| (2) Auxiliary operation | X | Annually | Perform the tests prescribed for 28(b). |
| 29. Low-power radio (wireless systems) | X | N/A | The following procedures describe additional acceptance and reacceptance test methods to verify wireless protection system operation:<br>(1) Use the manufacturer's published instructions and the as-built drawings provided by the system supplier to verify correct operation after the initial testing phase has been performed by the supplier or by the supplier's designated representative.<br>(2) Starting from the functional operating condition, initialize the system in accordance with the manufacturer's published instructions. Confirm the alternative communications path exists between the wireless control unit and peripheral devices used to establish initiation, indication, control, and annunciation. Test the system for both alarm and trouble conditions.<br>(3) Check batteries for all components in the system monthly unless the control unit checks all batteries and all components daily. |
| 30. Mass notification systems | | | |
| (a) Functions | X | Annually | At a minimum, test control equipment to verify correct receipt of alarm, supervisory, and trouble signals (inputs); operation of evacuation signals and auxiliary functions (outputs); circuit supervision, including detection of open circuits and ground faults; and power supply supervision for detection of loss of ac power and disconnection of secondary batteries. |
| (b) Fuses | X | Annually | Verify the rating and supervision. |
| (c) Interfaced equipment | X | Annually | Verify integrity of single or multiple circuits providing interface between two or more control units. Test interfaced equipment connections by operating or simulating operation of the equipment being supervised. Verify signals required to be transmitted at the control unit. |
| (d) Lamps and LEDs | X | Annually | Illuminate lamps and LEDs. |
| (e) Primary (main) power supply | X | Annually | Disconnect all secondary (standby) power and test under maximum load, including all alarm appliances requiring simultaneous operation. Reconnect all secondary (standby) power at end of test. For redundant power supplies, test each separately. |
| (f) Audible textual notification appliances (speakers and other appliances to convey voice messages) | X | Annually | Measure sound pressure level with a sound level meter meeting ANSI S1.4a, *Specifications for Sound Level Meters,* Type 2 requirements. Measure and record levels throughout protected area. Set the sound level meter in accordance with ANSI S3.41, *American National Standard Audible Evacuation Signal,* using the time-weighted characteristic F (FAST). Record the maximum output when the audible emergency evacuation signal is on.<br>Verify audible information to be distinguishable and understandable. |
| (g) Visible | X | Annually | Perform test in accordance with manufacturer's published instructions. Verify appliance locations to be per approved layout and confirm that no floor plan changes affect the approved layout. Verify that the candela rating marking agrees with the approved drawing. Confirm that each appliance flashes. |
| (h) Control unit functions and no diagnostic failures are indicated | X | Annually | Review event log file and verify that the correct events were logged. Review system diagnostic log file; correct deficiencies noted in file. Delete unneeded log files. Delete unneeded error files. Verify that sufficient free disk space is available. Verify unobstructed flow of cooling air is available. Change/clean filters, cooling fans, and intake vents. |
| (i) Control unit reset | X | Annually | Power down the central control unit computer and restart it. |
| (j) Control unit security | X | Annually | If remote control software is loaded onto the system, verify that it is disabled to prevent unauthorized system access. |
| (k) Audible/visible functional test | X | Annually | Send out an alert to a diverse set of predesignated receiving devices and confirm receipt. Include at least one of each type of receiving device. |

**Table 14.4.3.2** ***Continued***

| Component | Initial Acceptance | Periodic Frequency | Method |
|---|---|---|---|
| (l) Software backup | X | Annually | Make full system software backup. Rotate backups based on accepted practice at site. |
| (m) Secondary power test | X | Annually | Disconnect ac power. Verify the ac power failure alarm status on central control equipment. With ac power disconnected, verify battery voltage under load. |
| (n) Wireless signals | X | Annually | Check forward/reflected radio power is within specifications. |
| (o) Antenna | X | Annually | Check forward/reflected radio power is within specifications. Verify solid electrical connections with no observable corrosion. |
| (p) Transceivers | X | Annually | Verify proper operation and mounting is not compromised. |

[a] Some transmission equipment (such as but not limited to cable modems, fiber-optic interface nodes, and VoIP interfaces) are typically powered by the building's electrical system using a secondary (standby) power supply that does not meet the requirements of this Code. This is intended to ensure that the testing authority verifies full secondary (standby) power as required by Chapter 10. Additionally, refer to Table 14.4.3.2, items 7 through 9, for secondary (standby) power supply testing.

[b] The automatic transmission of the check-in (handshake) signal can take up to 60 minutes to occur.

[c] See Table 14.4.3.2, Item 4(a) for the testing of transmission equipment.

[d] Example: $4000\ \text{mAh} \times \frac{1}{25} = 160\ \text{mA}$ charging current at 77°F (25°C).

[e] The voltmeter sensitivity has been changed from 1000 ohms per volt to 100 ohms per volt so that the false ground readings (caused by induced voltages) are minimized.

[f] Initiating devices such as smoke detectors used for elevator recall, closing dampers, or releasing doors held in the open position that are permitted by the Code *(see* NFPA *101 9.6.3)* to initiate supervisory signals at the fire alarm control unit (FACU) should be tested at the same frequency (annual) as those devices when they are generating an alarm signal. They are not supervisory devices, but they initiate a supervisory signal at the FACU.

[g] Fusible thermal link detectors are commonly used to close fire doors and fire dampers. They are actuated by the presence of external heat, which causes a solder element in the link to fuse, or by an electric thermal device, which, when energized, generates heat within the body of the link, causing the link to fuse and separate.

[h] Note, it is customary for the manufacturer of the smoke detector to test a particular product from an aerosol provider to determine acceptability for use in smoke entry testing of their smoke detector/ smoke alarm. Magnets are not acceptable for smoke entry tests.

[i] There are some detectors that use magnets as a manufacturer's calibrated sensitivity test instrument.

[j] For example, it might not be possible to individually test the heat sensor in a thermally enhanced smoke detector.

[k] Manufacturer's instructions should be consulted to ensure a proper operational test. No suppression gas or agent is expected to be discharged during the test of the solenoid. See Test Plan of 14.2.10.

[l] Testing of CO device should be done to the requirements of NFPA 720.

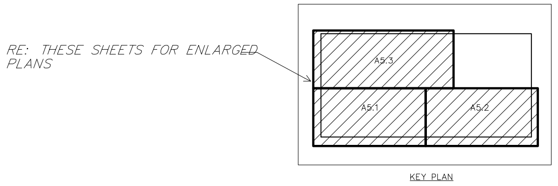
[m] A monitor module installed on an interface device is not considered a supervisory device and therefore not subject to the quarterly testing frequency requirement. Test frequencies for interface devices should be in accordance with the applicable standard. For example, fire pump controller alarms such as phase reversal are required to be tested annually. If a monitor module is installed to identify phase reversal on the fire alarm control panel, it is not necessary to test for phase reversal four times a year.

[n] Chapter 18 would require 15 dB over average ambient sound for public mode spaces. Sometimes the ambient sound levels are different from what the design was based upon. Private operating mode would require 10 dB over average ambient at the location of the device.

[o] Where building, system, or occupancy changes have been observed, the owner should be notified of the changes. New devices might need to be installed and tested per the initial acceptance testing criteria.

[p] See A.14.4.3.2, and Table 14.4.3.2, Item 24.

# APPENDIX K – OCCUPANT EGRESS PLANS



SEE CALCULATIONS IN APPENDIX B FOR STAIR LOADING CALCULATIONS AND OTHER DETAILS

| SPACE NAME |
|---|
| FLOOR AREA( SF) |
| OCC. LOAD FACTOR/OCC. LOAD |

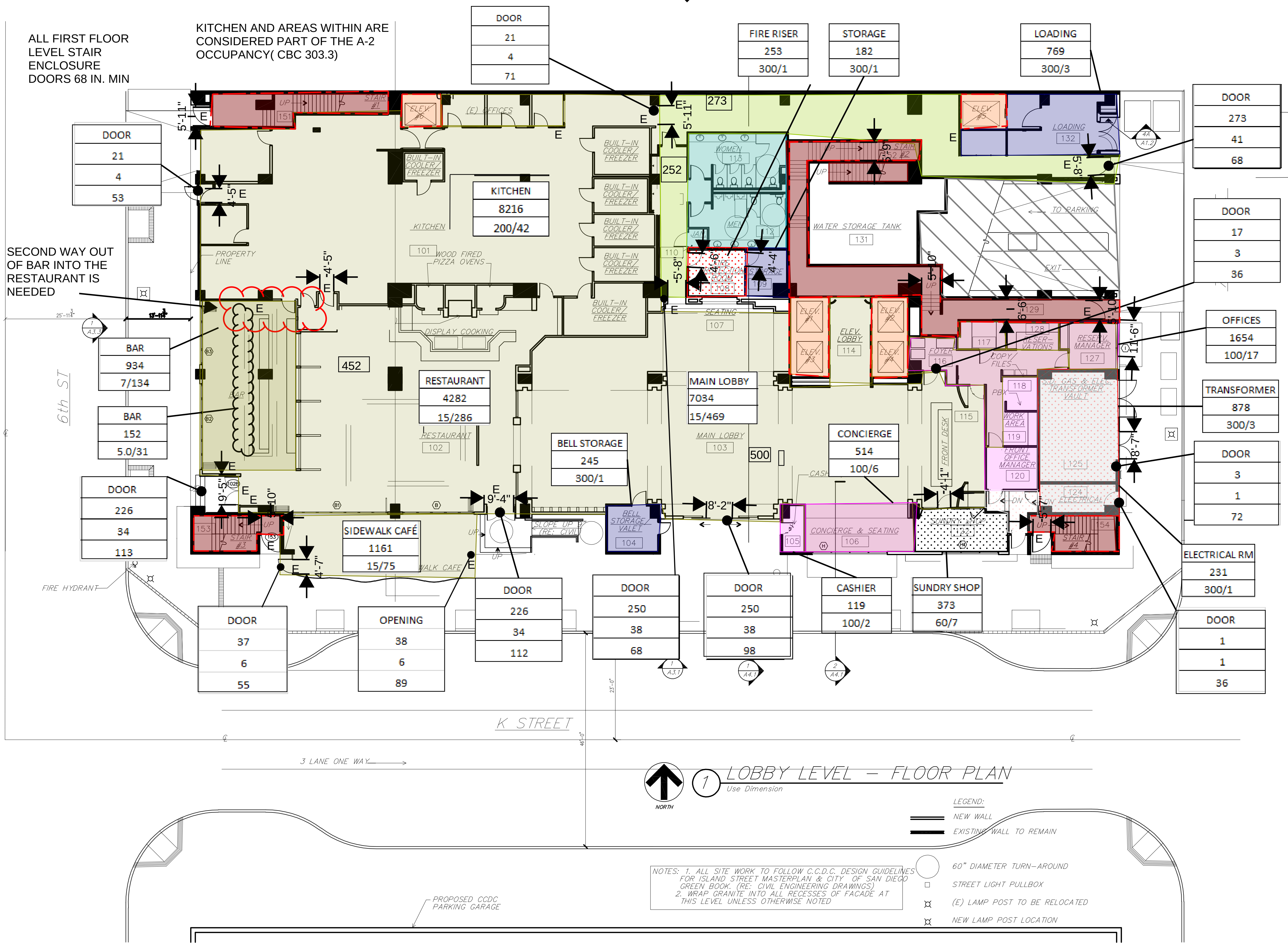
| DOOR OR STAIR |
|---|
| OCC. LOAD |
| REQUIRED WIDTH |
| PROVIDED WIDTH |

E=EXIT SIGN

EL =LOW LEVEL EXIT SIGN

| EGRESS ELEMENTS | COLOR |
|---|---|
| STAIRS ( 2 HR RATED) | 🟥 |
| STAIRS ( NON-RATED) | ▨ |
| CORRIDORS (1HR RATED) | 🟦 |
| CORRIDORS (NON- RATED) | 🟩 |
| EXIT PASSAGEWAYS( 2 HR RATED) | 🟥 |
| OTHER 2 HR RATED SHAFTS | 🟧 |

| OCCUPANCY | COLOR |
|---|---|
| A-2 | ▩ |
| A-2(BAR) | ▩ |
| A-3 | ▨ |
| B | 🟪 |
| F-1 | ▦ |
| M | ▦ |
| R-1 | ▩ |
| S-2 | 🟦 |



# 1 LOBBY LEVEL — FLOOR PLAN

Use Dimension

LEGEND:

NEW WALL

EXISTING WALL TO REMAIN

60" DIAMETER TURN-AROUND

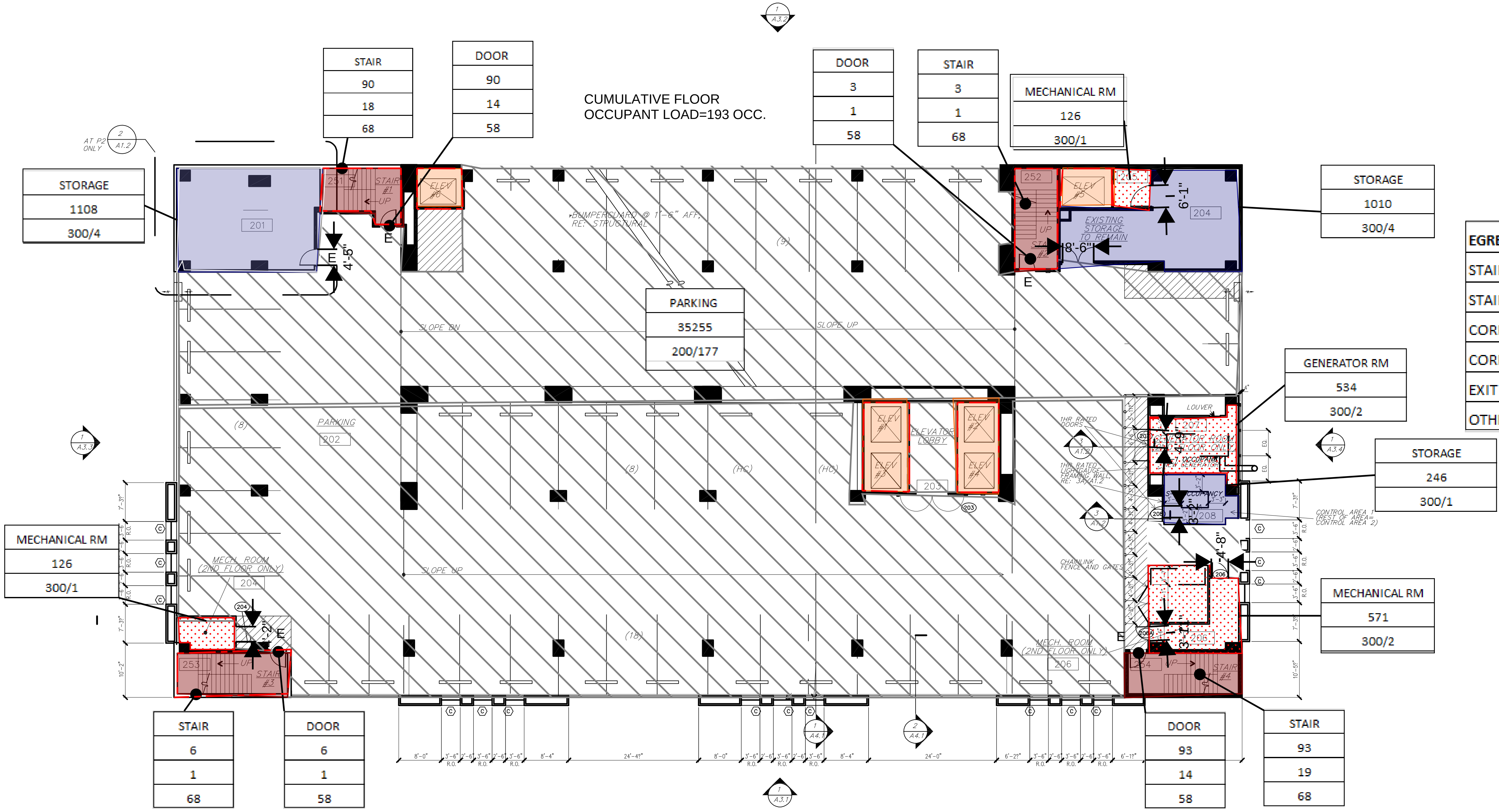
STREET LIGHT PULLBOX

(E) LAMP POST TO BE RELOCATED

NEW LAMP POST LOCATION

NOTES: 1. ALL SITE WORK TO FOLLOW C.C.D.C. DESIGN GUIDELINES FOR ISLAND STREET MASTERPLAN & CITY OF SAN DIEGO GREEN BOOK. (RE: CIVIL ENGINEERING DRAWINGS)
2. WRAP GRANITE INTO ALL RECESSES OF FACADE AT THIS LEVEL UNLESS OTHERWISE NOTED

A1.1



# 1 TYPICAL PARKING LEVELS 2ND–6TH

Use Dimension

NOTE: MECHANICAL EQUIPMENT SPACES AT NORTH EAST AND SOUTHEAST CORNERS VARY FROM ONE PARKING LEVEL TO THE OTHER.

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| ○ | 60" DIAMETER TURN–AROUND |

NORTH

| |
|---|
| SPACE NAME |
| FLOOR AREA( SF) |
| OCC. LOAD FACTOR/OCC. LOAD |

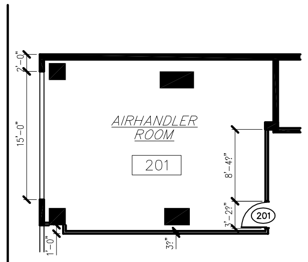
| |
|---|
| DOOR OR STAIR |
| OCC. LOAD |
| REQUIRED WIDTH |
| PROVIDED WIDTH |

| EGRESS ELEMENTS | COLOR |
|---|---|
| STAIRS ( 2 HR RATED) | 🟥 |
| STAIRS ( NON-RATED) | ▨ |
| CORRIDORS (1HR RATED) | 🟦 |
| CORRIDORS (NON- RATED) | 🟩 |
| EXIT PASSAGEWAYS( 2 HR RATED) | 🟥 |
| OTHER 2 HR RATED SHAFTS | 🟧 |

E=EXIT SIGN

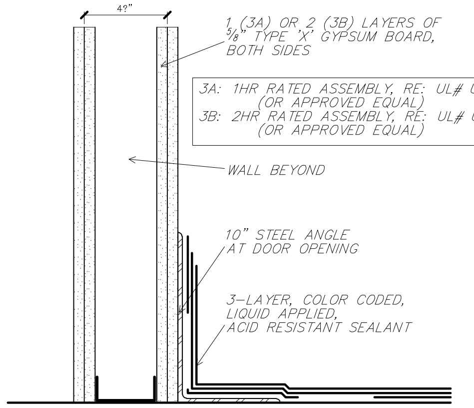
EL =LOW LEVEL EXIT SIGN

| OCCUPANCY | COLOR |
|---|---|
| A-2 | ▢ |
| A-2(BAR) | ▢ |
| A-3 | ▨ |
| B | 🟪 |
| F-1 | ▦ |
| M | ▦ |
| R-1 | ▢ |
| S-2 | 🟦 |
| PARKING GARAGE S-2 | ▨ |



## 2 CORNER AT P2

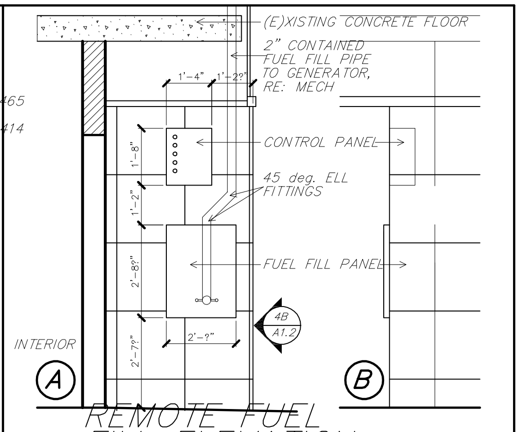
?" = 1'-0"



3A: 1HR RATED ASSEMBLY, RE: UL# U465 (OR APPROVED EQUAL)
3B: 2HR RATED ASSEMBLY, RE: UL# U414 (OR APPROVED EQUAL)

## 3 THRESHOLD DETAIL

3" = 1'-0"

