**Fire and Life Safety Evaluation
of the Providence Pavilion**

by

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Culminating Project

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Key words: Life Safety Code, RSET, ASET, Performance Based Design, Fire Dynamics Simulator

Dedication

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In recognition of the architectural firm of Jon R. Jurgens & Associates of Portland, Oregon for their permission to use proprietary design information in the preparation of my graphics, exhibits, and engineering models in this study; and

With gratitude, recognition, and appreciation that cannot adequately be expressed to my patient and constantly supportive wife Jay, who carried me through the FPE program day by day, night by night, weekend by weekend- never doubting that we would succeed:

I dedicate this culminating work in Master's program studies to my Master, the Lord Jesus Christ. I can do all things through Christ, who strengthens me.

Abstract

Fire and Life Safety Analysis of the Providence Pavilion

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California Polytechnic State University, 2013

The fire and life safety systems of the Providence Pavilion, a four-story addition to the Providence Medford Medical Center in Medford, Oregon, are examined for compliance with applicable design and construction codes and standards and are found to comply with codes and conform to standards. The prescriptive requirements for occupancy classification, construction type, structural fire protection, egress systems, fire alarms, and fire protection are reviewed. Three different fire scenarios are developed and are then employed to study the fire and life safety systems' performance using fire and egress modeling tools and simulations. Using this performance-based approach, the fire and life safety systems are shown to perform satisfactorily in the three scenarios that are presented.

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Chapter 1: Introduction to the Facility

The Providence Pavilion is a 4-story addition to the Providence Medford Medical Center (PMMC) in Medford, Oregon. PMMC is a 168-bed, acute-care regional hospital serving a large area of southern Oregon and northern California along the Interstate Highway 5 corridor. The Pavilion project developed in the early 1990s from the growing shift away from hospital inpatient care in favor of outpatient care and day surgery for procedures and treatment which do not require an overnight hospital stay.

Figure 1: Southwest aspect of the Pavilion, showing one of two main entrances.

The Pavilion was constructed on the west side of the original hospital and it adjoins a separate 4-story medical office building, the Providence Plaza. The Plaza provides professional offices and clinical space for medical specialists and practitioners and is a Business occupancy. The main hospital, the Pavilion, and the Plaza are connected on several levels by corridors, lobbies, and other public and circulation spaces.

Figure 2: The Providence Medford Medical Center Campus. Pavilion is outlined at left center. Arrows indicate main entry/exit points.

Visible in the aerial photo are the main entry to the hospital at the top, with the two main nursing towers to each side of it; the “Birthplace” (maternity center) and Emergency entrances on the east side, the Central Plant and service entrance at the south,

one of the primary entrances to the Pavilion facing a multistory parking structure at the southwest side, and various outlying parking areas for staff and visitors. The Pavilion has public entrances at its north and southwest sides.

Construction of the Pavilion began with the building foundation and two massive reinforced-concrete rooms which contain the radiation therapy linear accelerators at the southeast corner on the ground floor. Along with these, the building shell, core services on all levels, vertical transport, and mechanical penthouse were completed in the first phase of construction.

The second phase was the completion of the second floor, which functions as the Short Stay Unit (SSU) of the hospital and is one of its highest revenue-producing services. The third phase included the finish-out of the ground floor, which comprises both radiation and infusion cancer treatment and staff support facilities.

The final phase of construction of the Pavilion was the finish-out of the top two floors for tenants, which comprise specialty medical practice and business administration suites, and which do not connect horizontally with the hospital.

The design and construction of the Pavilion were guided and governed by various codes and standards which were in effect at the time. Among those which are relevant to this evaluation are the Oregon Building Codes (now called the Oregon Structural, Mechanical, Electrical, Plumbing, Fire, and Energy Efficiency Specialty Codes). The Oregon codes are based on the International Building Codes, which are promulgated by the International Code Council, or ICC. Also governing, or required by reference in the

Oregon codes, are the Oregon Administrative Rules (OARs) and various of the National Fire Protection Association's publications. The following is a partial listing of the rules, codes, and standards which affect the fire and life safety systems and which are referenced in this evaluation:

- OAR 333-535, "New Construction and Alterations of Existing Hospitals"
- NFPA 99, "Standard for Health Care Facilities"
- NFPA 101, "Life Safety Code"
- NFPA 13, "Standard for the Installation of Sprinkler Systems"
- NFPA 24, "Standard for the Installation of Private Fire Service Mains"
- NFPA 72, "National Fire Alarm and Signaling Code"
- NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilation Systems".

For this evaluation, the facility and its systems are reviewed with reference to the current (as of June, 2013) editions of the codes, standards, and rules. The Oregon Structural Specialty Code is referred to as "OSSC" in this evaluation.

Chapter 2: Floor Plans and Occupancies

The first floor of the Pavilion (plan, Fig. 3) comprises an ambulatory outpatient cancer treatment center and includes chemotherapy infusion rooms, education and consultation rooms, two linear accelerator rooms for radiation treatment, and support spaces for staff and patients. Cancer treatment patients enter the main reception and waiting area from the southwest. A contemplation courtyard and garden is outside the west exposure of the building, providing a separation between the Pavilion and Plaza. The north entry lobby and east-west corridor provide the main connecting backbone between the Pavilion, the hospital, and the Plaza. There are elevators and stairways at the northeast and southwest corners of the building for vertical transport. The sprinkler riser is located in the southwest stairway in the building. The connecting link between the Pavilion and Plaza has a roll-down fire shutter to separate the buildings when the fire alarm control panel goes into alarm so exits from the link are not considered to be usable by the Pavilion.

Figure 3: Ground (first) floor plan.

On the second level, the SSU occupies the floor and it connects directly to the hospital surgical and medical imaging suites through an intervening corridor system which also provides refuge space for patients who are evacuated on gurneys through horizontal exits. Within the SSU, two nurse stations serve a total of 22 patient cubicles. Patient registration, intake, discharge, and a family waiting area with 40 movable chairs (Fig. 4) are located outside the SSU on the north side of the building. At night when the SSU is not in use, rolling security gates close off the registration and reception area from the lobby. The second floor plan is shown in Fig. 5.

Figure 4: Short Stay Registration and Family Waiting, looking west.

Figure 6: Third level plan. Dark boxes in center are duct/pipe shafts.

The third floor (Fig. 6) comprises specialty medical practice suites, with a mix of patient waiting areas, lobbies, receptionist stations, circulation corridors, exam rooms, offices, treatment rooms, and utility areas. Other than a mechanical penthouse over the surgical suite, the hospital does not extend above the second floor in the area of the Pavilion, so there is no connection to it on the 3rd or 4th floors. The link from this floor west to the adjoining Plaza is only accessible to the staff and the path of travel goes through staff break and conference rooms; it is not a horizontal exit. The exits for the third floor are the two stairways. The staff passage door into the break room and conference room in the link has a closer on it to maintain separation, since egress in that direction would traverse intervening spaces to get to the corridor and stairways beyond.

The fourth floor (Fig. 7) is very much like the third, differing only slightly in that it also houses some of the hospital's business functions including a large staff conference room and the Providence Foundation.

The mechanical penthouse is located above part of the fourth floor and houses the central air conditioning air handlers, hydronic pumps, and other mechanical equipment that serves all areas of the Pavilion (Fig. 8). It is accessed by an open walkway across the roof from the stairway at the northeast corner.

Figure 8: Roof and mechanical penthouse.

Chapter 3: Construction and Finishes

The Pavilion is classified as an I-2 Institutional (hospital) occupancy. Although the upper two floors function as classification B (Business) occupancies, the Owner elected to construct the entire building to comply with I-2 requirements and this report studies the facility under that classification. The main structure is slightly less than 53 feet above the level of fire department access, with the highest occupied floor at 39 feet above that level. Since this is less than 75 feet, the OSSC does not consider the Pavilion to be a high-rise building. With an area of 22,553 ft² on the first floor, 15,440 on the second floor, and 12,418 on each of the two upper floors, the total area of the addition is 62,829 ft². A review of OSSC Table 503 “Allowable Building Heights and Areas” (Fig. 9) indicates that all but construction types I-A and I-B are ruled out for this building area, number of stories, height, and occupancy. Sections 504.2 and 506 of the OSSC permit an increase in number of floors by 1 and an area increase of 200% for fully sprinklered buildings with ample frontages, but these increases are not sufficient to permit construction of other than Types I-A or I-B. The Owners elected to construct the building to Type I-A requirements.

TABLE 503 ALLOWABLE BUILDING HEIGHTS AND AREAS*										
Building height limitations shown in feet above grade plane. Story limitations shown as stories above grade plane. Building area limitations shown in square feet, as determined by the definition of "Area, building," per story										
GROUP	HEIGHT (feet)	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
		UL	160	65	55	65	55	65	50	40
STORIES(S) AREA (A)										
A-1	S	UL	5	3	2	3	2	3	2	1
	A	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
A-2	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-3	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-4	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-5	S	UL	UL	UL	UL	UL	UL	UL	UL	UL
	A	UL	UL	UL	UL	UL	UL	UL	UL	UL
B	S	UL	11	5	3	5	3	5	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
E	S	UL	5	3	2	3	2	3	1	1
	A	UL	UL	26,500	14,500	23,500	14,500	25,500	18,500	9,500
F-1	S	UL	11	4	2	3	2	4	2	1
	A	UL	UL	25,000	15,500	19,000	12,000	33,500	14,000	8,500
F-2	S	UL	11	5	3	4	3	5	3	2
	A	UL	UL	37,500	23,000	28,500	18,000	50,500	21,000	13,000
H-1	S	1	1	1	1	1	1	1	1	NP
	A	21,000	16,500	11,000	7,000	9,500	7,000	10,500	7,500	NP
H-2 ^d	S	20	3	2	1	2	1	2	1	1
	A	21,000	16,500	11,000	7,000	9,500	7,000	10,500	7,500	3,000
H-3 ^d	S	20	6	4	2	4	2	4	2	1
	A	UL	60,000	26,500	14,000	17,500	13,000	25,500	10,000	5,000
H-4	S	20	7	5	3	5	3	5	3	2
	A	UL	UL	37,500	17,500	28,500	17,500	36,000	18,000	6,500
H-5	S	4	4	3	3	3	3	3	3	2
	A	15	15	27,500	23,000	28,500	10,000	36,000	18,000	0,000
I-2/I-2, I'	S	UL	4	2	1	1	NP	1	1	NP
	A	UL	UL	15,000	11,000	12,000	NP	12,000	9,500	NP
I-3 ^e	S	UL	2	NP	NP	NP	NP	NP	NP	NP
	A	UL	15,100	NP	NP	NP	NP	NP	NP	NP
I-4	S	UL	5	3	2	3	2	3	1	1
	A	UL	60,500	26,500	13,000	23,500	13,000	25,500	18,500	9,000

Figure 9: Building height and area allowances. [Source: OSSC]

All elements of the Pavilion structure comply with the required fire resistance ratings for this construction type. Table 601 of the OSSC, "Fire Resistance Rating Requirements for Building Elements" (Fig.10) lists the required ratings for each element. The primary structural frame consists of steel wide-flange columns, girders, beams, and joists with spray-applied fire resistive material to provide a 3 hour fire resistance rating. The roof and floor assemblies are composite metal decking joined to the joists with headed studs, topped with lightweight concrete and with welded wire fabric reinforcement to provide a 2 hour fire resistance rating. Exterior walls are constructed of steel studs with fiberglass batt insulation, painted 5/8" gypsum board interior finish, and 5/8" gypsum board exterior sheathing with a brick veneer. The exterior walls are all

nonbearing and have a 2 hour fire resistance rating. Interior walls and partitions are all nonbearing and are constructed of steel studs with fiberglass batt sound insulation, with painted 5/8" gypsum board finish on both sides. The interior walls and partitions are not required to have a rating except where they form part of an area separation or a smoke compartment.

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 ^d	B	A ^d	B	HT	A ^d	B
Primary structural frame ^e (see Section 202)	3 ^a	2 ^a	1	0	1	0	HT	1	0
Bearing walls									
Exterior ^{f, g}	3	2	1	0	2	2	2	1	0
Interior	3 ^a	2 ^a	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions	See Table 602								
Exterior									
Nonbearing walls and partitions	0	0	0	0	0	0	See Section 602.4.6	0	0
Interior ^h									
Floor construction and secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and secondary members (see Section 202)	1 1/2 ^b	1 ^{b, c}	1 ^{b, c}	0 ^c	1 ^{b, c}	0	HT	1 ^{b, c}	0

Figure 10: Required fire resistance ratings. [Source: OSSC]

The required minimum classes of interior finishes for the Pavilion are set forth in Table 803.9 of the OSSC, "Interior Wall and Ceiling Finish Requirements By Occupancy" (Fig. 11). The Table indicates that at least Class B finishes are required in all but administrative spaces or rooms with a capacity of four persons or less (these exceptions are noted in footnotes *h, i*, which are not shown in the figure).

**TABLE 803.9
INTERIOR WALL AND CEILING FINISH REQUIREMENTS BY OCCUPANCY^k**

GROUP	SPRINKLERED ^j			NONSPRINKLERED		
	Exit enclosures and exit passageways ^{a, b}	Corridors	Rooms and enclosed spaces ^c	Exit enclosures and exit passageways ^{a, b}	Corridors	Rooms and enclosed spaces ^c
A-1 & A-2	B	B	C	A	A ^d	B ^e
A-3 ^f , A-4, A-5	B	B	C	A	A ^d	C
B, E, M, R-1	B	C	C	A	B	C
R-4	B	C	C	A	B	B
F	C	C	C	B	C	C
H	B	B	C ^g	A	A	B
I-1	B	C	C	A	B	B
I-2	B	B	B ^{h, i}	A	A	B
I-3	A	A ^j	C	A	A	B
I-4	B	B	B ^{h, i}	A	A	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		

Figure 11: Required wall and ceiling finish classes. [Source: OSSC]

All wall and ceiling finishes in the Pavilion are Class A or B, having a flame spread index of 75 or less and a smoke-developed index of 450 or less. This includes suspended acoustical ceilings, painted gypsum board ceilings with and without texture, painted gypsum board walls with and without texture, trim and accent paints, vinyl base/cove moldings, and factory prefinished panels.

