CAL POLY

SAN LUIS OBISPO

Fire Protection Engineering

FPE-596-FINAL REPORT

WESTSIDE CHRISTIAN HIGH SCHOOL ADDITIONS AND REMODEL VIEW LOOKING NORTHEAST

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DATE: JUNE 6, 2014

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Statement of Disclaimer

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Key words: Fire Suppression, Fire Detection, Egress, Fire Alarm, Tenability, Fire Dynamic Simulator (FDS), Prescriptive, Performance Based Design.

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I would like to thank Dan Quatier and the Westside High school faculty for allowing me access to the building and for being accommodating in my requests. Without them this would not be possible.

Building Overview & Description

The building I have chosen to use as the model for exemplifying the components of a wet fire suppression system is Westside Christian High School (WCHS). This building completed construction in January of 2014 and is located at: **8200 SW Pfaffle Street Tigard, Oregon 97223**. The existing structure was previously owned and occupied by City Bible Church who will now lease space from the High school during and after construction. The renovations include the addition of space for music, art classes, fitness center, gym, science labs, and others. The renovations will also be widening existing rooms and hallways. The core of the building will remain and the additional spaces are being added to each face.

Building Construction Type Details

- Single story type “E” occupancy
- Non-combustible construction
- Automatic fire sprinkler system throughout (existing and new)
- Construction type II-B
- Existing Area (35,965)+ Addition(25,052)= 61,017 Sq.ft.

Applicable Codes & Standards

- 2010 International Building Code (IBC)
- 2010 Oregon Fire Code (OFC); State adopted IFC standards.
- 2010 Oregon Structural Specialty Code (OSSC); State adopted IBC standards.
- 2010 NFPA #13-Standard for the Installation of Sprinkler Systems
- 2010 NFPA #25-Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection.
- 2010 NFPA #72-National Fire Alarm Code

Site Visits

- 10/11/2013 Site visit/tour was conducted with WCH faculty mid-morning to view the construction progress.
- 12/06/13 conducted a site visit with the general contractor to view construction progress and verify locations of fire hydrants, sprinkle riser, exterior and interior doors.
- 01/06/14 conducted a site visit with WCH faculty to view completed construction (prior to owner move-in).
- 01/13/14 Site visit to view completed construction and occupied spaces.
- 04/10/14-Site visit to witness and record fire drill. Pre-movement and total evacuation times recorded and videotaped for analysis and comparison to pathfinder results.

Passive Fire Protection Building Components

Occupancy Classification & Fire Resistance Rating

Occupancy Classification

Westside Christian High school is classified as a Group E which is defined by OSSC (2010) as *“Includes among others, the use of a building or structure, or a portion thereof, by six or more persons at any one time for educational purposes through 12th grade.”*. Although this is the main /majority use, there are also other occupancies within the building as well. These occupancies include: Business, Storage, and assembly groups A2, A3 & A4.

Construction Type

The construction type is determined using OSSC (2010) Table 503, the corresponding occupancy (determined above to be Group E), and physical characteristics of the building. In this instance we have a Group E, single story, Fully Sprinkled (allowing the use of building area modification calculation Section 506), we find that the corresponding construction types for this application is **Type II B (fully sprinkled)**.

SUMMARY:

BUILDING IS A ONE-STORY TYPE 'E' OCCUPANCY, NONCOMBUSTIBLE CONSTRUCTION. THERE IS AN AUTOMATIC FIRE SPRINKLER SYSTEM THROUGHOUT PER OSSC 2010, SECTION 903.3.1.1.

USE & OCCUPANCY:

GROUP E: CONSISTING OF GENERAL CLASSROOMS, CAFETERIA/COMMONS, OFFICES AND ADMINISTRATION.
(NOTE: ASSEMBLY USE AREAS ARE ACCESSORY TO GROUP E OCCUPANCY PER OSSC 2010, SECTION 303.1, EXCEPTION 4)

CONSTRUCTION TYPE:

II-B (TABLE 503)

ALLOWABLE HEIGHT:

55' (TABLE 503) + 20' (504.2) = 75'

ALLOWABLE NUMBER OF STORIES:

2 (TABLE 503) + 1 (504.2) = 3

ACTUAL NUMBER OF STORIES:

1

ALLOWABLE AREA:

14,500 SF PER OSSC 2010, TABLE 503

AREA MODIFICATION PER FLOOR: (PER OSSC 2010 SECTION 506)

$$I_f = \left[\frac{F}{P} - 0.25 \right] \frac{W}{30} = \left[\frac{1,110}{1,110} - 0.25 \right] \frac{30}{30} = \left[1 - 0.25 \right] 1 = 0.75$$

$I_s = 300$ PERCENT (PER OSSC 2010, SECTION 506.3, ONE STORY)

GROUP E OCCUPANCY - TOTAL ALLOWABLE PER FLOOR:

$$A_a = A_t + \left[A_t I_f \right] + \left[A_t I_s \right] = 14,500 + \left[14,500 \times 0.75 \right] + \left[14,500 \times 3 \right] = 68,875 \text{ SF}$$

EXISTING AREA COMPARED TO ACTUAL ALLOWABLE (A_a)

EXISTING AREA = 35,965 SF COMPARED TO 68,875 SF (A_a)

EXISTING AREA IS LESS THAN ALLOWABLE THEREFORE MEETS CODE REQUIREMENTS.

Fire-Resistance Rating Requirements for Building Elements (hours)

Based on Type II B construction and in accordance with OSSC chapter 6 (table 601) the fire resistive rating for ALL building elements is '0'.

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} Interior	3 3 ^a	2 2 ^a	1 1	0 0	2 1	2 0	2 1/HT	1 1	0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior ^e	0	0	0	0	0	0	See Section 602.4.6	0	0
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} ^h 2	1 ^{h, c}	1 ^{h, c}	0 ^c	1 ^{h, c}	0	HT	1 ^{h, c}	0

Fire-Resistance Rating Requirements for Exterior Walls

Based on fire separation distance greater than 30ft and the occupancy group of 'E', the fire resistive rating is '0' per OSSC Table 602. The aerial photograph below shows that this is a standalone building and there are no other buildings in close proximity to it.

