Culminating Project U.S. Federal Courthouse FPE 596 - Spring 2013

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Outline

- 1 Building Description
- 2 Applicable Codes and Standards
- 3 Code Analysis
- 4 Egress Analysis
- 5 Fire Alarm Initiation and Notification
- 6 Fire Suppression
- 7 Performance Based Analysis
- 8 Conclusions

1 Building Description

- Building Use: Federal Courthouse
- Construction Cost: \$70,000,000
- Area: ~115,000 square feet
- Height: 4 Stories plus basement (71 ft)
- Fully sprinklered

Slide removed for security purposes

4th Floor

Slide removed for security purposes

3rd Floor

Slide removed for security purposes

2nd Floor

Slide removed for security purposes

1st Floor

Slide removed for security purposes

Basement

2 Applicable Codes

ICC International Building Code, 2012 edition

NFPA 101, Life Safety Code, 2012 edition

NFPA 13, Installation of Sprinklers, 2010 edition

NFPA 14, Standpipe and Hose Systems, 2010 edition

NFPA 70, National Electric Code, 2011 edition

NFPA 72, Fire Alarm & Signaling Code, 2010 edition

NFPA 90A, Installation of AC & Venting Systems, 2012 edition

ASME A17.1, Elevator Safety Code, 2010 edition

NFPA 25, Water Based Fire Protection ITM, 2011 edition

NFPA 80, Fire Doors & Opening Protectives, 2010 edition

3 Code Analysis

(Ref: IBC and NFPA 101)

Code Analysis – Occupancy Classification

(Ref: IBC, Chapter 3 and NFPA 101, 6.1.1.1)

Fl	Area (sf)	Building Use	IBC	NFPA
4th	21,875	Offices/Courtrooms	B/A-3	Business/Assembly
3rd	21,875	Offices/Courtrooms	B/A-3	Business/Assembly
2nd	24,375	Offices	B	Business
1st	25,575	Offices/Jury Assembly	B/A-3	Business/Assembly
B	20,820	Shops/Parking Garage	B/S-2	Business/Storage

Code Analysis – Occupancy Separation

(Ref: IBC, Table 508.4)

	IBC	Rating
Occupancies Separated	Table 508.4	Provided
Business/Assembly	1	0
Business/Parking Garage (Storage)	1	2

Code Analysis – Height and Area Limitations

(Ref: IBC, Table 503)

NFPA construction types added

TABLE 503
ALLOWABLE HEIGHT AND BUILDING AREAS^a
 Height limitations shown as stories and feet above grade plane.
 Area limitations as determined by the definition of "Area, building," per story

GROUP	HGT(feet) HGT(S)	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
		Type 1(332) UL	Type II(222) 160	Type II(111) 65	Type II(000) 55	Type III(211) 65	Type III(200) 55	Type IV(2HH) 65	Type V(111) 50	Type V(000) 40
A-1	S A	UL UL	5 UL	3 15,500	2 8,500	3 14,000	2 8,500	3 15,000	2 11,500	1 5,500
A-2	S A	UL UL	11 UL	3 15,500	2 9,500	3 14,000	2 9,500	3 15,000	2 11,500	1 6,000
A-3	S A	UL UL	11 UL	3 15,500	2 9,500	3 14,000	2 9,500	3 15,000	2 11,500	1 6,000
A-4	S A	UL UL	11 UL	3 15,500	2 9,500	3 14,000	2 9,500	3 15,000	2 11,500	1 6,000
A-5	S A	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL
B	S A	UL UL	11 UL	5 37,500	4 23,000	5 28,500	4 19,000	5 36,000	3 18,000	2 9,000
S-1	S A	UL UL	11 48,000	4 26,000	3 17,500	3 26,000	3 17,500	4 25,500	3 14,000	1 9,000
S-2 ^{b,c}	S A	UL UL	11 79,000	5 39,000	4 26,000	4 39,000	4 26,000	5 38,500	4 21,000	2 13,500
U ^c	S A	UL UL	5 35,500	4 19,000	2 8,500	3 14,000	2 8,500	4 18,000	2 9,000	1 5,500

Most stringent

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m².

UL = Unlimited, NP = Not permitted.

a. See the following sections for general exceptions to Table 503:

1. Section 504.2, Allowable height increase due to automatic sprinkler system installation.
2. Section 506.2, Allowable area increase due to street frontage.
3. Section 506.3, Allowable area increase due to automatic sprinkler system installation.
4. Section 507, Unlimited area buildings.

b. For open parking structures, see Section 406.3.

c. For private garages, see Section 406.1.

d. See Section 415.5 for limitations.