With respect to interior floor finishes, OSSC Section 804 permits Class II floor coverings in the exit enclosures, exit passageways, and corridors of a fully-sprinklered I-2 occupancy. The floor finishes and coverings in all other areas must pass the DOC FF-1 “pill test” (CPSC 16 CFR, Part 1630 test procedure). All interior floor finishes and coverings in the Pavilion are Class I or II, with a critical radiant heat flux of at least 0.22 W/cm². This includes vinyl composition tile, seamless sheet vinyl, welded-seam vinyl sheet, nonconductive vinyl sheet, and carpeting.

Chapter 4: Egress Systems

The Pavilion has seven exits at grade level (first floor): there are two main patient/public entries with automatic sliding doors, two exits to the stairways at the northeast and southwest quadrants, an exit to the contemplation courtyard at the west, and two staff entry doors at the north and south. The second floor, with the likelihood of involving patients on gurneys or in wheelchairs unable to exit without assistance, has four horizontal exits into other areas of the hospital in addition to the two stairways for ambulatory occupant egress. The main egress means for the two upper floors of the Pavilion, which are above the highest level of the main hospital and thus do not connect with it horizontally, are the two stairways.

The number of occupants per floor is determined using the occupant load factors in OSSC Table 1004.1.1, “Maximum Floor Area Allowances Per Occupant”. The occupant load factors for Institutional Outpatient and Business areas are the same, at 100 ft²/occupant.

For each floor of the Pavilion, the code requirement for a minimum of two exits remotely located from each other (1 to 500 occupants per floor) in OSSC Table 1021.1, “Minimum Number Of Exits For Occupant Load”, is adequately met by the physical arrangement of the two stairways. The exit capacity for each floor is calculated with capacity for stairways at 0.3” width per person and capacity for doors and other

horizontal elements at 0.2" width per person, in accordance with OSSC Section 1005. The required and supplied exit capacities are listed in Table 1.

For the ground floor, the limiting elements are the doorways leading out of the oncology suite. The 48" door leading east out of Radiation Oncology into Corridor GC18 provides a capacity of 240 persons. The 60" double-sliding door with panic breakaway leading southwest out of Shared Waiting 100 into Entrance S110 has a capacity of 300 persons. Finally, there is a pair of 36" out-swinging doors from Hall 143 into Corridor S112 on this floor with a capacity of 360 persons. The total for doorways is thus 900 persons.

For the SSU on the second floor, the limiting elements are the two stairways. Each stairway is 44" wide, providing an exit capacity from the floor of $(147 \times 2) = 194$ persons. There are also horizontal exits from the SSU and the main waiting areas into the hospital proper, which provide the ability to transport incapacitated patients on gurneys or in wheelchairs horizontally to other compartments of the building. The areas beyond the horizontal exit doorways must provide a free area of 30 ft²/patient for gurney refuge when patients are evacuated (OSSC Section 1025.4 for horizontal exits). For the 22 beds in the SSU, that equates to 660 ft² of required gurney refuge, and 1,088 ft² are provided.

For the third and fourth floors, as for the second, the limiting elements are the two 44" stairways with a total exit capacity of 194 persons. This is adequate for the calculated number of occupants on each of the two upper floors.

Floor	Area, sq.ft.	No. Occupants	Exit Capacity	Complies?
First	22,553	226	900	Yes
Second	15,440	155	194	Yes
Third	12,418	125	194	Yes
Fourth	12,418	125	194	Yes

Table 1: Exit loading by floor.

The requirements for travel distance to exits are contained in OSSC Table 1016.1, “Exit Access Travel Distance”, which limit the travel distance to 200 ft. for fully sprinklered I-2 occupancies. All of the spaces on all floors of the Pavilion comply with these limits. An example of one of the longest travel distances to exit is Dirty Utility D400.09 on the 4th floor, with a travel distance of just under 140 ft.

Section 1018.4 of the OSSC prescribes a maximum length of 20 ft. for corridor dead-ends. There are some dead ends and common paths of travel in the SSU (e.g., Restroom P2058 by Camera Rm. 1, Restroom P2037 in Short Stay, and Staff Conference P2007), but none of them are more than 15 ft. long.

Means of egress are illuminated in compliance with OSSC Section 1006, “Means Of Egress Illumination”, to an average of at least 1 footcandle. Exit signs, which are illuminated and are powered by the Life Safety branch of the hospital’s essential electrical systems, are placed in compliance with OSSC Section 1011, “Exit Signs”.

Chapter 5: Fire Protection and Fire Alarm Systems

The Pavilion is protected throughout by a wet-pipe sprinkler system, with coverages provided as defined in NFPA 13 for Light Hazard on the occupied floors and Ordinary Hazard in the penthouse. In addition to the sprinkler system, Class I standpipes are installed in each of the two stairways. The as-built sprinkler and utility plans for the Pavilion indicate that the water-based fire suppression systems of sprinklers and standpipes are supplied from the Medford Water Commission's underground main that traverses the PMMC campus. The service main to the Pavilion is indicated to be a 4" ductile iron pipe from the utility main tap to the base of the riser (BOR). According to NFPA 13 Section 23.1.3.2, if the system requirements for flow and pressure can be met with 4" pipe, this size is permitted since there are no hydrants supplied by the main.

Water flow data used for the system design were obtained from the site utility plan and the flow test indicates a static pressure of 104 psi and a residual pressure of 98 psi with 1400 gpm flowing.

The hydraulically most demanding area is the mechanical penthouse, in that it is the highest area of the building and is the area that is most distant from the riser in terms of total equivalent length of piping. A piping schematic of the sprinkler system to and including the penthouse is shown in Fig. 12.

Figure 12: Wet-pipe sprinkler system schematic.

The required coverage for the penthouse is 0.15 gpm/ft^2 over a 1500 sq.ft. design area. The area selected for calculation contains 13- Central Sprinkler Model GB upright heads having a $\frac{1}{2}$ " orifice and k factor of 5.6. The heads are spaced at 10'-6" on center along the branch lines and the branch lines are spaced at 11'-6" apart on the cross main. This results in a coverage area per head of about 120 sq.ft., with a corresponding flow of 18 gpm for the most remote head. The hydraulic calculation table for the system, Fig. 13,

begins with this value for the calculations and proceeds back to the sprinkler riser at the ground floor.

Project name:		Providence Pavilion - penthouse		Oscar Zuniga		Date:		14-Mar-12	
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	1 BL1	q	1"		L 10.5	C= 120	Pt 10.3	Pt	k= $q = k * (Pt)^{1/2}$ p=10.3
		Q 18.5			F		Pe	Pv	
					T 10.5	pf 0.034	Pf 0.4	Pn	
2	2	q 18.3	1-1/4"		L 10.5	C=	Pt 10.7	Pt	k=
		Q 36.3			F		Pe	Pv	
					T 10.5	pf 0.103	Pf 1.1	Pn	
3	3	q 19.2	1-1/4"		L 10.5	C=	Pt 11.8	Pt	k=
		Q 55.5			F		Pe	Pv	
					T 10.5	pf 0.226	Pf 2.4	Pn	
4	4	q 21.1	1-1/4"		L 10.5	C=	Pt 14.2	Pt	k=
		Q 76.6			F		Pe	Pv	
					T 10.5	pf 0.411	Pf 4.3	Pn	
5	5 DN RN to CM	q 24.1	1-1/2"	2T-16	L 11	C=	Pt 18.5	Pt	keq= 18.05 for BL
		Q 100.7			F 16		Pe 0.7	Pv	
					T 37.5	pf 0.321	Pf 12.0	Pn	
6	6 CM to BL2	q	3"		L 11.5	C=	Pt 31.2	Pt	k=
		Q 100.7			F		Pe	Pv	
					T 11.5	pf 0.014	Pf 0.2	Pn	
7	7 BL2 to BL3	q 100.3	3"		L 11.5	C=	Pt 31.4	Pt	
		Q 201.0			F		Pe	Pv	
					T 11.5	pf 0.050	Pf 0.6	Pn	
8	8 BL3 CM to DROP	q 77.1	3"	2L-14	L 40	C=	Pt 32.0	Pt	
		Q 278.1			F 14		Pe	Pv	
					T 54	pf 0.091	Pf 4.9	Pn	
9	9 DROP to TOP RISER	q	3"	3L-21 1T-15	L 106.5	C=	Pt 36.9	Pt	
		Q 278.1			F 36		Pe 25.3	Pv	
					T 142.5	pf 0.091	Pf 13.0	Pn	
10	10 TOP of RISER to BOR	q	3"	GV-1 CV-16	L 10	C=	Pt 75.2	Pt	
		Q 278.1			F 17		Pe 4.3	Pv	
					T 27	pf 0.091	Pf 2.5	Pn	
		q			L	C=	Pt 82.0	Pt	

Figure 13: Wet-pipe sprinkler system hydraulic calculations.

Manual hydraulic calculations result in a required sprinkler water flow of 278.1 gpm with a pressure of 82.0 psi at the base of the riser; computer-based hydraulic calculations of the system were not performed for this study and report. A graph of required vs. available fire flows is shown in Fig. 14. Based on this graph, the fire flow requirement can be met by the available supply. A hose stream allowance is not added to the sprinkler flow requirement for this system due to the inclusion of a standpipe system.

Section 11.1.6.6 of NFPA 14 permits the system water supply calculation to exclude a hose stream allowance if a standpipe system is installed.

Figure 14: Sprinkler system fire flow summary.

Class I standpipes are installed in each of the two stairways and a fire department connection (FDC) is located outside the southwest entrance to the building. The standpipe system piping is all 4" in size and there are no hose cabinets or hoses with nozzles fixed in place. For the standpipes, NFPA 14 requires a minimum design flow of 500 GPM and a maximum of 1000 GPM. Based on an inspection of the contractor's shop drawings as well as on-site observation of the installed systems, the piping is almost entirely fabricated of Schedule 40 black steel pipe. The larger piping is joined using cut grooving and semi-flexible Victaulic/Grinnell-style mechanical groove-lock couplings.

Smaller piping is joined using threaded pipe male ends and malleable iron threaded fittings.

Transition from the ductile iron water supply main that comes into the riser room, to the black steel base of riser that continues into the building, is just above floor level in the riser room at a flanged pipe joint between the two. The system riser into the building is 4", as are the wet-pipe control valve and the riser accessories (Fig. 15). Piping feed mains extending into each floor are uniformly 3" in size, as are the cross-mains. The majority of the branch lines begin as 1-1/2" and reduce in size as sprinklers are supplied and the flow drops off toward the end of each branch. Several of the branches begin as 2", particularly where higher flow heads are used on those lines and flow demand is increased.

Figure 15: Sprinkler riser, valve, standpipe, and drain.

Seismic bracing for the sprinkler and standpipe system piping is installed in accordance with NFPA 13 requirements. The seismic design Occupancy Category is IV (hospital), Importance Factor is 1.5, and the resulting Seismic Design Category is D based on OSSC and ASCE-7 seismic design tables. The piping supports and bracing are deemed to comply with OSSC and ASCE-7 seismic design requirements for non-structural components since they comply with NFPA 13 requirements for support and bracing.

There are six different types of sprinkler heads used in the Pavilion. The most common type of head originally used is the Central Model GB, style SSP (pendent), brass finish, with ½” orifice, 155°F glass bulb element and a k-factor of 5.6. These heads were installed throughout the unfinished (shell) spaces in the upper floors of the Pavilion, but most of them do not remain today as they have been replaced with various other types of heads as the shell spaces were finished out to tenant-occupied spaces.

The next most common head used is the recessed Central Model GB QR (quick response), white finish, with ½” orifice, 155°F glass bulb element and a k-factor of 5.6. These heads are used in stairs, lobbies, waiting areas, and throughout most of the finished medical clinic and consulting suites. The recessed feature provides for a smooth, flush, and unobtrusive appearance in the medical spaces.

The third most populous head is the Central Model GB in style SSU (upright, brass finish, ½” orifice, 200°F element, k-factor 5.6). These heads are used only in the mechanical penthouse, the higher temperature rating reflecting the mechanical usage of

the space and the exposed nature of the walls and roof, leading to elevated temperatures, especially during summertime.

The fourth most-used head is the Central Model ELO LH, recessed, white finish, with a 17/32" orifice, 155°F element, and k-factor of 11.4. These heads are used in lobbies and corridors and utilize a fusible element rather than a frangible glass liquid-filled bulb for thermal activation. They are an extended coverage head, used in areas where architectural features such as bulkheads or coffers create larger discrete areas that require coverage with a single head. Fig. 16 shows a corridor area with such bulkheads and ceiling coffers.

The fifth type of head used is the Central Model GB recessed head, chrome finish, 1/2" orifice, 165°F element, k-factor of 5.6. These heads are used in stairways and areas of rescue assistance.

Figure 16: Headers create individual ceiling coffers. Sprinkler heads and smoke detectors are installed in each coffered compartment.

The head with the fewest occurrences in the Pavilion is the Central Model GB in style SSP (pendent, brass body, 1/2" orifice, 200°F thermal element, k-factor 5.6). These heads, similar to the heads that were used throughout the unfinished shell spaces except with a higher thermal element temperature rating, are used only in the electrical equipment rooms on each floor and their higher thermal element rating reflects the expectation that heat release from installed equipment will result in higher ambient temperatures in these rooms under conditions of normal usage.

In accordance with the requirements of the Oregon Fire Code, Section 907.2.6.2 for I-2 occupancies, a complete manual and automatic fire alarm system is installed in the facility. The fire alarm system was designed and installed in accordance with NFPA 72.

The fire alarm system panel is a fully-addressable Notifier AM2020 installed in the hospital's Engineering office. An annunciator and firemen's control panel is installed immediately inside the southwest entrance to the Pavilion, near the fire department connection and the stairway where the sprinkler riser and one of the standpipes are installed. Remote power supplies are provided on each floor to provide normal and reserve power for detection and notification appliances. Battery calculations for the panel and power supplies indicate that the system is capable of meeting the requirements in 10.5.6.1.1.2 of NFPA 72 for operating in standby mode for 4 hours, followed by operating in alarm for 5 minutes. This requirement applies to fire alarm systems supplied by the hospital's emergency generator through the life safety branch of the essential electrical systems.

The Notifier panel receives alarm, supervisory, and trouble signals from the Pavilion as well as from all other areas of the hospital. The panel contains a digital alarm communicator transmitter (DACT) that connects the hospital with a remote supervising station for the transmission of signals to the remote station.

