ECS Project Report
48655 Fall 19

Submitted by
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Contents

PART 1
BUILDING ENVELOPE

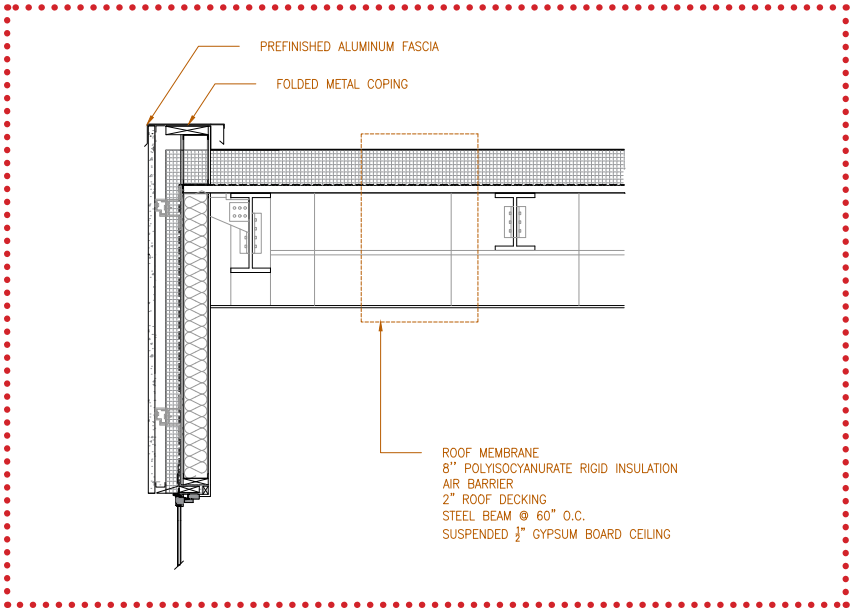
SITE

The site is located in Uptown, Pittsburgh. The site has a long east-west axis and the long end of it is exposed to Fifth Avenue, which connects Uptown and Downtown. Heavy transportation on Fifth Avenue is both an opportunity and a risk to the site. The design is put on the east side of the site, and the main entrance of the building is facing to where the traffic flow comes from. A small plaza is put outside of the main entrance for safety considerations.

Pittsburgh has a cold season that lasts for 3 months and the temperature in winter can drop to 23°F. Therefore, insulation is one of the priorities in the envelope design to minimize thermal bridge and heat loss. The design strives for an R60 Roof and R28.5 walls to achieve high tightness. In addition, because of the high PM2.5 level in Pittsburgh, the design relies more on mechanical ventilation than natural ventilation. A large amount of the windows are not operatable or connected with air condition sensors. The main building materials are steel, concrete and wood.

According to IECC Section C301, Pittsburgh is located in **Zone 3A.**

Roof

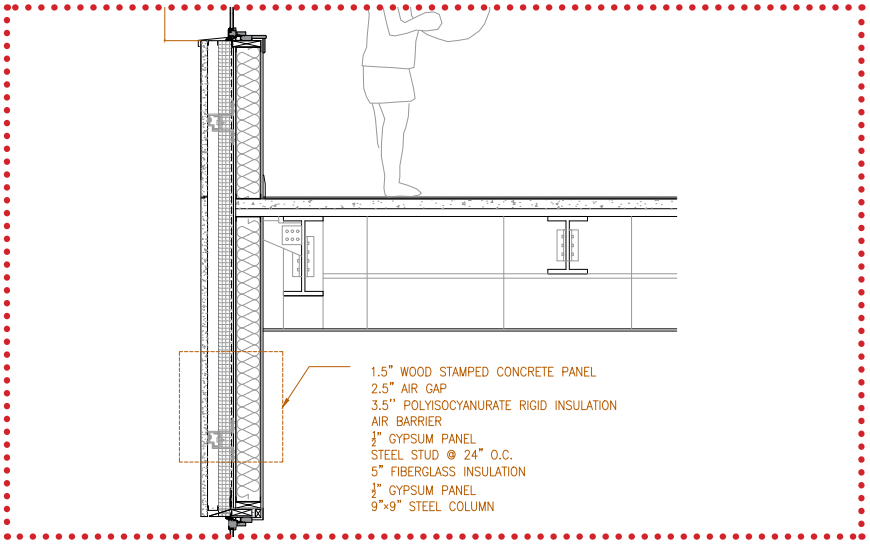


Exterior air film	0.17
Single-ply roofing membrane	0.15
8” Polyisocyanurate rigid insulation	5.56*8 = 44.48
5” Air barrier	1
2” Roof decking	0
Suspended gypsum board ceiling	0
Interior air film	0.61

Roof assembly R-value = sum of all = ***46.41***
R-value above roof deck = ***45.8***

Insulation for entirely above roof decks in Zone 3 required by IECC 2018 is R-25ci. The roof assembly fulfils the requirement.

Wall

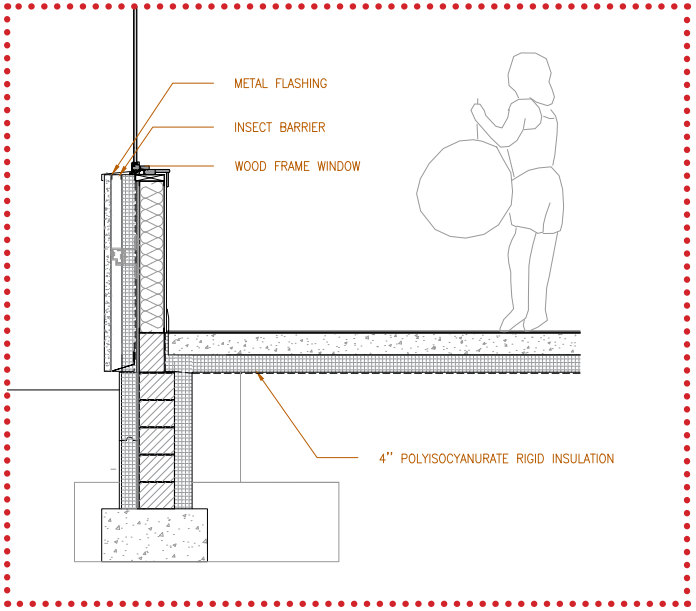


Exterior air film	0.17
5” Wood stamped concrete panel	0.61
5” Air gap	1
5” Polyisocyanurate rigid insulation	5.56*5 = 27.8
0.5” Air barrier	1
0.5” Gypsum panel	0.45
5” Fiberglass insulation	4*5 = 20
Or 2*6 Steel stud	6.875
Interior air film	0.61

Area without studs: R-value = ***51.74***
Area with studs: R-value = ***38.615***
Framing factor = ***12%***
Wall assembly R-value = 1/(0.12*1/38.615+0.88*1/51.74) = 49.7

Insulation for metal framed walls above grade in Zone 3 required by IECC 2018 is R-13+R-25ci. The wall assembly fulfils the requirement.

Foundation



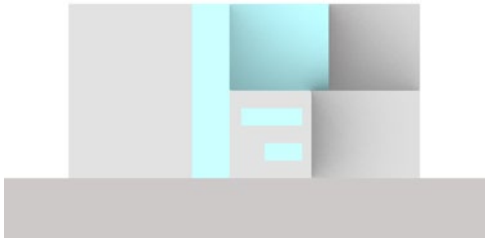
4" Polyisocyanurate rigid insulation
5.56*4 = 22.24
6" Concrete slab 1.2
0.75" Plywood floor 0.825
Interior air film 0.61

Foundation assembly R-value = sum of all
= ***24.875***

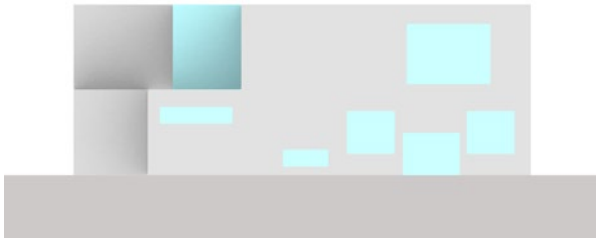
Insulation for mass floors in Zone 3 required by IECC 2018 is R-10ci. The floor assembly fulfils the requirement.

WWRs

According to IECC C402.4.1, WWR in each direction should not exceed the limit of 30%.
Note: the WWRs are calculated using a simplified model of the original design. Therefore there will be some acceptable errors in the calculation.



East Elevation
WWR = 0.36 >0.3
Not allowed by IECC 2018



North Elevation
WWR = 0.25 < 0.3
Allowed by IECC 2018

South Elevation
WWR = 0.35 > 0.3
Not allowed by IECC 2018

West Elevation
WWR = 0.14 <0.3
Allowed by IECC 2018

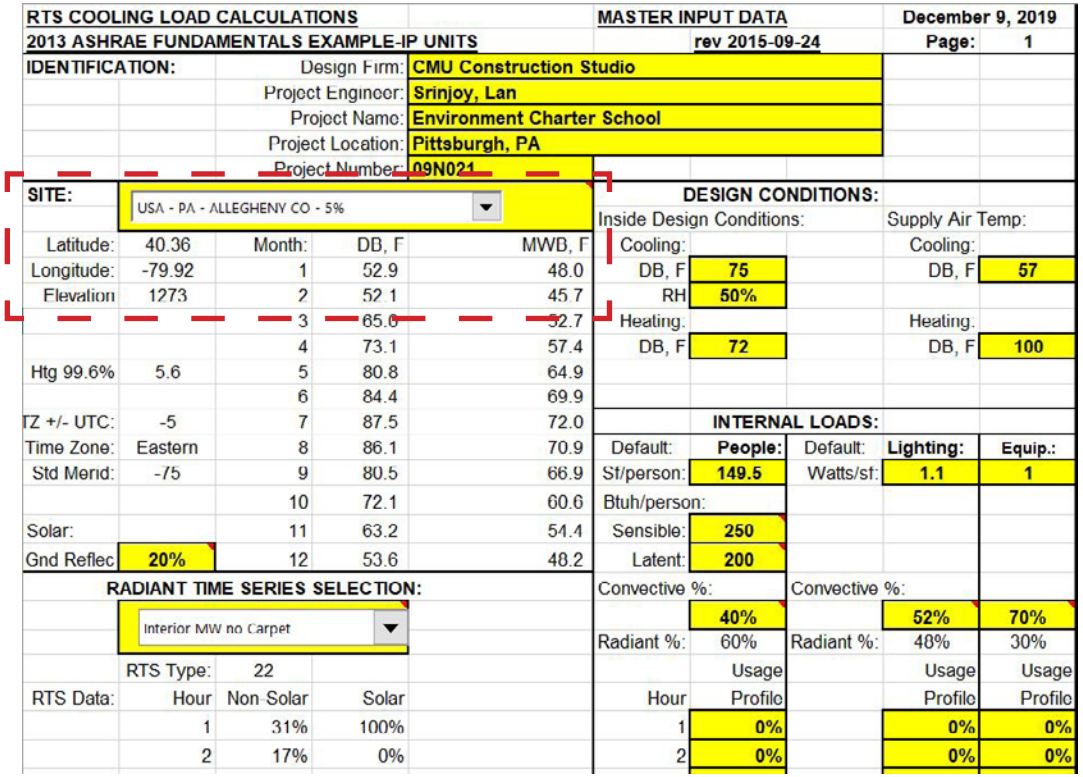
Glazing

In the design, triple-glazed LSG low-e windows are adopted in every orientation. The characteristics are compared to requirements in IECC 2018 Table C402.4.