TABLE 602
FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE^{a, *}

FIRE SEPARATION DISTANCE = X (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP H ^f	OCCUPANCY GROUP F-1, M, S-1 ^g	OCCUPANCY GROUP A, B, E, F-2, I, R, S-2 ^g , U ^b
$X < 5^c$	All	3	2	1
$5 \leq X < 10$	IA Others	3 2	2 1	1 1
$10 \leq X < 30$	IA, IB IIB, VB Others	2 1 1	1 0 1	1 ^d 0 1 ^d
$X \geq 30$	All	0	0	0

Fire-Resistance Rating Requirements for Corridors

Based on occupancy type A, B and E, and being fully sprinkled, the required fire –resistance rating (hours) for corridors is equal to ‘0’ per OSSC 1018.1,

**TABLE 1018.1
CORRIDOR FIRE-RESISTANCE RATING**

OCCUPANCY	OCCUPANT LOAD SERVED BY CORRIDOR	REQUIRED FIRE-RESISTANCE RATING (hours)	
		Without sprinkler system	With sprinkler system ^c
H-1, H-2, H-3	All	Not Permitted	1
H-4, H-5	Greater than 30	Not Permitted	1
A, B, E, F, M, S, U	Greater than 30	1	0
R	Greater than 10	Not Permitted	0.5
I-2 ^a , I-4	All	Not Permitted	0
I-1, I-3	All	Not Permitted	1 ^b

Interior Wall and Ceiling Finish Requirements

The interior wall and ceiling finishes are determined in accordance with the occupancy. Per OSSC 803.9 the primary finish type is type ‘C’ however in exist enclosures and exit passage ways it is to be of type ‘B’.

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

GROUP	SPRINKLERED ^d			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		

Prescriptive Fire Protection Building Components

Fire Suppression-System Description

The fire suppression system that serves the Westside Christian High School (WCHS) is a wet type system. Modifications and additional will be made to the existing wet (scheduled pipe) system already in place. Additions will follow the schedule system where applicable and the addition of a “grid” system will be installed in the new gymnasium. All sprinkler heads to be of quick response therefore, all existing sprinkler heads that are standard response are to be replaced. The primary system components of this system consist of (but are not limited to) the following items:

- Underground supply line from city main 8” ductile Iron.
- “Riser” with control valve, main drain, inspectors test, check valve, Fire Department Connection (FDC), water motor gong, and flow switch.
- Fire sprinkler feed mains (typically 2” steel pipe and larger)
- Branch lines (typically 2” steel pipe and smaller, but not less than 1”)
- Groove type fittings (typically located on mains) and threaded type fitting (typically located on branch lines).
- Upright sprinkler heads where there is not a dropped ceiling and construction type is “combustible”.
- 1” sprinkler drops to supply pendant heads.
- Pendent sprinkler heads at dropped ceilings.

Fire Suppression – Water Supply

The water supply serving the fire suppression is an 8” ductile iron pipe that originates from an 8” city main located on the adjacent city highway (Pacific highway 99W) at an elevation of 221ft. immediately exiting the connection point the supply is routed into an underground vault with a backflow device and fire department connection. Exiting the vault, the 8” supply line continues west to the building which is located at a finished floor elevation of 242 ft.

Flow Test & Available Supply:

- Date: Unknown

-

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Fire Suppression-Occupancy Classification

The building has undergone several renovations since inception. The building was originally built and occupied by General Motors over 25 years ago. In more recent years, it has been occupied by City Bible Church, and now it will be the home to Westside Christian High. As the occupancy has changed over time the historical track record of its past can be seen in the existing sprinkler system. Below is a breakdown of the different design criteria's in the past and to date.

- Original building (General Motors) design was an ordinary hazard, **pipe scheduled system** with 120 sq.ft. head spacing.
- Recent residence (City Bible Church) design occupancy was light hazard, **pipe schedule system** with head spacing at 200 sq.ft.
- New building (Westside Christian High) to be of *light hazard* occupancy *Per NFPA 13 5.2* "....occupancies or portions of other occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected.", hydraulically calculated to a density of 0.10 GPM/1,500 sq.ft. and applying the area reduction per NFPA 11.2.3.2.3.1 for fast response heads throughout. % reduction will vary depending on the ceiling height at area of application. Sprinkle head spacing shall not exceed 15 ft X 15ft spacing with exception of areas protected by extended coverage sprinkler heads, in which case the spacing shall be in accordance with the listed spacing but shall not exceed 400sq.ft.

Existing and new construction is non-combustible therefore, no sprinklers are required above the ceiling with exception of the "common area" where there are ceiling clouds and the floor is open to structure.

Fire Suppression-System Components

Sprinkler heads:

Sprinkler head spacing and location verified in a site visit on 01/06/14. Locations of pendant heads have been plotted on the reflected ceiling plan drawings in appendix A. Sprinkler head type determined based on shop drawings and head type in head box adjacent to the fire riser, they are as follows:

- Reliable FIFR Upright (SSU); ½”; 5.6k factor; 155 F
- Reliable J112 (Extended Coverage) Upright (SSU); ¾”; 11.2k factor; 155 F
- Reliable FIFR Pendent (SSP); ½”; 5.6k factor; 155 F
- Reliable QREC (Extended Coverage) Pendent (SSP); ½”; 5.6k factor; 155 F

Manufacturer cut sheets included for each head type in Appendix “A”. All heads are approved for light hazard application.

Special Note: *Reference reflected ceiling plan area “A” in appendix A. There are extended coverage sprinkler heads utilized in some select areas (Heads colored purple with “x” through them). Intermixing of extended coverage and standard coverage sprinkler heads is not typically advised as this can (especially same size orifice heads) as is it possible/more likely that during a replacement or remodel these heads can be mistaken for standard coverage, or visa versa.*

System Riser:

Location is indicated on the piping plan (reference appendix A). The size of the supply stubbed through the floor is 8”. An existing 8” riser has been replaced with a 4” riser that ties into the existing piping at the ceiling, and a new 2 ½” riser to be installed adjacent to that for the new gymnasium. As of the date of this report, the gymnasium has not been erected however the riser has been modified with the new 4” riser and a 2 ½” grooved port has been left for future build out.

Mains & line piping:

Mains, cross mains, and branch lines vary in size. The general location of existing and new piping is shown on the piping plan in Appendix A.

Special Note: *Building is located in the NW where freeze conditions exist therefore; sprinkler risers, backflows, piping, and system components of a wet pipe system shall be located such that they are not susceptible to freeze. Underground piping to be below the freeze line/bury depth (30" top of pipe), Riser room to be heated, piping to at ceiling level to be below insulation at roof.*

Fire Suppression-Hydraulic Calculations

Available water supply:

TUALATIN VALLEY WATER DISTRICT Test # 993 FIRE HYDRANT FLOW TEST REPORT Hydrant ID #: 1S1W36C5H50

Location: PFAFFLE ST & 82ND AVE Date: 11/27/2011

Test made by: HERB & JAMES

Witness: Time: 12:45

Project name:

Discharge coefficient: .54816

Inside dia. of outlet = 4.5 inches

Pitot reading = 33 psi Pitot 2 = 0 psi

Observed flow rate = 1901.5 gpm

Flow method: HOSE MONSTER

Static pressure: 78 psi Residual pressure: 63 psi

Flow at 20psi residual pressure (calculated): 3947 gpm

Location map: To be attached to test report and to show which hydrants were used to monitor residual pressure and flow.

