

# Technology Campus



FPE 596 Culminating Project

Fire Life Safety Design of Technology Office

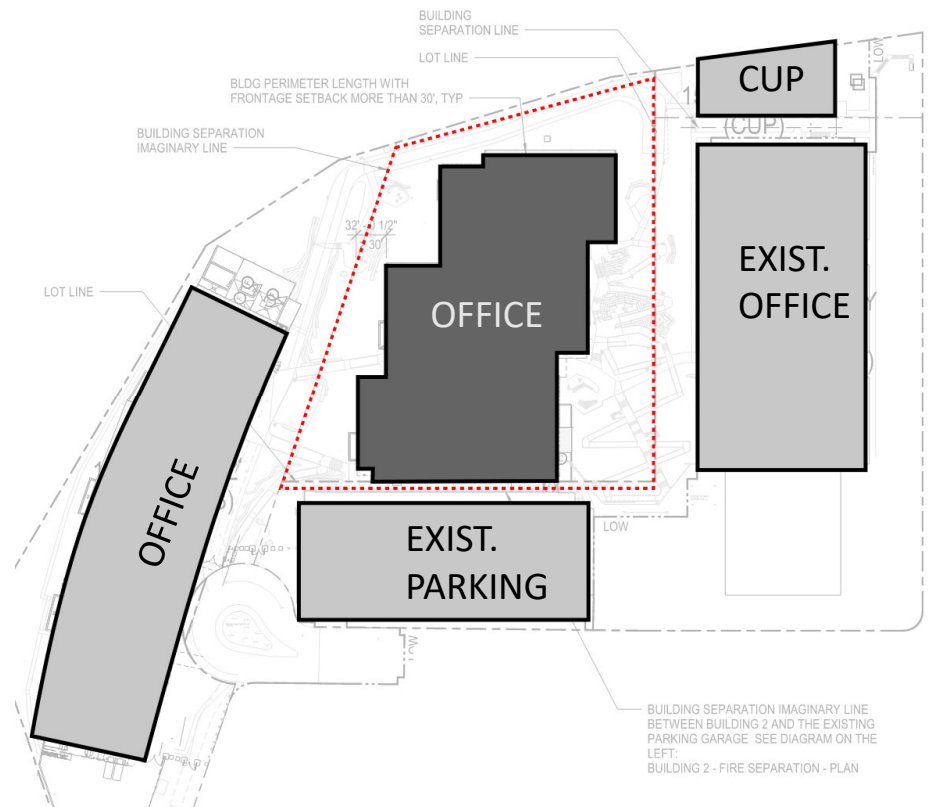
Jared Ellis

March 21, 2023

Slide 1

# Building Overview

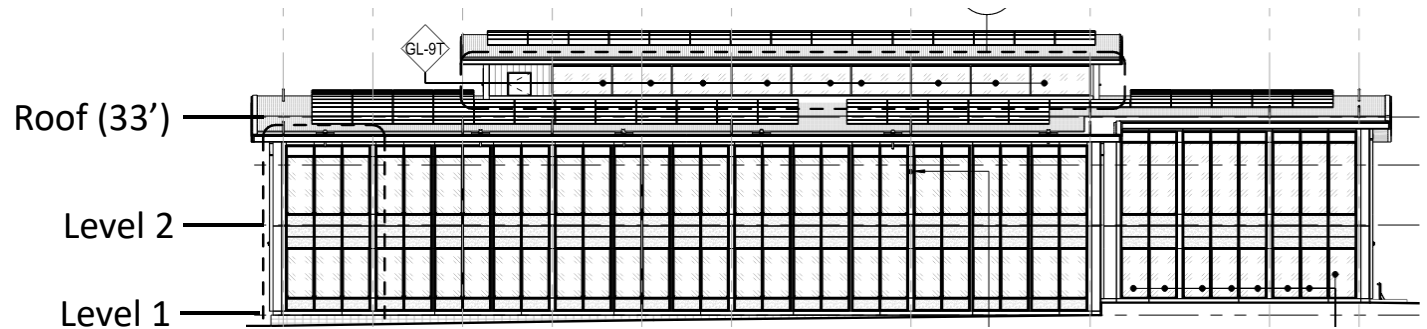
- Expansion of existing campus
- Owner-occupied
- Existing office building and parking garage present at site
- This phase includes 3 new buildings, including the subject building, another new office and a central utility plant (CUP).



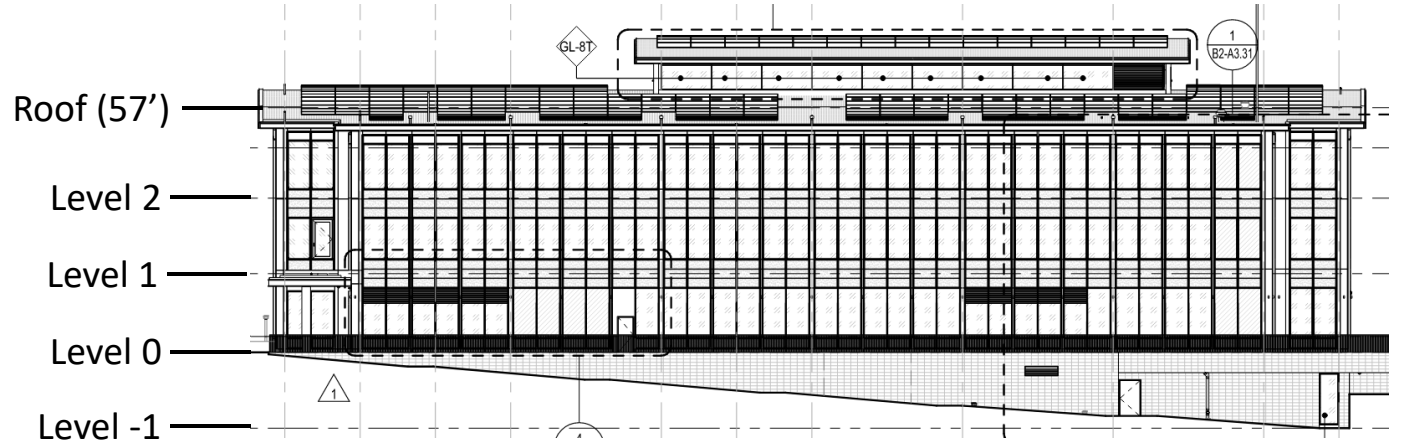
 **SITE PLAN**

# Building Overview

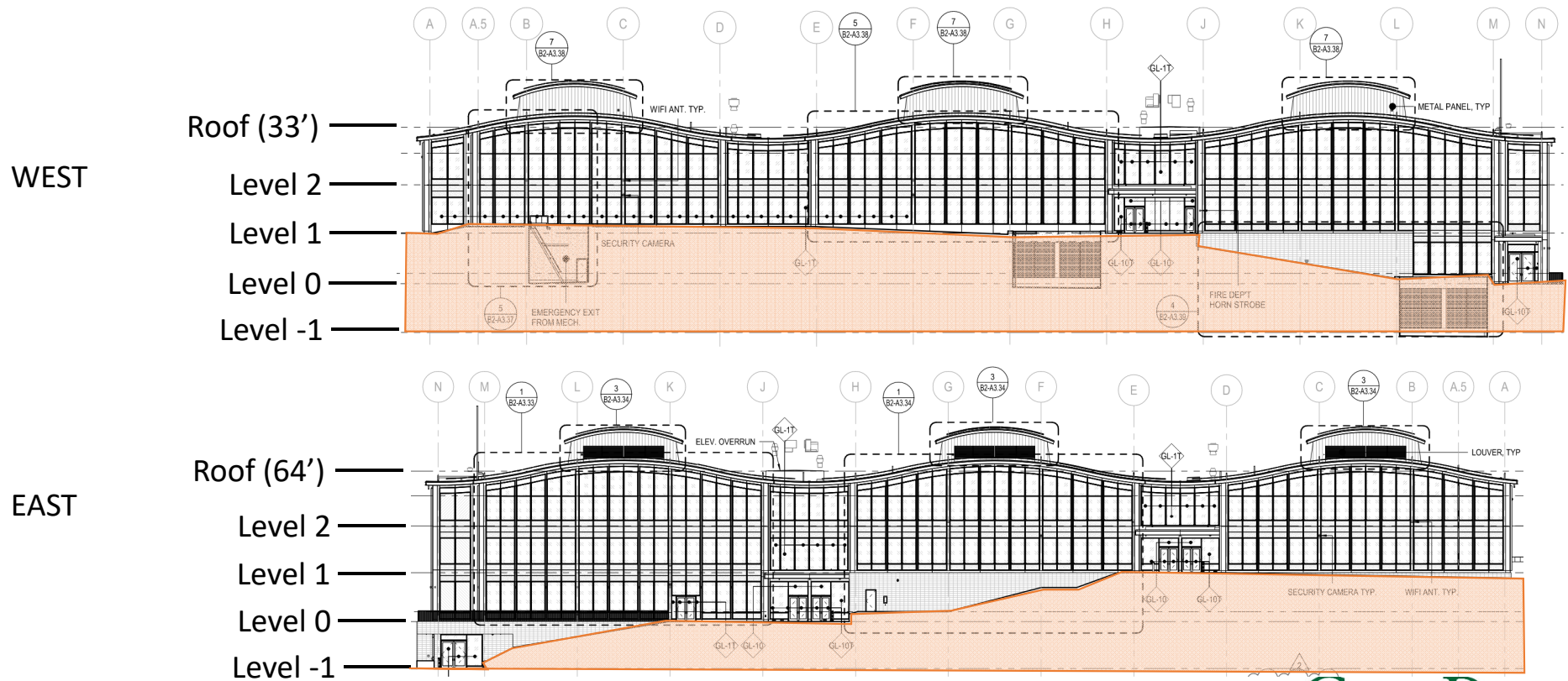
NORTH ELEVATION



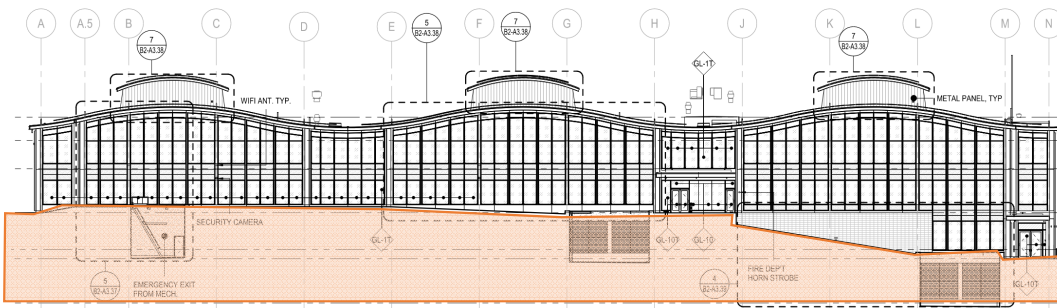
SOUTH ELEVATION



# Building Overview



# Building Overview

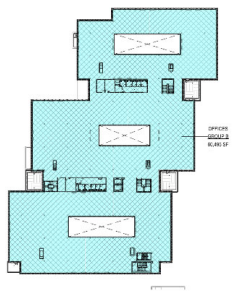


# Codes & Standards

- 2019 California Building, M,E,P, and Energy Codes (CBC), Parts 2 through 6
- 2019 California Fire Code, Part 9, CBSC
  - ERRC
    - NFPA 1221, 2016 – Standard for the Installation Maintenance and Use of Emergency Services Communications Systems
  - Fire Sprinkler
    - NFPA 13, 2016 – Standard For The Installation Of Sprinkler Systems
    - NFPA 14, 2016 – Standard For The Installation Of Standpipes & Hose Systems
    - NFPA 25, 2017 – Standard For The Inspection, Testing, And Maintenance
  - Fire Alarm
    - NFPA 72, 2016 – National Fire Alarm And Signaling Code

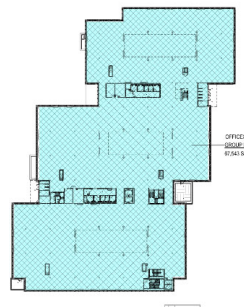
# Occupancy

Building Area	Occupancy
Café	Group A-2
Large Conference Room	Group A-3
Fitness	Group A-3
Conference Rooms < 735 SF	Group B
Offices	Group B
Transient Lobby	Group B
Mech Rooms, Utilities	Group S-2
Bike Parking	Group S-2



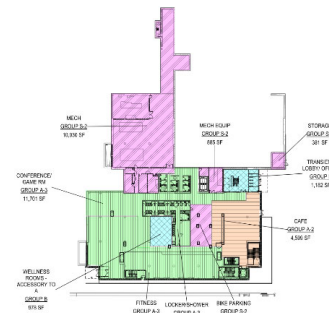
BUILDING 2 - LEVEL 2  
SCALE: 1" = 40'-0"

389



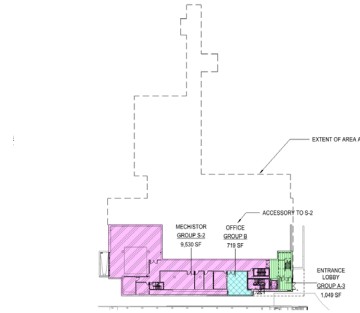
BUILDING 2 - LEVEL 1  
SCALE: 1" = 40'-0"

437



BUILDING 2 - LEVEL 0  
SCALE: 1" = 40'-0"  
(BASED ON INFORMATION PROVIDED)

752



BUILDING 2 - LEVEL -1  
SCALE: 1" = 40'-0"

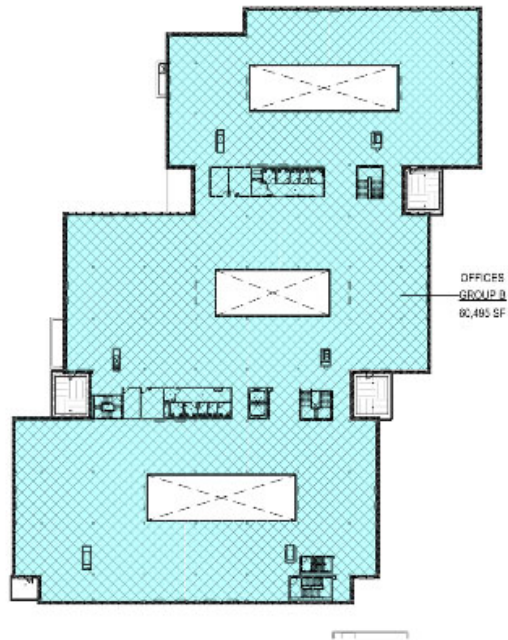
41



BUILDING 2 - LEVEL -2  
SCALE: 1" = 40'-0"

6

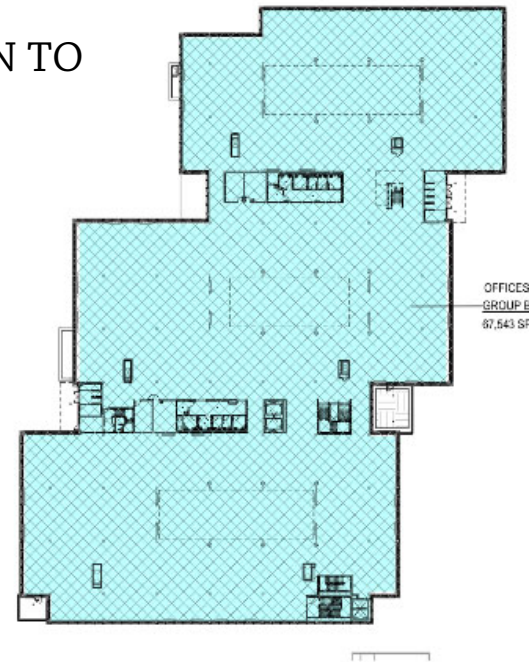
# Occupancy



5 BUILDING 2 - LEVEL 2  
SCALE: 1" = 40'-0"

389 OCC

LEVEL 2 OPEN TO FLOOR BELOW

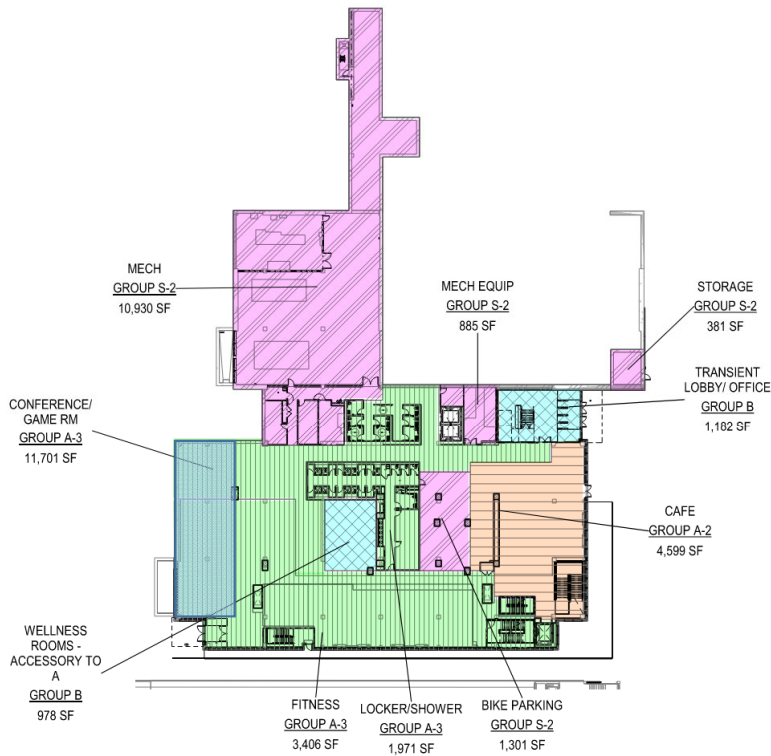


4 BUILDING 2 - LEVEL 1  
SCALE: 1" = 40'-0"

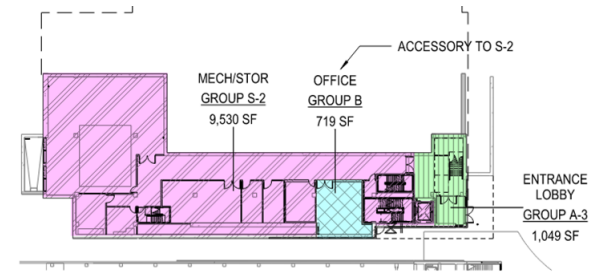
437 OCC



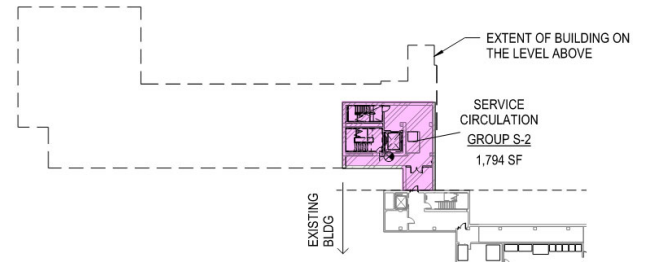
# Occupancy



**3 BUILDING 2 - LEVEL 0 (BASED ON ASSUMED TI PROGRAM) 752 OCC**  
B2-G1.02 SCALE: 1" = 40'-0"



**2 BUILDING 2 - LEVEL -1 41 OCC**  
B2-G1.02 SCALE: 1" = 40'-0"



**1 BUILDING 2 - LEVEL -2 6 OCC**  
B2-G1.02 SCALE: 1" = 40'-0"

# Construction Type

- In accordance with IBC 2021 Chapter 5 General Building Heights and Areas, specifically Table 504.3 and Table 504.4 the subject building is designated as TYPE IIIA.