U-factor: 0.22 < 0.46 (Fixed fenestration maximum value)
SHGC: 0.25 <= 0.25 (SEW)/0.33(N)
VT: 0.4 > 1.1*SHGC

Glazing design is compliant with IECC 2018

PART 2
LOAD CALCULATIONS



RTS COOLING LOAD CALCULATIONS — MASTER INPUT DATA — December 9, 2019
2013 ASHRAE FUNDAMENTALS EXAMPLE-IP UNITS — rev 2015-09-24 — Page: 1

IDENTIFICATION:
Design Firm: CMU Construction Studio
Project Engineer: Srinjoy, Lan
Project Name: Environment Charter School
Project Location: Pittsburgh, PA
Project Number: 09N021

SITE: USA - PA - ALLEGHENY CO - 5%

		Month:	DB, F	MWB, F
Latitude:	40.36	1	52.9	48.0
Longitude:	-79.92	2	52.1	45.7
Elevation	1273	3	65.0	52.7
		4	73.1	57.4
Htg 99.6%	5.6	5	80.8	64.9
		6	84.4	69.9
TZ +/- UTC:	-5	7	87.5	72.0
Time Zone:	Eastern	8	86.1	70.9
Std Merid:	-75	9	80.5	66.9
		10	72.1	60.6
Solar:		11	63.2	54.4
Gnd Reflec	20%	12	53.6	48.2

RADIANT TIME SERIES SELECTION: Interior MW no Carpet

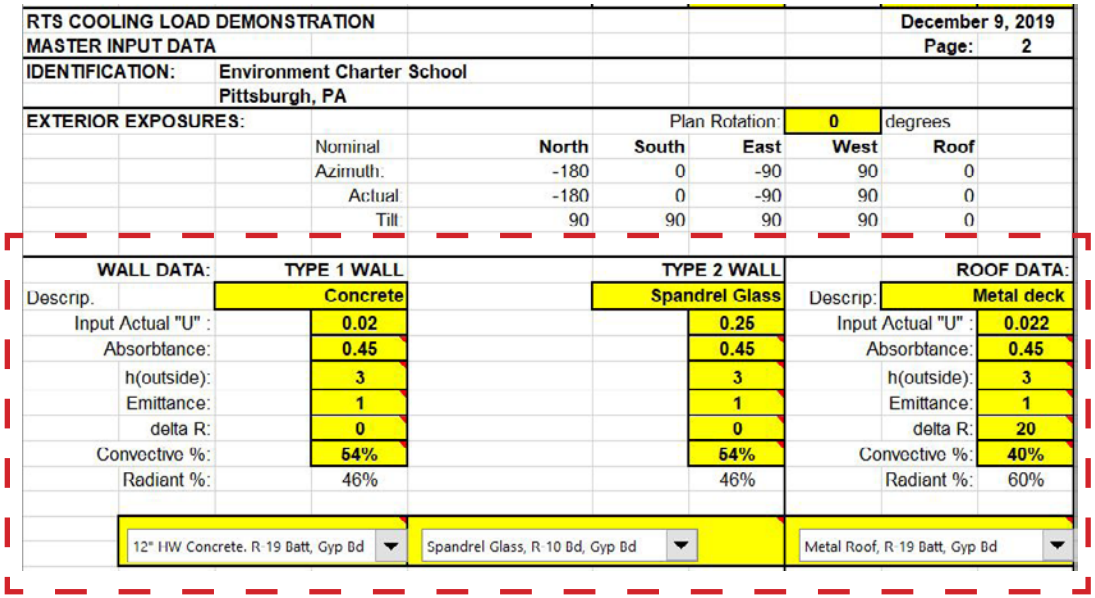
	RTS Type:	22	
RTS Data:	Hour	Non-Solar	Solar
	1	31%	100%
	2	17%	0%

DESIGN CONDITIONS:

Inside Design Conditions:		Supply Air Temp:	
Cooling:		Cooling:	
DB, F	75	DB, F	57
RH	50%		
Heating:		Heating:	
DB, F	72	DB, F	100

INTERNAL LOADS:

	Default:	People:	Default:	Lighting:	Equip.:
Sf/person:		149.5	Watts/sf:	1.1	1
Btuh/person:					
Sensible:		250			
Latent:		200			
Convective %:		40%	Convective %:	52%	70%
Radiant %:		60%	Radiant %:	48%	30%
		Usage		Usage	Usage
Hour		Profile		Profile	Profile
1		0%		0%	0%
2		0%		0%	0%



RTS COOLING LOAD DEMONSTRATION — December 9, 2019
MASTER INPUT DATA — Page: 2

IDENTIFICATION: Environment Charter School
Pittsburgh, PA

EXTERIOR EXPOSURES: Plan Rotation: 0 degrees

	Nominal	North	South	East	West	Roof
	Azimuth:	-180	0	-90	90	0
	Actual	-180	0	-90	90	0
	Tilt	90	90	90	90	0

WALL DATA:	TYPE 1 WALL	TYPE 2 WALL	ROOF DATA:
Descrip.	Concrete	Spandrel Glass	Metal deck
Input Actual "U" :	0.02	0.25	0.022
Absorbtance:	0.45	0.45	0.45
h(outside):	3	3	3
Emittance:	1	1	1
delta R:	0	0	20
Convective %:	54%	54%	40%
Radiant %:	46%	46%	60%

12" HW Concrete, R-19 Batt, Gyp Bd | Spandrel Glass, R-10 Bd, Gyp Bd | Metal Roof, R-19 Batt, Gyp Bd

Calculating Heating Loads through RTS Load Calculation Sheet - Master Inputs section

Location : Pittsburgh, Allegheny County - 5%

As we showed earlier in our drawing details, we have used two kinds of wall assemblies in our schools.
The values entered into the load calcs sheet are the closest approximation available.

2013 ASHRAE FUNDAMENTALS EXAMPLE-IP UNITS					rev 2015-09-24		09-Dec-19
	CMU Construction Studio						Srinjoy, Lan
09N021	Environment Charter School						Pittsburgh, PA
ROOM NO./NAME:	AHU-2	2nd Floor Block Load - with 10' overhang and no roof/lights to RA					
Length:	86	feet				Infiltration cfm	
Width:	120	feet	Area	10320	sq. feet	Cooling:	Heating:
Ceiling Height:	12.5	feet	Volume	129000	cubic feet	190.5	381
INTERNAL LOADS:		Btuh/person:	Lighting,	Equipment,	Inside Design Conditions:		
	# People:	Sensible:	watts:	watts:	Cooling:	DB, F	75
Over-ride Room Input:	105	250	0	0		RH	50%
Default:	69	Latent:	11352	10320	Heating:	DB, F	72
Use:	105	200	11352	10320	Outside Cooling Weather:		
EXPOSURES:	North	South	East	West		USA - PA - ALLEGHENY CO - 5%	
Nominal Azimuth:	-180	0	-90	90	Heating 99.6%, F:		5.6
Actual Azimuth:	-180	0	-90	90	Supply	Cooling, F	57
Tilt:	90	90	90	90	Air:	Heating, F	100
Type 1 Wall Area, sf:	2013	1594	1146	1272	Concrete		
Type 2 Wall Area, sf:	0	0	540	540	Spandrel Glass		
No. Type 1 Windows:	203	412	63	0	Trpl glazed		
No. Type 2 Windows:	203	412	63	0	Trpl glazed		
Roof Area, sf:	0	0%	= Roof % to RA		0%	= Lights % to RA	

WINDOWS:		Window Area,sf:	Btuh/win sf				
Window Type 1:	Trpl glazed						
1 sf/window	North	203	8.9	1,811			2,965
26% SHGF(0)	South	412	23.1	9,526			6,018
0.22 U factor	East	63	11.8	744			920
74% IAC	West	0	0.0	-			-
Window Type 2:	Trpl glazed						
1 sf/window	North	203	8.9	1,811			2,965
26% SHGF(0)	South	412	23.1	9,526			6,018
0.22 U factor	East	63	11.8	744			920
74% IAC	West	0	0.0	-			-
INFILTRATION LOADS:		cfm	Btuh/cfm				
	Cooling, Sensible:	190.5	12.2	2,326			
	Cooling, Latent:	190.5	16.9			3,216	
	Heating:	381	73.0				27,828
				=====	=====	=====	=====
			ROOM LOAD TOTALS =	124,745	-	24,216	73,566
			COOLING CFM =	6,300		HEATING CFM =	2,389
			CFM/SF =	0.6			
BLOCK LOADS:	TOTAL ROOM SENS+RA+LATENT =			148,961		ROOM HTG:	73,566
Peak Block Load Occurs:	OUTSIDE AIR:		OA Sensible:	-		OA Heating:	-
Month: 8	OA cfm =	0	OA Latent:	-			=====
Hour: 14	FAN HEAT:	5.8	HP to S. Air:	14,767		TOT HEATING,btuh=	73,566
	PUMP HEAT:	0	HP to CHW:	-		Heating btuh/sf =	7.1
				=====	tons	sf/ton	
			TOTAL BLOCK COOLING LOAD, btuh =	163,729	13.6	756	

Calculating Heating Loads through RTS Load Calculation Sheet for CLASSROOM FLOOR

The primary classroom floor has 4 classrooms each having 24 students and 1 teacher, and an office space having 5 people. Hence a total of 105 people occupy the space as opposed to the 69 suggested by the RTS sheet according to its average occupancy per square foot of the entire building. Thus we find that the occupancy on this floor is higher than average.

The load calculations for the classroom floor show that -

Total Heating Load - 73,566 BTUH
Total Cooling Load - 163,729 BTUH

Calculating Heating Loads through RTS Load Calculation Sheet for SCHOOL BUILDING

2013 ASHRAE FUNDAMENTALS EXAMPLE-IP UNITS					rev 2015-09-24		09-Dec-19
	CMU Construction Studio						Srinjoy, Lan
09N021	Environment Charter School						Pittsburgh, PA
ROOM NO./NAME:	Building	Building Block Load - 10' Overhang - no lights/roof to RA-Table 38					
Length:	388.7	feet				Infiltration cfm	
Width:	120	feet	Area	46644	sq. feet	Cooling:	Heating:
Ceiling Height:	12.5	feet	Volume	583050	cubic feet	1143	2286
INTERNAL LOADS:		Btuh/person:	Lighting,	Equipment,	Inside Design Conditions:		
	# People:	Sensible:	watts:	watts:	Cooling:	DB, F	75
Over-ride Room Input:	0	250	0	0		RH	50%
Default:	312	Latent:	51308	46644	Heating:	DB, F	72
Use:	312	200	51308	46644	Outside Cooling Weather:		
EXPOSURES:	North	South	East	West		USA - PA - ALLEGHENY CO - 5%	
Nominal Azimuth:	-180	0	-90	90	Heating 99.6%, F:		5.6
Actual Azimuth:	-180	0	-90	90	Supply	Cooling, F	57
Tilt:	90	90	90	90	Air:	Heating, F	100
Type 1 Wall Area, sf:	7267	6264	4674	6270	Concrete		
Type 2 Wall Area, sf:	724	0	2372	980	Spandrel Glass		
No. Type 1 Windows:	842	1705	102	0	Trpl glazed		
No. Type 2 Windows:	842	1705	102	0	Trpl glazed		
Roof Area, sf:	16525	0%	= Roof % to RA		0%	= Lights % to RA	

WINDOWS:		Window Area,sf:		Btuh/win sf				
Window Type 1:	Trpl glazed							
1	sf/window	North	842	8.9	7,513			12,300
26%	SHGF(0)	South	1705	23.1	39,422			24,907
0.22	U factor	East	102	11.8	1,205			1,490
74%	IAC	West	0	0.0	-			-
Window Type 2:	Trpl glazed							
1	sf/window	North	842	8.9	7,513			12,300
26%	SHGF(0)	South	1705	23.1	39,422			24,907
0.22	U factor	East	102	11.8	1,205			1,490
74%	IAC	West	0	0.0	-			-
INFILTRATION LOADS:			cfm	Btuh/cfm				
		Cooling, Sensible:	1143	12.2	13,956			
		Cooling, Latent:	1143	16.9			19,296	
		Heating:	2286	73.0				166,969
					=====	=====	=====	=====
				ROOM LOAD TOTALS =	523,942	-	81,696	368,667
				COOLING CFM =	26,462	HEATING CFM =		11,970
				CFM/SF =	0.6			
BLOCK LOADS:		TOTAL ROOM SENS+RA+LATENT =			605,638		ROOM HTG:	368,667
Peak Block Load Occurs:		OUTSIDE AIR:		OA Sensible:	-		OA Heating:	-
Month:	8	OA cfm =	0	OA Latent:	-			=====
Hour:	14	FAN HEAT:	22	HP to S. Air:	56,014		TOT HEATING,btuh=	368,667
		PUMP HEAT:	0	HP to CHW:	-		Heating btuh/sf =	7.9
					=====	tons	sf/ton	
				TOTAL BLOCK COOLING LOAD, btuh -	661,652	55.1	846	

The inputs for the whole building for this section are derived from the master input shown earlier, unless specified otherwise. The wall, roof, window and floor areas have been entered and infiltration calculated on the basis of those values.

The load calculations for the building show that -

Total Heating Load - 368,667 BTUH
Total Cooling Load - 661,652 BTUH

PART 3
LIGHTING

This section of the report deals with investigating and specifying **optimal lighting demands** in the classrooms of the school. Since the classroom sizes are typical, we are working out the lighting requirement for one classroom which can be used in the other classrooms. Since almost all the classrooms are located on the northern side of the building, we will get a decent amount of diffused light in each space.

Assumptions

Allowed or required watts from IECC 2018 Table C405.3.2(2) = .96 watt/sqft
Values relative to the fixtures and luminaires have been taken from the spec sheet provided hereafter (LN4 Suspended Ambient LED Luminaire - Direct/Indirect - 4”).

Code Requirements

Each classroom is approximately 38.5 x 28. ie. 1078 sqft.
Thus from IECC 2018 Table C405.3.2, the total wattage required for one classroom = 1078 x .96 = 1034.88 watts

The **CREE fixture uses 32 watts**, hence 1034.88/32 = **32.34 or or 33 fixtures are allowed by code**.

Calculations

RCR = $\frac{5\ HRC\ (L+W)}{(LXW)}$ where L = 38.5ft and W = 28ft

HRC = 8.5ft for direct and 10ft for indirect (12’6” Ceiling & Fixture suspended at 11”, working plane at 2’6”)

RCRdirect = 5 X 8.5 X (38.5+28) /(38.5*28)
= 2826.25/1078
= 2.62

RCRindirect = 5 X 10 X (38.5+28) /(38.5*28)
= 3325/1078
= 3.08

Hence the composite RCR =(3.08x.6)+(2.62x.4) =1.85+1.04 =2.89

Based on 80% ceiling reflectance & 50% wall reflectance, the CU for each fixture is:

CU =~0.68
33 Fixtures x 3700 lumens = 122,100 total lumens
LMF at 68F for either 25K or 50K hours =1.00

FC = (122,100 X 0.68 X 1)/1078 sqft = ~77.02FC would fall on the working plane based on the no. of fixtures allowed by code.

However, based on the IESNA RP-1 recommended lighting levels, Row R specifies 250 lux or 250/10.76 = 23.23 or 24 FC based on the type of activity and age.