The requirements for disposition of alarm, supervisory, and trouble signals are contained in sections 10.9 (Fire Alarm Signals), 10.10 (Fire Alarm Signal Deactivation), 10.11 (Supervisory Signals), and 10.12 (Trouble Signals) of NFPA 72. In general, the Code stipulates the permissible delay times between signal initiation and indication,

either audible or visible or both, at the required locations. It also stipulates the conditions under which the alarm, supervisory, or trouble signals can be silenced, cleared, or canceled and in all instances it requires that successive alarms or repeated silencings must re-enable the alarm, supervisory, or trouble signal so that continuation or escalation of a problem cannot be readily ignored or overridden. The means for silencing alarm, supervisory, and trouble signals are required to be key-operated or contained within a locked cabinet to prevent unauthorized silencing. At PMMC, the keys for control of these functions are in the Engineering office, which is only accessible by trained Engineering and Security personnel. In any case, the panel may not permit the condition to be cleared and restored to normal until the device in alarm is reset, the supervisory device is reset, or the trouble condition is cleared and continuity is restored.

There are three types of fire detection devices used in the Pavilion. The first type are the wet-pipe fire sprinkler system heads. When the thermal element in a sprinkler head is activated and the sprinkler begins to flow water, the flow switch in the sprinkler riser initiates the alarm sequence at the fire alarm panel.

The second type of detection devices are the ceiling-mounted smoke detectors that are used throughout the facility, with a variant of these detectors being mounted in housings with duct probes, where they are used as duct smoke detectors at each of the air handlers serving the zones and floors of the building. Although there have been different types and versions of smoke detectors installed in areas of the facility, all are Johnson Controls/Notifier addressable, intelligent detectors with a B210LPJ or B501BS base. There are at least six different models used in the facility, resulting from the phased construction which spanned a period of several years and during which the manufacturer

released different versions and models of detector appropriate for this application. Both photoelectric and ionization type detectors are used, and most of them also incorporate either fixed temperature (135°F) or rate-of-rise heat detection capability.

The third type of fire detection devices in the Pavilion are ceiling-mounted heat detectors. As with the smoke detectors, there are various models and versions of heat detectors installed, but all are Johnson Controls/Notifier and most are 5951J series intelligent detectors with the same bases as the smoke detectors, with activation set at 190°F. They are only used in electrical and datacom equipment rooms in the Pavilion.

NFPA 72 prescribes the allowable coverage area for individual detectors, with the coverage area under the general rule being described by a square area per head. Additional flexibility is allowed for irregular geometry by permitting the maximum distance from a head to any point in its coverage area to be no more than 0.707 times the detector spacing. The coverage area provided by the Johnson Controls/Notifier 2951J photoelectric head is stated as a spacing of 30 ft. between detectors for ceiling heights not exceeding 10 ft., of which there are none in the Pavilion. For the heat detectors, the 5951J series detectors are UL approved for a spacing of up to 50 x 50 feet and FM approved for a spacing of up to 25 x 25 feet. Since they are only used in electrical and datacom rooms of much smaller size than this, they all comply with the approvals. Device placement, spacing, and coverage in all areas of the Pavilion complies with NFPA 72 requirements, and is exceeded in many cases since smoke detection is not required throughout the fully-sprinklered facility but the Owners have elected to provide such coverage. The Oregon Fire Code only requires smoke detectors in corridors, sleeping rooms, and spaces open to the corridors but detection has been provided throughout.

Occupant notification is by horns and strobes in public areas, chimes and strobes in staff areas, and by voice notification over the public address system throughout the facility. The hospital is operated continuously and there is a continuously-staffed central office with a trained operator to provide emergency instructions as well as general paging, staff notification, and announcements. With very few exceptions that can be determined from the available information (such as candela output settings on variable-output devices), notification is very complete and provides Code-required coverage both audibly and visually. In some spaces, audible notification is in the form of chimes rather than horns, where the response is intended to be provided by trained staff rather than by the general public. In public areas such as elevator lobbies, corridors, and waiting areas, notification appliances are combination horn/strobes either on walls or in ceilings.

The first and second floors of the Pavilion, as well as the corridors, elevator lobbies, and public areas of the 3rd and 4th floors, have public address speakers in most areas. These speakers are used for issuance of “code” calls to physicians and nursing staff, paging of physicians and individuals, and issuance of general information such as notification of system tests, improperly parked vehicles, and impending significant weather changes. The system operator position is continuously manned and the operator, together with the continuously-manned security staff and internal communications system, is trained in issuance of instructions and in handling of emergency notification. The hospital’s fire plan, evacuation plan, and Code Red fire drill instructions are contained in Appendix A.

The public address system amplifier and power supplies are powered by the Critical branch of the essential electrical system of the hospital, backed up in the short term by an uninterruptible power supply and in the long term by the hospital's emergency generators. Not all of the wiring is installed in conduit nor is the system inspected and tested to the more recent standards contained in NFPA 72 for EVACS systems.

Chapter 6: Performance-Based Analysis of Fire and Life Safety Systems

In this section, the prescriptively-designed and -constructed fire and life safety features of the Pavilion are challenged by developing fire scenarios which are then modeled and simulated using computational methods, and the performance of the building systems is evaluated. The methodology used in each scenario is to compare the required safe evacuation time for the occupants (RSET) to the available safe evacuation time (ASET), based on the modeled fire and its effects on the spaces and occupants involved. In a healthcare occupancy, where the occupants are assumed to be in compromised health or incapable of self-preservation, it is of the utmost importance that safe evacuation be achieved. In all cases, ASET must exceed RSET or the occupants cannot evacuate from the involved area without encountering untenable conditions.

Chapter 5 of NFPA 101 covers the performance-based design of life safety systems as an acceptable alternative to prescriptive methods. Section 5.5 of that Chapter covers design fire scenarios and 5.5.3 describes eight scenarios which are required to be considered under a complete performance-based design. Included in the evaluation of the Pavilion are fire scenarios which represent the first three types of fires outlined in Section 5.5 of the Code. However, various elements of several of the other scenarios are also included in the models presented here.

The modeling and simulation tools used to evaluate fire and life safety system performance in this evaluation are Thunderhead Engineering's *Pathfinder 2012*^[1] and the program *Fire Dynamics Simulator* (FDS) version 5^[2], developed by the National Institute of Standards and Technology (NIST). *Pathfinder* is an agent-based emergency egress simulator which employs independent 'agents' with assigned human movement and behavior characteristics to traverse a simulated 3D model of the space under study. Using *Pathfinder*, travel times and movement characteristics can be studied to maximize egress effectiveness and to predict evacuation times. In this evaluation *Pathfinder* is used in Fire Scenario 3 to predict the time for all occupants to evacuate from the 3rd floor of the Pavilion as a fire develops and smoke spreads into the spaces. The modeling tool is useful due to the number of occupants to be evacuated (125), their random location throughout the medical offices and examination rooms on the 3rd floor, and due to the presence of only two exits on that floor., which limits the speed of evacuation. The movement of occupants in Scenarios 1 and 2 is calculated by hand since fewer occupants are involved and their egress travel is straightforward.

FDS is a computational fluid dynamics model of fire-driven fluid flow. Together with the companion visualization tool *Smokeview*, which converts the computed output data stream from *FDS* into viewable sequences in simulated 3D on the computer screen, *FDS* can model fire growth and spread, temperature patterns, and the concentration and movement of combustion products in the modeled spaces. In this evaluation *FDS* is used in all three fire scenarios to simulate the ignition and development of the design fires within the modeled domain, and *Smokeview* is used to visualize the fire and smoke effects on tenability over the course of the fires in the involved spaces.

Establishing tenability is essential to validating the outcome of a performance-based analysis since tenable conditions must exist throughout the ASET period and careful consideration must be given to establishing those limits for the design population. The three parameters or indicators which have been used to determine tenability in this evaluation are *temperature*, *carbon monoxide concentration*, and *visibility*.

For the *temperature* parameter, 60°C is used as the tenable limit for the occupied space. The majority of humans at rest with bare skin exposed can tolerate humid air at 60°C for a period in excess of 60 minutes.^[3] Beyond these exposure limits, skin burns and respiratory irritation may occur in susceptible members of the population.

For the *carbon monoxide* parameter, tenability is assumed to exist at a carbon monoxide concentration of up to 1400 ppm in the occupied space for a period of up to 30 minutes.^[4] Beyond these exposure limits, incapacitation or loss of consciousness may occur in susceptible members of the population.

For the *visibility* parameter, tenability in Scenarios 1 and 3 is assumed to exist at a forward visibility of at least 13 meters (43 ft.) at approximately eye level (1.8m or 6 ft.).^[5] For Scenario 2, which involves trained staff evacuating patients on gurneys, a forward visibility of at least 4 meters (13 ft.) is used as the tenable limit since the evacuating staff are trained and are familiar with their surroundings and the paths of travel.^[6]

In addition to the programs described above, the time for smoke detectors to respond to products of combustion is estimated using the Excel spreadsheet “Detector_Activation_Time” developed by the United States Nuclear Regulatory

Commission (NUREG) ^[7]. This spreadsheet is based on fire plume and hot gas layer behaviors for smooth, flat ceilings, which do not typify the ceilings where the three analyzed fire scenarios are staged. However, in Scenarios 1 and 2, automatic smoke detection and alarm are not used to trigger the beginning of occupant movement and in Scenario 3 the smoke detector located nearest to the design fire detects smoke so quickly that the activation of the fire alarm system is for all intents and purposes simultaneous with the fire's detection by the occupants.

Fire Scenario 1: Family Waiting

Figure 17: Fire Scenario 1. Fire originates in a trash can, igniting an upholstered chair. Red circle locates nearest smoke detector.

Design Fire Scenario 1 in NFPA 101 tries to capture the type of fire that is most likely to occur in a given occupancy. For this scenario, a fire is originated in a trash can in Family Waiting outside of the SSU (Fig. 17). There is a large fuel load in this area, consisting of the waiting room furniture, seasonal decorations, furnishings, and a significant amount of readily-ignitable food and beverage wrappers, containers, and trash in the trash cans on any typical day. A fire in this area will cut off access to one of the two elevators serving the floor, and will likely also compromise one of the stairways and the main east-west corridor connecting Short Stay with the rest of the hospital.

Early in the day, the waiting area is populated by a mix of patients who have brought themselves in for day surgery, patients who are on crutches or in wheelchairs who have been brought in for surgery, family members who are accompanying or assisting the patients, caseworkers who are registering and discharging patients, and staff and visitors who transit the waiting room while passing from the hospital to the adjoining Plaza building. For purposes of studying this area of the building, an occupant count of 50 is used, based on the number of chairs in the waiting room plus the number of fixed staff positions in the registration area. This count corresponds to an occupant density of about 33 ft²/person, which is three times the Code-stipulated density for this occupancy but which is realistic. For occupant movement speed 2.5 ft/s is used as the travel speed for mobility-impaired persons ^[8], and for travel distance to exit the diagonal distance across the waiting area of 62 ft. is used, resulting in a travel time of 25 seconds. A second possible path of egress to the southwest stairway avoids moving through the area where smoke and heat will be developing quickly, but that path is longer and is less likely to be taken since most patients coming to the SSU enter through the reception and

registration desk and they will most likely seek to evacuate the same way that they entered. Traversing the alternate exit route adds 19 seconds to the travel time. This fire scenario is diagrammed in Figure. 18.

The design fire is an upholstered chair, commonly referred to as type F21 in the literature ^[9], with a peak heat release rate of 2000kW and a medium fire growth rate. To simulate the somewhat sooty smoke that is anticipated to be produced by combustion of the wooden chair frame with polyurethane upholstery foam and synthetic polyester fabrics used in this type of furniture, a soot yield of 0.10 kg per kg of fuel is used in the FDS fire model. This number is a composite of the soot yields of the three major components of the furniture. To approximate the carbon monoxide yield of a well-ventilated fire, which a single upholstered chair in a relatively large and open room might provide, a CO yield of 0.028 kg per kg of fuel is similarly used ^[10].

Figure 18: Diagram of Fire Scenario 1.

In order to determine the ASET for this scenario, the Family Waiting area outside SSU is modeled and run in FDS. A perspective image of the modeled space is shown in Figure 19 and the FDS input file for this fire scenario is included in Appendix B. Included in the model are two fire sprinkler heads and a ceiling smoke detector, all of which are placed based on their positions in the actual building.

Figure 19: Smokeview model of Fire Scenario 1.

The FDS model is run for 600 seconds, with the heat release rate (HRR) of the burning chair ramped to simulate the HRR profile obtained in furniture calorimeter fire tests. A comparison of the calorimeter HRR with the simulated profile is shown in Figure 20. From the FDS simulation it is estimated that the first sprinkler head will open at about 290 seconds after ignition. From the HRR profile, it can be seen that the burning chair is reaching its peak heat output at that time, so the fire is permitted to continue to ramp to burnout and it is then assumed that the activation of the sprinklers acts to prevent the involvement of any other fuels in the area.

Figure 11. Effect of specimen padding and fabric on rate of heat release

Figure 20: Heat release rate curves for Fire Scenario 1. Furniture calorimeter data on left, FDS ramp simulation on right.

The FDS results suggest that tenable limits are reached in the Family Waiting area at 170 seconds after fire ignition. At that time, visibility drops to 10 meters in all of the waiting area, but it remains above that value in the egress corridors leading from the space. Figure 21 is a Smokeview image of the visibility in the waiting area at the 6 ft. level at 170 seconds after ignition, with the index in the right margin (black outline) set to identify the limits of areas with a visibility of 10 meters. The tenability limit for temperature is not reached until 275 seconds after ignition and the level of CO never exceeds 500ppm for the duration of the simulation. It is therefore assumed that visibility is the determining factor for ASET for this simulation and that ASET is 170 seconds.

Figure 21: Smokeview image of the visibility in Family Waiting at $t = 170s$. Slice file is taken at 6 ft. above the floor.

Four factors combine to determine RSET: notification (or alarm) time, reaction time, pre-evacuation activity time, and travel time. Notification time is the time between fire ignition and the moment when occupants become aware that there is a fire. In this scenario, the involved trash can and chair are in close proximity to the waiting room occupants and readily apparent to them. A notification time of 10 seconds is used for this scenario.

Reaction time is the time during which occupants take stock of what is happening, perhaps begin to question one another about what to do, assess the hazard to themselves, and then decide to take action. A reaction time of 10 seconds is used for this scenario.