- Confirm total allowable area is not exceeded
- Confirm Assembly area does not trigger occupancy upgrade

Sprinklered building	Type IIIA	
	Allowable Height	Allowable Stories
A with area increase	65 feet	3
B	85 feet >52	6 > 3
S-2	85 feet	5

Table 504.3

Building 2	Level	Occupancy Group	Area (SF)	Allowable Area (SF)	A/Aa (CBC 506.2.4)	
Construction Type IIIA Above Grade	Level 2 (180'-0")	B	60495	100320	0.603	
	Level 1 (165'-0")	B	67543	100320	0.673	
	Level 0 (149'-4")	A-2 (Cafe+Kitchen)	4599	49280	0.093	
		A-3 (Conference + Fitness)	17079	49280	0.347	
		B (Accessory to A)	2161	49280	0.044	
		B (Transient Lobby)	1182	100320	0.012	
		S-2 (Bike Parking + Mech)	13497	137280	0.098	
	Level -1 (Grade level) (134'-3")	A-3 (Lobby)	1049	49280	0.021	
	Construction Type IIIA Below Grade	Level -2 (Basement) (111'-4 13/16")	S-2 (Mech) + B accessory	10249	137280	0.075
			S-2 (Storage)	1794	137280	
CBC 506.2.4 Check	Total < 3				1.97	
	Group A Floor < 2				0.59	

# Passive Ratings

IBC/CBC Requirements:

**TABLE 601  
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)**

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B
Primary structural frame <sup>f</sup> (see Section 202)	3 <sup>a,b</sup>	2 <sup>a,b,c</sup>	1 <sup>b,c</sup>	0 <sup>c</sup>	1 <sup>b,c</sup>	0	3 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>	HT	1 <sup>b,c</sup>	0
Bearing walls												
Exterior <sup>e,f</sup>	3	2	1	0	2	2	3	2	2	2	1	0
Interior	3 <sup>a</sup>	2 <sup>a</sup>	1	0	1	0	3	2	2	1/HT <sup>g</sup>	1	0
Nonbearing walls and partitions Exterior	See Table 705.5											
Nonbearing walls and partitions Interior <sup>d</sup>	0	0	0	0	0	0	0	0	0	See Section 2304.11.2	0	0
Floor construction and associated secondary structural members (see Section 202)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary structural members (see Section 202)	1 1/2 <sup>b</sup>	1 <sup>b,c</sup>	1 <sup>b,c</sup>	0 <sup>c</sup>	1 <sup>b,c</sup>	0	1 1/2	1	1	HT	1 <sup>b,c</sup>	0

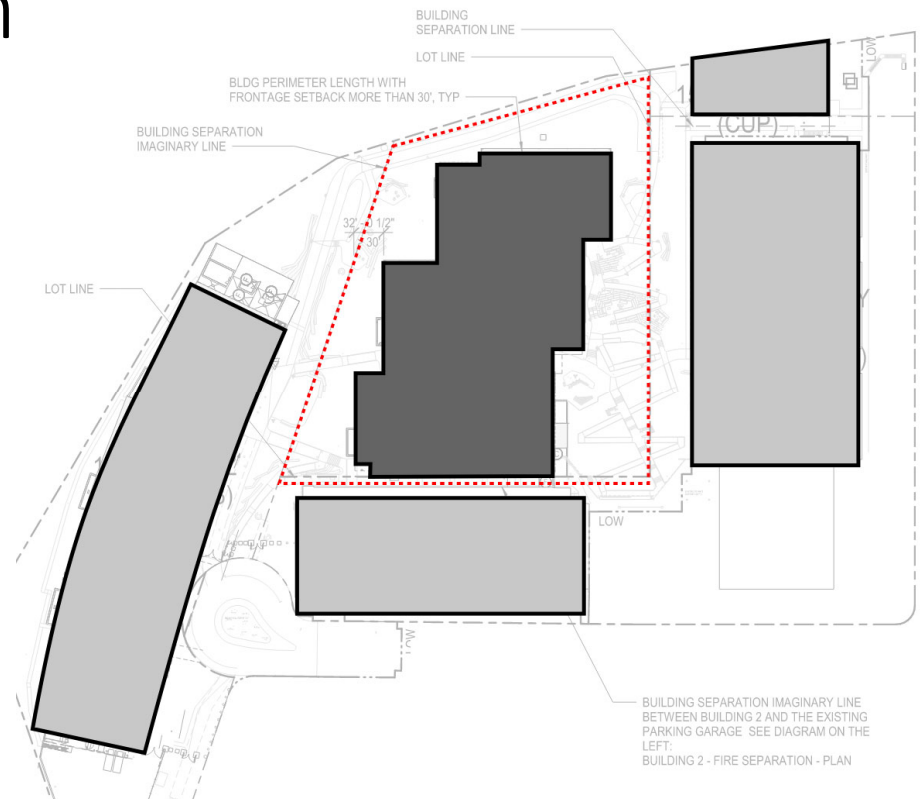
# Allowable Bldg Height:

TABLE 504.3  
ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE\*

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION												
	See Footnotes	Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A, B, E, F, M, S, U	NS <sup>b</sup>	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	270	180	85	85	70	60
H-1, H-2, H-3, H-5	NS <sup>c, d</sup>	UL	160	65	55	65	55	120	90	65	65	50	40
	S	UL	180	85	75	85	75	140	100	85	85	70	60
H-4	NS <sup>c, d</sup>	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	140	100	85	85	70	60
I-1 Condition 1, I-3	NS <sup>d, c</sup>	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	180	120	85	85	70	60
I-1 Condition 2, I-2	NS <sup>d, e, f</sup>	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85		65	55	65	65	65	65	50	40
I-4	NS <sup>d, z</sup>	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	180	120	85	85	70	60
R <sup>h</sup>	NS <sup>d</sup>	UL	160	65	55	65	55	65	65	65	65	50	40
	S13D	60	60	60	60	60	60	60	60	60	60	50	40
	S13R	60	60	60	60	60	60	60	60	60	60	60	60
	S	UL	180	85	75	85	75	270	180	85	85	70	60

# Building Separation

- Compliance with Table 602 as referenced by 705.5
- More than 30 ft to north property line
- More than 60 ft to Bldgs to east and west
- 15 ft separation to south requires rated wall



— SITE PLAN

# Interior Wall and Ceiling Finishes – ASTM E84

TABLE 803.13  
INTERIOR WALL AND CEILING FINISH REQUIREMENTS BY OCCUPANCY\*

GROUP	SPRINKLERED <sup>1</sup>			NONSPRINKLERED		
	Interior exit stairways and ramps and exit passageways <sup>a, b</sup>	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces <sup>c</sup>	Interior exit stairways and ramps and exit passageways <sup>a, b</sup>	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces <sup>c</sup>
A-1 & A-2	B	B	C	A	A <sup>d</sup>	B <sup>c</sup>
A-3 <sup>f</sup> , A-4, A-5	B	B	C	A	A <sup>d</sup>	C
B, E, M, R-1	B	C <sup>m</sup>	C	A	B	C
R-4	B	C	C	A	B	B
F	C	C	C	B	C	C
H	B	B				
I-1	B	C				
I-2	B	B				
I-3	A	A <sup>i</sup>				
I-4	B	B				
R-2	C	C	C	B	B	C
R-3	C	C	C	C	C	C
S	C	C	C	B	B	C
U	No restrictions			No restrictions		

Class B = Flame spread index 26–75; smoke-developed index 0–450.

Class C = Flame spread index 76–200; smoke-developed index 0–450.

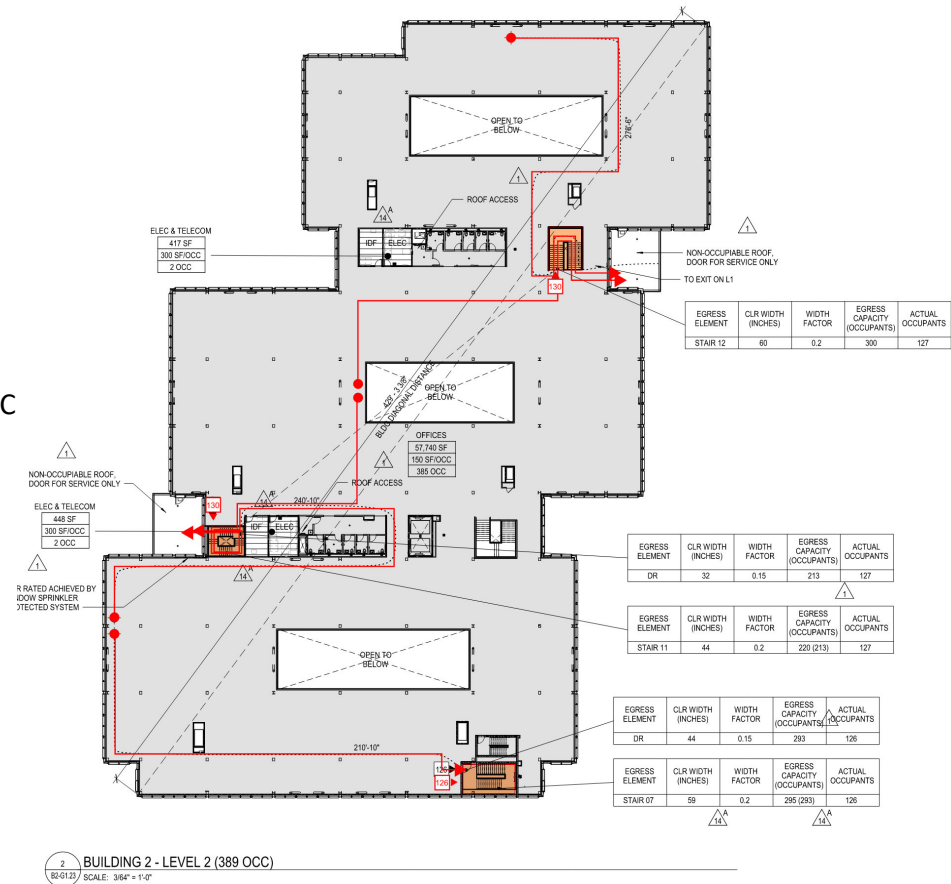
# Egress

## • Sizing

- Door and stair widths, 0.15" and 0.2" per occupant respectively
  - Per IBC 1005.3.2 exception 1 and 1005.3.1. exception 1
  - Sprinklered in accordance w/ IBC 903.1 and
  - Emergency Voice/Alarm Communication in accordance w/ IBC

EGRESS ELEMENT	CLR WIDTH (INCHES)	WIDTH FACTOR	EGRESS CAPACITY (OCCUPANTS)	ACTUAL OCCUPANTS
DR	32	0.15	213	127

EGRESS ELEMENT	CLR WIDTH (INCHES)	WIDTH FACTOR	EGRESS CAPACITY (OCCUPANTS)	ACTUAL OCCUPANTS
STAIR 11	44	0.2	220 (213)	127



# Egress L1

- 4 exits, actual/capacity

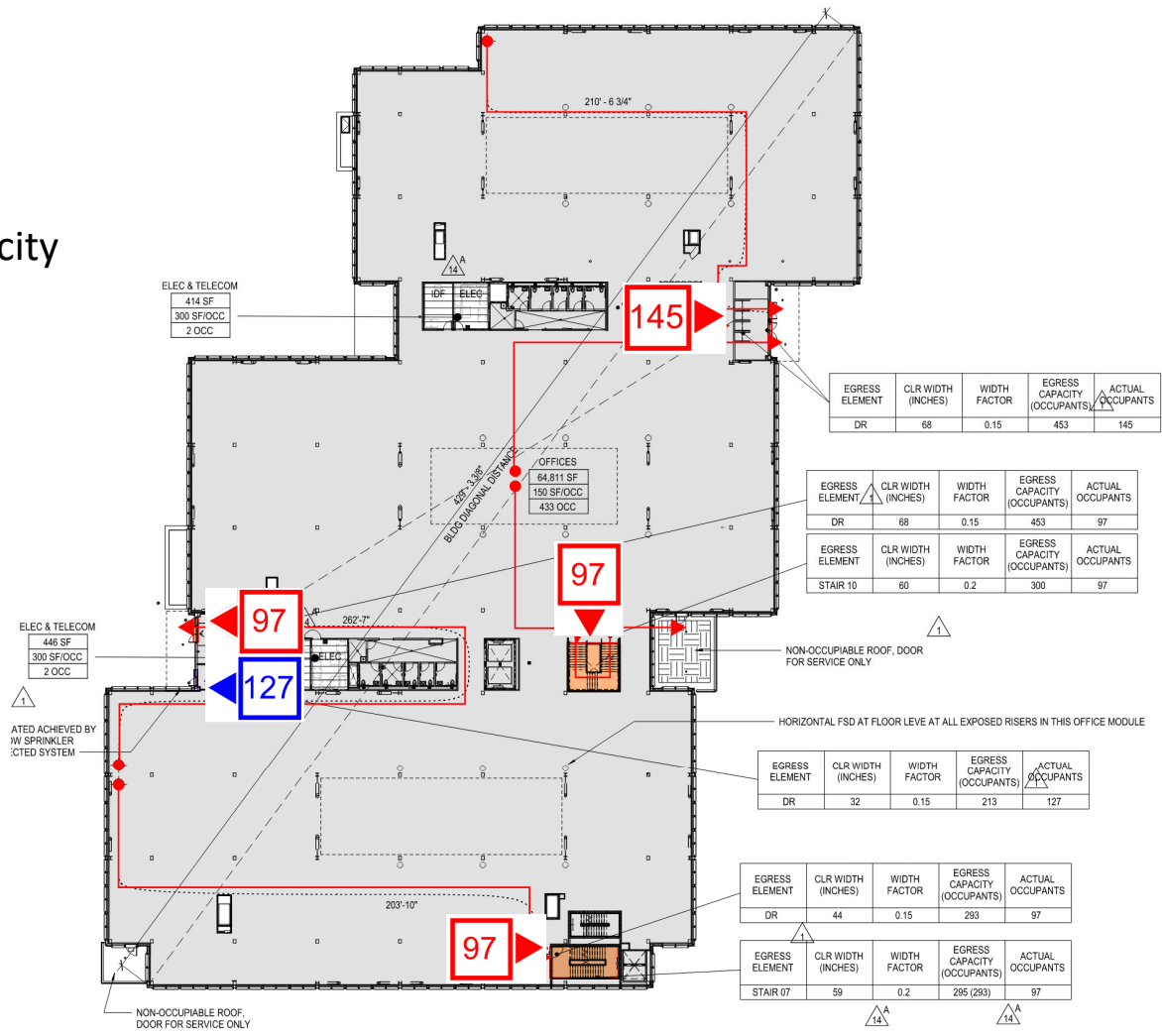
145/453

97/453

97/300

+ 97/293

436/1499





# Egress LO

- 5 exits

3/213

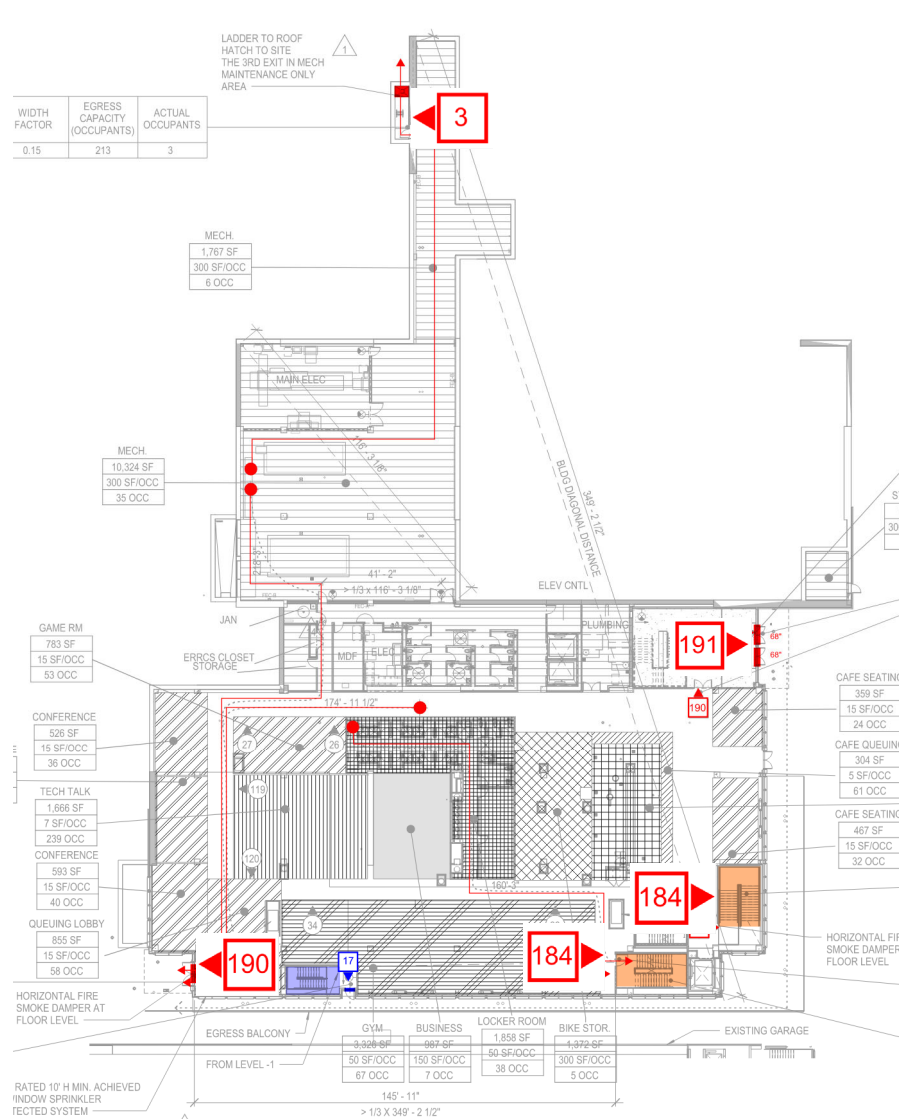
191/453

184/360

184/260

190/453

752/1739



# Fire Alarm

- A NFPA 72 compliant fire detection, notification and communication system, including:
  - FACU, Cabinets, Audio Amplifiers (Notifier NFS2-3020)
  - Smoke Detection in Electrical and Technology (MDF/IDF) Rooms
  - Smoke Detection in elevator lobbies with recall
  - Smoke Detection and shutdown for AC units (smoke control)
  - Audible and visual (speaker strobes and strobes) throughout
  - Manual pull stations at egress exits