Hence no. of CREE luminaires = $\frac{(24 \times 1078)}{3700 \times .68 \times 1}$ = 10.28 or 11

Therefore, we can use 11 CREE fixtures instead of the 33 allowed by code to achieve the lighting levels required - thus saving 22 fixtures per classroom, making for a more efficient design solution.

Controls as per IECC 2018

As per IECC 2018, section C 405 indicates the following controls that need to be included in the space(s)–

1. Occupant sensor control function
    a. Auto turn off lights within 20 min of all occupants leaving the space
    b. Be manual on or controlled to automatically turn the light to not more than 50%of the power.
2. Light reduction control by at least 50%
3. Manual controls (LLLC or Luminair Level Lighting Control would be effective in maintaining efficiency)
4. Daylight responsive controls
5. Specific application controls (for instance, for displays and projectorscreens).

LN Series

LN4™ Suspended Ambient LED Luminaire – Indirect/Direct – 4'

Product Description

The LN4™ suspended ambient luminaire delivers up to 115 lumens per watt utilizing Cree WaveMax™ Technology. The 4' (1.2m) luminaire offers up to 3,700 lumens of Cree TrueWhite® Technology 90+ CRI in both 3500K and 4000K color temperatures. The LN Series features an architectural, sleek design with an indirect/direct lighting system that delivers superior ceiling uniformity and creates a comfortable visual environment. The LN4 luminaire offers standard 0-10V dimming.

Applications: Suspended ambient applications for new construction and upgrade

Performance Summary

Utilizes Cree TrueWhite® Technology

Utilizes Cree WaveMax™ Technology

Made in the U.S.A. of U.S. and imported parts

Initial Delivered Lumens: Up to 3,700 lumens (60% uplight, 40% downlight)

Input Power: 32 watts

Efficacy: Up to 115 LPW

CRI: 90+ CRI

CCT: 3500K, 4000K

Input Voltage: 120-277 VAC, 60Hz

Limited Warranty[1]: 10 years

Dimensions: L 48.8" (1240mm) x W 11.7" (298mm) x H 2.7" (69mm)

Controls: 0-10V dimming to 5%

[1] See www.cree.com/canada for warranty terms

Accessories

Field-Installed

Mounting Hardware

LN-EC
- Power canopy and hanging hardware required to support a run. Order 1 LN-EC per run, regardless of number of fixtures in a run. For continuous rows, one LN-CK-0-AC accessory must be ordered for each additional 8' (2.4m) section added to run
- Maximum continuous run is 48' (14.6m) at 120V or 136' (41.5m) at 277V
- Includes 4.6" (117mm) Canopy w/32" (813mm) Aircraft Cable and Power Feed, 2.1" (53mm) Canopy w/32" (813mm) Aircraft Cable, and set of End Caps, one which accepts power feed

LN-CK-0-AC
- One required for each 8' (2.4m) section added to run beyond starter
- 2.1" (53mm) Canopy Kit w/32" (813mm) Aircraft Cable, no Power Feed

Emergency Options

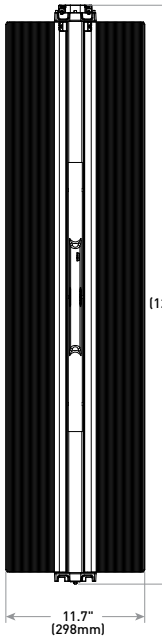
Inverter

ELI-125W
- Emergency 125W inverter (ceiling installation)
- Can't be combined in continuous rows with non-emergency luminaires
- Powers continuous runs up to 12' at 100% output; maximum continuous run length (48' @ 120V; 136' @ 277V) at 5% output
- Minimum 90 minutes

Emergency Relay
- For use with customer supplied generators/inverters

EL-SR-120
- 120V UL-924 Relay

EL-SR-277
- 277V UL-924 Relay



Product Specifications

CREE WAVEMAX™ TECHNOLOGY

Featuring up to 90% optical efficiency and precise control, Cree WaveMax™ Technology provides unmatched comfort and decreased LED source luminance by smoothly spreading brightness over a broader area. When integrated with luminous surfaces made of a polymer medium engineered with DiamondFacet™ optical elements, extremely high efficacy luminaires are the result – ultimately creating more visually comfortable and appealing environments while exceeding illumination performance.

CREE TRUEWHITE® TECHNOLOGY

A revolutionary way to generate high-quality white light, Cree TrueWhite® Technology is a patented approach that delivers an exclusive combination of 90+ CRI, beautiful light characteristics and lifelong color consistency, all while maintaining high luminous efficacy – a true no compromise solution.

CONSTRUCTION & MATERIALS
- Constructed of durable lightweight aluminum
- Acrylic lens delivers a low-glare, diffused light distribution
- Maximum continuous run is up to 48' (14.6m) at 120V and 136' (41.5m) at 277V
- **Weight:** 9.4 lbs. (4.3kg)

OPTICAL SYSTEM
- Cree WaveMax™ Technology optics enable more uniform ceiling and task illumination for a comfortable visual environment
- Inspired design targeted to deliver 60% directional uplight and 40% volumetric downlight to create a soft balanced light experience
- Optimal mounting is 18" (457mm) from ceiling

ELECTRICAL SYSTEM
- **Power Factor:** > 0.9
- **Input Power:** Stays constant over life
- **Input Voltage:** 120-277 VAC, 60Hz
- **Operating Temperature Range:** 0°C - +35°C (32°F - +95°F)
- **Total Harmonic Distortion:** < 20%
- **10V Source Current:** 0.25mA

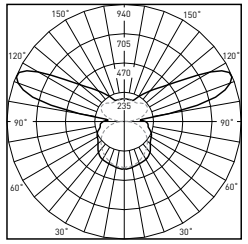
CONTROLS
- Continuous dimming to 5% with 0-10V DC control protocol
- For use with Class 1 or Class 2 dimming systems. Reference www.creelink.com/exLink.asp?7098214OZ58R34I26620963 for recommended dimming controls and wiring diagrams

REGULATORY & VOLUNTARY QUALIFICATIONS
- cULus Listed
- Suitable for damp locations
- Designed for indoor use
- Meets FCC Part 15, Subpart B, Class A standards for conducted and radiated emissions
- Meets Buy American requirements within ARRA
- DLC Premium qualified. Please refer to www.designlights.org/QPL for most current information
- RoHS compliant. Consult factory for additional details

Photometry

LN4-34L-35K-CMA BASED ON CESTL REPORT TEST #: PL07271-001B

Luminaire photometry has been conducted by a NVLAP accredited testing laboratory in accordance with IESNA LM-79-08. IESNA LM-79-08 specifies the entire luminaire as the source resulting in a luminaire efficiency of 100%



Coefficients Of Utilization – Zonal Cavity Method

RC %:	80			
RW %:	**70**	**50**	**30**	**10**
RCR: 0	105	105	105	105
1	94	89	85	81
2	85	77	70	64
3	77	67	59	53
4	70	59	50	44
5	64	52	44	37
6	59	47	38	32
7	54	42	34	28
8	50	38	30	24
9	47	34	27	22
10	44	31	24	19

Effective Floor Cavity Reflectance: 20%

Average Luminance Table (cd/m²)

Vertical Angle \ Horizontal Angle	0°	45°	90°
45°	1,068	1,195	1,197
55°	1,118	1,270	1,279
65°	1,195	1,409	1,617
75°	1,302	1,868	2,246
85°	1,685	4,329	6,199

Reference http://creecanada.com/products/interior/suspended-ambient/ln-series/ for detailed photometric data

Zonal Lumen Summary

Zone	Lumens	% Lamp	Lumina
0-30	297	N/A	8.5%
0-40	500	N/A	14.4%
0-60	950	N/A	27.3%
0-90	1,472	N/A	42.3%
90-120	1,145	N/A	32.9%
90-150	1,849	N/A	53.2%
90-180	2,006	N/A	57.7%
0-180	3,478	N/A	100%

Recommended LN Series Lumen Maintenance Factors (LMF)[1]

Ambient	Initial LMF	25K hr Projected[2] LMF	50K hr Projected[2] LMF	75K hr Calculated[3] LMF	100K hr Calculated LMF
0°C (32°F)	1.07	1.06	1.05	1.05	1.04
5°C (41°F)	1.05	1.04	1.04	1.04	1.03
10°C (50°F)	1.04	1.03	1.03	1.02	1.02
15°C (59°F)	1.03	1.02	1.01	1.01	1.00
20°C (68°F)	1.01	1.00	1.00	1.00	0.99
25°C (77°F)	1.00	0.99	0.99	0.98	0.98
30°C (86°F)	0.99	0.98	0.97	0.97	0.96
35°C (95°F)	0.97	0.96	0.96	0.96	0.95

[1] Lumen maintenance values at 25°C are calculated per TM-21 based on LM-80 data and in-situ luminaire testing
[2] In accordance with IESNA TM-21-11, Projected Values represent interpolated value based on time durations that are within six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing (DUT) i.e. t packaged LED chip)
[3] In accordance with IESNA TM-21-11, Calculated Values represent time durations that exceed six times (6X) the IE LM-80-08 total test duration (in hours) for the device under testing (DUT) i.e. the packaged LED chip)

Ordering Information

Example: LN4-34L-35K-10V; must specify mounting hardware (see accessory table above)

LN4	34L		10V	
Product	**Initial Delivered Lumens**	**CCT**	**Control**	**Voltage**
LN4	**34L** 3,400 – 3,700 lumens	**35K** 3500K **40K** 4000K	**10V** 0-10V dimming to 5%	**Blank** 120-277 Volt

Electrical Data*

System Watts 120-277V	Total Current			
	120V	208V	240V	277V
32	0.27	0.15	0.13	0.12

* Electrical data at 25°C (77°F). Actual wattage may differ by +/- 10% when operating between 120-277V +/- 10%

US: lighting.cree.com/lighting T (800) 236-6800 F (262) 504-5415 Canada: www.cree.com/canada T (800) 473-1234 F (800) 890-7

PART 4
OUTDOOR AIR, MECHANICAL VENTILATION HEATING AND COOLING

This section of the report deals with investigating and specifying **outdoor air and mechanical ventilation demands** on the second floor of the school building. This floor has the following spaces apart from the corridor circulation and atrium -

Classrooms (4) = 4 x 38.5 x 28 = 4 x 1078 = 4312 sqft
Office (1) = 892 sqft
Toilets (2) = 2 x 22 x 10.6 = 2 x 233.2 = 466.4 sqft

Since the school building is located in Pittsburgh, a brief survey of Pittsburgh's temperatures and outdoor air quality is in order.

Location	Dry Bulb Climate Data Winter/Summer *	Wet Bulb Climate Data Winter/Summer *	Grade for High Ozone Days (2014-2016)**	Grade for 24-Hour Particle Pollution (PM2.5)**	Grade for Annual Particle Pollution (PM2.5)**
Pittsburgh	5F/90F	5F/72F	F	F	Fail

* Data sources: 2% climate data from Grondzik/Kwok + Harriman's Humidity Control Design Guide
** American Lung Association 2019 grades for particle pollution, 2019 State of the Air Report

Health Impacts of exposure to elevated levels of PM2.5

- Causes early death (both short-term and long-term exposure)
- Causes cardiovascular harm (e.g., heart attacks, strokes, heart disease, congestive heart failure)
- Likely to cause respiratory harm (e.g., worsened asthma, worsened COPD, inflammation)
- May cause cancer
- May cause reproductive and developmental harm

Health Impacts of exposure to elevated ground-level ozone

Ozone aggressively attacks lung tissue by reacting chemically with it. EPA's summary of the health effects as listed in the ALA report:

- Causes respiratory harm (e.g., worsened asthma, worsened COPD, inflammation)
- Likely to cause early death (both short-term and long-term exposure)
- Likely to cause cardiovascular harm (e.g., heart attacks, strokes, heart disease, congestive heart failure)
- May cause harm to the central nervous system
- May cause reproductive and developmental harm

Natural Ventilation System

The IMC, Section 402, requires that the minimum openable area to outdoors (windows, doors, louvers, other openings) in a space to be naturally ventilated is 4% of the floor area. So, for the spaces here, the calculated minimum openable area would have to be:

Classroom : 0.04 X 1078 ft2 = 43.12 ft2 for each classroom. 172.48 ft2 for 4 classrooms combined.
Office : 0.04 x 892 ft2 = 35.68 ft2
Toilet : 0.04 X 233.2 ft2 = 9.328 ft2 for each toilet. 18.64 ft2 for 2 classrooms combined.

Since the outdoor air quality of Pittsburgh is not good, a combination of strategies based on pollution levels as well as temperature and relative humidity. In this case, the following strategies can be implemented

1. Unfiltered air through operable windows or other openings when OA pollutant levels are acceptable.
2. OA temp and RH sensors to indicate to occupants when windows can be open or should be closed (for comfort & energy impact)
3. An OA sensor that can monitor PM2.5 AND an indicator to occupants when windows can be open or should be closed
4. Filtered air intake and mechanical ventilation when OA quality is poor
5. Dedicated Outdoor Air System (DOAS) with energy recovery and/or Demand Control Ventilation (occupancy sensors and/or CO2 sensors) to save energy for conditioning OA
6. A filter of MERV 12 or higher considering filtration efficiency.

Code based OA Requirement (IMC 2018) for second floor of building

Location	Area (sqft)	IMC Table 403.3.1.1 Occupancy based on floor area	IMC Table 403.3.1.1 CFM based on occupancy	IMC Table 403.3.1.1 CFM based on floor area	Total CFM
Classroom (4)	1078 each	70*	70x10 = 700 cfm	1078x.12 = 129.36 cfm	729.36 x 4 = 2917.44
Office (1)	892	5	5x5 = 25 cfm	892x.06 = 53.52 cfm	78.52
Toilet (2)	233.2 each	-	-	_	_

*The design brief fixes the number of students at 24 per class, however satisfying the code requirement equips the classrooms for a higher occupancy in case of future expansion or greater intake per class.