Gage information:

Static and residual pressure gage: 120997-2C Pitot gage: 9864E-1

Hydrant information:

	Hydrant ID	Year	Make	Notes
Flow hydrant:	1S1W36C5H50	1995	US PIPE	see map for location
Read hydrant:	1S1W36C6H50	2001	WATEROUS	see map for location

Hydraulics calculation performed for the new piping in the (Fitness/Commons addition), details as follows:

- Light hazard
- Area of sprinkler operation: 935 sq.ft.
- Density: 0.10
- Area per sprinkler: 168 sq.ft.
- Head types: Reliable F1FR SSP ½: 5.62 k-factor 155 Degree
- Hose allowance: 100gpm (at base of riser)
- “C” factor(s): 120 for all piping above ground; 140 for underground piping

HYDRAULIC CALCULATIONS

CONTRACT NAME

West Side Commercial

SHEET 1 OF 2

NOZZLE IDENT. AND LOCATION	FLOW IN GPM	PIPE SIZE	PIPE FITTINGS AND DEVICES	EQUIV. PIPE LENGTH	FRICTION LOSS PSI/FT	PRESSURE SUMMARY	NORMAL PRESSURE	NOTES
LSSC A121	q	1"	L 16.5		.094	Pt 9.00	Pt	
	q 16.8		2E F 4			Pe 1.08	Pv	
			Sum 40 T 20.5			Pf 1.92	Pn	
5.6K T9.84	q 17.5	1 1/4"	L 12.7		.093	Pt 9.84	Pt	
	q 34.3		F			Pe —	Pv	
			T 12.7			Pf 1.18	Pn	
5.6K T11.02	q 18.6	1 1/4"	L 10		.206	Pt 11.02	Pt	
	q 52.9		F			Pe —	Pv	
			T 10			Pf 2.06	Pn	
5.6K T13.08	q 20.2	1 1/4"	L 2		.375	Pt 13.08	Pt	
	q 73.1		T F 6			Pe —	Pv	
			T 8			Pf 3.0	Pn	
	q	2"	L		.043	Pt 16.08	Pt	$K = \frac{73.1}{16.16} = 18.18$
	q 73.1		F			Pe —	Pv	
			Sum 10 T 10.2			Pf .44	Pn	
18.18K 116.52	q 73.9	2"	L 130.2		.155	Pt 16.52	Pt	
	q 147		3T F 30			Pe —	Pv	
			T 160.2			Pf 24.83	Pn	
	q	4"	L 2.5		.008	Pt 41.35	Pt	
	q 147		F			Pe —	Pv	
			Sum 40 T 2.5			Pf .02	Pn	
	q	5"	L 20.2		.005	Pt 41.37	Pt	
	q 147		F			Pe —	Pv	
			Sum 40 T 20.2			Pf .10	Pn	
	q	6"	L 22.7		.002	Pt 41.47	Pt	
	q 147		E.T F 44			Pe —	Pv	
			Sum 40 T 66.7			Pf .013	Pn	
	q	4"	L 9		.008	Pt 41.60	Pt	Node 5
	q 147		GV F 2			Pe 3.89	Pv 9'0"	
			Sum 10 T 11			Pf .09	Pn	
	q	8"	L 108		.004	Pt 45.58	Pt	Node 4
	q 147		GV F 83			Pe 3.46	Pv 8'0"	
			T 191			Pf .08	Pn	

HYDRAULIC CALCULATIONS

CONTRACT NAME

WESLEY CHASTAIN

SHEET 2 OF 2

NOZZLE IDENT. AND LOCATION	FLOW IN GPM	PIPE SIZE	PIPE FITTINGS AND DEVICES	EQUIV. PIPE LENGTH	FRICTION LOSS PSI/FT	PRESSURE SUMMARY	NORMAL PRESSURE	NOTES
Hose	q 100	8" C.S.		L 245	.0006	Pt 49.12	Pt	NODE 3
	Q 247		4EE, F	F 71.3		Pe /	Pv	
				T 316.8		Pf .19	Pn	
	q	8"		L		Pt 49.31	Pt	NODE 2
	Q 247		DDGU	F		Pe 5	Pv	
				T		Pf 6.02	Pn	
	q	8" C.S.		L 90	.0006	Pt 55.33	Pt	NODE 1
	Q 247		2E, G	F 99		Pe 7.8	Pv 18'	
				T 189		Pf .11	Pn	
	q			L		Pt 63.24	Pt	NODE 0
	Q			F		Pe	Pv	
				T		Pf	Pn	
				L		Pt	Pt

Fire Suppression-Inspection, Testing & Maintenance

Inspection testing and maintenance should be conducted in accordance with NFPA 25 Table 5.1.1.2
Items applicable to water based fire suppression system need only apply.

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

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

Inspections

Visual inspections are not intended to be forensic or destructive instead a visual to ensure nothing is showing obvious signs of failure. Visual inspection include, but are not limited to:

- Visual inspection of the sprinkler heads to insure clearances are met, no sign of degradation or premature failure is occurring.
- Visual inspection of the pipe and fittings to ensure that no visual sign of corrosion, leakage, or damage is prevalent in any area.

Testing

- Sprinkler heads:
 - Testing of sprinkler heads is required when the component has been in service for over 50 years, or the sprinkler heads are subjected to “harsh” environments such as coastal properties or other corrosive atmospheres. Testing shall take place in accordance with NFPA 25 section 5.3
- Gages:
 - Gages shall be replaced or recalibrated every 5 years and should be within 3% of calibrated gage.
- Water flow Device
 - Shall be tested semi-annually by opening an inspectors test at the riser or at remote location. Verify alarm and signal operable.

Maintenance

- Sprinkler heads
 - Replacement of sprinkler heads shall be of same properties as those installed throughout. Replacement heads should be available in the “head box” in an areas where temperature do not exceed 100 Deg C..

No antifreeze, dry system, fire pumps, or hose valves exist on this project.

Egress-Exits

Egress-Occupancy Classification

Egress-Occupant Load & Exit Capacity

- Occupant load calculated in accordance with Oregon Structural Specialty Code (OSCC) 2010 section 1004.