Pre-evacuation activity time is the time during which occupants collect their belongings, close books and laptop computers, and prepare to evacuate after deciding to

take action. A pre-evacuation activity time of 30 seconds is used for this scenario since there may be occupants who must prepare folding walkers, canes, crutches, or wheelchairs for their movement.

Together with the travel time of 25 seconds determined at the beginning of development of this scenario, the four RSET elements sum to 75 seconds, which is well within the 170 second ASET. For the alternate egress route another 19 seconds of travel time are required, for an RSET of 94 seconds. The comparison of ASET to RSET for Fire Scenario 1 is shown in Figure 22.

Figure 22: ASET and RSET for Fire Scenario 1.

Design Fire Scenario 2

Figure 23: Fire Scenario 2. Fire originates in rolling trash hampers near SSU south nurse station.

Design fire scenario 2 in NFPA 101 envisions the maximum effects of smoke and toxic products in the primary means of egress, with interior doors open at the start of the fire. Similar to Scenario 1, it addresses a reduction in the number of available means of egress in connection with an ultrafast fire. For this scenario, fire starts in a rolling trash hamper inside the SSU. There is a very high patient turnover rate in SSU, which generates a great deal of disposable material comprising a high percentage of plastics and paper, including IV drip tubing, respiratory therapy tubing, disposable gloves, oxygen

masks, patient trays, dressings, wrappings, and packaging. This material is collected in large rolling hampers which are emptied periodically. An ultrafast fire develops in two full containers of disposable materials.

Although the likelihood of having incapacitated patients in all 22 of the patient cubicles during a normal day is low, this scenario examines the possibility of the hospital having to deal with casualties from a catastrophe of some sort. In this case, every available bed could be in use and could contain an immobile patient. The occupant count is relatively unimportant in the analysis of evacuation time, since family or visitors will be able to move with the patient or travel independently to an exit, while attending staff will set the pace and efficiency of egress travel. For this scenario, an occupant movement speed of 2 ft/s is used as the travel speed. This rate will pass each 7 ft. long gurney and its attendant through the horizontal exit doors to refuge in approximately 4 seconds. For travel distance to exit the distance from Patient Cubicle 8 to the horizontal exit, 82 ft., is used, resulting in a travel time of 41 seconds. Other paths of egress are available to the other SSU cubicles; the route for Cubicle 8 is the longest travel distance and that cubicle is the one nearest the fire. This fire scenario is diagrammed in Figure. 24.

A peak heat release rate of 350kW is used for this fire, based on test burn data from the literature ^[11]. While this exact mix of material has not been full-scale burn tested, comparisons between the heat release rates of similar volumes of collected metro train trash, airline trash, construction rubble, and household garbage all showed peak HRRs in the range of 275-350kW. The HRR used to model the fire in this scenario is taken from the SFPE Handbook as being representative of this type of fire. Soot yield and CO yield values used for this fire are the same as for Fire Scenario 1.

Figure 24: Diagram of Fire Scenario 2.

As in Fire Scenario 1, the ASET for this scenario is determined by modeling the involved area of the SSU and running the simulation in FDS. A perspective image of the modeled space is shown in Figure 25 and the FDS input file for this fire scenario is

included in Appendix B. Included in the model are two fire sprinkler heads and a ceiling smoke detector, all of which are placed based on their positions in the actual building.

Figure 25: Smokeview model of Fire Scenario 2.

The FDS model is run for 600 seconds, with the heat release rate (HRR) of the burning trash bags ramped to simulate the HRR profile obtained from fire tests. A comparison of the calorimeter HRR with the simulated profile is shown in Figure 26. From the FDS simulation it is estimated that the first sprinkler head will open at about 62 seconds after ignition. From the HRR profile, it can be seen that the burning trash bags are at their peak heat output at that time, so the fire is permitted to continue to ramp to burnout and it is then assumed that the activation of the sprinklers acts to prevent the involvement of any other fuels in the area, including the overhead cabinets at the fire location.

Figure 26: Heat release rate curves for Fire Scenario 2. Calorimeter data on left, (data plot 20), FDS ramp simulation on right.

The FDS results suggest that tenable limits are reached in the involved SSU area at 170 seconds after fire ignition. At that time, visibility drops to 4 meters in all of the south nurse station and patient cubicle areas, but it remains above that value in the north areas of the Unit. Figure 27 is a Smokeview image of the visibility in the south SSU at the 6 ft. level at 170 seconds after ignition, with the index in the right margin (black outline) set to identify the limits of areas with a visibility of 4 meters. The tenability limit for temperature is only reached momentarily as the fire HRR peaks, but it is not sustained for more than several seconds and then does not exceed 50°C for the duration of the simulation. The CO concentration never exceeds 500ppm during the burn. It is therefore assumed that visibility is the determining factor for ASET for this simulation and that ASET is 170 seconds.

Figure 27: Smokeview image of the visibility in SSU South at $t = 170s$. Slice file is taken at 6 ft. above the floor.

The four factors which combine to determine RSET are evaluated. In this scenario, the involved trash hampers are in immediate proximity to the south nurse station and are readily apparent, so a *notification time* of 5 seconds is used for this scenario. A *reaction time* of 5 seconds is used for this scenario, since the responders are trained and prepared. *Pre-evacuation activity time* is taken up with disconnecting patients from headwall utilities and preparing them for transport to safety. A duration of 30 seconds is assigned to pre-evacuation activity.

Together with the travel time of 41 seconds determined at the beginning of development of this scenario, the four RSET elements sum to 81 seconds, which is well within the 170 second ASET. The comparison of ASET to RSET for Fire Scenario 2 is shown in Figure 28.

Figure 28: ASET and RSET for Fire Scenario 2.

Design Fire Scenario 3 in 5.5.3 of the Life Safety Code outlines a situation in which a fire starts in a normally unoccupied room and migrates into spaces that may hold the greatest number of occupants in the building. For this scenario, the design fire is staged in a storage closet that adjoins a nurse station and reception station on the 3rd floor of the Pavilion. The offices and exam rooms on this floor are in a semi-open plan arrangement with connecting corridors and lobbies. The occupants are assumed to be a mix of able-bodied persons, some ill, some children, some disabled and elderly. Many of the patients are attended by family members, and the floor has only two exits (the two stairways), so a fire that spreads smoke out to the main reception lobby may also cut off one of the two exits.

The previously-established occupant count of 125 persons was used in a Pathfinder simulation using the SFPE method of occupant movement, resulting in a time to evacuate of 109 seconds, and a conventional hand calculation was also run, resulting in a time to evacuate of 156 seconds. The 30% difference between these two evacuation times is attributed to the more realistic and efficient actions of Pathfinder simulated ‘agents’ in deciding when and how to move to exits. Predictably (since the exit doors into the stairways are 36” wide and have less capacity than the stairways), queuing occurs at the exit doors to the stairways and occupant movement speed to the exits is not the major consideration in arriving at the time to evacuate. However, both the simulation and the calculation divided the occupants between two available exits. As will be shown in the FDS simulation, both exits are not available for the full time needed for evacuation, thus justifying this scenario as a useful challenge to the fire and life safety systems on this floor.

For this scenario, fire is started in a supply closet with the door to the closet open or ajar and a medium growth rate fire develops in open shelves of common office supplies and paper materials. This fire scenario is diagrammed in Figure. 29.

Figure 29: Diagram of Fire Scenario 3.

A peak heat release rate of 3000kW was initially used for this fire, based on test burn data obtained from the SFPE Fire Protection Engineering Handbook for magazines, books, and publications in storage racks ^[12]. However, this rate is not proportional to the actual stored materials or to their arrangement on shelves. In the FDS simulation the sprinkler head installed in the closet is shown to discharge water at about 195 seconds after ignition, at which time the HRR is 605 kW. The HRR output data from the simulation is graphed in Figure 30, where it is shown that the HRR cycles around 600-800 kW for the duration of the burn. The fire smolders in its incipient stage early in the burn, thus the extended time to sprinkler activation. For this closet, which has an area of 2.3m², a HRR of 605 kW translates to a heat release rate per unit area (HRRPUA) of 263 kW/m². This value compares favorably with values obtained in fire tests for the HRRPUA of stacked paper, both covered and uncovered, given for the Cook County Administration Building fire investigation performed by NIST ^[13]. Based on that comparison, the FDS simulation data were retained for use in this analysis without further adjustment. A soot yield of 0.10 kg/kg fuel and CO yield of 0.028 kg/kg fuel values used for this fire are representative of examples noted in other FDS simulations of this type.

Figure 30: Heat release rate plot for Fire Scenario 3.

As in the other scenarios, the ASET for Scenario 3 is established by modeling the involved area of the clinical suite and running the simulation in FDS. A perspective image of the modeled space is shown in Figure 31 and the FDS input file for this fire scenario is included in Appendix B. Included in the model are two fire sprinkler heads and a ceiling smoke detector, all of which are placed based on their positions in the actual building. One sprinkler head is located in the ceiling of the involved storage room.

Figure 31: Smokeview model of Fire Scenario 3.

The FDS results suggest that tenable limits are reached in the involved area of the reception/waiting/office/exam spaces at 285 seconds after fire ignition. At that time, visibility drops to 10 meters in all of the waiting and reception areas which provide access to the exit stairway, but it remains above that value in the north areas of the suite

at the other stairway. Figure 32 is a Smokeview image of the visibility in the waiting and reception desk area at the 6 ft. level at 285 seconds after ignition, with the index in the right margin (black outline) set to identify the limits of areas with a visibility of 10 meters. The tenability limit for temperature is only reached in the immediate area of the fire, at about $t = 250$ s when the second sprinkler head activates. The CO concentration never exceeds 430ppm in the egress areas during the burn. It is therefore assumed that visibility is the determining factor for ASET for this simulation and that ASET is 285 seconds.

Figure 32: Smokeview image of the visibility in office suite at $t = 285$ s. Slice file is taken at 6 ft. above the floor.

The four factors which combine to determine RSET are evaluated. In this scenario, the involved storage room is not in immediate proximity to the main attended location and is by statement of this scenario NOT readily apparent, so a *notification time*

of 195 seconds is used for this scenario. This is the time at which the first sprinkler head discharges, initiating the fire alarm sequence and notifying all occupants of a fire. A *reaction time* of 5 seconds is then used for this scenario, since the responding staff are trained and prepared. *Pre-evacuation activity time* is taken up with collection of personal belongings and preparing to move. A duration of 15 seconds is assigned to pre-evacuation activity.

Together with the evacuation time of 109 seconds determined by the Pathfinder simulation, the four RSET elements sum to 324 seconds, which exceeds the 285 second ASET. While this indicates that some of the occupants may be subjected to untenable conditions for 40 seconds, it should be noted that the evacuation time simulation demonstrates that queuing occurs at the stairway door and that all occupants can move to the door in a much shorter time than the RSET. Even though they must wait to evacuate, they do not have to move through the smoke and they are in close proximity to other occupants as visibility decreases in the space. While this is a condition which would certainly lead to disorientation, anxiety, and discomfort for the occupants waiting to exit, it is not severe. The comparison of ASET to RSET for this scenario is shown below.

Figure 33: ASET and RSET for Fire Scenario 2.

Chapter 7: Conclusions and Summary

Like most highly-regulated and periodically-inspected institutional facilities whose occupants may not be capable of self-preservation in an emergency, the Providence Pavilion is protected by robust, reliable, and complete fire and life safety systems. The building construction, finishes, compartmentalization, and structural fire protection provide passive measures which are designed to provide safety when occupants are to be defended in place for extended periods. The egress means and building exiting are ample, well distributed to provide multiple egress pathways, and where appropriate, are sized to accommodate the safe and efficient movement of patients on gurneys and in wheelchairs.

The facility's active fire alarm and fire protection systems are compliant with prescriptive requirements, are regularly inspected and tested, and are maintained in ready condition at all times. The maintenance and operations staff is well trained in the inspection, testing, and maintenance of both active and passive fire protection systems, with regular inspections of fire dampers, fire and smoke detectors, supervisory and releasing devices, sprinkler systems, fire and smoke barrier integrity verification, and with regular drills and exercises of the systems and procedures. The facility undergoes annual inspections by the local fire marshal, State hospital licensing authorities, Federal healthcare facility accreditation inspectors, and internal Providence Health System staff.

In this study, the performance of the fire and life safety systems has been challenged by posing three different fire scenarios as prescribed by NFPA 101, Section 5.5, for Performance-Based Design. In two of these three fire scenarios, the Available Safe Evacuation Time (ASET) has been found to equal or exceed the Required Safe Evacuation Time (RSET), demonstrating that the prescriptively-designed systems should perform as expected in those two fire scenarios. In the third scenario, with a fire starting in an unoccupied area, delayed notification, rapid smoke development, and queuing behavior at the stairway exits lead to the last of the exiting occupants being subjected to potentially untenable conditions for a short time. Under two of the scenarios studied, all occupants are able to safely evacuate the building or fire compartment in the time available for their movement. Under the third scenario, it is likely that occupants will be able to safely evacuate, but some of them may be subjected to reduced visibility in smoke.

Recommendations to the owners and operators of the facility are to maintain continued awareness of the age and condition of the fire and life safety systems, to continue all recommended and required inspection, testing, and maintenance regimens, and in particular to be vigilant in observing changes in space usage, occupancy, and fixturing so that the installed protective measures are not compromised or their capabilities exceeded by changes in space usage or arrangement.

Appendix A

Providence Fire and Evacuation Plans and Fire Drill Instructions

ADMINISTRATIVE POLICY STATEMENT

POLICY NAME: Evacuation Policy
POLICY NUMBER: 600428
EFFECTIVE DATE: January 2013
REVIEW/REVISION HISTORY: Original Date: Dec 6, 2010
1/12, 1/13

SUBJECT: FACILITY EVACUATION POLICY

DEFINITIONS:

“T” Occupancy – Hospital buildings, structures and areas where in-patient care is occurring. PMMC Hospital and Pavilion are “T” Occupancies.

“B” Occupancy – Buildings, structures and areas where mostly business functions are occurring. PMMC Plaza, campus stand-alone buildings, and off-site clinics are “B” Occupancies.

Fire Strategies – “T” Occupancy is Protect and Defend in-place. In case of fire, evacuate to the next horizontal smoke compartment, then if necessary vertical evacuation, then if necessary, to outside.

