

River Trails Early Learning Center Remodeling

Mt Prospect, Illinois

Pre-Certified:

PHIUS + 2018

PHIUS + SOURCE ZERO

ICECF Net Zero Building Grant



Tom Boeman
boeman
design

Boeman Design LLC

2607 West Leland Avenue | Chicago, IL 60625



FGM ARCHITECTS

Project Team



Owner

FGM ARCHITECTS

Project Architect



MEP/FP Engineer



Construction Manager



Photovoltaic Design

boeman
design

Certified Passive House Consultant



PHIUS Certifier



DISTRICT 26 EARLY
LEARNING CENTER

What's Interesting about this Project

- It's a ***Retrofit***
- It's ***Net Zero***
- It's an ***Educational Building***
- Its performance is being ***Monitored*** as a condition of Grant Funding.
- ***My First CPHC*** Project.

Project Scope

- First Remodeling of 1960s Modern 27,930 SF single story masonry Elementary School.
- Building includes School Offices, Classrooms, District Offices and Multipurpose room.
- Pursuing Net Zero Building Grant through the Illinois Clean Energy Community Foundation (ICECF)
- New Exterior Envelope including Walls, Roof, Doors and Windows.
- New HVAC System.
- New Interior and Exterior lighting systems.
- New roof-mounted PV array to offset source energy.

ICECF Net Zero Building Grant



ACCOUNT LOGIN
CONTINUE APPLICATION
OR SUBMIT REQUIREMENTS

About the Foundation

Energy Program

Natural Areas Program

Grants Awarded

Contact Us



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Net Zero Energy Building Program

The Foundation's **Net Zero Energy Building Program** will award grants to new construction or retrofit projects that achieve site net zero energy performance or better, over the course of a year. Buildings must, at a minimum, offset all of their energy consumption with on-site generation from renewable resources. Grants will be paid incrementally, with full payment contingent on actual building performance.

The program goal is to encourage exemplary buildings that bring together beautiful design and careful construction to maximize energy efficiency, showcase renewable energy and, by educating the public and professionals, help pave the way for a larger shift in the building sector. The Foundation aims to fund projects that demonstrate that net zero energy buildings are realistic and achievable. These flagship projects will add to the knowledge base on net zero building design and operation.



Exterior construction of Bott Park Indoor Recreation Center in Plainfield, IL. Photo: Wight & Company.

Grant requires dramatic reductions in energy consumption **prior** to offsetting with renewables. Reductions substantiated by: PHIUS + 2018 or Petal (Energy) Living Building Certification

Grant requires all Renewable Energy to be generated on site.

Grant requires Monitoring of energy use and renewable production for 12 consecutive months to verify modeling

ICECF expects an EUI in the “high teens” to “low twenties”

Existing Building



Existing Building



Existing Building

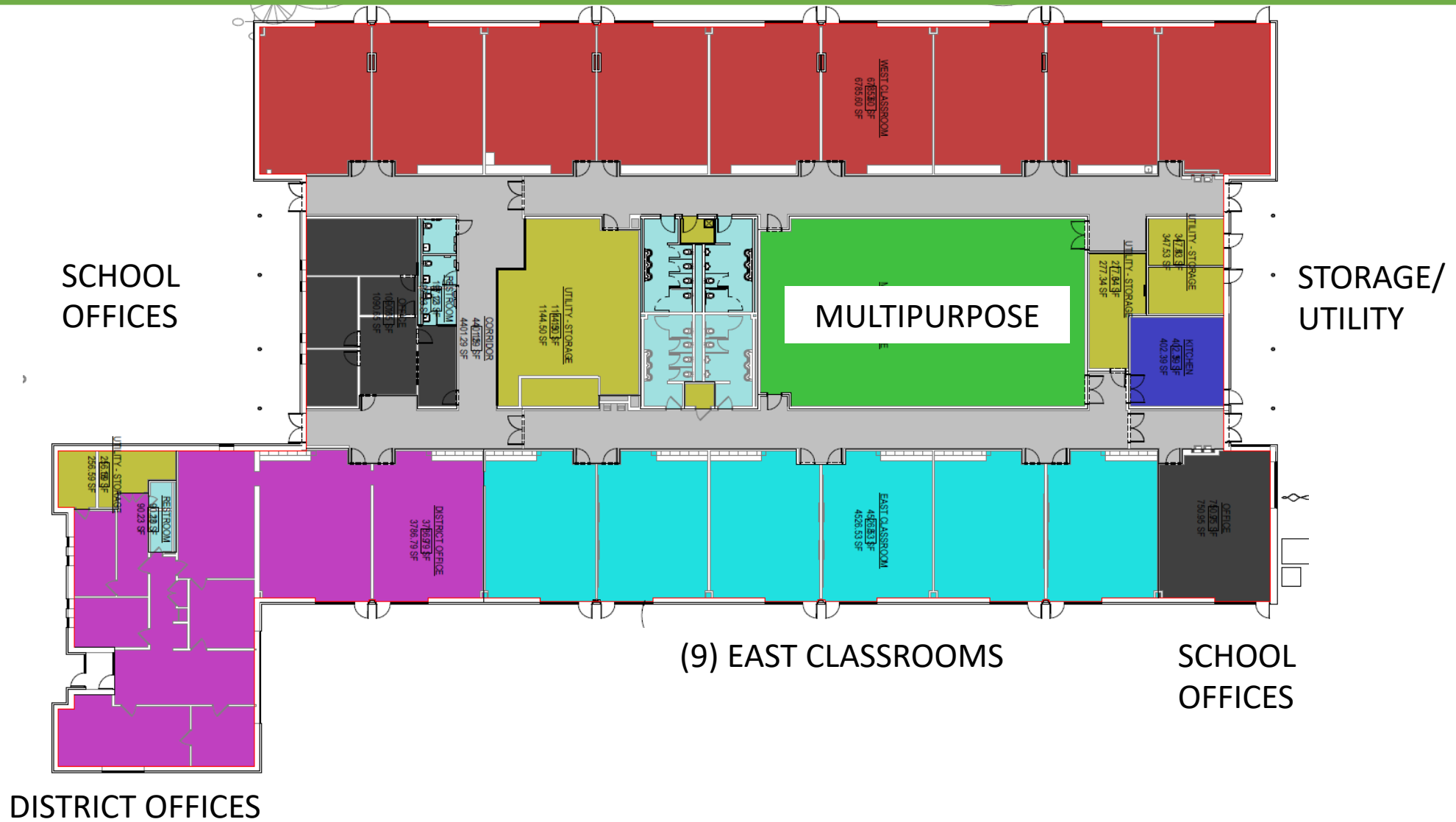


Existing Building



Existing Building

(9) WEST CLASSROOMS



Physical Opportunities

- All new exterior envelope including wall finishes, glazing system and roofing.
- All new mechanical systems.
- All new Lighting Systems
- No Historic features or finishes were being preserved.

Physical Challenges

- “Pancake” building with relatively high surface area to iCFA. Less than optimal form.
- No opportunities to adjust window orientation or massing.
- Existing un-insulated slab on grade.

Process Opportunities

- The Owner had a strong commitment to achieving Net Zero
- The Architect, FGM, had a strong technical grasp of the issues. Adopted a straightforward “Textbook” approach
- The MEP Engineer, IMEG, had Net Zero building Experience
- The Builder Nicolas and Associates had 2 team members take the PHIUS Builder training in preparation for the project.

Process Challenges

- The CPHC was brought in at 100% Design Development
- The building was already designed as “Net Zero”

..... But with IECC levels of insulation

PHIUS + Criteria Calculator: Inputs

PHIUS+ 2018 Final Calculator v2

PHIUS+ 2018 Space Conditioning Criteria Calculator v2

METHOD: CALCULATOR ▾

UNITS: IMPERIAL (IP) ▾

STATE / PROVINCE: ILLINOIS ▾

CITY: CHICAGO OHARE INTL AP ▾

Envelope Area (ft²) / iCFA (ft²) **2.58** or enter here:

iCFA (ft²) / person **527** or enter here:

*Calculator method is used for official certification targets.

Space Conditioning Criteria

Annual Heating Demand	8.3	kBTU/ft ² yr
Annual Cooling Demand	7.8	kBTU/ft ² yr
Peak Heating Load	6.3	BTU/ft ² hr
Peak Cooling Load	4.0	BTU/ft ² hr

Typed entry will override sliding scale.

The results of the CALCULATOR method take precedence over the ESTIMATOR method.

Update

Reset

Inputs

Local Climate Data Chicago Illinois

- Envelope to floor area: **2.58**
- iCFA **27,930 Sf**
- Max Occupancy **297**
(used for peak load)
- Average Occupancy **53**
(used for annual demand)

PHIUS + Criteria Calculator: Targets

PHIUS+ 2018 Final Calculator v2

PHIUS+ 2018 Space Conditioning Criteria Calculator v2

METHOD: CALCULATOR ▾
UNITS: IMPERIAL (IP) ▾

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Typed entry will override sliding scale.
The results of the CALCULATOR method take precedence over the ESTIMATOR method.

Targets:

Project Specific Targets for:

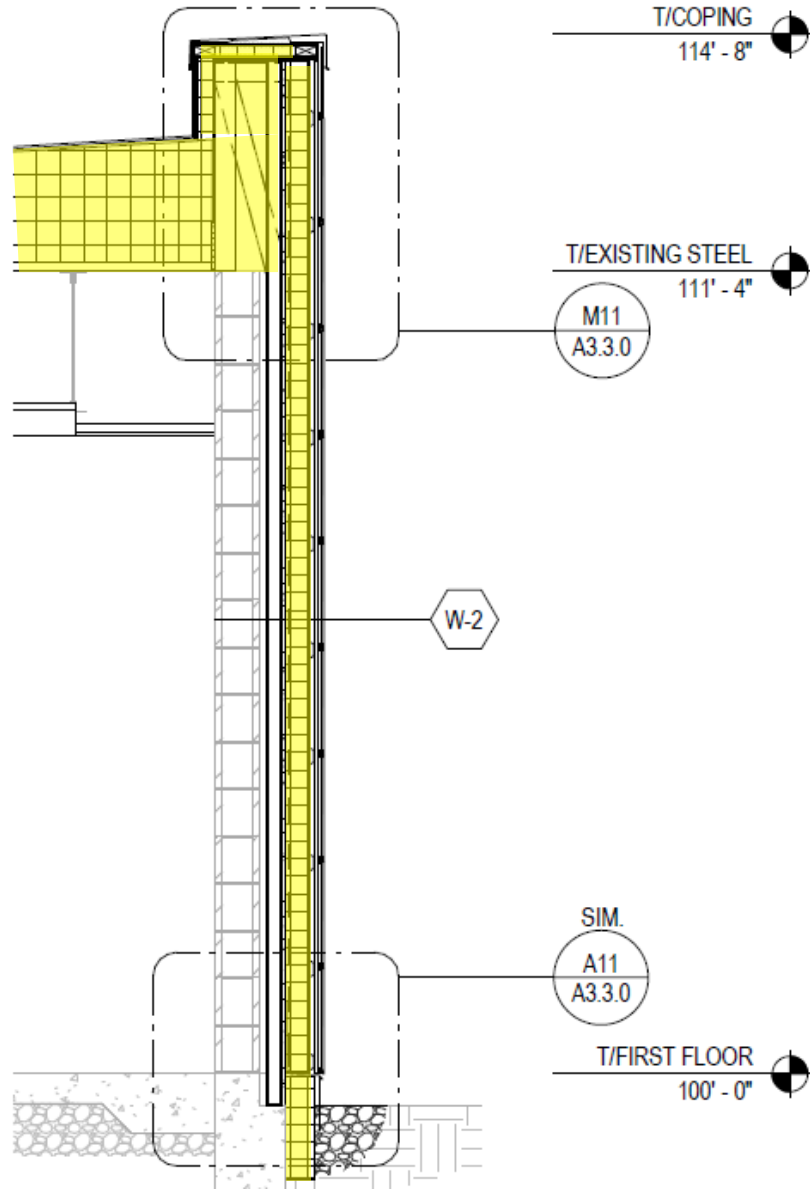
- Annual Heating Demand: **8.3 kBTU/ft²yr**
- Annual Cooling Demand: **7.8 kBTU/ft²yr**
- Peak Heating Load: **6.3 BTU/ft²hr**
- Peak Cooling Load: **4.0 BTU/ft²hr**

Universal Targets for:

- Source Energy: **34.8 kBTU/ ft² yr** (110 kWh/ m² yr)
- Air Tightness: q₅₀ ≤ **0.060 CFM₅₀/ft²** (Envelope)



Thermal Envelope - Wall Section



R-80 Roof (Effective)

Tapered Polyisocyanurate (10" Min – 20" Max)

R-24 Walls (Total R-27)

4" Polyisocyanurate
(Maximum accepted by Cladding Manufacturer)