- See Appendix A.; Exit Capacities calculated in accordance with Oregon Structural Specialty Code (OSCC) 2010 section 1005. Using 0.2 inch/occupant; Assumes 33” clear width for 3ft doors, and 66” for 6ft doors.
- Reference Appendix A; Results for exit capacity as follows:
 - a. Exit Area #1- Insufficient; (exit capacity)1,463 < 1,472 (occupant load)
 - i. Recommend the addition of an exterior exit or widening of existing exit 166F to accommodate occupant load.
 - b. Exit Area #2-Insufficeint; Exit capacity at vestibule #100 (660) less than the anticipated occupant load of 726.
 - i. Recommend addition of exterior door at East end of Commons room 150
 - c. Exit Area #3-Sufficiently meets the exit capacity relative to the occupant load.
- Per OSSC (2010) Table 1021.1 the total number of exits required is a minimum of (4) based on an occupant load that exceeds 1,000. This condition is met as there are more than the required exits per area.

- Arrangement of exits in conformance with OSSC(2010). At two locations (hall 143, and Hall 102) there are areas that could potentially be “dead-end” situations at the gates if they were closed. However the length of dead-end corridor is allowed to be up to 50ft. Both locations are only less than 50ft. thus, acceptable.

Egress-Exits, Fire Ratings, Exit signs, and Interior Finishes

For each floor of the building selected analyze the following:

- Reference Appendix B; Horizontal exits exist at multiple locations in the building.
- Fire resistance rating for corridors is permitted to be (0) per OSSC Table 1018 for occupancy types consistent in this building (E, B, S A, and F); fully sprinkled.
- Reference Appendix B; Exit sign placement is shown in figures 1.4 and 1.5 as well, in accordance with OSSC (2010) section 1011. Must be visible from any direction of egress travel & not more than 100 feet from any exit corridor. Paths of travel to the exits shall be clearly marked by the signs.
- Per Life Safety Code (LSC) -2012; Chapter 14 New Education; section 14.3.3.2 Interior wall and ceiling finish is required to be as follows:
 - a. Interior wall and ceiling finish materials complying with section 10.2 shall be permitted to be:
 - i. Exits-Class A
 - ii. Other than Exits-Class A or B
 - iii. Low-height partitions not exceeding 60in and used in locations other than exits-Class A, B, or C
 - b. Classification of wall finishes can be characterized by their inherent flame spread index, and smoke developed index. These values are established using ASTM E84, and ANSI/UL 723. The properties of class A, B, & C are as follows:
 - i. Class A
 1. Flame Spread index: 0-25
 2. Smoke Developed index: 0-450
 - ii. Class B
 1. Flame Spread index: 26-75
 2. Smoke Developed index: 0-450
 - iii. Class C
 1. Flame Spread index: 76-200
 2. Smoke Developed index: 0-450

Egress-Occupant Characteristics & Pre-movement

- Below I will discuss some characteristics of the typical occupant during standard operation hours of a school day. This facility will at times have varying occupant types outside of normal hours. This includes the church tenant that will occupy selected areas of office common area, and assembly during nights and weekends. Also, the school will be leasing some education and business space out to a college for night school. In each scenarios the occupant characteristics will be different. Relative to the school they are as follows(positive in green, and negative in red):
 - a. Familiarity-Since the school is required to conduct regular fire drills, the occupants are likely aware of the evacuation procedure and are more likely to start evacuation rapidly.
 - b. Responsibility- Unlike in their own residence the student occupants (majority of personnel) will look for staff direction (even if audible alarms are sounding).
 - c. Social Affiliation-Occupants are more likely to attempt to gather with people of their social group during the pre-evacuation stage.
 - d. Commitment- Student are not likely to be committed to an operation or task that would delay add to the pre-evacuation time. Conversely, faculty may be more inclined to finish an email, save a file etc...
 - e. Alertness and Limitation-I would anticipate the students to be alert as they will be awake and unlikely to be under the influence of a substance that would impair judgment.
 - f. Staff or Warden-I would anticipate that the staff/faculty will be well rehearsed and aid in increasing the speed in which occupants will respond.
- Pre-movement is the largest varying factor in calculating RSET. It is my opinion that a pre-movement time of 60 seconds would be conservative. This is based on the previous line item s identifying pre-movement contributors (most of which leaned toward a rapid evacuation). Also, according to research by Sime and Proulx pre-movement and movement times are reduced by more than 50% when a PA system is utilized. For these reason I feel that a pre-movement time of 60seconds is ideal.

Egress-Evacuation Time (Hand Calculation)

- For purposes of this exercise I have limited the calculation to only include exit area #1. Exit area #1 includes a “transition area” at Hall 160. Assumptions are:
 - a. Doors are not automatically held open. Specific flow calculated to be within the range of 40-60 person/minute as discussed in SFPE HB.

- Assumes a boundary layer of 6" at exit doors.
- Assumes door 166B is closed (based on previous capacity calculations)
- Assumes occupants are agile, awake, familiar with facility

The results for the calculated evacuation times are as follow:

- Gymnasium = 171 seconds
- Hall 160 (includes fitness 159, and occupants from gymnasium) = 142

EXIT AREA #1 - GYM

$$S_{(GYM)} = K - aKD = 162 \text{ P/MIN}$$

$$K = 275 \text{ (TABLE 3-13.2 SFPE HB)}$$

$$a = 2.86 \text{ FT/MIN (SFPE HB 3-379)}$$

$$D = \frac{1,474 \text{ P}}{10,307 \text{ Sq FT}} = 0.143 \rightarrow \checkmark \rightarrow \begin{matrix} \text{SLOW} \\ \text{PACE} \end{matrix} 0.05 < 0.143 < \begin{matrix} \text{NO} \\ \text{MOVEMENT} \end{matrix} 0.35$$

$$F_s(GYM) = SD = 23.17$$

$$W_e(GYM) = 4(6' - 6'') + (33' - 6'') = \frac{267''}{12} = 22.25$$

BOUNDARY LAYER

$$F_c(GYM) = F_s(GYM) W_e(GYM) = (23.17)(22.25) = 515 \frac{\text{PEOPLE}}{\text{MIN}}$$

$$t_p = \frac{1,474 \text{ PEOPLE}}{515 \frac{\text{P}}{\text{MIN}}} = 2.86 \text{ MIN} = 171 \text{ SECONDS} \quad t_{p(GYM)}$$