“B” Occupancy is evacuation. In case of fire in that area, evacuate the building/area via the closest fire exit. Evacuation routes could be into the adjoining hospital compartments or outside.

Smoke Compartment - A space within a building enclosed by smoke barriers on all sides, top and bottom. Smoke Compartments are separated by automatic-closing Smoke/Fire doors, located in the egress corridors.

Defend in Place - Relocation within Facility: Defend in place is the process of relocating patient(s) from the smoke compartment where a fire has occurred to another protected location (smoke compartment) within the same building. The purpose of defend in place is to first remove the patient(s) from rooms that are in the immediate vicinity of the fire origin and to relocate them

into an adjacent smoke compartment that is protected from the migration of products of combustion (smoke, heat, toxic gases, & flames) caused by the fire.

Horizontal Evacuation - Movement from one smoke compartment to another on the same floor

Vertical Evacuation - Exit down to another floor in an area to a safe smoke compartment.

POLICY:

In the event of an extreme emergency that would necessitate evacuation of a department of, or all of Providence Medford Medical Center, a primary and secondary evacuation site has been identified. Primary evacuation site is to evacuate to the next horizontal smoke compartment, then vertical evacuation if needed. Secondary evacuation sites if the entire hospital must be evacuated include:

Avamere at Three Fountains
Ashland Community Hospital

Rogue Valley Medical Center
Three Rivers Hospital

In the event PMMC would be required to operate an alternative care site, Avamere at Three Fountains is the first facility that would be used. See EC policy 600411 Alternate Care Site policy for specifics.

PROCEDURE:

1. Incident Commander (or designee) will contact PBX Operator to announce three times "Evacuation Plan" is in effect – specify location to be evacuated and location to evacuate to.
2. Administration will direct the opening of a Command Center and Labor Pool. Employees will be notified of the openings by overhead paging.
3. Unscheduled employees will be called in only if needed and if authorized by the Incident Commander (Administrator-on-call).
4. If evacuation is to another hospital, staff will follow transfer protocols, EMTALA agreements and other standard operating procedures for the safe and effective transfer of patient care.

ACTIVATION:

1. The Administrator-on-call or Incident Commander will determine if an evacuation of part or all of the facility is warranted.
2. If a partial evacuation (Defend-in-place) of the hospital is ordered and the evacuation site is to be another location (Smoke Compartment) within the hospital, patients will be transported via beds, gurneys, and wheelchairs. If the entire site must be evacuated, see #3 & #4 below.

3. An authorized individual from secondary evacuation site will be contacted using the site's emergency telephone tree to obtain access to the building.
4. Patients will be transported to the secondary site using the Ambulance service, Fire Department first responder vehicles, the facility vans and, if necessary other private vehicles as needed. See EC policy 600411 Alternate Care Site policy for specifics.
5. Staff members will remain with the evacuated patients while they are at the evacuation facility.

RESPONSIBILITIES

1. Department Managers - Affected Department
 - a. Follow directives of Incident Commander (Administrator-on-call)
 - b. Begin preparation for evacuation
 - c. If evacuation is within the hospital, coordinate with admitting, receiving department, and Incident Commander, if time allows.
 - d. Notify command Center of number and acuity of patients moved.
 - e. If authorized, follow the Call Tree for own department staffing needs first.
 - f. Request additional support from the Labor Pool and Command Center for transportation.
2. Department Managers - Non Affected Department(s)
 - a. Follow directives of Incident Commander (Administrator-on-call)
 - b. Report number and expertise of available employees to Labor Pool
 - c. Prepare to assist where/when needed.
3. Employees on Duty
 - a. Follow directions of their managers.
 - b. Assist in moving all patients to the designated safe area.
 - c. Act in a decisive and authoritative manner and control panic reactions.
4. Employees Called In
 - a. Wear Name Tags for identification when entering the hospital grounds.
 - b. Report for duty in own department. If not immediately needed, report to the Labor pool.
 - c. Act in a decisive and authoritative manner, taking directions from the department manager where assigned, control panic reactions.
5. Physicians
 - a. Available physicians should report to the Labor Pool to receive instruction from the Medical Director or Designee.
 - b. Provide medical assistance during transfer to all patients.

EVACUATION TO SAFE AREAS

1. Command Center
 - a. Determine need for and assign job roles (using HICS) as required to manage event

- b. Direct the evacuation process. Evacuations will proceed in the following order. #1 is preferred and #5 is used only as a last resort.
 - 1) Horizontal to nearest appropriate unaffected area (Smoke Compartment)
 - 2) Vertical, up or down floors as instructed, preferably down.
 - 3) Other designated area within the facility
 - 4) Evacuation to designated areas located outside the hospital building.
 - 5) Secondary evacuation site location
 - c. Direct and coordinate movement of patients by outside agencies.
- 2. Department Managers
 - a. Inform staff of the conditions and significant changes as they occur.
 - b. Inform staff of the designated area of refuge
 - c. Direct evacuation using the following triage order
 - 1) Persons in immediate danger
 - 2) Ambulatory patients
 - 3) Patients who can be removed via wheelchair, gurney
 - 4) Bed patients
 - d. Request additional assistance through the Labor Pool
 - e. Notify command Center if any problems occur during the evacuation.
 - f. Notify Command Center when evacuation is complete
 - g. Ensure that all equipment is shut down before leaving
 - h. Ensure that department is clear of any persons
 - i. Ensure that all rooms, including bathrooms, storage areas, have been checked and marked as empty. **Place an "X" on the door with tape after room has been checked so others know room is empty. (tape is located in all Dept Emergency boxes)**
 - j. Ensure removal of all patient charts, if possible
 - k. Assign nurses to remove medication carts, if possible
- 3. Employees Assisting with Evacuation
 - a. Provide patients with clothing and shoes, if possible, and wrap in blankets
 - b. Place charts with patients, if possible
 - c. Ensure one employee accompanies each patient or group of patients to the safe location. No patient is to be left to evacuate on own.
 - d. Use appropriate lifting techniques to move patients
 - e. Use the nearest unobstructed exit. Do not block exits or allow them to become blocked
 - f. Assist in evacuation of visitors and other persons present within the department
 - g. Remain in the designated location until additional instructions are received
- 4. Patient Tracking - On-site Manager or designee of Access Services will be appointed the Patient Registration Unit Leader.

- a. Coordinate inpatient and outpatient admissions and discharges. Collaborate with patient/bed tracking manager to monitor and document the location of patients at all times.
- b. Develop and implement strategy and tactics to carry out the objectives established by the Incident Commander.
- c. Organize and supervise staff/duties/assignments.
- d. Appoint a patient tracking lead/manager to monitor patient tracking staff, coordinate with bed tracking lead/manager, runners, etc.
- e. Designate staff to track patients leaving affected unit.
- f. Designate staff to track patients received in arriving location
- g. Designate a runner to report to affect area and run patient evacuation tracking forms to admitting bed/tracking staff.
- h. Assign bed tracking clerk to make bed transfers in the system.
- i. Coordinate and help set up discharge area as appropriate.
- j. Assign additional operator to team up with main operator to help field calls during code.

CLEARANCE OF "EVACUATION"

- 1. Incident Commander
 - a. Assess the overall incident and coordinate clearance of code with appropriate managers and Command Center staff.
 - b. Assess patient status. Contact Emergency Department to ensure all patients have been treated and the department is back to pre-event activities
 - c. Contact managers/employees in the safe locations to assure status is stable.
 - d. Notify PBX Operator to announce three times "Evacuation all clear"
 - e. Facilities Manager, Administrator-on-call, and outside agencies (as appropriate) to determine when/if it is safe to open the evacuated locations and give directions to return patients and employees.
 - f. Establish and announce time and place for event debriefing.
 - g. A written report of the event will be prepared.
- 2. Begin Recovery
 - a. Department managers and employees will coordinate recovery process with Incident Commander.
 - b. Bed assignment will be verified through Access Services
 - c. Community Relations, with authorization from Incident Commander, will notify media the emergency is cleared.

APPROVALS:

<u>Environment of Care Committee</u>	<u>January 10, 2013</u>
ASSISTANT ADMINISTRATOR OR COMMITTEE WITH	DATE
APPROVAL AUTHORITY	

FINAL APPROVAL:

<u>Susan L. Cresswell</u>	<u>January 10, 2013</u>
DIRECTOR, QUALITY RESOURCES	DATE

<u>Tom Hanenburg</u>	<u>January 10, 2013</u>
Tom Hanenburg, Chief Executive Officer	Date

CROSS REFERENCE: Internal Triage 600402

APPLICABLE

STANDARDS:

SOURCE OR AUTHOR:	Ron Neet
POLICY OWNER:	Ron Neet
STAKEHOLDERS:	Emergency Mgmt, Safety Officer
SCHEDULED REVIEW	January 2014 (annual)
DATE:	

ADMINISTRATIVE POLICY STATEMENT

POLICY NAME: Fire Plan (Code Red)

POLICY NUMBER: EC 600501

EFFECTIVE DATE: December, 2012

**REVIEW/REVISION
HISTORY:**

ORIGINAL DATE: 1/88

Review Dates: 1/91, 1/92, 1/95, 8/98, 9/98, 7/06, 3/08, 9/10, 12/10,
12/11, 12/12

PURPOSE/SCOPE: The following are general guidelines for use in case of fire at Providence Medford Medical Center, regardless of the magnitude of the fire. The following plan will be used in conjunction with the Emergency Preparedness and Evacuation plans.

This fire plan shall be followed by all staff, volunteers, and licensed independent practitioners that are involved in patient care or patient care support at the Providence Medford Medical Center. Off-site Clinics and buildings will follow **EC 600510 Code Red & Emergencies at Off-Site Facilities**.

OBJECTIVE:

- A. Protect Life and Property
- B. Establish Fire Reporting Procedure
- C. Assign Responsibilities and Procedures for Hospital Organization and Fire Control.
- D. Establish evacuation policy in case of fire.

DEFINITIONS:

“I” Occupancy – Hospital buildings, structures and areas where in-patient care is occurring. PMMC Hospital and Pavilion are “I” Occupancies.

“B” Occupancy – Buildings, structures and areas where mostly business functions are occurring. PMMC Plaza, campus stand-alone buildings, and off-site clinics are “B” Occupancies.

Fire Strategies – “I” Occupancy is Protect and Defend in-place. In case of fire, evacuate to the next horizontal smoke compartment, then if necessary vertical evacuation, then if necessary, to outside.

“B” Occupancy is evacuation. In case of fire in that area, evacuate the building/area via the closest fire exit. Evacuation routes could be into the adjoining hospital compartments or outside.

Smoke Compartment - A space within a building enclosed by smoke barriers on all sides, top and bottom. Smoke Compartments are separated by automatic-closing Smoke/Fire doors, located in the egress corridors.

Relocation within Facility (Defend in Place) - Defend in place is the process of relocating patient(s) from the smoke compartment where a fire has occurred to another protected location (smoke compartment) within the same building. The purpose of defend in place is to first remove the patient(s) from rooms that are in the immediate vicinity of the fire origin and to relocate them into an adjacent smoke compartment that is protected from the migration of products of combustion (smoke, heat, toxic gases, & flames) caused by the fire.

Horizontal Evacuation - Movement from one smoke compartment to another on the same floor

Vertical Evacuation - Exit down to another floor in an area to a safe smoke compartment.

REQUIREMENTS: (Any City, County, State, and/or Federal Requirements)

- A. Joint Commission Elements of Performance
- B. OR-OSHA
- C. State of Oregon Fire Marshall’s 2008 Hospital Guidelines
- D. Local Fire department policies and procedures

INSTRUCTIONS:

- A. The FIRE PLAN (CODE RED) has been designed in cooperation with state and local fire authorities to best safeguard the lives of all patients, staff, and visitors at Providence Medford Medical Center. A copy of the plan is on file at the local fire department.
- B. The foremost consideration in hospital fire safety is the protection of all people in the hospital.

- C. The Chain of Command shall be: 1) Highest-Ranking Hospital Administrator on-site or Administrator-on-call, 2) House Supervisor, and 3) Facilities Manager (normally in a consultative role to the Administrator or House Supervisor). When the fire department arrives, the ranking fire fighter will be in charge. If the HICS Incident Command System is implemented, the HICS organizational structure supersedes.
- D. Department managers are responsible for establishing any necessary department specific fire response or evacuation plans. The department-specific plans are attached to the Code Red Fire Plan as an addendum.
 - 1. Each staff member is responsible for knowing the **Fire Plan** and location of exits, alarms, oxygen shut offs, and firefighting equipment.
- E. The Hospital fire plan is briefly covered in hospital-wide orientation. Department Managers and Supervisors are responsible for further orientation of their new employees to the Fire Plan and specific departmental plans.
- F. Any Hospital staff member noticing a fire safety hazard shall report it immediately to their supervisor or a member of the EOC or Safety Committee.

Person Discovering the Fire:

- 1a. Raise the alarm by loudly announcing "CODE RED". Remove all persons in Immediate danger and close doors.
- 2a. Notify the fire department by (1) pulling the closest fire alarm, (2) dial 999 to PBX - give the PBX operator the exact location, floor, and severity of the fire.

-OR-

If the alarm system is THE FIRST INDICATION YOU HAVE OF FIRE, the first person to respond to the location of the fire shall:

- 1b. Immediately determine the physical location of the fire as indicated by the fire alarm panel. Remove all persons in immediate danger and close doors.
- 2b. Dial 999 to PBX - give the PBX operator the exact location, floor, and severity/type of the fire. If the fire is located within your department, direct available staff to respond to the fire area with fire extinguishers.
- 3. PBX is staffed 24/7/365. The PBX operator will, at the sound of the first alarm verify location and announce "CODE RED" and the "LOCATION" (as read from the fire alarm panel) over the public address system. This is repeated three times at 5-second intervals. All other personnel shall remain in their department on

“stand-by” to await further instruction (or all clear) over the public address system.