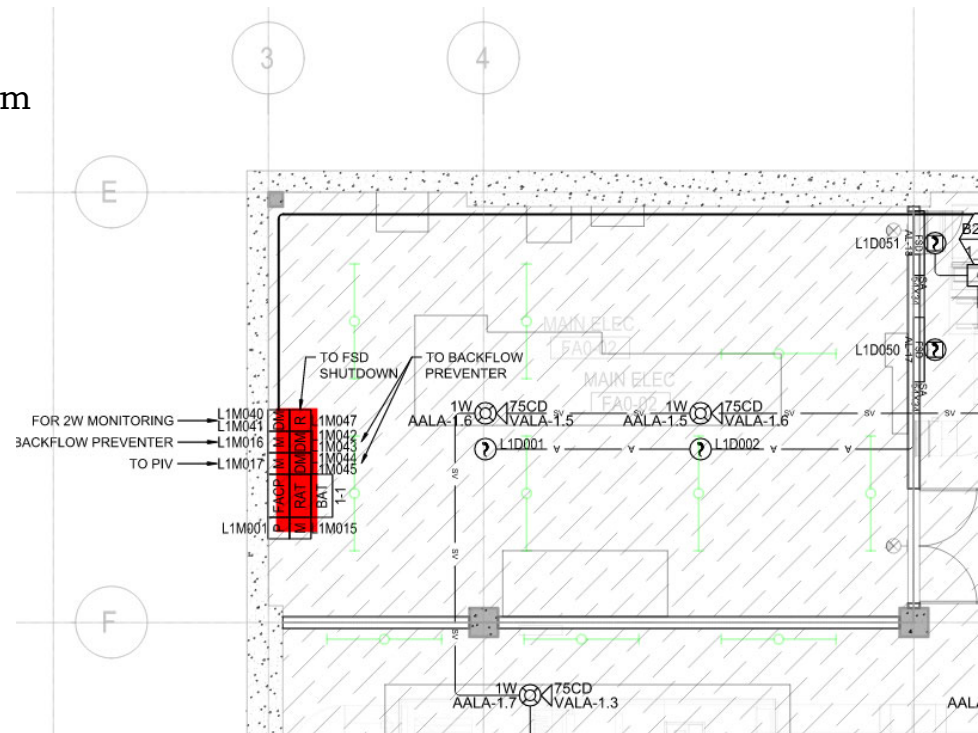
# Fire Alarm

“MAY I HAVE YOUR ATTENTION PLEASE, THERE HAS BEEN A FIRE REPORTED IN THE BUILDING, PLEASE EXIT THE BUILDING USING THE NEAREST EXIT. DO NOT USE THE ELEVATOR”.

SPACE / ROOM	INTELLIGIBLE	AUDIBILITY	VISUAL
OFFICE ( <300 SQ. FT.), PHONE	NO	YES	NO
FLEX WORK, OPEN OFFICE, LOBBY, RECEPTION	YES	YES	YES
CONFERENCE ROOMS ( >200 SQ. FT.), TECH TALK, COFFEE, LAB, GAME ROOM, LOUNGE, HALLWAY	YES	YES	YES
CONFERENCE ROOMS ( <200 SQ. FT.), HUDDLE, COPY, MOTHERS, MASSAGE, TOILET, RESTROOM, SHOWER, MEDITATION	NO	YES	YES
ELECTRICAL, STORAGE, JANITOR, AV, POD	NO	NO	NO
MDF, IDF	NO	NO	YES

# Fire Alarm

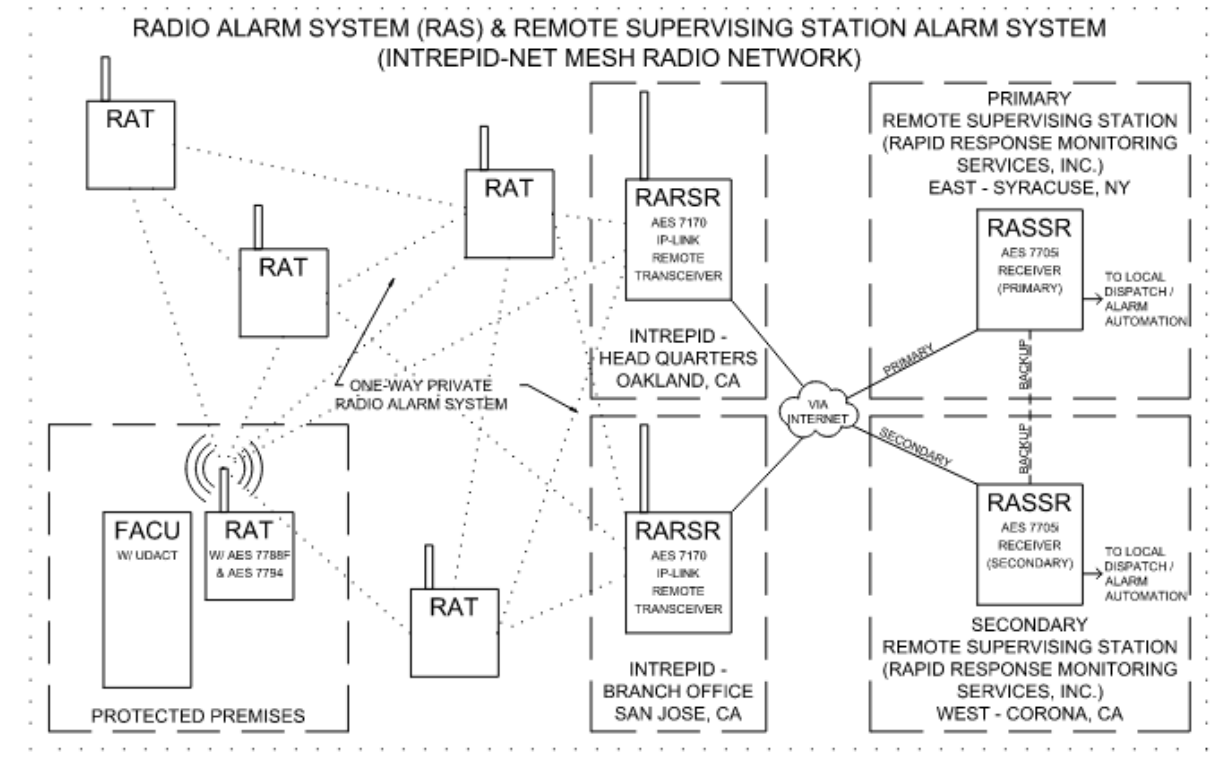
- FACP located on Level 0, in Main Electrical Room



Level 0 – Amenities Level  
 Northwest corner

# Fire Alarm

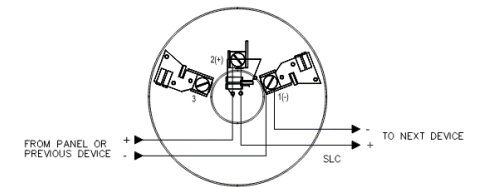
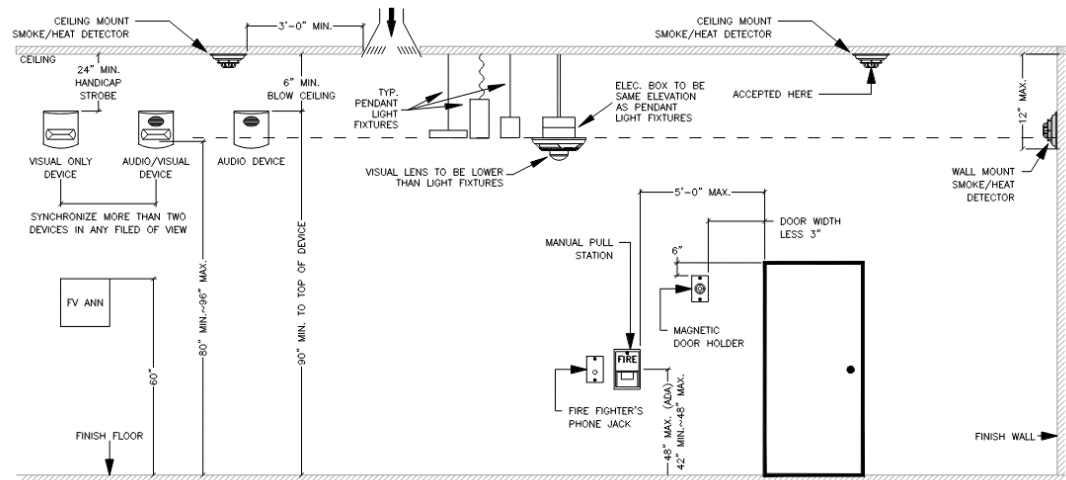
- Remotely monitored for
  - Fire Alarm
  - Fire Supervisory
  - General Trouble
- Emergency Responder Radio Coverage System (ERRCS)



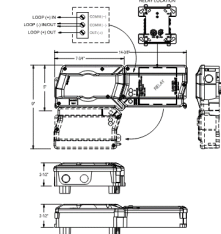
# Fire Alarm

- NFPA 72 Compliance
  - Initiating Devices Ch 17
  - Notification Devices Ch 18

23	23	①	SMOKE DETECTOR; HEAD; ADDRESSABLE	NOTIFIER	FSP-951	7272-0028:0503
23	23	—	SMOKE DETECTOR; BASE; ADDRESSABLE	NOTIFIER	B210LP	7300-1653:0109
11	11	②	DUCT SMOKE DETECTOR; BASE; ADDRESSABLE	NOTIFIER	DNRW	3242-1653:0209
11	11	—	DUCT SMOKE DETECTOR; HEAD; ADDRESSABLE	NOTIFIER	FSP-951	7272-0028:0503
11	11	—	DUCT SMOKE DETECTOR; BASE; ADDRESSABLE	NOTIFIER	B210LP	7300-1653:0109



MOUNTING INSTRUCTIONS:  
MOUNT BASE ON BOX WHICH IS AT LEAST 1.5" DEEP. SUITABLE BOXES INCLUDE 4" SQUARE, 3-1/2" OR 4" OCTAGONAL BOX. SINGLE GANG BOX (EXCEPT RELAY OR ISOLATOR BASE).



# Fire Alarm



• Speaker Strobe



• Strobe



• Smoke Detector



Level 2 – North Pod – Representative Reflected Ceiling Plan

# Fire Alarm



• Speaker Strobe



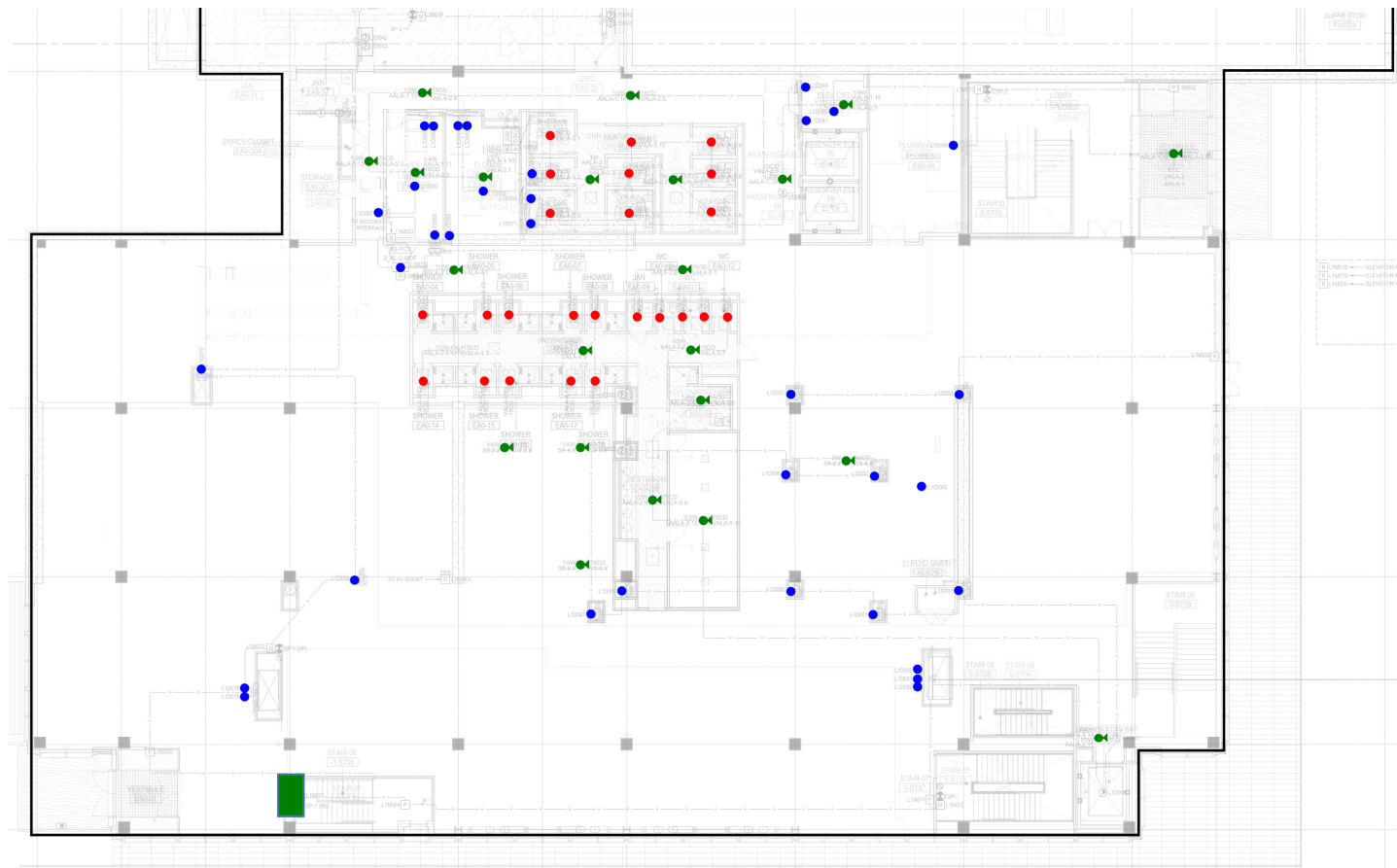
• Strobe



• Smoke Detector



• Remote  
Annunciator &  
Microphone



Level 0 – South Pod – Amenity Level





# Fire Sprinklers

- Fully Sprinklered, hydraulic designed per NFPA 13, 2016 Section 11.2.5 Water Demand Requirements – Hydraulic Calculation Methods.
- Ch 19 General Design Approach, Occupancy Hazard Fire Control
- Wet Pipe System, Class I and II Standpipes
- CMDA, office levels and rooms have are light hazard while mechanical, electrical, and misc. storage are ordinary hazard 1, ranging from 0.15 gpm/sf to 0.20 gpm/sf respectively. Sprinkler areas do not exceed 1500 square feet. Occupancy densities include an additional 0.05 GPM/SF.
- Typically quick response, k=5.6 sprinklers are used in pendant, concealed, and horizontal positions.



## Series TY-FRB – 2.8, 4.2, 5.6, and 8.0 K-Factor Upright, Pendant, and Recessed Pendant Sprinklers Quick Response, Standard Coverage

### General Description

The TYCO Series TY-FRB 2.8, 4.2, 5.6, and 8.0 K-factor Upright, Pendant, and Recessed Pendant Sprinklers described herein are quick response, standard coverage, decorative 3 mm glass bulb-type spray sprinklers. They are designed for use in light or ordinary hazard, commercial occupancies such as banks, hotels, and shopping malls.