EXIT AT HALL 160 - EXIT AREA #1

$$F_s(FITNESS) = SD = 5.19$$

$$S = K - aKD = 259.27$$

$$D = \frac{22}{1094} = 0.2$$

$$W_e(FITNESS) = (33' - 6'') \times 2 = \frac{54''}{12} = 4.5$$

$$F_c(FITNESS) = (5.19)(4.5) = 23.4$$

$$F_s(GYM) = \frac{F_s(GYM) W_e(GYM) + F_s(FITNESS) W_e(FITNESS)}{W_e(DOOR 160A)}$$

$$= \frac{(23.17)(5) + (5.19)(4.5)}{5} = 27.8$$

$$W_e(GYM) = \frac{60}{12} = 5 \text{ (Assumes 11 Doors)}$$

$$W_e(160A) = \frac{60}{12} = 5$$

$$F_c(OUT) = F_s(OUT) W_e(OUT) = \frac{189 \text{ P}}{\text{MIN}}$$

$$t_p(HALL 160) = \frac{380}{139} = 2.73 \text{ MIN}$$

$$= 142 \text{ SEC}$$

- This hydraulic method can be used to establish egress performance in an informative manner and the values such as velocity, and density can vary greatly in a given situation. **limitations** of the model include the following as described by (SFPE HB 3-376):
 - Behaviors that detract from movement are not explicitly considered
 - Number of people considered rather than their individual attributes

- c. Movement between egress components, rather than within them

Assumptions and Variances:

- d. Full occupant load relative to the corresponding capacity factor vs actual occupant load
- e. Assumes all exits will be available at the time of evacuation
- f. Neglect that occupant will often times first attempt to exit through where they entered, and until warranted other exits may not be utilized as uniformly as calculated.
- g. Movement between egress components, rather than within them

Egress-Evacuation Time (Computer Simulation)

- Assumes fully occupied per area/OLF, and all exits available. Parameters of the model were observed however, no changes to “default” setting were adjusted. Without further in-depth knowledge of how these parameters/input field effect the overall calculation adjusting them seemed unwarranted.
- The evacuation times were as follows:
 - a. Gymnasium = 174 seconds—vs 179s (hand calculation)
 - b. Hall 160=168 (transition area)-→vs 158 (hand calculation)

The calculated evacuation time for the gym area appears to be in line with the hand calculations however there is discrepancy in the transition area Hall 160. This is because the hand method does not account for travel time into the transition space thus it is expected to be less.

- The uses and limitation of a computer model are similar to that of the hand calculations however computer simulations appear to be more superior. Because, they are capable of include random logic and inputting specific characteristics and traits to individuals within a space vs generalizing an area.

Egress-Tenability Criteria and Approach

- Tenability is defined as “capable of being held, maintained, or defended” (Mariam Webster) in fire protection this term is used in reference to the occupant’s life and their surrounding environment. This is the condition that is measured when implementing a performance based design. Section 5.2 of the LSC(2012) provides the methodology and requirement that must be adhered by. 5.2.2 states “any occupant who is not intimate with the ignition shall not be exposed to instantaneous or cumulative untenable condition.” As this statement infers, both instantaneous and cumulative conditions can result in death or incapacitation. Before either of these conditions can be identified, the designer must first determine the appropriate method which simulates a threat/hazardous fire condition.
- Section A5.2.2 gives 4 methods for which the design team can implement. The 2nd of which is the most appropriate for my course project building. In this scenario the design team must “demonstrate that each room or area will be fully evacuated before the smoke and toxic gas layer in that room descends to a level lower than 6ft above the floor.” I feel that this methodology is the most appropriate because it demonstrates that the occupants are evacuated before the smoke /gas layer reaches a height that would be threatening. Based on previous evacuations times calculated, the rooms with the longest egress time is in area #1, the gymnasium. A transient analysis should be conducted in order to compare the Fractional Effective Dose (FED) to RSET and ASET. The time interval at which the $FED \geq 1$ should(must) coincide with a time interval $(t) \leq ASET > RSET$.

Egress-Specific Requirements for Type ‘E’ Occupancy

- 14.3.4.2.3.2; Manual fire alarm boxes permitted to be eliminated where protected by automatic fire protection system, and provision is made at a central point to manually activate the evacuation signal.
- 14.3.4.3.1.5-Provisions for preventing student from re-entry when building is burning are to be made. The recall signal shall be separate and distinct, and the button to enact the recall signal shall be under lock and key of the principal.
- Emergency Egress drills in accordance with 4.7 and 14.7.2.3

- 14.7.4.3- Artwork and teaching material shall be permitted to be attached directly to the walls in accordance with (2) for sprinkled buildings, shall not exceed 50% of wall area in building.

Fire Alarm-Type & Operating Characteristics

Westside Christian High School is equipped with a fire alarm system that is both automatic and manual. The building is also fully sprinkled with a wet type fire sprinkler system. There is a mass communication system in place via the intercom controlled/located by the main office.

All wiring is installed as a class B circuit. As a class B circuit, supervisions in the circuit is recognized by passing a low current through the installation wire and an end-of-line resistor. The alarm panel detects the change in current and sends an alarm or trouble when detected. In a class B circuit, an open node point disables all devices electrically beyond the that point.

The operating characteristics of the system is a function of the components that make up the system. These devices are almost all automatic in nature and include, but are not limited to: smoke detectors, fire sprinkler heads, flow switches, and tamper switches. Conversely there is also a manual component to the system which is that of manual pull station.

The Fire Alarm Control Panel (FACP) is located in the Mechanical Room, and the Remote annunciator is located at the main entrance. The style of panels is are: IFC-320 and Silent IFC LCD2-80 (for 80 characters).

Fire Alarm-Devices

The following fire alarm detection and operating devices installed in the building are proprietary to IFC (unless noted otherwise):

- Fire Alarm Control Panel-IFC-320
- Remote Annunciator –IFC LCD2-80
- Pull Station (single)-IFC JBG-12LX
- Photo Electric Sensor-IFC 2951J
- Multi-Candela Notification Horn/Strobe-System Sensor P2R
- Multi-Candela Notification Strobe-System Sensor SR
- Water Flow Switch-Potter Electric VSR

- Sprinkler Tamper-Potter ElectricPVCS

The components above and their relative location were identified from contract documents and site inspections:

- Fire Alarm Control Panel is located in the mechanical room centrally located in the building.
- Remote Annunciator is located at the main entrance
- Pull Station located inside the building behind reception desk.
- Smoke detectors/Photo Electric Sensor located in mechanical and electrical rooms as well as inside of HVAC ducts.
- Multi-Candela Notification appliances are located on walls inside enclosed finished rooms and corridors.
- Water Flow Switches located at the base of riser (BOR) above control valve.
- Tamper switch located at BOR and on OS& Y valves in backflow vault.

Fire Alarm-Detection Device Placement/Location

Fire sprinkler heads

Fire sprinkler heads are a fire detection device with their governing code derived from NFPA 13, and not the National Fire Alarm and Signaling code. Sprinkler head deflector locations below the ceiling and underside of structures. Pendent sprinkler heads in dropped ceilings are quick response heads with red glass bulbs Spacing is of light and ordinary hazard.