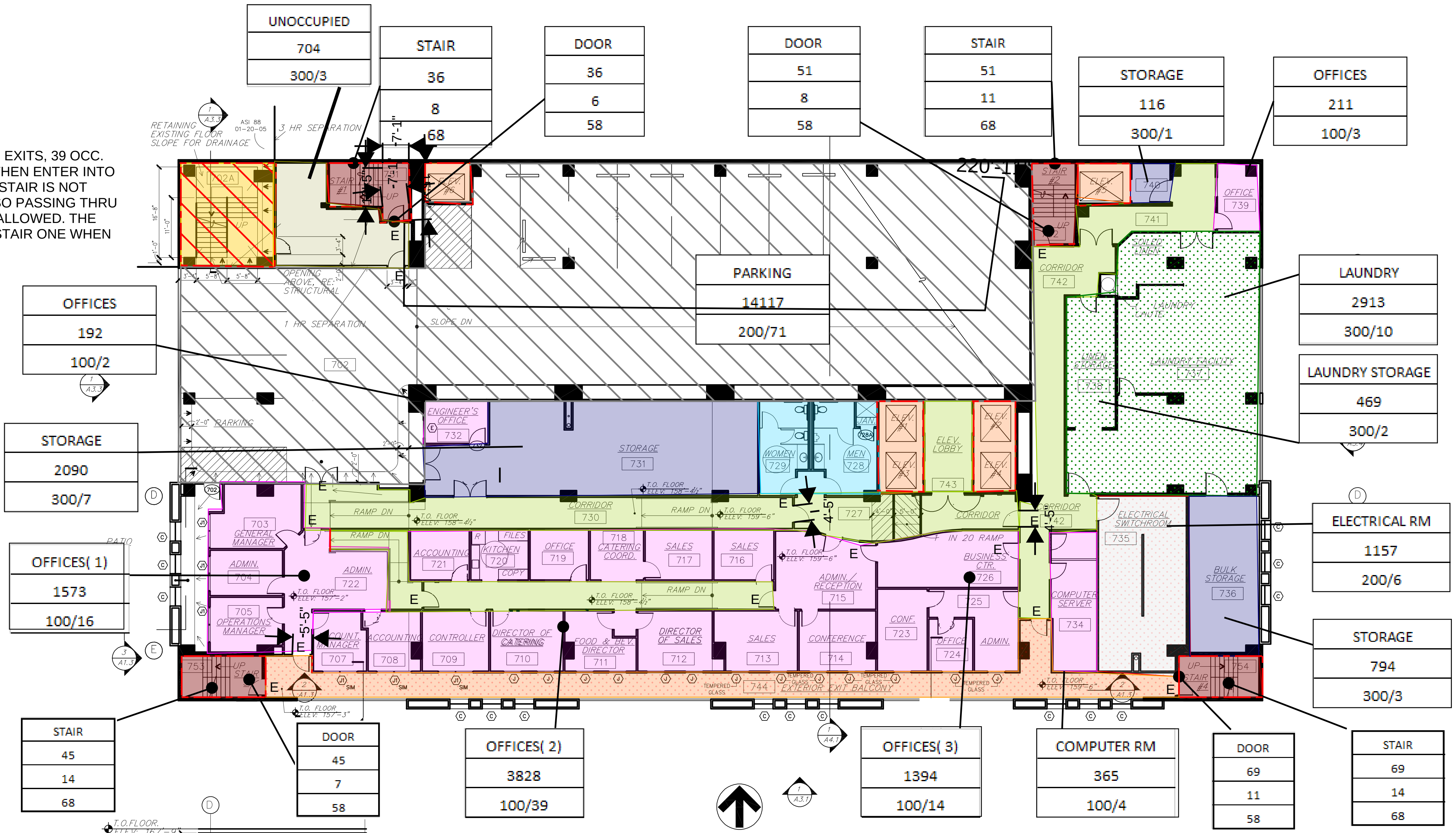


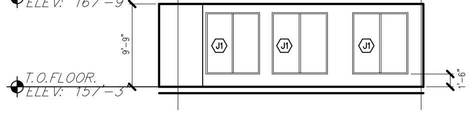
## 4 REMOTE FUEL FILL ELEVATION

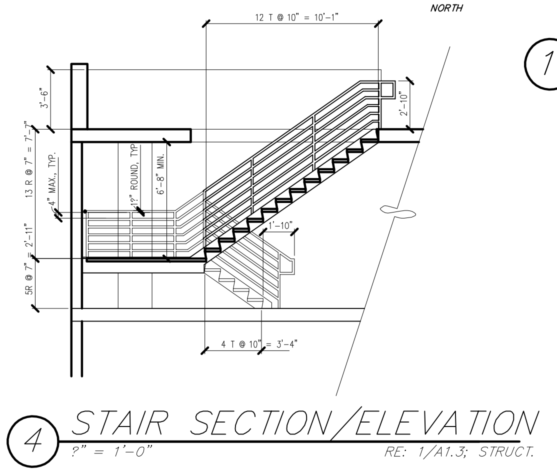
?" = 1'-0"

A1.2

WHEN THE EIGHTH FLOOR EXITS, 39 OCC. COME DOWN THIS STAIR THEN ENTER INTO STAIR 1. THE TWO STORY STAIR IS NOT REQUIRED TO BE RATED SO PASSING THRU THE ADJACENT SPACE IS ALLOWED. THE OCCUPANT IS ADDED TO STAIR ONE WHEN THE 8TH FLOOR EXITS.







④ STAIR SECTION/ELEVATION

?" = 1'-0"

RE: 1/A1.3; STRUCT.

## ① SEVENTH FLOOR — PROPOSED PLAN

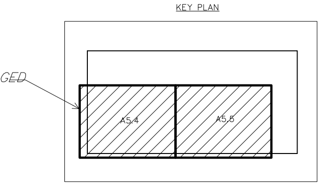
Use Dimension

EXISTING OVERALL PARKING COUNT:
277 TOTAL PARKING STALLS
34 ACCESSIBLE PARKING STALLS
15 EXISTING STALLS, INCLUDING 2 ACCESSIBLE, LOST.

PROPOSED PARKING COUNT REDUCTION:
18 EXISTING STALLS, INCLUDING 2 ACCESSIBLE, LOST.

LEGEND:
NEW WALL
EXISTING WALL TO REMAIN
60" DIAMETER TURN-AROUND

RE: THESE SHEETS FOR ENLARGED PLANS



SPACE NAME
FLOOR AREA( SF)
OCC. LOAD FACTOR/OCC. LOAD

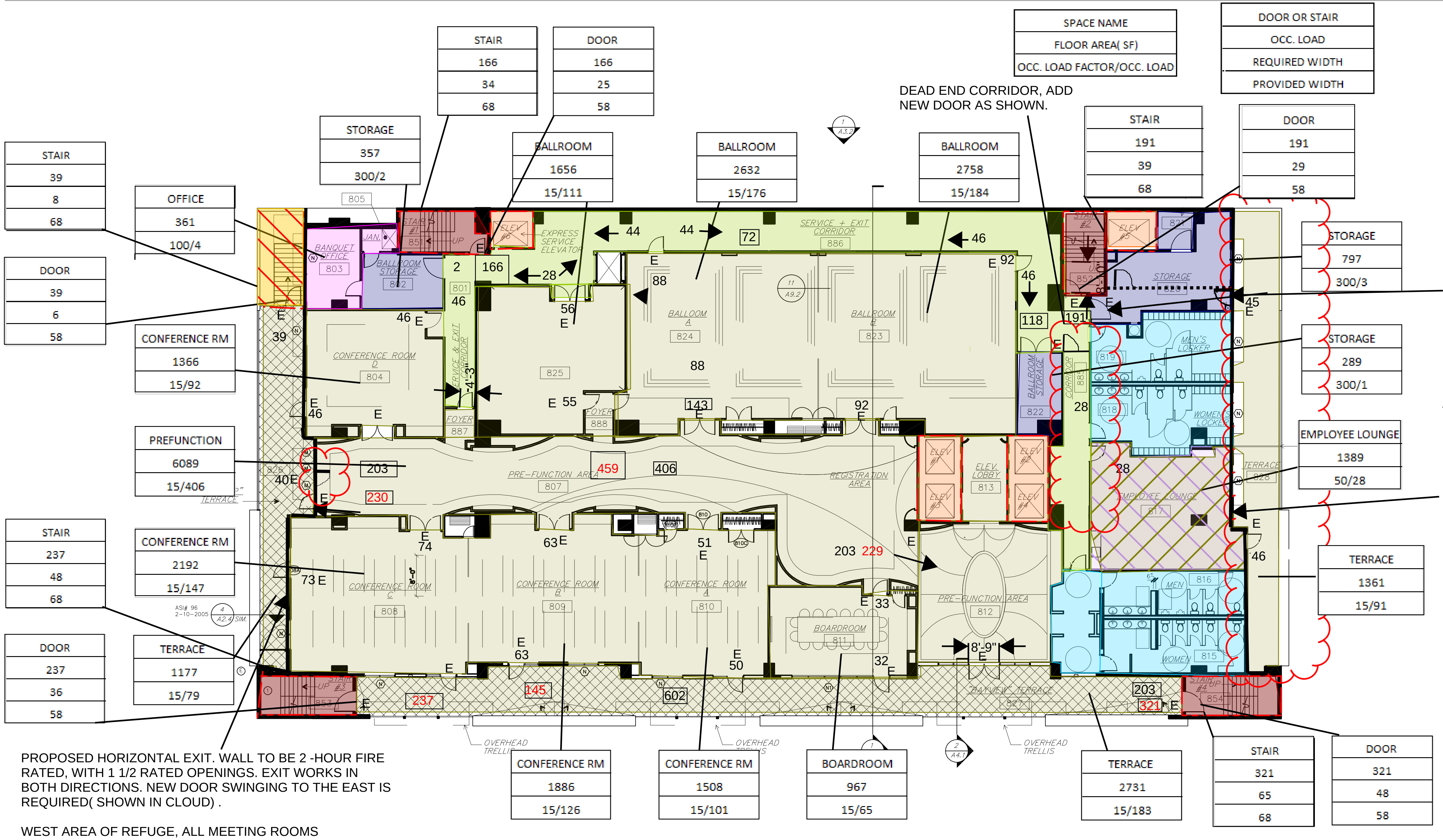
DOOR OR STAIR
OCC. LOAD
REQUIRED WIDTH
PROVIDED WIDTH

E=EXIT SIGN
EL =LOW LEVEL EXIT SIGN

| EGRESS ELEMENTS | COLOR |
|---|---|
| STAIRS ( 2 HR RATED) | 🟥 |
| STAIRS ( NON-RATED) | ▨ |
| CORRIDORS (1HR RATED) | 🟦 |
| CORRIDORS (NON- RATED) | 🟩 |
| EXIT PASSAGEWAYS( 2 HR RATED) | 🟥 |
| OTHER 2 HR RATED SHAFTS | 🟧 |

| OCCUPANCY | COLOR |
|---|---|
| A-2 | ⬜ |
| A-2(BAR) | 🟨 |
| A-3 | ▨ |
| B | 🟪 |
| F-1 | ░ |
| M | ░ |
| R-1 | 🟪 |
| S-2 | 🟦 |
| PARKING GARAGE S-2 | ▨ |

A1.3



# EIGHTH FLOOR (CONFERENCE LEVEL) – PROPOSED PLAN

Use Dimension

LEGEND:

═ NEW WALL – MINIMUM 54 STC RATING (1 HR RATED)

▬ EXISTING WALL TO REMAIN

○ 60" DIAMETER TURN-AROUND

PROPOSED HORIZONTAL EXIT. WALL TO BE 2 -HOUR FIRE RATED, WITH 1 1/2 RATED OPENINGS. EXIT WORKS IN BOTH DIRECTIONS. NEW DOOR SWINGING TO THE EAST IS REQUIRED( SHOWN IN CLOUD) .

WEST AREA OF REFUGE, ALL MEETING ROOMS OCCUPIED, 349 OCC. 1047 SF NEEDED, 1177 SF PROVIDED.
PREFUNCTION OCCUPIED, 203 OCC. 609 SF NEEDED, 1177 SF PROVIDED.
EAST AREA OF REFUGE, 50% OF TERRACE LOAD SENT EAST( THUR NEW DOOR) 40 OCC. 120 SF NEEDED, 6089 SF PROVIDED.

| EGRESS ELEMENTS | COLOR |
|---|---|
| STAIRS ( 2 HR RATED) | 🟥 |
| STAIRS ( NON-RATED) | ▨ |
| CORRIDORS (1HR RATED) | 🟦 |
| CORRIDORS (NON- RATED) | 🟩 |
| EXIT PASSAGEWAYS( 2 HR RATED) | 🟥 |
| OTHER 2 HR RATED SHAFTS | 🟧 |

ADD NEW DOOR(36 IN ) AND CORRIDOR. REVERSE SWING OF WEST DOOR OUT OF CORRIDOR.

LOADING THE EMPLOYEE LOUNGE AT 15 SF PER OCC. IS EXCESSIVE( 93 OCC.). EMPLOYEES TAKE BREAKS IN SHIFTS. 50 SF PER OCC. IS PROPOSED. WILL REQUIRE AHJ APPROVAL.

THE TERRACE NEEDS TWO EXITS( 1361 SF/ 15= 91 OCC.). ONE IS PROVIDED. A HORIZONTAL EXIT IS PROPOSED. WALL TO BE 2 -HOUR FIRE RATED, WITH 1 1/2 RATED OPENINGS. IN ADDITION, A NEW NORTH EXIT WILL BE PROVIDED. 50%(45) OF THE OCCUPANTS WILL TRAVEL TO THE NORTH AND EXIT OUT THROUGH A NEW CORRIDOR AND INTO STAIR 2. 50%(46) OF THE OCCUPANTS WILL TRAVEL TO THE SOUTH AND THUR THE EXISTING DOOR INTO THE AREA OF REFUGE IN THE EMPLOYEE LOUNGE. DOOR SWING WILL NEED TO BE REVERSED. THE AREA OF REFUGE IS REQUIRED TO BE 138 SF IN SIZE( 46 X 3 SF PER OCC).

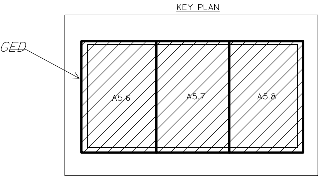
ASSUME PREFUNCTION IS NOT OCCUPIED SIMULTANEOUSLY WITH BALLROOMS/CONFERENCE ROOMS.
EGRESS MUST WORK FOR EACH CASE:
ALL MEETING ROOMS OCCUPIED=459 OCCUPANTS
PREFUNCTION OCCUPIED= 406 OCCUPANTS

XX =CUMULATIVE OCCUPANT LOAD

| OCCUPANCY | COLOR |
|---|---|
| A-2 | ⬜ |
| A-2(BAR) | ⬜ |
| A-3 | ▨ |
| B | 🟪 |
| F-1 | ▨ |
| M | ▨ |
| R-1 | ⬜ |
| S-2 | 🟦 |

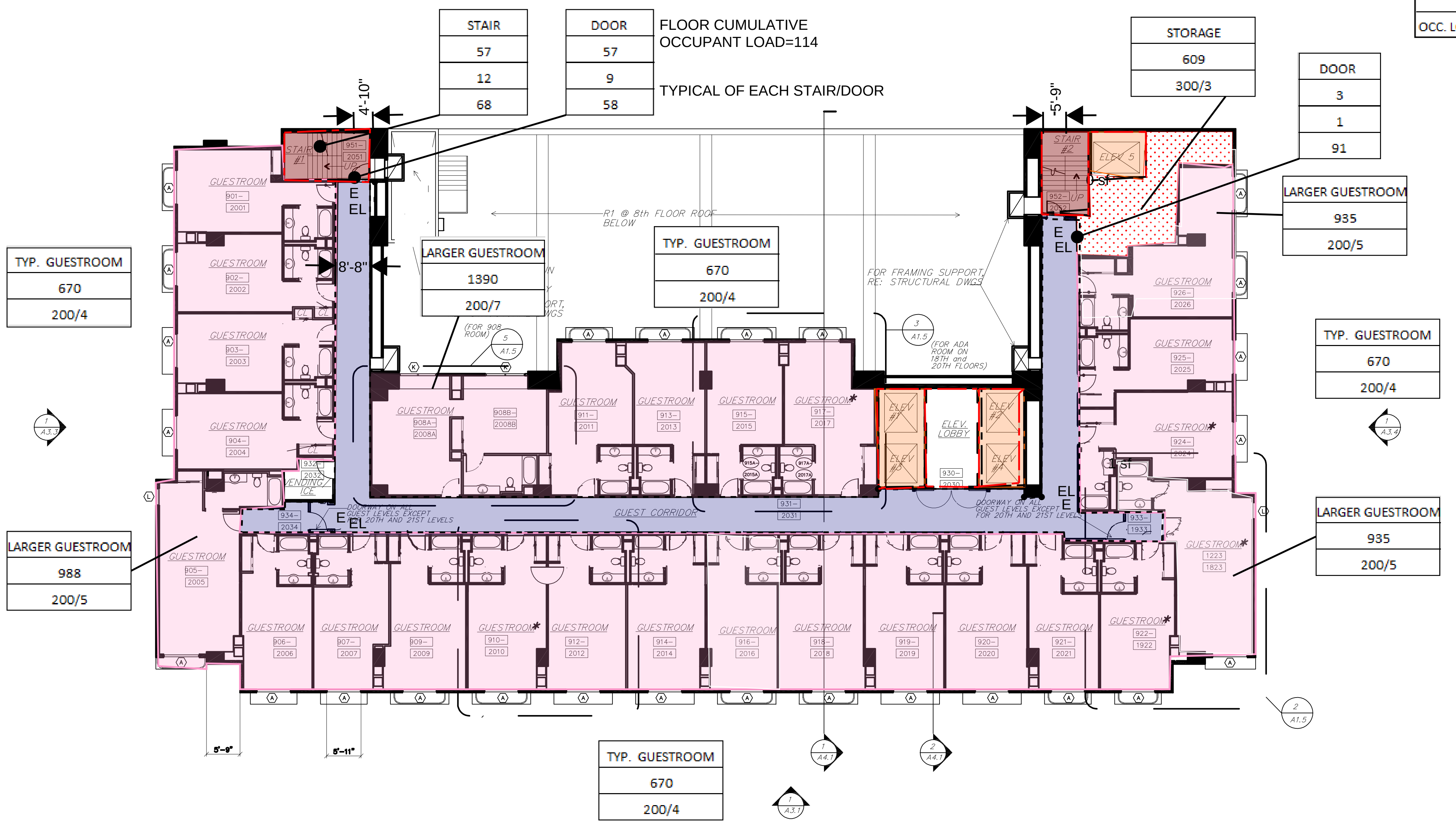
E=EXIT SIGN
EL =LOW LEVEL EXIT SIGN

RE: THESE SHEETS FOR ENLARGED PLANS



A1.4

13 MAY 2004



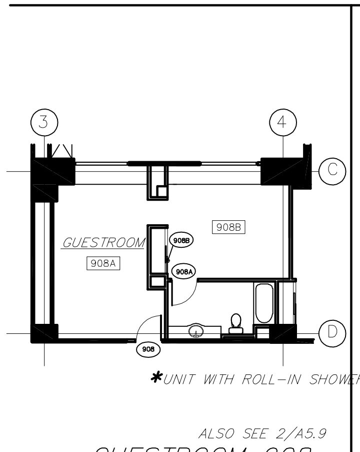
| SPACE NAME |
|---|
| FLOOR AREA( SF) |
| OCC. LOAD FACTOR/OCC. LOAD |

| DOOR OR STAIR |
|---|
| OCC. LOAD |
| REQUIRED WIDTH |
| PROVIDED WIDTH |

| EGRESS ELEMENTS | COLOR |
|---|---|
| STAIRS ( 2 HR RATED) | 🟫 |
| STAIRS ( NON-RATED) | ▨ |
| CORRIDORS (1HR RATED) | 🟪 |
| CORRIDORS (NON- RATED) | 🟩 |
| EXIT PASSAGEWAYS( 2 HR RATED) | 🟫 |
| OTHER 2 HR RATED SHAFTS | 🟧 |

E=EXIT SIGN
EL =LOW LEVEL EXIT SIGN

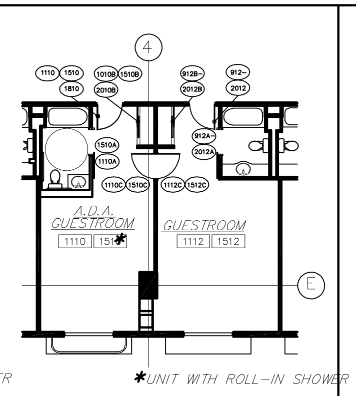
| OCCUPANCY | COLOR |
|---|---|
| A-2 | ⬜ |
| A-2(BAR) | 🟨 |
| A-3 | ▨ |
| B | 🟪 |
| F-1 | ▦ |
| M | ▦ |
| R-1 | 🟪 |
| S-2 | 🟦 |



ALSO SEE 2/A5.9

GUESTROOM 908

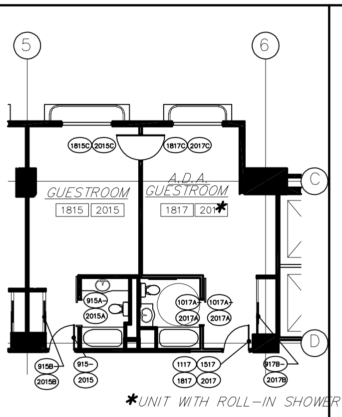
?" = 1'-0" RE: 1/A1.5



ALSO SEE 3/A5.10

ADA GUESTROOMS

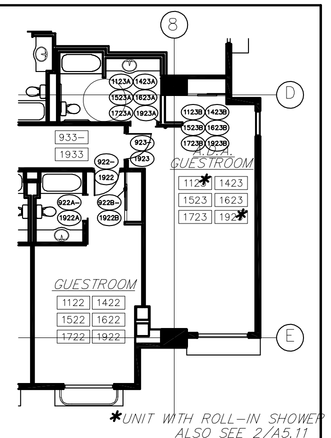
?" = 1'-0" RE: 1/A1.5



ALSO SEE 2/A5.10

ADA GUESTROOMS

?" = 1'-0" RE: 1/A1.5



ALSO SEE 2/A5.11

ADA GUESTROOMS

?" = 1'-0" RE: 1/A1.5

NORTH

# TYPICAL GUESTROOM FLOOR PLAN (9th–12th & 14th–20thFLOORS)

Use Dimension NOTE: THERE IS NO 13th FLOOR

NOTE 1: GUESTROOM LAYOUTS BASED ON ORIGINAL CONSTRUCTION DOCUMENTS. SPACES HAVE NOT BEEN CONFIRMED BY RECENT OBSERVATION.

NOTE 2: NUMBER OF GUESTROOMS: 321 PLUS CLUB LEVEL LOUNGE

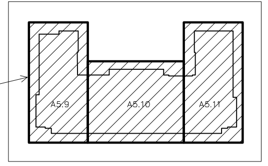
NOTE 3: ADA COMPLIANT GUESTROOMS LOCATED ON ELEVENTH, FIFTEENTH, EIGHTEENTH, AND TWENTY-FIRST FLOORS.