The TY-FRB Recessed Pendant Sprinkler, where applicable, is intended for use in areas with a finished ceiling. This recessed pendant sprinkler uses one of the following Recessed Escutcheons:

- A two-piece Style 10 (1/2 in. NPT) or Style 40 (3/4 in. NPT) Recessed Escutcheon with 1/2 in. (12.7 mm) of recessed adjustment or up to 3/4 in. (19.1 mm) of total adjustment from the flush pendant position.
- A two-piece Style 20 (1/2 in. NPT) or Style 30 (3/4 in. NPT) Recessed Escutcheon with 1/4 in. (6.4 mm) of recessed adjustment or up to 1/2 in. (12.7 mm) of total adjustment from the flush pendant position.

The adjustment provided by the Recessed Escutcheon reduces the accuracy to which the fixed pipe drops to the sprinklers must be out.

Corrosion-resistant coatings, where applicable, are utilized to extend the life of copper alloy sprinklers beyond what would be obtained when exposed

**IMPORTANT**  
Refer to Technical Data Sheet TFP3300 for warnings pertaining to regulatory and health information. Always refer to Technical Data Sheet TFP100 for the "INSTALLER WARNING" that provides cautions with respect to handling and installation of sprinkler systems and components. Improper handling and installation can permanently damage a sprinkler system or its components and cause the sprinkler to fail to operate in a fire situation or cause it to operate prematurely.

Page 1 of 12

to corrosive atmospheres. Although corrosion-resistant coated sprinklers have passed the standard corrosion tests of the applicable approval agencies, the testing is not representative of all possible corrosive atmospheres. Consequently, it is recommended that the end user be consulted with respect to the suitability of these coatings for any given corrosive environment. The effects of ambient temperature, concentration of chemicals, and gas/



Worldwide Contacts | www.tyco-fire.com

## Series RFI1 – 5.6 K-factor "Royal Flush II" Concealed Pendant Sprinklers Quick & Standard Response, Standard Coverage

### General Description

The TYCO Series RFI1 5.6 K-factor, "Royal Flush II" Concealed Pendant Sprinklers Quick Response (3 mm bulb) and Standard Response (5 mm bulb), are decorative sprinklers featuring a flat cover plate designed to conceal the sprinkler. These sprinklers are optimal for architecturally sensitive areas such as hotel lobbies, office buildings, churches, and restaurants.

Each sprinkler includes a Cover Plate/Retainer Assembly and a Sprinkler Support Cup Assembly. The separable, two-piece assembly design provides the following benefits:

- Allows installation of the sprinkler and pressure testing of the fire protection system prior to installation of a suspended ceiling or application of the finish coating to a fixed ceiling.
- Permits the removal of suspended ceiling panels for access to building service equipment without having to first shut down the fire protection system and remove sprinklers.
- Provides for 1/2 in. (12.7 mm) of vertical adjustment to allow a measure of flexibility in determining the length of fixed piping to cut for the sprinkler drops.

The Series RFI1 Sprinklers are shipped with a Disposable Protective Cap. The Protective Cap is temporarily removed during installation and replaced to help protect the sprinkler during ceiling installation or finish. The top of the Protective Cap can be used to mark the center of the ceiling hole into plaster board or ceiling tiles by gently pushing the ceiling product against the Protective Cap. When ceiling installation is complete, the Protective Cap is removed and the Cover Plate/Retainer Assembly is installed.

As an option, the Series RFI1 Standard Responses (5 mm bulb) "Royal Flush II" Concealed Pendant Sprinklers can be fitted with a silicone Air and Dust Seal. See Figure 5. The Air and Dust Seal is desirable to prevent air and dust from the area above the ceiling to pass through the cover plate.

**NOTE:**  
The Series RFI1 Concealed Pendant Sprinklers described herein must be installed and maintained in compliance with this document and with the applicable standards of the NATIONAL FIRE PROTECTION ASSOCIATION (NFPA), in addition to the standards of any authorities having jurisdiction. Failure to do so may impair the performance of these devices.

The owner is responsible for maintaining their fire protection system and devices in proper operating condition. The installing contractor or sprinkler manufacturer should be contacted with any questions.

### Sprinkler Identification Number (SIN)

TF3351 – 3 mm bulb

TF3352 – 5 mm bulb

Page 1 of 4

AUGUST 2020

TFP181



### Technical Data

**Sprinkler Approvals**  
Approvals apply only to the service conditions indicated in the Design Criteria section.

- TY331 (3 mm Bulb) is UL Listed, C-UL Listed and NYC Approved (MEA 353-R-I) as Quick Response.
- TY331 (3 mm Bulb) is VES Approved (Certificate No. 1403000).
- TY331 (3 mm Bulb) is FM and LPCB Approved (Ref. No. 004470) as Standard Response.

**Note:** FM and LPCB do not approve concealed sprinklers for quick response.

- TY331 (5 mm Bulb) is UL Listed, C-UL Listed, FM Approved, LPCB Approved (Ref. No. 004470), and NYC Approved (MEA 353-R-I) as Standard Response.

**Approvals for Air and Dust Seal**  
UL and C-UL Listed for use with the RFI1 Standard Recessed Concealed Sprinkler (TF3551).

**Maximum Working Pressure**  
Maximum 250 psi (17.2 bar) by UL, C-UL, and NYC.

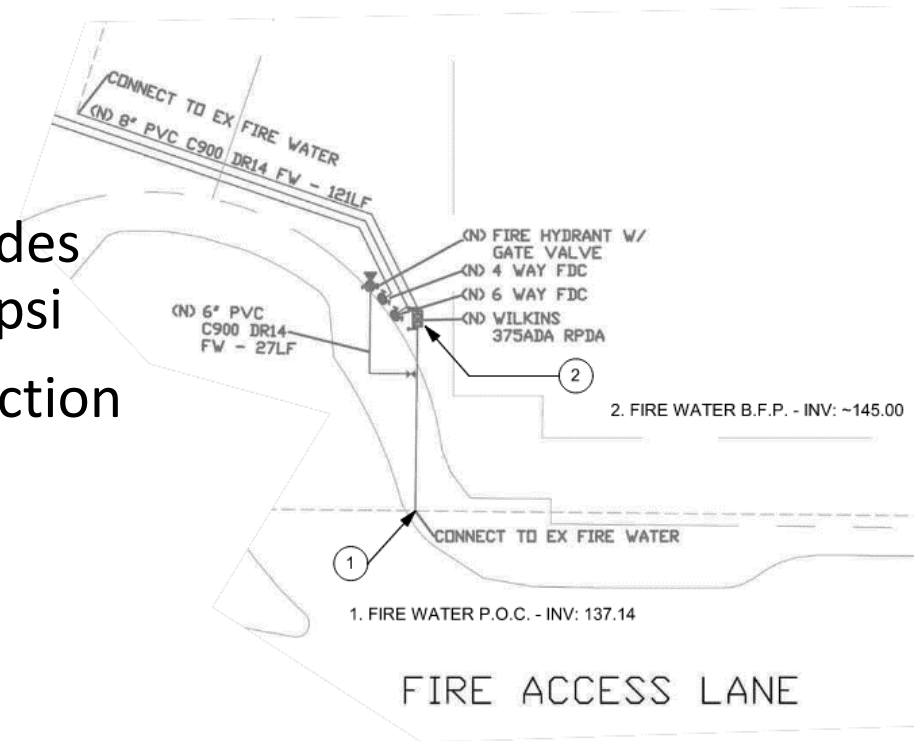
Maximum 175 psi (12.1 bar) by FM, VES, and LPCB.

**Temperature Rating**  
157°F (70°C) Sprinkler with UL or C-UL Cover Plate.

200°F (93°C) Sprinkler with 157°F (70°C) Cover Plate.

# Fire Sprinklers

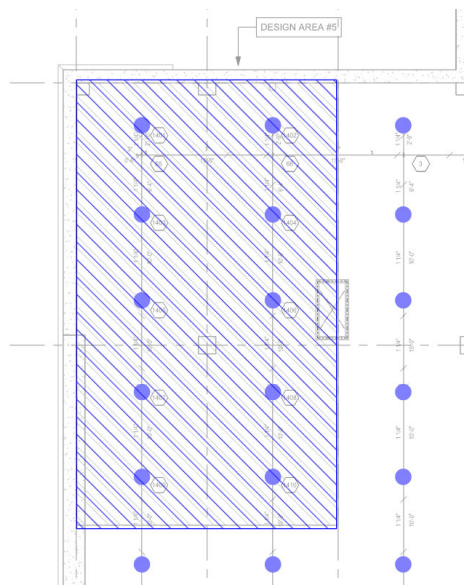
- Municipal 8" underground PVC provides roughly 900 gpm at a pressure of 95 psi
- Larger cross mains at 3" to reduce friction losses
- Public Works flow test at hydrant



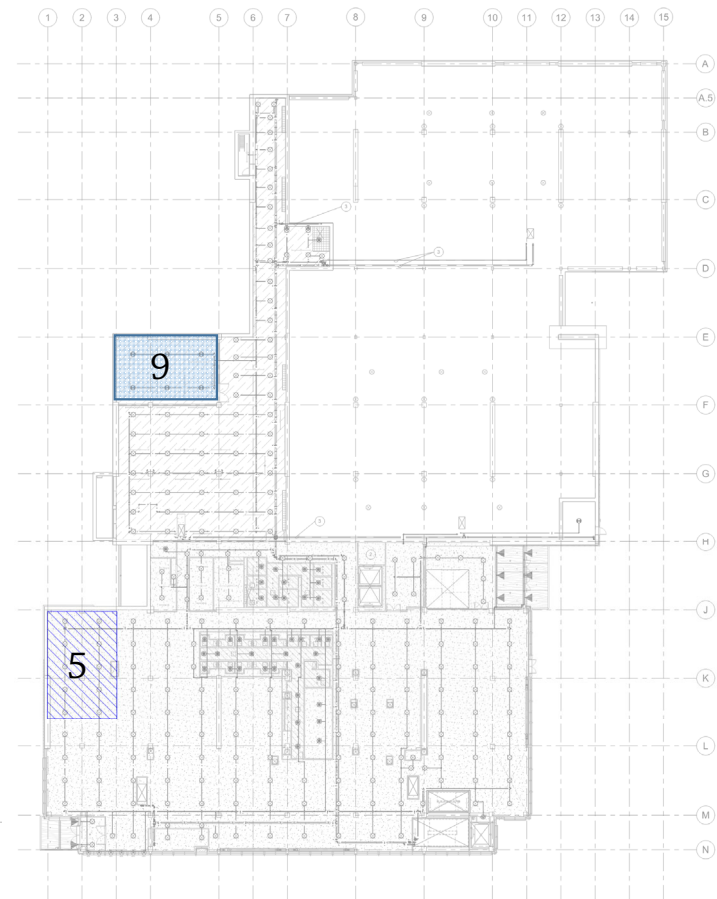
# Fire Sprinklers

HYDRAULIC CALCULATION INDEX							
DESIGN / REMOTE AREA	SHEET	LEVEL & ZONE	LOCATION / SPACE	DESIGN CLASSIFICATION	AMMR Density	AREA SIZE	NOTES
1	B2-FP2.31	LEVEL -2	CORRIDOR [EA-2-01]	LIGHT HAZARD	.15 gpm/sqft	715 SQFT	CORRIDOR IS LESS THAN 1,500 SQFT
2	B2-FP2.31	LEVEL -1	MECHANICAL [EA-1-12]	ORDINARY HAZARD I	.20 gpm/sqft	1,500 SQFT	N/A
3	B2-FP2.31	LEVEL -1	STOR [EA-1-09]	ORDINARY HAZARD I	.20 gpm/sqft	806 SQFT	STORAGE AREA IS LESS THAN 1,500 SQFT
4	B2-FP2.31	LEVEL -1	STORAGE [EA-1-06] & [EA-1-05]	ORDINARY HAZARD I	.20 gpm/sqft	~550 SQFT	STORAGE AREA IS LESS THAN 1,500 SQFT
5	B2-FP2.32A	LEVEL 0 - SOUTH	FUTURE OFFICE	LIGHT HAZARD	.20 gpm/sqft	1,500 SQFT	INCREASED DENSITY FOR FUTURE USE OF FLEXS
6	B2-FP2.32A	LEVEL 0 - SOUTH	STORAGE [EA0-30]	ORDINARY HAZARD I	.20 gpm/sqft	~300 SQFT	STORAGE AREA IS LESS THAN 1,500 SQFT
7	B2-FP2.32A	LEVEL 0 - SOUTH	FUTURE CAFE / KITCHEN	ORDINARY HAZARD I	.20 gpm/sqft	1,500 SQFT	N/A
8	B2-FP2.32B	LEVEL 0 - NORTH	MECH [FA0-01]	ORDINARY HAZARD I	.20 gpm/sqft	1,500 SQFT	N/A
9	B2-FP2.32B	LEVEL 0 - NORTH	MAIN ELEC [FA0-02]	ORDINARY HAZARD I	.20 gpm/sqft	1,300 SQFT	EXTENDED COVERAGE SPRINKLER
10	B2-FP2.33A	LEVEL 1 - SOUTH - ZONE 3	FUTURE OFFICE (CORE & SHELL)	LIGHT HAZARD	.15 gpm/sqft	1,500 SQFT	FLEXHEADS INCLUDED FOR IA-BUILD-OUT
11	B2-FP2.33B	LEVEL 1 - NORTH - ZONE 2	FUTURE OFFICE (CORE & SHELL)	LIGHT HAZARD	.15 gpm/sqft	1,500 SQFT	FLEXHEADS INCLUDED FOR IA-BUILD-OUT
12	B2-FP2.33B	LEVEL 1 - NORTH - ZONE 1	FUTURE OFFICE (CORE & SHELL)	LIGHT HAZARD	.15 gpm/sqft	1,500 SQFT	FLEXHEADS INCLUDED FOR IA-BUILD-OUT
13	B2-FP2.34A	LEVEL 2 - SOUTH - ZONE 3	FUTURE OFFICE (CORE & SHELL)	LIGHT HAZARD	.15 gpm/sqft	1,500 SQFT	FLEXHEADS INCLUDED FOR IA-BUILD-OUT
14	B2-FP2.34B	LEVEL 2 - NORTH - ZONE 2	FUTURE OFFICE (CORE & SHELL)	LIGHT HAZARD	.15 gpm/sqft	1,500 SQFT	FLEXHEADS INCLUDED FOR IA-BUILD-OUT
15	B2-FP2.34B	LEVEL 2 - NORTH - ZONE 1	FUTURE OFFICE (CORE & SHELL)	LIGHT HAZARD	.15 gpm/sqft	1,500 SQFT	FLEXHEADS INCLUDED FOR IA-BUILD-OUT
16	B2-FP2.35A	LEVEL 2 - SOUTH - ZONE 3	ROOF MONITOR / MECHANICAL	LIGHT HAZARD / OH I	.15 & .20 gpm/sqft	1,500 SQFT	MIXED OCCUPANCY

# Fire Sprinklers

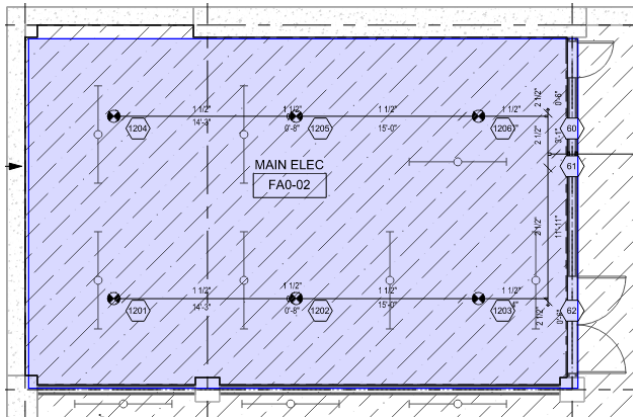


Hydraulic Information	
Design / Remote Area #	5
Area of Calculation	1500 ft <sup>2</sup>
Occupancy Classification	Light Hazard
Density	0.20 GPM
Total Hose Streams	250.00 GPM
Flowing Heads	16
K-Factor	5.6
Total Water Required	735.21 GPM
Total Pressure Required	73.86 psi
Base of Riser	485.21 GPM
Base of Riser	62.09 psi
Safety Margin	+23.08 (23.81%)