Smoke Detectors

Most all smoke detectors are existing and located in mechanical and electrical rooms. As well as in HVAC ducts. Detector location, spacing and placement appears to be installed in accordance with NFPA 72.

Fire Alarm-Design Fire & Response Characteristics

The fire scenario that I propose is discussed in further detail later in this report under Performance based design. Briefly, the design fire scenario occurs in a storage room adjacent to the auditorium. This space is used for storage of stacked metal/fabric chairs. Since no smoke detector exists in this room, it is assumed that the detection of the fire will occur one of two ways: (1) Activation of the sprinkler head, (2) Human detection.

Fire Sprinkler Head Response

SFPE Handbook, Fig 3-1.19 shows HRR for stacked chairs in a corner. This HRR curve represents a fire growth rate of .08 (between fast and ultra-fast). Using FDS modeling, the fire sprinkler head located in this room was calculated to release at 50 seconds from the start of the fire.

Figure 3-1.19. HRR of metal-frame, upholstered stacking chairs.

Human Detection

Using FDS modeling it was determined that smoke particulate would begin exiting into the auditorium space after 30 seconds. It is then presumed that this smoke would be visually detected, or smelled at or around this same time interval.

Fire Alarm-Operation & Sequence

Alarm

Given the design fire scenario presented in previous section, the following is a breakdown of events that would unfold based on the governing sequence of operation:

CAUSE	EFFECT																			COMMENTS
	Alarm AI (FACP) Fire Alarm Control Panel	Alarm AI (FSA) Fire System Annunciator	Alarm AI (FAC) Fire Alarm Communicator	Activate Notification Audibles	Activate Notification Visuals	Trouble AI (FACP) Fire Alarm Control Panel	Trouble AI (FSA) Fire System Annunciator	Trouble AI (FAC) Fire Alarm Communicator	Supervisory AI (FACP) Fire Alarm Control Panel	Supervisory AI (FSA) Fire System Annunciator	Supervisory AI (FAC) Fire Alarm Communicator	Deactivate ADA Notification Audibles	Deactivate ADA Notification Visuals	System Normal						
Manual Alarm Station	X	X	X	X	X															
Smoke Detector	X	X	X	X	X															
Waterflow Switch	X	X	X	X	X	X														
AC Failure								X	X	X										
Fire Alarm Trouble								X	X	X								Open, Shorts, or Grounds		
Duct Detector											X	X	X						HVAC Control	
Post Indicator Valve										X	X	X								
Signal Silence															X					
System Reset															X	X				

We can assume that alarm is triggered either by manual pull station or from fire sprinkler activation, which occur around 50 seconds (as discussed in previous section) the fire alarm system will go into “alarm”. In alarm, the control panel, annunciator and off site monitoring

station will display alarm. Also, the audible and visual notification devices will activate. All of the same actions of “alarm” would occur in the event that a smoke detector or duct detector was initiated.

Trouble

Any irregular circuitry or power signals will signal a trouble at the main panel, annunciator and remote monitoring station.

Supervisory

Tampering of valves equipped with tamper devices, or low air pressure detected in a sprinkler system will initiate a supervisory signal at the main panel, annunciator, and remote monitoring station.

Fire Alarm-Devices and Operating Characteristics

Audible Devices

The location and operating characteristics of audible devices are defined in NFPA 72 (2010):

A.18.4.3 –Public Mode Audible Requirements-To ensure audible public mode signals are clearly heard, unless otherwise permitted by 18.4.3.2 through 18.4.3.5, they shall have a sound level at least 15 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds, whichever is greater, measured 5 ft (1.5 m) above the floor in the area required to be served by the system using the A-weighted scale (dBA).

18.4.8.1- If ceiling heights allow, and unless otherwise permitted by 18.4.8.2 through 18.4.8.5, wall-mounted appliances shall have their tops above the finished floors at heights of not less than 90 in. (2.29 m) and below the finished ceilings at distances of not less than 6 in. (150 mm).

The System Sensor P2R series used in this application is acceptable for use in Class A and B operation (per product data sheets) and are capable of emitting different levels of sound which varies depending upon the wiretap used in installation. Per contract documents the input/wire tap used throughout is 1/2W intern producing 79dBA (@ 10ft).

Based on the average ambient sound level provided in NFPA 72(2010) table A.18.4.3 I have assumed the building to be of location type “Education” which translates to an average ambient sound level of 45dBA thus, requiring the emitted sound to be 60dBA (15dBA above ambient.)

Visible Devices

The location and operating characteristics of audible devices are defined in NFPA 72 (2010):

A.18.5.4.1 – Wall-mounted appliances shall be mounted such that the entire lens is not less than 80 in. (2.03 m) and not greater than 96 in. (2.44 m) above the finished floor or at the mounting height specified using the performance-based alternative of 18.5.4.5.

Several representative samples were observed during site visit and they meet the installation requirement specified above.

The System Sensor series used in this application :

Selectable Output Horns, Strobes, and Horn/Strobes

SpectrAlert® Advance selectable-output horns, strobes, and horn/strobes are rich with features guaranteed to cut installation times and maximize profits.

The SpectrAlert Advance series of notification appliances is designed to simplify installations, with features such as plug-in designs, instant feedback messages to ensure correct installation of individual devices, and 11 field-selectable candela settings for wall and ceiling strobes and horn/strobes.

When installing Advance products, first attach a universal mounting plate to a four-inch square, four-inch octagon or double-gang junction box. The two-wire mounting plate attaches to a single-gang junction box.

Next, connect the notification appliance circuit wiring to the SEMS terminals on the mounting plate.