Meets code

Meets code w/AS

Code Analysis – Height and Area Limitations

(Ref: IBC, Table 503)

Building Construction

Type I B per IBC

Type II (222) per NFPA 5000/220

Could have used IBC Type IIA or Type IIIA
NFPA 101 Type II(111) or Type III(211)

Code Analysis – Fire Resistance Ratings

(Ref: IBC, Table 601)

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 ^g	B	A ^g	B	HT	A ^g	B
Structural frame ^a	3 ^b	2 ^b	1	0	1	0	HT	1	0
Bearing walls									
Exterior ^g	3	2	1	0	2	2	2	1	0
Interior	3 ^b	2 ^b	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions									
Exterior			See Table 602						
Nonbearing walls and partitions									
Interior ^f	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction									
Including supporting beams and joists	2	2	1	0	1	0	HT	1	0
Roof construction									
Including supporting beams and joists	1 1/2 ^c	1 ^{c, d}	1 ^{c, d}	0 ^{c, d}	1 ^{c, d}	0 ^{c, d}	HT	1 ^{c, d}	0

For SI: 1 foot = 304.8 mm.

- The structural frame shall be considered to be the columns and the girders, beams, trusses and spandrels having direct connections to the columns and bracing members designed to carry gravity loads. The members of floor or roof panels which have no connection to the columns shall be considered secondary members and not a part of the structural frame.
- Roof supports: Fire-resistance ratings of structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.
- Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.
- In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.
- An approved automatic sprinkler system in accordance with Section 903.3.1.1 shall be allowed to be substituted for 1-hour fire-resistance-rated construction, provided such system is not otherwise required by other provisions of the code or used for an allowable area increase in accordance with Section 506.3 or an allowable height increase in accordance with Section 504.2. The 1-hour substitution for the fire resistance of exterior walls shall not be permitted.
- Not less than the fire-resistance rating required by other sections of this code.
- Not less than the fire-resistance rating based on fire separation distance (see Table 602).

Code Analysis – Fire Resistance Ratings

(Ref: IBC, Table 601)

Building Construction - Type I B or Type II (222)

Structural Frame – 2 hr

Bearing Walls – 2 hr

Floors – 2 hr

Roof – 1 hr

Code Analysis – Protection of Shaft Enclosures

(Ref: IBC 713.4)

Stories
Served
 ≥ 4

Enclosure Fire
Resistance Rating
2 hrs

Opening Fire
Protection Rating
1-1/2 hours

for stair, elevator, HVAC and utility shafts

Code Analysis – Protection from Hazards

(Ref: IBC Table 509)

1 hour

-Basement Boiler Rm

-1st Floor Locker Rm

Code Analysis – Other Rooms Requiring Protection

1 hour

- Basement Electrical Rm with 112.5 kVA transformer
(Ref: NFPA 70, 450.21B)
- 1st Floor Fire Command Center (Ref: IBC 508.1.2)

2 hours

- 4th Floor Elevator Machine Rooms
(Ref: ASME A17.1, 2.7.1.1.1)

Code Analysis – Main Entry (Two Story Atrium)

(Ref: IBC 404)

Code Analysis – Main Entry (Two Story Atrium)

(Ref: IBC 404)

Atriums must be separated by 1 hour fire barrier
unless:

- a smoke control system is provided

However, for two story atriums, IBC doesn't require:

- 1 hour fire barrier (712.1.8)

- smoke control (404.5)

Neither provided...

4 Egress Analysis

(Ref: NFPA 101, Chapter 7)

Egress Analysis – Occupant Load & Capacity

(Ref: NFPA 101, Tables 7.3.1.2 and 7.3.3.1)

Table 7.3.3.1 Capacity Factors

Area	Stairways (width/person)		Level Components and Ramps (width/person)	
	in.	mm	in.	mm
Board and care	0.4	10	0.2	5
Health care, sprinklered	0.3	7.6	0.2	5
Health care, nonsprinklered	0.6	15	0.5	13
High hazard contents	0.7	18	0.4	10
All others	0.3	7.6	0.2	5

No.	Location	Stair Width	Stair Capacity	Door Width	Door Capacity
1	SW	56"	187	36"	180*
2	NE	56"	187	36"	180*
3	NW	44"	147*	36"	180