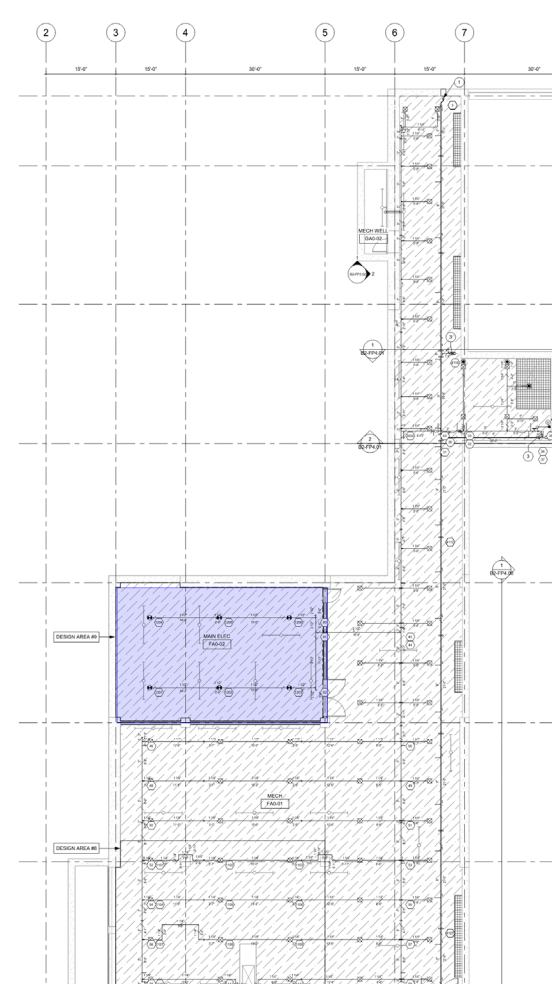


Level 0 – Amenities Level

# Fire Sprinklers

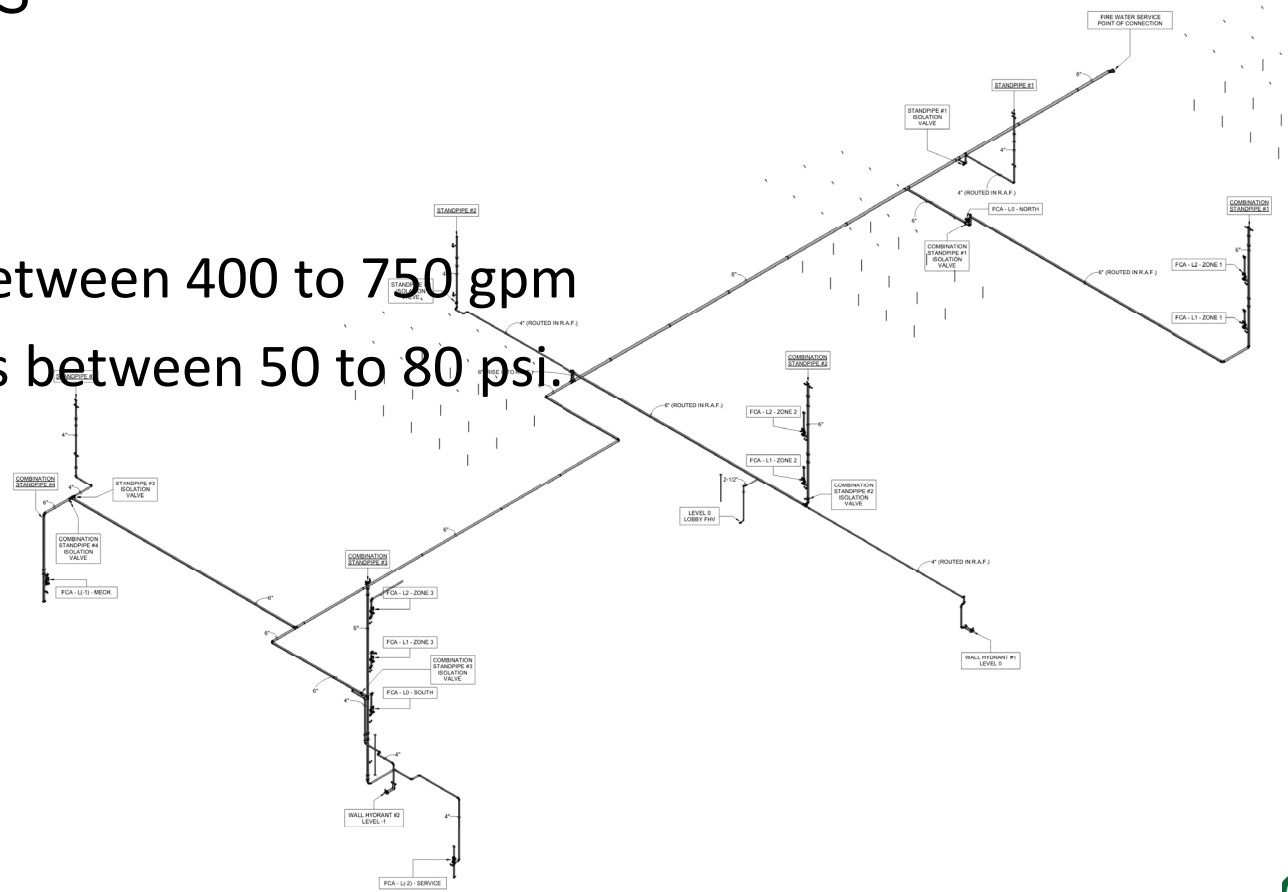


Hydraulic Information	
Design / Remote Area #	9
Area of Calculation	1285 ft <sup>2</sup>
Occupancy Classification	Ordinary Hazard Group 1
Density	0.20 GPM
Total Hose Streams	0.00 GPM
Flowing Heads	12
K-Factor	11.2
Total Water Required	511.02 GPM
Total Pressure Required	78.93 psi
Base of Riser	287.08 GPM
Base of Riser	62.53 psi
Safety Margin	+18.04 (18.61%)

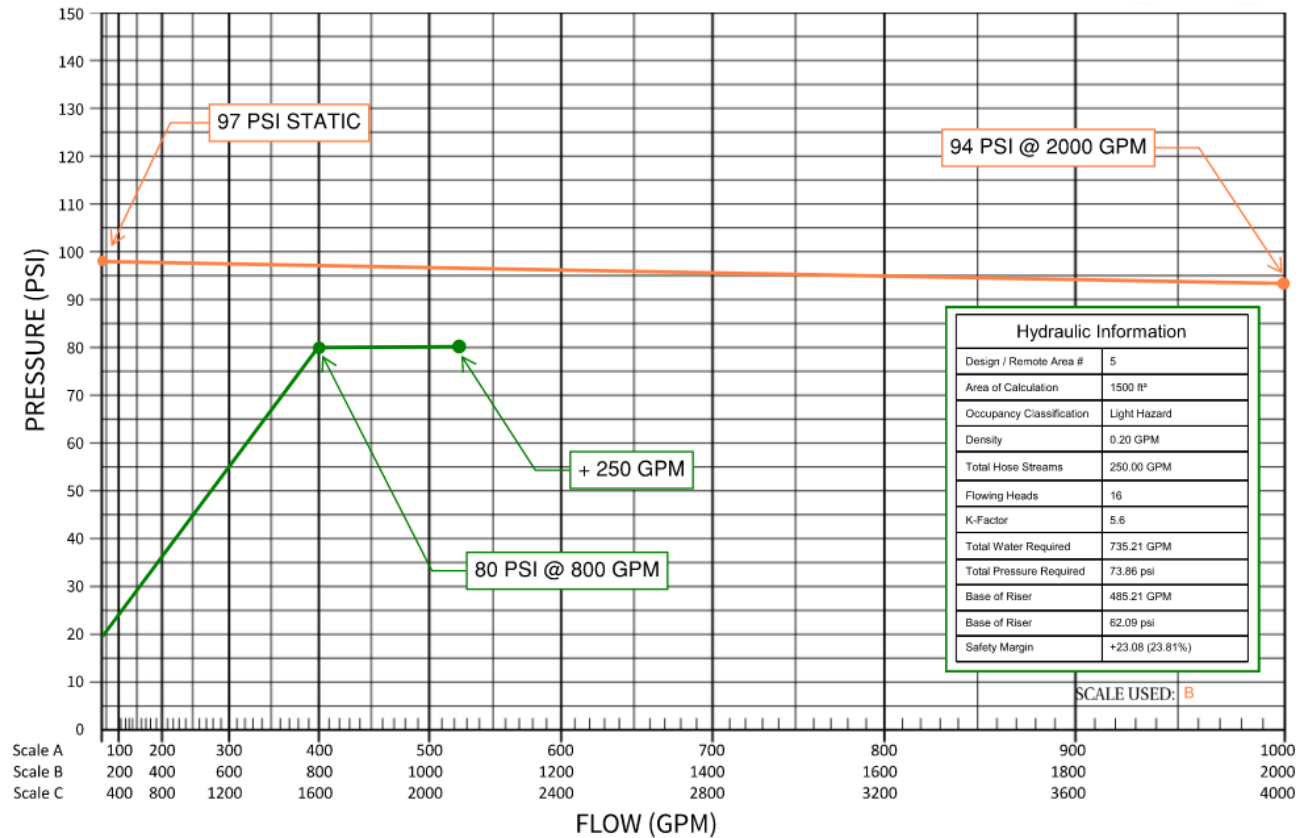


# Fire Sprinklers

- 16 design areas
- Flows demands between 400 to 750 gpm
- Pressure demands between 50 to 80 psi.



# Fire Sprinklers



Slide 33

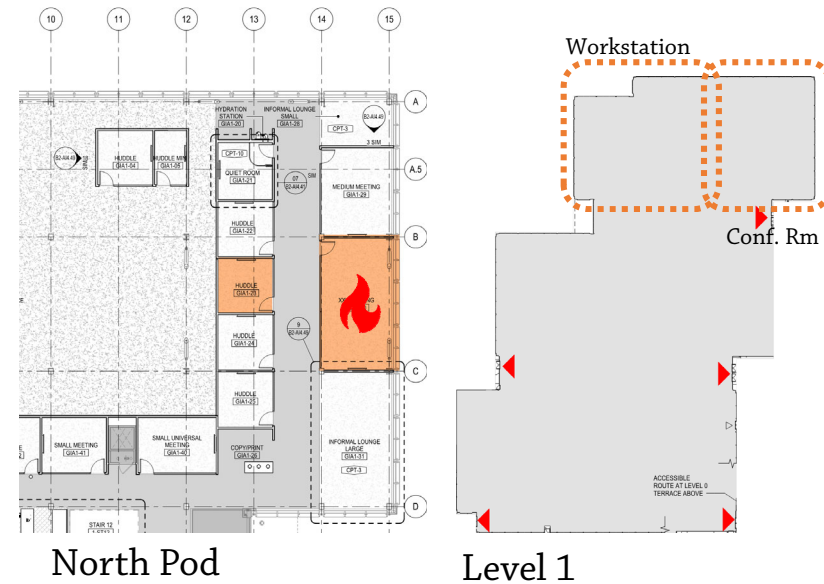


# Performance Based Design

- Life-Safety Objective ( $RSET < ASET$ )
  - Design Fires
  - ASET (FDS model)
  - RSET (SFPE Calculation)
- Exposed Timber Variance
  - Structural Fire Design
  - Check Thermal Exposure for realistic char

# Design Fires

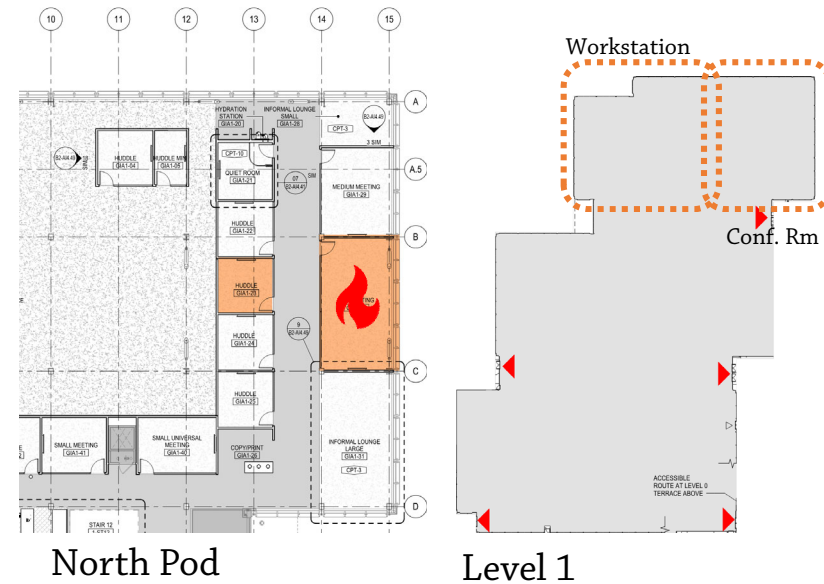
- NFPA 101 §5.5.3 Design Fire Scenarios
  1. Occupancy Specific, Typical
  2. Ultrafast growth, limiting egress
  3. Unoccupied origin, migrating to high-risk area
  4. Concealed origin, migrating to high-risk area
  5. Slow growth, secondary ignition
  6. Most severe, largest possible fuel load under normal operation of the building
  7. Exterior fire, blocking exits.
  8. Ordinary combustibles, sprinklers or passive assumed to fail.
    1. AHJ can waive if high reliability and single system performance are acceptable.



Level 0 – Amenities Cafe

# Design Fires

- NPFA 101 §5.5.3 Design Fire Scenarios
  1. **Occupancy Specific, Typical (workstations)**
  2. Ultrafast growth, limiting egress
  3. Unoccupied origin, migrating to high-risk area
  4. Concealed origin, migrating to high-risk area
  5. **Slow growth, secondary ignition (café)**
  6. **Most severe, largest possible fuel load under normal operation of the building (conf)**
  7. Exterior fire, blocking exits.
  8. **Ordinary combustibles, sprinklers or passive assumed to fail. (all)**
    1. AHJ can waive if high reliability and single system performance are acceptable.



North Pod

Level 1



Level 0 – Amenity Cafe

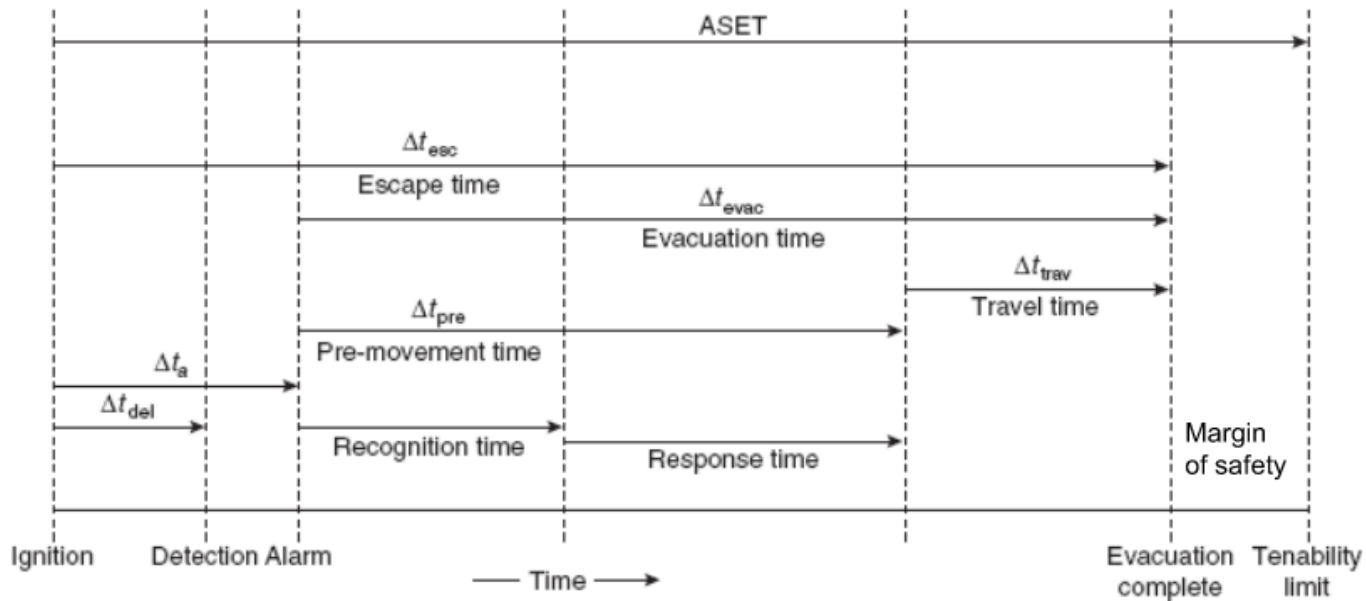
# Design Fires

- Design Fire Scenarios

1. NIST Office Workstations (1. Typical, 8. Sprinklers Fail) – 6 MW @ 5 min
2. NIST CLT Conference Room (6. Severe, 8. Sprinklers Fail) – 6 MW @ 25 min
  1. Small Conference Room – 2 MW @ 25 minutes
  2. XXL Conference Room – 6 MW @ 25 minutes
3. Café Fire (5. Secondary Ignition, 8. Sprinklers Fail) – 2 MW @ 15 minutes

# Life-Safety: RSET < ASET

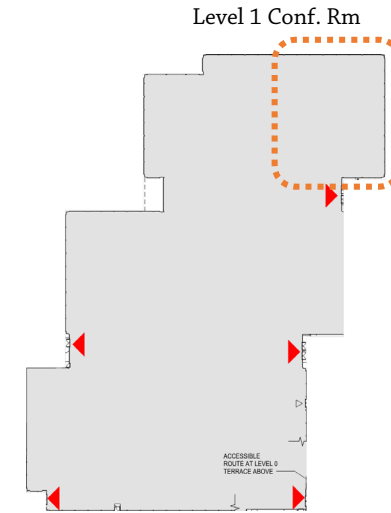
SFPE Handbook, 3rd Edition:



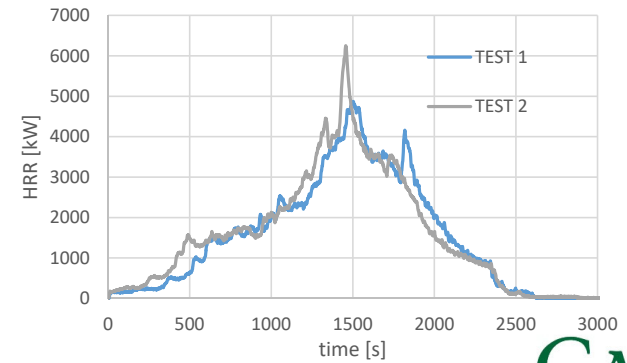
# NIST CLT Conference Room



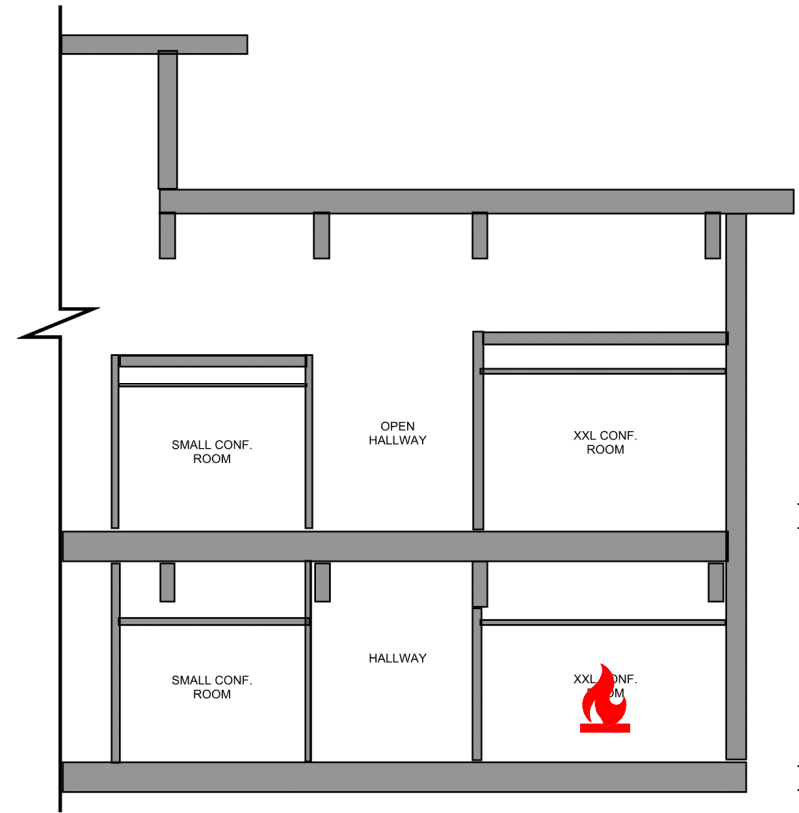
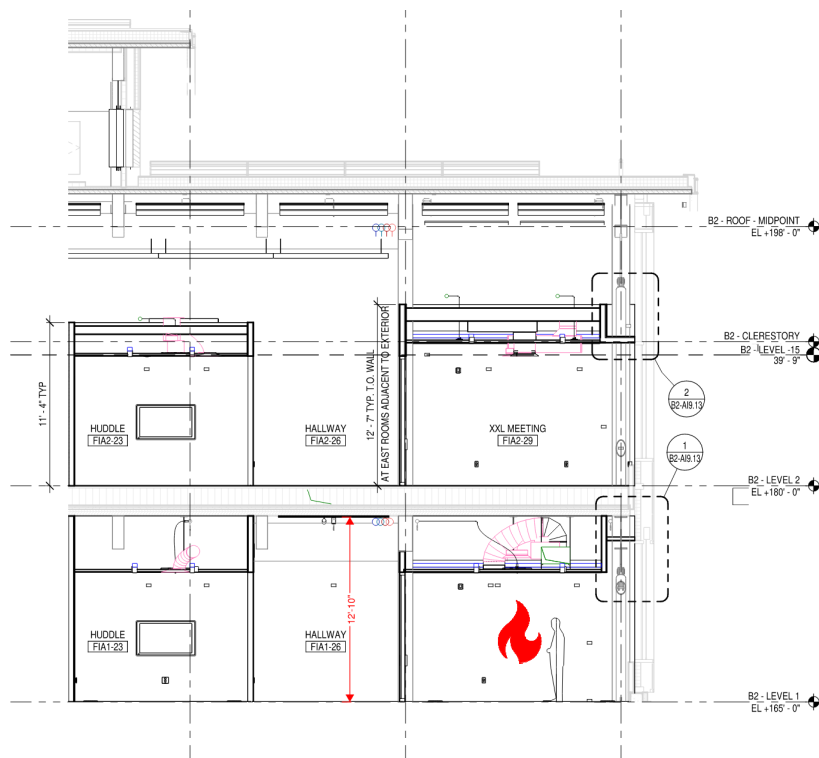
Level 1



NIST CLT XXL Conf. Room



# Egress and Tenability - ASET

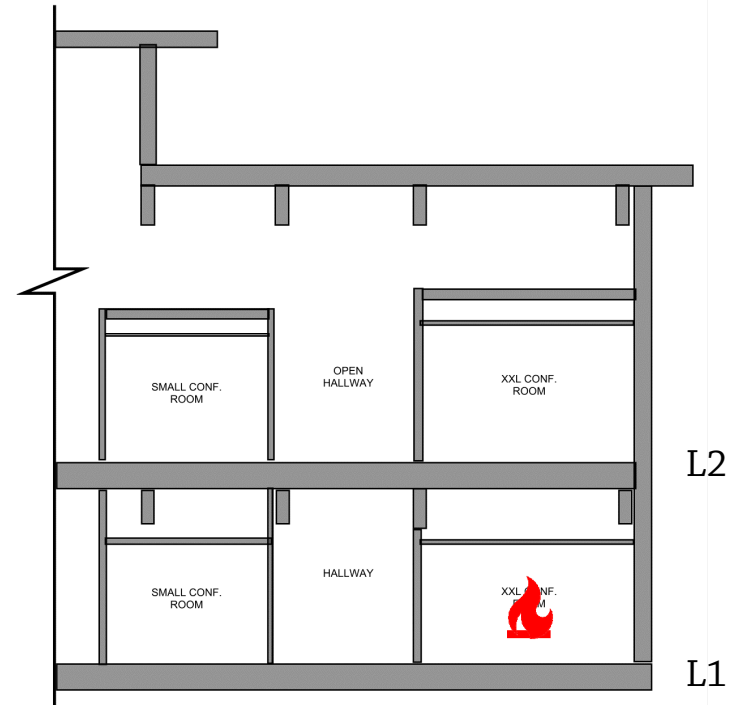
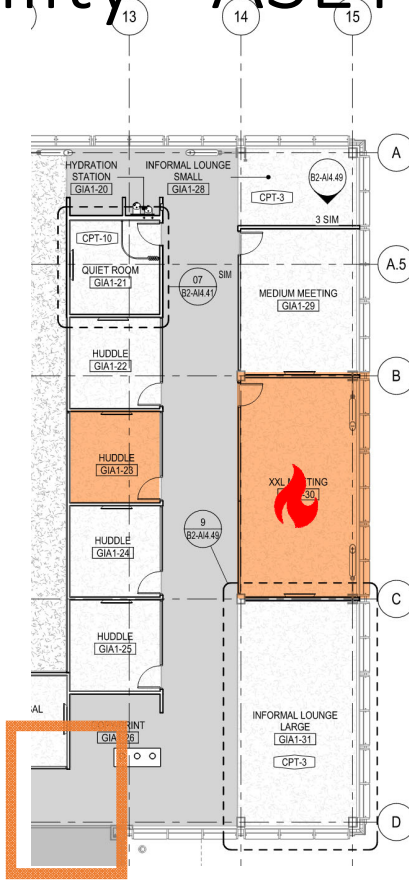
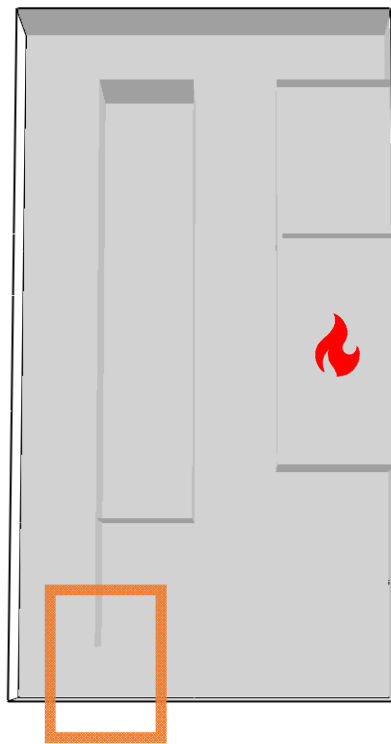


Level 2

Level 1

1 INTERIOR ELEVATION - EAST MEETING ROOMS  
B2-A301 SCALE: 1/4" = 1'-0"

# Egress and Tenability - ASET

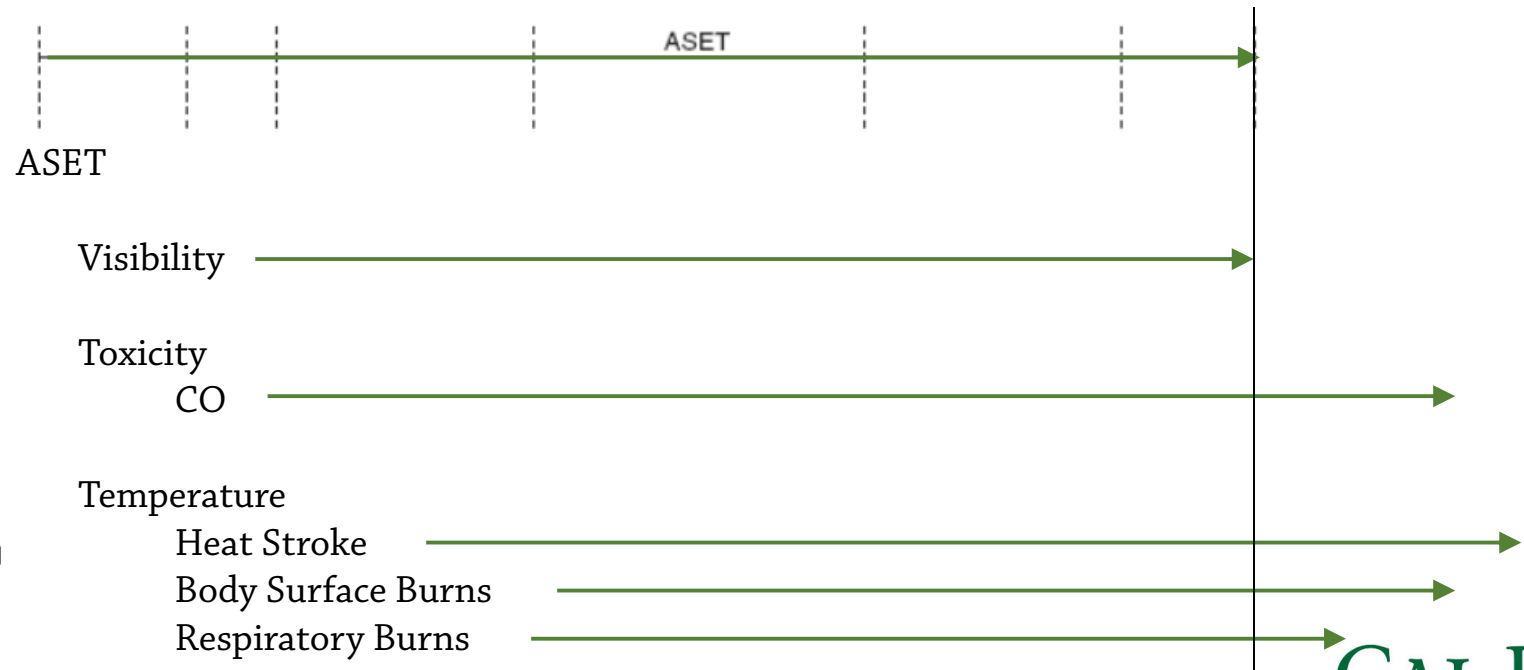


Slide 41



# Life-Safety: RSET < ASET

NFPA 130 Tenability limits

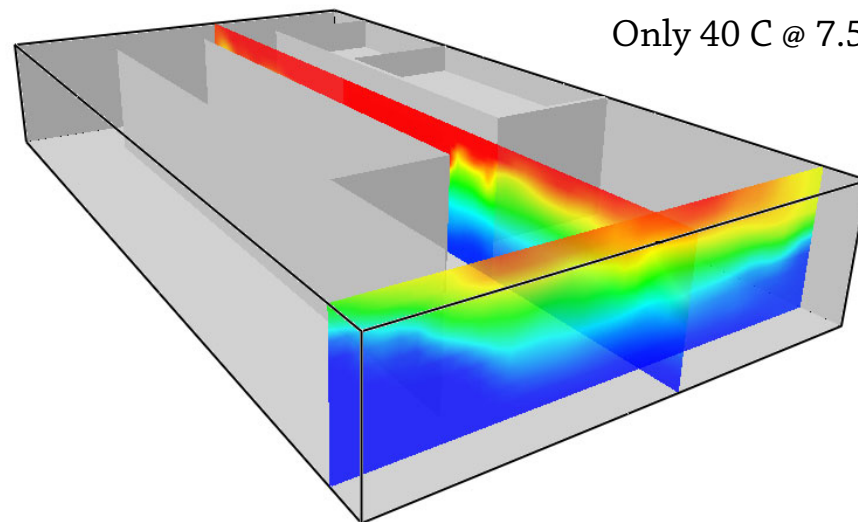


# Life-Safety: RSET < ASET

NFPA® 130  
ANNEX B

Table B.3.3.3 Maximum Exposure Time

Exposure Temperature		Without Incapacitation (min)
°C	°F	
80	176	3.8
75	167	4.7
70	158	6.0
65	149	7.7
60	140	10.1
55	131	13.6
50	122	18.8
45	113	26.9
40	104	40.2



Visibility is usually initial tenability limit, while heat and toxicity cause fatalities.  
TENABILITY CRITERIA IN UNIQUE SITUATIONS AND ATYPICAL BUILDINGS by AH  
Gager & G. Dominguez

# Egress and Tenability - ASET

**Table A.39** Yields of fire products and chemical, convective, and radiative heats of combustion for well-ventilated fires<sup>a</sup> [15]

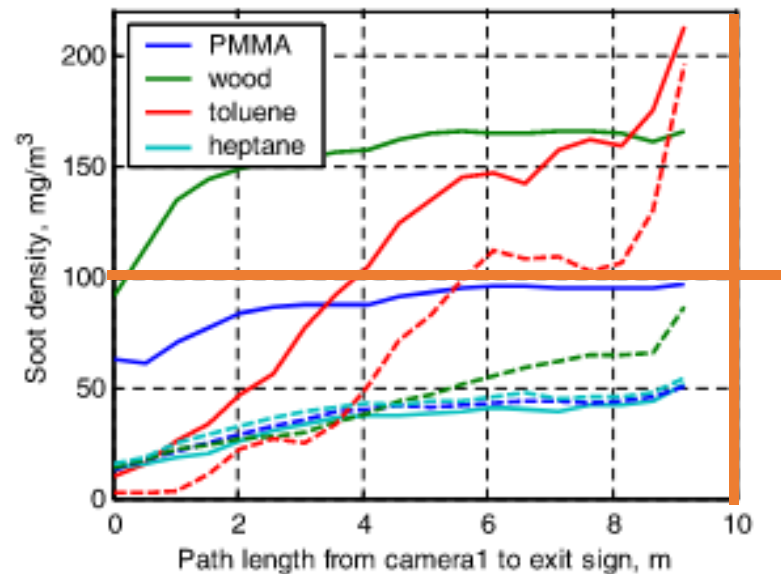
Material	$\Delta H_T$ (kJ/g)	$y_{CO_2}$ (g/g)	$y_{CO}$ (g/g)	$y_{ch}$ (g/g)	$y_s$ (g/g)	$\Delta H_{ch}$ (kJ/g)	$\Delta H_{con}$ (kJ/g)	$\Delta H_{rad}$ (kJ/g)
Wood (Douglas fir)	16.4	1.31	0.004	0.00	-	13.0	8.1	4.9
Wood (pine)	17.9	1.33	0.005	0.00	-	12.4	8.7	3.7
Corrugated paper	-	-	-	-	-	13.2	-	-
Particleboard (PB)	-	1.2	0.004	-	-	14.0	-	-
Fiberboard (FB)	-	1.4	0.015	-	-	14.0	-	-
Medium-density FB	-	1.2	0.002	-	-	14.0	-	-
Wood panel	-	1.2	0.002	-	-	15.0	-	-
Melamine-faced PB	-	0.8	0.025	-	-	10.7	-	-
Gypsumboard (GB)	-	0.3	0.027	-	-	4.3	-	-
Paper on GB	-	0.4	0.028	-	-	5.6	-	-
Plastic on GB	-	0.4	0.028	-	-	14.3	-	-
Textile on GB	-	0.4	0.025	-	-	13.0	-	-
Polyester-1	32.5	1.65	0.070	0.020	0.091	20.6	10.8	9.8
Polyester-2	32.5	1.56	0.080	0.029	0.089	19.5	-	-
Epoxy-1	28.8	1.59	0.080	0.030	-	17.1	8.5	8.6
Epoxy-2	28.8	1.16	0.086	0.026	0.098	12.3	-	-

Based on SFPE Table A.39, BRANZ 185 and NIST TN 1453:

	Soot Yield [g/g]	CO [g/g]
Fuel Limited	0.10	0.05
Vent Limited	0.20	0.10

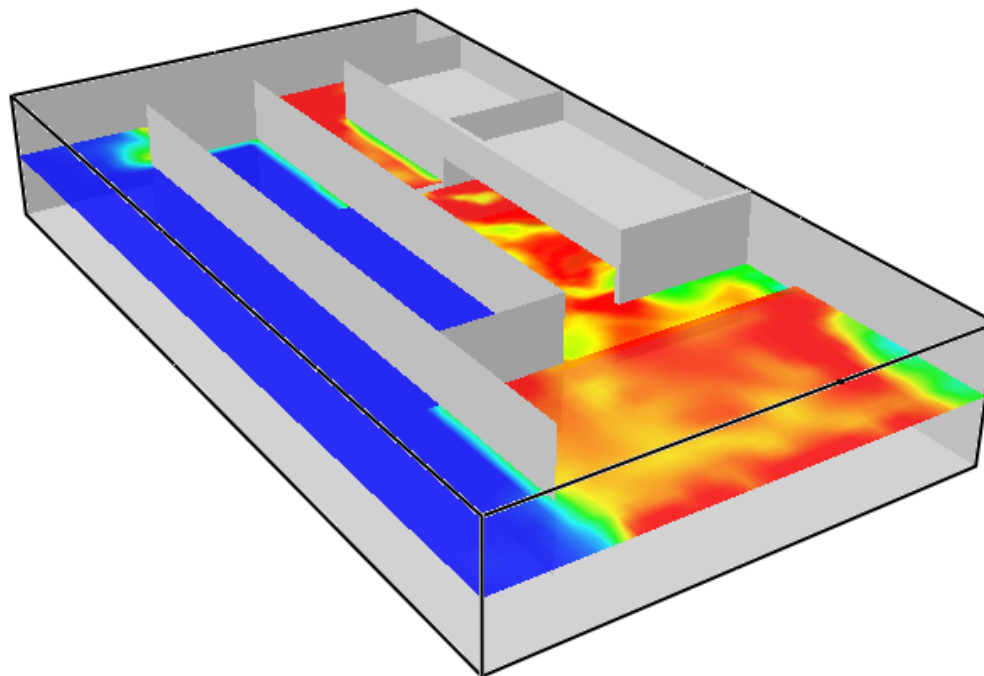
# Egress and Tenability - ASET

Soot Density  $100 \text{ mg/m}^3$  NIST XXL Conf Room @ 7.5 minutes



Experimental Validation of the FDS Simulations of Smoke and Toxic Gas Concentrations by Tuomo Rinne, Jukka Hietaniemi & Simo Hostikka, Fig. 27