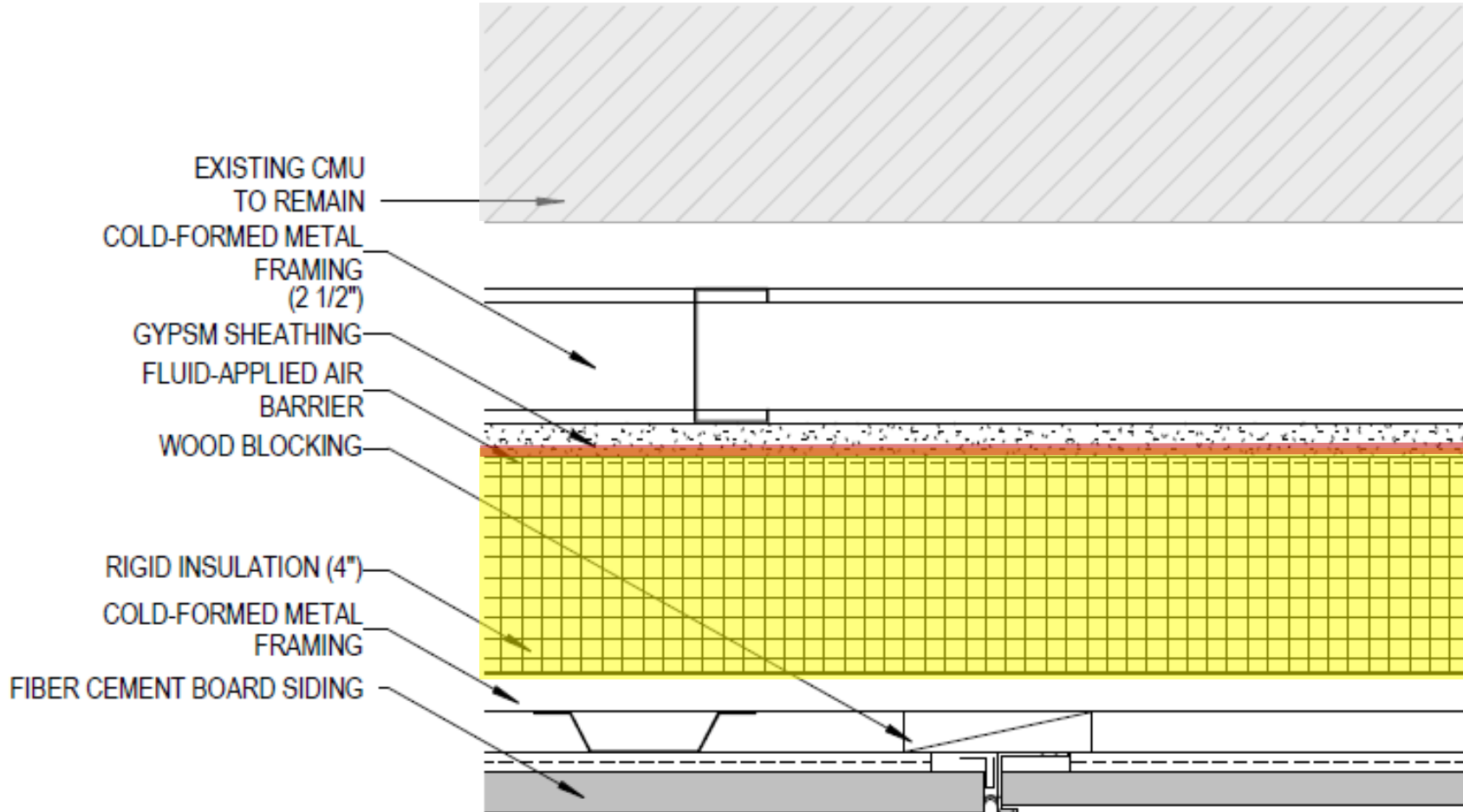
R-30 Slab Edge/Foundation Wall

6" Polyisocyanurate
2'-0" deep



Thermal Envelope – Wall Detail

INTERIOR



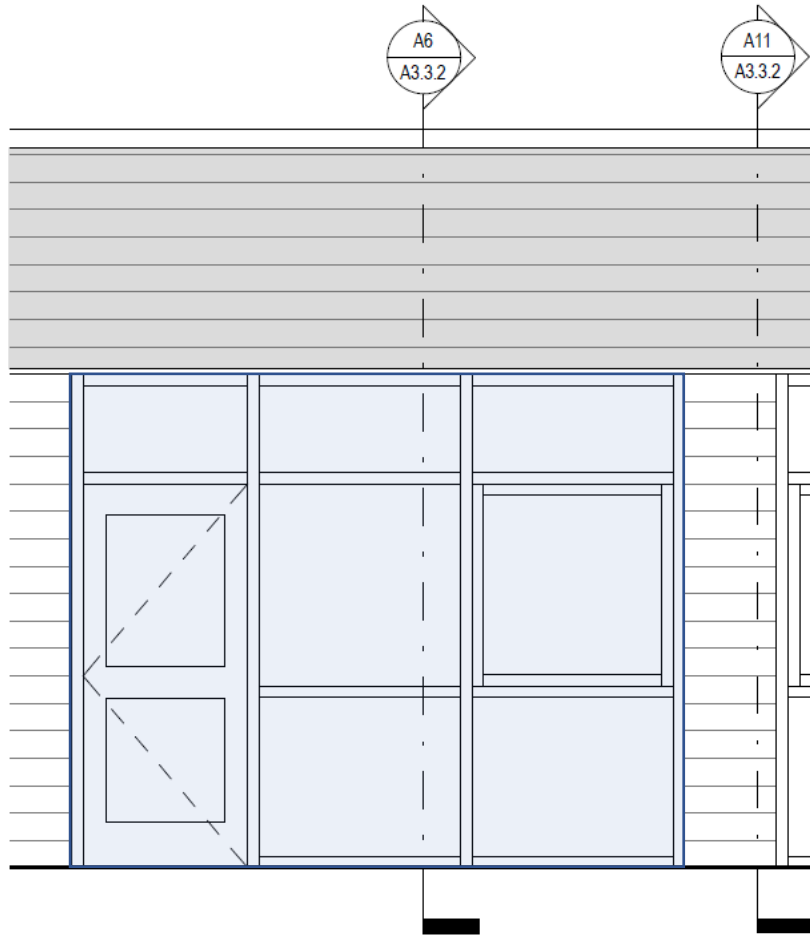
EXTERIOR



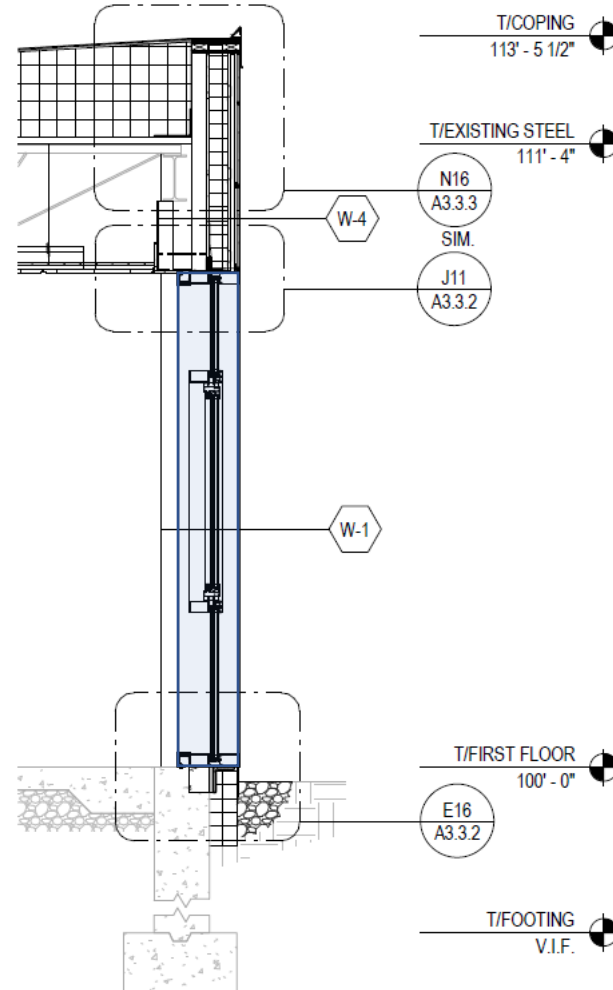
KNIGHT CI RAIN SCREEN SYSTEM



Thermal Envelope - Windows



Typical Classroom Glazing



Glass:

U_{cog} 0.111

Triple Glazed Double Coated

Frame:

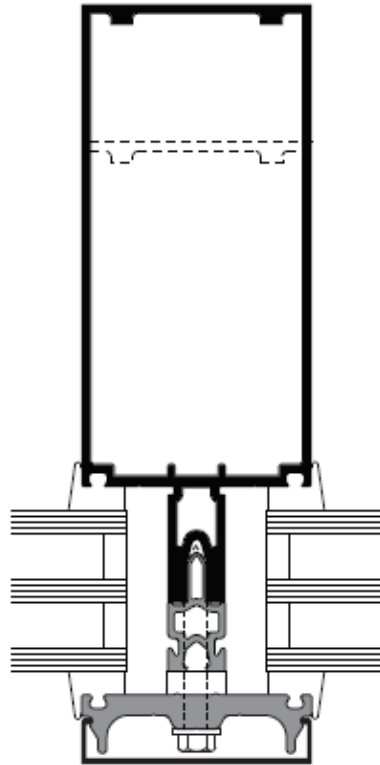
$U_{frame} \sim 0.88$

**Eliminate Spandrel Glass
above Ceiling**

**Reduce to One Operable
Window**



Thermal Envelope - Windows



Kawneer 1600UT
Triple glazed and Fiberglass
Pressure Plates

Calculation based on ISO 15099

Product name: 1600UT System™ Curtain Wall- Fiberglass PP		Center-of-glass properties				
ASHRAE/IECC/ DOE North American Climate Zone	South-facing North, East, West -facing	 Passive House Institute US		Vitro SB60 / Argon / Clear / Argon / SB60 (6mm/6mm/6mm) 45mm IG No Grids		
Climate specific recommendations:		Whole-window installed U-value		Ucog-Value		
		W/m2K	BTU/hr.ft2.F	SHGC	W/m2K	BTU/hr.ft2.F
8		1.10	0.19	0.329	0.684	0.121
7		1.07	0.19	0.329	0.656	0.116
6		1.05	0.18	0.329	0.635	0.112
5		1.05	0.18	0.329	0.632	0.111
4		1.04	0.18	0.329	0.628	0.111
Marine North		1.04	0.18	0.329	0.627	0.110
Marine South	✓	1.04	0.18	0.329	0.627	0.111
3	✓	1.04	0.18	0.329	0.627	0.110
2 West		1.05	0.18	0.329	0.632	0.111
2 East		1.05	0.18	0.329	0.632	0.111

1600UT System™ Curtain Wall- Kommerling TPS Spacer Horizontal two lite left	FRAME				Psi-spacer	
	Frame height		U-frame		Ψ	
	mm	in	W/m2K	BTU/hr.ft2.F	W/mK	BTU/hr.ft.F
left head	35	1.38	4.81	0.85	-0.001	-0.001
left sill	35	1.38	4.82	0.85	-0.001	-0.001
left jamb	35	1.38	5.17	0.91	-0.001	-0.001
right MR	35	1.38	5.17	0.91	-0.001	-0.001

1600UT System™ Curtain Wall- Fi Kommerling TPS Spacer Horizontal two lite right	FRAME				Psi-spacer		Psi-opaque
	Frame height		U-frame		Ψ		
	mm	in	W/m2K	BTU/hr.ft2.F	W/mK	BTU/hr.ft.F	
right head	35	1.38	4.81	0.85	-0.001	-0.001	0.180
right sill	35	1.38	4.82	0.85	-0.001	-0.001	BTU/hr.ft.F
right jamb	35	1.38	5.17	0.91	-0.001	-0.001	0.104
left MR	35	1.38	5.17	0.91	-0.001	-0.001	Grade C

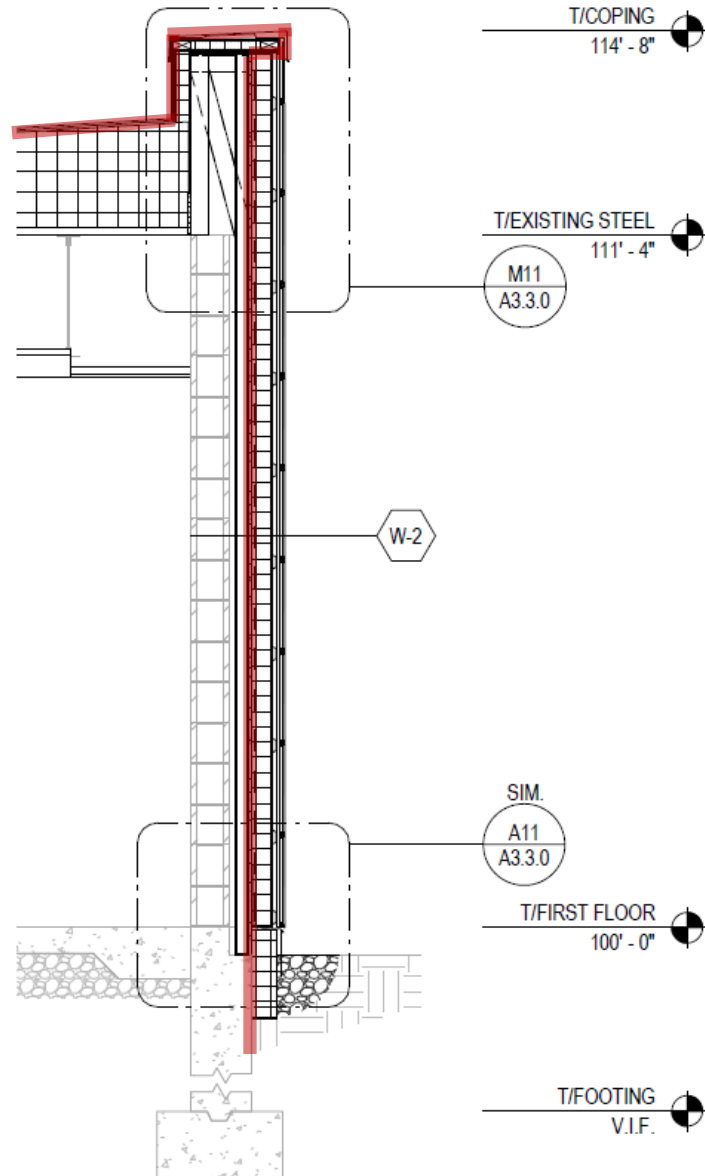
For horizontal slider the right MR is the right jamb for the left segment and the left MR is the left jamb for the right segment

Valid through June 2021

PHIUS Verified Window Data.



Continuous Air Barrier



Air Barrier Components:

Roof Membrane

Fluid Applied Air Barrier

Wall Sheathing and Foundation Face Below.

Stainless Steel Transition Flashing.

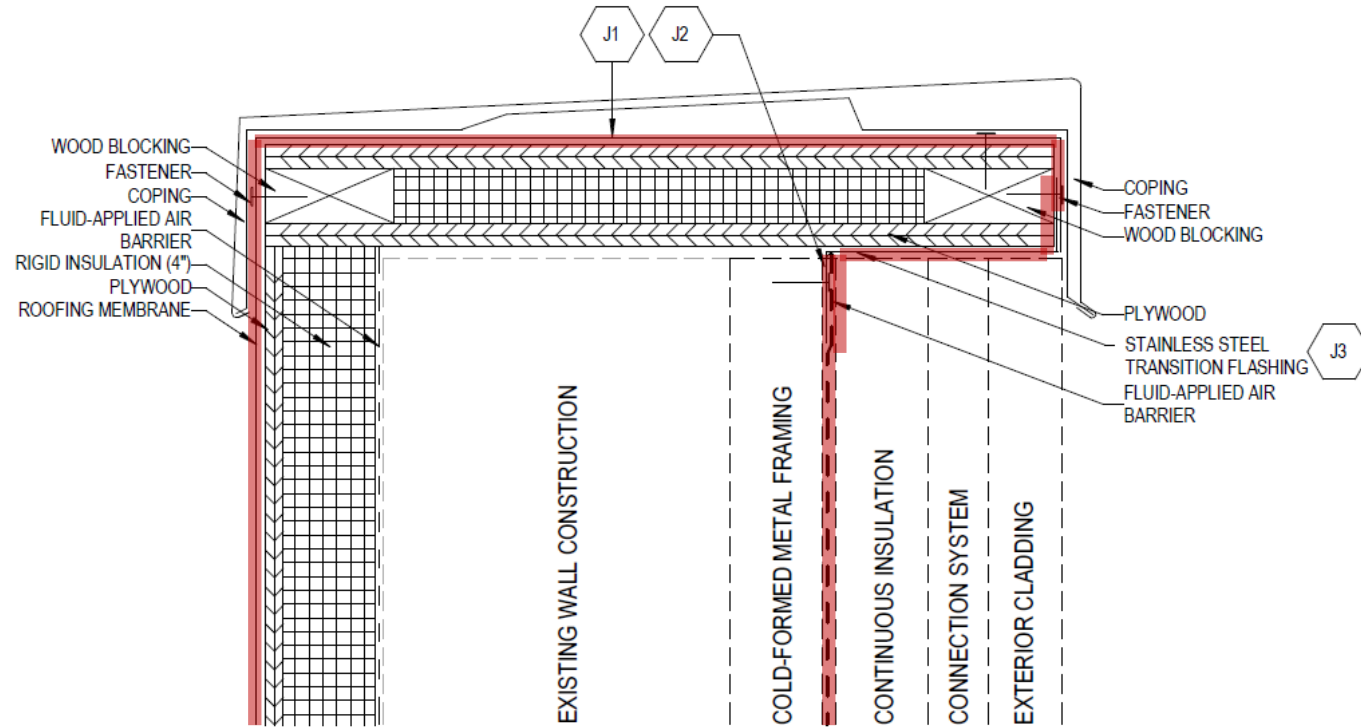
Between Fluid Applied Air Barrier and Roof Membrane.

Silicone Window Flashing

Clamped into Glazing Channel



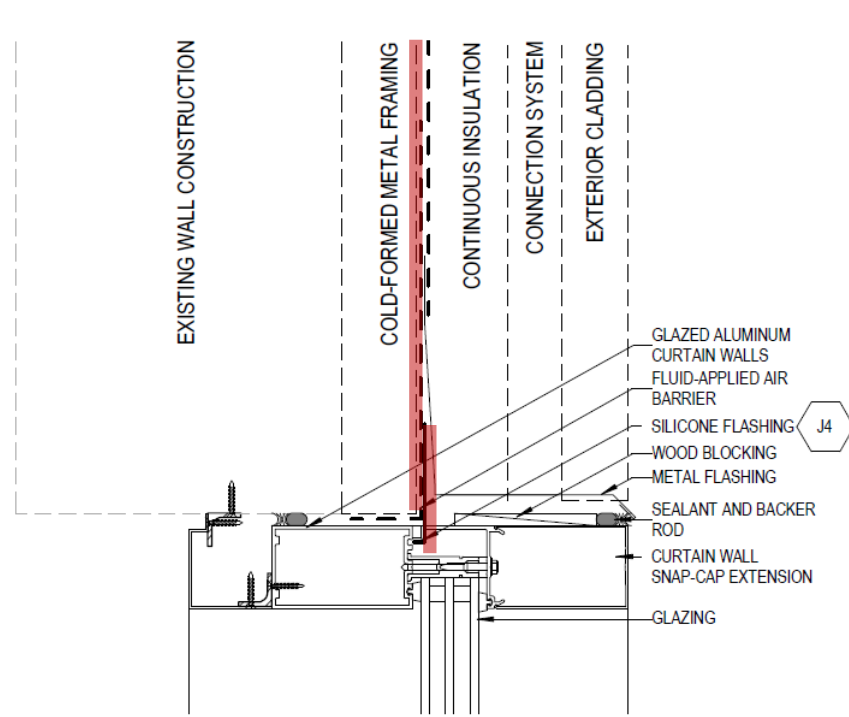
Continuous Air Barrier



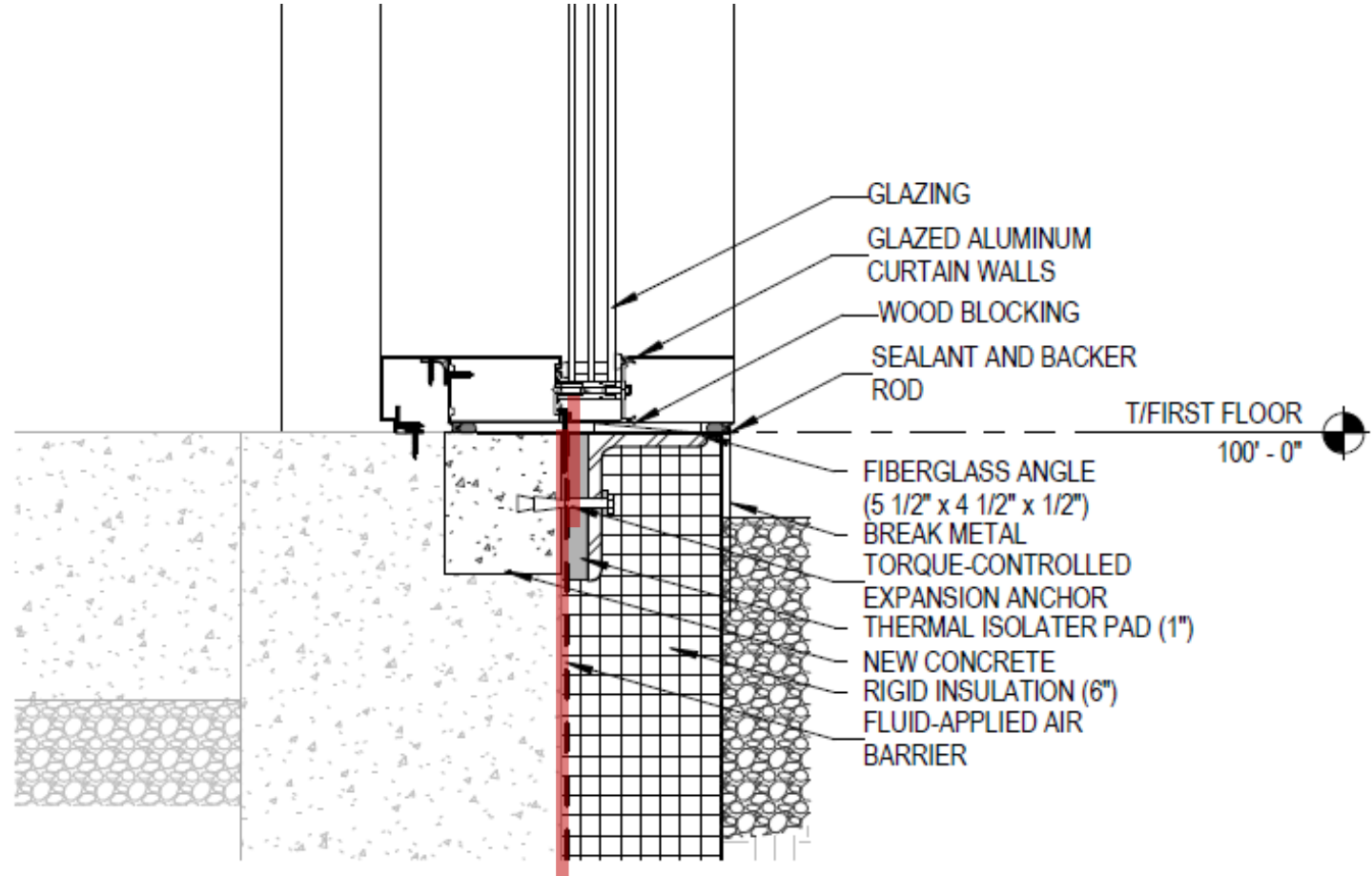
TYPICAL PARAPET



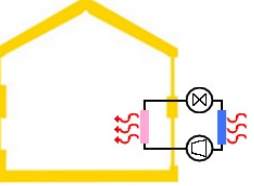
Continuous Air Barrier



TYPICAL WINDOW JAMB



TYPICAL WINDOW SILL



DOAS COUPLED WITH VRF SYSTEM





DEDICATED OUTSIDE AIR SYSTEM (DOAS)

DOAS Components:

ECM Motor Fan

Electronically Commutated Motor

Energy Recovery Wheel

All building exhaust is recovered

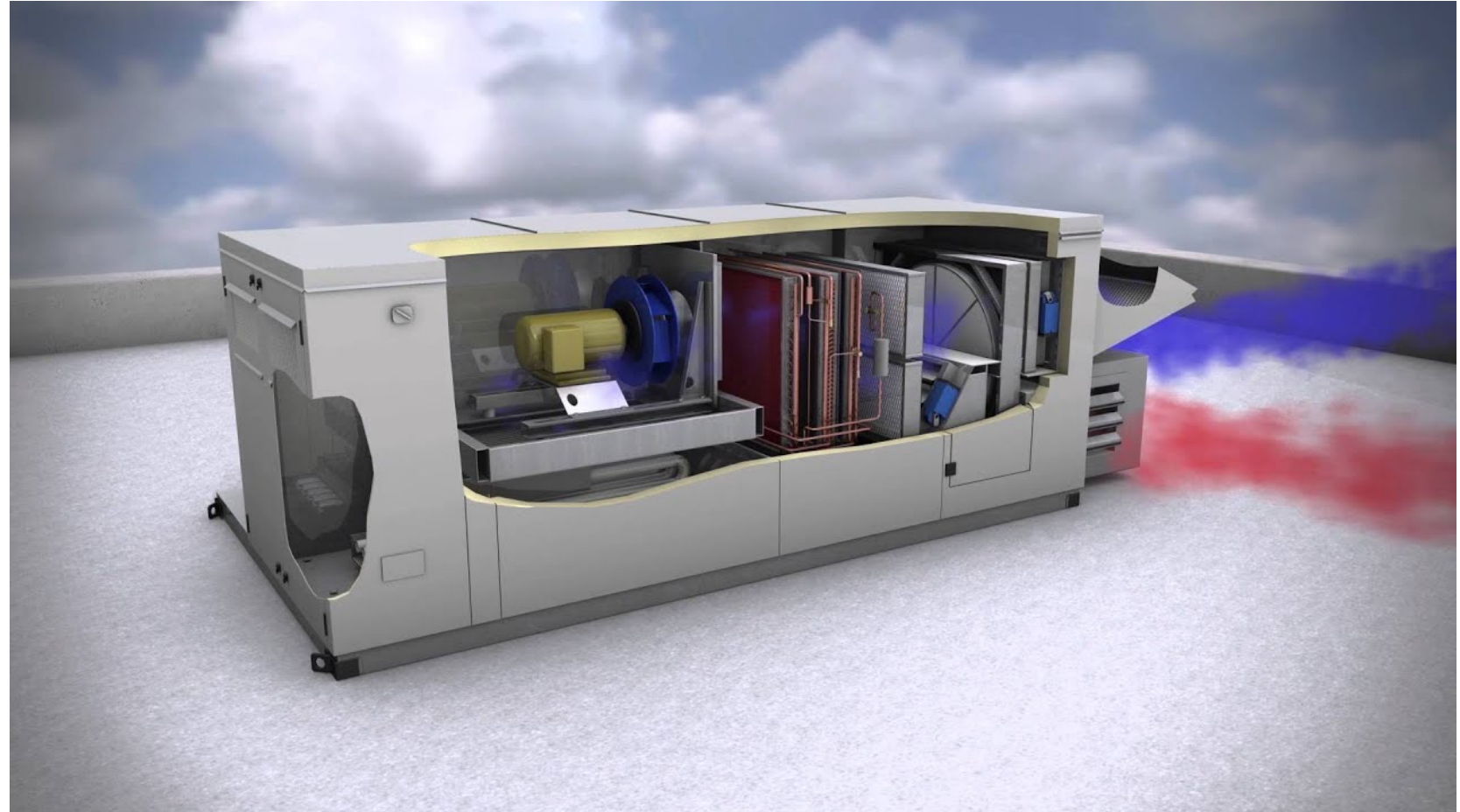
Digital Scroll Compressors

Match Compressor output to load

Heat Pump Heating

Coefficient of Performance of 2.3

Operates in heating down to 0°F





DEDICATED OUTSIDE AIR SYSTEM (DOAS)

DOAS Operating Modes:

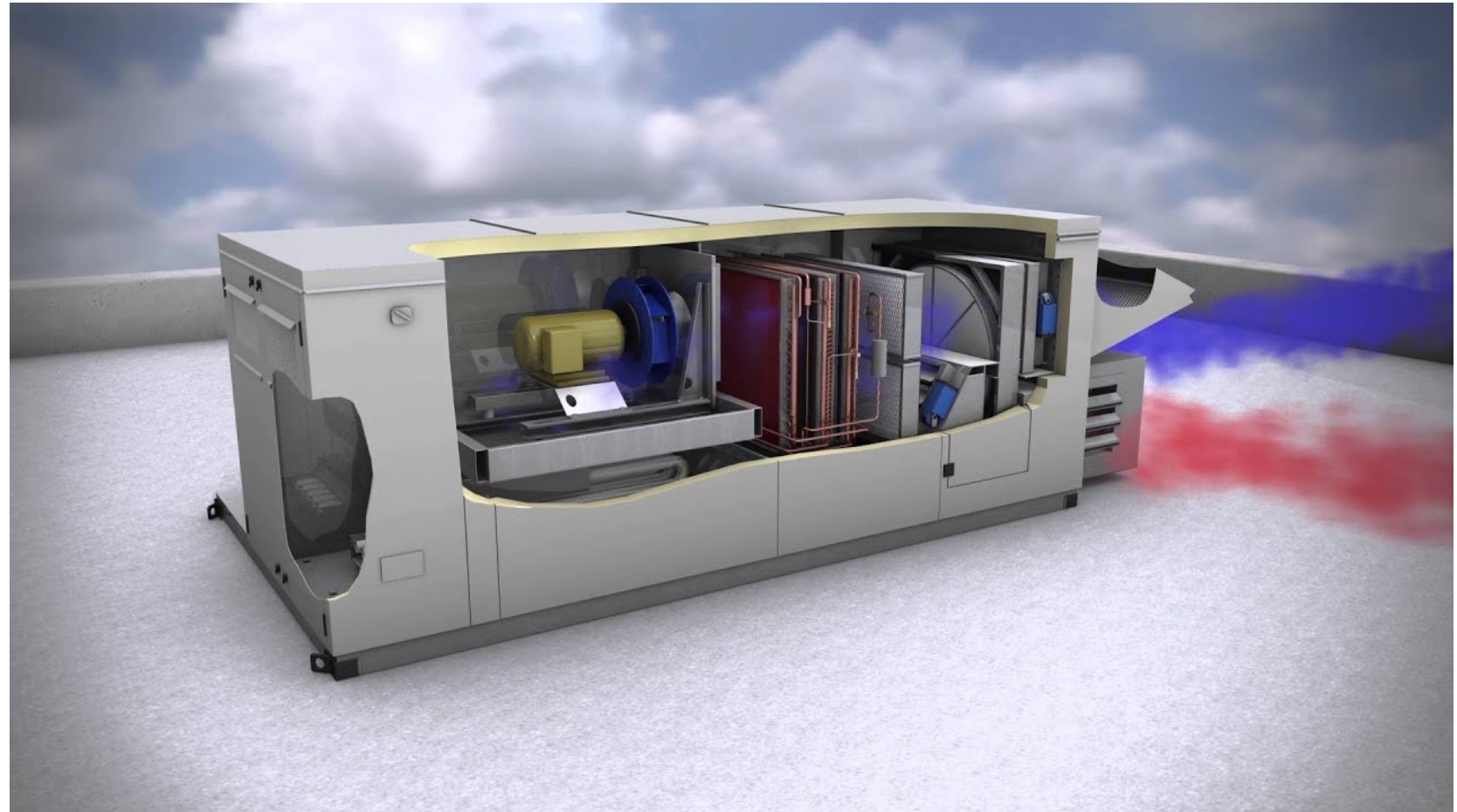
Economizer Mode

Manages Moisture content of air
Optimizes Dew point of outside air
for Supply air

Free Cooling Mode

Provides additional cooling through
ventilation when Outside air
conditions are cooler than inside.

Dehumidification





DEDICATED OUTSIDE AIR SYSTEM (DOAS)





Certificate of Product Ratings

AHRI Certified Reference Number : 518128 Date : 11-20-2019 Model Status : Active

Old AHRI Reference Number :
 Brand Name : Airchange
 Product Type : Wheel
 Model Number : ERC-3014C
 Selection Software Name :
 Selection Software Version :

Rated as follows in accordance with the latest edition of ANSI/AHRI 1060 (I-P) Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment and subject to rating accuracy by AHRI-sponsored, independent, third party testing:

Nominal Air Flow (sofm) : 1400
 Pressure Drop (at nominal airflow, in. H₂O) : 1.00

Leakage Ratings	PressureDiff	EATR(%)	OACF	PurgeAngle
Test 1 :	0	2.4	1.04	N/A
Test 2 :	0.5	0.8	1.08	2
Test 3 :	1	0.0	1.10	1

	Sensible(%)	Latent(%)	Total(%)
100% Air Flow Heating :	76	70	74
75 % Air Flow Heating :	80	75	78
100% Air Flow Cooling :	76	70	72
75% Air Flow Cooling :	80	75	77

	Net Sensible(%)	Net Latent(%)	Net Total(%)
100% Air Flow Heating :	76	70	74
75 % Air Flow Heating :	80	75	78
100% Air Flow Cooling :	74	69	72
75% Air Flow Cooling :	80	74	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.

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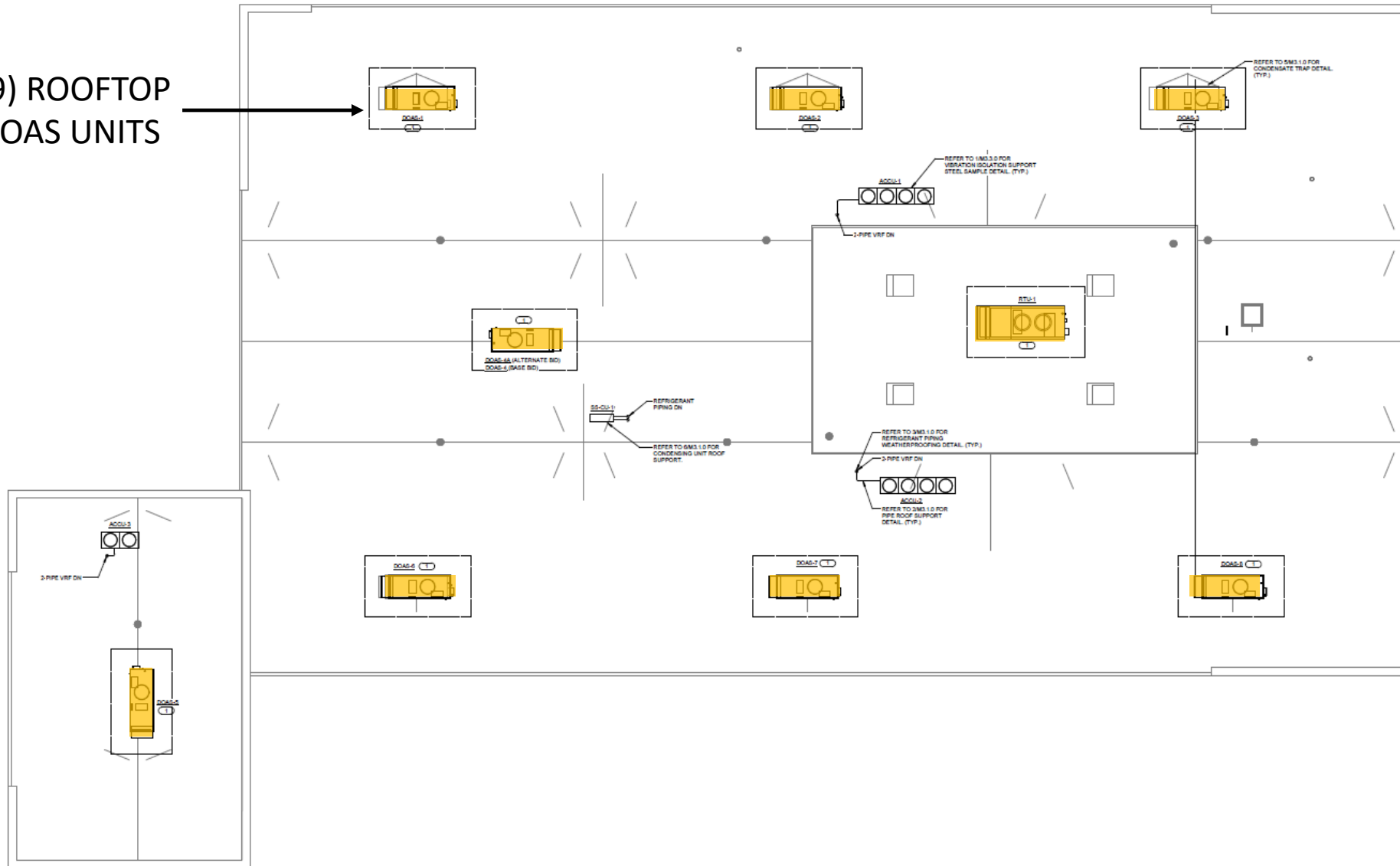
CERTIFICATE NO.: 132187591191029440

AHRI ERV performance extrapolation - straight line method												
WUFI Inputs												
Sensible Recovery Efficiency		Total Design Airflow										
0.81		10,435										
Humidity Recovery Efficiency												
0.75												
Model	Units	CFM	Net Sensible (%)		Net Latent (%)		Weighted Sensible Recovery	Weighted Humidity Recovery	Net Sensible Slope		Net Latent Slope	
			Heating	Cooling	Heating	Cooling			Heating	Cooling	Heating	Cooling
DOAS-1	100% AHRI Rated Airflow	1,400	76	74	70	69	0.0759	0.0714	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	980	80.8	81.2	76.0	75.0						
DOAS-2	100% AHRI Rated Airflow	1,400	76	74	70	69	0.1114	0.1017	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	1,570	74.1	71.1	67.6	66.6						
DOAS-3	100% AHRI Rated Airflow	1,400	76	74	70	69	0.0725	0.0684	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	930	81.4	82.1	76.7	75.7						
DOAS-4	100% AHRI Rated Airflow	1,400	76	74	70	69	0.0765	0.0720	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	990	80.7	81.0	75.9	74.9						
DOAS-5	100% AHRI Rated Airflow	1,400	76	74	70	69	0.0712	0.0671	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	910	81.6	82.4	77.0	76.0						
DOAS-6	100% AHRI Rated Airflow	1,400	76	74	70	69	0.0563	0.0537	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	700	84.0	86.0	80.0	79.0						
DOAS-7	100% AHRI Rated Airflow	1,400	76	74	70	69	0.1112	0.1014	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	1,565	74.1	71.2	67.6	66.6						
DOAS-8	100% AHRI Rated Airflow	1,400	76	74	70	69	0.0739	0.0696	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	950	81.1	81.7	76.4	75.4						
RTU-1	100% AHRI Rated Airflow	3,200	65	64	61	60	0.1626	0.1418	0.0200	0.0143	0.0143	0.0143
	75% AHRI Rated Airflow	2,400	72	69	66	65						
	Design airflow	1,840	92.2	83.4	80.4	79.4						
	100% AHRI Rated Airflow						0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0						
	100% AHRI Rated Airflow						0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0						
	100% AHRI Rated Airflow						0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0						
	100% AHRI Rated Airflow						0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0						



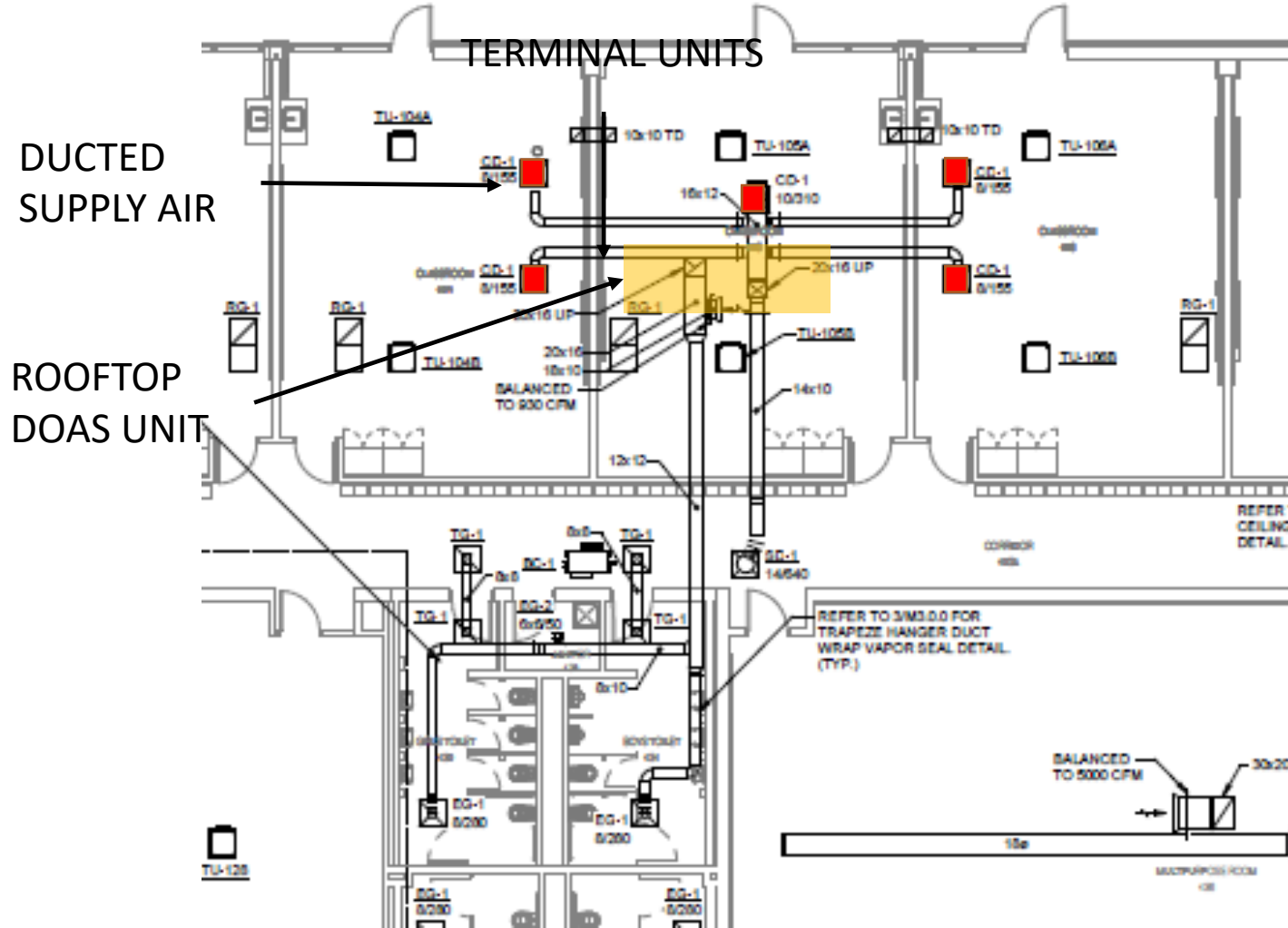
DEDICATED OUTSIDE AIR SYSTEM (DOAS)

(9) ROOFTOP DOAS UNITS





DEDICATED OUTSIDE AIR SYSTEM (DOAS)

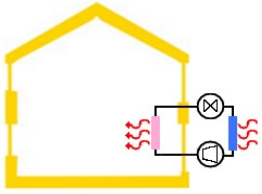


Ventilation Air Distribution:

Ducted Supply to Classrooms, Corridors and other occupied spaces.

Plenum Return from Occupied Spaces

Ducted Return from Restrooms



Variable Refrigerant Flow System (VRF)

VRF System Components:

Air Source Heat Pump

High Efficiency COP: 3.66

Branch Controllers

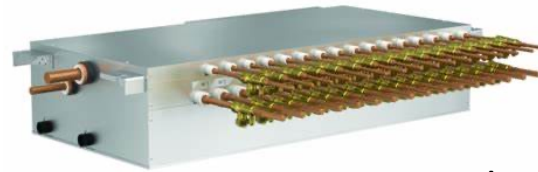
Energy Recovery allows different rooms on the same branch controller to be simultaneously heating and cooling.

Terminal Units

Located in each conditioned space.



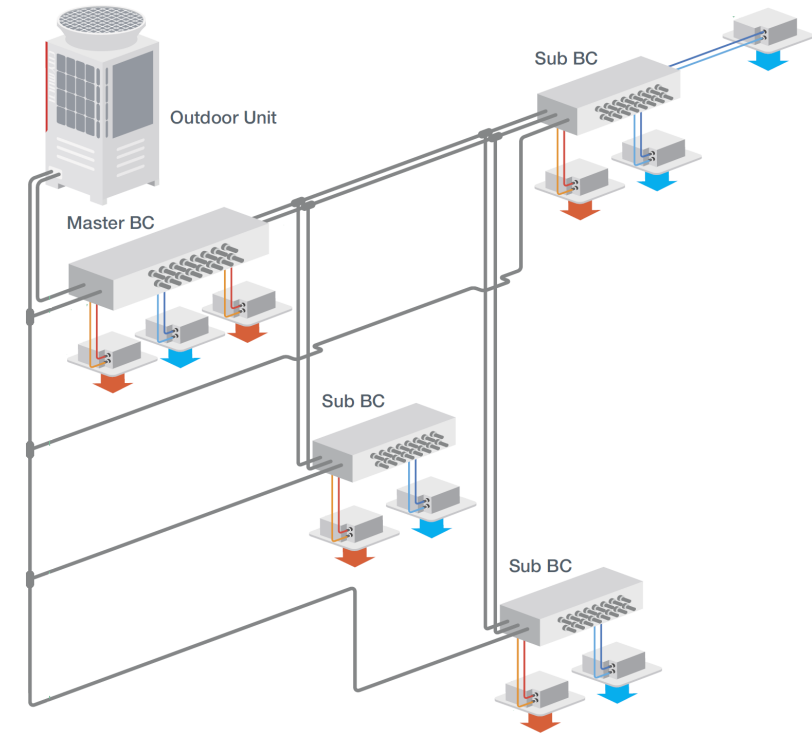
Air Source
Condensing Unit

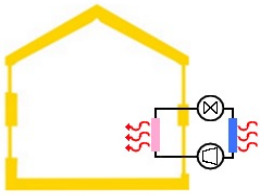


Branch Controller



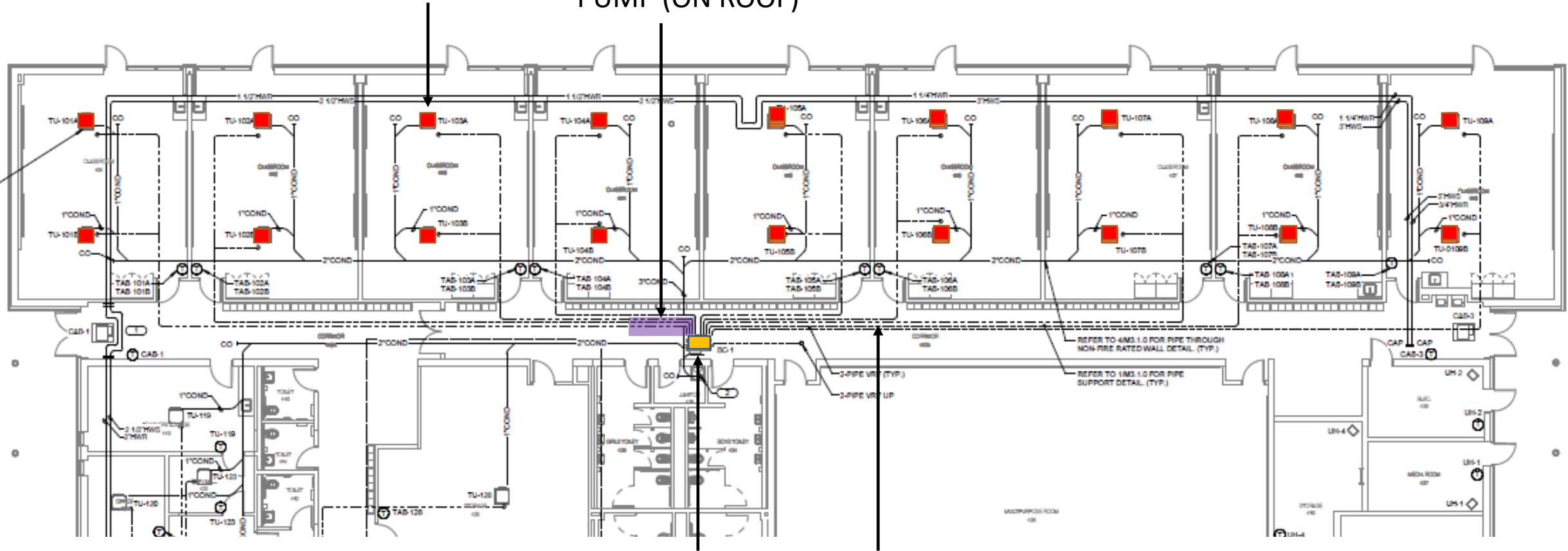
Terminal Unit - Cassette





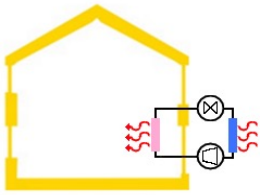
Variable Refrigerant Flow System (VRF)

TERMINAL UNITS AIR SOURCED HEAT PUMP (ON ROOF)



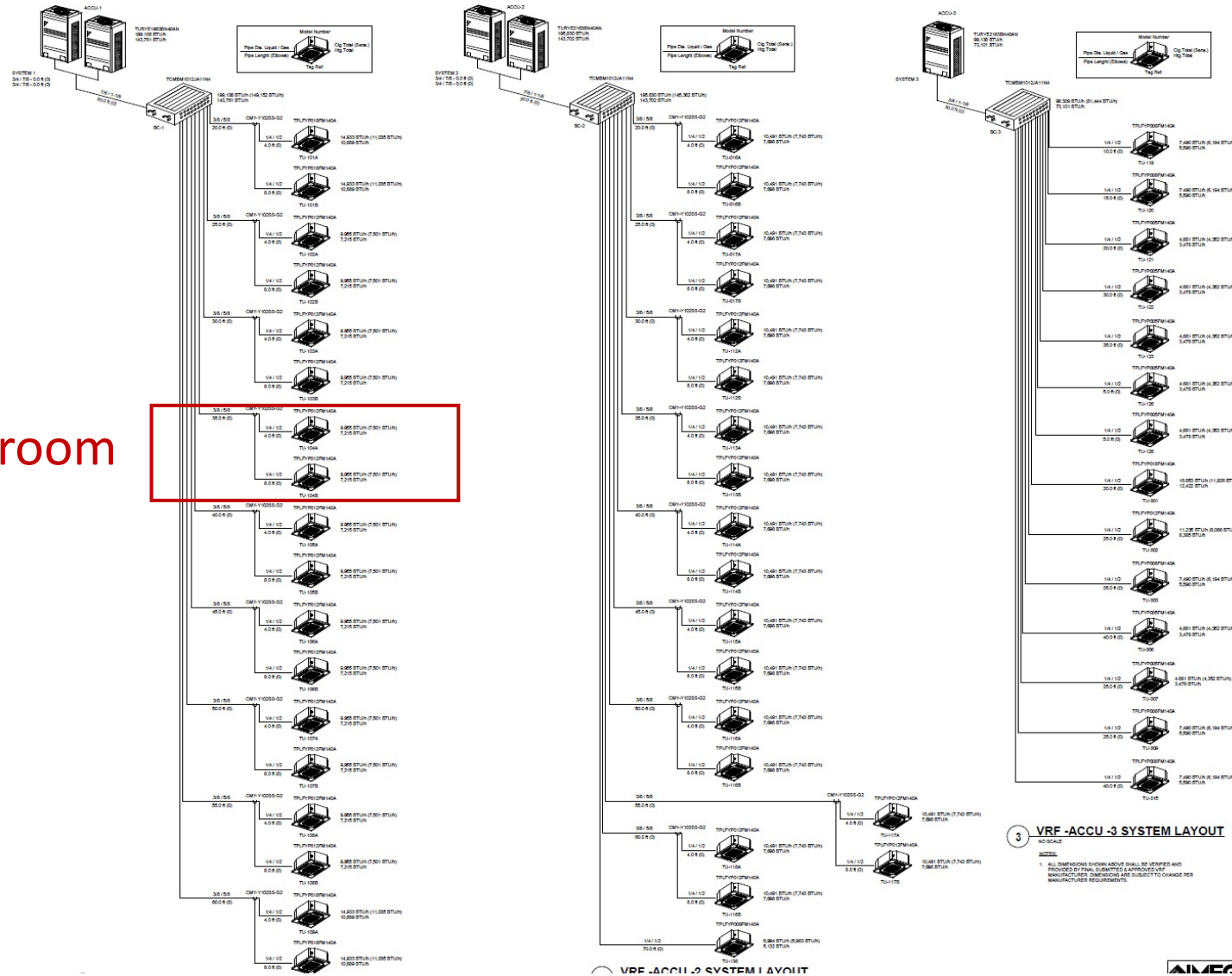
BRANCH CONTROLLER

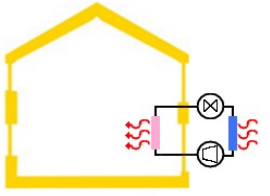
REFRIGERANT LINES



Variable Refrigerant Flow System (VRF)

Typical Classroom

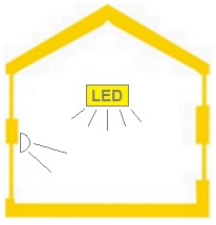




Variable Refrigerant Flow System (VRF)

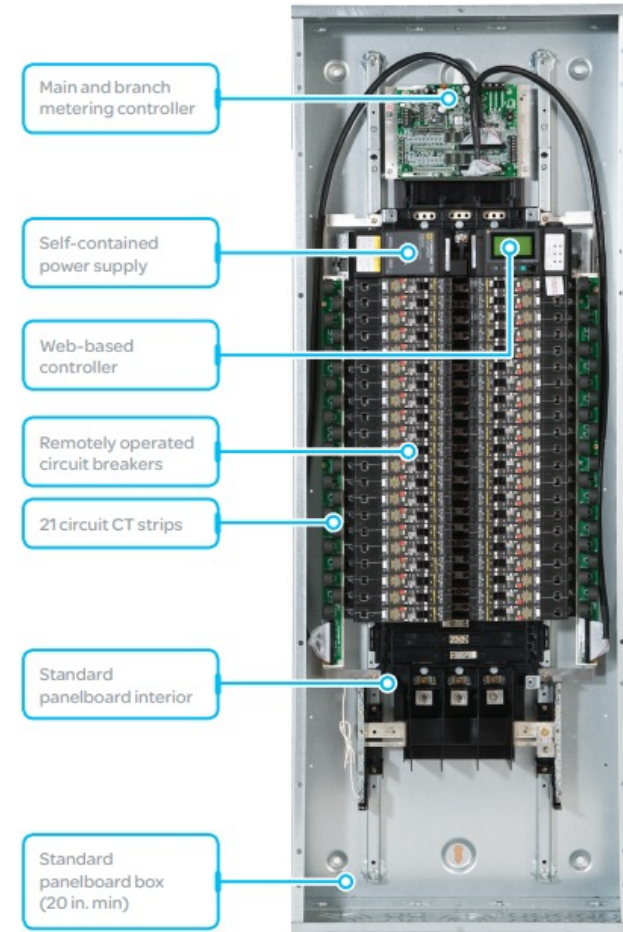
Make sure you know what things look like. Team was surprised by the shrouds over the VRF Units.



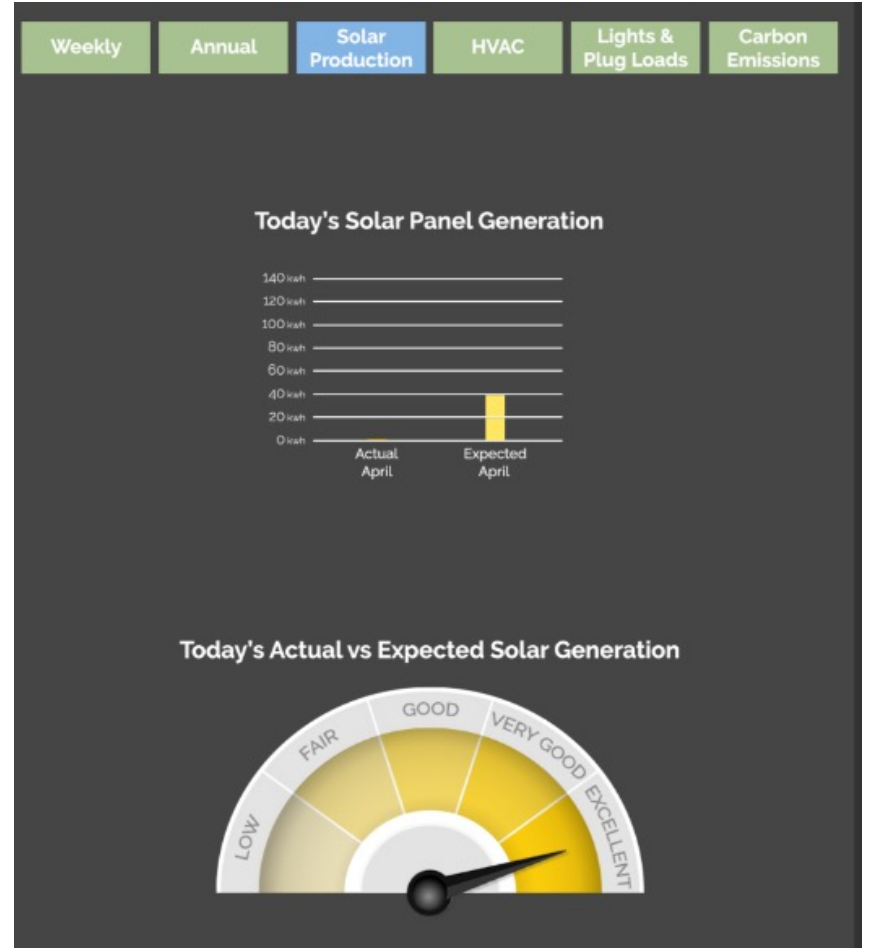
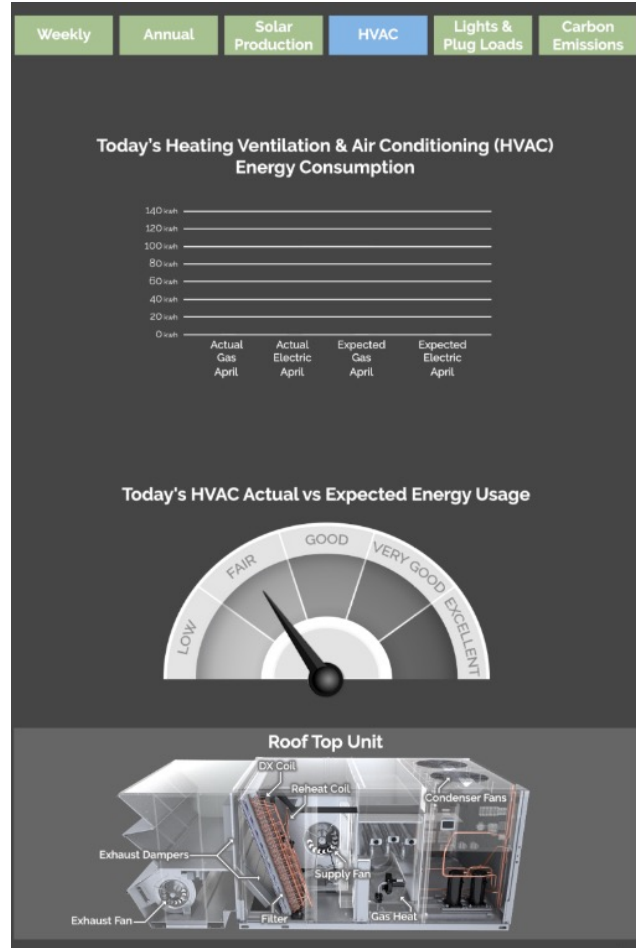
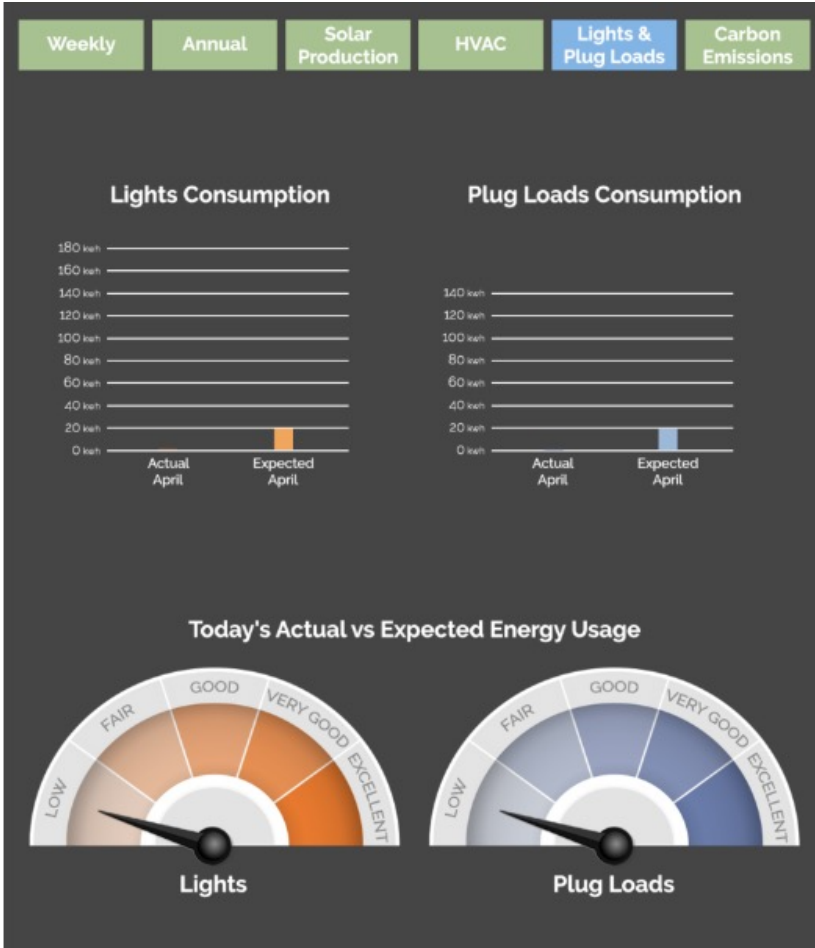


Energy Efficient Lighting and DHW Systems

- All LED Lighting
- All lighting on “Vacancy” Sensors or “Occupancy” Sensor where possible.
- DHW loop on thermostat controlled “On Demand” System.
- Measurement and Verification Electrical Panels for energy monitoring



Energy Monitoring



Energy Monitoring

*For a Monitored Project to be successful. Not only does the modeling and execution have to be done right... The **Occupants have to behave** as expected.*

Outreach and Education are Critical

Operational Considerations - Scheduling

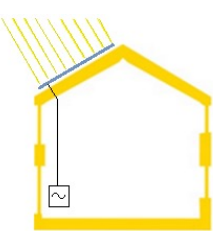
Operating schedule impacts occupant Load, lighting load, and ventilation rates

Park View School
River Trails School District 26

Occupancy Summary for WUFI	Occupant Type	Occupancy	Start Time	End Time	Hours	Days/Year	Include in Max (only concurrent uses)	Max	Occupant Hours per Year	Average Occupancy (= Occupant Hours per yr / 8760 hrs per yr)
School Year (Heating Season)										
Educational										
Classrooms	Children (age 0-10)	250	8:30 AM	3:00 PM	6.50	185	y	250	300625	34.32
Classrooms	Adult Standing or Light Work	25	7:00 AM	5:00 PM	10.00	185	y	25	46250	5.28
School Offices	Adult Standing or Light Work	10	7:00 AM	5:00 PM	10.00	210	y	10	21000	2.40
District Offices	Adult Standing or Light Work	12	6:00 AM	6:00 PM	12.00	260	y	12	37440	4.27
Extracurricular School Use										
Multipurpose Room	Children (age 0-10)	160	6:00 PM	10:00 PM	4.00	5		0	3200	0.37
Multipurpose During School Day (For Ventilation) daytime occupancy is from students and teachers accounted for in Classroom Count)		0	8:30 AM	5:00 PM	8.00	185		0	0	0.00
Public Use										
Multipurpose (Adult) - AM Child Care	Adult Standing or Light Work	3	6:00 AM	8:30 AM	2.00	185		0	1110	0.13
Multipurpose (Adult) - PM Child Care	Adult Standing or Light Work	3	3:00 PM	6:30 PM	3.50	185		0	1943	0.22
Multipurpose (Children) - AM Child Care	Children (age 0-10)	15	6:00 AM	8:30 AM	2.50	185		0	6938	0.79
Multipurpose (Children) - PM Child Care	Children (age 0-10)	15	3:00 PM	6:30 PM	3.00	185		0	8325	0.95
Classroom (Public Use)	Adults	20	7:00 PM	9:00 PM	2.00	87		0	3480	0.40
Summer (Cooling Season)										
Educational										
Classrooms Pre K Summer	Children (age 0-10)	50	8:00 AM	12:00 PM	4.00	58		0	11600	1.32
Public										
Multipurpose (Children) - Camp	Children (age 0-10)	25	8:00 AM	4:00 PM	8.00	58		0	11600	1.32
Multipurpose (Adult) - Camp	Adult Standing or Light Work	2	8:00 AM	4:00 PM	8.00	58		0	928	0.11
Multipurpose (Children) - PM	Children (age 0-10)	30	7:00 PM	9:00 PM	2.00	24		0	1440	0.16
Multipurpose (Adult) - PM	Adult Standing or Light Work	2	7:00 PM	9:00 PM	2.00	24		0	96	0.01
Classrooms - Camp	Children (age 0-10)	15	8:00 AM	4:00 PM	8.00	58		0	6960	0.79
Classrooms - Camp	Adult Standing or Light Work	1	8:00 AM	4:00 PM	8.00	58		0	464	0.05
		638						297	463398.00	53
								WUFI Peak Occupancy	WUFI Demand Occupancy	

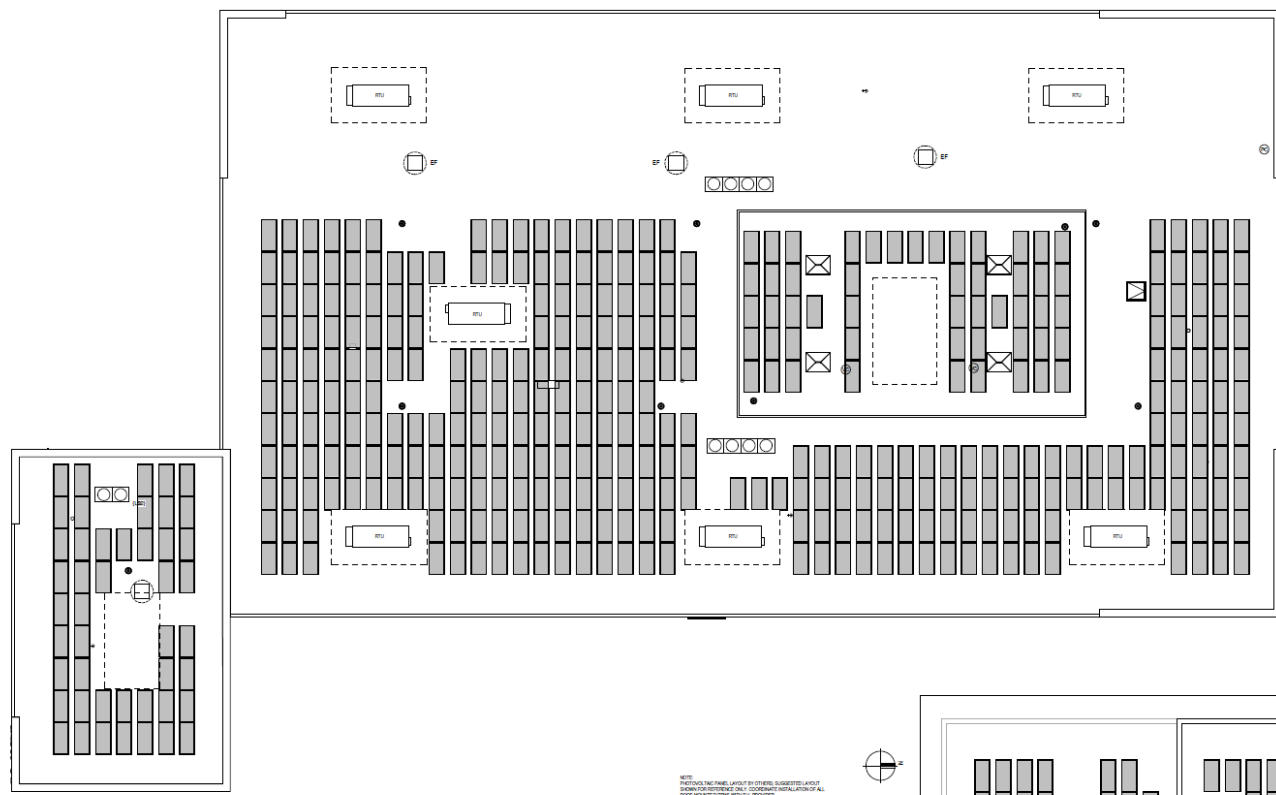
Operational Considerations - Scheduling

Tighten the Schedule and Make sure the owner and operating engineer are on board with the ventilation strategy.



Offset Site Energy with Renewables.

- ICECF Grant required all Renewable production to be “On Site”
- 166.4 KW Roof top Photovoltaic Array.



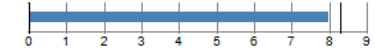
Model Results

PASSIVEHOUSE REQUIREMENTS

Certificate criteria: **PHIUS+ 2018**

Heating demand

specific: **7.97** kBtu/ft²yr
 target: **8.3** kBtu/ft²yr
 total: **222,607.52** kBtu/yr



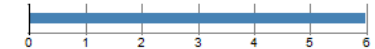
Cooling demand

sensible: **0.38** kBtu/ft²yr
 latent: **1.16** kBtu/ft²yr
 specific: **1.54** kBtu/ft²yr
 target: **5.3** kBtu/ft²yr
 total: **43,126.85** kBtu/yr



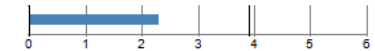
Heating load

specific: **5.99** Btu/hr ft²
 target: **6.3** Btu/hr ft²
 total: **167,268.2** Btu/hr



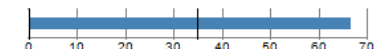
Cooling load

specific: **2.31** Btu/hr ft²
 target: **3.9** Btu/hr ft²
 total: **64,465.63** Btu/hr



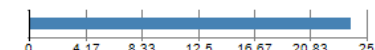
Source energy

total: **545,688.86** kWh/yr
 specific: **66.66** kBtu/ft²yr
 target: **34.8** kBtu/ft²yr
 total: **1,861,783.88** kBtu/yr
 specific: **66.66** kBtu/ft²yr



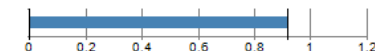
Site energy

total: **664,922.81** kBtu/yr
 specific: **23.81** kBtu/ft²yr
 total: **194,888.88** kWh/yr
 specific: **6.98** kWh/ft²



Air tightness

ACH50: **0.92** 1/hr
 CFM50 per envelope area: **0.06** cfm/ft²
 target: **0.92** 1/hr
 target CFM50: **0.06** cfm/ft²



WUFI® Passive V.3.2.0.1 | 1676 - Park View School Renovation - Tom Boeman | 0. Energy Model | 1676 Park View School Renovation - Energy Model Submission 3_PRE-CERT.mwp

File Input Options Database Help

Scope: **Passive house verification** | English | Outer dimensions | PHIUS+ 2018 | Assign data | Project/Cases/Case 1: PHIUS+ 2018 - Uninsulated slab / Localization/Climate: User defined

Project: Case 1: PHIUS+ 2018 - Uninsulated slab

Localization/Climate: User defined

PH Case: Passive house: School

Zone 1

Visualized components

- Component 1: Roof
- Component 2: Roof opening Multipurpose Room
- Component 3: Wall - Base
- Component 4: Windows Fixed Bottom Right
- Component 5: Doors - Office Entrance
- Component 6: Doors - Paired Exits
- Component 7: Doors - Service
- Component 8: Doors - Classroom
- Component 9: Windows Fixed Top Left
- Component 10: Windows Fixed Top
- Component 11: Windows Operable Left
- Component 12: Windows Operable Right
- Component 13: Windows Fixed
- Component 14: Windows Fixed Bottom Left
- Component 15: Windows Fixed Bottom
- Component 16: Windows Fixed Top Left Right
- Component 17: Wall - Multipurpose Room
- Component 18: Windows Fixed Top Right
- Component 19: Skylight Multipurpose
- Component 20: Windows Fixed Bottom
- Component 21: Windows Operable Bottom Right
- Component 22: Windows Fixed Left Right Top Bottom
- Component 23: Windows Operable Bottom Left
- Component 24: Wall Infill at existing spandrel
- Component 25: Walls Exterior Clad Masonry
- Component 26: Windows Operable Bottom
- Component 27: Floor Slab
- Component 28: Roof Multipurpose Room
- Component 29: Floor Slab Multipurpose

Localization | Climate | Source energy/CO2-Factor

Data: User defined

Setting	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Heating W. 1	Heating W. 2	Cooling W. 1	Cooling W. 2
Temperature [°F]																
Ambient	23.72	27.5	38.84	50	59.54	69.98	75.38	71.24	64.58	51.8	40.46	25.34	7.52	21.2	80.78	
Dew point	15.08	17.24	29.3	39.2	44.96	55.4	65.66	61.88	55.22	41	32.72	18.32				
Sky*	-16.24	-5.26	7.88	17.78	29.3	37.58	51.98	47.84	38.12	21.38	14.36	-11.38				
Ground*																
Solar radiation [Btu/hMonth]																
North	8.24194	10.1436	12.0456	12.6796	18.0686	19.9706	19.6536	15.5326	11.0946	8.55896	6.33906	6.97394	11.41194	11.41194	28.21285	
East	17.4346	21.8726	27.8956	31.0656	40.2587	40.5757	39.94136	50.331	38.224	09.15	21.56	15.8496	35.82081	15.53292	64.66765	
South	30.7486	31.3826	32.3336	26.6276	28.2126	24.7256	27.5786	28.5286	31.3826	32.9676	24.4086	27.8956	67.20364	23.77487	43.11177	
West	11.7286	14.5816	17.7516	20.6046	27.2616	27.5786	28.5286	24.4086	19.0196	14.2646	8.55896	9.82096	19.65389	13.63093	42.79477	
Global	17.1176	21.8726	32.9676	41.2096	57.6936	58.9616	59.9126	49.7661	38.9907	27.8956	16.8006	14.2646	27.57885	20.28789	95.09949	

* Optional input, Sky/Ground: if not defined, temperatures will be estimated

Data state/results | Show warnings | Calculate WUFI shading

Heating demand: **7.97** kBtu/ft²yr

Cooling demand: **1.54** kBtu/ft²yr

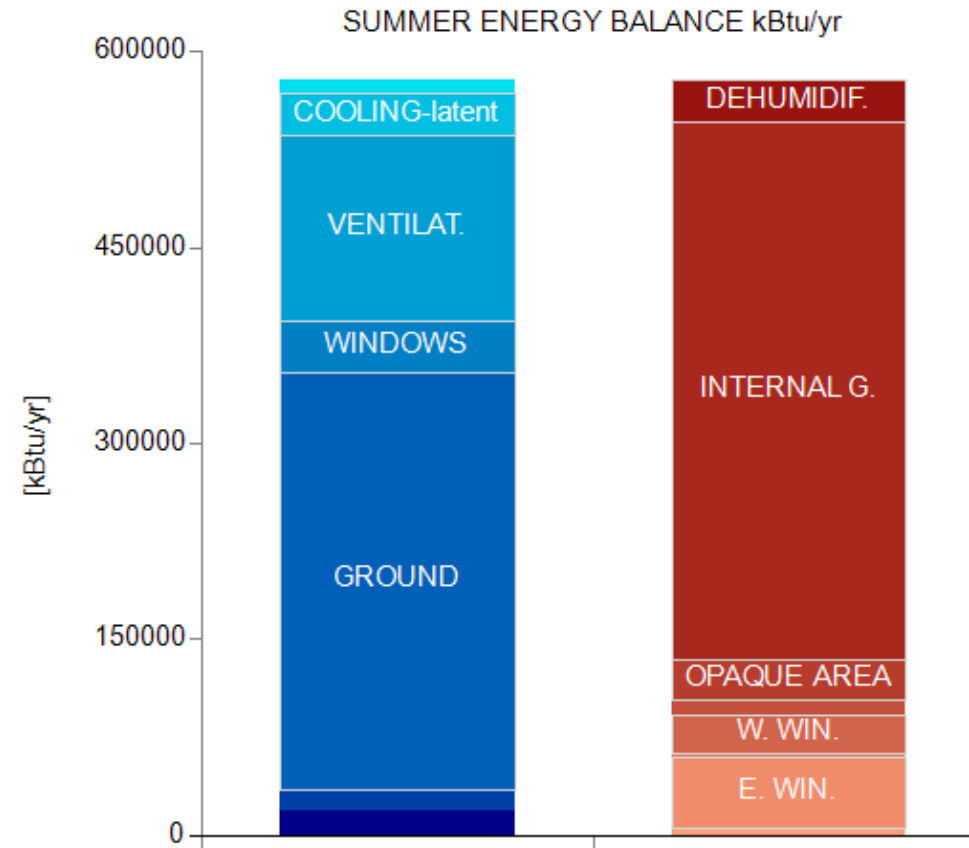
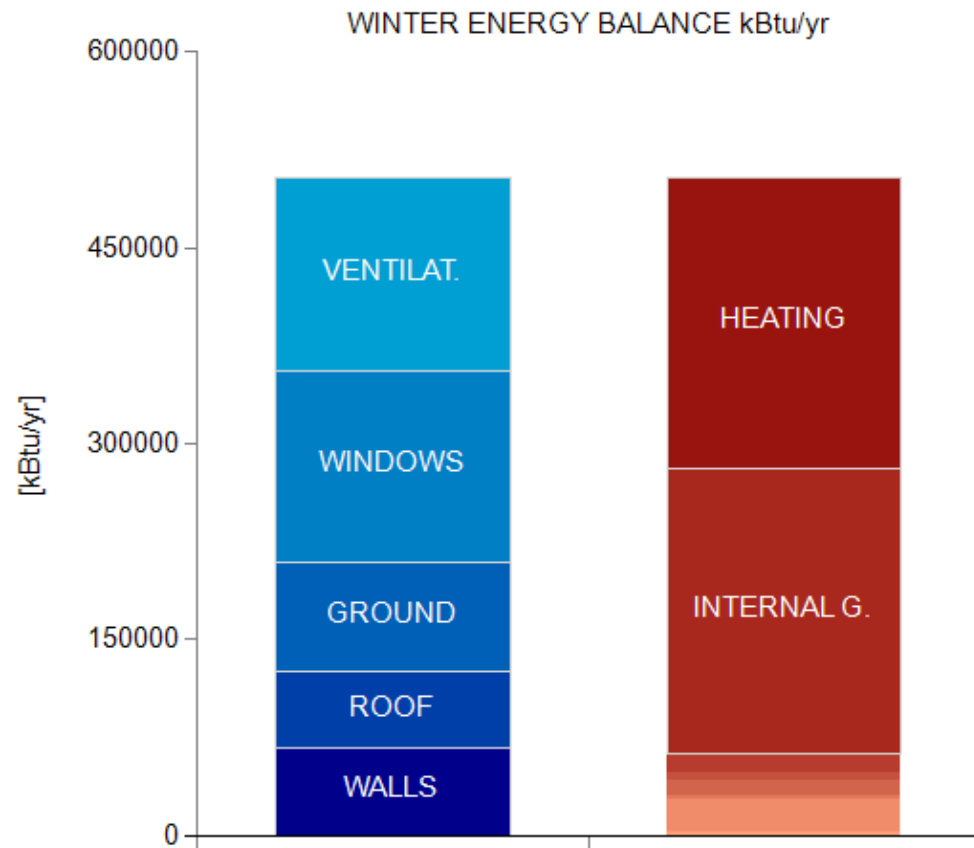
Heating load: **5.99** Btu/hr ft²

Cooling load: **2.31** Btu/hr ft²

Source energy: **0** kBtu/ft²yr

Site energy: **-2.01** kBtu/ft²yr

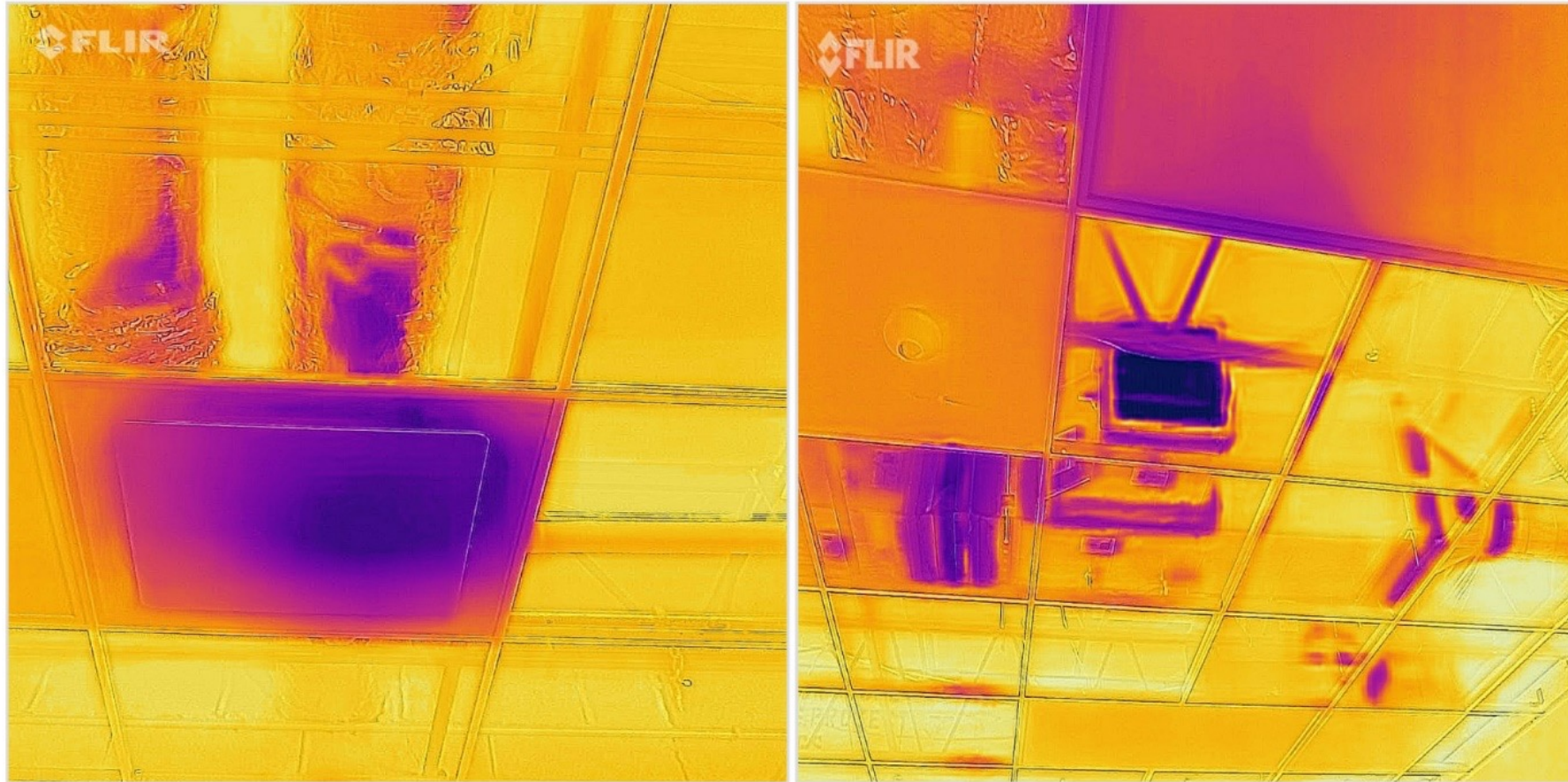
Model Results



Field Verification



Field Verification



Purple color in ducts indicates they are connected to the outside even though intake and exhaust are taped off.

Field Verification

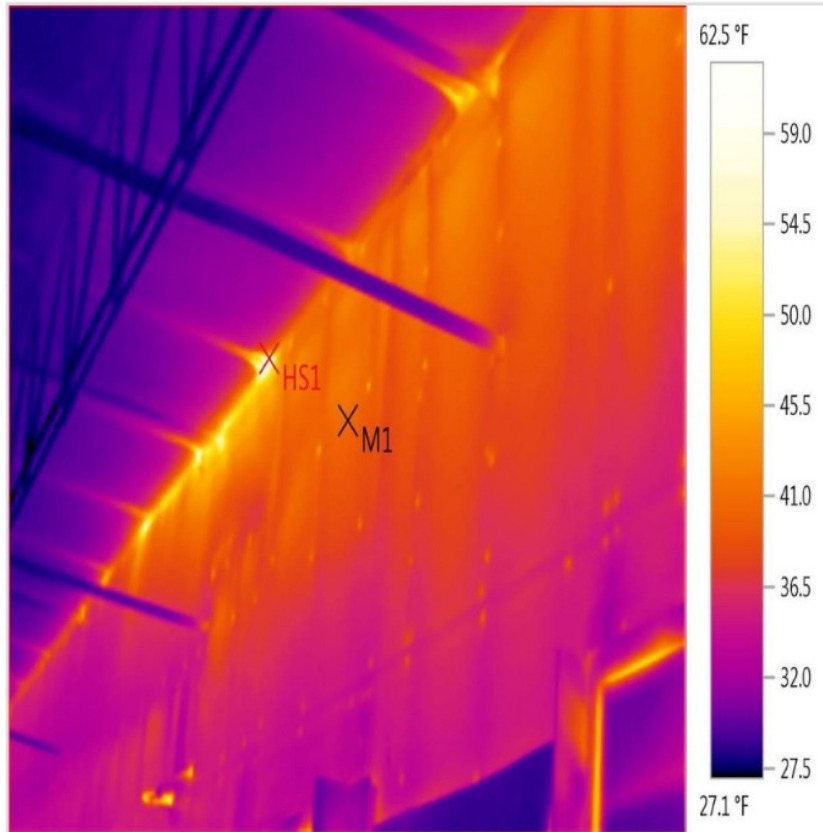
Loose joint between
DOAS main enclosure
and ERV module



Field Verification

DOAS Units include a large volume of air outside the building envelope. And they can leak. Provide Dampers on the interior duct connections to the units.

Field Verification

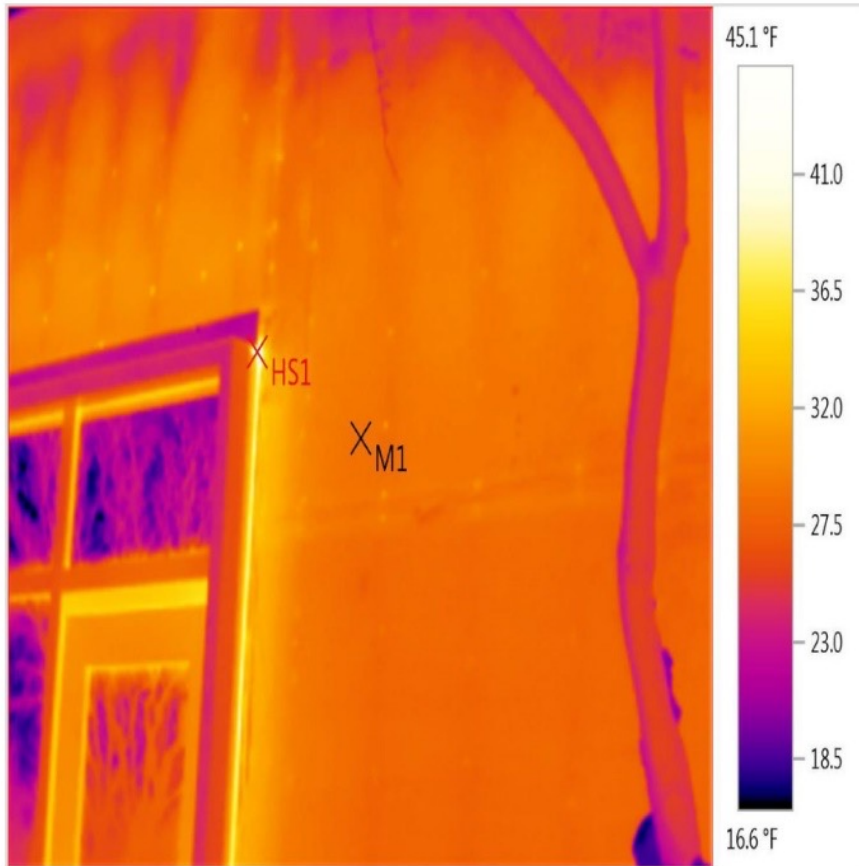


Areas of bright orange in this image indicate potential imperfections in the air seal between the wall and roof overhang.



See accompanying IR image of the same location. We recommend double-checking the integrity of the air seal between the entire wall / roof intersection at the roof overhangs on the north and south ends of the building.

Field Verification



The bright orange line running down the side of the window could be a thermal bridge and not an air leak. But we'd recommend double checking that all of the window flashing is air tight one last time before concealing it with insulation and siding.



See comment on IR image. Flashing appears to be well installed.

The Final Product



PETER McCULLOUGH PHOTO + DRONE

FGM ARCHITECTS

The Final Product



PETER McCULLOUGH PHOTO + DRONE

FGM ARCHITECTS

The Final Product



The Final Product



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The Final Product



PETER McCULLOUGH PHOTO + DRONE

FGM ARCHITECTS

The Final Product



Photo by Trane Technologies

Education and Outreach



The image shows two children, a boy on the left and a girl on the right, peeking over two educational cards. The cards are green and white, with a 'GREEN SPOTLIGHT' logo. The boy's card has a white circle with a motion sensor icon and text about finding a white box on the wall. The girl's card has a white box with a ceiling icon and text about looking up at insulated pipes and a VRF system. Both cards have a 'GREEN SPOTLIGHT' logo in a circular badge at the bottom left.

Can you find it?

Look for a white box on the wall.

Motion sensors know when people leave the room and turn off the lights automatically. This is one way the school saves electricity.

GREEN SPOTLIGHT

Look up!

What is hidden in the ceiling?

Insulated pipes carry water to the restrooms and water fountains.

The **VRF system** brings fresh air from the outside directly into your classroom.

GREEN SPOTLIGHT

Education and Outreach

THIS INTERACTIVE COMPARES THE ENERGY EFFICIENCIES OF THE OLD BOILER SYSTEM TO THE NEW VRF SYSTEM. THROUGH A REPRESENTATIONAL VISUAL COMPARISON OF THE COMPLEX "OLD PANEL" VS THE SIMPLIFIED MINIMAL "NEW PANEL" THE STUDENT CAN ACTIVATE EACH SYSTEM TO FEEL THE DIFFERENCE IN BLOW STRENGTH FROM A SERIES OF OVERHEAD REGISTERS.

A GRAPHIC OF WHAT THE OLD BOILER ROOM MAY HAVE LOOKED LIKE SITS TO THE RIGHT OF A WINDOW LOOKING INTO THE NEW ELECTRICAL ROOM WHERE THE VRF SYSTEM PANEL IS HOUSED. WHEN THE VRF SYSTEM IS ACTIVATED FOCUSED SPOT LIGHTS HIGHLIGHT THE PANEL & SYSTEMS WITHIN THE NEW ROOM.

WHEN THE OLD BOILER SYSTEM IS ACTIVATED THE LIGHTS & SOME GAUGES WILL ACTIVE ON THE OVERHEATED PANEL. AN ACCOMPANYING SOUND MIGHT FURTHER EMPHASIS THE OLD VS NEW.

page 09

THIS INTERACTIVE SHOWCASES MATERIAL LAYERING OF THE WALL COMPOSITE THROUGH A SERIES OF CUTAWAYS WITH GRAPHIC DEPICTIONS MOUNTED DIRECTLY TO THE FACE OF THE MATERIALS. EACH MATERIAL & ITS PROPERTIES ARE DESCRIBED WITHIN THE COMPOSITE TO HELP THE STUDENTS UNDERSTAND INSULATION IN THE REALM OF ENERGY CONSERVATION. THE FIXED CUTAWAY FORMAT ALLOWS STUDENTS TO VIEW THE COMPOSITE IN ITS ENTIRETY WHILE ALSO ENGAGING IN TACTILE INTERACTION OF THE MATERIALS.

WALL COMPOSITE & PANELS TO BE BUILT FROM ACTUAL BUILDING MATERIALS WITH THE EXCEPTION OF SAFETY & DURABILITY RESTRICTIONS. IN INSTANCES WHERE MATERIALS CANNOT BE USED IN TRUE FORM TEXTURE WILL BE REPLACATED. SOME MATERIALS COLORS WILL BE EMPHASISED OR ALTERED TO FURTHER DIFFERENTIATE THE LAYERS.

6b - Old Boiler vs New VRF system "Energy Efficiency & Energy Loss"



1a - Exterior Wall Composite "Fixed Layers"



Monitoring (Issues)

- The team noticed several of the DOAS units were using the electric resistance backup heating element in lieu of the more efficient Heat Pump in the unit.
- Set Points are important. Cabinet Unit heaters near doors and in utility rooms were set initially to 68deg. In the winter, they ran continuously, meeting the heating demand with less efficient resistance heaters rather than the more efficient VRF heat pump.

Monitoring

Annual



Prairie Trails School Net Zero Energy Building

Solar

Annual

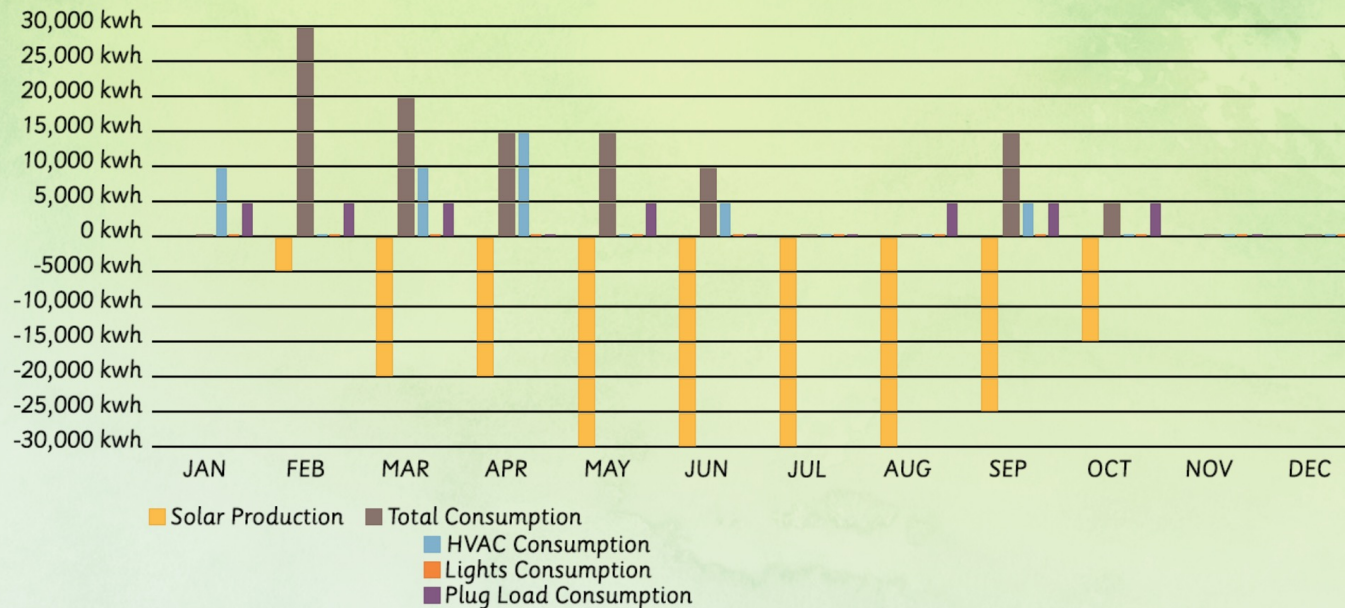
Rolling Average

HVAC

Lights & Plug Load

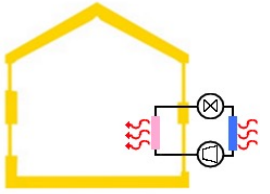
Carbon

ANNUAL ENERGY USAGE AND GENERATION





Thank You!
Hope to see you on Saturday



Variable Refrigerant Flow System (VRF)

Zone VRF Branch controllers to take advantage of simultaneous heating and cooling efficiencies. Consider what scenarios might require simultaneous heating and cooling and Zone Accordingly.

Consider implications of running refrigerant lines throughout the interior space.



DEDICATED OUTSIDE AIR SYSTEM (DOAS)

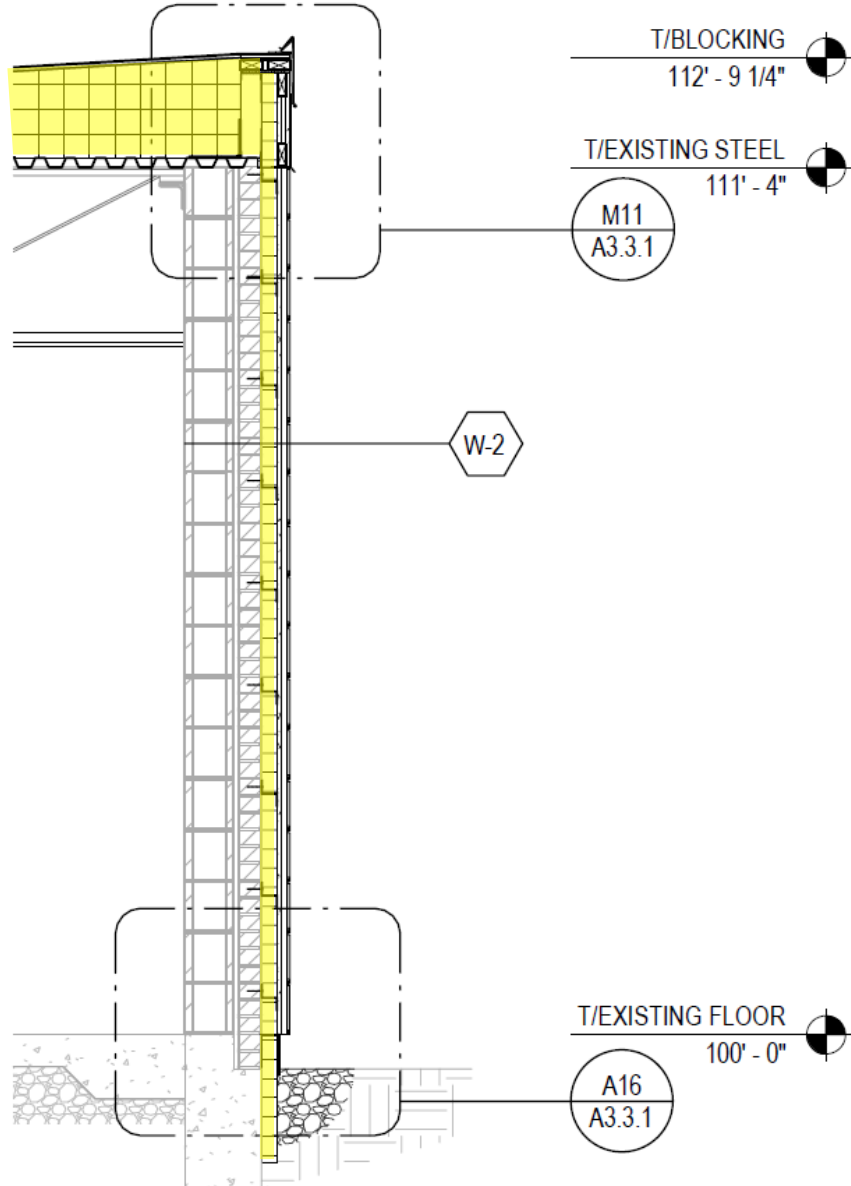
Make sure there is no direct exhaust ventilation. Except as required for kitchens or combustion appliances.

Align Ventilation Zones with Operational Zones as much as possible

Use Heat pump for DOAS Ventilation air Conditioning



Thermal Envelope - Wall Section: 100% DD



R-30 Roof

Tapered Polyisocyanurate

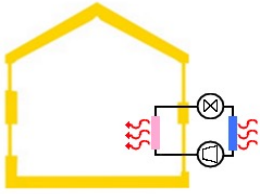
R-15 Walls (Total R-18)

2 ½" Polyisocyanurate

R-15 Slab Edge

2 ½" Polyisocyanurate

2'-0" Deep



Mechanical System Selection

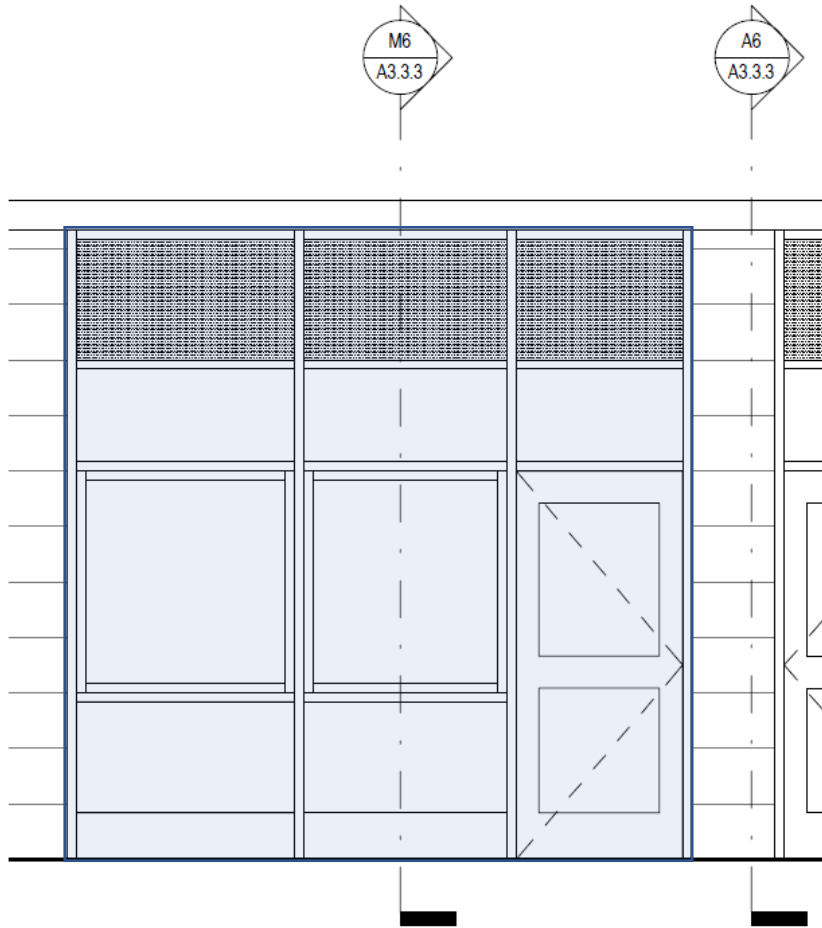
System/Plant	EUI		Energy Cost	
	(kBtu/sqft/yr)	% Savings	(\$/yr)	% Savings
Baseline: 90.1-2013	75	-	\$ 30,128	-
Single Pipe Hybrid Geothermal	20	74%	\$ 21,854	27%
Single Pipe 100% Geothermal	20	74%	\$ 21,682	28%
VRF Hybrid Geothermal	17	78%	\$ 18,264	39%
VRF 100% Geothermal	16	78%	\$ 18,026	40%
VRF Air Cooled	23	69%	\$ 25,327	16%

Energy Source	Utility Costs	
Electric	\$0.086 per kWh	\$0.025 per kBtu
Natural Gas	\$0.386 per therm	\$0.004 per kBtu

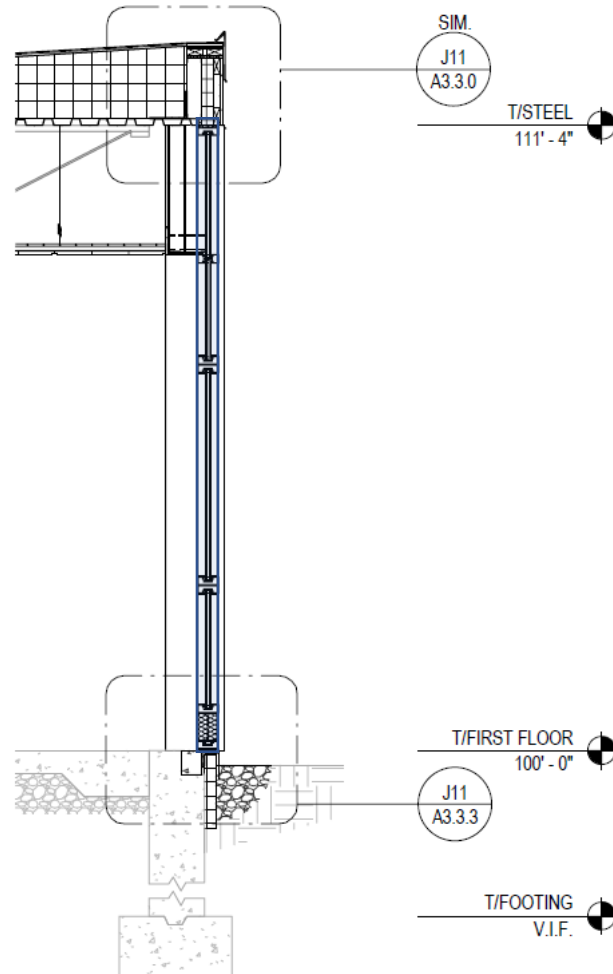
Envelope Assumptions	
Exterior Wall:	R-18 (U-0.055)
Roof:	U-0.032
Windows:	U-0.42 and SHGC: 0.40
Window to Wall Ratio:	35%



Thermal Envelope - Windows: 100% DD



Typical Classroom Glazing



Glass:

U_{cog} 0.20
Double Glazed

Frame:

$U_{frame} \sim 0.88$

Spandrel Glass Above Ceiling

Two Operable Windows

PHIUS+ Certification & ICECF Grant Process

Design

Construction

Post Construction



PHIUS Requirements

Pre - Certification

Final - Certification



Energy Model and Documentation



On-Site QA/QC Testing/Inspection



ICECF Requirements

Pre Proposal

Full Proposal

Monitoring

12 Consecutive Months Monitoring

First Grant Payout (30%)

Second Grant Payout (30%)

Final Grant Payout (40%)