Fl	Grade Exit Location	No. of Doors	Door Width	Door Capacity
1 st	Main Entry	4	36"	720
1 st	Stair 1	1	36"	180
1 st	Stair 2	1	36"	180
B	Garage	2	36"	360

Egress Analysis – Occupant Load & Capacity

(Ref: NFPA 101, Tables 7.3.1.2 and 7.3.3.1)

Table 7.3.1.2 Occupant Load Factor

Use	(ft ² /person) ^a	(m ² /person) ^a
Assembly Use		
Concentrated use, without fixed seating	7 net	0.65 net
Less concentrated use, without fixed seating	15 net	1.4 net
Bench-type seating	1 person/18 linear in.	1 person/455 linear mm
Fixed seating	Use number of fixed seats	Use number of fixed seats
Waiting spaces	See 12.1.7.2 and 13.1.7.2.	See 12.1.7.2 and 13.1.7.2.
Business Use (other than below)	100	9.3
Air traffic control tower observation levels	40	3.7

Table 7.3.1.2 Continued

Use	(ft ² /person) ^a	(m ² /person) ^a
Storage Use		
In storage occupancies	NA	NA
In mercantile occupancies	300	27.9
In other than storage and mercantile occupancies	500	46.5
Mercantile Use		
Sales area on street floor ^{b,c}	30	2.8
Sales area on two or more street floors ^c	40	3.7
Sales area on floor below street floor ^c	30	2.8
Sales area on floors above street floor ^c	60	5.6
Floors or portions of floors used only for offices	See business use.	See business use.
Floors or portions of floors used only for storage, receiving, and shipping, and not open to general public	300	27.9
Mall buildings ^d	Per factors applicable to use of space ^e	

NA: Not applicable. The occupant load is the maximum probable number of occupants present at any time.

^aAll factors are expressed in gross area unless marked "net."

Egress Analysis – Occupant Load & Capacity

(Ref: NFPA 101, Table 7.3.1.2 and Table 7.3.3.1)

Fl	Area (sf)		Occupant Load (OL)		Total OL	Capacity (56" stairs + 44" stair + Exits at grade)
	Business	Other ¹	Business	Other ²		
4 th	17,875	4,000	179	83 x 2	345	507 (2x180* + 1x147 + 0)
3 rd	17,875	4,000	179	72 x 2	323	507 (2x180* + 1x147 + 0)
2 nd	24,375		244		244	507 (2x180* + 1x147 + 0)
1 st	24,075	1,500	241	100	341	1227 (0 + 1x147 + 6x180)
B	10,620	10,200	107	21	128	720 (2x180 + 0 + 2x180)

Occupant Load < Capacity (ok)

¹ 3rd & 4th floors each have two courtrooms; 1st floor has a jury assembly room; basement contains a garage

² 4th floor courtrooms each with 90' of benches (1080"/18"pp = 60 occs) + 23 seats;

² 3rd floor courtrooms each with 72 seats

2-56" stairs and 1-44" stair; all stair doors are 36" wide (*stair door width dictates capacity of 180, not 187)

Note: calculated occupant loads far exceed the population expected, especially on 3rd & 4th floors

Egress Analysis – Special Locking of Doors

(Ref: NFPA 101, 7.2.1.5.8 , 7.2.1.6.1)

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Egress Analysis – Travel Distances, Common Paths of Travel and Dead End Corridors

(Ref: NFPA 101, Table A.7.6)

	Common Path		Dead End		Travel Distance	
	Actual	Max Allowed	Actual	Max Allowed	Actual	Max Allowed
4 th	63/0	<100/<20	25/0	<50/<20	136/84	<300/<250
3 rd	63/0	<100/<20	25/0	<50/<20	136/84	<300/<250
2 nd	77	<100	0	<50	154	<300
1 st	47/0	<100/<20	15/0	<50/<20	115/68	<300/<250
B	25/ 56	<100/<50	0/NA	<50/<50	107/68	<300/<200

Business/Assembly (1st, 3rd and 4th floors)

Business/Storage (basement)

Egress Analysis – Common Paths of Travel

(Ref: NFPA 101, Table A.7.6)

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Egress Analysis – Other Requirements

(Ref: NFPA 101)

Number of Exits (7.4)

Arrangement/Remoteness of Exits (7.5.1.3)

Exit Discharge (7.7)

Illumination of Means of Egress(7.8)

Emergency Lighting (7.9)

Marking of Exits (7.10)

All other requirements met

5 Fire Alarm Initiation and Notification

(Ref: IBC Sections 907 and NFPA 72)