# Egress and Tenability - ASET



Slice  
rho\_CO.9H0.1  
kg/m3  
\*10^-3

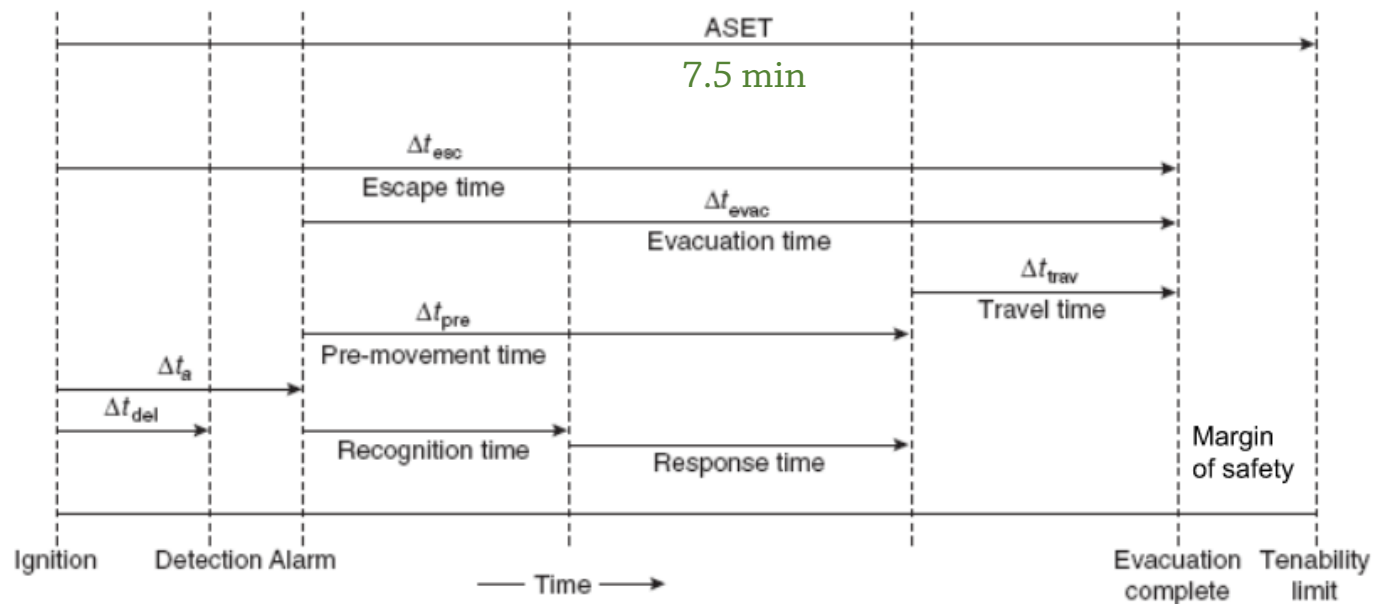
0.1  
0.09  
0.08  
0.07  
0.06  
0.05  
0.04  
0.03  
0.02  
0.01  
0.0



Soot Density 100 mg/m3 NIST XXL Conf Room @ 7.5 minutes

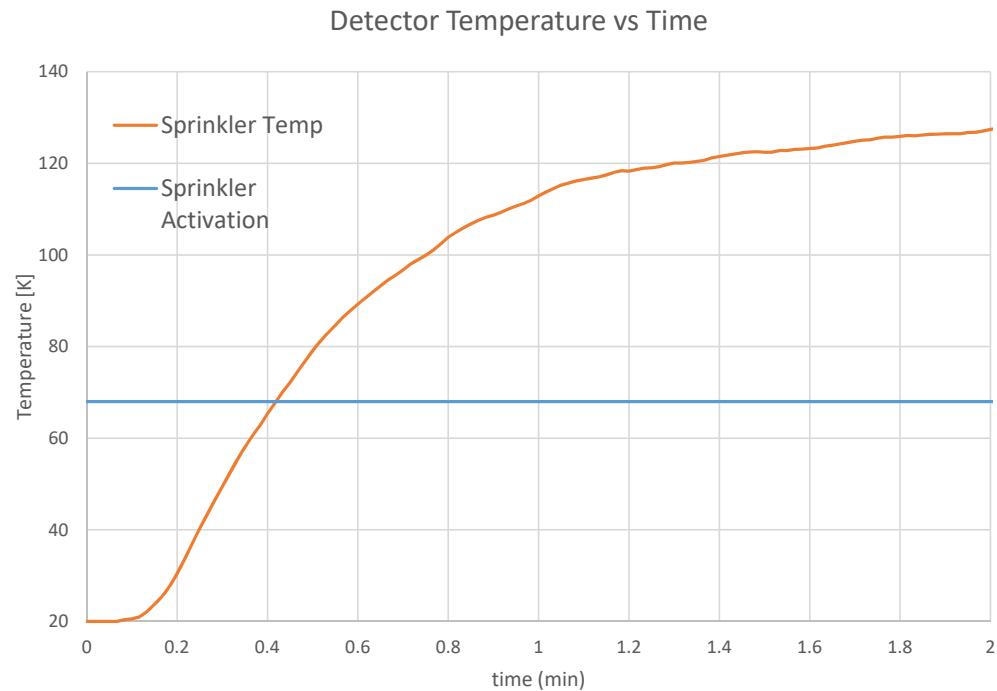
# Egress and Tenability - RSET

Calculate time to alarm, premovement time, and travel time.



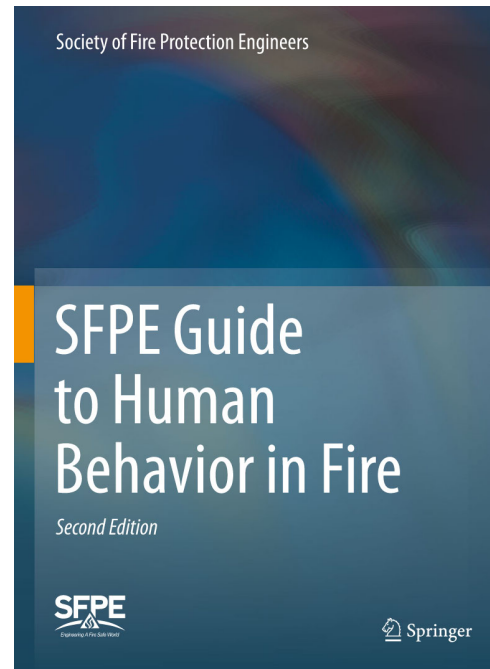
# RSET – Detection & Alarm

Time to detection, 0.4 min, use 0.5 minutes to account for time to alarm



# RSET – Pre-movement time

- Population Characteristics (SFPE Guide to Human Behavior)
  - Familiarity with building
  - Distribution & activities
  - Alertness
  - Physical and Cognitive Ability
  - Training (Floor Wardens, Fire Drills)





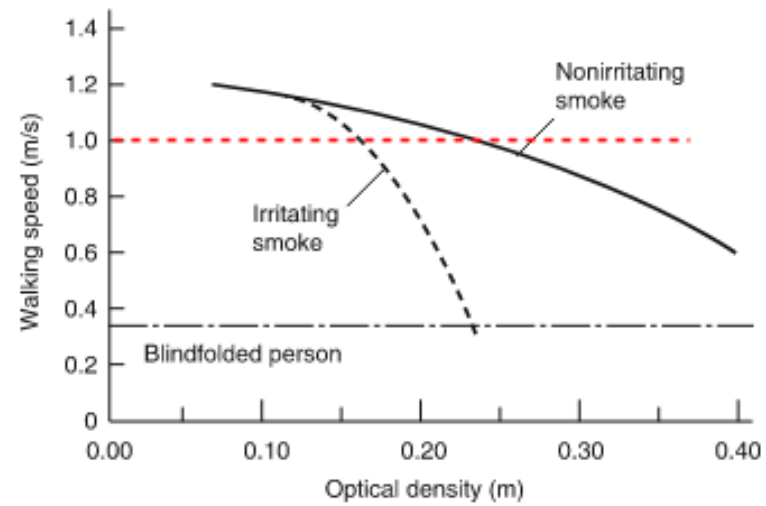
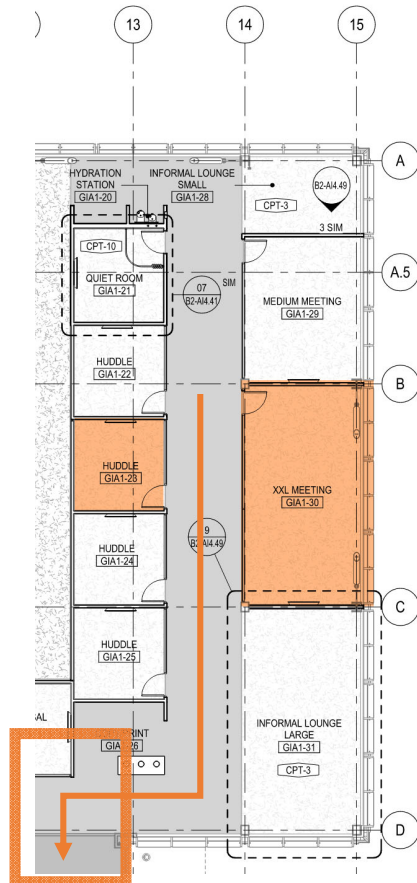
# RSET – Pre-movement time

## SFPE Handbook – Engineering Data

**Table 64.5** Pre-evacuation data—business occupancy

Occupancy	Source	Observational conditions (L: location, N: nature, SC: spatial configuration, P: participants, E: environment, V: variable)	Procedure		Sample		Results (sec)		Additional information
			Strategy	Staff (designated)	Technology	Collection method	Size	Mean S.D., range	
Business	Gwynne et al. [47]	L: USA N: UE1-2 SC: 14 floors  P: 825 evacuees: 44 % F, 56 % M, 1 % impaired V: impact of procedure (UE1-2)	Phased	2-4/floor	AL, PV (duration 15-20s) to 3 floors followed by general alarm	Video, observer	UE1: 132	[74.0 -, 23-152] <sup>a</sup>	*Times are arrive to stair door Raw data and frequency distributions Categorized by floor and collection method
			UE1: local alarm UE2: general alarm		Tone alert		UE2: 150	[-, 5-173] <sup>a</sup>	
	Sharma et al. [48]	L: UK N: UE, pre-2009 SC: 6 floors P:- E:- V: performance	Full	-	-	Video, survey	19	28 [11, 10-55]	Paper gives raw data (to nearest 5 s)
	Christoffersen and Söderlind [49]	L: Denmark N: UE, pre-2009 SC: 12 floors P: V: performance given pre-recorded voice	Full	-	PV	Video, Observer	70	[-, 12-105]	
	Proulx and Benichou [51]	L: Canada N: UE, 2006 SC: 3 floors, 6 stairwells (4 observed) P: 350 workers per floor—(18-64) E: PLM installations/reduced V: performance given alarm	Full	Floor emergency officers	AL	Video	1191	329	Bell alert used
	Purser [52]	L: UK N: UE SC: room within office P: 12 V: performance given voice alarm	Full	-	-V	Video	12	46 [-, 32-57]	

# RSET – Travel Time

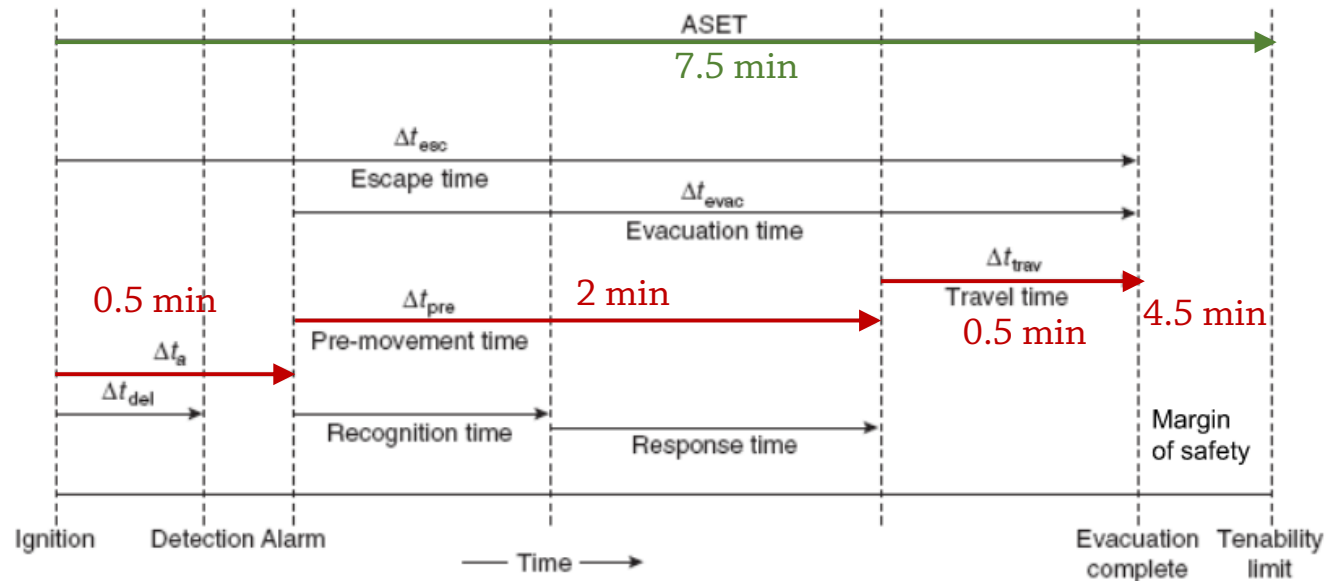


SFPE Walking Speed, Fig. 51.13

20 meters at 1 m/s, egress in under 30 seconds after pre-movement time

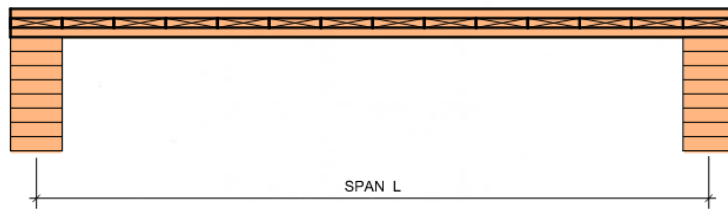
# Performance Based Design - RSET

XXL Conf. Design Fire:



# Structural Design for Fire

- Cross-Laminated Timber (CLT) panels span between Glulam Beams

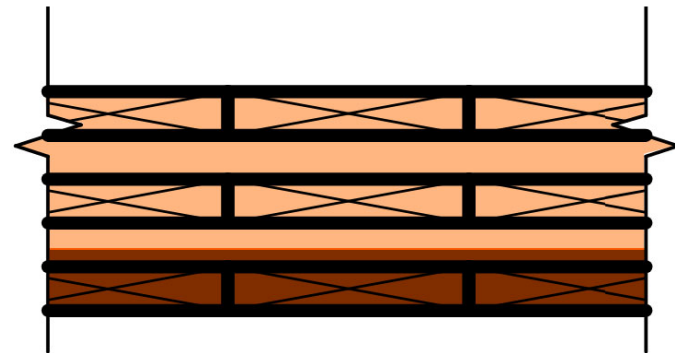


NDS (Wood Code):

**Table 16.2.1B Effective Char Depths (for CLT with  $\beta_n = 1.5 \text{ in./hr.}$ )**

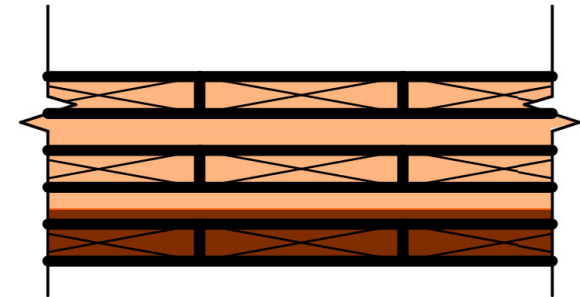
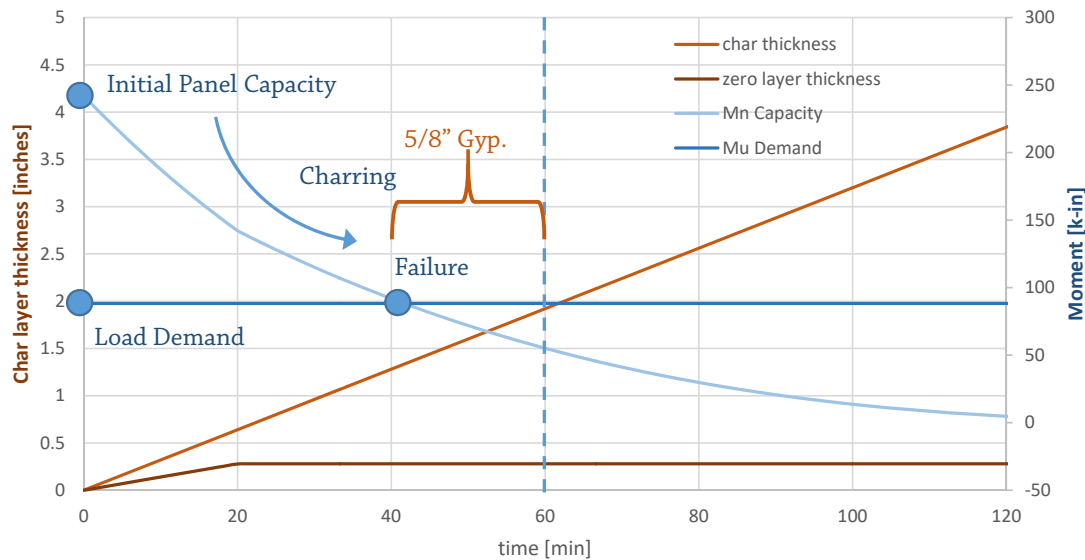
Required Fire Resistance (hr.)	Effective Char Depths, $a_{ef}$ (in.)								
	lamination thicknesses, $h_{lam}$ (in.)								
	5/8	3/4	7/8	1	1-1/4	1-3/8	1-1/2	1-3/4	2
1-Hour	2.2	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.8
1½-Hour	3.4	3.2	3.1	3.0	2.9	2.8	2.8	2.8	2.6
2-Hour	4.4	4.3	4.1	4.0	3.9	3.8	3.6	3.6	3.6