4. PBX will, after receiving the phone call from the fire scene with specific fire location, floor, and type information, call 911 and report the CODE RED to the 911 Operator, providing any specific location or fire-type information that they received.
5. At the Fire location, calmly alert others for assistance.
6. If small fire (smaller than a trash can), use extinguisher and attempt to extinguish.
7. When instructed by the Unit Manager (or designee), turn off oxygen and gases in the area.
8. Turn off electrical equipment, except lights in area.
9. The “on-shift” Security Officer will respond to the main Fire Panel with a radio and await further instructions.
10. All available Engineering, and Environmental Services staff and either the “highest-ranking” Hospital Administrator or House Supervisor should respond to the fire location.
11. Hallways are cleared of obstacles by department staff, and the elevator is not used. Any available staff in close proximity to the elevators, will monitor the elevators to ensure they are not used.
12. Have a staff member meet the Fire Department at closest entrance or the ground floor receiving entrance to direct them to the fire’s location.
13. Close all windows, doors, and vents.
14. Pack sheets/towels under doors to contain smoke.
15. If required, turn off oxygen main line to wing. Facilities staff will turn off as instructed by unit leader.
16. Begin relocation of all patients and visitors to the next smoke compartment

Note: Employees located close to building exits, immediately standby those exits-check all those leaving for evidence of infant abduction, and await further instructions.

A quick way to remember the 15 steps above is by using the acronym **RACER**:

R - Rescue people in immediate danger.

A – Activate the alarm by activating the nearest alarm pull station*

C - Contain smoke & fire.

E - Extinguish fire & evacuate if necessary.

R – Relocate all patients from the smoke compartment containing the fire, into the next adjacent smoke compartment, exit enclosure, or exterior exit.

A quick way to remember how to use a fire extinguisher is using **PASS**:

P - Pull the pin.

A - Aim the nozzle.

S - Squeeze the handle.

S - Sweep from side to side at the base of the fire.

The PBX Operator:

1. Note location of fire from print out or Fire Panel display.
2. Immediately page the affected 3 times on PA system:
"CODE RED (DRILL) AND GIVE LOCATION and FLOOR"
3. If the Code Red is paged before or during the fire audible alarms, RE-PAGE Code Red, with location and Floor, immediately following the fire alarm "silence".
4. After phone call is received from fire scene with specific information on location, floor and type of fire, call 911 and provide dispatcher with fire location, floor, and type.
5. Page the Facilities On-duty Engineer, House Supervisor, and Administrator-on-call.
6. When instructed by House Supervisor or Administrator-on-call:
 - a. Call Facilities to shutdown essential systems.
 - b. When signaled from the Administrator-in-charge, overhead page on PA system 3 times:

"CODE RED (DRILL) HAS BEEN COMPLETED", or
"CODE "INTERNAL TRIAGE" at location (Fire Scene location) IS IN
EFFECT.

7. If CODE INTERNAL TRIAGE is called and HICS (Incident Command System) has been activated: Follow instructions of Incident Commander.
 - a. If relocation or evacuation has been ordered by Incident Commander, overhead page 3 times "EVACUATION PLAN IS IN EFFECT – Relocate/Evacuate to (designated location)
 - b. If a second fire is reported by a person or fire alarm panel, follow steps outlined for "Code Red Fire Procedure" but overhead page on PA system:
"CODE RED #2 (DRILL) and GIVE LOCATION and Floor"

Highest-Ranking On-Site Administrator, House Supervisor, or Administrator-on-Call:

1. Report to fire scene. **The Highest-Ranking On-Site Administrator (day shift Mon - Fri)** or the **House Supervisor (evenings and weekends)** will always report to the site of the Code Red (Drill). The Highest-Ranking On-Site Administrator or House Supervisor acts as the Incident Commander and decides when to call the Administrator-on-call or other administrators/managers, as applicable.
2. The Administrator-in-Charge or House Supervisor, after responding to the fire scene, calls to provide an update on the following to the Administrator-on-call:
 - a. Type of fire.
 - b. Location and floor of fire.
 - c. Magnitude of fire and smoke.
 - d. Need for evacuation.
 - e. Progress and status of fire.
 - f. Phone fire department 9-1-1 dispatch with status update, if Fire Dept is not on site.
3. The Administrator-in-Charge/House Supervisor constantly evaluates the scene and determines "when and if" it is necessary to call a "CODE INTERNAL TRIAGE" or RELOCATION/EVACUATION (Consults with Administrator-on-call if available.)
4. Assumes responsibility for all fire operations, from fire scene, until relieved by another competent person to assume charge of the Fire scene, and/or the Fire Department arrives.
5. If "CODE INTERNAL TRIAGE" has been called, the House Supervisor/Administrator-on-call determines location to set-up incident command center, moves to that location, sets up communication method for in-house staff and to Fire Department and implements the incident command system.

6. When event has concluded, determines termination of the code or drill and calls the "All Clear" notification.

Engineering, Security, and Environmental Services Staff:

1. The On-Duty Security Officer will respond to the Engineering Office to man fire alarm panel, phone, and radio.
2. All available personnel are to report to location of fire, bringing a fire extinguisher with them, and assist in containing or extinguishing fire.
 - a. Environmental Services staff bring fire extinguishers to fire scene from floor where fire is located. Other EVS staff close doors and assist in containment in locations where they are working.
 - b. Engineering staff bring fire extinguishers from their current location to the fire scene.
3. Engineering staff will recall any elevators to the lobby floor that do not recall automatically.
4. RESCUE – Assist with removal of any person who is in immediate danger of fire.
ALARM -- Pull fire alarm, if alarm has not already sounded. Notify House Supervisor or Administrator-on-call of the fire and its location if this has not already been done.
CONTAIN
 - a. Turn off all equipment in effected area
 - b. Close all doors and windows, making sure they are not locked
 - c. Shut-off all Air Handlers and Ventilation fans serving the area unless part of a designed smoke control system.
 - d. Verify that med gases have been shut off in the affected area.
 - d. Designate an employee to stand by the main electrical power rooms to carry out any order from the Fire Department.
 - e. Designate one person to stand by to shut off the O2 and N2 valves at the main tank location upon receiving instructions from the Facilities Leader, or Administrator-on-call.EXTINGUISH – Extinguish the fire if it is small enough to be extinguished by one or two portable extinguishers.
RELOCATE – Area relocation/evacuation may be ordered by the Incident Commander or the Fire Department. Relocate to the next adjacent smoke compartment or location as determined by on-scene leader. Assist with relocation of patients to next smoke compartment or to evacuation site.

Employees/Staff:

Not in affected department at time of Code Red (drill) should remain where they are, close all doors, and wait for further instructions via the PA system. Employees or staff located close to public areas should monitor elevators to ensure they are not used and to re-assure visitors and guests and asked them to stay where they are until the "All-Clear" is sounded. The exception is if staff are close to building exits, then proceed to those exits to monitor in case of infant abduction.

Staff in their own department should remain there. Departmental personnel shall clear hallways of food carts, housekeeping equipment, etc., so there will be clear access for fire equipment or for evacuation. If fire is at night and on same floor, a designee from each department on that floor will respond with an extinguisher. Those in patient care areas should close doors, and reassure patients. Those in offices should close all doors, and go out into the hall to listen for instructions. Everyone should be in a place where he or she can hear the overhead announcements. Once the fire doors have closed, travel from one smoke compartment to another is discouraged unless required for patient care or emergency response.

Directors & Managers:

Report to their department and wait for further instructions via PA system.

Director/Managers are to assist the Scene Leader with directing the evacuation of their areas in accordance with the evacuation plan.

Relocation, Partial or Complete Evacuation

The need for relocation to the next smoke compartment, partial or complete evacuation shall be determined in accordance with the Emergency Operations Plan and the decision of the Incident Commander (Administrator-on-call) or Fire Department. If relocation, partial or complete evacuation is ordered, the degree of relocation or evacuation and routes will be specified by the Incident Commander using the 4-Step process:

- 1) Move patients from immediate danger and close doors;
- 2) Move patients horizontally past fire/smoke doors to the next smoke compartment;
- 3) If needed, move patients and visitors outside to designated areas. Refer to the Providence Medford Medical Center Evacuation Plan for all further instructions.

“B” Occupancy Locations (Plaza)

For “B” Occupancy locations, if a fire occurs in these locations, the procedure is that after primary notification to “911”, evacuate all patients, visitors, and staff from the building or area.

Specific Response Procedures

It is important that the following procedures always be followed:

1. Always remove nearby patients to safe areas, which are:
 - a. Away from the fire, and
 - b. Toward an exit, depending upon the location of the fire. This may be to the opposite end of a hall, or another location past the fire/smoke doors.
2. If ordered, the removal of patients from a unit or the entire hospital will be as follows:
 - a. Those nearest the fire and in immediate danger will be removed first.
 - b. Ambulatory patients will then be removed.
 - c. Patients who can be evacuated by wheelchairs will be removed next.
 - d. Stretcher/bed patients will be removed last.
Removal of these patients will be by using available stretchers or carrying the patient out using the sheet from the bed or blankets laid on the floor. All patients should have robes, slippers, as applicable, and be wrapped in blankets from the bed prior to evacuation. Nursery infants will be wrapped in blankets and taken to their mothers for evacuation. Boarder babies will be removed by a qualified nurse.
3. One nurse will accompany each patient or group of patients and direct them on the proper evacuation route. No patient should be directed to proceed and then left on their own to find their way out of the hospital.
4. A unit secretary or nurse will be assigned to retain a list of patients and maintain a list of patient destinations if total evacuation is ordered. A designated nurse will also remove as much patient medications as possible to aid in further treatment of patients once evacuation is complete. Every effort is to be made in securing patients records.
5. The rooms should be checked for stragglers and all doors and windows closed when the rooms are vacated. Tape should be placed over the door and doorjamb after it has been checked.
6. Patients and staff will remain in the evacuation location until given permission to re-occupy the facility or instructed to further evacuate to another facility.

- 7. If an actual fire occurs in any of the Providence Southern Oregon Service Area (SOSA) facilities, the State Fire Marshal's Office must be notified by phone within 24 hours. Contact the following:**

Office of State Fire Marshal at 503-934-8257 or 503-428-8029.

If unable to directly contact the State Fire Marshal's Office, call the Duty Officer at 503-931-5732, provide the Duty Officer with the name of the facility, location, and nature of emergency condition.

Provide a description and magnitude of the fire, location within the facility, and current status of facility.

General Considerations

Each Director/Manager will see that all personnel are familiar with the location of fire extinguishers and be instructed in how to use them, the location of med gas and oxygen valves, and fire alarm pull boxes.

Director/Managers will also be responsible to assure that exits, egress corridors, exit ways, stairs and fire escapes in their department are always kept clear of obstructions and encumbrances.

When a fire has been discovered, do not shout "fire" and do not become alarmed. It is imperative that staff remains calm. When it becomes necessary to inform patients and visitors of the existence of fire, reassure them that the necessary precautions have been taken for their safety and that you are available to them to provide all required assistance.

APPROVALS:

Environment of Care Committee – Brian Herwig

December, 2012

**ASSISTANT ADMINISTRATOR OR COMMITTEE WITH
APPROVAL AUTHORITY** **DATE**

FINAL APPROVAL:

Susan Cresswell

December, 2012

DIRECTOR, QUALITY RESOURCES **DATE**

Tom Hanenburg

December, 2012

Tom Hanenburg, Chief Executive Officer

Date

CROSS REFERENCE:

APPLICABLE

STANDARDS:

SOURCE OR AUTHOR: Ron Neet

POLICY OWNER: Ron Neet

STAKEHOLDERS: All PMMC Staff

SCHEDULED REVIEW December 2013 - annually

DATE:

ADMINISTRATIVE POLICY STATEMENT

POLICY NAME: Code Red Fire Drill Procedure

POLICY NUMBER: 600509

EFFECTIVE DATE: April 4, 2013

REVIEW/REVISION Original Date: 10/10

HISTORY: 4/13

PURPOSE/SCOPE: To exercise all aspects of the fire plan. To ensure operational knowledge and effectiveness of all personnel on all shifts should there be an actual fire. The drills are used to test equipment and staff knowledge on the use and operation of fire alarm systems, transmission of alarms, containment of smoke and fire, transfer to areas of refuge, fire extinguishments, specific fire-response duties and preparation for building evacuation.

The Code Red Drill policy/procedure applies to all staff, volunteers, and licensed independent practitioners that are involved in patient care, patient care support, or other business functions at all of the Providence Medford Medical Center facilities and buildings.

Note: Follow EC 600510 Code Red and Emergencies – Off site facilities, when performing Fire drills at off-site facilities.

REQUIREMENTS: (Any City, County, State, and/or Federal Requirements)

OR-OSHA: NFPA Life Safety Code 19.7.1.2, JCAHO

INSTRUCTIONS:

- 1.) Providence Medford Medical Center inpatient (“I”) occupancy areas are divided up into drill sections or departments, ensuring that each major area is drilled during the year, that at least one drill occurs per shift each quarter, and that two drills per shift each quarter are initiated in locations where Interim Life Safety Measures (ILSM’s) are in place. The locations throughout the facility where ILSM’s are currently in place are maintained by Facilities in the Engineering Office. Staff in freestanding buildings classified as business (“B”) occupancy will participate in one fire drill per occupied shift, annually. An annual schedule of drills is developed and adhered to whenever possible. At least fifty percent of the drills are unannounced.

- 2.) All aspects of the Fire plan are tested and checked. Staff knowledge is tested and documented on the Fire Drill Evaluation Form. Fire Life Safety systems are inspected and evaluated for effectiveness during the drills.
- 3.) A fire drill team consisting of Facilities Department representatives, and EOC/Safety Committee members, on occasion, conduct the drills. Fully operational fire alarm and system testing shall occur with the exception of the night shift, in which initiation of fire drills is conducted by overhead announcement by PBX.
- 4.) Prior to implementation of each drill, the Fire panel located in the Engineering office will be staffed by a Facilities Engineer or Security Officer to silence and reset the system. The on-duty Facilities Engineer will notify the off-site monitoring company, the local Fire Department, and the 911 Dispatch Operator (541-770-4784), that we will be conducting a fire drill. The Engineer will then notify the PBX operator of the pending fire drill.
- 5.) At the time of the drill (as per the campus Matrix), a flag or paper denoting “FIRE” will be placed in a chosen department or an initiation device (smoke detector) will be triggered. The closest employee to the location will be notified of the Fire Drill and location of the fire.
- 6.) On discovery of the fire flag by departmental personnel, the Fire Plan is to be implemented, to include pulling of the fire alarm pull station nearest to the fire drill’s location. Personnel are to call 999 and notify the PBX Operator that a fire (drill) is occurring and the exact location and type of fire.
- 7.) The PBX Operator will overhead page and announce “3” times: Code Red Drill and (its location). The location is visible via the Fire Panel digital display at the PBX and Nurse’s stations throughout the hospital. Once staff from the fire scene has called PBX with specific fire location and type information, PBX will call 911, notifying them that we have a “CODE RED DRILL” and provide specific location and type of fire information to the 911 dispatcher.
- 8.) Staff in the immediate area carry out “**R.A.C.E.R**”, while other departments respond, as they would, should there be an actual fire. All available Facilities and Environmental Services staff responds to the scene with fire extinguishers. The “highest ranking” Hospital Administrator and the Manager of the department where the Fire drill was initiated responds to the scene during day-shift, and the House Supervisor responds to the scene of the fire drill after hours and on weekends, and will determine if it is necessary to call the Administrator-on-call.