Fire Alarm Initiation and Notification – General

- Addressable voice alarm evacuation system
- System designed and installed in accordance with NFPA 72
- Alarm signals transmit to a central station service
- Fire command center on 1st floor

Fire Alarm Initiation and Notification – General (continued)

- Alarm notification via speakers and synchronized strobes
- Full evacuation via temporal 3 signal
- Live voice capability to override pre-recorded message and to convey non-fire emergency messages (e.g., terrorist alert)

Fire Alarm Initiation and Notification – General (continued)

- Manual pull stations adjacent to every exit and located in fire command center
- Smoke detectors only installed in elevator lobbies and elevator machine rooms – initiate elevator recall
- Heat detectors in elevator machine room – initiate shunt trip
- Duct smoke detectors installed in supply air units > 2,000 cfm and return air units >15,000 cfm per NFPA 90A – initiate HVAC system shutdown

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1st Floor

Fire Alarm Initiation and Notification – Sequence of Operation Matrix

Initiating Device/Operation	Activate speakers	Activate strobes	Shut down HVAC	Unlock doors	Recall elevator to 1st floor	Recall elevator to basement	De-energize elevator power	Transmit alarm to central station	Transmit supervisory signal
Manual pull station	x	x						x	
FACP smoke detector	x	x						x	
Duct smoke detector			x						x
Elevator lobby smoke detector (B, 2, 3, 4)	x	x			x			x	
Elevator lobby smoke detector (1)	x	x				x		x	
Elevator machine room smoke detector	x	x			x			x	
Elevator machine room heat detector	x	x					x	x	
Waterflow switch	x	x		x				x	
Tamper switch									x

6 Fire Suppression

(Ref: IBC Sections 903 & 905, and NFPA 13)

Fire Suppression – General

- Building protected by a wet pipe sprinkler system except for elevator hoistways
- Sprinkler system designed & installed in accordance with NFPA 13
- Quick response sprinklers installed throughout
- Design for light hazard occupancy, except for shops, storage and mechanical rooms
- Calculation are based upon the density/area method

Fire Suppression – General (continued)

- Class I manual wet standpipes installed in all stairs in accordance with NFPA 14
- Sprinkler piping to be schedule 40 black steel pipe
- Dry sidewalls in main entry vestibule & loading dock
- Backflow prevention

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Fire Suppression – Available Water Supply

- Static Pressure – 86 psi
- Residual Pressure – 75 psi
- Flow at Residual Pressure – 1470 gpm

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Basement

Slide removed for security purposes

4th Floor

Fire Suppression – Sprinkler Demand

Hydraulically Most Remote Locations

			Hazard	Density	Area	Hose	Flow	Pressure
Zone	Fl	Use	Classification	(gpm/ft ²)	(ft ²)	(gpm)	(gpm)	(psi)
1	4	SW Office	Light	0.10	1500	100	271	72
2	4	Mech Rm	Ordinary Gp 1	0.15	644	250	170	64
3	B	SW Shop	Ordinary Gp 2	0.20	1500	250	544	77

Density, area and hose requirements from NFPA 13, Figure 11.2.3.1.1 and Table 11.2.3.1.2

FIRE PROTECTION WATER SUPPLY ANALYSIS

LOCATION Federal Courthouse

DATE May 30, 2013 TIME 9:15 AM

#	Floor	Use	Hazard Classification	Density (gpm/ft ²)	Area (ft ²)	Hosestream (gpm)	Flow (gpm)	Pressure (psi)
1	4th	SW Offices	Light Hazard	0.10	1500	100	271	72
2	4th	Mech Rm	Ordinary Hazard 1	0.15	644	250	170	64
3	Bsmt	Shops	Ordinary Hazard 2	0.20	1500	250	544	77

7 Performance Analysis

Goal: Life Safety

Determine whether the available safe egress time (ASET) exceeds the required safe egress time (RSET) with a sufficient margin of safety, based upon an assumed fire.

Occupants would be considered safe if they are separated from the effects of fire or can safely relocate before products of combustible effect tenability.