Round Duct Sizing for 2nd floor (friction loss of 0.1)

Location	CFM of 2 unit	Round Duct Sizing	CFM of n units	Round Duct Sizing
Classroom	729.36	12.5”	1458.72 (n=2)	16”
Office	78.52	5.4”	78.52 (n=1)	5.4”
Cumulative CFM			2996	21”

As we can see, the total CFM required for the entire floor is 2917.44+78.52 = 2996 cfm. Since we have 12 classrooms total in the building, the total OA requirement, we are concerned with, is (729.36 x 12)+78.52 = 8830 cfm.

Possible strategies to reduce the energy impact of outdoor air requirements

- Separate ventilation air from heating & cooling
- Energy recovery to pre-condition OA
- Operable windows/other façade openings when OA quality, temp and relative humidity are suitable for direct delivery to occupants
- Demand control ventilation (like CO2 sensors) to reduce OA volume to suitable level based on actual occupancy or indoor air quality
- Straight duct runs and larger ducts to reduce friction and associated fan power
- Technologies: DOAS with ERV

Possible strategies to design an optimal mechanical ventilation system

- 12 MERV filter
- Energy Recovery OR Renewable Energy like earth tubes to pre-condition OA
- Either DOAS that fully conditions ventilation air OR pre-conditioned OA that's ducted to return of heating/cooling system
- CO2 sensors or Occupancy sensors or general term, demand control ventilation (DCV), to limit the time OA system operates and save energy (protect indoor air quality when OA is not good)
- Diffusers to reduce air velocity to comfort range (50 fpm to 100 or 200 fpm)

Mechanical ventilation system description for school

As we plan to use Variable Refrigerant Flow (VRF) heating and cooling systems, we will have a dedicated outdoor air system to tackle the outdoor air. We can break up the OA delivery to the building by floors. The total OA requirement for the second floor is 2996 cfm. The OA requirement of the whole building for our purposes is calculated to be 8830 cfm.

RD 4XIN
Application Type:Indoor
Ventilation Type:Static plate, heat and humidity transfer
Typical Airflow Range:1,000-4,250 CFM
AHRI 1060 Certified Core:Four L125-G5
OA Filter(s):Total Qty. 6, (4) MERV 8: 20" x 20" x 2" and (2) 20" x 14" x 2"
RA Filter(s):Total Qty. 6, (4) MERV 8: 20" x 20" x 2" and (2) 20" x 14" x 2"
Unit Dimensions & Weight:97" L x 108" W x 62 1/2" H, 1,885-2,514 lbs. (varies by option)

This equipment can provide 1000-4250 cfm which covers the required 2996 cfm. It is selected to serve the second floor spaces as specified before. 3 of these units are enough to serve the building requirement of 8830 cfm.
The default MERV 8 filter is able to provide fresh outdoor air. However, replacing the filter with a MERV 12 or higher will be able to provide cleaner better filtered air.

DOAS Efficiency calculations for the second floor

12/3/2019 RenewAire ERV Calculator

RenewAire Energy Recovery Ventilation

Simplicity - Reliability - Performance

Name: QuickCalc 12/03/2019
General Description:
Model Number: RD4XIN (Info)
Core Designation: G5 = J

Engineer:
Firm/Company:
Prepared By:
Phone Number:
Fax Number:
Email Address:

Ventilation Inputs

				Winter			Summer	
Fresh Air Flow Rate:	2996	CFM	Room Exhaust Air	DB:	72.0	F	DB:	75.0	F
Fresh Air Ext. Static Pressure:	0.50	in W.C.	Room Exhaust Air	RH:	35	%	RH:	55	%
Exhaust Air Flow Rate:	2996	CFM	Outside Air	DB:	5.0	F	DB:	90.0	F
Exhaust Air Ext. Static Pressure:	0.50	in W.C.	Outside Air	WB:	5.0	F	WB:	72.0	F

Performance Data

	Sensible		Total	
	Winter	Summer	Winter	Summer
Exchanger Effectiveness (Info)	70 %	70 %	66 %	58 %

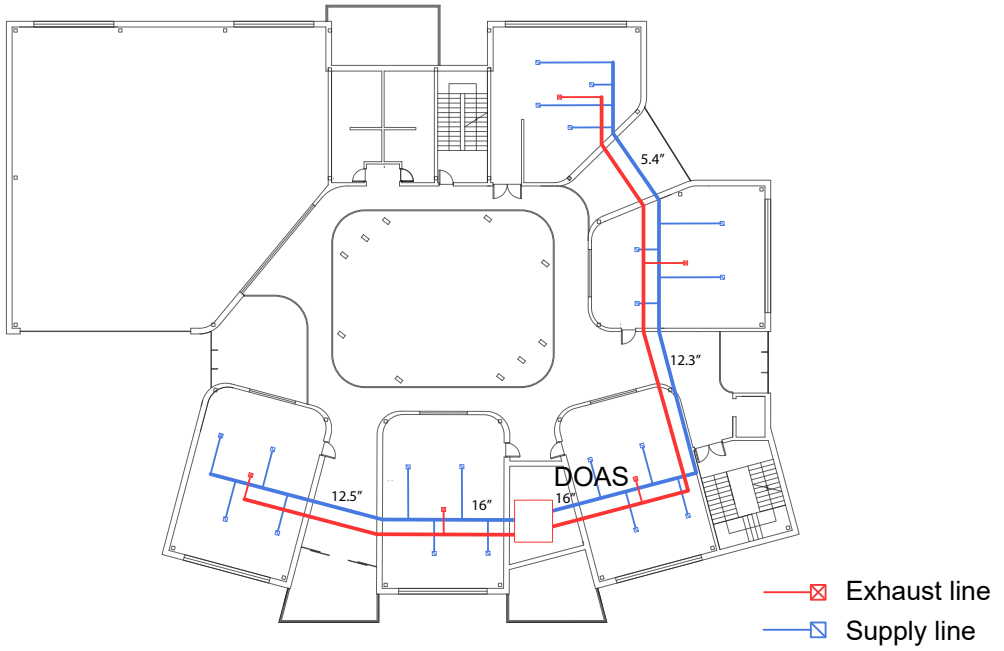
	Room Exhaust		Outside Air		Supply Air	
	Winter	Summer	Winter	Summer	Winter	Summer
Dry Bulb (F)	72.0	75.0	5.0	90.0	51.9	79.5
Wet Bulb (F)	55.9	64.0	5.0	72.0	42.3	67.5
Relative Humidity (%)	35	55	100	43	44	55
Absolute Humidity (lbH20/dryair)	0.0058	0.0102	0.0010	0.0127	0.0035	0.0117
Enthalpy (BTU/lb)	23.6	29.1	2.3	35.6	16.3	31.9

	Sensible		Latent		Total	
(Info on Loads)	Winter	Summer	Winter	Summer	Winter	Summer
Original Load (BTU/h)	216791	48535	71095	38456	287886	86991
Original Load (Tons)		4.0		3.2		7.2
Load with RenewAire (BTU/h)	64991	14550	34324	22074	99315	36624
Load with RenewAire (Tons)		1.2		1.8		3.1
Savings (BTU/h)	151800	33985	36771	16382	188571	50367
Savings (Tons)		2.8		1.4		4.2
Load Savings Ratio (Info)					66 %	58 %

The system considered offers 70% savings in terms of sensible heat in both winter and summer. It gives us 51% reduced latent loads in winter and 42% reduced latent loads in summer.
Overall, the system allows us to have 66% reduced loads in winter and 58% reduced loads in summer.This signifies the degree or percentage to which the supply air with energy recovery approaches the indoor setpoint temperatures at peak temperatures in winter and summer. Since these calculations are based on peak conditions, the total kBTU savings for a full year would be higher than the savings for the peak hours, but the percentage would be lower.

Controls & Consideration for sustainability

A DOAS works best in our scenario since it eliminates any extra load on the heating/cooling equipment from the OA. The sustainability of the system boils down to the control system employed.
Centralized building automation system and scattered **CO2 sensors**, constitutes a **demand control ventilation system**, which will automatically turn on mechanical ventilation when CO2 concentration exceeds 700 ppm. Demand control ventilation reduces unnecessary energy consumption, and bring us additional energy savings. 4 diffusers per room deliver the air at comfortable velocities to each classroom.



Heating and Cooling System

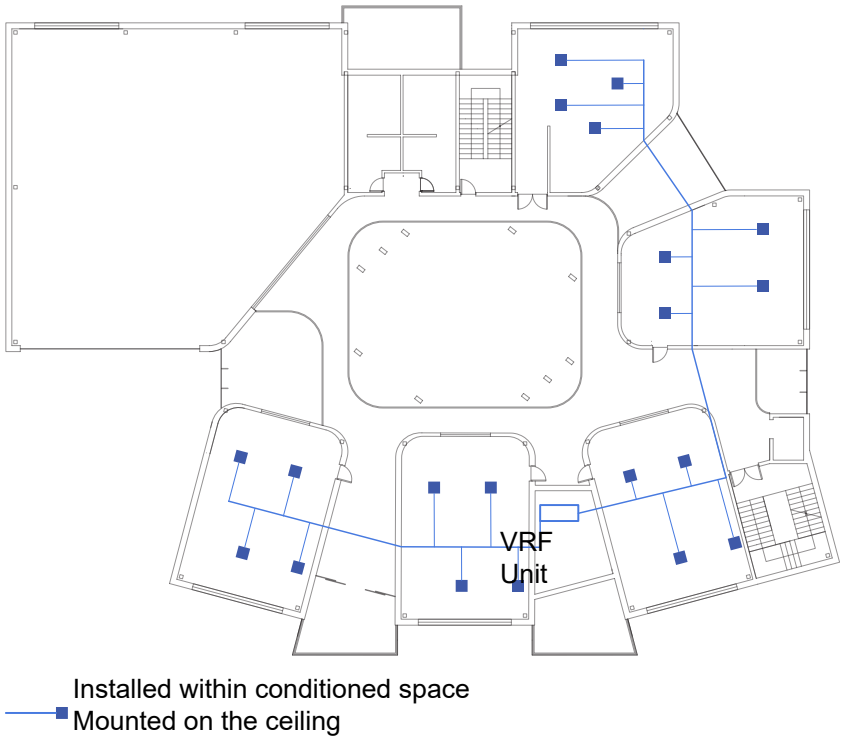
A 12.5’ high ceiling and even distribution of windows for each classroom enhance natural ventiation when the outdoor conditions permit. When the temperature and humidity are too extreme to be comfortable, the mechanical system kicks in.
Individual thermal control for each space is required so that we can shut down the heating and cooling systems when some of the spaces are not occupied. Each space is equipped with multiple thermostats so that occupants can set multiple setback temperatures according to their needs.

For heating and cooling requirements, a VRF Air Conditioner and Heat Pump system is selected.

4 units of the Panasonic WU-168MF2U94 which is a non-ducted system, are chosen to service the building. Each unit has two modules (96K and 72K; ie 96+72=168K), a cooling capacity (95F) of 168,000 BTUH and a heating capacity of 176,000 BTUH (47F) and 118,000 BTUH (17F), A single unit on each of the four floors are to be placed. 4-Way Cassette36” X 36”(Type U2) or Concealed Duct -Low Static(Type M2) indoor units can be used in individual spaces.

1 unit satisfies the load requirement for the classroom floor : Total Cooling Load - 163,729 BTUH, Total Heating Load - 73,566 BTUH

4 units (4x168,000= 672,000 BTUH for cooling, 4x118,000= 472,000 BTUH for heating) satisfy the load of the building - Total Cooling Load - 661,652 BTUH, Total Heating Load - 368,667 BTUH.



Brand	# of units	Indoor Type	Cooling capacity/unit (95F) BTU/h	Total Cooling Capacity at 95F (based on # of units) BTU/h	EER (95F)	IEER	Low Heating Capacity (17F) BTU/h	Total Heating Capacity (based on # of Units) BTU/h	Low COP
Panasonic	4	Ductless	168,000	672,000	11.80	25.10	118,000	472,000	2.77

AHRI CERTIFIED®
www.ahridirectory.org

Certificate of Product Ratings

AHRI Certified Reference Number : 10611656 Date : 12-03-2019 Model Status : Active

Brand Name : PANASONIC

Series Name : MF2

AHRI Type : HMSR-A-CB

Indoor Type : Non-Ducted Indoor Units

System Model Number : WU-168MF2U94

Module Model Number 1 : U-72MF2U94

Module Model Number 2 : U-96MF2U94

Rated as follows in accordance with the latest edition of AHRI Standard 1230 for VRF Air-Conditioning and Heat Pump Equipment and subject to rating accuracy by AHRI-sponsored, independent, third party testing:

Cooling Capacity (95F) : 168000

EER (95F) : 11.80

IEER : 25.10

SCHE : 27.00

High Heating Capacity (47F) : 176000

High COP (47F) : 3.40

Low Heating Capacity (17F) : 118000

Low COP (17F) : 2.77

†"Active" Model Status are those that an AHRI Certification Program Participant is currently producing AND selling or offering for sale; OR new models that are being marketed but are not yet being produced."Production Stopped" Model Status are those that an AHRI Certification Program Participant is no longer producing BUT is still selling or offering for sale.
Ratings that are accompanied by WAS indicate an involuntary re-rate. The new published rating is shown along with the previous (i.e. WAS) rating.