- 9.) During the drill, all staff throughout the hospital are expected to respond as they would in the case of a real fire. Staff should remain in their designated departments. Employees working in patient care areas should close doors, and reassure patients that this is a drill. Those in offices should close all doors, and go out into the hall to listen for instructions. Staff located close to public areas should seek out any visitors/guests and inform them of the fire drill. Everyone should be in a place where he or she can hear the overhead announcements. Once the fire doors have closed, do not move from one area to another unless needed in the line of duty.
- 10.) Leadership should return to their departments and use the time to review with staff: RACER, PASS, location of fire extinguishers, location of alarm pull stations, medical gas shut-off valves, fire compartments/evacuation procedures, exits, and what staff would be doing if there were a fire in their area of the hospital.
- 11.) Elevators are not to be used during a fire drill.
- 12.) When the drill has successfully been completed, the House Supervisor or Duty Administrator will call for a reset of the system and will announce, or notify the PBX Operator to announce “3” times: Code Red Drill - All Clear. Facilities staff will reset all fire systems and *elevators*, noting any problems for correction. All Fire doors will be re-opened throughout the facility.
- 13.) Fire drills are critiqued to identify deficiencies and opportunities for improvement using the Fire Drill Evaluation form. A numerical score from 1 to 5 will be used to measure the overall effectiveness of the fire drill response actions.
- a. Facilities department staff shall complete the Fire Drill Evaluation form documenting the performance, and any areas in need of improvement, for the on-scene responders and staff.
- The evaluation forms will evaluate staff knowledge of the following:
1. When and how to sound the fire alarms
 2. When and how to transmit for offsite fire responders
 3. Containment of smoke and fire
 4. Transfer of patients to areas of refuge
 5. Fire extinguishment
 6. Specific fire response duties
 7. Preparation for building evacuation
- b. The Engineering Admin Assistant will request a “Kronos” report from regional payroll showing all staff currently “clocked in” on the date and time of the drill. This documentation along with the on-scene fire drill evaluation forms will be used to track employee participation in the fire drills.

- c. The Fire Drill Evaluation form and the Kronos employee reports for each drill shall be retained by Facilities. These two forms will document and evaluate staff knowledge and participation for that specific fire drill.

ADDENDUM A - Tips for Staff education after a Fire Drill

- **R.A.C.E.R**
 - R = rescue or remove those in immediate danger.
 - In the event of a drill doors should be closed and staff should stand in hallway to listen for further overhead pages.
 - In patient care area, doors should be closed. Staff should say to patients “For your safety we periodically have fire drills – this is a drill and will only take a few minutes. To help keep the noise down, I am going to close your door.”
 - A = activate the alarm
 - Dial 999 for PBX
 - Provide location – including department, floor, type, magnitude of fire.
 - Pull closest fire alarm pull station – located near Exits.

- Staff should familiarize themselves with location of pull stations.
- C = Contain the smoke or fire.
 - Containment could mean closing a door, throwing a blanket over the fire, etc
 - Importance of not using the elevators during a drill or real fire.
 - Ensure staff can locate the O2/gases shut off - make sure they know which valve shuts off which rooms/areas.
- E = Extinguish or Evacuate
 - Discuss making the decision to extinguish or evacuate. Remind staff: evacuate does not necessarily mean evacuating the building. Discuss Fire Compartments – how to know when to move to the next compartment. Importance of listening to overhead pages.
- R = Relocate - Relocate all patients from the smoke compartment containing the fire,
 - into the next adjacent smoke compartment, exit enclosure, or exterior exit.
 - How and where will patients and staff be relocated to in the event of a fire and/or smoke.

WHEN AND HOW TO SOUND FIRE ALARMS

Staff verbalize understanding of RACER (see above).

Staff can locate fire alarm pull station(s).

- Pull stations are located near exits.
- Staff should be familiar with locations of pull stations in their area.

Staff reassures patients and visitors this is a drill.

- It is important that staff reassure patients and visitors. “For your safety we periodically have fire drills – this is a drill and will only take a few minutes. To help keep the noise down, I am going to close your door.”

WHEN AND HOW TO TRANSMIT FOR OFFSITE FIRE RESPONDERS

Staff knows how and when to notify local authorities of Fire.

- Internal Fire alarm system automatically notifies Fire Department
- Staff at the scene to contact PBX by dialing 999 and provide: location, type, and magnitude of fire.
- PBX will overhead page “Code Red” house-wide 3 times so responders know exact location.

PBX Operator calls 911 and provides location, type, and magnitude of fire to 911 dispatcher

- Provide location – including campus address, location of fire, type, and magnitude of fire. In the event of a drill, please simulate calling 911.

CONTAINMENT OF SMOKE AND FIRE

All egress and hallway doors are to be closed.

Appropriate staff, department Manager, and House Supervisor respond to Fire scene with Fire Extinguishers.

Fire and Smoke doors have closed automatically.

- Unless it is an emergency, staff should not move through closed Fire doors.

Staff knows location of O2/Gases shutoff.

- Which valves shut off which rooms/areas.

Elevator use is restricted.

- Elevators should not be used during a drill or actual fire.

TRANSFER OF PATIENTS TO AREAS OF REFUGE

Staff verbalizes understanding of fire/smoke compartments.

Staff verbalize evacuation plan.

- Discuss what it means to evacuate: when, how, who makes decision, where to go, etc?

People were removed from immediate danger.

FIRE EXTINGUISHMENT

Staff knows location of fire extinguishers.

- Fire extinguishers are generally located _____ -
- Staff should familiarize themselves with the locations of fire extinguishers.

Staff use PASS & verbalize proper use of fire extinguishers.

- P = pull the pin
- A = Aim the nozzle
- S = Squeeze the trigger/handle
- S = Spray by sweeping and the base of the fire

SPECIFIC FIRE RESPONSE DUTIES

Staff actively listen to overhead pages for further instruction.

- Can pages be heard throughout department/area?

Staff exhibits understanding of department specific responsibilities and fire plan.

PREPARATION FOR BUILDING EVACUATION

Staff can verbalize understanding of evacuation procedures.

- Discuss evacuation plan. In patient care area, how would staff evacuate their patient(s): method, priority, communication with family members, etc?
- How does the department/area ensure that all staff/patients are removed from the area in the event of an evacuation?

APPROVALS:

Brian Herwig

**ASSISTANT ADMINISTRATOR OR COMMITTEE WITH
APPROVAL AUTHORITY**

DATE

FINAL APPROVAL:

DIRECTOR, QUALITY RESOURCES

DATE

Chief Executive Officer

Date

CROSS REFERENCE:

APPLICABLE

STANDARDS:

SOURCE OR AUTHOR: **Ron Neet**

POLICY OWNER: **Ron Neet**

STAKEHOLDERS: **All PMMC Staff**

SCHEDULED REVIEW **April 2016 – 3 yr reviews**

DATE:

Appendix B

FDS Input Files

Z596Scenario1.fds

Upholstered chair burns in Short Stay waiting area of Providence Pavilion

&HEAD CHID='Z596Scenario1', TITLE= 'Oscar Zuniga FPE596 FDS Fire Scenario 1 simulation'/

&TIME T_END= 600./

&DUMP RENDER_FILE='Z596Scenario1.ge1'/

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&MISC TMPA=20.0 /

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FYI = 'C_6.3 H_7.1 N O_2.1, NFPA Handbook, Babrauskas',
SOOT_YIELD = 0.10,
CO_YIELD = 0.028,
MASS_EXTINCTION_COEFFICIENT=8.7000000E003,
VISIBILITY_FACTOR=3.00,
N = 1.0,
C = 6.3,
H = 7.1,
O = 2.1 /

&SURF ID = 'BURNER',
HRRPUA = 2000.,
COLOR = 'RASPBERRY',
RAMP_Q = 'chair' /

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&RAMP ID='chair', T= 100.0, F=0.025 /
&RAMP ID='chair', T= 200.0, F=0.125 /
&RAMP ID='chair', T= 260.0, F=0.095 /
&RAMP ID='chair', T= 290.0, F=0.77 /
/&RAMP ID='chair', T= 320.0, F=0.65 /
/&RAMP ID='chair', T= 350.0, F=0.40 /
/&RAMP ID='chair', T= 400.0, F=0.375 /
/&RAMP ID='chair', T= 500.0, F=0.350 /
/&RAMP ID='chair', T= 600.0, F=0.425 /

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FYI = 'Quintiere, Fire Behavior',
CONDUCTIVITY = 0.48,
SPECIFIC_HEAT = 0.84,
DENSITY = 1440. /

&MATL ID = 'CARPET PILE',
FYI = 'Completely made up',
CONDUCTIVITY = 0.16,
SPECIFIC_HEAT = 2.0,
DENSITY = 750.,
N_REACTIONS = 1,
NU_FUEL = 1.,

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REFERENCE_TEMPERATURE = 290.,
HEAT_OF_COMBUSTION    = 22300.,
HEAT_OF_REACTION      = 2000. /

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  MATL_ID             = 'GYPSUM PLASTER',
  THICKNESS           = 0.012 /

&SURF ID              = 'CARPET',
  MATL_ID             = 'CARPET PILE',
  COLOR               = 'KHAKI',
  BACKING             = 'INSULATED',
  THICKNESS           = 0.006 /

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  WATER=.TRUE.,
  AGE=4.00/

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BETA_E=-0.70, ALPHA_C=0.80, BETA_C=-0.90/
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/&DEVC ID='Cleary', PROP_ID='Cleary Ionization I1', XYZ=1.00,10.00,9.60,
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Partition 14

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Face 12, corridor
&VENT SURF_ID='OPEN', XB=28.9,31.3,10.5,10.5,0.0,3.00, COLOR='INVISIBLE'/
Face 5, corridor

&PROP ID='K-5.6', QUANTITY='SPRINKLER LINK TEMPERATURE', RTI=100., C_FACTOR=0.7,
ACTIVATION_TEMPERATURE=68., OFFSET=0.10,PART_ID='water drops', FLOW_RATE=70.3,
DROPLET_VELOCITY=10., SPRAY_ANGLE=30.,80. /

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&SLCF QUANTITY='TEMPERATURE', PBX=30.1/
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&TAIL /

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Z596Scenario2.fds
Disposable items in trash bags burn in Short Stay

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simulation'/
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CO_YIELD     = 0.03,
MASS_EXTINCTION_COEFFICIENT=8.7000000E003,
VISIBILITY_FACTOR=3.00,
N            = 1.0,
C            = 6.3,
H            = 7.1,
O            = 2.1 /

&SURF ID          = 'BURNER'
HRRPUA        =350.
COLOR         = 'RASPBERRY'
RAMP_Q        = 'disposables' /

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&RAMP ID='disposables', T= 300.0, F=0.171 /
&RAMP ID='disposables', T= 400.0, F=0.157 /
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FYI          = 'Quintiere, Fire Behavior',
CONDUCTIVITY   = 0.48,
SPECIFIC_HEAT  = 0.84,
DENSITY        = 1440. /

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FYI          = 'Completely made up',
CONDUCTIVITY   = 0.16,
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DENSITY        = 750.,
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NU_FUEL        = 1.,
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  MATL_ID              = 'SHEET VINYL FLOORING',
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  THICKNESS            = 0.006 /

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  AGE=4.00/

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Station

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cubicle 2
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&OBST XB= 0.0,3.0,3.1,3.1,0.0,2.54, SURF_ID='WALL' / Patient
cubicle 10

&OBST XB= 3.0,3.0,0.0,8.6,2.13,2.54, SURF_ID='WALL' / Header
1
&OBST XB= 3.0,12.2,2.75,2.75,2.13,2.54, SURF_ID='WALL' / Header
2
&OBST XB= 13.4,13.4,2.75,17.0,2.13,2.54, SURF_ID='WALL' / Header
3
&OBST XB= 11.0,11.0,8.7,17.0,2.13,2.54, SURF_ID='WALL' / Header
4
&OBST XB= 11.0,13.4,8.7,8.7,2.13,2.54, SURF_ID='WALL' / Header
5
&OBST XB= 3.0,5.05,8.6,8.6,2.13,2.54, SURF_ID='WALL' / Header
6

&VENT SURF_ID='OPEN', XB=11.0,13.4,17.5,17.5,0.0,2.54, COLOR='INVISIBLE' /
Hallway Face 13
&VENT SURF_ID='OPEN', XB=0.00,5.05,17.5,17.5,0.00,2.54, COLOR='INVISIBLE' /
Hallway

&PROP ID='K-5.6', QUANTITY='SPRINKLER LINK TEMPERATURE', RTI=100., C_FACTOR=0.7,
ACTIVATION_TEMPERATURE=68., OFFSET=0.10,PART_ID='water drops', FLOW_RATE=70.3,
DROPLET_VELOCITY=10., SPRAY_ANGLE=30.,80. /

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&DEVC ID='Spr_1', XYZ=14.9,7.0,2.49, PROP_ID='K-5.6' /
&DEVC ID='SPR_2',XYZ=12.2,7.0,2.49,PROP_ID='K-5.6' /