RSET vs. ASET

Design Scenario 1

Car fire in basement parking garage

Design Scenario 1 (Car Fire) Egress

Maximum travel distance – 94' (74' realistically)

Design Scenario 1 (Car Fire) Egress

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Design Scenario 1 (Car Fire) HRR

4.5 MW car fire in basement parking garage

Ref: SFPE Fig 3-1.46

Design Scenario 1 (Car Fire) RSET Results

Sprinkler Activation Time = 178 s = 3.0 min (FDS)

Alarm Time = 30 s = .5 min (waterflow switch delay)

Pre-Movement Time = 30 s = .5 min (elevator occupants)

Movement Time = 1.0 min

= Corridor Travel + Door Flow (3)

= 74'/138'/min + 3 x (8 p/ 48 p/min)

RSET = 5.0 (3 + .5 + .5 + 1)

1.5 x RSET = 7.5 min

Design Scenario 1 (Car Fire) ASET Criteria

a. Temperature < 60°C (140°F) for 1.5 x RSET

Ref: SFPE Figure 2-6.26

b. CO Concentration < 2500 ppm for 1.5 x RSET

Ref: SFPE Figure 2-6.14

c. Visibility > 4 m (13 ft) for 1.5 x RSET

Ref: SFPE Table 2-4.2

Figure 2-6.26. Thermal tolerance for humans at rest, naked skin exposed, with low air movement (less than 30 m/min). Adapted from Blockley.¹¹³ See text and Table 2-6.16 for discussion of data points A to D.^{112,115,116}

Figure 2-6.14. Time to incapacitation by carbon monoxide for a 70 kg human at different levels of activity. Curve A—40 percent carboxyhemoglobin RMV 8.5 L/min at rest sitting; Curve B—30 percent carboxyhemoglobin RMV 25 L/min, light work (e.g., walking 6.4 km/h); Curve C—20 percent carboxyhemoglobin RMV 50 L/min, heavy work (e.g., slow running 8.5 km/h) (or for walking 5.6 km/h up a 17 percent gradient).

Table 2-4.2 Allowable Smoke Densities and Visibility That Permits Safe Escape

Degree of Familiarity with Inside Building	Smoke Density (extinction coefficient)	Visibility
Unfamiliar	0.15 1/m	13 m
Familiar	0.5 1/m	4 m

Design Scenario 1 (Car Fire) ASET Results

a. Temperature < 60°C (140°F) for 1.5 x RSET

Smokeview 6.0.8 - Nov 6 2012

$t = 7.5 \text{ min (1.5 x RSET)}$

Slice
temp
C

93.5

85.7

77.9

70.1

62.3

54.5

46.7

38.9

31.1

23.3

15.5

Frame: 1000

Time: 450.1

mesh: 1

Design Scenario 1 (Car Fire) ASET Results

b. CO Concentration < 2500 ppm for 1.5 x RSET

Smokeyview 6.0.8 - Nov 6 2012

$t = 7.5 \text{ min (1.5 x RSET)}$

Slice
X_CO
ppm

450
405
360
315
270
225
180
135
90.0
45.0
0.00

Frame: 1000
Time: 450.1

mesh: 1

Design Scenario 1 (Car Fire) ASET Results

c. Visibility ≥ 4 m (13 ft) for 1.5 x RSET

t = 3.0 min (sprinkler activation)

Frame: 472
Time: 178.5

t = 4.0 min (occupants arrive)

Frame: 631
Time: 238.5

t = 3.5 min (alarm notification)

Frame: 551
Time: 208.3

t = 5.0 min (RSET)

Frame: 789
Time: 298.3

Design Scenario 1 (Car Fire) RSET vs. ASET

Design Scenario 1 (Car Fire) Alternate Scenarios

Slide removed for security purposes

Design Scenario 1 (Car Fire) ASET Results

Visibility Levels over time for fire at SE corner

t = 3.0 min (sprinkler activation)

Frame: 405
Time: 182.3

t = 4.0 min (occupants arrive)

Frame: 538
Time: 242.1

t = 3.5 min (alarm notification)

Frame: 471
Time: 212.0

t = 5.0 min (RSET)

Frame: 671
Time: 302.0

Design Scenario 2

Security equipment fire in entry lobby (“atrium”)

Design Scenario 2

Security equipment fire in “atrium”

Design Scenario 2 (“Atrium” Fire) Egress

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Design Scenario 2 (“Atrium” Fire) HRR

600 kW equipment fire in atrium

Ref: SFPE Fig 3-1.14

Figure 3-1.14. Business machine cabinets made from polyphenylene oxide plastic.