Features

- Electrically compatible with existing SpectrAlert products
- Automatic selection of 12- or 24-volt operation at 15 and 15/75 candela
- Plug-in design
- Field selectable candela settings on wall and ceiling units: 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, 185
- Same mounting plate for wall- and ceiling-mount units
- Shorting spring on mounting plate for continuity check before installation
- Tamper resistant construction

Visible notification devices are to be spaced in accordance with the figures and tables represented in 18.5.4.3.1 (see below figures):

Table 18.5.4.3.1(a) Room Spacing for Wall-Mounted Visible Appliances

Maximum Room Size		Minimum Required Light Output [Effective Intensity (cd)]		
		One Light per Room	Two Lights per Room (Located on Opposite Walls)	Four Lights per Room (One Light per Wall)
ft	m			
20 × 20	6.10 × 6.10	15	NA	NA
28 × 28	8.53 × 8.53	30	Unknown	NA
30 × 30	9.14 × 9.14	34	15	NA
40 × 40	12.2 × 12.2	60	30	15
45 × 45	13.7 × 13.7	75	Unknown	19
50 × 50	15.2 × 15.2	94	60	30
54 × 54	16.5 × 16.5	110	Unknown	30
55 × 55	16.8 × 16.8	115	Unknown	28
60 × 60	18.3 × 18.3	135	95	30
63 × 63	19.2 × 19.2	150	Unknown	37
68 × 68	20.7 × 20.7	177	Unknown	43
70 × 70	21.3 × 21.3	184	95	60
80 × 80	24.4 × 24.4	240	135	60
90 × 90	27.4 × 27.4	304	185	95
100 × 100	30.5 × 30.5	375	240	95
110 × 110	33.5 × 33.5	455	240	135
120 × 120	36.6 × 36.6	540	305	135
130 × 130	39.6 × 39.6	635	375	185

NA: Not allowable.

Figure 1-Room spacing for Wall mounted devices

FIGURE 18.5.4.3.1 Room Spacing for Wall-Mounted Visible Appliances.

**Ceiling mounted spacing (18.5.4.3.1(b)) not show as it is not applicable to this application.*

Location and quantity of the visible devices appear to be in accordance with the room spacing requirement set forth in chapter 18.

Fire Alarm-Mass Notification Possibilities

Mass notification is an available feature as the building is equipped with an intercom primarily used for faculty to communicate to staff and students daily regarding events. This system could be used as communication in the event of a fire (or other emergencies system) if needed however, it should be noted that if fire alarms/strobes are activated it is unlikely. On 04/10/14 a practice fire drill was observed. The mass notification was not utilized and interviews of faculty and students post drill revealed that it was impractical on account of the “extremely loud” horns. Additionally the system is not set up for prerecorded messages.

Fire Alarm-Calculations

Secondary supply/Battery calculations will be performed to verify adequacy of the battery backup. I have chosen to exemplify this exercise using only the components associated with Power Supply #2 (PS2).

FCPS-24S8 GENERAL WIRING DETAIL AND SETTING

[illegible][illegible]

important cross reference inspection and testing procedures with equipment manufacturers specifications.

Table 14.3.1 Visual Inspection Frequencies

Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually
1. Control equipment: fire alarm systems monitored for alarm, supervisory, and trouble signals					
(a) Fuses	X	—	—	—	X
(b) Interfaced equipment	X	—	—	—	X
(c) Lamps and LEDs	X	—	—	—	X
(d) Primary (main) power supply	X	—	—	—	X
2. Control equipment: fire alarm systems unmonitored for alarm, supervisory, and trouble signals					
(a) Fuses	X (weekly)	—	—	—	—
(b) Interfaced equipment	X (weekly)	—	—	—	—
(c) Lamps and LEDs	X (weekly)	—	—	—	—
(d) Primary (main) power supply	X (weekly)	—	—	—	—
3. Batteries					
(a) Lead-acid	X	X	—	—	—
(b) Nickel-cadmium	X	—	—	X	—
(c) Primary (dry cell)	X	X	—	—	—
(d) Sealed lead-acid	X	—	—	X	—
4. Transient suppressors	X	—	—	X	—
5. Fire alarm control unit trouble signals	X (weekly)	—	—	X	—
6. Fiber-optic cable connections	X	—	—	—	X
7. In-building fire emergency voice/alarm communications equipment	X	—	—	X	—
8. Remote annunciators	X	—	—	X	—
9. Initiating devices					
(a) Air sampling	X	—	—	X	—
(b) Duct detectors	X	—	—	X	—
(c) Electromechanical releasing devices	X	—	—	X	—
(d) Fire extinguishing system(s) or suppression system(s) switches	X	—	—	X	—
(e) Manual fire alarm boxes	X	—	—	X	—
(f) Heat detectors	X	—	—	X	—
(g) Radiant energy fire detectors	X	—	X	—	—
(h) Smoke detectors (excluding one- and two-family dwellings)	X	—	—	X	—
(i) Supervisory signal devices	X	—	X	—	—
(j) Waterflow devices	X	—	X	—	—

Table 14.3.1 Continued

Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually
10. Guard's tour equipment	X	—	—	X	—
11. Combination systems					
(a) Fire extinguisher electronic monitoring device/systems	X	—	—	X	—
(b) Carbon monoxide detectors/systems	X	—	—	X	—
12. Interface equipment	X	—	—	X	—
13. Alarm notification appliances — supervised	X	—	—	X	—
14. Exit marking audible notification appliances	X	—	—	X	—
15. Supervising station alarm systems — transmitters					
(a) DACT	X	—	—	X	—
(b) DART	X	—	—	X	—
(c) McCulloh	X	—	—	X	—
(d) RAT	X	—	—	X	—
16. Special procedures	X	—	—	X	—
17. Supervising station alarm systems — receivers*	X	—	—	X	—
18. Public emergency alarm reporting system transmission equipment					
(a) Publicly accessible alarm box	X	—	—	X	—
(b) Auxiliary box	X	—	—	—	X
(c) Master box	X	—	—	X	—
(1) Manual operation	X	—	—	—	X
(2) Auxiliary operation	X	—	—	—	X
19. Mass notification system, supervised					
(a) Control equipment					
(1) Fuses	X	—	—	—	X
(2) Interfaces	X	—	—	—	X
(3) Lamps/LED	X	—	—	—	X
(4) Primary (main) power supply	X	—	—	—	X
(b) Secondary power batteries					
(1) Lead-acid	X	—	—	—	X
(2) Nickel-cadmium	X	—	—	—	X
(3) Primary (dry-cell)	X	—	—	—	X
(4) Sealed lead-acid	X	—	—	—	X
(c) Initiating devices	X	—	—	—	X
(d) Notification appliances	X	—	—	—	X

Table 14.3.1 Continued

Component	Initial/ Reacceptance	Monthly	Quarterly	Semiannually	Annually
20. Mass notification system, non-supervised systems installed prior to adoption of this edition					
(a) Control equipment					
(1) Fuses	X	—	—	X	—
(2) Interfaces	X	—	—	X	—
(3) Lamps/LED	X	—	—	X	—
(4) Primary (main) power supply	X	—	—	X	—
(b) Secondary power batteries					
(1) Lead-acid	X	—	—	X	—
(2) Nickel-cadmium	X	—	—	X	—
(3) Primary (dry cell)	X	—	—	X	—
(4) Sealed lead-acid	X	—	—	X	—
(c) Initiating devices	X	—	—	X	—
(d) Notification appliances	X	—	—	X	—
21. Mass notification system Antenna	X	—	—	—	X
22. Mass notification system Transceivers	X	—	—	—	X

*Reports of automatic signal receipts shall be verified daily.