Reduced panel thickness due to char:



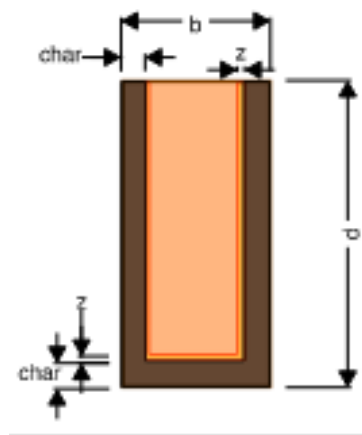
# Structural Design for Fire

CLT Char and Moment Demand vs Capacity



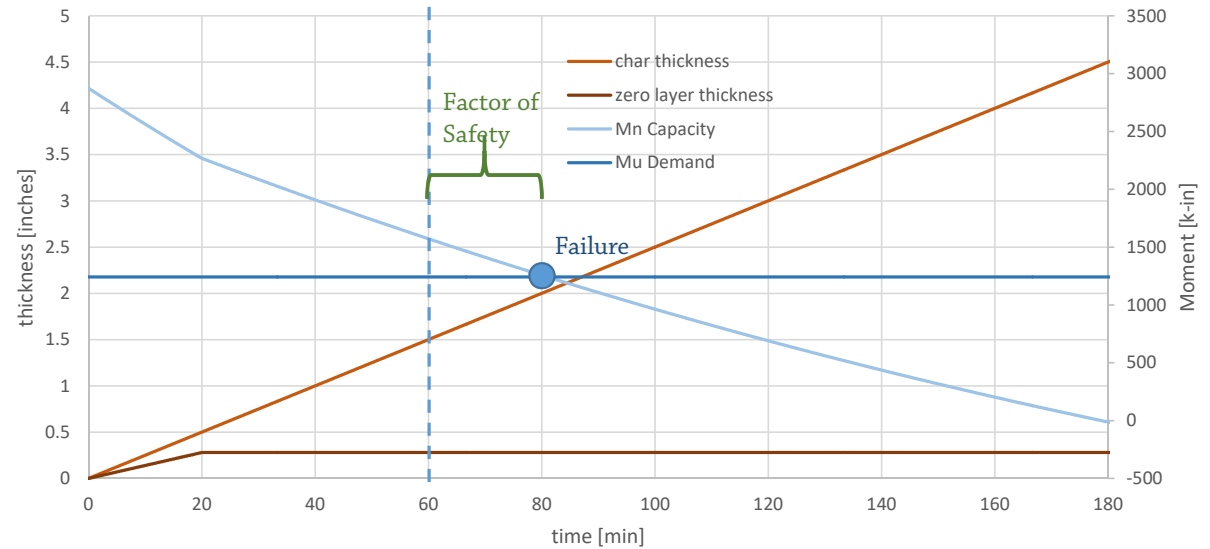
# Structural Design for Fire

- Glulam Beams

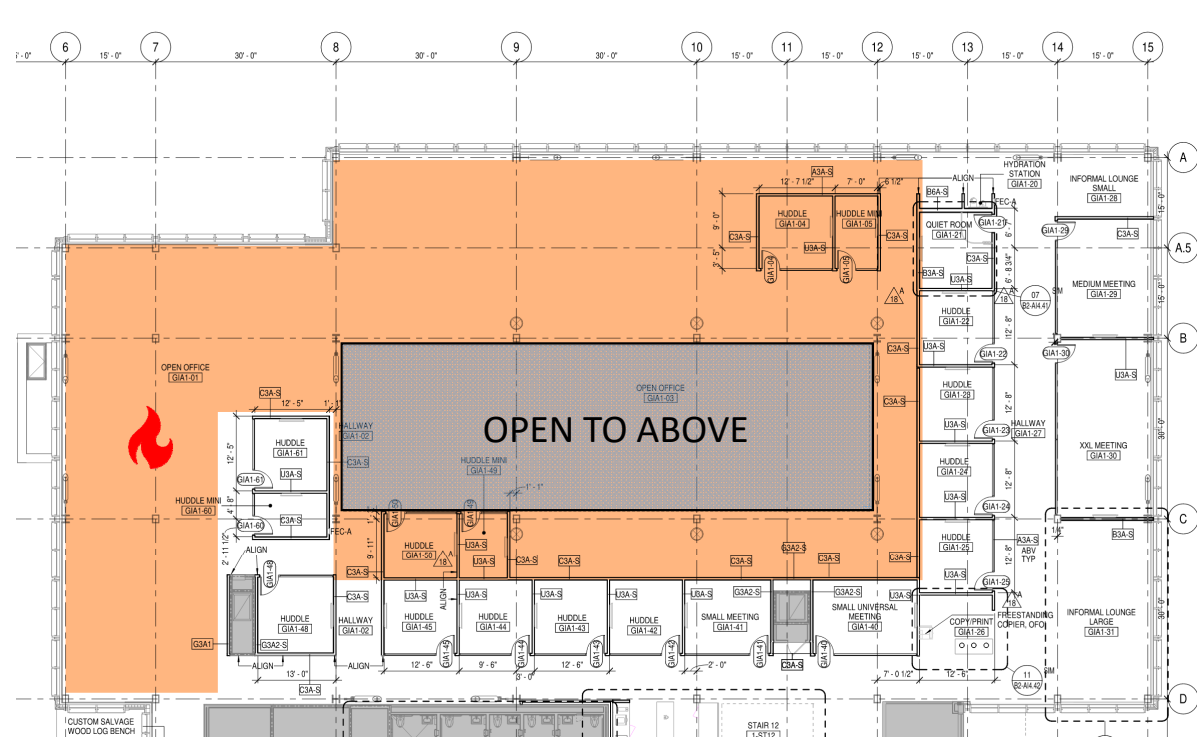
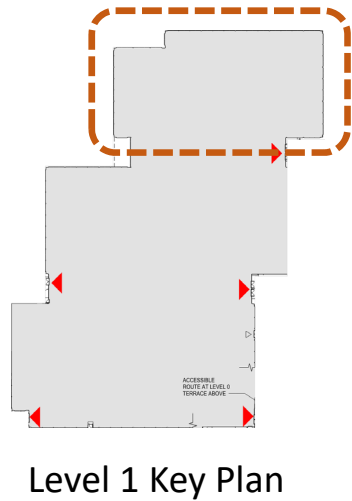


Beam Cross Section

Beam Char and Moment Behavior

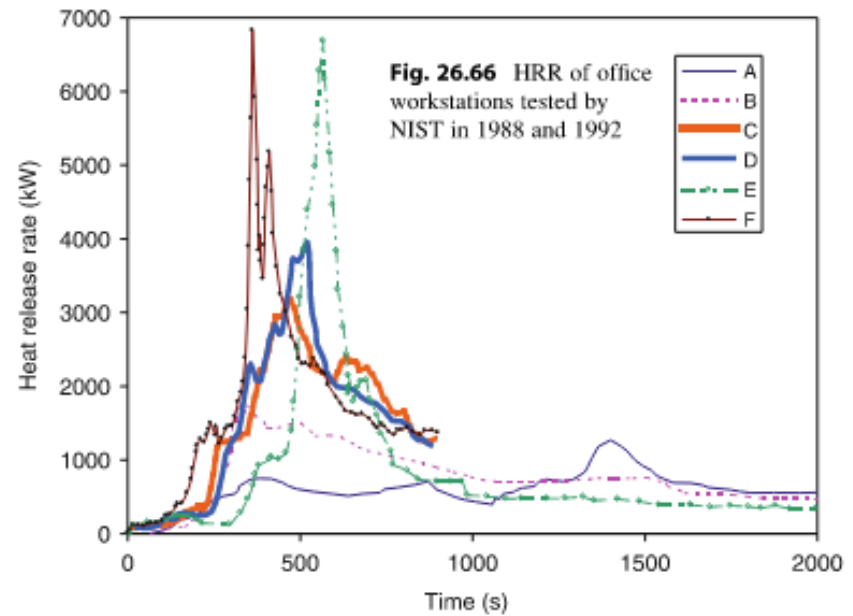
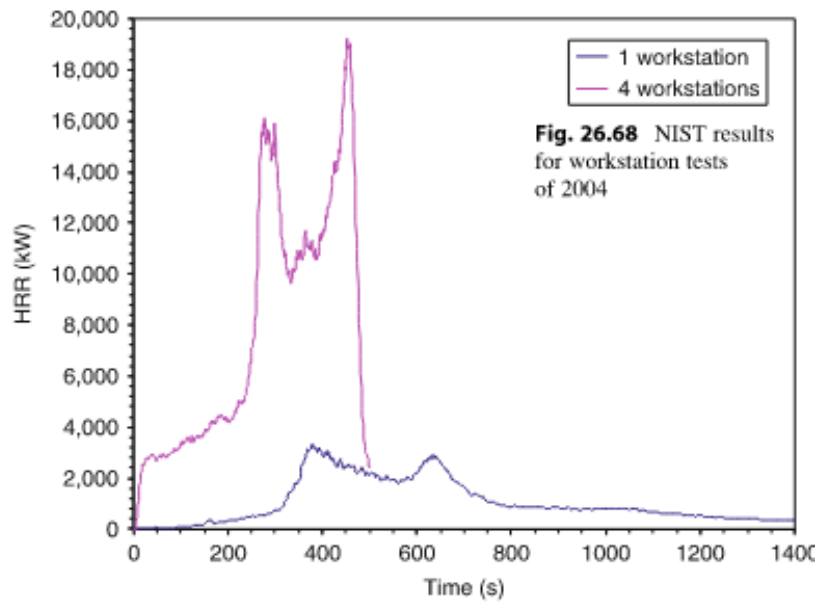


# Exposed Timber - NIST Office Workstation



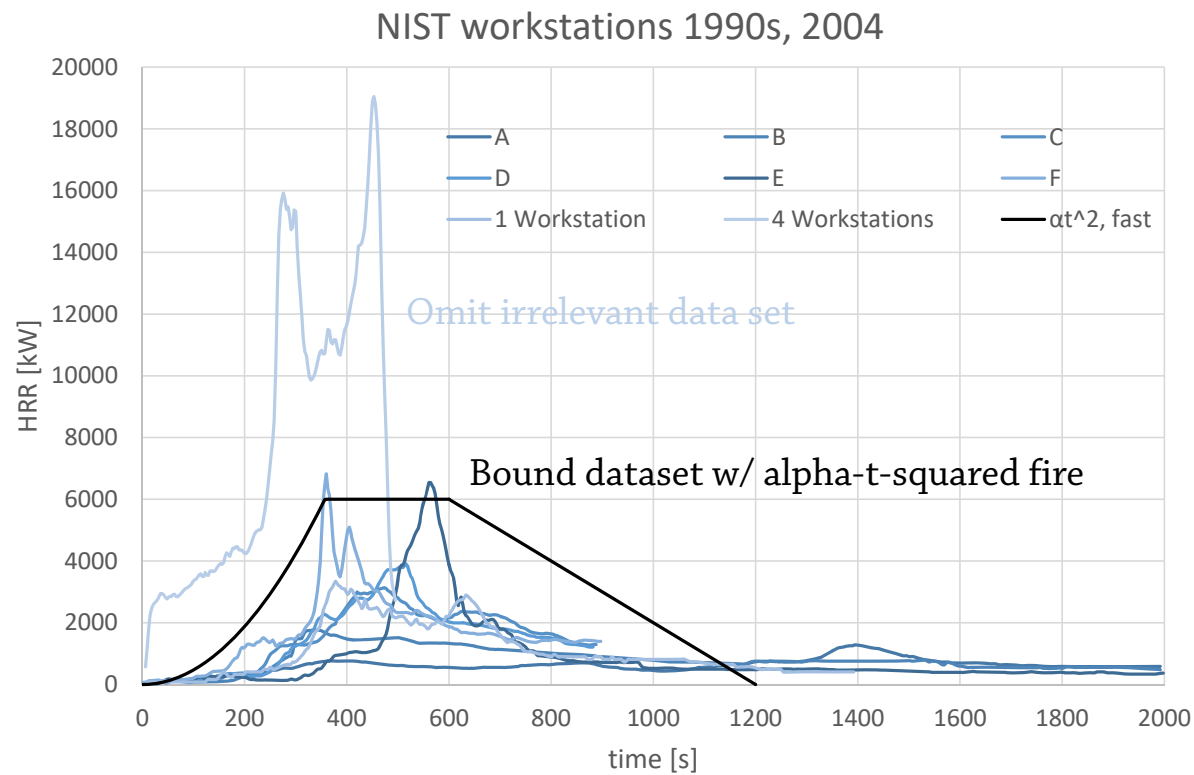
This 6 MW design fire will be used for evaluating exposed timber beams and CLT

# NIST Office Workstation



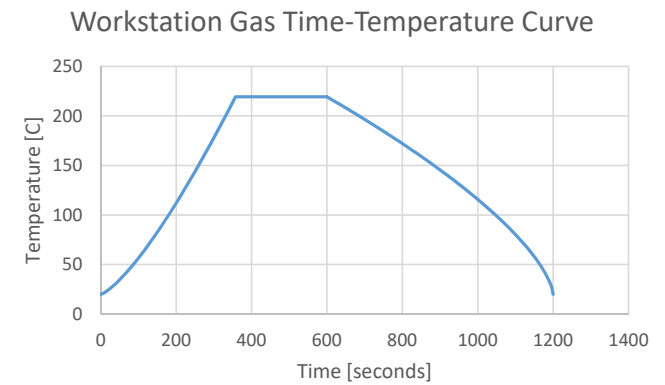
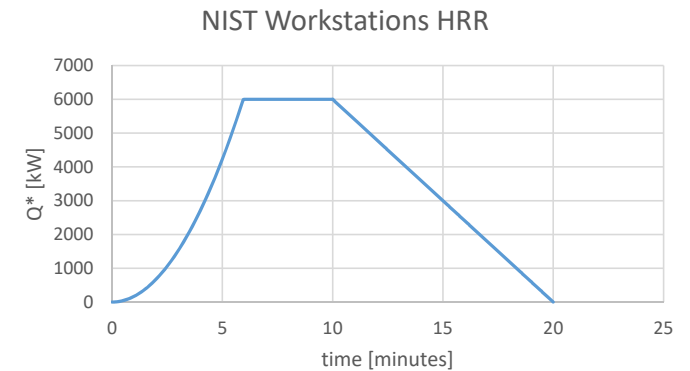
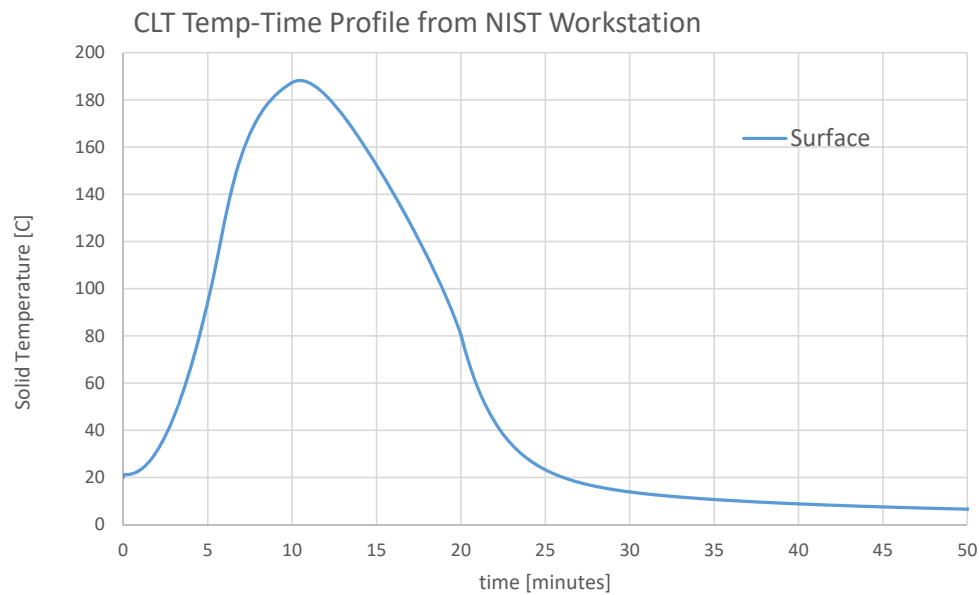


# NIST Office Workstation



# Structural Design for Fire

- Design Fire Thermal Analysis



# Conclusion

- Prescriptive Compliance for
  - Egress
  - Interior finishes
  - Passive Protection
  - Active Protection
    - Fire alarm
    - Fire sprinklers
- Performance-Based Design
  - Confirms life-safety for egress under 6 MW Conf. Room design fire
  - Permits exposed CLT acceptable under 6 MW Workstation design fire

Thank you!