CERTIFICATE NO.: 132198598910548605

AHRI Rating Certificate for selected system

Indoor unit (1) : One such unit for each of 4 floors

Possible indoor units

4-Way Cassette 36” X 36” (Type U2)	S-07MU2U6	Concealed Duct -Low Static (Type M2)	S-07MM2U6

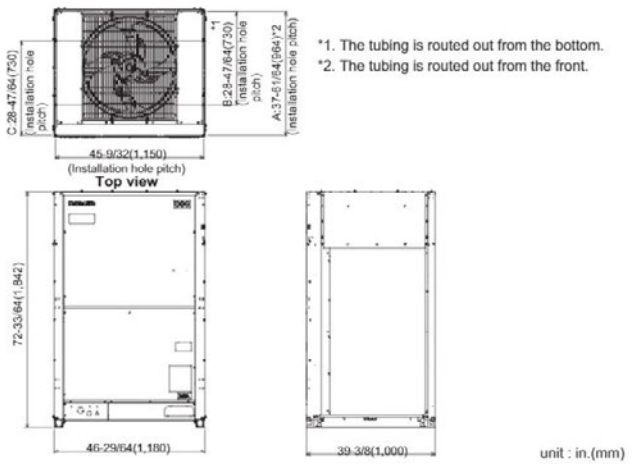
Controls & Consideration for sustainability

- As different spaces have different conditioning requirements based on the activity in the space, the VRF system is able to absorb heat from the gym and release heat into the classroom which helps in optimizing both heating and cooling loads.
- The heat pump is capable of both heating and cooling within a single system.
- Centralized automation system and occupancy sensors allow all equiment to be switched off within a certain time after the occupants have left. Multiple thermostats allow occupants to exercise decentralized thermal control within a single space, which can satisfy the comfort needs of more people.

Heating and Cooling System : Relevant information from specification sheets

Outdoor units

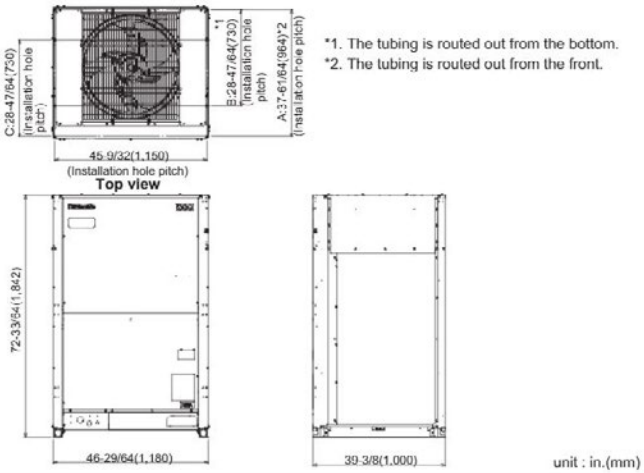
Type	72
Capacity: BTU/h (kW) Cooling / Heating	72,000 (21.1) / 81,000 (23.7)
Outdoor Unit	U-72MF2U9 U-72MF2U94



*1. The tubing is routed out from the bottom.
*2. The tubing is routed out from the front.

unit : in.(mm)

Type	96
Capacity: BTU/h (kW) Cooling / Heating	96,000 (28.1) / 108,000 (31.6)
Outdoor Unit	U-96MF2U9 U-96MF2U94



*1. The tubing is routed out from the bottom.
*2. The tubing is routed out from the front.

unit : in.(mm)

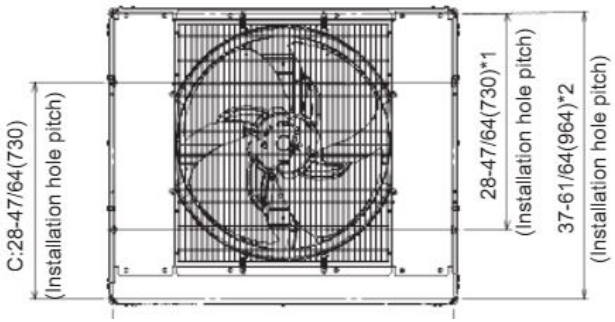
■ Maximum number of connectable indoor units when connected with minimum capacity

Total system tonnage	Number of indoor units	Total system tonnage	Number of indoor units
6	14	14	33
8	19	16	38
10	24	18	43
12	28	20	48
		22~30	52

■ Dimensions

6-Ton U-72MF2U9
U-72MF2U94
8-Ton U-96MF2U9
U-96MF2U94
10-Ton U-120MF2U9
U-120MF2U94
12-Ton U-144MF2U9
U-144MF2U94

6, 8, 10, 12 Ton



PART 5
WATER SYSTEMS

Strategies

Low-flow fixtures are adopted in all of the restrooms.
Cisterns are places in the courtyard for harvesting rainwater, which is used for toliet flushing.
Landscape and permeable pavement at the entrance and the courtyard retains stormwater.
Solar hotwater collectors.

Fixtures

According to 2018 IPC 403.1.1, the number of both male and females are **312/2 = 156**. The numbers used are under the Educational Occupancy on the IPC table. Fractional numbers should be rounded up to the closet integer.

CLASSIFICATION	DESCRIPTION	WATER CLOSETS (URINALS: SEE SECTION 424.2)		LAVATORIES		BATHTUBS/ SHOWERS	DRINKING FOUNTAIN (SEE SECTION 410)	OTHER
		MALE	FEMALE	MALE	FEMALE			
Educational	Educational facilities	1 per 50		1 per 50		—	1 per 100	1 service sink
Requested for the uptown ECS:		4	4	4	4		4	1

The code requires very few fixtures. Because the building has 4 floors and easy access to the fixtures should be provided on each floor, and students tend to use restrooms in short periods of time after classes, the numbers of fixtures are increased as the following:

WATER CLOSETS (URINALS: SEE SECTION 424.2)		LAVATORIES		BATHTUBS/ SHOWERS	DRINKING FOUNTAIN (SEE SECTION 410)	OTHER
MALE	FEMALE	MALE	FEMALE			
16 (8 can be urinals)	16	16	16		4	4

Fixture Water Usage Saving Percentage

Fixture type	Usage Rate (gallons/flush)		
	Current code	3rd generation high-efficiency	Savings from current code
Water closet	1.6 gpf	Dual flush 1.6/1.0 gpf (1.12 gpf on average)	30%
Urinal	1.0 gpf	1.75 gpm	87.5%
Lavatory	2.2 gpf	0.5 gpm	77.3%

Fixture Water Usage Saving Amount

According to the WUI graph given in class, the usage of a K-12 school is about 10 gal/ft2/year. The amount of water used in restrooms accounts for about 45% of the total water usage.
Total water usage: 10 * 46,647 ft2 = 466,470 gal/year
Restroom water usage: 466,470 * 45% = 209,912 gal

However, in this report, the LEED approach is adopted to calculate the fixture uses. The fixture uses by occupancy type are shown in the following table:

Fixture Type	FTE	Student/Visitor	Retail Customer	Resident
	Uses/Day			
Water Closet				
— Female	3	0.5	0.2	5
— Male	1	0.1	0.1	5
Urinal				
— Female	0	0	0	n/a
— Male	2	0.4	0.1	n/a
Lavatory Faucet — duration 15 sec; 12 sec with autocontrol — residential, duration 60 sec	3	0.5	0.2	5
Shower — duration 300 sec — residential, duration 480 sec	0.1	0	0	1
Kitchen Sink, — duration 15 sec — residential, duration 60 sec	1 n/a	0 n/a	0 n/a	n/a 4

	# of uses of water closets	Gallons Used by Code-Based Water Closets	# uses of urinals	Gallons Used by Code-based Urinals	# uses of lavatories	Gallons Used by Code-based lavatories
156 females	0.5*156 = 78	1.6 * 78 = 124.8	0	0	0.5*156 = 78	2.2 * 78 = 171.6
156 males	0.1*156 = 15.6	1.6*15.6 = 24.96	0.4*156 = 62.4	1.0*62.4 = 62.4	0.5*156 = 78	2.2 * 78 = 171.6
Total Daily Gal		149.76 gal		62.4 gal		343.2 gal
Gal Saved by type of Fixture/Day		149.76*30% = 44.9 gal		62.4*87.5% = 54.6 gal		343.2*77.3% = 265.3 gal

Assume that in one school year there are 38 weeks that the school is occupied, and 5 days per week. And thus the school is occupied for 190 days per year.
Total saving: 190 * (44.9+54.6+265.3) = **69,312 gal/year**

Rooftop Rainwater Capture

Because the top layer of the roof is membrane, a effciency of 90% is adopted in the calculation. Rooftop rainwater capture is calculated using the spreadsheet given in class.

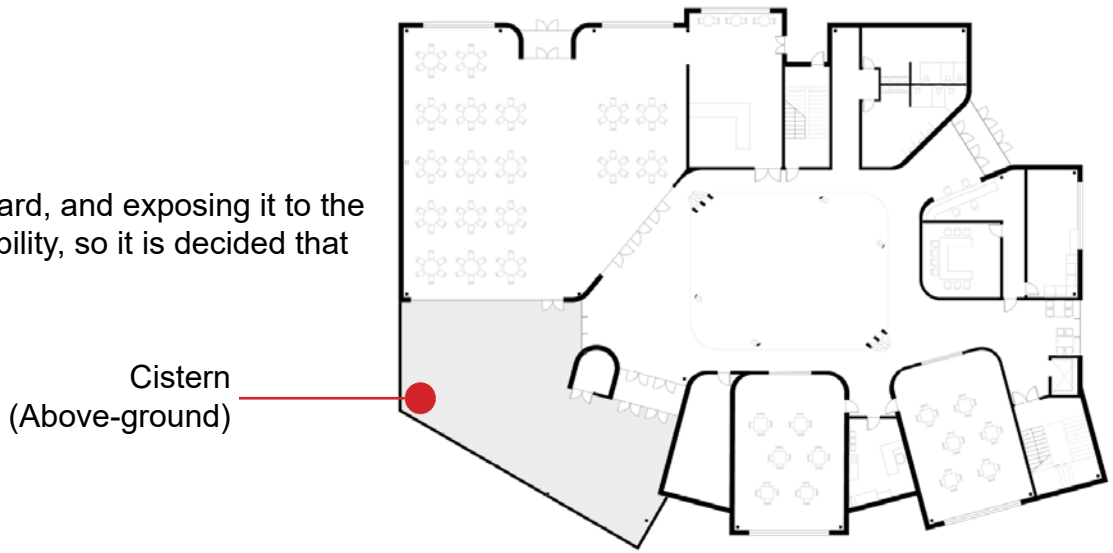
Month	Avg Monthly Rainfall in Inches	Avg Gallons of Rainfall per Ft2 of roof area (Col B x 0.623)	Avg Gal Available per Month based on Roof Area in Ft2*	Collection at 90% Efficiency** (in Gallons)	Rooftop Collection at 80% Efficiency***(in Gallons)	Total Gallons Required Per Month ****	Monthly Surplus Gallons if Any (based on 90% eff)	Cummulative Surplus if any (gal)	Cubic Feet of Storage Needed to Retain Surplus
Jan	3.1	1.93	90,089	81,080	72,071	38,873	42,208	42,208	5,643
Feb	2.8	1.74	81,371	73,234	65,097	38,873	34,361	76,569	10,237
Mar	3.7	2.31	107,526	96,773	86,021	38,873	57,901	134,470	17,977
Apr	3.5	2.18	101,714	91,542	81,371	38,873	52,670	187,140	25,019
May	3.8	2.37	110,432	99,389	88,346	38,873	60,516	247,657	33,109
Jun	4	2.49	116,244	104,620	92,995	38,873	65,747	313,404	41,899
Jul	4	2.49	116,244	104,620	92,995	38,873	65,747	379,151	50,689
Aug	3.6	2.24	104,620	94,158	83,696	38,873	55,285	434,437	58,080
Sep	3.4	2.12	98,808	88,927	79,046	38,873	50,054	484,491	64,772
Oct	2.8	1.74	81,371	73,234	65,097	38,873	34,361	518,853	69,365
Nov	3.3	2.06	95,902	86,311	76,721	38,873	47,439	566,291	75,707
Dec	3.3	2.06	95,902	86,311	76,721	38,873	47,439	613,730	82,050

Concerning about legionella issue, the cistern is assumed to be able to hold only 20 days of water supply. Assume the school is using 3rd generation high-efficiency fixtures.
According to the calculation in the last page, the total restroom usage in the 20 days period is:
(149.76 *(1-30%) + 62.4*(1-87.5%) + 343.2*(1-77.3%))*20 = **3810.8 gal**
The amount is smaller than the rainwater amount that can be collected, and thus the cistern will be sized to hold this amount of water.

The height of the cistern is assumed to be 10 ft.

3810.8 gal = 3.14 * r2 * 10ft * 7.48gal/ft3
r = 4 ft

The cistern will occupy only a small portion in the courtyard, and exposing it to the students can make it an educational tool about sustainability, so it is decided that the cistern will be placed above ground in the courtyard.