Design Scenario 2 (“Atrium” Fire)

Design Scenario 2 (“Atrium” Fire) RSET Results

(Smoke) Detection Time = 107 s = 1.8 min (worse case)

(Manual) Detection Time = 60 s = 1 min (assumed)

Alarm Time = 0 (if automatic detection)

Alarm Time = 30 s = .5 min (if manual detection)

Pre-Movement Time = .5 min (assumed)

Movement Time = 7.4 mins

= Corridor Travel + Initial Stair Fill + Queuing + Stair Fill/Clear

= 1.0 + .36 + 4.66 + 1.35

RSET = 9.7 min (1.8 + 0 + .5 + 7.4)

1.5 x RSET = 14.6 min

Design Scenario 2 (“Atrium” Fire) RSET Results

(Smoke) Detection Time = 107 s = 1.8 min (worse case)

(Manual) Detection Time = 60 s = 1 min (assumed)

Alarm Time = 0 (if automatic detection)

Alarm Time = 30 s = .5 min (if manual detection)

Pre-Movement Time = .5 min (assumed)

Movement Time = 2.7 mins

= Corridor Travel + Door Flow

= 1.0 + 1.7

RSET = 5.0 min (1.8 + 0 + .5 + 2.7)

1.5 x RSET = 7.5 min

Design Scenario 2 (“Atrium” Fire) ASET Criteria

a. Temperature < 60°C (140°F) for 1.5 x RSET

Ref: SFPE Figure 2-6.26

b. CO Concentration < 1200 ppm for 1.5 x RSET

Ref: SFPE Figure 2-6.14

c. Visibility > 13 m (42.6 ft) for 1.5 x RSET

Ref: SFPE Table 2-4.2

Figure 2-6.26. Thermal tolerance for humans at rest, naked skin exposed, with low air movement (less than 30 m/min). Adapted from Blockley.¹¹³ See text and Table 2-6.16 for discussion of data points A to D.^{112,115,116}

Figure 2-6.14. Time to incapacitation by carbon monoxide for a 70 kg human at different levels of activity. Curve A—40 percent carboxyhemoglobin RMV 8.5 L/min at rest sitting; Curve B—30 percent carboxyhemoglobin RMV 25 L/min, light work (e.g., walking 6.4 km/h); Curve C—20 percent carboxyhemoglobin RMV 50 L/min, heavy work (e.g., slow running 8.5 km/h) (or for walking 5.6 km/h up a 17 percent gradient).

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Degree of Familiarity with Inside Building	Smoke Density (extinction coefficient)	Visibility
Unfamiliar	0.15 1/m	13 m
Familiar	0.5 1/m	4 m

Design Scenario 2 (“Atrium” Fire) ASET Results

a. Temperature < 60°C (140°F) for 1.5 x RSET

Smokeview 6.0.8 - Nov 6 2012

t = 3.7 min (worse values)

Slice
temp
C

>40 (kW/m3)

Frame: 221

Time: 219.7

mesh: 1

Design Scenario 2 (“Atrium” Fire) ASET Results

b. CO Concentration < 1200 ppm for 1.5 x RSET

Smokeview 6.0.8 - Nov 6 2012

t = 3.7 min (worse values)

■ >40 (kW/m³)

Frame: 221

Time: 219.7

mesh: 1

Design Scenario 2 (“Atrium” Fire) ASET Results

c. Visibility ≥ 13 m (42.6 ft) for 1.5 x RSET

Frame: 90
Time: 108.1

mesh: 1

t = 1.8 min (detection/alarm)

Frame: 115
Time: 138.0

mesh: 1

t = 2.3 min (movement begins)

Design Scenario 2 (“Atrium” Fire) RSET vs. ASET

Design Scenario 2 (“Atrium” Fire) ASET Results

c. Visibility ≥ 4 m (14 ft) for 1.5 x RSET

Frame: 90
Time: 108.1

t = 1.8 min (detection)

mesh: 1

Frame: 115
Time: 138.0

t = 2.3 min (movement)

mesh: 1

Frame: 148
Time: 177.6

t = 3 min (visibility < 4 m)

mesh: 1

Design Scenario 2 (“Atrium” Fire) RSET vs. ASET

Conclusions

1. Parking garage doesn't meet visibility criteria

- **Construct a protected exit passageway from elevator lobby to exit**
- **Install a smoke control system**

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Conclusions (conclusions)

2. “Atrium” doesn’t meets visibility criteria

- **Enclose atrium**
- **Install a smoke control system**

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Conclusions (continued)

Atrium might meet performance for a different fire

Meeting prescriptive requirements does not necessarily guarantee safety

Questions?

2013

CAL POLY.
MS Degree Program
fpe.calpoly.edu
Est. 2010

Thank you!