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| * | ROOMS WITH VISUAL ALARMS ON SELECT LEVELS (SEE SHEET A0.0) |
| ○ | 60" DIAMETER TURN-AROUND |

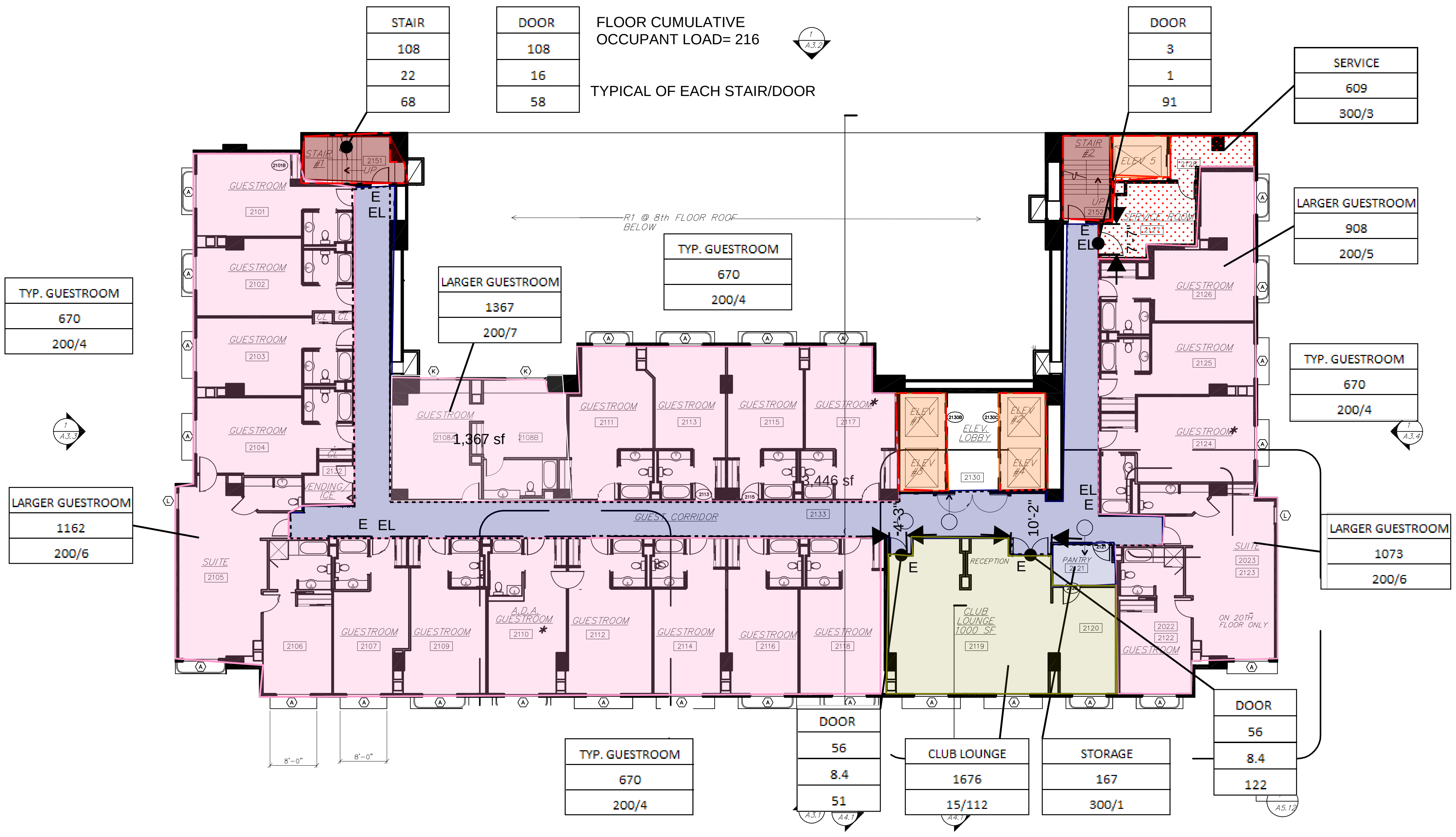
RE: THESE SHEETS FOR ENLARGED PLANS

KEY PLAN



A1.5

NORTH



| SPACE NAME |
|---|
| FLOOR AREA( SF) |
| OCC. LOAD FACTOR/OCC. LOAD |

| DOOR OR STAIR |
|---|
| OCC. LOAD |
| REQUIRED WIDTH |
| PROVIDED WIDTH |

| EGRESS ELEMENTS | COLOR |
|---|---|
| STAIRS ( 2 HR RATED) | 🟫 |
| STAIRS ( NON-RATED) | ▨ |
| CORRIDORS (1HR RATED) | 🟦 |
| CORRIDORS (NON- RATED) | 🟩 |
| EXIT PASSAGEWAYS( 2 HR RATED) | 🟫 |
| OTHER 2 HR RATED SHAFTS | 🟧 |

| OCCUPANCY | COLOR |
|---|---|
| A-2 | ⬜ |
| A-2(BAR) | 🟨 |
| A-3 | ▨ |
| B | 🟪 |
| F-1 | ░ |
| M | ░ |
| R-1 | ⬜ |
| S-2 | 🟦 |

E=EXIT SIGN
EL =LOW LEVEL EXIT SIGN

NORTH

## 1 CLUB LEVEL (21st FLOOR)

Use Dimension

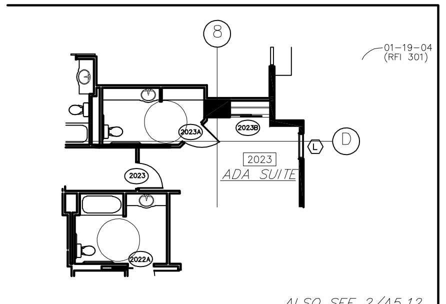
NOTE 1: GUESTROOM LAYOUTS BASED ON ORIGINAL CONSTRUCTION DRAWINGS. SPACES HAVE NOT BEEN CONFIRMED BY RECENT OBSERVATION.

NOTE 2: NUMBER OF GUESTROOMS: 321 PLUS CLUB LEVEL LOUNGE

NOTE 3: NEW ADA COMPLIANT GUESTROOM NOT SHOWN

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| * | ROOMS WITH VISUAL ALARMS ON SELECT LEVELS (SEE SHEET A0.0) |
| ○ | 60" DIAMETER TURN-AROUND |

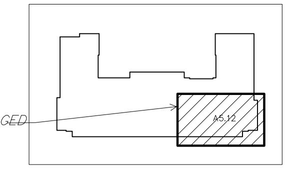


ALSO SEE 2/A5.12

## 2 BATHROOM @ 20TH FLOOR

?" = 1'-0"

KEY PLAN



RE: THESE SHEET FOR ENLARGED PLANS

A1.6

# APPENDIX L – OCCUPANT EGRESS CALCULATIONS

| ROOM NO. | DESCRIPT. | DESCRIPTION | OCCUPANCY | SIZE | OCCUPANT LOAD FACTOR | OCCUPANTS |
|---|---|---|---|---|---|---|
| 702 | PARKING | PARKING | S-2 | 14117 | 200 | 71 |
| 703 | OFFICES | BUSINESS | B | 369 | 100 | 4 |
| 704 | | BUSINESS | B | 244 | 100 | 3 |
| 705 | | BUSINESS | B | 273 | 100 | 3 |
| 722 | | BUSINESS | B | 605 | 100 | 6 |
| SUBTOTAL GROUP 1 | | TOTAL | B | 1573 | | 16 |
| 707 | | BUSINESS | B | 230 | 100 | 3 |
| 708 | | BUSINESS | B | 252 | 100 | 3 |
| 709 | | BUSINESS | B | 301 | 100 | 4 |
| 710 | | BUSINESS | B | 322 | 100 | 4 |
| 711 | | BUSINESS | B | 323 | 100 | 4 |
| 712 | | BUSINESS | B | 341 | 100 | 4 |
| 713 | | BUSINESS | B | 354 | 100 | 4 |
| 714 | | BUSINESS | B | 355 | 100 | 4 |
| 715 | | BUSINESS | B | 527 | 100 | 5 |
| 716 | | BUSINESS | B | 214 | 100 | 3 |
| 717 | | BUSINESS | B | 246 | 100 | 3 |
| 718 | | BUSINESS | B | 192 | 100 | 2 |
| 719 | | BUSINESS | B | 218 | 100 | 3 |
| 720 | | BUSINESS | B | 214 | 100 | 3 |
| 721 | | BUSINESS | B | 221 | 100 | 3 |
| SUBTOTAL GROUP 2 | | TOTAL | | 3828 | | 52 |
| 723 | | BUSINESS | B | 321 | 100 | 4 |
| 724 | | BUSINESS | B | 167 | 100 | 2 |
| 725 | | BUSINESS | B | 363 | 100 | 4 |
| 726 | | BUSINESS | B | 543 | 100 | 6 |
| SUBTOTAL GROUP 3 | | TOTAL | | 1394 | | 16 |
| 31 | | STORAGE | S-2 | 2090 | 300 | 7 |
| 32 | | BUSINESS | B | 192 | 100 | 2 |
| 33 | | STORAGE | S-2 | 91 | 300 | 1 |
| 34 | | COMPUTER ROOM | B | 365 | 100 | 4 |
| 35 | | ELECTRICAL SWITCHGEAR | F-1 | 1157 | 200 | 6 |
| 36 | | STORAGE | S-2 | 794 | 300 | 3 |
| 37 | | LAUNDRY | F-1 | 2913 | 300 | 10 |
| 38 | | LAUNDRY STORAGE | S-2 | 469 | 300 | 2 |

| FLOOR | EXIT PATH | TOTAL OCC. | FLOORR AREA SF | TOTAL OCC. PER FLOOR | REQED STAIR ENTRY DOOR WIDTH (IN.) | PROVD STAIR ENTRY DOOR WIDTH (IN.) | REQD STAIR WIDTH (IN.) | PROVD STAIR WIDTH (IN.) | REQD GROUND LEVEL EXIT DOOR WIDTH (IN.) | PROVD GROUND LEVEL EXIT DOOR WIDTH (IN.) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | FROM FLOOR | 1015 | 26209 | 1015 | 153 | 552 | **NA** | | | |
| | FROM BLDG | | | | | | **NA** | | | |
| 2-6 Typ. | FROM FLOOR | 193 | 38976 | 193 | 28.95 | 232 | 38.6 | 272 | | |
| | FROM BLDG | 193 | | 193 | | | 38.6 | 272 | 28.95 | 272 |
| 7 | FROM FLOOR | 201 | 37129 | 201 | 30.15 | 232 | 40.2 | 272 | | |
| | FROM BLDG | 185 | | 185 | | | 37 | 272 | 30.15 | 272 |
| 8 | FROM FLOOR | 915 | 41026 | 909 | 137.25 | 232 | 183 | 340 | | |
| | FROM BLDG | 915 | | 909 | | | 183 | 272 | 137.25 | 272 |
| 9-12,14-20 | FROM FLOOR | 113 | 19650 | 113 | 16.95 | 232 | 22.6 | 272 | | |
| | FROM BLDG | 113 | | 113 | | | 22.6 | 272 | 16.95 | 272 |
| 21 | FROM FLOOR | 216 | 19629 | 216 | 32.4 | 232 | 43.2 | 272 | | |
| | FROM BLDG | 216 | | 216 | | | 43.2 | 272 | 32.4 | 272 |

Table A1: Occupant Egress Calculation Summary (Repeated from the body of the report for reader convenience)

| FLOOR NO. | OCCUPANTS PER FLOOR | FLOOR AREA | REQUIRED NO. OF EXITS | PROVIDED NO. OF EXITS |
|---|---|---|---|---|
| 1 | 1015 | 26209 | 4 | 8 |
| 2 | 193 | 38976 | 2 | 4 |
| 3 | 193 | 38976 | 2 | 4 |
| 4 | 193 | 38976 | 2 | 4 |
| 5 | 193 | 38976 | 2 | 4 |
| 6 | 193 | 38976 | 2 | 4 |
| 7 | 201 | 37129 | 2 | 4 |
| 8 | 915 | 41206 | 3 | 5 |
| 9 | 113 | 19659 | 2 | 2 |
| 10 | 113 | 19659 | 2 | 2 |
| 11 | 113 | 19659 | 2 | 2 |
| 12 | 113 | 19659 | 2 | 2 |
| 14 | 113 | 19659 | 2 | 2 |
| 15 | 113 | 19659 | 2 | 2 |
| 16 | 113 | 19659 | 2 | 2 |
| 17 | 113 | 19659 | 2 | 2 |
| 18 | 113 | 19659 | 2 | 2 |
| 19 | 113 | 19659 | 2 | 2 |
| 20 | 113 | 19659 | 2 | 2 |
| 21 | 216 | 19629 | 2 | 2 |
| TOTAL | 4555 | 535302 |  |  |

Table A2: Summary of Floor Occupancy and Required Number of Exits (Repeated from the body of the report for reader convenience)

| ROOM NO. | DESCRIPTION | OCCUPANCY | SIZE | OCCUPANT LOAD FACTOR (SQ./OCC) | GROSS OR NET | OCCUPANTS | ROUND UP | NOTES | EXIT CAPACITY FACTOR | REQD EXIT WIDTH (IN) | PRVD EXIT WIDTH (IN) | NUMBER EXITS REQD | NUMBER EXITS PRVD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | KITCHEN | A-2 | 8216 | 200 | G | 41.08 | 42 | | 0.15 | 6.3 | 124 | | 2 |
| 102 | RESTAURANT | A-2 | 4282 | 15 | N | 285.47 | 286 | | 0.15 | 42.9 | 225 | 2 | 2 |
| | BAR SPACE | A-2 | 934 | 7 | N | 133.43 | 134 | 934 SPACE AREA- BAR AND SPACE BEHIND. SECOND DOOR IS NEEDED INTO THE RESTAURANT | 0.15 | 20.1 | | 2 | 1 |
| | STANDING AT BAR | A-2 | 152 | 5 | N | 30.40 | 31 | STANDING AT BAR | 0.15 | 4.65 | | 2 | 1 |
| 103 | MAIN LOBBY | A-2 | 7034 | 15 | N | 468.93 | 469 | | 0.15 | 70.35 | 166 | 2 | 2 |
| 106 | CONCIERGE | B | 514 | 100 | N | 5.14 | 6 | | 0.15 | 0.9 | 96 | 1 | 1 |
| 122 | SUNDRY SHOP | M | 373 | 60 | G | 6.22 | 7 | | 0.15 | 1.05 | 49 | 1 | 1 |
| 104 | BELL STORAGE | S-2 | 245 | 300 | G | 0.82 | 1 | | 0.15 | 0.15 | 42 | 1 | 2 |
| 132 | LOADING | S-2 | 769 | 300 | G | 2.56 | 3 | | 0.15 | 0.45 | 108 | 1 | 1 |
| 109 | STORAGE | S-2 | 182 | 300 | G | 0.61 | 1 | | 0.15 | 0.15 | 52 | 1 | 1 |
| 108 | FIRE RISER | S-2 | 253 | 300 | G | 0.84 | 1 | | 0.15 | 0.15 | 54 | 1 | 1 |
| 105 | CASHIER | B | 119 | 100 | N | 1.19 | 2 | | 0.15 | 0.3 | 36 | 1 | 1 |
| 125 | TRANSFORMER VAULT | F-1 | 878 | 300 | G | 2.93 | 3 | | 0.15 | 0.45 | 103 | 1 | 1 |
| 124 | ELECTRICAL ROOM | F-1 | 231 | 300 | N | 0.77 | 1 | | 0.15 | 0.15 | 36 | 1 | 1 |
| 122 | SUNDRY SHOP | M | 373 | 60 | G | 6.22 | 7 | | 0.15 | 1.05 | 49 | 1 | 1 |
| 116 | OFFICES | B | 719 | 100 | G | 7.19 | 8 | | 0.15 | 1.2 | | 1 | 1 |
| 117 | OFFICES | B | 126 | 100 | G | 1.26 | 1 | | 0.15 | 0.15 | | 1 | 1 |
| 118 | OFFICES | B | 112 | 100 | G | 1.12 | 2 | | 0.15 | 0.3 | | 1 | 1 |
| 119 | OFFICES | B | 112 | 100 | G | 1.12 | 2 | | 0.15 | 0.3 | | 1 | 1 |
| 120 | OFFICES | B | 206 | 100 | G | 2.06 | 3 | | 0.15 | 0.45 | | 1 | 1 |
| 127 | OFFICES | B | 239 | 100 | G | 2.39 | 3 | | 0.15 | 0.45 | | 1 | 1 |
| 128 | OFFICES | B | 140 | 100 | G | 1.40 | 2 | | 0.15 | 0.3 | | 1 | 1 |
| OFFICES | | | | | | 16.54 | 17 | | 0.15 | 3.15 | 36 | 1 | 1 |
| TOTAL | | | 26209 | | | | 1015.00 | | 0.15 | 152.25 | 565 | | |
| PATIO | SIDEWALK CAFÉ | A-2 | 1161 | 15 | N | 77.40 | 75 | | 0.15 | 11.25 | 144 | 2 | 2 |

Table A3: First Floor Occupant Loading Calculations

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| 9 |  | BUSINESS | B | 211 | 100 | 3 |
| 40 |  | STORAGE | S-2 | 116 | 300 | 1 |
| 51A |  | SPACE NEAR STAIR 751 | B | 624 | 100 | 7 |
| SUBTOTAL |  |  |  |  |  | 46 |
| TOTAL |  |  |  | 37129 |  | 201 |

Table A4: 7th Floor Egress Details

| STAIR NO. | OCCUPANT ORIGIN | NO. OCC. | REQ. DOOR WIDTH(IN.) | PROVIDED DOOR WIDTH (IN.) | REQ. STAIR WIDTH(IN.) | PROVIDED STAIR WIDTH(IN.) |
|---|---|---|---|---|---|---|
| 1 | 702 | 36 | 7.2 | 58 | 5.4 | 68 |
| TOTAL | | 36 | 7.2 | 58 | 5.4 | 68 |
| | | | | | | |
| 2 | 702 | 35 | 5.25 | 58 | 7 | 68 |
| | 734 | 2 | 0.3 | | 0.4 | |
| | 735 | 2 | 0.3 | | 0.4 | |
| | 736 | 3 | 0.45 | | 0.6 | |
| | 737 | 5 | 0.75 | | 1 | |
| | 738 | 1 | 0.15 | | 0.2 | |
| | 739 | 2 | 0.3 | | 0.4 | |
| | 740 | 1 | 0.15 | | 0.2 | |
| TOTAL | | 51 | 7.65 | 58 | 10 | 68 |
| 3 | GROUP 1 | 8 | 1.6 | | | |
| | GROUP 2 | 25 | 5 | | | |
| | GROUP 3 | 7 | 1.4 | | | |
| | 731 | 4 | 0.8 | | | |
| | 732 | 1 | 0.2 | | | |
| TOTAL | | 45 | 6.75 | | 9 | |
| 4 | GROUP 1 | 8 | | | | |
| | GROUP 2 | 27 | | | | |
| | GROUP 3 | 9 | | | | |
| | 734 | 2 | | | | |
| | 735 | 2 | | | | |
| | 736 | 3 | | | | |
| | 731 | 3 | | | | |
| | 732 | 1 | | | | |
| | 737 | 5 | | | | |
| | 738 | 1 | | | | |
| | 739 | 1 | | | | |
| | 740 | 1 | | | | |
| TOTAL | | 69 | 10 | 58 | 13.8 | 68 |

Table A 5: 7th Floor Occupant Dispersion Calculations

| ROOM NO. | DESCRIPTION | OCCUPANCY | SIZE | OCCUPANT LOAD FACTOR | GROSS OR NET | OCCUPANTS | ROUND UP |
|---|---|---|---|---|---|---|---|
| 804 | CONFERENCE ROOM D | A-2 | 1366 | 15 | G | 91.07 | 92 |
| 808 | CONFERENCE ROOM C | A-2 | 2192 | 15 | G | 146.13 | 147 |
| 809 | CONFERENCE ROOM B | A-2 | 1886 | 15 | G | 125.73 | 126 |
| 810 | CONFERENCE ROOM A | A-2 | 1508 | 15 | G | 100.53 | 101 |
| 811 | BOARDROOM | A-2 | 967 | 15 | G | 64.47 | 65 |
| 812 | PREFUNCTION | A-2 | 6089 | 15 | G | 405.93 | 406 |
| 817 | EMPLOYEE LOUNGE | A-3 | 1389 | 15 | G | 92.60 | 93 |
| 823 | BALLROOM B | A-2 | 2758 | 15 | G | 183.87 | 184 |
| 824 | BALLROOM A | A-2 | 2632 | 15 | G | 175.47 | 176 |
| 825 | BALLROOM C | A-2 | 1656 | 15 | G | 110.40 | 111 |
| 802 | BALLROOM STORAGE | S-2 | 357 | 300 | N | 1.19 | 2 |
| 803 | BANQUET OFFICE | B | 361 | 100 | N | 3.61 | 4 |
| 822 | BALLROOM STORAGE | S-2 | 298 | 300 | N | 0.99 | 1 |
| 820 | STORAGE | S-2 | 797 | 300 | N | 2.66 | 3 |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| 826 | BAYVIEW TERRACE | A-2 | 1177 | 15 | N | 78.47 | 79 |
| 827 | BAYVIEW TERRACE | A-2 | 2731 | 15 | N | 182.07 | 183 |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  | MOVEABLE PARTION COMBINATIONS |  |  |  |  |  |  |
|  | BALLROOMS A AND B TOGETHER | A-2 | 5390 | 15 | N | 359.33 | 400 |
|  | CONFERENCE ROOMS A AND B TOGETHER | A-2 | 3394 | 15 | N | 226.27 | 227 |
|  | CONFERENCE ROOMS B AND C TOGETHER | A-2 | 4078 | 15 | N | 271.87 | 272 |
| TOTAL |  |  | 41026 |  |  |  |  |

Table A 6: $8^{TH}$ Floor Occupant Loading Calculations

# APPENDIX M – COMPOSITE LIFE SAFETY PLANS

# 1 LOBBY LEVEL — FLOOR PLAN

Use Dimension

LEGEND:

NEW WALL

EXISTING WALL TO REMAIN

○ 60" DIAMETER TURN-AROUND

□ STREET LIGHT PULLBOX

¤ (E) LAMP POST TO BE RELOCATED

¤ NEW LAMP POST LOCATION

NOTES: 1. ALL SITE WORK TO FOLLOW C.C.D.C. DESIGN GUIDELINES FOR ISLAND STREET MASTERPLAN & CITY OF SAN DIEGO GREEN BOOK. (RE: CIVIL ENGINEERING DRAWINGS)
2. WRAP GRANITE INTO ALL RECESSES OF FACADE AT THIS LEVEL UNLESS OTHERWISE NOTED

| | |
|---|---|
| **STRUCTURAL ELEMENTS** | |
| **STAIR ENCLOSURES 2 HR RATED** | 🟥 |
| **STAIR ENCLOSURES NON- RATED** | ▨ |
| **CORRIDORS 1 HR RATED** | 🟪 |
| **CORRIDORS NON-RATED** | 🟩 |
| **EXIT PASSAGEWAYS 2 HR RATED** | 🟥 |
| **OTHER 2 HR RATED SHAFTS** | 🟧 |