Maintenance

Because fire alarm system serve a vital fire and life safety function, it is imperative that these systems receive continued and regular maintenance and testing. Unlike many other components of a building system, the fire alarm system is dormant for extended periods of time but is expected to respond promptly and adequately when needed.

Performance Fire Protection & Building Components

Design Fire

The design fire scenario that I have chosen to apply and evaluate at Westside Christian high school is a combination of the design fire scenarios set forth in the life safety code chapter five. The designed fire will be a fire that starts in a normally unoccupied room with potential to endanger a large number of occupants in an adjacent or larger room area. Additionally, it will be an ultra-fast developing fire which will impede the primary means of egress.

5.5.3.2* Design Fire Scenario 2. Design Fire Scenario 2 shall be described as follows:

- (1) It is an ultrafast-developing fire, in the primary means of egress, with interior doors open at the start of the fire.
- (2) It addresses the concern regarding a reduction in the number of available means of egress.

5.5.3.3* Design Fire Scenario 3. Design Fire Scenario 3 shall be described as follows:

- (1) It is a fire that starts in a normally unoccupied room, potentially endangering a large number of occupants in a large room or other area.
- (2) It addresses the concern regarding a fire starting in a normally unoccupied room and migrating into the space that potentially holds the greatest number of occupants in the building.

It is assumed that the fire will propagate during a time of church service in which it is fully occupied with 429 occupants. The fire will originate in an adjacent storage room(#161), where the fuel load will be metal-fabric chairs being stacked and stored. The storage room doors are assumed to be opened intern blocking the Southern most double-door exit.

ASET vs. RSET

ASET and RSET will be used to compare and validate the results for the performance approach. ASET is that time and from the ignition until tenability limits are reached. RSET is the time from ignition until evacuation of occupants is completed. Below is the signature tie in the development period for occupants during a fire event. This illustrates a generic breakdown however, collectively it is referred to as pre-movement time. Values for this will to discussed in further details.

Tenability

Tenability in essence it is the measure of environmental conditions for which in the occupants can endure, and in a building in fire the main hazards to the occupants are exposures to these items:

1. Temperature/exposure to heat when can be life threatening in three ways: Heatstroke, skin pain and/or burns and respiratory tract burns.
2. Exposure to toxic gases or asphyxiate is the name cause of incapacitation in fires.
3. Smoke obscurity is not directly life threatening however, it can reduce walking speed intern increasing the exposure time.

There is not a single set of values for tenability. Instead it is up to the engineer to use sound judgment to determine the acceptable levels of exposure that will not subject the occupants to untenable levels. Based on publications in SFPE Handbook, I have established the following to be the thresholds (measured at 2 meters):

- Temperature < 60°C (140°F)
- CO < 1,400 PPM
- Visibility > 10m (30ft)

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Using FDS the design fire scenario was modeled accordingly:

The Fuel load is assumed to be a stack of fabric/metal chairs, and the Heat Release Rate(HRR) Test data used is from SFPE handbook figure 3-1.19. The HRR was calculated to be somewhere between a “fast” and “ultrafast” fire with an alpha equal to 0.08.

RSET

The below illustration shows a timeline of events that account for the Total Required Safe Egress Time of 212 seconds.

- Detection = 30 seconds (Human detection-Smoke Visual-FDS Model)
- Notifications = 20 Seconds (NFPA H.B. study); Sprinkler Head Release (@50 sec)
- Pre-movement = 10 Seconds (NFPA Study)
- Travel Time= 152 Seconds (Pathfinder Model)
- **Total Required Safe Egress Time = 212 Seconds**

Detection & Notification (50 Seconds)

Given that the adjacent room is fully occupied and that smoke detection is nonexistent in these areas, it is assumed that detection occurs one of two ways. First, human detection in which an occupant notices smoke or smells the smoke, and then proceeds to notify the other occupants. Second, is detection and notification by way of a fire sprinkler head dislodging and activating the fire alarm. Both scenarios coincidentally equate to approximately 50 seconds. Using FDS a fire sprinkler head in the room of inception activates after 50 seconds. Alternatively, FDS modeling and using human behavior reports from NFPA handbook it was determined that human detection would be very likely within 30 seconds (point at which smoke particulate begins to leave the storage rooms) and notification to other recipients occurring 20 seconds after detection, for a total elapsed time of 50 seconds.

Pre-movement time (30 seconds)

The pre-movement time is premised on two pieces of data. First, is the Station Nightclub Fire investigative report published in the NFPA handbook. Within this report it was reported that once patrons recognized the fire danger “the bulk of the crowd began to evacuate” which occurred at an elapsed time of approximately 30 seconds. Secondly, on 04/10/14 at 10:50 am I witnessed, and recorded the school’s first fire drill. A hidden camera was set up in the art room where there was approximately ten students and one teacher. The video showed a pre-movement time of approximately 10 seconds. I would expect the 10 seconds to increase respectively with the number of occupants (10 occupants vs. the 429 occupant being modeled in the auditorium). Therefore I would not expect the pre-movement time to be of only 30 seconds; instead I would be more inclined to use data from the Station Night club fire.

Travel Time

Using evacuation simulation model “Pathfinder” the travel time was calculated to be 152 seconds.

Results

Tenability conditions were measured within the 212 second window to determine if at any point during evacuation the tenable conditions fell below the threshold established previously. Using FDS modeling the following conditions existed:

- Temperature = **Acceptable**
- CO Concentration = **Acceptable**
- Visibility = **Fails**

Although visibility fails, it is not a direct threat to the occupants. Instead it can be assumed that the calculated evacuation times modeled in pathfinder will be retarded as a result. However, even if evacuation time doubles, exposure to tenable levels are still below the threshold.

Recommendations

On the East end of the stage where an exit use to be, there is an exit sign that still hangs above the sealed up exit. This exit sign should be removed immediately to prevent any misdirection & confusion. Secondly, the single door existing the stage on the West end is capable of being locked and should be outfitted with a panic bar and suitable landing.

Conclusion

The prescriptive methods of the fire protection components appear to meet the requirements in most all regards, with exception of those noted in recommendation. The performance analysis has proven safe/tenable conditions in the event of a aggressive design fire scenario in which the fuel load is ultrafast and results in the blockage of an exit of the auditorium which is fully occupied. Visibility has proven to be below the acceptable threshold however, visibility does not directly impact or pose a threat to human life instead, it will retard the evacuation time. Given the time difference in RSET vs. ASET I would conclude that the passive and active fire protection components in place are acceptable.