Water Heating

According to 2015 ASHRAE Applications Handbook, the maximum hour hot water use in a middle school is 1.0 gal/student. In this ECS, the amount would be: 1.0 * 312 = **312 gal at maximum hour**

Assume that 70% of the water can be extracted from the storage tank. Therefore, the minimum volume of the tank should be:
312 gal/0.7 = 445.7 gal

Basic information of the equipment selected:

Type of water heater: Gas storage water heater, EnergyStar qualified, model GDHE-75
# of units: 445.7 gal/75 = 6
Fuel it uses: Natural gas
First hour rating (FHR): 130
Efficiency: 96%
Dimension: 64 3/4” high x 27 3/4” diameter

ENERGY STAR CERTIFIED
Water Heaters

A. O. Smith - GDHE 75* : GDHE 75*

Specifications

ENERGY STAR Partner:	Lochinvar, LLC
Brand Name:	A. O. Smith
Model Name:	GDHE 75*
Model Number:	GDHE 75*
Type:	Gas Storage
Fuel:	Natural Gas
Storage Volume (gallons):	74.0
Tank Height (inches):	51.9
Height to Vent (inches):	8.0
Tank Diameter (inches):	22.5
Vent Size (inches):	2
Vent Size 2 (inches):	3
Electric Usage at 125°F outlet temp (kWh/yr):	23.0
Input Rate (BTU/hr):	100000
Uniform Energy Factor (UEF):	0.86
Therms Per Year at 125°F outlet temp:	196
First Hour Rating at 125°F outlet temp (gallons/hr):	130
Recovery Efficiency per UEF test method (%):	96
Date Certified:	2019-11-19
Markets:	United States, Canada
ENERGY STAR Certified:	Yes

Additional Model Information

COMMERCIAL-GRADE
RESIDENTIAL GAS WATER HEATERS

VERTEX™ VERSATILE POWER DIRECT VENT
Up to 0.88 Uniform Energy Factor (96% Thermal Efficiency)

Today's homes demand more hot water than ever before, and the high efficiency Vertex™ power direct vent gas water heaters offer unprecedented levels of performance to meet the need. The fully condensing Vertex design is so advanced, it can deliver "continuous hot water for shower after shower" at a constant flow of over 4 gallons per minute.*

ENERGY STAR® QUALIFIED

ADVANCED ELECTRONIC CONTROL

- Exclusive A. O. Smith designed touch display control system
- Precise temperature control
- Built-in diagnostics and operational information

CONDENSING DESIGN

- High efficiency operation with up to 0.88 Uniform Energy Factor (96% thermal efficiency) to save money on operating costs
- Equipped with condensate drain tee

HELICAL INTERNAL HEAT EXCHANGER

- Spiral heat exchanger keeps hot combustion gases in the tank longer to lengthen the heat transfer cycle
- Positioned in the center of the tank for more even heat distribution
- Spiral design reduces lime scale formation on the heat exchanger to maintain high efficiency operation over time

POWER DIRECT VENT DESIGN

- Combined vertical and horizontal runs terminating through an outside wall. Vents using PVC, CPVC, or polypropylene pipe. Canadian installations require ULC S636 approved PVC, CPVC or polypropylene pipe for venting.
- 2" pipe, vents up to 45 equivalent feet
- 3" pipe, vents up to 125 equivalent feet

SIDE-MOUNTED HOT AND COLD RECIRCULATING TAPS

- Allows Vertex to be installed as part of combination space heating/water heating applications

AVAILABLE IN NATURAL GAS OR PROPANE

TOP FIRED ULTRA-LOW NOX GAS BURNER

- Enhanced Ultra-low NOx burner complies with SCAQMD Rule 1146.2 and other Air Quality Management Districts with similar requirements for NOx emissions of less than 14 ng/j

BLUE DIAMOND® GLASS COATING

- Provides superior corrosion resistance compared to industry standard glass lining.

HEAVY-DUTY ANODIC PROTECTION

- Provides even more protection against corrosion

CSA CERTIFIED AND ASME RATED T&P RELIEF VALVE

MAXIMUM HYDROSTATIC WORKING PRESSURE: 150 PSI

CODE COMPLIANCE

- Meets IBC and ICC National Codes.
- Meets the thermal efficiency and standby loss requirements of the U.S. Department of Energy and current edition of ASHRAE/IES 90.1.

DESIGN-CERTIFIED BY UNDERWRITERS LABORATORIES

- Certified at 300 psi test pressure and 150 psi working pressure. Listed according to ANSI Z21.10.3 - CSA 4.3 standards governing storage tank-type water heaters.

6-YEAR LIMITED TANK AND PARTS WARRANTY

- For complete information, consult written warranty or go to hotwater.com

*Continuous hot water based on 4.31 GPM continuous flow with a 65°F inlet water temperature, 110°F outlet temperature, and a unit installed per the manufacturer's instructions.

MODEL SHOWN GDHE-75
SERIES 300/301

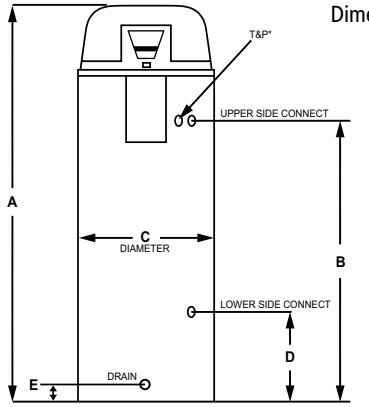
www.hotwater.com | 800-527-1953 Toll-Free USA | A. O. Smith Corporation | 500 Tennessee Waltz Parkway | Ashland City, TN 37015

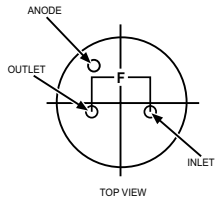
COMMERCIAL-GRADE
RESIDENTIAL GAS WATER HEATERS

Model Number	Nominal Capacity	Rated Storage Volume	First Hour Rating (Gallons)	UEF	Thermal Efficiency	Recovery @ 90° Rise Gallon Per Hour	BTU Input Per Hour	Vent Size	Dimensions in Inches		Approx. Shipping Weight (lbs)
									Height to Top of Heater	Diameter	
GDHE-50	50	49	100	0.88	96%	129	100,000	2 or 3	66-3/4	22	255
GDHE-75	75	74	130	0.86	96%	129	100,000	2 or 3	64-3/4	27-3/4	382

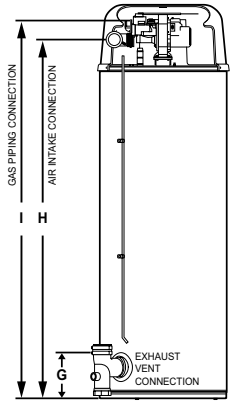
Available in Propane (LP) gas. Specify when ordering Propane (LP) gas.
Models certified for sea level to 10,100 ft. elevation.
Optional Condensate Neutralizer Kit available (Part Number 100112380).

Dimensions for GDHE-50

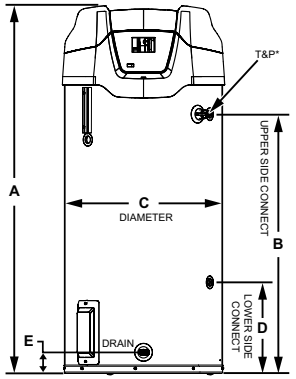


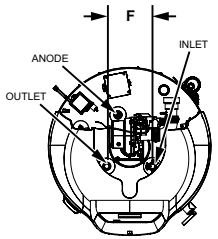


*INSTALL IN ACCORDANCE WITH LOCAL CODES.

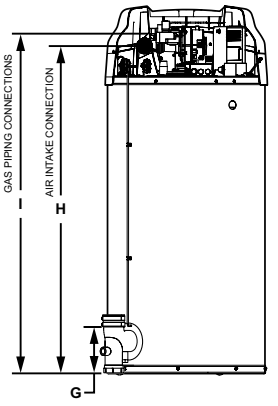


Dimensions for GDHE-75





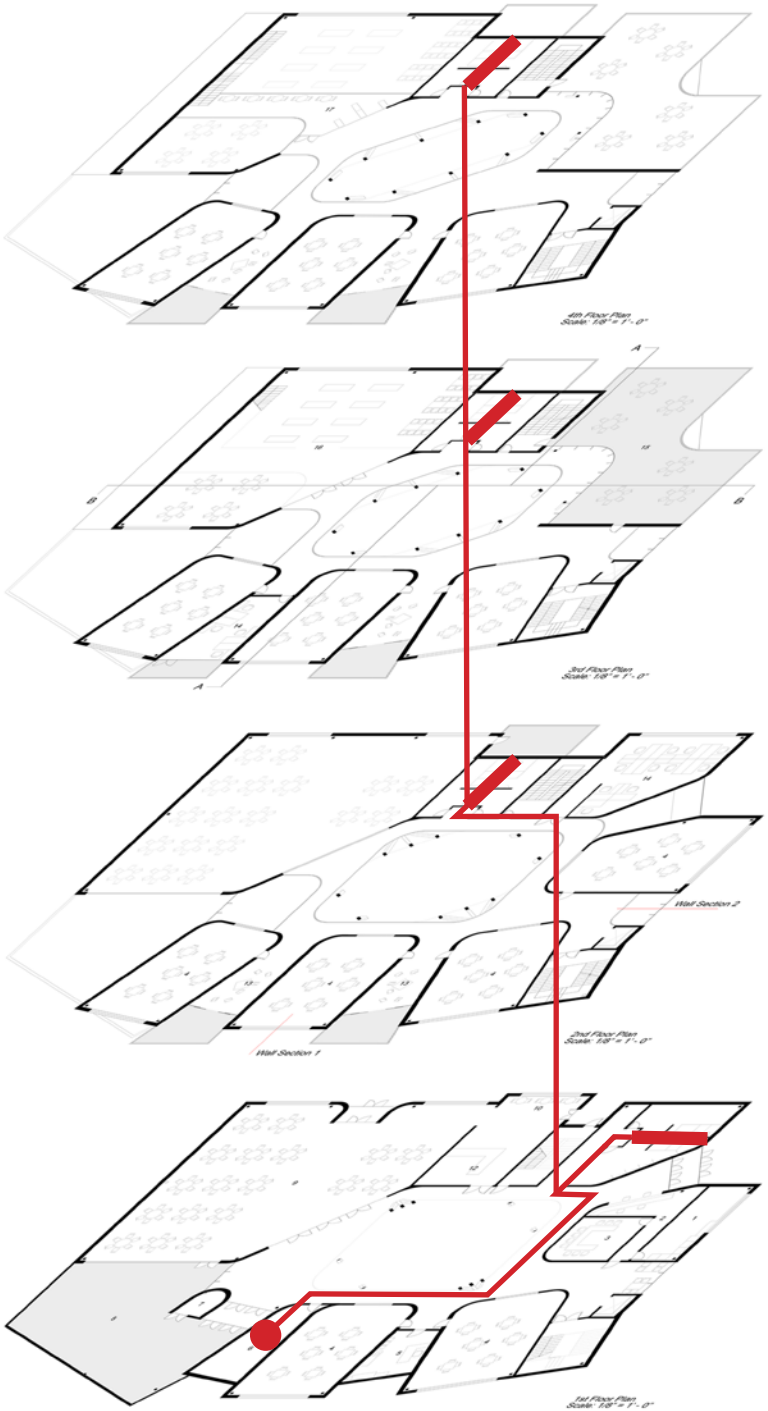
*INSTALL IN ACCORDANCE WITH LOCAL CODES.



For Technical Information call 800-527-1953. A.O.Smith Corporation reserves the right to make product changes or improvements without prior notice.

www.hotwater.com | 800-527-1953 Toll-Free USA | A. O. Smith Corporation | 500 Tennessee Waltz Parkway | Ashland City, TN 37015

Layout of Hot Water System



PART 6
RENEWABLE ENERGY

Solar PV and Solar Water Heater

The total roof area we have available to us is approximately **16,525 sqft**.
The total cooling load for the building is given by **661,652 BTU or 193.91kWh**.
The **Sunpower SPR-X21-470-COM** (470 W, 128 cell Monocrystalline module, white backsheet, silver frame) with a safety certification UL 1703, nameplate rating of 470W and **PTC of 438 W** is the panel that is chosen for this system.
The number of such panels required to satisfy the building load of 193.91kW = 193910/438 = **442 panels** each panel being 81.4”(l) X 41.2”(w) taking an area of 23.27sqft. Thus the total area taken by the solar pv array is **10,289 sqft, which is 62.26% of the roof area**.

Thus sizing it to cover **75% of the roof area,** would give us **extra energy to return to the grid** and make use of the net metering incentive.
75% of roof area = 16,525 x .75 = 12,393.75 or **12400sqft** approx.
The number of panels that can be fit in that area = 12,400/23.27 = **532 panels**.
The total energy generated by 532 panels = 438 x 532 = **233 kWh**, thus giving us **40kWh extra**.

After entering this sizing in the PV watts calculator, and setting the **tilt at 34degrees** by tweaking it, the maximum output obtained was around **290kWh**, which is around 97 kWh over what is needed for the building’s heating and cooling equipment loads. The PVwatts estimate is shown here and the specifications for the solar panel chosen have been provided in the following pages.

We calculated the peak hot water demand at the maximum hour to be **446 gallons**.

The solar water heating system we have selected for the project is a **Heliodyne pumped indirect system (HPAS 1 410 G 80 AC D) with a glazed flat plate collector (GOBI 410 001)** that has a total **panel area of 40.26 sqft**. It houses an **80 gallon solar tank** along with a **50 gallon gas powered backup tank**. **6** such systems can meet the peak hot water demand of the building by providing 480 gallons (446 required). The roof area required by the panels for 6 systems would be **241.56 sqft**. The SRCC certification for the said system can be found in following pages.