**SEE STRUCTURAL DRAWINGS FOR MORE DETAIL**

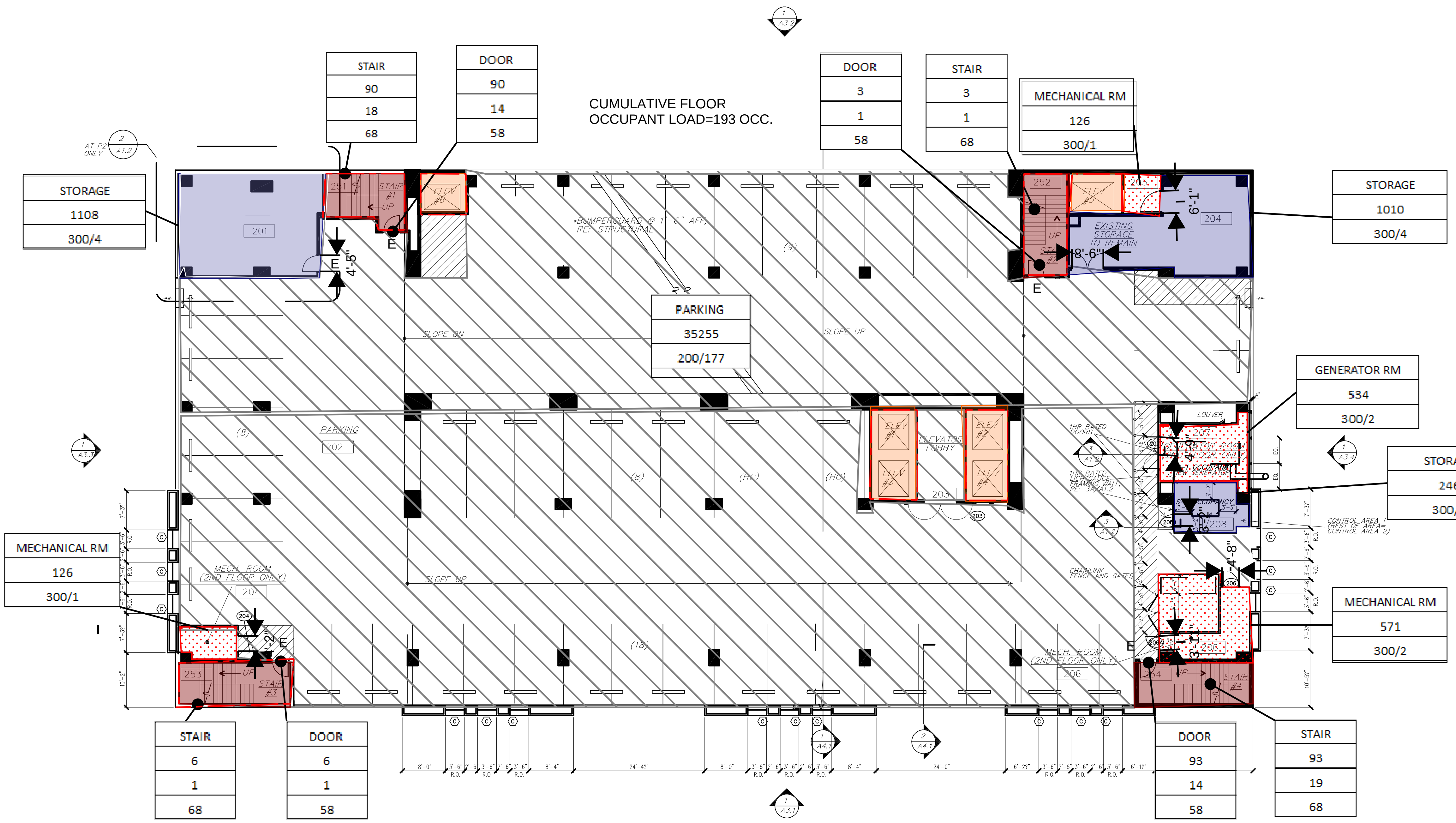
| |
|---|
| DOOR OR STAIR |
| OCC. LOAD |
| REQUIRED WIDTH |
| PROVIDED WIDTH |

| |
|---|
| SPACE NAME |
| FLOOR AREA( SF) |
| OCC. LOAD FACTOR/OCC. LOAD |

■ **POURED IN PLACE REINFORCED CONCRETE COLUMN 3 HR-RATED**

| OCCUPANCY | COLOR |
|---|---|
| A-2 | 🟫 |
| A-2(BAR) | 🟫 |
| A-3 | ▨ |
| B | 🟪 |
| F-1 | ▨ |
| M | ▨ |
| R-1 | 🟪 |
| S-2 | 🟦 |

A1.1



CUMULATIVE FLOOR
OCCUPANT LOAD=193 OCC.

|  |  |
|---|---|
| STRUCTURAL ELEMENTS |  |
| STAIR ENCLOSURES 2 HR RATED | 🟥 |
| STAIR ENCLOSURES NON- RATED | ▨ |
| CORRIDORS 1 HR RATED | 🟦 |
| CORRIDORS NON-RATED | 🟩 |
| EXIT PASSAGEWAYS 2 HR RATED | 🟥 |
| OTHER 2 HR RATED SHAFTS | 🟧 |

**SEE STRUCTURAL DRAWINGS FOR MORE DETAIL**

DOOR OR STAIR
OCC. LOAD
REQUIRED WIDTH
PROVIDED WIDTH

SPACE NAME
FLOOR AREA( SF)
OCC. LOAD FACTOR/OCC. LOAD

| OCCUPANCY | COLOR |
|---|---|
| A-2 | ■ |
| A-2(BAR) | ■ |
| A-3 | ▨ |
| B | 🟪 |
| F-1 | 🟥 |
| M | ▩ |
| R-1 | ■ |
| S-2 | 🟦 |
| PARKING GARAGE S-2 | ▨ |

## 1 TYPICAL PARKING LEVELS 2ND–6TH

Use Dimension

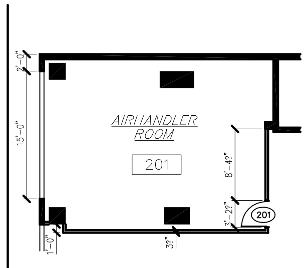
NOTE: MECHANICAL EQUIPMENT SPACES AT NORTH EAST AND SOUTHEAST CORNERS VARY FROM ONE PARKING LEVEL TO THE OTHER.

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| ○ | 60" DIAMETER TURN–AROUND |

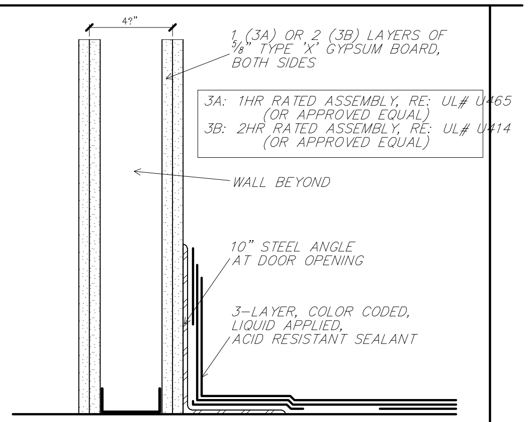
NORTH

■ POURED IN PLACE REINFORCED CONCRETE COLUMN



## 2 CORNER AT P2

?" = 1'–0"



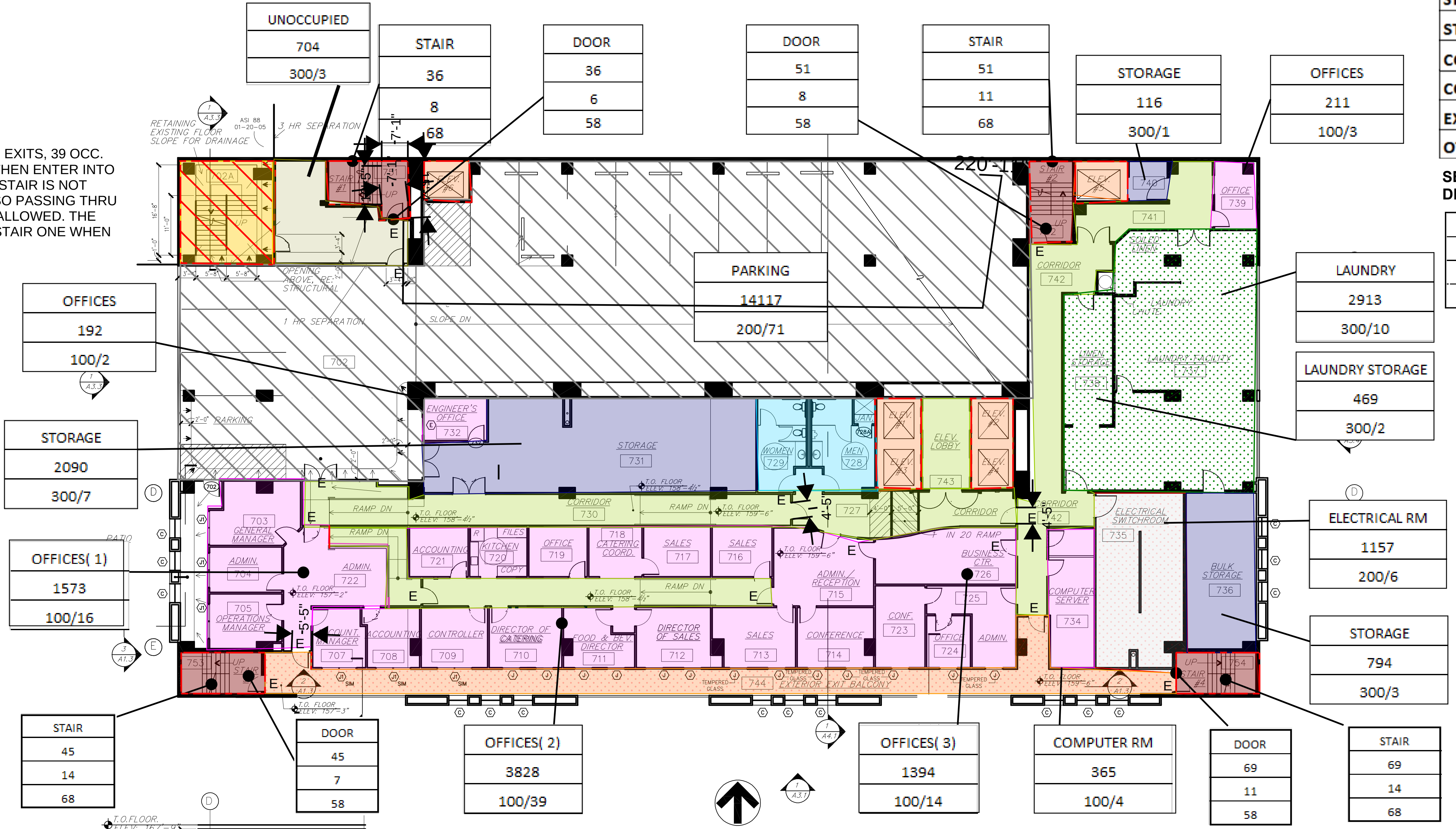
3A: 1HR RATED ASSEMBLY, RE: UL# U465 (OR APPROVED EQUAL)
3B: 2HR RATED ASSEMBLY, RE: UL# U414 (OR APPROVED EQUAL)

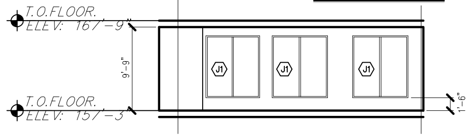
## 3 THRESHOLD DETAIL

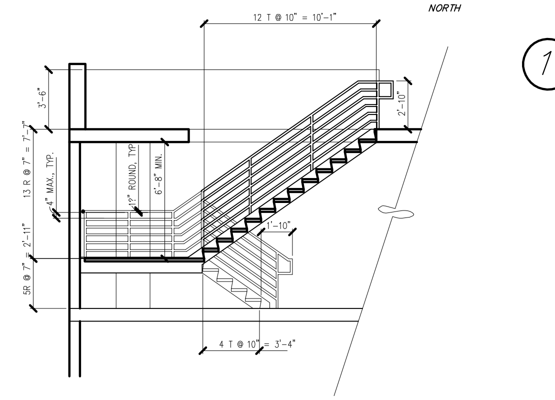
3" = 1'–0"

A1.2

WHEN THE EIGHTH FLOOR EXITS, 39 OCC. COME DOWN THIS STAIR THEN ENTER INTO STAIR 1. THE TWO STORY STAIR IS NOT REQUIRED TO BE RATED SO PASSING THRU THE ADJACENT SPACE IS ALLOWED. THE OCCUPANT IS ADDED TO STAIR ONE WHEN THE 8TH FLOOR EXITS.







4 STAIR SECTION/ELEVATION

?" = 1'-0"    RE: 1/A1.3; STRUCT.

1 SEVENTH FLOOR – PROPOSED PLAN

Use Dimension

EXISTING OVERALL PARKING COUNT:

277 TOTAL PARKING STALLS
34 ACCESSIBLE PARKING STALLS
15 EXISTING STALLS, INCLUDING 2 ACCESSIBLE, LOST.

PROPOSED PARKING COUNT REDUCTION:

18 EXISTING STALLS, INCLUDING 2 ACCESSIBLE, LOST.

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| ○ | 60" DIAMETER TURN-AROUND |

| STRUCTURAL ELEMENTS | |
|---|---|
| STAIR ENCLOSURES 2 HR RATED | 🟥 |
| STAIR ENCLOSURES NON- RATED | ▨ |
| CORRIDORS 1 HR RATED | 🟪 |
| CORRIDORS NON-RATED | 🟩 |
| EXIT PASSAGEWAYS 2 HR RATED | 🟥 |
| OTHER 2 HR RATED SHAFTS | 🟧 |

SEE STRUCTURAL DRAWINGS FOR MORE DETAIL

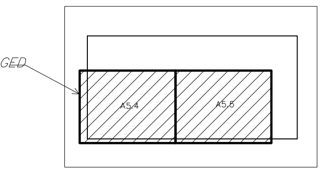
| |
|---|
| DOOR OR STAIR |
| OCC. LOAD |
| REQUIRED WIDTH |
| PROVIDED WIDTH |

| |
|---|
| SPACE NAME |
| FLOOR AREA( SF) |
| OCC. LOAD FACTOR/OCC. LOAD |

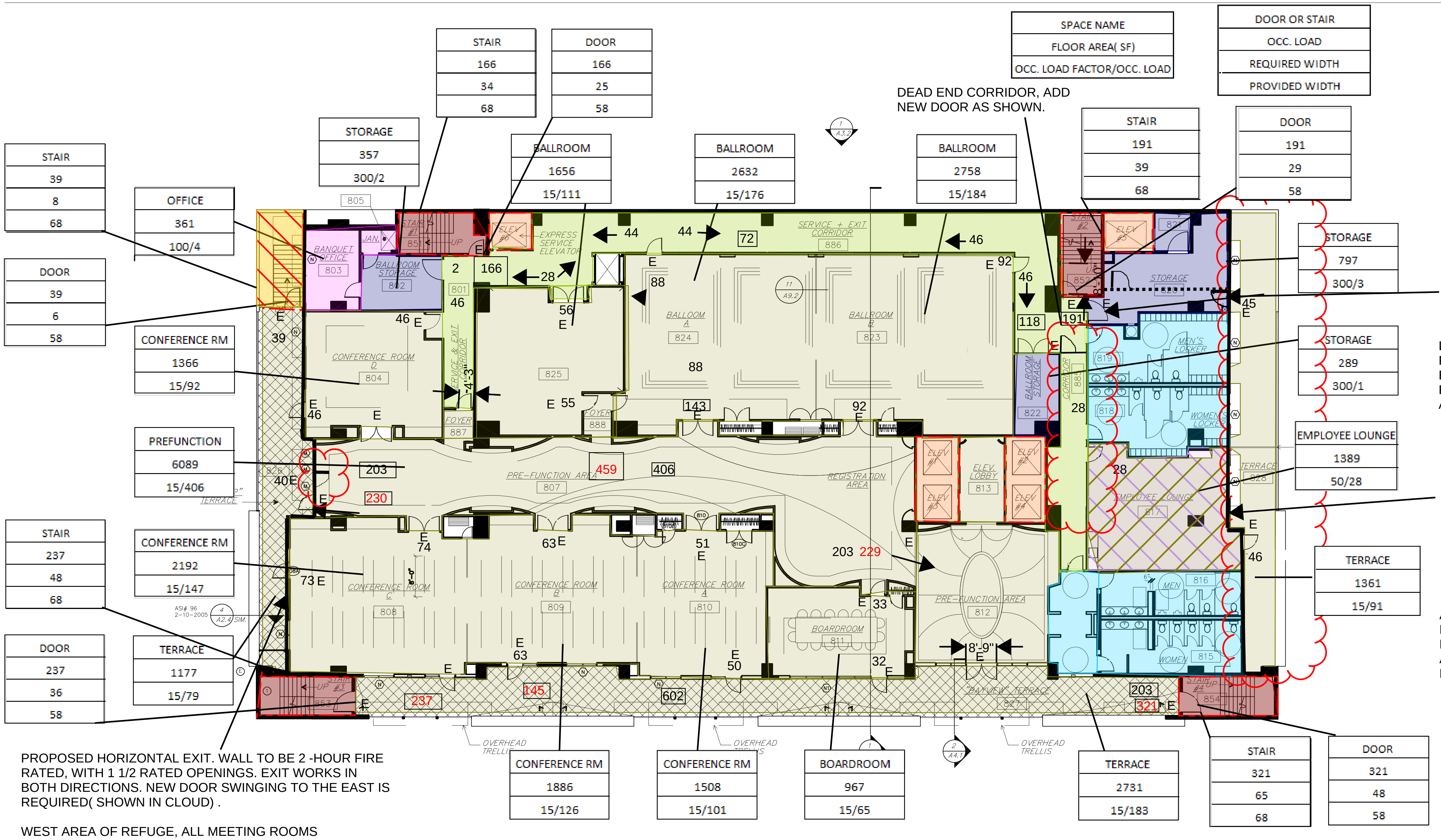
| OCCUPANCY | COLOR |
|---|---|
| A-2 | ⬜ |
| A-2(BAR) | 🟫 |
| A-3 | ▨ |
| B | 🟪 |
| F-1 | ⬚ |
| M | ⬚ |
| R-1 | ⬜ |
| S-2 | 🟪 |
| PARKING GARAGE S-2 | ▨ |

■ POURED IN PLACE REINFORCED CONCRETE COLUMN

KEY PLAN



RE: THESE SHEETS FOR ENLARGED PLANS



PROPOSED HORIZONTAL EXIT. WALL TO BE 2 -HOUR FIRE RATED, WITH 1 1/2 RATED OPENINGS. EXIT WORKS IN BOTH DIRECTIONS. NEW DOOR SWINGING TO THE EAST IS REQUIRED( SHOWN IN CLOUD) .

WEST AREA OF REFUGE, ALL MEETING ROOMS OCCUPIED, 349 OCC. 1047 SF NEEDED, 1177 SF PROVIDED. PREFUNCTION OCCUPIED, 203 OCC. 609 SF NEEDED, 1177 SF PROVIDED.
EAST AREA OF REFUGE, 50% OF TERRACE LOAD SENT EAST( THUR NEW DOOR) 40 OCC. 120 SF NEEDED, 6089 SF PROVIDED.

| STRUCTURAL ELEMENTS | |
|---|---|
| STAIR ENCLOSURES 2 HR RATED | 🟥 |
| STAIR ENCLOSURES NON- RATED | ▨ |
| CORRIDORS 1 HR RATED | 🟦 |
| CORRIDORS NON-RATED | 🟩 |
| EXIT PASSAGEWAYS 2 HR RATED | 🟥 |
| OTHER 2 HR RATED SHAFTS | 🟧 |

SEE STRUCTURAL DRAWINGS FOR MORE DETAIL

ADD NEW DOOR(36 IN ) AND CORRIDOR. REVERSE SWING OF WEST DOOR OUT OF CORRIDOR.

LOADING THE EMPLOYEE LOUNGE AT 15 SF PER OCC. IS EXCESSIVE( 93 OCC.). EMPLOYEES TAKE BREAKS IN SHIFTS. 50 SF PER OCC. IS PROPOSED. WILL REQUIRE AHJ APPROVAL.

THE TERRACE NEEDS TWO EXITS( 1361 SF/ 15= 91 OCC.). ONE IS PROVIDED. A HORIZONTAL EXIT IS PROPOSED. WALL TO BE 2 -HOUR FIRE RATED, WITH 1 1/2 RATED OPENINGS. IN ADDITION, A NEW NORTH EXIT WILL BE PROVIDED. 50%(45) OF THE OCCUPANTS WILL TRAVEL TO THE NORTH AND EXIT OUT THROUGH A NEW CORRIDOR AND INTO STAIR 2. 50%(46) OF THE OCCUPANTS WILL TRAVEL TO THE SOUTH AND THUR THE EXISTING DOOR INTO THE AREA OF REFUGE IN THE EMPLOYEE LOUNGE. DOOR SWING WILL NEED TO BE REVERSED. THE AREA OF REFUGE IS REQUIRED TO BE 138 SF IN SIZE( 46 X 3 SF PER OCC).