&SLCF QUANTITY='TEMPERATURE', PBX=12.0 /
&SLCF QUANTITY='TEMPERATURE', PBY=7.0 /
&SLCF QUANTITY='TEMPERATURE', PBZ=1.8 /
&SLCF QUANTITY='VISIBILITY', PBX=12.0 /
&SLCF QUANTITY='VISIBILITY', PBY=7.0 /
&SLCF QUANTITY='VISIBILITY', PBZ=1.8 /
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., PBY=10.0/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., PBZ=1.0 /
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., PBX=5.0 /
&SLCF QUANTITY='extinction coefficient', PBY=10.0 /
&SLCF QUANTITY='carbon monoxide',SPEC_ID= 'CARBON MONOXIDE', PBX=12.0 /
&SLCF QUANTITY='carbon monoxide',SPEC_ID= 'CARBON MONOXIDE', PBY=7.0 /
&SLCF QUANTITY='carbon monoxide',SPEC_ID= 'CARBON MONOXIDE', PBZ=1.8 /
&SLCF QUANTITY='soot', PBZ=3.0 /
&SLCF QUANTITY='soot density', PBZ=3.0 /
&SLCF QUANTITY='soot volume fraction', PBZ=3.0 /

&TAIL /

```

Z596Scenario3.fds

Paper and office supplies burn in a storage closet, 3rd floor Providence Pavilion

&HEAD CHID='Z596Scenario3', TITLE= 'Oscar Zuniga FPE596 FDS Fire Scenario 3
simulation'/

&TIME T_END=600./

&DUMP RENDER_FILE='Z596Scenario3.ge1'/

&MESH IJK=200,135,18, XB=0.00,28.8,0.00,19.6,0.00,2.6 /

&MISC TMPA=20.0 /

&REAC ID = 'CELLULOSE',
FYI = 'C_6. H_10. N O_5., paper pulp, various sources'
SOOT_YIELD = 0.10,
CO_YIELD = 0.015,
MASS_EXTINCTION_COEFFICIENT=8.7000000E003,
VISIBILITY_FACTOR=3.00,
N = 1.0,
C = 6.,
H = 10.,
O = 5. /

&SURF ID = 'BURNER',
HRRPUA =3000.,
COLOR = 'RASPBERRY',
RAMP_Q = 'supplies'

&RAMP ID='supplies', T= 0.0, F=0.00 /
&RAMP ID='supplies', T= 150.0, F=0.00 /
&RAMP ID='supplies', T= 180.0, F=0.05 /
&RAMP ID='supplies', T= 195.0, F=0.202 /
&RAMP ID='supplies', T= 600.0, F=0.202 /

&MATL ID = 'GYPSUM PLASTER',
FYI = 'Quintiere, Fire Behavior',
CONDUCTIVITY = 0.48,
SPECIFIC_HEAT = 0.84,
DENSITY = 1440. /

&MATL ID = 'SHEET VINYL FLOORING',
FYI = 'Completely made up',
CONDUCTIVITY = 0.16,
SPECIFIC_HEAT = 2.0,
DENSITY = 750,
N_REACTIONS = 1,
NU_FUEL = 1.,
REFERENCE_TEMPERATURE = 290.,
HEAT_OF_COMBUSTION = 22300.,
HEAT_OF_REACTION = 2000. /

&SURF ID = 'WALL',

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        RGB                = 200,200,200,
        MATL_ID             = 'GYPSUM PLASTER',
        THICKNESS           = 0.012 /

&SURF ID                   = 'VINYL',
        MATL_ID             = 'SHEET VINYL FLOORING',
        COLOR               = 'KHAKI',
        THICKNESS           = 0.006 /

&PART ID='water drops',
        WATER=.TRUE.,
        AGE=4.00/

/&PROP ID='Cleary Ionization I1', QUANTITY='spot obscuration', ALPHA_E=2.50,
BETA_E=-0.70, ALPHA_C=0.80, BETA_C=-0.90/
/&DEVC ID='beam', QUANTITY='path obscuration', XB=2.0,19.00,5.00,5.00,9.60,9.60/
/&DEVC ID='Cleary', PROP_ID='Cleary Ionization I1', XYZ=1.00,10.00,9.60,
LATCH=.FALSE./

&OBST XB=27.44,28.44,11.61,12.61,0.00,0.50,
SURF_ID6='INERT','INERT','INERT','INERT','INERT','BURNER'/ Design Fire
&OBST XB=0.0,28.8,0.0,19.6,0.0,0.00, SURF_ID='VINYL' / Floor
&OBST XB=0.0,28.8,0.0,19.6,2.6,2.6, SURF_ID='WALL',COLOR='INVISIBLE'/ Ceiling
&OBST XB=0.0,0.0,0.0,19.6,0.0,2.6, SURF_ID='WALL',COLOR='INVISIBLE'/ Left
limit
&OBST XB=0.1,0.1,7.62,14.12,0.0,2.6 SURF_ID='WALL' / Stair
wall
&OBST XB= 1.68,1.68,2.06,7.62,0.0,2.6, SURF_ID='WALL' / Face
1
/&OBST XB=0.76,1.68,6.7,5.79,0.00,2.6, SURF_ID='WALL' / Face 2
/&OBST XB=1.22,1.68,5.33,5.79,0.0,2.6, SURF_ID='WALL' / Face 3
/&OBST XB=1.22,2.85,5.33,2.85,0.0,2.6, SURF_ID='WALL' / Face 4
/&OBST XB=2.85,5.26,2.85,1.22,0.0,2.6, SURF_ID='WALL' / Face 5
/&OBST XB=5.26,5.72,1.22,1.68,0.0,2.60, SURF_ID='WALL' / Face 6
/&OBST XB=5.72,6.25,1.68,1.14,0.0,2.60, SURF_ID='WALL' / Face 7
&OBST XB=1.68,7.32,2.06,2.06,0.0,2.60, SURF_ID='WALL' / Face 8
&OBST XB=7.32,7.32,0.00,3.81,0.00,2.60, SURF_ID='WALL' / Face 9
&OBST XB=7.32,10.90,3.81,3.81,0.0,2.60, SURF_ID='WALL' / Face 10
&OBST XB=10.9,10.9,0.00,3.81,0.0,2.60, SURF_ID='WALL' / Face 11
&OBST XB=10.9,12.95,1.98,1.98,0.0,2.60, SURF_ID='WALL' / Face 12
&OBST XB=12.95,12.95,1.98,7.92,0.0,2.60,SURF_ID='WALL' / Face 13
&OBST XB=10.97,12.95,7.62,7.62,0.0,2.60,SURF_ID='WALL' / Face 14
&OBST XB=10.97,10.97,7.62,11.28,0.0,2.60,SURF_ID='WALL' / Face
15
/&OBST XB=10.97,12.30,9.91,11.28,0.0,2.60,SURF_ID='WALL' / Face
16
&OBST XB=10.97,28.80,11.28,11.28,0.0,2.60,SURF_ID='WALL' / Face
17
&OBST XB=12.95,28.80,7.92,7.92,0.0,2.60,SURF_ID='WALL' / Face 18
&OBST XB=16.15,16.15,7.92,11.28,0.0,2.60,SURF_ID='WALL' / Face
19

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&OBST XB=19.36,19.36,7.92,11.28,0.0,2.60,SURF_ID='WALL'	/ Face
20	
&OBST XB=22.33,22.33,7.92,11.28,0.0,2.60,SURF_ID='WALL'	/ Face
21	
&OBST XB=25.40,25.40,7.92,11.28,0.0,2.60,SURF_ID='WALL'	/ Face
22	
&OBST XB=27.13,27.13,11.28,12.80,0.0,2.60,SURF_ID='WALL'	/ Face
23	
&OBST XB=25.60,28.80,12.80,12.80,0.0,2.60,SURF_ID='WALL'	/ Face
24	
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25	
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26	
&OBST XB=24.08,24.08,16.31,19.60,0.0,2.60,SURF_ID='WALL'	/ Face
27	
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28	
&OBST XB=17.22,24.08,19.20,19.20,0.0,2.60,SURF_ID='WALL'	/ Face
29	
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30	
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31	
&OBST XB=17.22,20.42,12.80,12.80,0.0,2.60,SURF_ID='WALL'	/ Face
32	
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33	
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34	
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35	
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36	
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37	
&OBST XB= 3.35,8.69,19.61,19.61,0.0,2.60, SURF_ID='WALL'	/ Face
38	
&OBST XB= 6.71,6.71,14.33,19.61,0.0,2.60, SURF_ID='WALL'	/ Face
39	
&OBST XB= 3.35,6.71,14.33,14.33,0.0,2.60, SURF_ID='WALL'	/ Face
40	
&OBST XB= 6.71,8.23,15.39,15.39,0.0,2.60, SURF_ID='WALL'	/ Face
41	
&OBST XB=12.04,12.04,16.76,17.83,0.0,2.60,SURF_ID='WALL'	/ Face
42	
&OBST XB=12.04,15.70,16.76,16.76,0.0,2.60,SURF_ID='WALL'	/ Face
43	
&OBST XB=15.70,15.70,16.76,17.83,0.0,2.60,SURF_ID='WALL'	/ Face
44	
&OBST XB=12.95,12.95,11.28,12.80,0.0,2.60,SURF_ID='WALL'	/ Face
45	

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&OBST XB= 3.35,3.35,7.62,19.61,0.0,2.60, SURF_ID='WALL' / Face
46
&OBST XB= 0.0,3.35,14.12,14.12,0.0,2.60, SURF_ID='WALL' / Face
47
&OBST XB= 0.0,3.35,7.62,7.62,0.00,2.60, SURF_ID='WALL' / Face
48

&OBST XB=22.10,23.93,12.80,13.72,0.0,1.00,SURF_ID='WALL' / Nurse
Station
&OBST XB= 9.14,15.70,12.80,13.72,0.0,1.00,SURF_ID='WALL' /
Reception counter 1
&OBST XB=14.78,15.70,13.72,16.76,0.0,1.00,SURF_ID='WALL' /
Reception counter 2
&OBST XB=12.04,14.78,16.00,16.76,0.0,1.00,SURF_ID='WALL' /
Reception counter 3
&OBST XB= 9.14,10.97,16.87,17.78,0.0,1.00,SURF_ID='WALL' /
Reception counter 4
&OBST XB= 8.23,9.14,12.80,17.78,0.0,1.00, SURF_ID='WALL' /
Reception counter 5

&HOLE XB=18.29,19.36,11.27,11.29,0.00,2.13 / Door 1
&HOLE XB=19.36,20.50,11.27,11.29,0.00,2.13 / Door 2
&HOLE XB=24.23,25.40,11.27,11.29,0.00,2.13 / Door 3
&HOLE XB=25.40,26.44,11.27,11.29,0.00,2.13 / Door 4
&HOLE XB=27.12,27.14,11.73,12.80,0.00,2.13 / Door 5
&HOLE XB=25.59,25.61,13.41,14.33,0.00,2.13 / Door 6
&HOLE XB=24.07,24.09,18.29,19.20,0.00,2.13 / Door 7
&HOLE XB=11.73,12.65,18.99,19.01,0.00,2.13 / Door 8
&HOLE XB= 6.70,6.72,16.46,17.37,0.00,2.13 / Door 9

&PROP ID='K-5.6', QUANTITY='SPRINKLER LINK TEMPERATURE', RTI=100., C_FACTOR=0.7,
ACTIVATION_TEMPERATURE=68., OFFSET=0.10,PART_ID='water drops', FLOW_RATE=70.3,
DROPLET_VELOCITY=10., SPRAY_ANGLE=30.,80. /

&DEVC ID='Spr_1',XYZ=27.5,11.5,2.55, PROP_ID='K-5.6' /
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&SLCF QUANTITY='VISIBILITY', PBY=12.0 /
&SLCF QUANTITY='VISIBILITY', PBZ=1.8 /
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&SLCF QUANTITY='extinction coefficient', PBY=10.0 /
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&SLCF QUANTITY='carbon monoxide',SPEC_ID= 'CARBON MONOXIDE', PBZ=1.8 /
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&SLCF QUANTITY='soot density', PBZ=1.8      /  
&SLCF QUANTITY='soot volume fraction', PBZ=1.8  /  
  
&TAIL /
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References

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- [2] National Institute of Standards and Technology 2012. Fire Dynamics Simulator 5.5, Smokeview 6.0.4. Gaithersburg, Maryland.
- [3] Society of Fire Protection Engineers, 4th Edition 2008. SFPE Handbook of Fire Protection Engineering; Fig. 2-6.27 “Thermal tolerance for humans at rest, naked skin exposed, with low air movement”. Bethesda, Maryland.
- [4] *ibid*; Table 2-6.B1 “Tenability Limits for Incapacitation or Death from Exposures to Common Asphyxiant Products of Combustion”.
- [5] *ibid*; Table 2-4.2 “Allowable Smoke Densities and Visibility That Permits Safe Escape”.
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- [7] United States Nuclear Regulatory Commission 2004. NUREG 1805, Chapter 11, “Estimating Smoke Detector Response Time”. Washington, D.C.
- [8] National Fire Protection Association, 20th Edition 2008. Fire Protection Handbook, Table 4.2.2 “Average Walking Speeds and Standard Deviation for Various Categories of Users of Two Shopping Centers”. Quincy, Massachusetts.
- [9] Society of Fire Protection Engineers, 4th Edition 2008. SFPE Handbook of Fire Protection Engineering; Fig. 3-1.102 “HRR of several upholstered furniture items test at NIST”. Bethesda, Maryland.
- [10] *ibid*; Table 3-4.16 “Yields of Fire Products and Chemical, Convective, and Radiative Heats of Combustion for Well-Ventilated Fires”.
- [11] *ibid*; Fig. 3-1.96 “HRR of trash bags”.
- [12] *ibid*; Fig. 3-1.56 “HRR of magazine racks loaded with magazines, newspapers, and books”.
- [13] National Institute of Standards and Technology 2004. Special Publication SP-1021 “Cook County Administration Building Fire, Heat Release Rate Experiments and FDS Simulations”. Gaithersburg, Maryland.

Vita

Oscar J. Zuniga, Jr. is a consulting professional engineer. Born and raised in Laredo, Texas, he received his bachelor's degree in Mechanical Engineering from The University of Texas at Austin in December of 1973. He obtained his registration to practice in mechanical engineering, followed later by registration by examination in electrical engineering in California, and he has continuously practiced mechanical and electrical engineering, consulting, and design in Texas, California, and Oregon since 1974. His life changed in June of 1978 when he became a Christian.

He was accepted into the graduate program of study in Fire Protection Engineering at California Polytechnic State University in the fall of 2011 and the foregoing work represents his Culminating Project in the Master's degree program. He has applied for registration as a Fire Protection Engineer in California, expecting to be examined in that discipline in October, 2013.

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This thesis was typed by Oscar J. Zuniga, Jr.