PVWatts Calculator

RESULTS

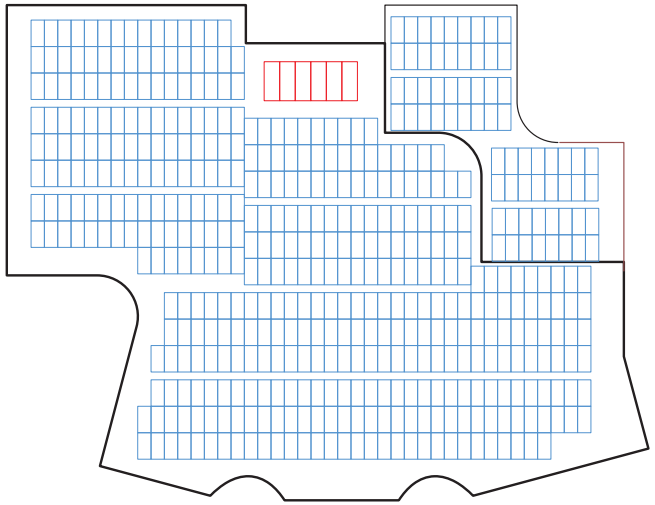
290,899 kWh/Year*

System output may range from 280,369 to 302,157 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	2.91	16,978	632
February	3.87	20,065	746
March	4.31	23,976	892
April	5.09	26,755	995
May	5.48	29,440	1,095
June	5.66	28,890	1,075
July	5.87	30,412	1,131
August	5.88	30,559	1,137
September	5.48	27,853	1,036
October	4.20	22,448	835
November	3.48	18,878	702
December	2.53	14,645	545
Annual	4.56	290,899	$ 10,821

Location and Station Identification	
Requested Location	15219, USA
Weather Data Source	Lat, Lon: 40.45, -79.98 0.5 mi
Latitude	40.45° N
Longitude	79.98° W
PV System Specifications *(Commercial)*	
DC System Size	233 kW
Module Type	Premium
Array Type	Fixed (roof mount)
Array Tilt	34°
Array Azimuth	180°
System Losses	14.93%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2
Economics	
Average Retail Electricity Rate	0.037 $/kWh
Performance Metrics	
Capacity Factor	14.3%

Thus the total roof area required for the PV panels and the solar flat plate collectors is **12,645 sqft** approx. which is **76.5%** of the roof area.



Glazed flat plate collector
Solar PV panels

Incentives to defray the costs of Renewable Energy Equipment Installation and miscellaneous equipment

Program Overview

Implementing Sector:	State
Category:	Regulatory Policy
State:	Pennsylvania
Incentive Type:	Net Metering
Web Site:	http://www.puc.pa.gov/consumer_info/electricity/alternative_energy.aspx
Administrator:	Pennsylvania Public Utilities Commission (PUC)
Start Date:	02/28/2005
Utilities:	Citizens Electric Co, Duquesne Light Co, Metropolitan Edison Co, Pennsylvania Electric Co, PPL Electric Utilities Corp, Pennsylvania Power Co, PECO Energy Co, Pike County Light & Power Co, UGI Utilities, Inc, Wellsborough Electric Co, West Penn Power Co
Eligible Renewable/Other Technologies:	Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Combined Heat & Power, Fuel Cells using Non-Renewable Fuels, Landfill Gas, Wind (Small), Hydroelectric (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels, Other Distributed Generation Technologies
Applicable Sectors:	Commercial, Industrial, Local Government, Nonprofit, Residential, Schools, State Government, Federal Government, Agricultural, Institutional
Applicable Utilities:	Investor-owned utilities
System Capacity Limit:	50 kW for Residential 3 MW for Non-residential 5 MW for micro-grid and emergency systems
Aggregate Capacity Limit:	No limit specified
Net Excess Generation:	Credited to customer's next bill at full retail rate; reconciled annually at "price-to-compare"
Ownership of Renewable Energy Credits:	Customer owns RECs
Meter Aggregation:	Virtual meter aggregation allowed

1. The net metering program (regulatory policy) by the state of Pennsylvania allows the customer-generators to be compensated for remaining NEG (Net excess generation) at the utility's "price-to-compare" at the end of the year.

Program Overview

Implementing Sector:	Utility
Category:	Financial Incentive
State:	Pennsylvania
Incentive Type:	Rebate Program
Web Site:	http://www.duquesnelight.com/wattchoices/
Administrator:	Duquesne Light Company
Utilities:	Duquesne Light Co
Eligible Efficiency Technologies:	Refrigerators/Freezers, Equipment Insulation, Lighting, Lighting Controls/Sensors, Air conditioners, Motors, Motor VFDs, Custom/Others pending approval, Other EE, Food Service Equipment, Commercial Refrigeration Equipment
Applicable Sectors:	Commercial, Construction, Industrial, Local Government, Schools, State Government, Federal Government, Institutional
Incentive Amount:	Custom: Varies Lighting: Varies by type Controls and Sensors: $15-$20 VFD for Chilled Water Loop $75/hp VFD for HVAC Fans: $75/hp Packaged Terminal AC: $60-$70/ton Food Service Equipment: Varies
Eligible System Size:	See rebate chart for eligible sizes
Equipment Requirements:	See rebate application and rebate catalog for equipment requirement
Installation Requirements:	Must have been installed after June 1, 2013.
Ownership of Renewable Energy Credits:	Not specified

2. The Duquesne Light Company - Commercial and Industrial Energy Efficiency Program (financial incentive) provides rebates on energy-saving equipment to commercial and industrial customers in the eligible service territory. The building uses several sensors in various spaces that are eligible for this rebate.

SunPower® X-Series Commercial Solar Panels | X21-470-COM

Electrical Data	SPR-X21-470-COM	SPR-X21-460-COM	SPR-X20-445-COM
Nominal Power (Pnom)[5]	470 W	460 W	445 W
Power Tolerance	+5/–0%	+5/–0%	+5/–0%
Avg. Panel Efficiency[6]	21.7%	21.3%	20.6%
Rated Voltage (Vmpp)	77.6 V	77.3 V	76.5 V
Rated Current (Impp)	6.06 A	5.95 A	5.82 A
Open-Circuit Voltage (Voc)	91.5 V	90.5 V	90.0 V
Short-Circuit Current (Isc)	6.45 A	6.39 A	6.24 A
Max. System Voltage	1000 V UL & 1000 V IEC		
Maximum Series Fuse	15 A		
Power Temp Coef.	–0.29% / ° C		
Voltage Temp Coef.	–223.2 mV / ° C		
Current Temp Coef.	2.9 mA / ° C		

Tests And Certifications	
Standard Tests[7]	UL1703 (Type 2 Fire Rating), IEC 61215, IEC 61730
Management System Certs	ISO 9001:2015, ISO 14001:2015
EHS Compliance	RoHS, OHSAS 18001:2007, lead free, REACH SVHC-163, PV Cycle
Sustainability	Cradle to Cradle Certified™ Silver (contributes to LEED categories)[8]
Ammonia Test	IEC 62716
Desert Test	10.1109/PVSC.2013.6744437
Salt Spray Test	IEC 61701 (maximum severity)
PID Test	1000V: IEC62804, PVEL 600hr duration
Available Listings	UL, TUV, CEC

Operating Condition And Mechanical Data	
Temperature	–40° F to +185° F (–40° C to +85° C)
Impact Resistance	1 inch (25 mm) diameter hail at 52 mph (23 m/s)
Appearance	Class B
Solar Cells	128 Monocrystalline Maxeon Gen III
Tempered Glass	High-transmission tempered anti-reflective
Junction Box	IP-65, 1230 mm cables / MC4 compatible
Weight	56 lbs (25.4 kg)
Max. Load	Wind: 50 psf, 2400 Pa front & back Snow: 112 psf, 5400 Pa front
Frame	Class 2 silver anodized; stacking pins

REFERENCES:

1 SunPower 360W compared to a Conventional Panel on same sized arrays (260W, 16% efficient, approx. 1.6 m2), 4% more energy per watt (based on 3pty module characterization and PVSim), 0.75%/yr slower degradation (Campeau, Z. et al. "SunPower Module Degradation Rate," SunPower white paper, 2013).

2 "SunPower Module 40-Year Useful Life" SunPower white paper, May 2015. Useful life is 99 out of 100 panels operating at more than 70% of rated power.

3 X-Series same as E-Series, 5 of top 8 panel manufacturers tested in 2013 report, 3 additional panels in 2014. Ferrara, C., et al. "Fraunhofer PV Durability Initiative for Solar Modules: Part 2". Photovoltaics International, 2014.

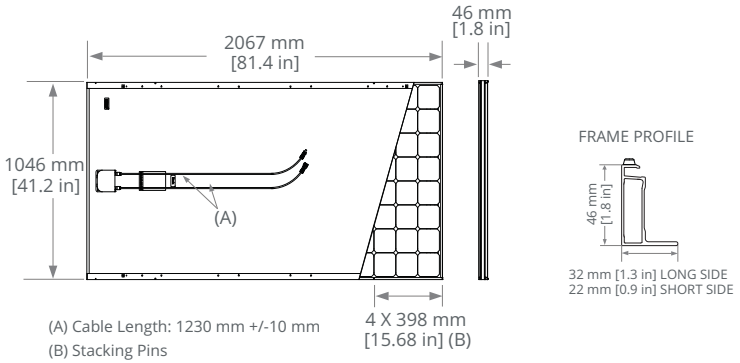
4 See us.sunpower.com/home-solar-system-warranty/ for more details.

5 Standard Test Conditions (1000 W/m² irradiance, AM 1.5, 25° C). NREL calibration Standard: SOMS current, LACCS FF and Voltage.

6 Based on average of measured power values during production.

7 Type 2 fire rating per UL1703:2013, Class C fire rating per UL1703:2002.

8 See salesperson for details.



(A) Cable Length: 1230 mm +/-10 mm
(B) Stacking Pins

FRAME PROFILE

32 mm [1.3 in] LONG SIDE
22 mm [0.9 in] SHORT SIDE

Please read the safety and installation guide.

OG-300 ICC-SRCC™ CERTIFIED SOLAR SYSTEM # 30004247

ICC-SRCC
SOLAR RATING & CERTIFICATION CORPORATION

Supplier:
Heliodyne, Inc.
4910 Seaport Avenue
Richmond, CA 94804 USA
www.heliodyne.com

Reference Standard:
ICC 900/SRCC Standard 300-2015

Brand:	HELIOPAS
Model:	HPAS 1 410 G 80 AC D Z
System Type:	Pumped, Indirect
Certification #:	30004247
Original Certification:	November 03, 2017
Renewal Expiration Date:	October 31, 2020

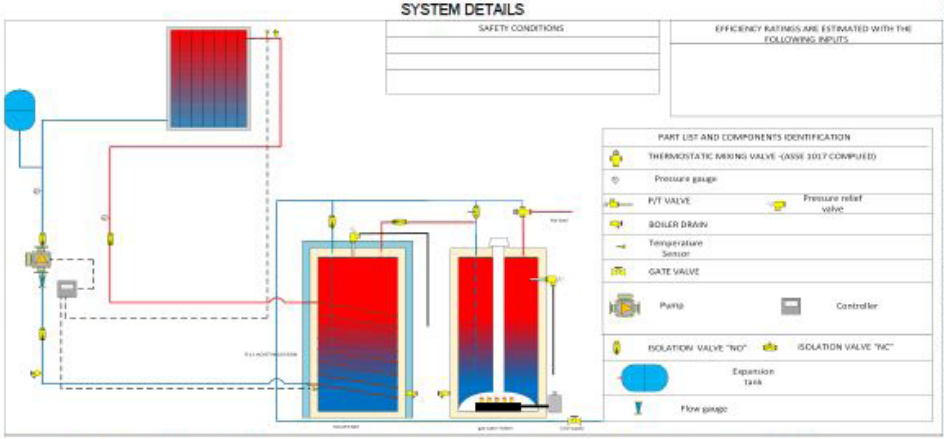
Certifications must be renewed annually.

This solar system has been evaluated by the Solar Rating & Certification Corporation™ (SRCC™), an ISO/IEC 17065 accredited and EPA recognized Certification Body, in accordance with SRCC OG-300, Operating Guidelines for Certifying Solar Water Heating Systems, and has been certified by the SRCC. This award of certification is subject to all terms and conditions of the Program Agreement and the documents incorporated therein by reference. This document must be reproduced in its entirety.

SYSTEM INFORMATION			
System Type:	Pumped	**Backup Source:**	Gas Tank
Collector Type:	Glazed Flat Plate	**Solar Tank Volume:**	303 liter (80 gal)
Collector Heat Transfer Fluid:	GRAS	**External Backup Type:**	None
Collector Freeze Protection:	Fluid	**Backup Tank Volume:**	189 liter (50 gal)
Freeze Tolerance:	-40 °C (-40 °F)	**Heat Exchanger Type:**	None
System Overheat Protection:	Tank high limit	**Controller Type:**	Differential

USA AVERAGE DAY RATINGS		CANADA SINGLE DAY RATING (GJ/year) (See Note 1)
Solar Energy Factor (SEF_D)	Solar Fraction (SF_D)	Estimated Energy Savings
1.2	0.48	6.4

SYSTEM DETAILS



REMARKS: R-11 jacket insulation must be installed on Solar Tank per manufacturer's instructions to achieve these OG-300 ratings.