ASSUME PREFUNCTION IS NOT OCCUPIED SIMULTANEOUSLY WITH BALLROOMS/CONFERENCE ROOMS.
EGRESS MUST WORK FOR EACH CASE:
ALL MEETING ROOMS OCCUPIED=459 OCCUPANTS
PREFUNCTION OCCUPIED= 406 OCCUPANTS

XX =CUMULATIVE OCCUPANT LOAD

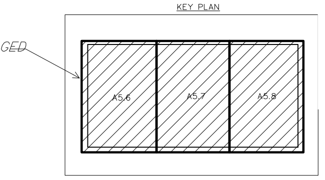
| OCCUPANCY | COLOR |
|---|---|
| A-2 | ▭ |
| A-2(BAR) | ▭ |
| A-3 | ▨ |
| B | 🟪 |
| F-1 | ▒ |
| M | ░ |
| R-1 | ▭ |
| S-2 | 🟦 |

NORTH

1 EIGHTH FLOOR (CONFERENCE LEVEL) – PROPOSED PLAN
Use Dimension

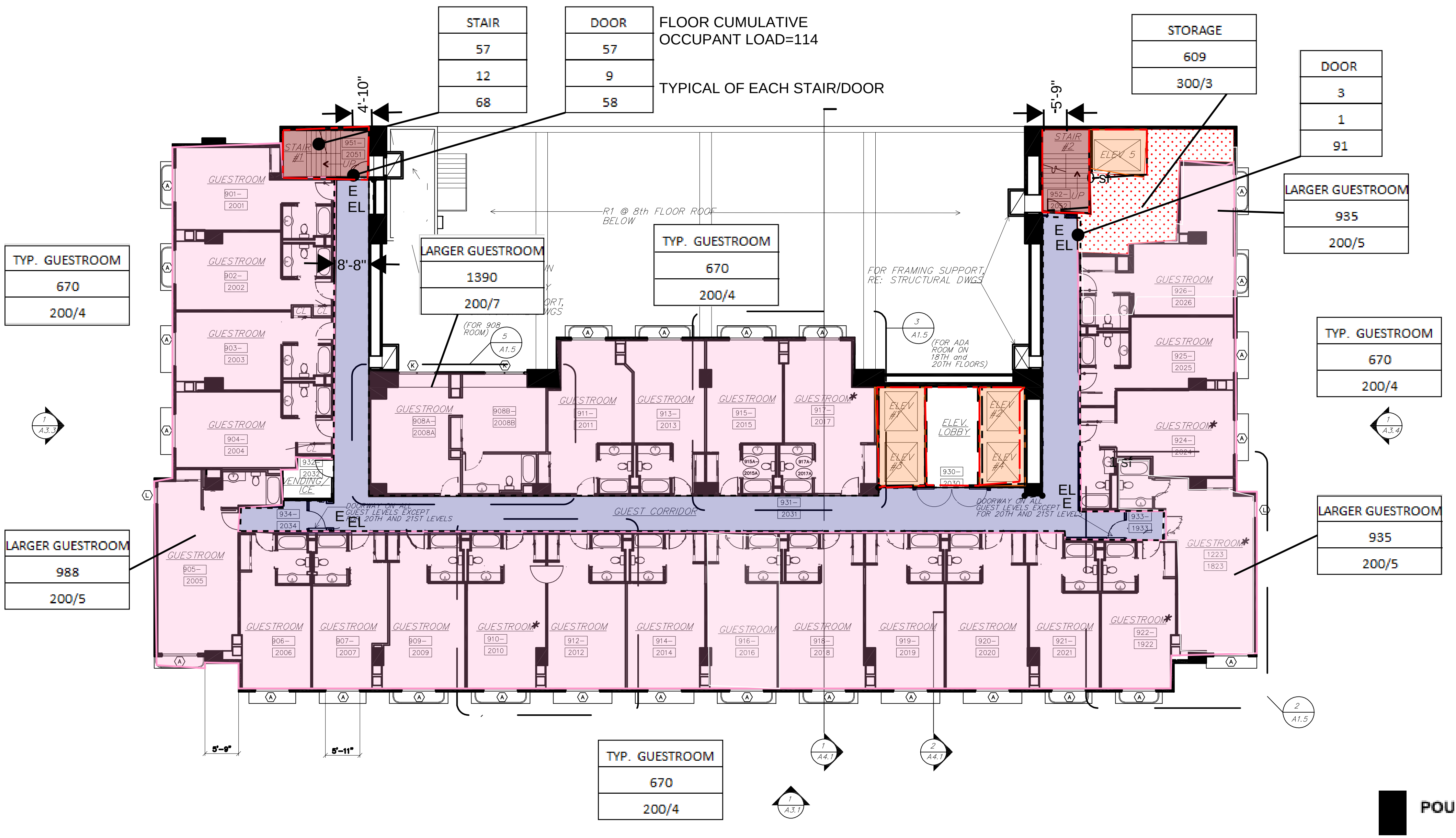
LEGEND:
NEW WALL – MINIMUM 54 STC RATING (1 HR RATED)
EXISTING WALL TO REMAIN
60" DIAMETER TURN-AROUND

RE: THESE SHEETS FOR ENLARGED PLANS



■ POURED IN PLACE REINFORCED CONCRETE COLUMN

13 MAY 2004



| STRUCTURAL ELEMENTS | |
|---|---|
| STAIR ENCLOSURES 2 HR RATED | 🟫 |
| STAIR ENCLOSURES NON- RATED | ▨ |
| CORRIDORS 1 HR RATED | 🟪 |
| CORRIDORS NON-RATED | 🟩 |
| EXIT PASSAGEWAYS 2 HR RATED | 🟫 |
| OTHER 2 HR RATED SHAFTS | 🟧 |

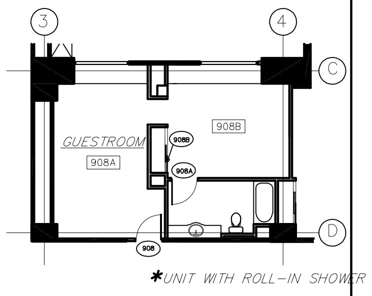
**SEE STRUCTURAL DRAWINGS FOR MORE DETAIL**

DOOR OR STAIR
OCC. LOAD
REQUIRED WIDTH
PROVIDED WIDTH

SPACE NAME
FLOOR AREA( SF)
OCC. LOAD FACTOR/OCC. LOAD

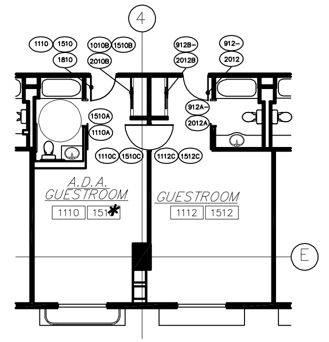
| OCCUPANCY | COLOR |
|---|---|
| A-2 | ⬜ |
| A-2(BAR) | 🟨 |
| A-3 | ▨ |
| B | 🟪 |
| F-1 | ░ |
| M | ░ |
| R-1 | ⬜ |
| S-2 | 🟦 |

■ POURED IN PLACE REINFORCED CONCRETE COLUMN



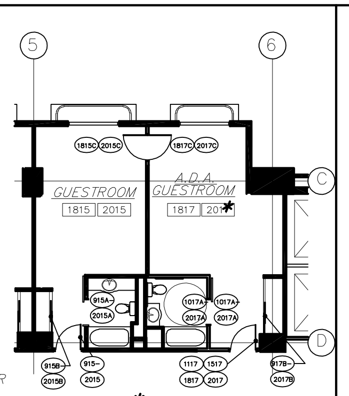
*UNIT WITH ROLL–IN SHOWER

ALSO SEE 2/A5.9
GUESTROOM 908
9" = 1'-0"
RE: 1/A1.5



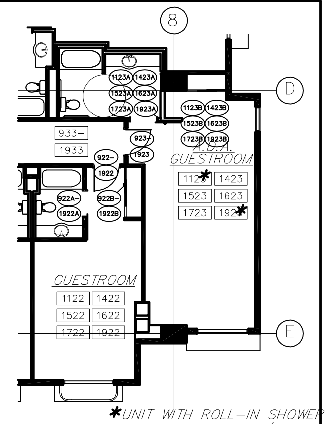
*UNIT WITH ROLL–IN SHOWER

ALSO SEE 3/A5.10
ADA GUESTROOMS
9" = 1'-0"
RE: 1/A1.5



*UNIT WITH ROLL–IN SHOWER

ALSO SEE 2/A5.10
ADA GUESTROOMS
9" = 1'-0"
RE: 1/A1.5



*UNIT WITH ROLL–IN SHOWER
ALSO SEE 2/A5.11
ADA GUESTROOMS
9" = 1'-0"
RE: 1/A1.5

NORTH

## TYPICAL GUESTROOM FLOOR PLAN (9th–12th & 14th–20thFLOORS)

Use Dimension

NOTE: THERE IS NO 13th FLOOR

NOTE 1: GUESTROOM LAYOUTS BASED ON ORIGINAL CONSTRUCTION DOCUMENTS. SPACES HAVE NOT BEEN CONFIRMED BY RECENT OBSERVATION.

NOTE 2: NUMBER OF GUESTROOMS: 321 PLUS CLUB LEVEL LOUNGE

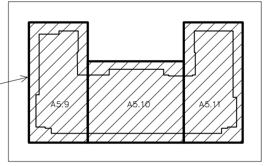
NOTE 3: ADA COMPLIANT GUESTROOMS LOCATED ON ELEVENTH, FIFTEENTH, EIGHTEENTH, AND TWENTY–FIRST FLOORS.

LEGEND:

| | |
|---|---|
| ═ | NEW WALL |
| ▬ | EXISTING WALL TO REMAIN |
| * | ROOMS WITH VISUAL ALARMS ON SELECT LEVELS (SEE SHEET A0.0) |
| ○ | 60" DIAMETER TURN–AROUND |

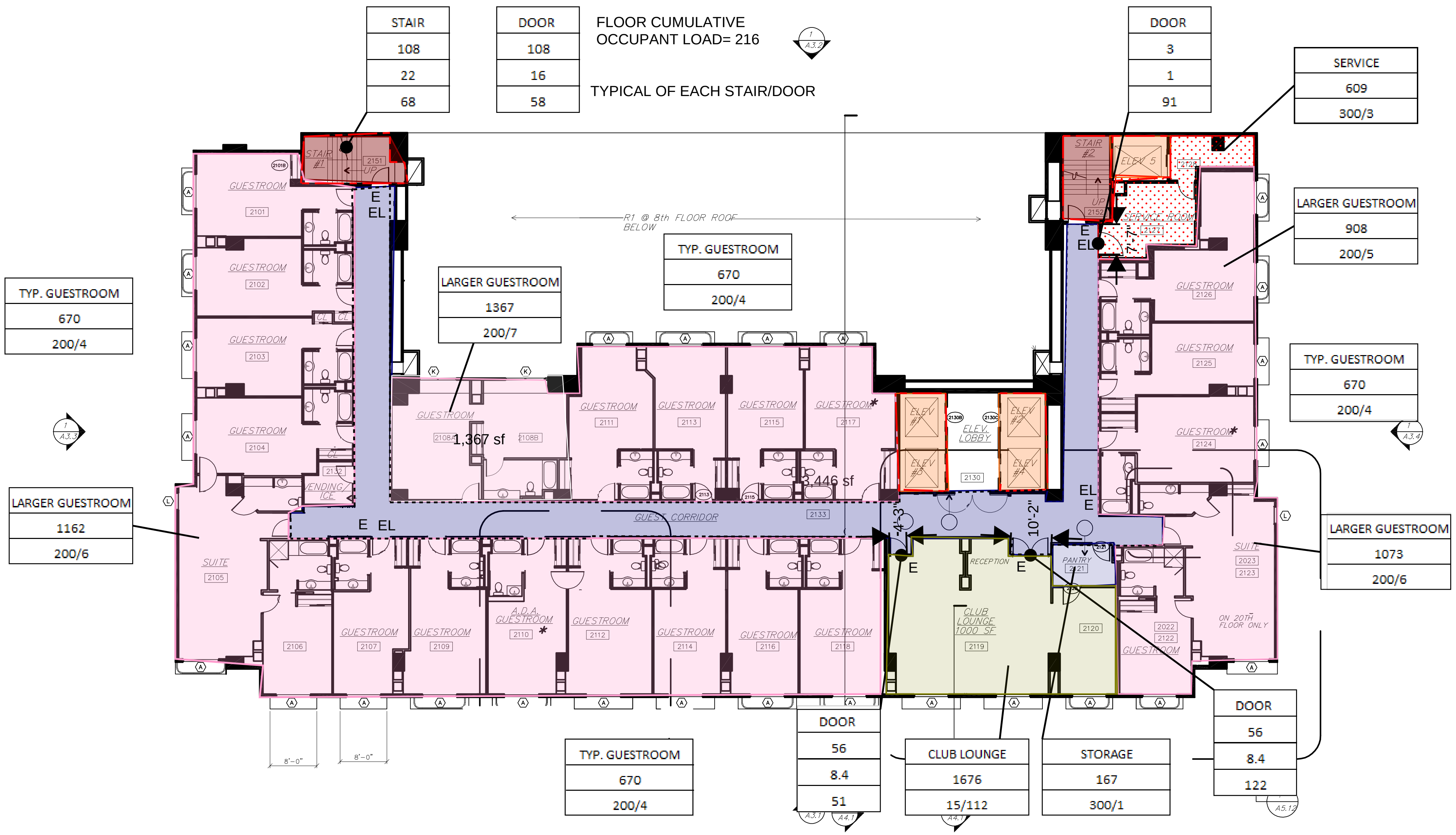
RE: THESE SHEETS FOR ENLARGED PLANS

KEY PLAN



A1.5

NORTH



# CLUB LEVEL (21st FLOOR)

1 Use Dimension

NORTH

NOTE 1: GUESTROOM LAYOUTS BASED ON ORIGINAL CONSTRUCTION DRAWINGS. SPACES HAVE NOT BEEN CONFIRMED BY RECENT OBSERVATION.

NOTE 2: NUMBER OF GUESTROOMS: 321 PLUS CLUB LEVEL LOUNGE

NOTE 3: NEW ADA COMPLIANT GUESTROOM NOT SHOWN

| | |
|---|---|
| STRUCTURAL ELEMENTS | |
| STAIR ENCLOSURES 2 HR RATED | 🟥 |
| STAIR ENCLOSURES NON- RATED | ▨ |
| CORRIDORS 1 HR RATED | 🟪 |
| CORRIDORS NON-RATED | 🟩 |
| EXIT PASSAGEWAYS 2 HR RATED | 🟥 |
| OTHER 2 HR RATED SHAFTS | 🟧 |

SEE STRUCTURAL DRAWINGS FOR MORE DETAIL

DOOR OR STAIR
OCC. LOAD
REQUIRED WIDTH
PROVIDED WIDTH

SPACE NAME
FLOOR AREA( SF)
OCC. LOAD FACTOR/OCC. LOAD

| OCCUPANCY | COLOR |
|---|---|
| A-2 | 🟨 |
| A-2(BAR) | 🟨 |
| A-3 | ▨ |
| B | 🟪 |
| F-1 | ▨ |
| M | ▨ |
| R-1 | 🟥 |
| S-2 | 🟪 |

■ POURED IN PLACE REINFORCED CONCRETE COLUMN

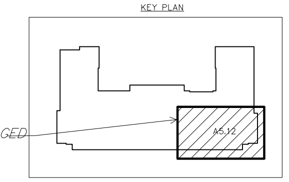
LEGEND:

═ NEW WALL

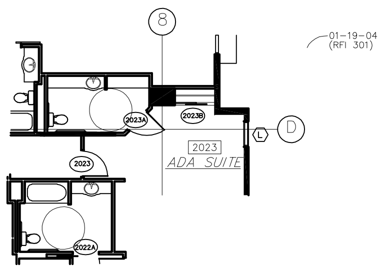
━ EXISTING WALL TO REMAIN

* ROOMS WITH VISUAL ALARMS ON SELECT LEVELS (SEE SHEET A0.0)

○ 60" DIAMETER TURN-AROUND



RE: THESE SHEET FOR ENLARGED PLANS



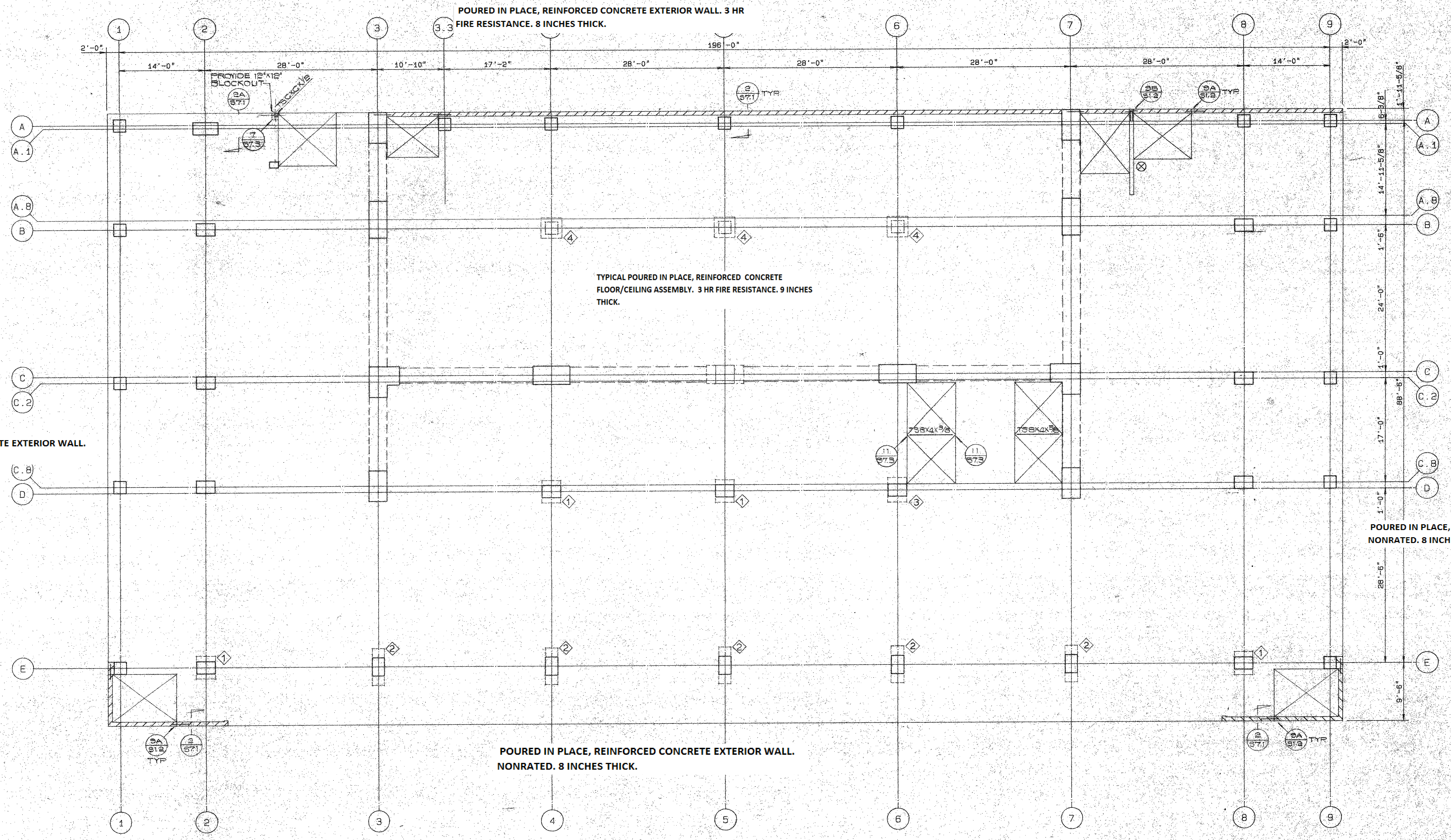
ALSO SEE 2/A5.12

## 2 BATHROOM @ 20TH FLOOR

?" = 1'-0"

# APPENDIX N – AVAILABLE STRUCTURAL DRAWINGS

POURED IN PLACE, REINFORCED CONCRETE EXTERIOR WALL. 3 HR FIRE RESISTANCE. 8 INCHES THICK.



TYPICAL POURED IN PLACE, REINFORCED CONCRETE FLOOR/CEILING ASSEMBLY. 3 HR FIRE RESISTANCE. 9 INCHES THICK.

POURED IN PLACE, REINFORCED CONCRETE EXTERIOR WALL. NONRATED. 8 INCHES THICK.

POURED IN PLACE, REINFORCED CONCRETE EXTERIOR WALL. NONRATED. 8 INCHES THICK.

POURED IN PLACE, REINFORCED CONCRETE EXTERIOR WALL. NONRATED. 8 INCHES THICK.

## 8TH FLOOR FRAMING PLAN

1/8" = 1'-0"

REFERENCE NORTH

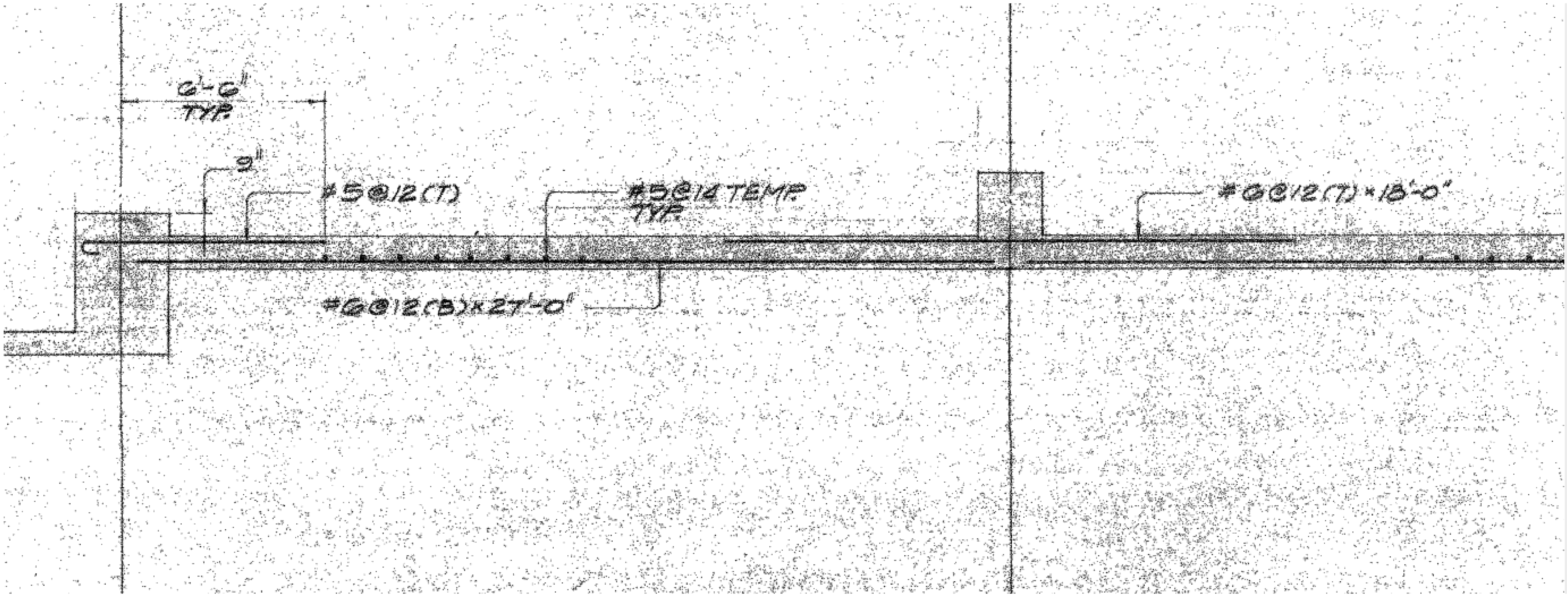
NOTES:
1. ELEVATION TOP OF CONCRETE SLAB AT 8TH FLR SHALL BE +84.75' UNLESS NOTED OTHERWISE THUS ◉ (±0.00')
2. 9" STRUCTURAL SLAB UNLESS NOTED OTHERWISE.
3. FOR COLUMN SIZES AND REINFORCING SEE SCHEDULE S3.1 AND S3.2
4. FOR FRAME ELEVATIONS SEE SHEETS S5.1, S5.2 AND S5.3
5. ◇2 INDICATES DROP PANELS SEE SCHEDULE S3.1

DRAWN BY
ENGINEER
BID ISSUE
CONST ISSUE

Robert Englekirk
Consulting Structural Engineers, Inc.
2116 Arlington Ave., Los Angeles, CA 90018-1397 (213) 733-6673

WATERSCAPE TOWER
8TH FLOOR FRAMING PLAN

JOB NUMBER
RE 85079
SHEET NUMBER
S2.9
OF SHEET


6'-6"
TYP.
9"
#5@12(T)
#5@14 TEMP.
TYP.
#6@12(T)×18'-0"
#6@12(B)×27'-0"

# APPENDIX O – STRUCTURAL CALCULATIONS

Scenario 1: Guestroom Fire

Time to burn out, Tb = Mf/R

Mf= Fuel Load Density (MJ/m²)

R= 0.1Ao√Ho

Given a standard guest room, 3 ft. x 6 ft. door.

Fuel Load Density = 560MJ/m²

$M_f$ = Mass of fuel (MJ/m²)

= Fuel load density/ $\Delta h_c$

$\Delta h_c$ =heat of combustion of the fuel (MJ/kg)

50% pine wood, 50% polypropylene = (21.0 +46.37)/2= 33.69 MJ/kg[41]

Ao= 1.67 m²

H= 1.82 m

R= 0.225

Tb= 28.86 minutes

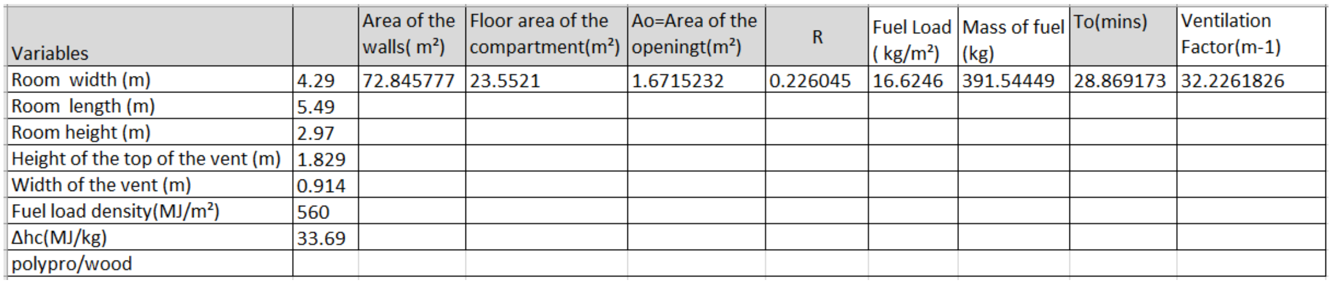
Ventilation factor = 32.226

From Thomas Plot temperature max = 800 °C

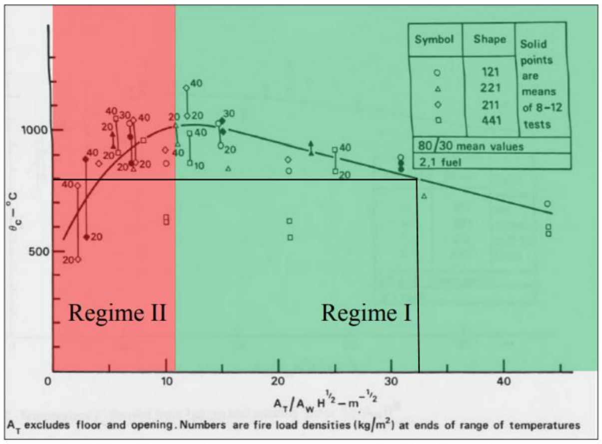
Design Fire

800 °C 0 ≤ t≤ 28.89 minutes

10°C/ minute decay > 28.89 minutes



| Variables | | Area of the walls( m²) | Floor area of the compartment(m²) | Ao=Area of the openingt(m²) | R | Fuel Load ( kg/m²) | Mass of fuel (kg) | To(mins) | Ventilation Factor(m-1) |
|---|---|---|---|---|---|---|---|---|---|
| Room width (m) | 4.29 | 72.845777 | 23.5521 | 1.6715232 | 0.226045 | 16.6246 | 391.54449 | 28.869173 | 32.2261826 |
| Room length (m) | 5.49 | | | | | | | | |
| Room height (m) | 2.97 | | | | | | | | |
| Height of the top of the vent (m) | 1.829 | | | | | | | | |
| Width of the vent (m) | 0.914 | | | | | | | | |
| Fuel load density(MJ/m²) | 560 | | | | | | | | |
| Δhc(MJ/kg) | 33.69 | | | | | | | | |
| polypro/wood | | | | | | | | | |



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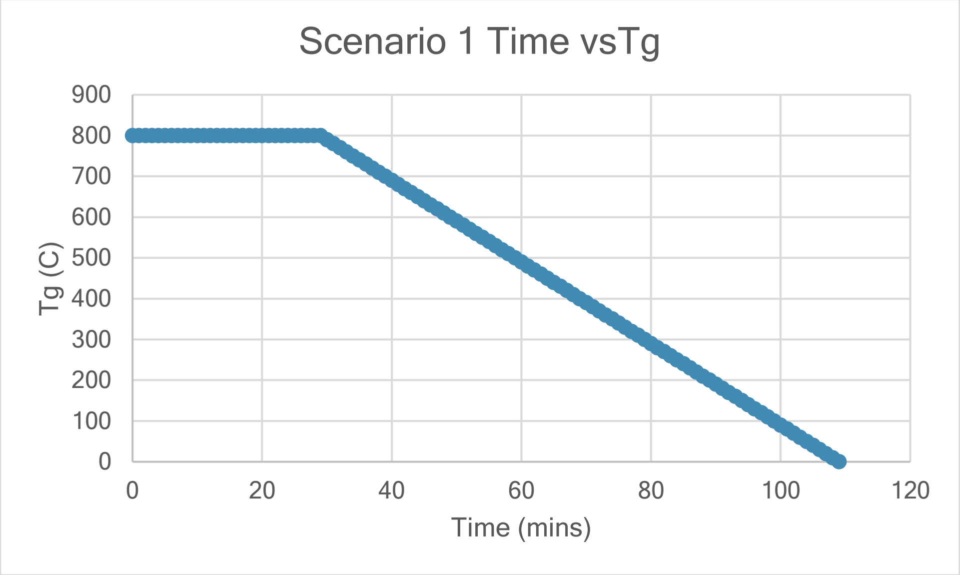
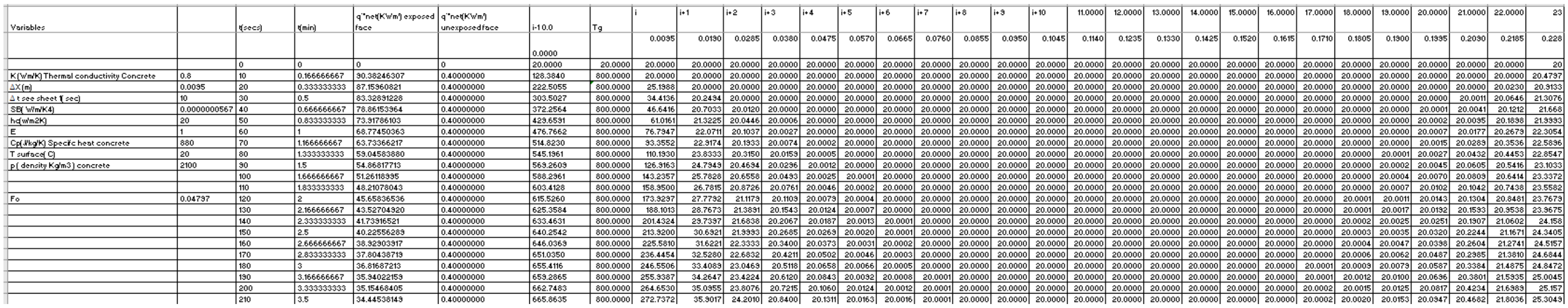
[41] SFPE Handbook, 4th edition, Table C.3



## FDM



| Variables | | t(secs) | t(min) | q"net(KW/m$^2$) exposed face | q"net(KW/m$^2$) unexposed face | i-1 0.0 | Tg | i | i+1 | i+2 | i+3 | i+4 | i+5 | i+6 | i+7 | i+8 | i+9 | i+10 | 11.0000 | 12.0000 | 13.0000 | 14.0000 | 15.0000 | 16.0000 | 17.0000 | 18.0000 | 19.0000 | 20.0000 | 21.0000 | 22.0000 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0.0000 | | 0.0095 | 0.0190 | 0.0285 | 0.0380 | 0.0475 | 0.0570 | 0.0665 | 0.0760 | 0.0855 | 0.0950 | 0.1045 | 0.1140 | 0.1235 | 0.1330 | 0.1425 | 0.1520 | 0.1615 | 0.1710 | 0.1805 | 0.1900 | 0.1995 | 0.2090 | 0.2185 | 0.228 |
| | | 0 | 0 | 0 | 0 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20 |
| K (W/m/K) Thermal conductivity Concrete | 0.8 | 10 | 0.166666667 | 90.38246307 | 0.40000000 | 128.3840 | 800.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.4797 |
| ΔX (m) | 0.0095 | 20 | 0.333333333 | 87.15960821 | 0.40000000 | 222.5055 | 800.0000 | 25.1988 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0230 | 20.9133 |
| Δ t see sheet 1( sec) | 10 | 30 | 0.5 | 83.32891228 | 0.40000000 | 303.5027 | 800.0000 | 34.4136 | 20.2494 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0011 | 20.0646 | 21.3076 |
| SB( W/m/K4) | 0.0000000567 | 40 | 0.666666667 | 78.86153964 | 0.40000000 | 372.2564 | 800.0000 | 46.6416 | 20.7033 | 20.0120 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0041 | 20.1212 | 21.668 |
| hc(w/m2K) | 20 | 50 | 0.833333333 | 73.91786103 | 0.40000000 | 429.6591 | 800.0000 | 61.0161 | 21.3225 | 20.0446 | 20.0006 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0095 | 20.1898 | 21.9993 |
| E | 1 | 60 | 1 | 68.77450363 | 0.40000000 | 476.7662 | 800.0000 | 76.7947 | 22.0711 | 20.1037 | 20.0027 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0007 | 20.0177 | 20.2679 | 22.3054 |
| Cp(J/kg/K) Specific heat concrete | 880 | 70 | 1.166666667 | 63.73366217 | 0.40000000 | 514.8230 | 800.0000 | 93.3552 | 22.9174 | 20.1933 | 20.0074 | 20.0002 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0015 | 20.0289 | 20.3536 | 22.5896 |
| T surface( C) | 20 | 80 | 1.333333333 | 59.04583880 | 0.40000000 | 545.1961 | 800.0000 | 110.1930 | 23.8333 | 20.3150 | 20.0159 | 20.0005 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0027 | 20.0432 | 20.4453 | 22.8547 |
| p ( density Kg/m3 ) concrete | 2100 | 90 | 1.5 | 54.86817713 | 0.40000000 | 569.2609 | 800.0000 | 126.9163 | 24.7949 | 20.4694 | 20.0296 | 20.0012 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0045 | 20.0605 | 20.5416 | 23.1033 |
| | | 100 | 1.666666667 | 51.26118995 | 0.40000000 | 588.2961 | 800.0000 | 143.2357 | 25.7828 | 20.6558 | 20.0493 | 20.0025 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0004 | 20.0070 | 20.0809 | 20.6414 | 23.3372 |
| | | 110 | 1.833333333 | 48.21078043 | 0.40000000 | 603.4128 | 800.0000 | 158.9500 | 26.7815 | 20.8726 | 20.0761 | 20.0046 | 20.0002 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0007 | 20.0102 | 20.1042 | 20.7438 | 23.5582 |
| Fo | 0.04797 | 120 | 2 | 45.65836536 | 0.40000000 | 615.5260 | 800.0000 | 173.9297 | 27.7792 | 21.1179 | 20.1109 | 20.0079 | 20.0004 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0011 | 20.0143 | 20.1304 | 20.8481 | 23.7679 |
| | | 130 | 2.166666667 | 43.52704920 | 0.40000000 | 625.3584 | 800.0000 | 188.1013 | 28.7673 | 21.3891 | 20.1543 | 20.0124 | 20.0007 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0017 | 20.0192 | 20.1593 | 20.9538 | 23.9675 |
| | | 140 | 2.333333333 | 41.73916521 | 0.40000000 | 633.4631 | 800.0000 | 201.4324 | 29.7397 | 21.6838 | 20.2067 | 20.0187 | 20.0013 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0025 | 20.0251 | 20.1907 | 21.0602 | 24.158 |
| | | 150 | 2.5 | 40.22556289 | 0.40000000 | 640.2542 | 800.0000 | 213.9200 | 30.6921 | 21.9993 | 20.2685 | 20.0269 | 20.0020 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0003 | 20.0035 | 20.0320 | 20.2244 | 21.1671 | 24.3405 |
| | | 160 | 2.666666667 | 38.92903917 | 0.40000000 | 646.0369 | 800.0000 | 225.5810 | 31.6221 | 22.3333 | 20.3400 | 20.0373 | 20.0031 | 20.0002 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0004 | 20.0047 | 20.0398 | 20.2604 | 21.2741 | 24.5157 |
| | | 170 | 2.833333333 | 37.80438719 | 0.40000000 | 651.0350 | 800.0000 | 236.4454 | 32.5280 | 22.6832 | 20.4211 | 20.0502 | 20.0046 | 20.0003 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0006 | 20.0062 | 20.0487 | 20.2985 | 21.3810 | 24.6844 |
| | | 180 | 3 | 36.81687213 | 0.40000000 | 655.4116 | 800.0000 | 246.5506 | 33.4089 | 23.0469 | 20.5118 | 20.0658 | 20.0066 | 20.0005 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0009 | 20.0079 | 20.0587 | 20.3384 | 21.4875 | 24.8472 |
| | | 190 | 3.166666667 | 35.94022159 | 0.40000000 | 659.2865 | 800.0000 | 255.9387 | 34.2647 | 23.4224 | 20.6120 | 20.0843 | 20.0092 | 20.0008 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0012 | 20.0100 | 20.0696 | 20.3801 | 21.5935 | 25.0045 |
| | | 200 | 3.333333333 | 35.15468405 | 0.40000000 | 662.7483 | 800.0000 | 264.6530 | 35.0955 | 23.8076 | 20.7215 | 20.1060 | 20.0124 | 20.0012 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0015 | 20.0125 | 20.0817 | 20.4234 | 21.6989 | 25.157 |
| | | 210 | 3.5 | 34.44538149 | 0.40000000 | 665.8635 | 800.0000 | 272.7372 | 35.9017 | 24.2010 | 20.8400 | 20.1311 | 20.0163 | 20.0016 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0020 | 20.0153 | 20.0947 | 20.4682 | 21.8036 | 25.3049 |

## Moment Calculation

| Variables | | | t( minutes) | t(sec) | Ts C | Yield Strength(KSI) | Yield Strength kip/in$^2$ <=600 | a (in) | Me k-ft | Yield Strength kip/in$^2$ >600<=1000 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0 | 0 | 20.0000 | 60.0000 | 60.0000 | 5.882352941 | 132.7205882 | 50.0000 |
| TA | Amb temp C | 20.0000 | 0.1666667 | 10 | 20.0000 | 49.75152038 | 49.75152038 | 4.877600037 | 120.4650143 | -75.72727273 |
| Δt | time increment(sec) | 10.0000 | 0.3333333 | 20 | 20.0000 | 49.75152038 | 49.75152038 | 4.877600037 | 120.4650143 | -75.72727273 |
| As | area steel (in$^2$) | 5.0000 | 0.5 | 30 | 20.24937138 | 49.7477231 | 49.7477231 | 4.877227755 | 120.4596782 | -75.793916 |
| D | (in) | 8.2500 | 0.6666667 | 40 | 20.70333742 | 49.74077853 | 49.74077853 | 4.876546914 | 120.4499178 | -75.91562529 |
| b | (in) | 12.0000 | 0.8333333 | 50 | 21.32246146 | 49.73124183 | 49.73124183 | 4.875611944 | 120.4365112 | -76.08242834 |
| F'c | (ksi) | 5.0000 | 1 | 60 | 22.07112216 | 49.71961008 | 49.71961008 | 4.874471576 | 120.4201542 | -76.28539681 |
| Fy | (ksi) | 60.0000 | 1.1666667 | 70 | 22.91739429 | 49.70633238 | 49.70633238 | 4.873169842 | 120.4014759 | -76.51651427 |
| | | | 1.3333333 | 80 | 23.83327091 | 49.69181059 | 49.69181059 | 4.871746137 | 120.3810393 | -76.76867973 |
| | | | 1.5 | 90 | 24.79492941 | 49.67639586 | 49.67639586 | 4.870234888 | 120.3593365 | -77.03576015 |
| | | | 1.6666667 | 100 | 25.78282193 | 49.66038559 | 49.66038559 | 4.868665254 | 120.3367851 | -77.31262346 |

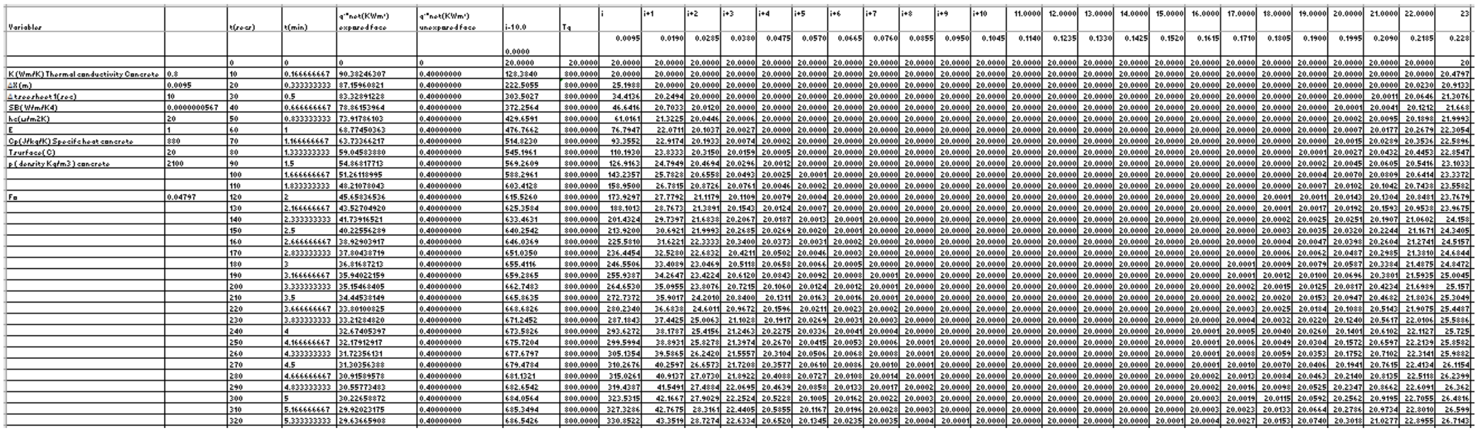
## Maximum Moment Reduction

| Variables | | | t( minutes) | t(sec) | Ts C | Yield Strength(KSI) | Yield Strength kip/in$^2$ <=600 | a (in) | Me k-ft | Yield Strength kip/in$^2$ >600<=1000 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 107.66667 | 6460 | 217.8060228 | 44.19304595 | 44.19304595 | 4.332651564 | 112.0233726 | -599.1399154 |
| | | | 107.83333 | 6470 | 218.8060228 | 44.15353256 | 44.15353256 | 4.328777702 | 111.9588458 | -626.6071487 |
| | | | 108 | 6480 | 219.8060228 | 44.11390394 | 44.11390394 | 4.324892543 | 111.8940668 | -656.7947212 |
| | | | 108.16667 | 6490 | 220.8060228 | 44.07415999 | 44.07415999 | 4.320996077 | 111.8290349 | -690.1278191 |
| | | | 108.33333 | 6500 | 221.8060228 | 44.03430059 | 44.03430059 | 4.317088294 | 111.7637492 | -727.1251074 |
| | | | 108.5 | 6510 | 222.8060228 | 43.99432566 | 43.99432566 | 4.313169182 | 111.6982091 | -768.4259129 |
| | | | 108.66667 | 6520 | 223.8060228 | 43.95423506 | 43.95423506 | 4.309238732 | 111.6324138 | -814.8274796 |
| | | | 108.83333 | 6530 | 224.8060228 | 43.9140287 | 43.9140287 | 4.305296932 | 111.5663626 | -867.3369358 |
| | | | 109 | 6540 | 225.8060228 | 43.87370647 | 43.87370647 | 4.301343772 | 111.5000547 | -927.2452283 |

Scenario 2:

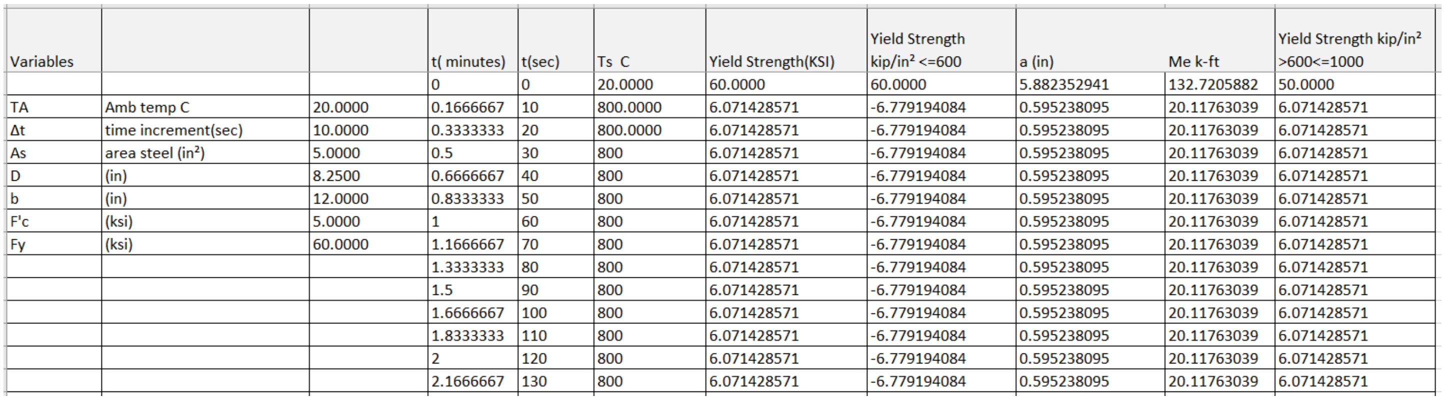
Same as Scenario 1, except steel rebar is exposed, so steel temperature is higher, the moment reduction due to fire is greatly reduced. See Scenario 1 for Thomas Plot analysis. However, the concrete temperature exceeded 500 °C. The 500° C Isotherm Calculation Method was used to calculate a new D dimension.

## FDM



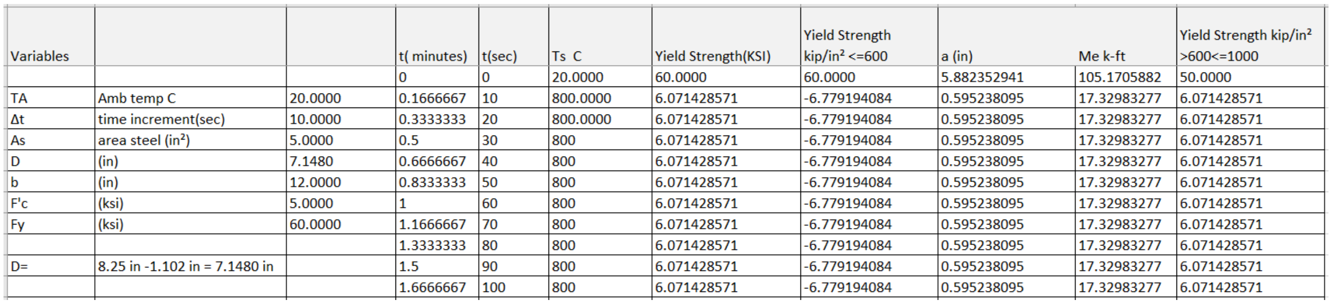
| Variables | | t(secs) | t(min) | q''net(KWm²) exposed face | q''net(KWm²) unexposed face | i-10.0 | Tq | i | i+1 | i+2 | i+3 | i+4 | i+5 | i+6 | i+7 | i+8 | i+9 | i+10 | 11.0000 | 12.0000 | 13.0000 | 14.0000 | 15.0000 | 16.0000 | 17.0000 | 18.0000 | 19.0000 | 20.0000 | 21.0000 | 22.0000 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0.0000 | | 0.0095 | 0.0190 | 0.0285 | 0.0380 | 0.0475 | 0.0570 | 0.0665 | 0.0760 | 0.0855 | 0.0950 | 0.1045 | 0.1140 | 0.1235 | 0.1330 | 0.1425 | 0.1520 | 0.1615 | 0.1710 | 0.1805 | 0.1900 | 0.1995 | 0.2090 | 0.2185 | 0.228 |
| | | 0 | 0 | 0 | 0 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20 |
| K (Wm/K) Thermal conductivity Concrete | 0.8 | 10 | 0.166666667 | 90.38246307 | 0.40000000 | 128.3840 | 800.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.4797 |
| ΔX (m) | 0.0095 | 20 | 0.333333333 | 87.15960821 | 0.40000000 | 222.5055 | 800.0000 | 25.1988 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0230 | 20.9133 |
| Δt sheet 1(sec) | 10 | 30 | 0.5 | 83.32891228 | 0.40000000 | 303.5027 | 800.0000 | 34.4136 | 20.2494 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0011 | 20.0646 | 21.3076 |
| SB( W/m/K4) | 0.0000000567 | 40 | 0.666666667 | 78.86153964 | 0.40000000 | 372.2564 | 800.0000 | 46.6416 | 20.7033 | 20.0120 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0041 | 20.1212 | 21.668 |
| hc(w/m2K) | 20 | 50 | 0.833333333 | 73.91786103 | 0.40000000 | 429.6591 | 800.0000 | 61.0161 | 21.3225 | 20.0446 | 20.0006 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0095 | 20.1898 | 21.9993 |
| E | 1 | 60 | 1 | 68.77450363 | 0.40000000 | 476.7662 | 800.0000 | 76.7947 | 22.0711 | 20.1037 | 20.0027 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0007 | 20.0177 | 20.2679 | 22.3054 |
| Cp(J/kg/K) Specifc heat concrete | 880 | 70 | 1.166666667 | 63.73366217 | 0.40000000 | 514.8230 | 800.0000 | 93.3552 | 22.9174 | 20.1933 | 20.0074 | 20.0002 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0015 | 20.0289 | 20.3536 | 22.5896 |
| Tsurface( C) | 20 | 80 | 1.333333333 | 59.04583880 | 0.40000000 | 545.1961 | 800.0000 | 110.1930 | 23.8333 | 20.3150 | 20.0159 | 20.0005 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0027 | 20.0432 | 20.4453 | 22.8547 |
| ρ ( density Kg/m3 ) concrete | 2100 | 90 | 1.5 | 54.86817713 | 0.40000000 | 569.2609 | 800.0000 | 126.9163 | 24.7949 | 20.4694 | 20.0296 | 20.0012 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0045 | 20.0605 | 20.5416 | 23.1033 |
| | | 100 | 1.666666667 | 51.26118995 | 0.40000000 | 588.2961 | 800.0000 | 143.2357 | 25.7828 | 20.6558 | 20.0493 | 20.0025 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0004 | 20.0070 | 20.0809 | 20.6414 | 23.3372 |
| | | 110 | 1.833333333 | 48.21078043 | 0.40000000 | 603.4128 | 800.0000 | 158.9500 | 26.7815 | 20.8726 | 20.0761 | 20.0046 | 20.0002 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0007 | 20.0102 | 20.1042 | 20.7438 | 23.5582 |
| Fo | 0.04797 | 120 | 2 | 45.65836536 | 0.40000000 | 615.5260 | 800.0000 | 173.9297 | 27.7792 | 21.1179 | 20.1109 | 20.0079 | 20.0004 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0011 | 20.0143 | 20.1304 | 20.8481 | 23.7679 |
| | | 130 | 2.166666667 | 43.52704920 | 0.40000000 | 625.3584 | 800.0000 | 188.1013 | 28.7673 | 21.3891 | 20.1543 | 20.0124 | 20.0007 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0017 | 20.0192 | 20.1593 | 20.9538 | 23.9675 |
| | | 140 | 2.333333333 | 41.73916521 | 0.40000000 | 633.4631 | 800.0000 | 201.4324 | 29.7397 | 21.6838 | 20.2067 | 20.0187 | 20.0013 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0025 | 20.0251 | 20.1907 | 21.0602 | 24.158 |
| | | 150 | 2.5 | 40.22556289 | 0.40000000 | 640.2542 | 800.0000 | 213.9200 | 30.6921 | 21.9993 | 20.2685 | 20.0269 | 20.0020 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0003 | 20.0035 | 20.0320 | 20.2244 | 21.1671 | 24.3405 |
| | | 160 | 2.666666667 | 38.92903917 | 0.40000000 | 646.0369 | 800.0000 | 225.5810 | 31.6221 | 22.3333 | 20.3400 | 20.0373 | 20.0031 | 20.0002 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0004 | 20.0047 | 20.0398 | 20.2604 | 21.2741 | 24.5157 |
| | | 170 | 2.833333333 | 37.80438719 | 0.40000000 | 651.0350 | 800.0000 | 236.4454 | 32.5280 | 22.6832 | 20.4211 | 20.0502 | 20.0046 | 20.0003 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0006 | 20.0062 | 20.0487 | 20.2985 | 21.3810 | 24.6844 |
| | | 180 | 3 | 36.81687213 | 0.40000000 | 655.4116 | 800.0000 | 246.5506 | 33.4089 | 23.0469 | 20.5118 | 20.0658 | 20.0066 | 20.0005 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0009 | 20.0079 | 20.0587 | 20.3384 | 21.4875 | 24.8472 |
| | | 190 | 3.166666667 | 35.94022159 | 0.40000000 | 659.2865 | 800.0000 | 255.9387 | 34.2647 | 23.4224 | 20.6120 | 20.0843 | 20.0092 | 20.0008 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0012 | 20.0100 | 20.0696 | 20.3801 | 21.5935 | 25.0045 |
| | | 200 | 3.333333333 | 35.15468405 | 0.40000000 | 662.7483 | 800.0000 | 264.6530 | 35.0955 | 23.8076 | 20.7215 | 20.1060 | 20.0124 | 20.0012 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0015 | 20.0125 | 20.0817 | 20.4234 | 21.6989 | 25.157 |
| | | 210 | 3.5 | 34.44538149 | 0.40000000 | 665.8635 | 800.0000 | 272.7372 | 35.9017 | 24.2010 | 20.8400 | 20.1311 | 20.0163 | 20.0016 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0020 | 20.0153 | 20.0947 | 20.4682 | 21.8036 | 25.3049 |
| | | 220 | 3.666666667 | 33.80100825 | 0.40000000 | 668.6826 | 800.0000 | 280.2340 | 36.6838 | 24.6011 | 20.9672 | 20.1596 | 20.0211 | 20.0023 | 20.0002 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0003 | 20.0025 | 20.0184 | 20.1088 | 20.5143 | 21.9075 | 25.4487 |
| | | 230 | 3.833333333 | 33.21284820 | 0.40000000 | 671.2452 | 800.0000 | 287.1843 | 37.4425 | 25.0063 | 21.1028 | 20.1917 | 20.0269 | 20.0031 | 20.0003 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0004 | 20.0032 | 20.0220 | 20.1240 | 20.5617 | 22.0106 | 25.5886 |
| | | 240 | 4 | 32.67405397 | 0.40000000 | 673.5826 | 800.0000 | 293.6272 | 38.1787 | 25.4156 | 21.2463 | 20.2275 | 20.0336 | 20.0041 | 20.0004 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0005 | 20.0040 | 20.0260 | 20.1401 | 20.6102 | 22.1127 | 25.725 |
| | | 250 | 4.166666667 | 32.17912917 | 0.40000000 | 675.7204 | 800.0000 | 299.5994 | 38.8931 | 25.8278 | 21.3974 | 20.2670 | 20.0415 | 20.0053 | 20.0006 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0006 | 20.0049 | 20.0304 | 20.1572 | 20.6597 | 22.2139 | 25.8582 |
| | | 260 | 4.333333333 | 31.72356131 | 0.40000000 | 677.6797 | 800.0000 | 305.1354 | 39.5865 | 26.2420 | 21.5557 | 20.3104 | 20.0506 | 20.0068 | 20.0008 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0008 | 20.0059 | 20.0353 | 20.1752 | 20.7102 | 22.3141 | 25.9882 |
| | | 270 | 4.5 | 31.30356388 | 0.40000000 | 679.4784 | 800.0000 | 310.2676 | 40.2597 | 26.6573 | 21.7208 | 20.3577 | 20.0610 | 20.0086 | 20.0010 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0010 | 20.0070 | 20.0406 | 20.1941 | 20.7615 | 22.4134 | 26.1154 |
| | | 280 | 4.666666667 | 30.91589578 | 0.40000000 | 681.1321 | 800.0000 | 315.0261 | 40.9137 | 27.0730 | 21.8922 | 20.4088 | 20.0727 | 20.0108 | 20.0014 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0013 | 20.0084 | 20.0463 | 20.2140 | 20.8135 | 22.5118 | 26.2399 |
| | | 290 | 4.833333333 | 30.55773483 | 0.40000000 | 682.6542 | 800.0000 | 319.4387 | 41.5491 | 27.4884 | 22.0695 | 20.4639 | 20.0858 | 20.0133 | 20.0017 | 20.0002 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0016 | 20.0098 | 20.0525 | 20.2347 | 20.8662 | 22.6091 | 26.362 |
| | | 300 | 5 | 30.22658872 | 0.40000000 | 684.0564 | 800.0000 | 323.5315 | 42.1667 | 27.9029 | 22.2524 | 20.5228 | 20.1005 | 20.0162 | 20.0022 | 20.0003 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0003 | 20.0019 | 20.0115 | 20.0592 | 20.2562 | 20.9195 | 22.7055 | 26.4816 |
| | | 310 | 5.166666667 | 29.92023175 | 0.40000000 | 685.3494 | 800.0000 | 327.3286 | 42.7675 | 28.3161 | 22.4405 | 20.5855 | 20.1167 | 20.0196 | 20.0028 | 20.0003 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0003 | 20.0023 | 20.0133 | 20.0664 | 20.2786 | 20.9734 | 22.8010 | 26.599 |
| | | 320 | 5.333333333 | 29.63665908 | 0.40000000 | 686.5426 | 800.0000 | 330.8522 | 43.3519 | 28.7274 | 22.6334 | 20.6520 | 20.1345 | 20.0235 | 20.0035 | 20.0004 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0004 | 20.0027 | 20.0153 | 20.0740 | 20.3018 | 21.0277 | 22.8955 | 26.7143 |

## Maximum Moment Reduction



| Variables | | | t( minutes) | t(sec) | Ts C | Yield Strength(KSI) | Yield Strength kip/in$^2$ <=600 | a (in) | Me k-ft | Yield Strength kip/in$^2$ >600<=1000 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0 | 0 | 20.0000 | 60.0000 | 60.0000 | 5.882352941 | 132.7205882 | 50.0000 |
| TA | Amb temp C | 20.0000 | 0.1666667 | 10 | 800.0000 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |
| Δt | time increment(sec) | 10.0000 | 0.3333333 | 20 | 800.0000 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |
| As | area steel (in$^2$) | 5.0000 | 0.5 | 30 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |
| D | (in) | 8.2500 | 0.6666667 | 40 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |
| b | (in) | 12.0000 | 0.8333333 | 50 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |
| F'c | (ksi) | 5.0000 | 1 | 60 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |
| Fy | (ksi) | 60.0000 | 1.1666667 | 70 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |
| | | | 1.3333333 | 80 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |
| | | | 1.5 | 90 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |
| | | | 1.6666667 | 100 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |
| | | | 1.8333333 | 110 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |
| | | | 2 | 120 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |
| | | | 2.1666667 | 130 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 20.11763039 | 6.071428571 |

## Modified D Calculation ( 500 °C Isotherm Calculation Method)



| Variables | | | t( minutes) | t(sec) | Ts C | Yield Strength(KSI) | Yield Strength kip/in$^2$ <=600 | a (in) | Me k-ft | Yield Strength kip/in$^2$ >600<=1000 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0 | 0 | 20.0000 | 60.0000 | 60.0000 | 5.882352941 | 105.1705882 | 50.0000 |
| TA | Amb temp C | 20.0000 | 0.1666667 | 10 | 800.0000 | 6.071428571 | -6.779194084 | 0.595238095 | 17.32983277 | 6.071428571 |
| Δt | time increment(sec) | 10.0000 | 0.3333333 | 20 | 800.0000 | 6.071428571 | -6.779194084 | 0.595238095 | 17.32983277 | 6.071428571 |
| As | area steel (in$^2$) | 5.0000 | 0.5 | 30 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 17.32983277 | 6.071428571 |
| D | (in) | 7.1480 | 0.6666667 | 40 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 17.32983277 | 6.071428571 |
| b | (in) | 12.0000 | 0.8333333 | 50 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 17.32983277 | 6.071428571 |
| F'c | (ksi) | 5.0000 | 1 | 60 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 17.32983277 | 6.071428571 |
| Fy | (ksi) | 60.0000 | 1.1666667 | 70 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 17.32983277 | 6.071428571 |
| | | | 1.3333333 | 80 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 17.32983277 | 6.071428571 |
| D= | 8.25 in -1.102 in = 7.1480 in | | 1.5 | 90 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 17.32983277 | 6.071428571 |
| | | | 1.6666667 | 100 | 800 | 6.071428571 | -6.779194084 | 0.595238095 | 17.32983277 | 6.071428571 |

Scenario 3:

Fire in Meeting Room 824 A

Given a meeting room, 3.25 m x 2.5 m door.

Fuel Load Density = 950MJ/$m^2$

$M_f$ = Mass of fuel (MJ/$m^2$)

= Fuel load density/ $\Delta h_c$

$\Delta h_c$ =heat of combustion of the fuel (MJ/kg)

= 50% pine wood, 50% polypropylene = (21.0 +46.37)/2= 33.69 MJ/kg

Ao= 8.22 $m^2$

H= 1.82 m

R= 1.300

Tb= 43.18 minutes

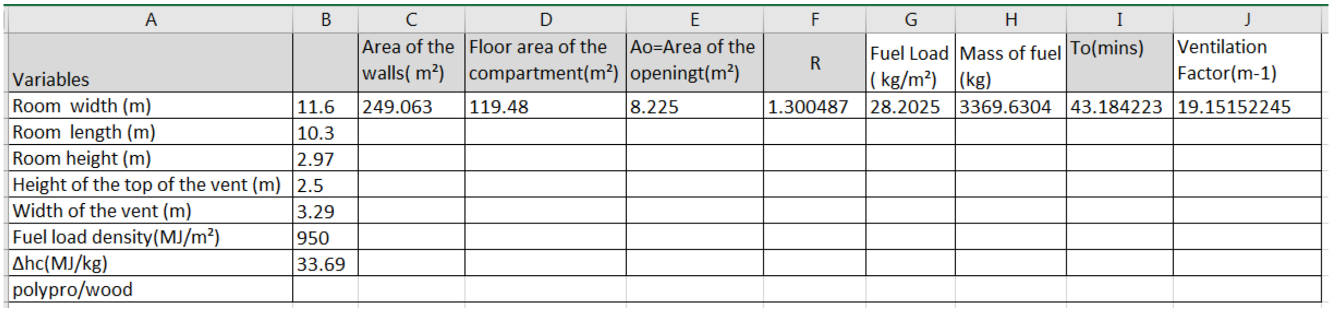
Ventilation factor = 19.15

From Thomas Plot temperature max = 960 °C

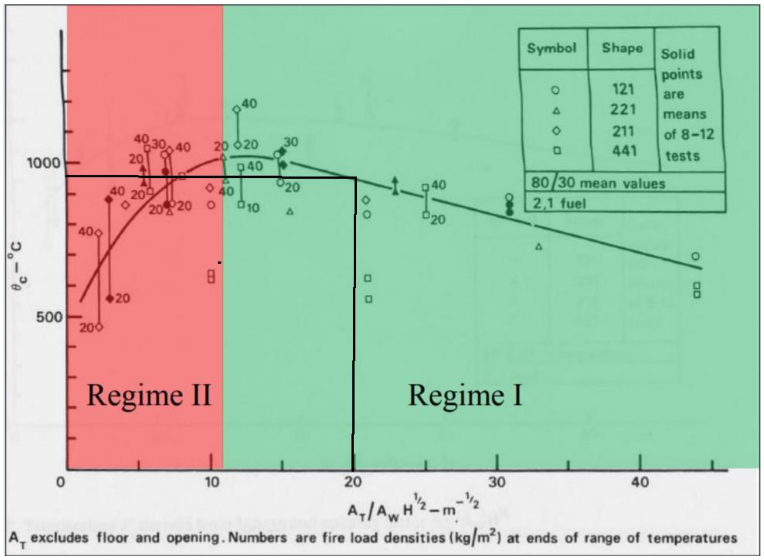
Design Fire

960 °C  $0 \leq t \leq 43.18$ minutes

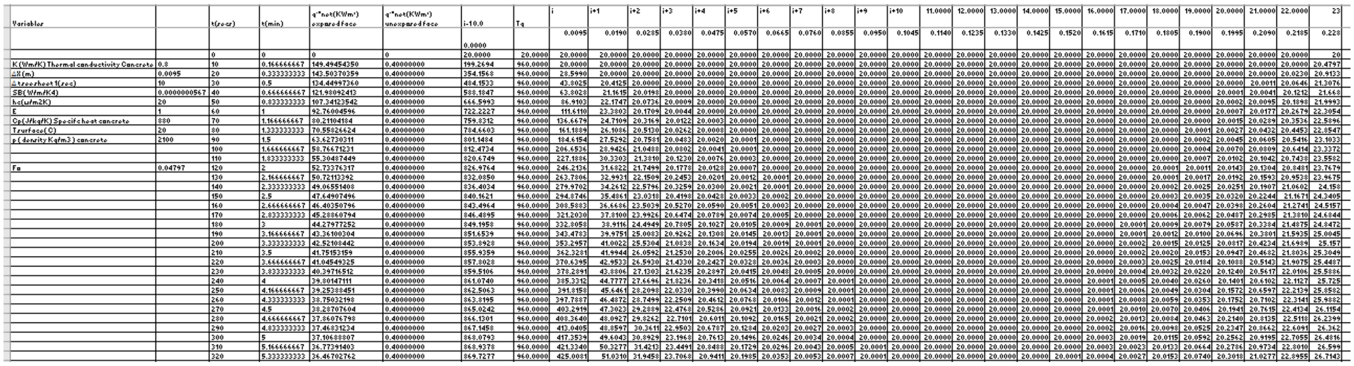
10°C/ minute decay > 43.18 minutes



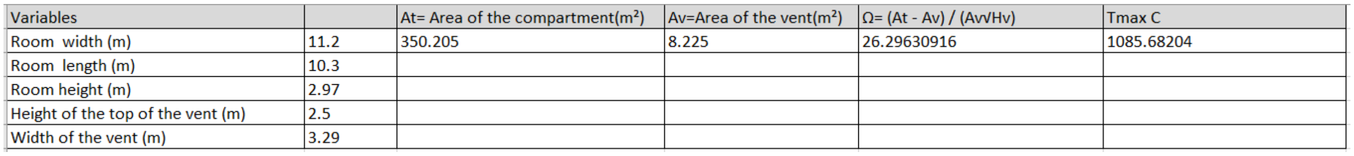
| A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|
| Variables | | Area of the walls( $m^2$) | Floor area of the compartment($m^2$) | Ao=Area of the openingt($m^2$) | R | Fuel Load ( kg/$m^2$) | Mass of fuel (kg) | To(mins) | Ventilation Factor(m-1) |
| Room width (m) | 11.6 | 249.063 | 119.48 | 8.225 | 1.300487 | 28.2025 | 3369.6304 | 43.184223 | 19.15152245 |
| Room length (m) | 10.3 | | | | | | | | |
| Room height (m) | 2.97 | | | | | | | | |
| Height of the top of the vent (m) | 2.5 | | | | | | | | |
| Width of the vent (m) | 3.29 | | | | | | | | |
| Fuel load density(MJ/$m^2$) | 950 | | | | | | | | |
| $\Delta$hc(MJ/kg) | 33.69 | | | | | | | | |
| polypro/wood | | | | | | | | | |



# FDM

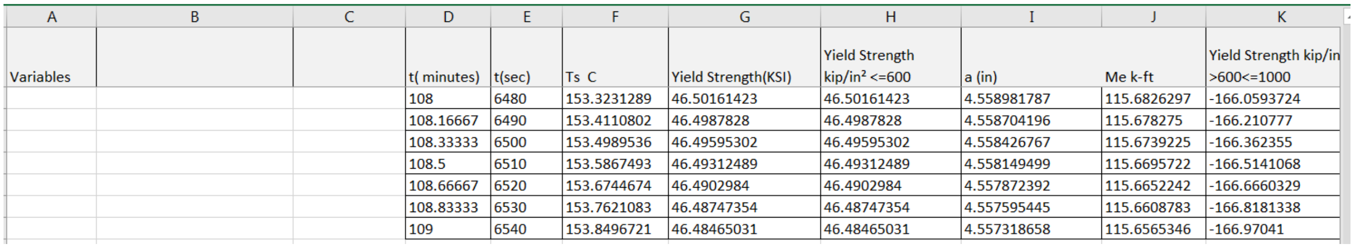


| Variables | | t(secs) | t(min) | q''net(KWm²) exposed face | q''net(KWm²) unexposed face | i-10.0 | Tg | i | i+1 | i+2 | i+3 | i+4 | i+5 | i+6 | i+7 | i+8 | i+9 | i+10 | 11.0000 | 12.0000 | 13.0000 | 14.0000 | 15.0000 | 16.0000 | 17.0000 | 18.0000 | 19.0000 | 20.0000 | 21.0000 | 22.0000 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0.0000 | | 0.0095 | 0.0190 | 0.0285 | 0.0380 | 0.0475 | 0.0570 | 0.0665 | 0.0760 | 0.0855 | 0.0950 | 0.1045 | 0.1140 | 0.1235 | 0.1330 | 0.1425 | 0.1520 | 0.1615 | 0.1710 | 0.1805 | 0.1900 | 0.1995 | 0.2090 | 0.2185 | 0.228 |
| | | 0 | 0 | 0 | 0 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20 |
| K (Wm/K) Thermal conductivity Concrete | 0.8 | 10 | 0.166666667 | 149.49454350 | 0.40000000 | 199.2694 | 960.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.4797 |
| ΔX (m) | 0.0095 | 20 | 0.333333333 | 143.50370359 | 0.40000000 | 354.1568 | 960.0000 | 28.5990 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0230 | 20.9133 |
| Δtreeshoot 1(sec) | 10 | 30 | 0.5 | 134.44997360 | 0.40000000 | 484.1533 | 960.0000 | 43.8025 | 20.4125 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0011 | 20.0646 | 21.3076 |
| SB( W/m/K4) | 0.0000000567 | 40 | 0.666666667 | 121.98092413 | 0.40000000 | 588.1847 | 960.0000 | 63.8028 | 21.1615 | 20.0198 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0041 | 20.1212 | 21.668 |
| hc(w/m2K) | 20 | 50 | 0.833333333 | 107.34123542 | 0.40000000 | 666.5993 | 960.0000 | 86.9103 | 22.1747 | 20.0736 | 20.0009 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0095 | 20.1898 | 21.9993 |
| E | 1 | 60 | 1 | 92.76004596 | 0.40000000 | 722.2227 | 960.0000 | 111.6110 | 23.3803 | 20.1709 | 20.0044 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0007 | 20.0177 | 20.2679 | 22.3054 |
| Cp(J/kg/K) Specifc heat concrete | 880 | 70 | 1.166666667 | 80.21104184 | 0.40000000 | 759.8312 | 960.0000 | 136.6679 | 24.7109 | 20.3169 | 20.0122 | 20.0003 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0015 | 20.0289 | 20.3536 | 22.5896 |
| Tsurface( C) | 20 | 80 | 1.333333333 | 70.55826624 | 0.40000000 | 784.6603 | 960.0000 | 161.1889 | 26.1086 | 20.5130 | 20.0262 | 20.0008 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0027 | 20.0432 | 20.4453 | 22.8547 |
| ρ ( density Kg/m3 ) concrete | 2100 | 90 | 1.5 | 63.62730311 | 0.40000000 | 801.1484 | 960.0000 | 184.6154 | 27.5292 | 20.7581 | 20.0483 | 20.0020 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0045 | 20.0605 | 20.5416 | 23.1033 |
| | | 100 | 1.666666667 | 58.76671231 | 0.40000000 | 812.4734 | 960.0000 | 206.6536 | 28.9426 | 21.0488 | 20.0802 | 20.0041 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0004 | 20.0070 | 20.0809 | 20.6414 | 23.3372 |
| | | 110 | 1.833333333 | 55.30487449 | 0.40000000 | 820.6749 | 960.0000 | 227.1886 | 30.3303 | 21.3810 | 20.1230 | 20.0076 | 20.0003 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0007 | 20.0102 | 20.1042 | 20.7438 | 23.5582 |
| Fo | 0.04797 | 120 | 2 | 52.73376317 | 0.40000000 | 826.9764 | 960.0000 | 246.2136 | 31.6822 | 21.7499 | 20.1778 | 20.0128 | 20.0007 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0011 | 20.0143 | 20.1304 | 20.8481 | 23.7679 |
| | | 130 | 2.166666667 | 50.72113392 | 0.40000000 | 832.0850 | 960.0000 | 263.7806 | 32.9931 | 22.1509 | 20.2453 | 20.0201 | 20.0012 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0017 | 20.0192 | 20.1593 | 20.9538 | 23.9675 |
| | | 140 | 2.333333333 | 49.06551408 | 0.40000000 | 836.4034 | 960.0000 | 279.9702 | 34.2612 | 22.5796 | 20.3259 | 20.0300 | 20.0021 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0025 | 20.0251 | 20.1907 | 21.0602 | 24.158 |
| | | 150 | 2.5 | 47.64907496 | 0.40000000 | 840.1621 | 960.0000 | 294.8746 | 35.4861 | 23.0318 | 20.4198 | 20.0428 | 20.0033 | 20.0002 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0003 | 20.0035 | 20.0320 | 20.2244 | 21.1671 | 24.3405 |
| | | 160 | 2.666666667 | 46.40350796 | 0.40000000 | 843.4964 | 960.0000 | 308.5883 | 36.6686 | 23.5039 | 20.5270 | 20.0590 | 20.0051 | 20.0003 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0004 | 20.0047 | 20.0398 | 20.2604 | 21.2741 | 24.5157 |
| | | 170 | 2.833333333 | 45.28860794 | 0.40000000 | 846.4895 | 960.0000 | 321.2030 | 37.8100 | 23.9926 | 20.6474 | 20.0789 | 20.0074 | 20.0005 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0006 | 20.0062 | 20.0487 | 20.2985 | 21.3810 | 24.6844 |
| | | 180 | 3 | 44.27977252 | 0.40000000 | 849.1958 | 960.0000 | 332.8058 | 38.9116 | 24.4949 | 20.7805 | 20.1027 | 20.0105 | 20.0009 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0009 | 20.0079 | 20.0587 | 20.3384 | 21.4875 | 24.8472 |
| | | 190 | 3.166666667 | 43.36100304 | 0.40000000 | 851.6539 | 960.0000 | 343.4783 | 39.9751 | 25.0083 | 20.9262 | 20.1308 | 20.0145 | 20.0013 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0012 | 20.0100 | 20.0696 | 20.3801 | 21.5935 | 25.0045 |
| | | 200 | 3.333333333 | 42.52108442 | 0.40000000 | 853.8928 | 960.0000 | 353.2957 | 41.0022 | 25.5304 | 21.0838 | 20.1634 | 20.0194 | 20.0019 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0015 | 20.0125 | 20.0817 | 20.4234 | 21.6989 | 25.157 |
| | | 210 | 3.5 | 41.75153159 | 0.40000000 | 855.9359 | 960.0000 | 362.3281 | 41.9944 | 26.0592 | 21.2530 | 20.2006 | 20.0255 | 20.0026 | 20.0002 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0020 | 20.0153 | 20.0947 | 20.4682 | 21.8036 | 25.3049 |
| | | 220 | 3.666666667 | 41.04549325 | 0.40000000 | 857.8028 | 960.0000 | 370.6395 | 42.9533 | 26.5930 | 21.4330 | 20.2427 | 20.0328 | 20.0036 | 20.0003 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0003 | 20.0025 | 20.0184 | 20.1088 | 20.5143 | 21.9075 | 25.4487 |
| | | 230 | 3.833333333 | 40.39716512 | 0.40000000 | 859.5106 | 960.0000 | 378.2891 | 43.8806 | 27.1303 | 21.6235 | 20.2897 | 20.0415 | 20.0048 | 20.0005 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0004 | 20.0032 | 20.0220 | 20.1240 | 20.5617 | 22.0106 | 25.5886 |
| | | 240 | 4 | 39.80147111 | 0.40000000 | 861.0740 | 960.0000 | 385.3312 | 44.7777 | 27.6696 | 21.8236 | 20.3418 | 20.0516 | 20.0064 | 20.0007 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0005 | 20.0040 | 20.0260 | 20.1401 | 20.6102 | 22.1127 | 25.725 |
| | | 250 | 4.166666667 | 39.25388451 | 0.40000000 | 862.5063 | 960.0000 | 391.8158 | 45.6461 | 28.2098 | 22.0330 | 20.3990 | 20.0634 | 20.0083 | 20.0009 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0006 | 20.0049 | 20.0304 | 20.1572 | 20.6597 | 22.2139 | 25.8582 |
| | | 260 | 4.333333333 | 38.75032198 | 0.40000000 | 863.8195 | 960.0000 | 397.7887 | 46.4872 | 28.7499 | 22.2509 | 20.4612 | 20.0768 | 20.0106 | 20.0012 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0008 | 20.0059 | 20.0353 | 20.1752 | 20.7102 | 22.3141 | 25.9882 |
| | | 270 | 4.5 | 38.28707604 | 0.40000000 | 865.0242 | 960.0000 | 403.2919 | 47.3023 | 29.2889 | 22.4768 | 20.5286 | 20.0921 | 20.0133 | 20.0016 | 20.0002 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0010 | 20.0070 | 20.0406 | 20.1941 | 20.7615 | 22.4134 | 26.1154 |
| | | 280 | 4.666666667 | 37.86076798 | 0.40000000 | 866.1301 | 960.0000 | 408.3640 | 48.0927 | 29.8262 | 22.7101 | 20.6011 | 20.1092 | 20.0165 | 20.0021 | 20.0002 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0013 | 20.0084 | 20.0463 | 20.2140 | 20.8135 | 22.5118 | 26.2399 |
| | | 290 | 4.833333333 | 37.46831234 | 0.40000000 | 867.1458 | 960.0000 | 413.0405 | 48.8597 | 30.3611 | 22.9503 | 20.6787 | 20.1284 | 20.0203 | 20.0027 | 20.0003 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0002 | 20.0016 | 20.0098 | 20.0525 | 20.2347 | 20.8662 | 22.6091 | 26.362 |
| | | 300 | 5 | 37.10688807 | 0.40000000 | 868.0793 | 960.0000 | 417.3539 | 49.6043 | 30.8929 | 23.1968 | 20.7613 | 20.1496 | 20.0246 | 20.0034 | 20.0004 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0003 | 20.0019 | 20.0115 | 20.0592 | 20.2562 | 20.9195 | 22.7055 | 26.4816 |
| | | 310 | 5.166666667 | 36.77391403 | 0.40000000 | 868.9378 | 960.0000 | 421.3340 | 50.3277 | 31.4213 | 23.4491 | 20.8488 | 20.1729 | 20.0296 | 20.0043 | 20.0005 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0003 | 20.0023 | 20.0133 | 20.0664 | 20.2786 | 20.9734 | 22.8010 | 26.599 |
| | | 320 | 5.333333333 | 36.46702762 | 0.40000000 | 869.7277 | 960.0000 | 425.0081 | 51.0310 | 31.9458 | 23.7068 | 20.9411 | 20.1985 | 20.0353 | 20.0053 | 20.0007 | 20.0001 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0000 | 20.0001 | 20.0004 | 20.0027 | 20.0153 | 20.0740 | 20.3018 | 21.0277 | 22.8955 | 26.7143 |



| Variables | | At= Area of the compartment(m²) | Av=Area of the vent(m²) | Ω= (At - Av) / (Av√Hv) | Tmax C |
|---|---|---|---|---|---|
| Room width (m) | 11.2 | 350.205 | 8.225 | 26.29630916 | 1085.68204 |
| Room length (m) | 10.3 | | | | |
| Room height (m) | 2.97 | | | | |
| Height of the top of the vent (m) | 2.5 | | | | |
| Width of the vent (m) | 3.29 | | | | |

# Maximum Moment Reduction



| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Variables | | | t( minutes) | t(sec) | Ts C | Yield Strength(KSI) | Yield Strength kip/in² <=600 | a (in) | Me k-ft | Yield Strength kip/in >600<=1000 |
| | | | 108 | 6480 | 153.3231289 | 46.50161423 | 46.50161423 | 4.558981787 | 115.6826297 | -166.0593724 |
| | | | 108.16667 | 6490 | 153.4110802 | 46.4987828 | 46.4987828 | 4.558704196 | 115.678275 | -166.210777 |
| | | | 108.33333 | 6500 | 153.4989536 | 46.49595302 | 46.49595302 | 4.558426767 | 115.6739225 | -166.362355 |
| | | | 108.5 | 6510 | 153.5867493 | 46.49312489 | 46.49312489 | 4.558149499 | 115.6695722 | -166.5141068 |
| | | | 108.66667 | 6520 | 153.6744674 | 46.4902984 | 46.4902984 | 4.557872392 | 115.6652242 | -166.6660329 |
| | | | 108.83333 | 6530 | 153.7621083 | 46.48747354 | 46.48747354 | 4.557595445 | 115.6608783 | -166.8181338 |
| | | | 109 | 6540 | 153.8496721 | 46.48465031 | 46.48465031 | 4.557318658 | 115.6565346 | -166.97041 |

# APPENDIX P – FIRE SAFETY MANAGEMENT PLAN

# 1 Fire Safety Management Plan

This facility Fire Safety Management Plan (FSMP) has been prepared to establish procedures required by the CBC for pre-fire planning and occupant evacuation. It is also designed to provide information to emergency services about the nature of the emergency so that a safe and effective response may be initiated. The

## 1.1 Responsibilities and Duties

An effective FSMP requires the coordination of all people within the building. All building occupants, including employees and guests, need to be aware of their roles and responsibilities in case of an emergency. This section outlines specific responsibilities for employees, as well as the evacuation director and wardens. Visitors should also be instructed on proper response to alarms and the need to evacuate.

### 1.1.1 Responsibilities of All Employees

- Be familiar with building emergency procedures and act in the event of an emergency.
- Participate in drills and training as required.
- Inform and assist visitors unfamiliar with building procedures as appropriate prior to and during an emergency.
- Supervisors orient new employees of this plan upon hire.
- Be familiar with guidelines herein to evacuate, take refuge, or stay in place if you are a person with mobility disabilities.

### 1.1.2 Responsibilities of Evacuation Director and Evacuation Wardens

The evacuation director, evacuation wardens, and their alternates are employees who have been appointed (or have volunteered) to serve in these positions have the following responsibilities:

- Evacuation Director Responsibilities - The evacuation director is the administrative lead for this plan and acts as the liaison with the responding emergency services in the event of a building emergency. If an emergency occurs when the evacuation director or alternate is not available, an evacuation warden or a senior employee may serve as liaison.
- Evacuation Warden Responsibilities- The evacuation wardens are lead staff members who should perform the following duties:
    - Check the area for visitors and others who may need assistance responding to the emergency. Visitors and other transient occupants who may not be familiar with how to evacuate should be informed on the location of the nearest exit. Direct occupants to the exits and tell them where to assemble outside.
    - Direct persons with disabilities to follow their individual plan. It they don’t have one direct them to an area of refuge.
    - Sweep the area by walking, calling out, knocking on doors, and closing doors if possible as you exit the building. Encourage others to respond promptly. Be assertive when communicating the need to evacuate. As a general rule, evacuation wardens should not fight fire with fire extinguishers or otherwise. Their primary role is

to encourage occupants to move towards exits quickly and to communicate with the evacuation director at the evacuation assembly point.

  - Exit the building and communicate with exiting occupants where to assemble outside. If fire or smoke is observed, wardens must discontinue their activities and evacuate immediately before the space becomes untenable.
  - Once outside, assertively direct people to the evacuation assembly point so they don't obstruct traffic or emergency responders. Remain at least 30 feet from the affected building.
  - If anyone has specific information about the nature or location of the emergency, immediately report the information to the evacuation director who will relay the information to first responders at the incident command location.
  - Accounting for all personnel is optional. Attempt to identify persons who may have remained behind. This is especially important if the building emergency is known and the persons unaccounted for work in or near the affected area. Confer with supervisors and co-workers and use any available lists or floor plans.
  - Immediately report to the evacuation director any missing persons who may be in the building or in jeopardy.
  - When notified by the evacuation director, help communicate the all clear so the building may be reoccupied. Don't reoccupy in response to the alarm being silenced. Await a definitive message.

### 1.1.3 Required Training for Evacuation Director and Evacuation Wardens

The following training is required:

- Attendance at weekly in-house training classes.
- Review of hotel brand corporate training classes
- Organize and lead monthly fire drills (employees only not guests)
- Attend portable fire extinguisher training course.

### 1.1.4 Evacuation Procedures

These procedures focus on evacuation of occupants as a result of a fire or other building emergency:

- Assume all alarms are real unless an announcement has been made just prior to the alarm.
- Begin immediate evacuation of the building or area when outlined in building emergency procedures.
- Take keys and valuables and close doors behind you as you exit.
- Evacuate via the nearest stairwell or grade level exit. Do not prop doors open; doors must remain closed to keep prevent smoke migration in the event of a fire. Do not take elevators or go to the roof.
- Go to your pre-determined Evacuation Assembly Point (EAP), typically outdoors a safe distance from the building and out of the way of emergency services.
- Persons with disabilities who are unable to evacuate will follow their personal plan to take refuge or report to an area of evacuation assistance
- Evacuation floor plans help to identify exits and exit routes for the building. Occupants should go to the nearest exit when the alarm sounds. If access to the nearest exit is

obstructed, an alternate exit should be taken. The building’s floor plans and evacuation routes are posted throughout the building.

### 1.1.5 Building Specific Information

The building is equipped with a monitored fire alarm system. In the event of a fire alarm activation, signals are sent to a central monitoring station who notifies the San Diego Fire Department. Evacuate and call 911 to report specific information about the emergency.

The Outdoor Evacuation Point (EAP), is located on J street across the street from the main entry. Occupants need to meet there after evacuation so that they may be accounted for or lend assistance as needed.

The building is equipped with an automatic fire sprinkler system. The control valves (shut off valves) for the guest room areas are located in the stairwell of each floor. Engineering staff should be aware of these locations in case shutdown of the sprinkler system is necessary.

### 1.1.6 Building Fire Protection Equipment Description and Maintenance Protocol

The building’s fire protection equipment description can be found in the following sections of this report:

- Fire suppression, standpipe, and fire pump systems- Sections 4.3 and 4.4
- Fire emergency voice/alarm communication system Section 4.7

The building’s fire protection equipment maintenance protocol can be found in the following sections of this report:

- Fire suppression, standpipe, and fire pump systems- Section 4.6
- Fire emergency voice/alarm communication system Section 4.9

### 1.1.7 Conclusion

The Fire Safety Management Plan was developed specifically for the Gaslamp Hotel. The plan presents the duties and responsibilities of employees and the requirements for the maintenance and testing of fire protection equipment. A detailed description of the various fire safety components of building are summarized as well. Adherence to the plan is critical to the safety of hotel guests, employees, and responding fire fighters. Based upon discussions with hotel staff, the plan will be implemented.