Shawn Martin
Technical Director

Print Date: December 01, 2019 Page 1 of 7
Please verify certification is active on the SRCC website www.solar-rating.org.

OG-300 ICC-SRCC™ CERTIFIED SOLAR SYSTEM # 30004247

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Certification #:	30004247
Original Certification:	November 03, 2017
Renewal Expiration Date:	October 31, 2020

Certifications must be renewed annually.

The OG-300 system is certified only when installed with the following approved collector options. Where the system specifies more than one collector, the collectors installed in the system must be identical, and cannot be mixed between models. If the system is installed with any collectors other than those listed below, the OG-300 certification is invalid.

APPROVED COLLECTORS

Option	Collector Panel Manufacturer	SRCC OG-100 Certification Number	Collector Panel Model Number	Collector Panel Name	Quantity per System	Total Panel Area(m^2)	Total Panel Area(ft^2)
1	Heliodyne, Inc.	2010115A	410 001	GOBI	1	3.74	40.26

The solar water system listed here has been certified by the SRCC as meeting the minimum standards for testing, installation, operation, maintenance, performance, reliability and safety as specified in SRCC Document OG-300. Thermal performance ratings are based on the successful durability and performance testing of a sample collector, where said tests have been conducted by an independent laboratory approved and listed by the SRCC. The system has been modeled using the computer simulation program TRNSYS to calculate the ratings.

Before the Supplier can make any change in design, materials, specifications, parts, or construction, the change(s) must be reported to the SRCC for evaluation of continued certification.

Note 1: The Canada Single Day Rating provides annual estimated energy savings determined using the standard day specified in the CAN/CSA F379 SERIES-09 (R2013) standard. Systems were modeled and simulated in TRNSYS using a 300 liter/day hot water draw. Results are reported as estimated energy savings in units of gigajoules per year. The results for pre-heat systems are suitable for use in NRCan's HOT2000 energy simulation and design tool for low-rise residential buildings. Note that the baseline energy savings for single-tank electric and gas tank-type water heaters (with no solar input) are -1.11 and -4.83 GJ/year, respectively. Negative values are indicative of the difference between the energy input to the water heater and the energy delivered to the load, or the sum of the parasitic and standby losses. Therefore, a SWH system with a rating of zero is one where the solar energy input to the system offsets all of the standby and parasitic losses. If the solar contribution in a single-tank system is smaller than the parasitic and stand-by losses, the system will have a negative rating.

OG-300 ICC-SRCC™ CERTIFIED SOLAR SYSTEM # 30004247

SOLAR RATING & CERTIFICATION CORPORATION

Supplier:
Heliodyne, Inc.
4910 Seaport Avenue
Richmond, CA 94804 USA
www.heliodyne.com

Reference Standard:
ICC 900/SRCC Standard 300-2015

Brand:	HELIOPAS
Model:	HPAS 1 410 G 80 AC D Z
System Type:	Pumped, Indirect
Certification #:	30004247
Original Certification:	November 03, 2017
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Certifications must be renewed annually.

This solar system has been evaluated by the Solar Rating & Certification Corporation™ (SRCC™), an ISO/IEC 17065 accredited and EPA recognized Certification Body, in accordance with SRCC OG-300, Operating Guidelines for Certifying Solar Water Heating Systems, and has been certified by the SRCC. This award of certification is subject to all terms and conditions of the Program Agreement and the documents incorporated therein by reference. This document must be reproduced in its entirety.

ANNUAL ICC-SRCC PERFORMANCE RATINGS TABLE

Location	Solar Energy Factor (SEF_A)	Solar Fraction (SF_A)	Annual Energy Savings (kWh)
PA - HARRISBURG	1.2	0.49	3260
PA - Philadelphia	1.2	0.50	3290
PA - Pittsburgh	1.1	0.44	3000
PA - Wilkes-Barre	1.1	0.43	2970
PR - San Juan	3.1	0.82	3900
SC - Charleston	1.6	0.64	3720
SC - Columbia	1.5	0.62	3690
SC - GREENVILLE	1.5	0.59	3660
TN - BRISTOL	1.2	0.50	3320
TN - Chattanooga	1.3	0.55	3490
TN - Knoxville	1.3	0.53	3350
TN - Memphis	1.5	0.62	3740
TN - Nashville	1.4	0.56	3560
TX - Amarillo	1.7	0.66	4230
TX - AUSTIN	1.8	0.69	3830
TX - Brownsville	1.8	0.69	3560
TX - Dallas-Fort Worth	1.8	0.68	3920
TX - El Paso	2.9	0.80	4770
TX - Houston	1.5	0.62	3430
TX - Midland	2.2	0.74	4360
TX - San Antonio	1.9	0.70	3860
TX - WACO	1.8	0.68	3850
UT - CEDARCITY	1.7	0.63	4410
UT - Salt Lake City	1.5	0.58	3990
VA - Norfolk	1.3	0.56	3480

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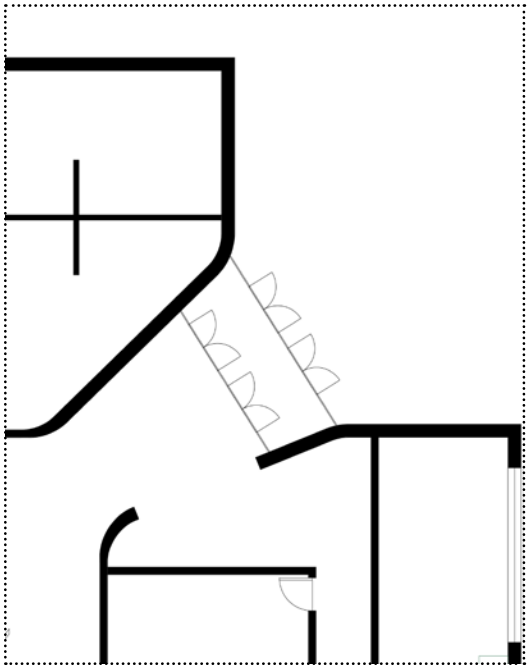
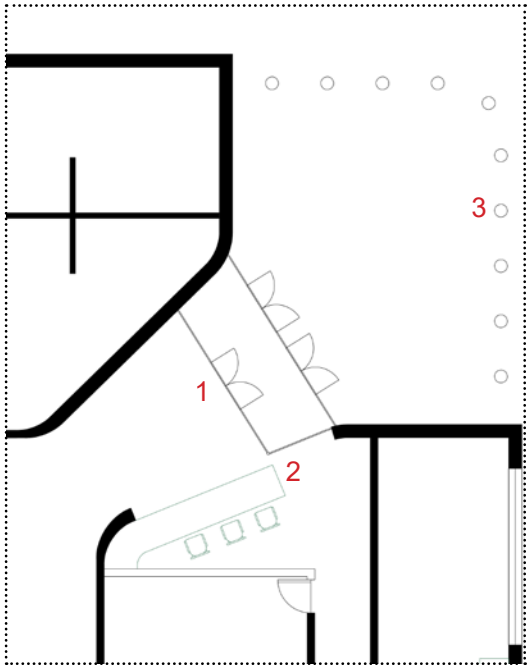
PART 7
SAFETY AND SECURITY

Entrance Design

Original Design



Alternative Design



New features

1. Incoming flow is constrained to one focused point, which also leaves more room for security screening.

2. Spaces around the entrance are more open and transparent, providing clear views of people entering the building from indoors.

3. Bollards are placed outside of the entrance to prevent vehicles from entering the building.

Safety and Security Guidelines for K-12 schools defines 5 layers of protection for a school:

- District-wide
- Property Perimeter
- Parking Lot Perimeter
- Building Perimeter
- Classroom/Interior Perimeter

Architects have some impacts on each of the 5 layers but have biggest impacts on the last two layers. One optional design feature is proposed for each of the two layers in the report. The features are:

- Use one-way film on exterior windows to prevent visual access
- Design a wing wall outside of each classroom to limit visual access to the classroom from the hallway (Inspired by Fruitport High School)

Wing walls in Fruitport High School

BUILDING PERIMETER LAYER

	TIER 1	TIER 2	TIER 3	TIER 4
• POLICIES AND PROCEDURES				
» Categorization of All Exterior Openings	✓	✓	✓	✓
» Entrances Marked With First Responder Numbering System	✓	✓	✓	✓
» Policy Established for Control of Exterior Openings	✓	✓	✓	✓
» Key Control Procedures	✓	✓	✓	✓
» Complete Distributed Antenna System (DAS) Site Survey	✓	✓	✓	✓
• PEOPLE (ROLES AND TRAINING)				
» Staff Trained to Lock/Unlock Doors per Policy	✓	✓	✓	✓
» Visitor Management Policy/Process Training	✓	✓	✓	✓
• ARCHITECTURAL				
» Signage (Directing to Appropriate Areas)	✓	✓	✓	✓
» Apply CPTED Principles Allowing Natural Access Control and Surveillance	✓	✓	✓	✓
» Secured Vestibule	✓	✓	✓	✓
» Emergency Building Access System for Fire/Law Enforcement	✓	✓	✓	✓
» DAS (New Construction/Renovation)	✓	✓	✓	✓
» One-Way Film on Exterior Windows to Prevent Visual Access	✓	✓	✓	✓
» Security Film on Exterior Door Vision Panels and Sidelites	✓	✓	✓	✓
» Ballistic Security Glass for Exterior Door Vision Panels and Sidelites			✓	✓
• COMMUNICATION				
» Public Address System	✓	✓	✓	✓
» Main Entry Door Intercom with Two Way Communications		✓	✓	✓
» Audible and Visual Mass Notification Tied to District-Wide System				✓
» Unify Communication Systems With Video Surveillance and Access Control				✓
• ACCESS CONTROL				
» All Exterior Doors Secured With Lock or Exit Device	✓	✓	✓	✓
» Patented/Restricted Key System	✓	✓	✓	✓
» Key Management System	✓	✓	✓	✓
» Cylinder Dogging With Indicator	✓	✓	✓	✓
» Door Status Monitoring	✓	✓	✓	✓
» Electronic Access Control of Primary Entrances	✓	✓	✓	✓
• VIDEO SURVEILLANCE				
» Video Intercom at Visitor Entrance Points	✓	✓	✓	✓
» Interior, Fixed Camera Coverage for All Entrance Points	✓	✓	✓	✓
» Wide Dynamic Range Cameras (When Conditions Require)	✓	✓	✓	✓
» Exterior, Fixed Camera Coverage at All Entry Points		✓	✓	✓
» Loitering Detection Analytics at Entry Points			✓	✓
•DETECTION AND ALARMS				
» Intrusion Detection System on all Exterior Access Points	✓	✓	✓	✓
» Intrusion Detection System Monitored 24/7	✓	✓	✓	✓
» Partitioned Intrusion Detection			✓	✓
» Automated Threat Detection				✓

CLASSROOM/INTERIOR PERIMETER LAYER

	TIER 1	TIER 2	TIER 3	TIER 4
• POLICIES AND PROCEDURES				
» Classroom Doors Closed and Locked When Occupied	✓	✓	✓	✓
• PEOPLE (ROLES AND TRAINING)				
» Teachers, Staff and Substitutes Trained on Emergency Protocols	✓	✓	✓	✓
• ARCHITECTURAL				
» Security Film on Door Vision Panels and Sidelites	✓	✓	✓	✓
» "Narrow-Lite" Style Classroom Doors with Blinds	✓	✓	✓	✓
» Compartmentalize Building with Cross-Corridor Doors	✓	✓	✓	✓
» Reinforced Walls at Shelter in Place Areas (New Construction)	✓	✓	✓	✓
» Safety/Security Optimization of Classroom Door Installation (New Construction)	✓	✓	✓	✓
• COMMUNICATION				
» Public Address System	✓	✓	✓	✓
» E-911 Added to Phone System (No Codes)	✓	✓	✓	✓
» Two-way Intercom System With Call Buttons		✓	✓	✓
» Duress Button System - Office and Classroom		✓	✓	✓
» In-Building Emergency Communication System			✓	✓
» Distributed Antenna System (DAS)			✓	✓
» Mass Notification Tied to District-Wide System			✓	✓
» Building-Wide Communication via Outside Calls (with record call option)				✓
» Use of Mobile Applications and Social Media				✓
• ACCESS CONTROL				
» Office, Storeroom or Security Classroom Function Locks	✓	✓	✓	✓
» Stand-Alone Electronic Locks With Fob			✓	✓
» Networked Electronic Locks				✓
• VIDEO SURVEILLANCE				
» Fixed Camera Coverage of All Common Areas	✓	✓	✓	✓
» Fixed Camera Coverage of Vestibule and/or Lobby Area	✓	✓	✓	✓
» Fixed Camera Coverage of Stairwells, Hallways and Restroom Entrances		✓	✓	✓
» Fixed Camera Coverage of Restricted Areas		✓	✓	✓
» Audio Analytic Integration			✓	✓
•DETECTION AND ALARMS				
» Intrusion Detection System Covering All Hallways and Public Areas		✓	✓	✓
» Intrusion and Duress (Panic) System Unified		✓	✓	✓
» Intrusion Detection System Covering All Classrooms			✓	✓
» Unified Communication and Detection System Monitored 24/7				✓
» Unified Communication and Detection System Monitored by District-Wide SOC				✓
» Alarms, Communications, Video Surveillance and Access Control Unified				✓
» Automated Threat Detection				✓


NATURE
PROVIDES A
FREE LUNCH
BUT ONLY
IF WE Control
OUR APPetites
SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS