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

Project Team

River Trails School District 26 Inspire to Excel

Owner

FGM ARCHITECTS

Project Architect

IMEG

MEP/FP Engineer

NICHOLAS

Construction Manager

Ingersoll Rand Inspiring Progress™

Photovoltaic Design

boeman design

Certified Passive House Consultant

ECO ACHIEVERS Building Wisdom

PHIUS Rater/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 will be ***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

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"

PHIUS+ Certification & ICECF Grant Process

Design	Construction	Post Construction

PHIUS Requirements

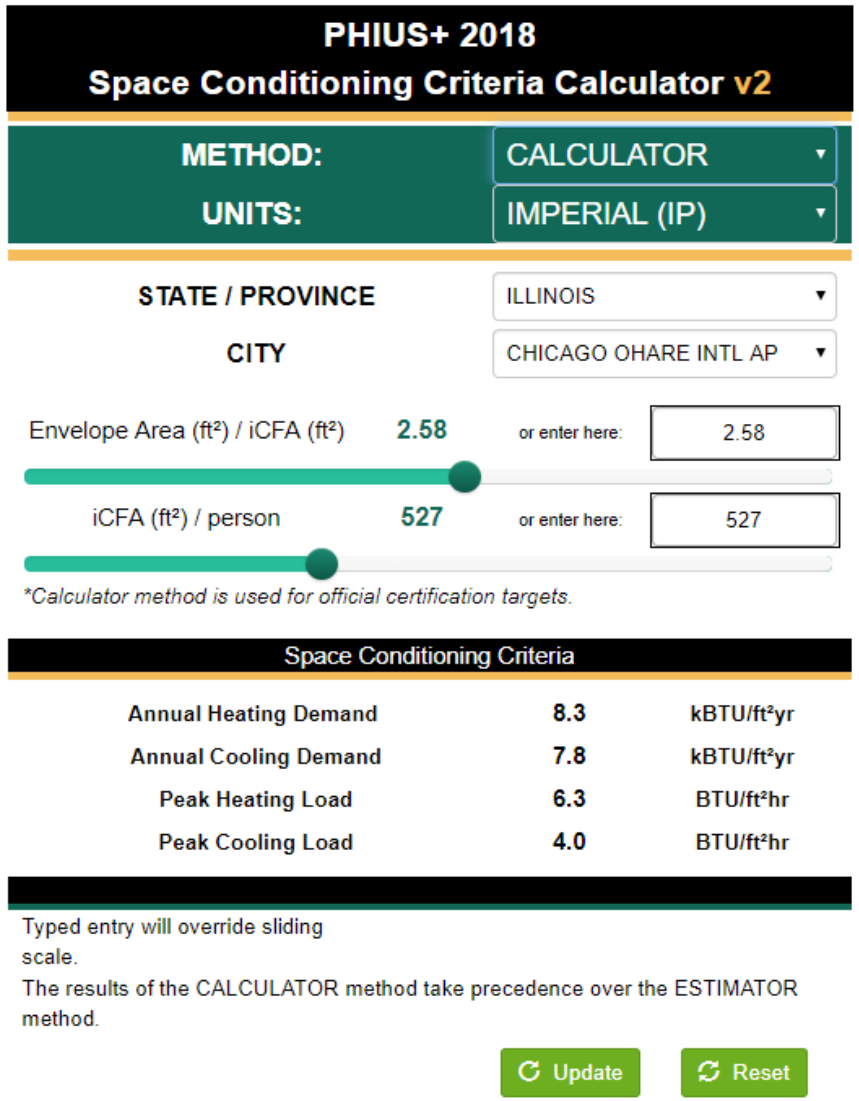
Pre - Certification	Final - Certification
CPHC®	PHIUS+ VERIFIER / PHIUS+ RATER
Energy Model and Documentation	**On-Site QA/QC Testing/Inspection**

ICECF Requirements

Pre Proposal	Full Proposal	Monitoring
		12 Consecutive Months Monitoring
First Grant Payout (30%)	Second Grant Payout (30%)	Final Grant Payout (40%)

PHIUS + Criteria Calculator: Inputs

PHIUS+ 2018 Final Calculator v2



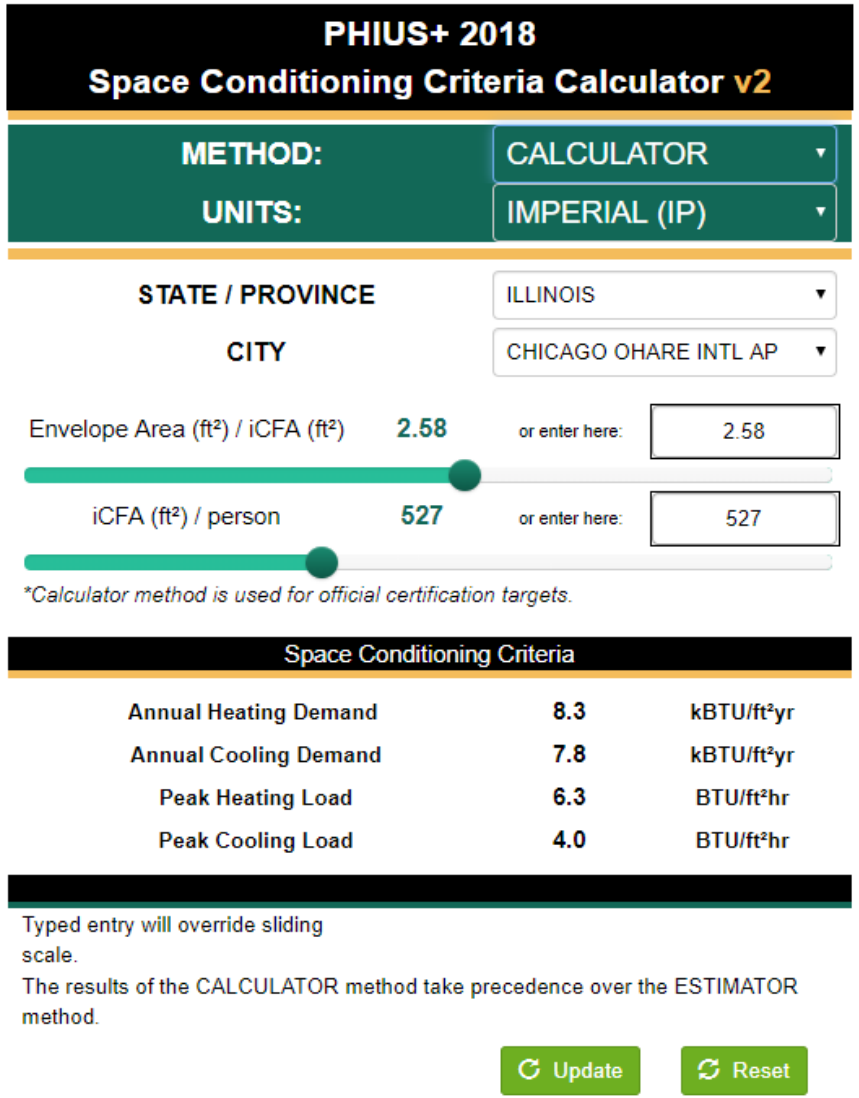
Inputs

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



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)

Existing Building

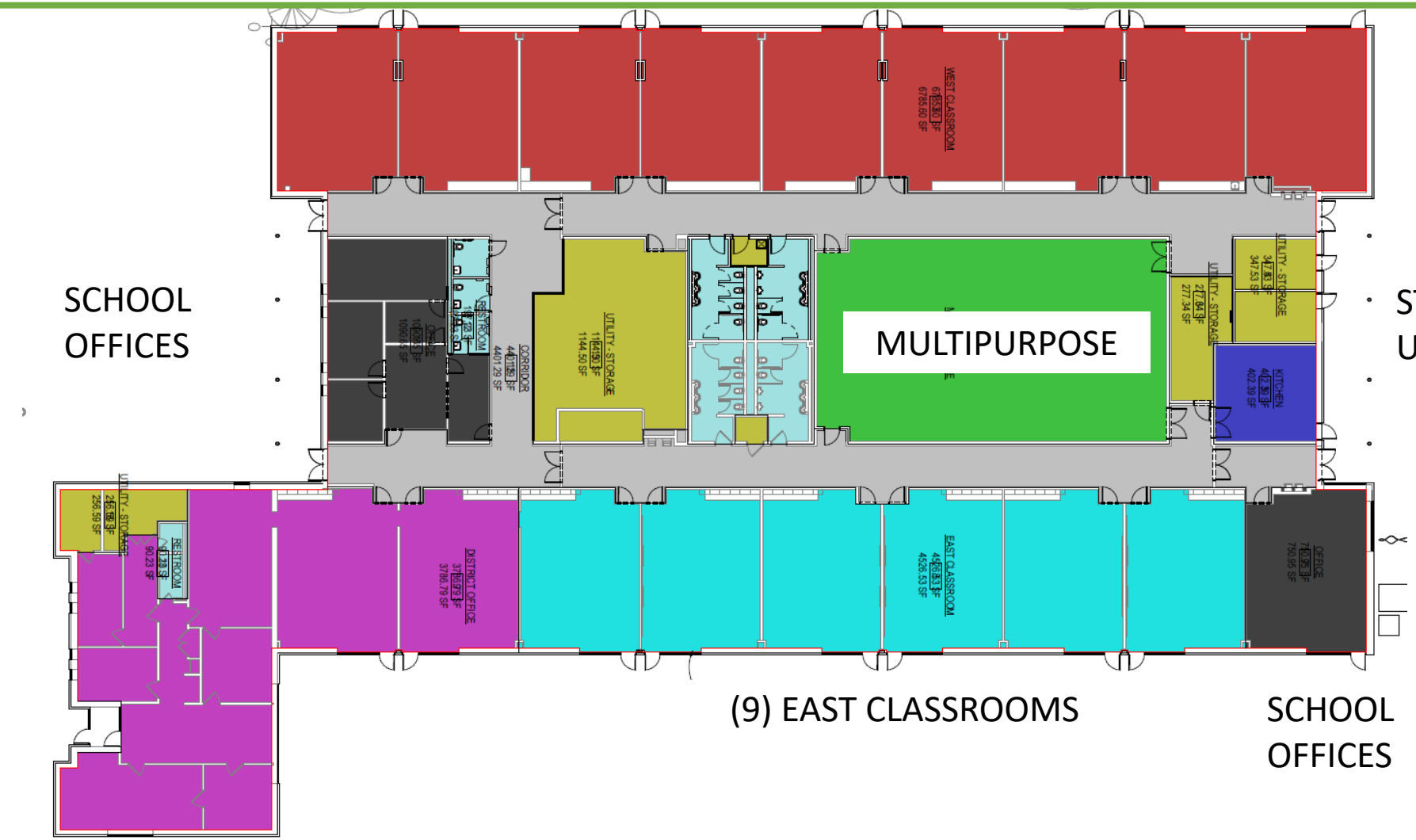
N

Existing Building

Existing Building

Existing Building

Existing Building



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.

New to Phius + Certification Guide V.3.

1.5.6 Retrofit Projects

The criteria for retrofit projects are the same as for new construction, except that a case-by-case energy allowance may be made for a foundation perimeter thermal bridge or other such hard-to-fix structural thermal bridges - provided that the design is also "damage-free," that is, low risk from a moisture point of view.

The allowance noted above may also apply to uninsulated slab-on-grade conditions. To determine the allowance in WUFI Passive, the prescriptive path R-value under the slab should be modeled. The difference in modeled performance results is equivalent to the allowance that may be applied.

Process Opportunities

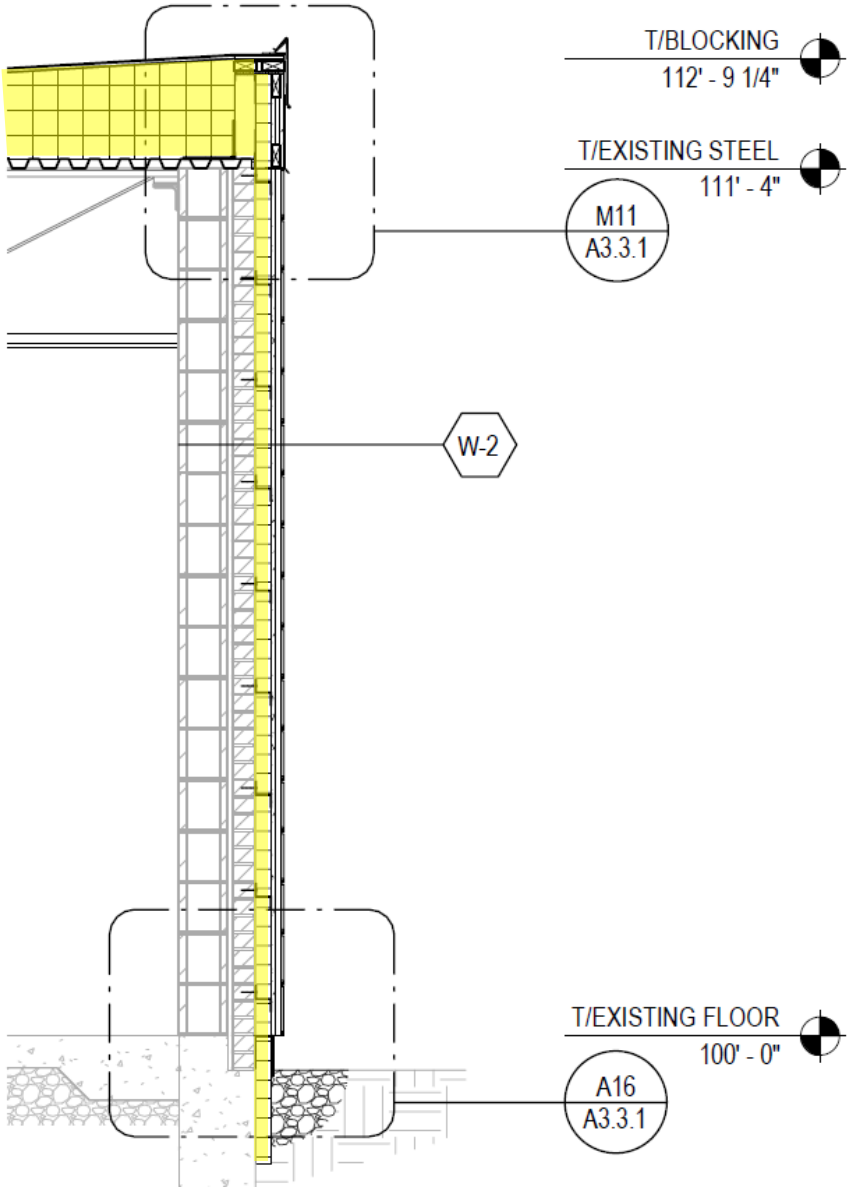
- The Owner had a strong commitment to achieving Net Zero
- The Architect, FGM, had a strong technical grasp of the issues. Adopted a straightforward “Textbook” approach
- The MEP Engineer, IMEG, had Net Zero building Experience
- The Builder Nicolas and Associates had 2 team members take the PHIUS Builder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

Thermal Envelope - Wall Section: 100% DD

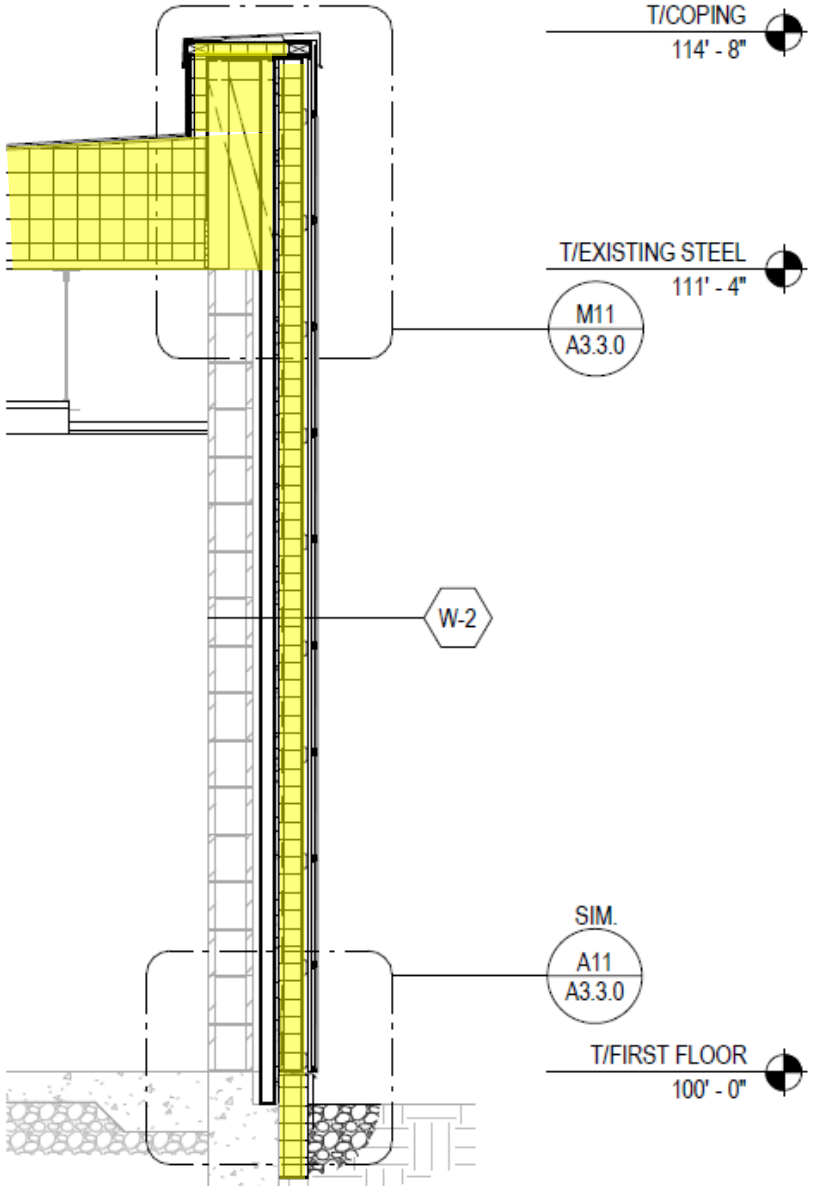


R-30 Roof
Tapered Polyisocyanurate

R-15 Walls (Total R-18)
2 ½" Polyisocyanurate

R-15 Slab Edge
2 ½" Polyisocyanurate
2'-0" Deep

Thermal Envelope - Wall Section: Final CDs



R-80 Roof (Effective)

Tapered" Polyisocyanurate (10" Min – 20" Max)

R-24 Walls (Total R-27)

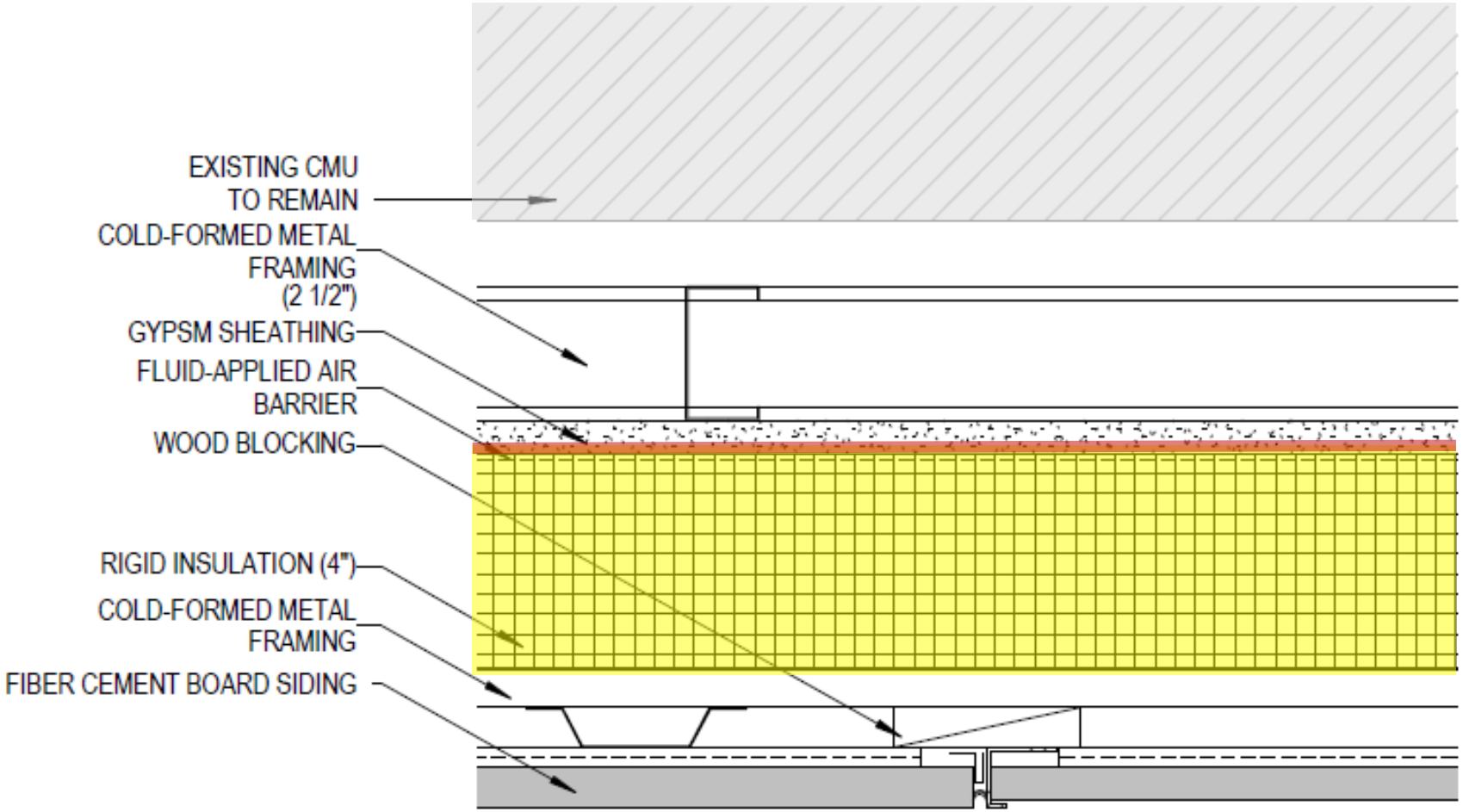
4"Polyisocyanurate
(Maximum accepted by Cladding Manufacturer)

R-30 Slab Edge/Foundation Wall

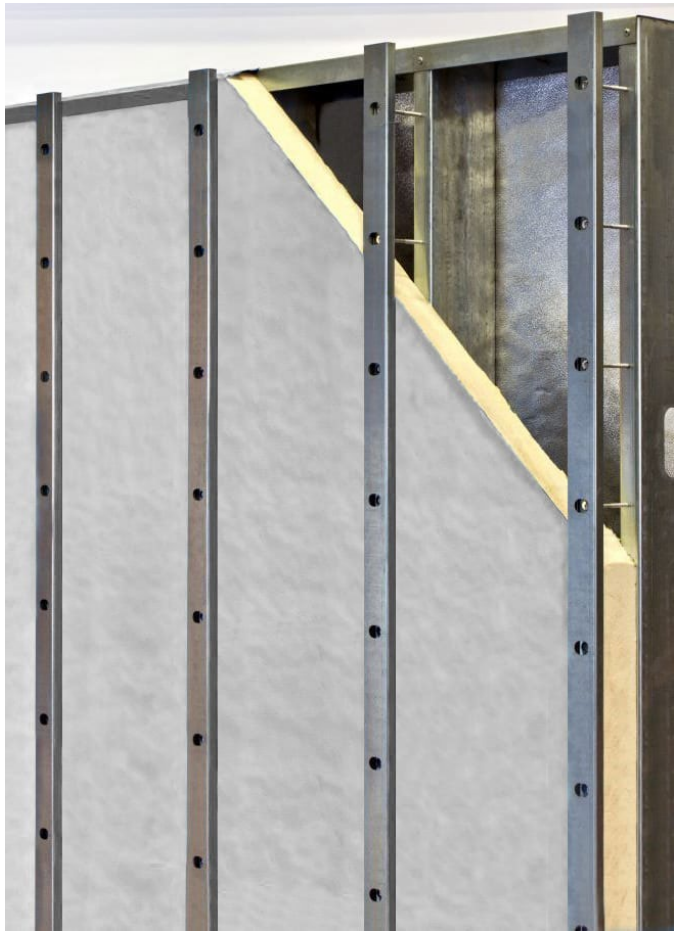
6"Polyisocyanurate
2'-0" deep

Thermal Envelope – Wall Detail

INTERIOR

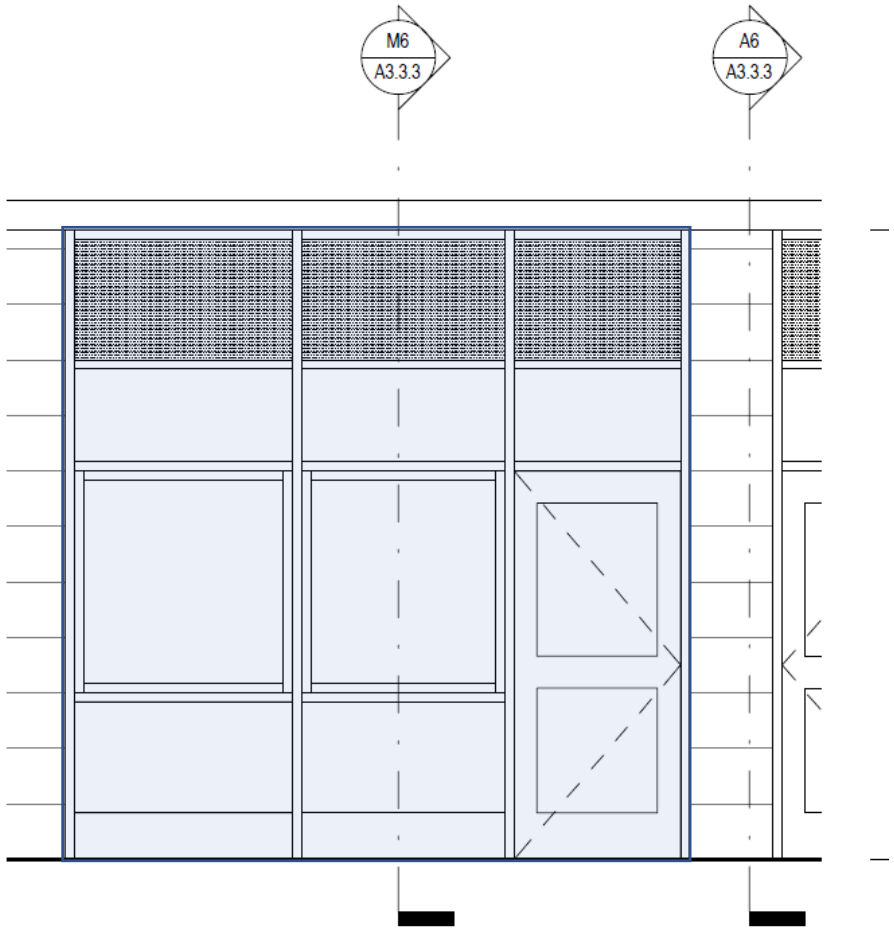


EXTERIOR

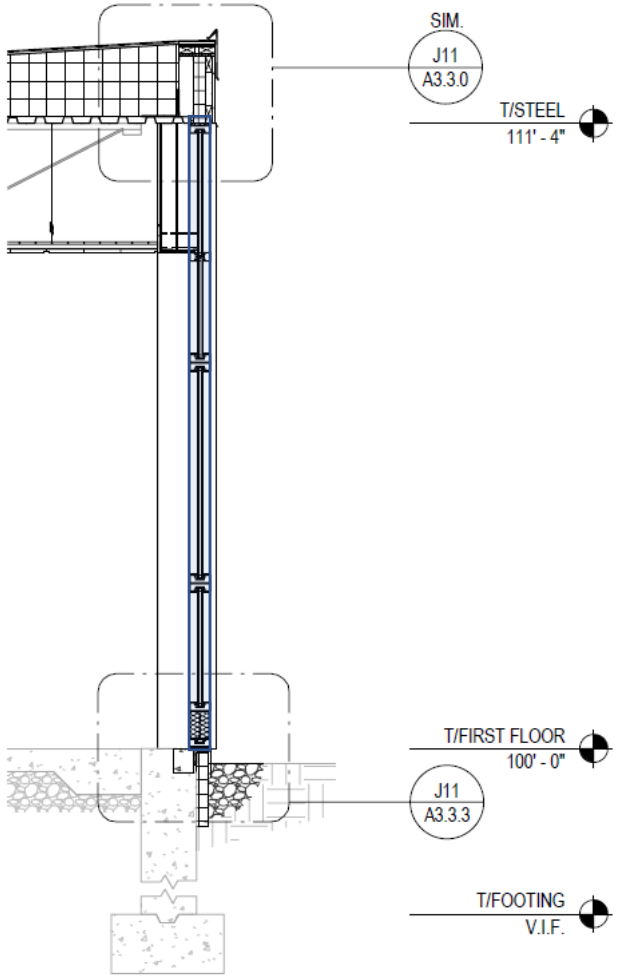


KNIGHT CI RAIN SCREEN SYSTEM

Thermal Envelope - Windows: 100% DD



Typical Classroom Glazing



Glass:

U_{cog} 0.20

Double Glazed

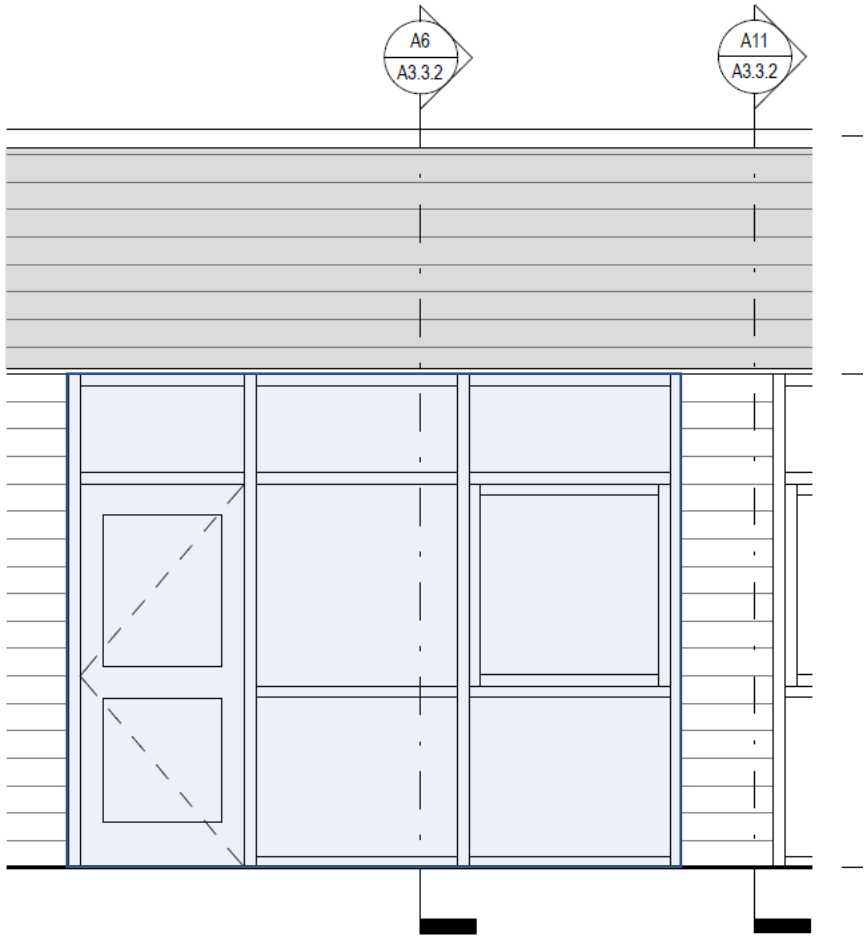
Frame:

U_{frame} ~0.88

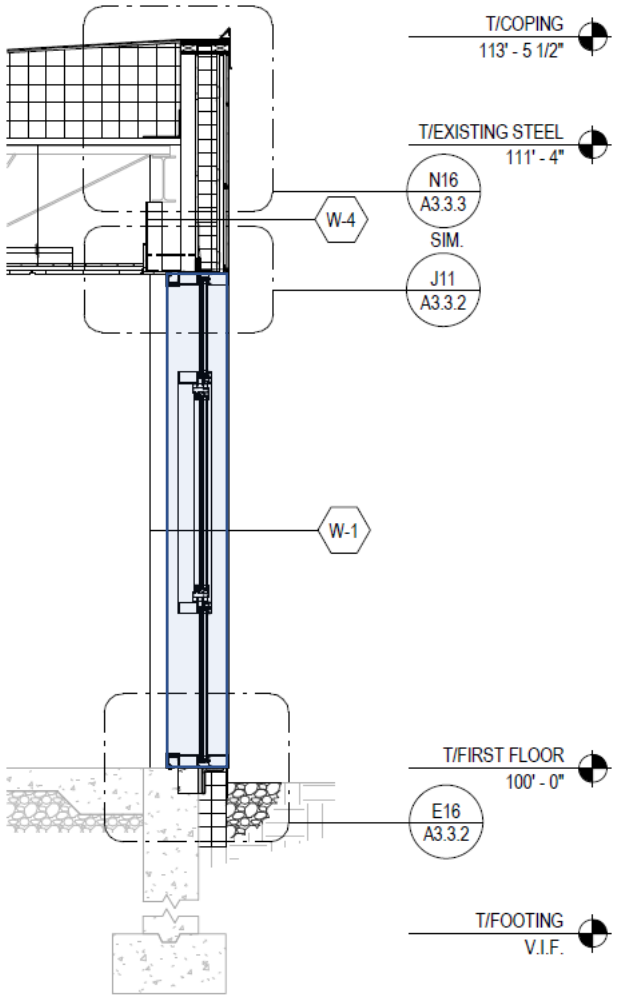
Spandrel Glass Above Ceiling

Two Operable Windows

Thermal Envelope - Windows: Final CDs



Typical Classroom Glazing



Glass:

U_{cog} 0.111

Triple Glazed Double Coated

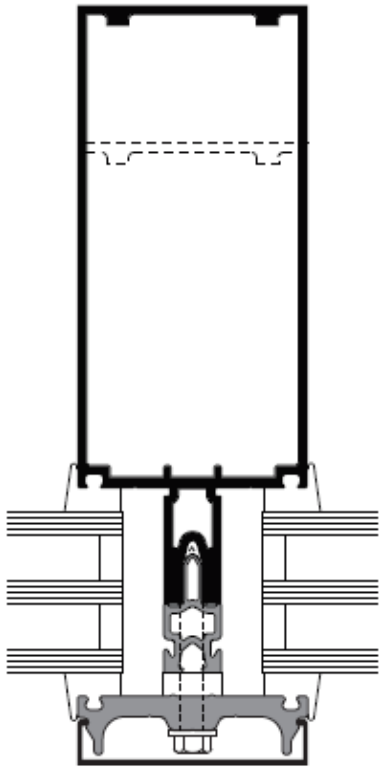
Frame:

U_{frame} ~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: Vitro SB60 / Argon / Clear / Argon / SB60 (6mm/6mm/6mm) 45mm IG No Grids

ASHRAE/IECC/ DOE North American Climate Zone	South-facing	North, East, West -facing	Whole-window installed U-value W/m2K	Whole-window installed U-value BTU/hr.ft2.F	Ucog-Value SHGC	Ucog-Value W/m2K	Ucog-Value BTU/hr.ft2.F
Climate specific recommendations:							
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 Frame height mm	FRAME Frame height in	FRAME U-frame W/m2K	FRAME U-frame BTU/hr.ft2.F	Psi-spacer Ψ W/mK	Psi-spacer Ψ 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

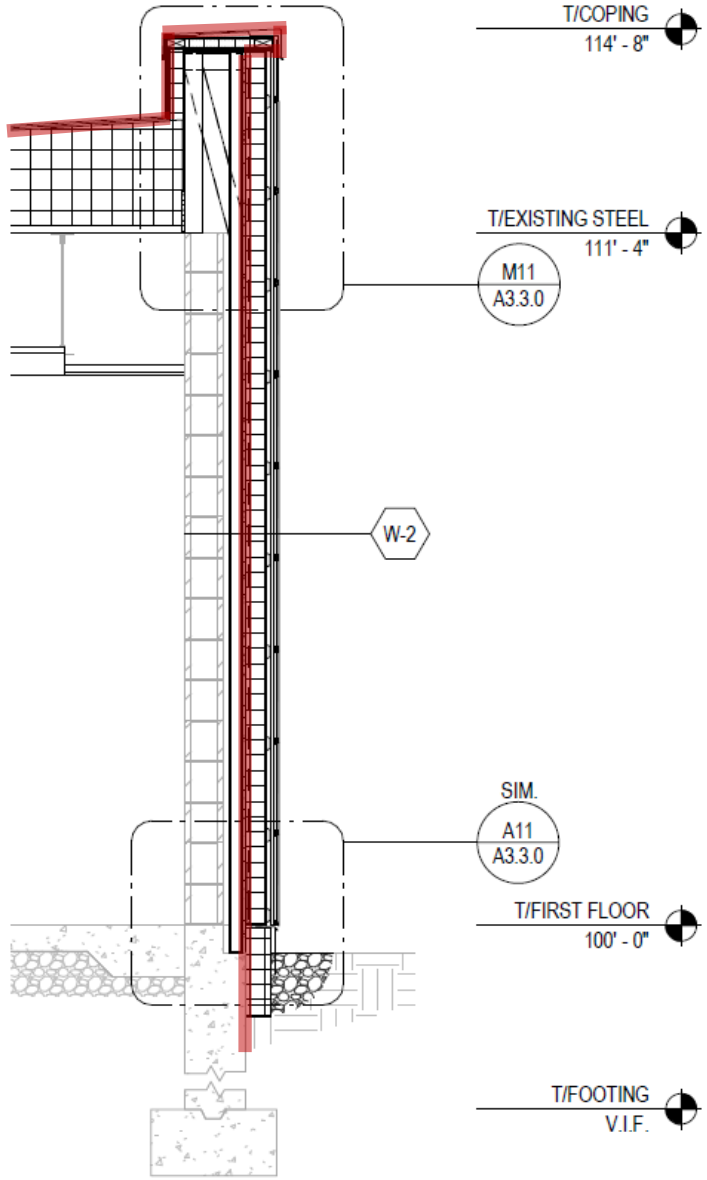
1600UT System™ Curtain Wall- Fi Kommerling TPS Spacer Horizontal two lite right	FRAME Frame height mm	FRAME Frame height in	FRAME U-frame W/m2K	FRAME U-frame BTU/hr.ft2.F	Psi-spacer Ψ W/mK	Psi-spacer Ψ BTU/hr.ft.F	Psi-opaque W/mK
right head	35	1.38	4.81	0.85	-0.001	-0.001	0.180
right sill	35	1.38	4.82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

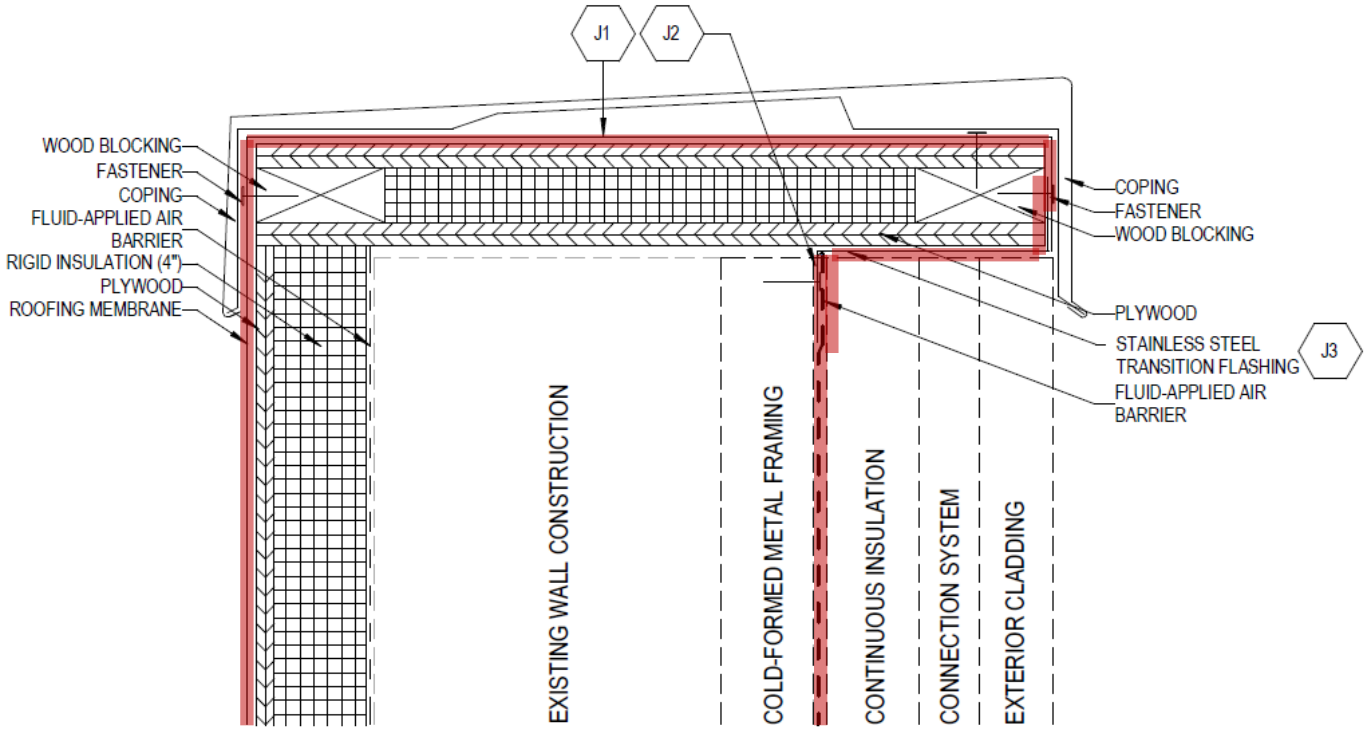
Roof Membrane

Fluid Applied Air Barrier
Wall Sheathing and Foundation Face Below.

Stainless Steel Transition Flashing.
Between Fluid Applied Air Barrier and Roof Membrane.

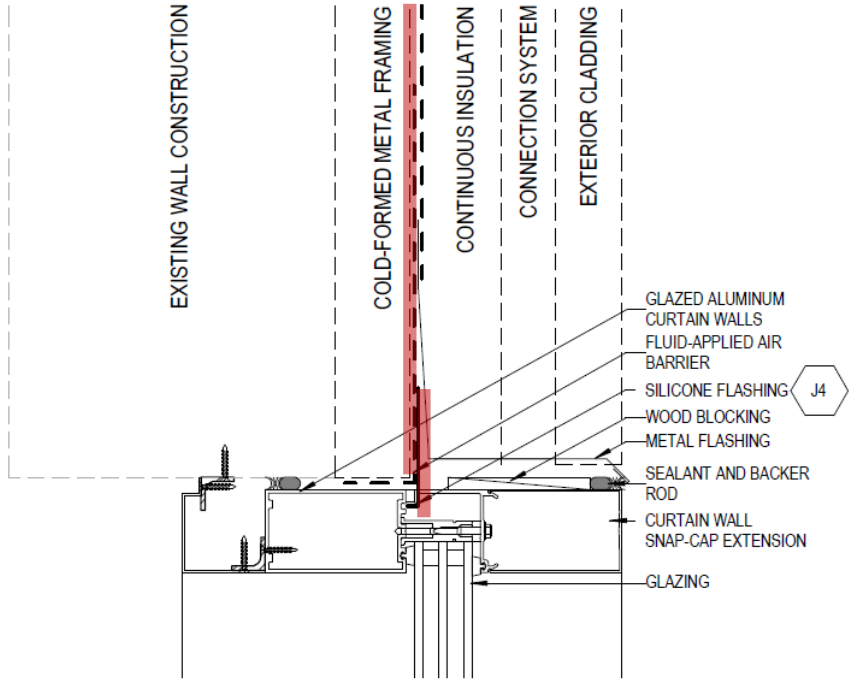
Silicone Window Flashing
Clamped into Glazing Channel

Continuous Air Barrier

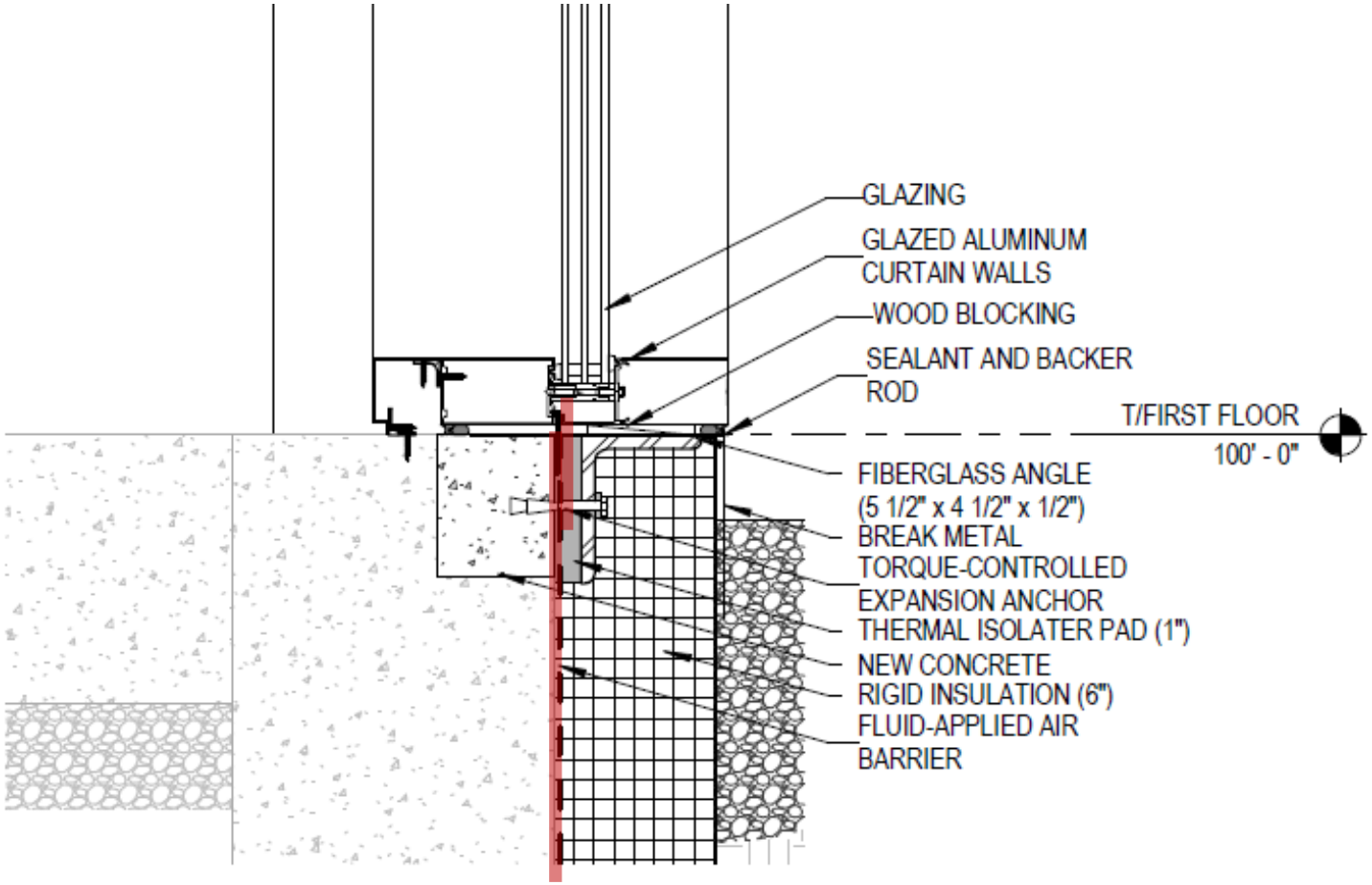


TYPICAL PARAPET

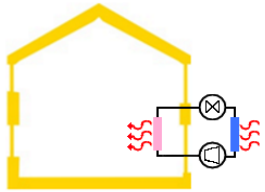
Continuous Air Barrier



TYPICAL WINDOW JAMB



TYPICAL WINDOW SILL



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%

DOAS COUPLED WITH VRF SYSTEM

DEDICATED OUTSIDE AIR SYSTEM (DOAS)

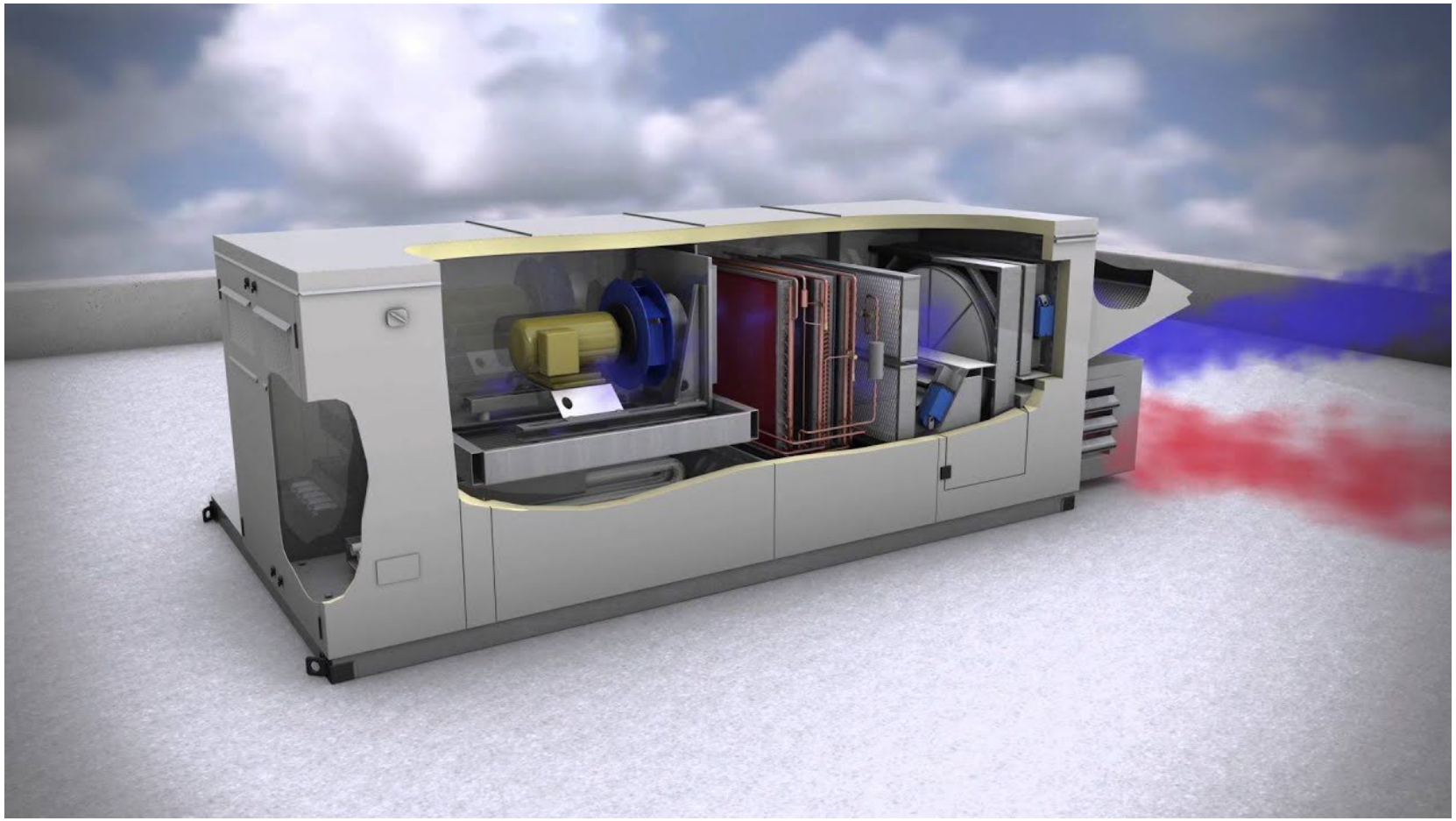
DOAS Components:

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:

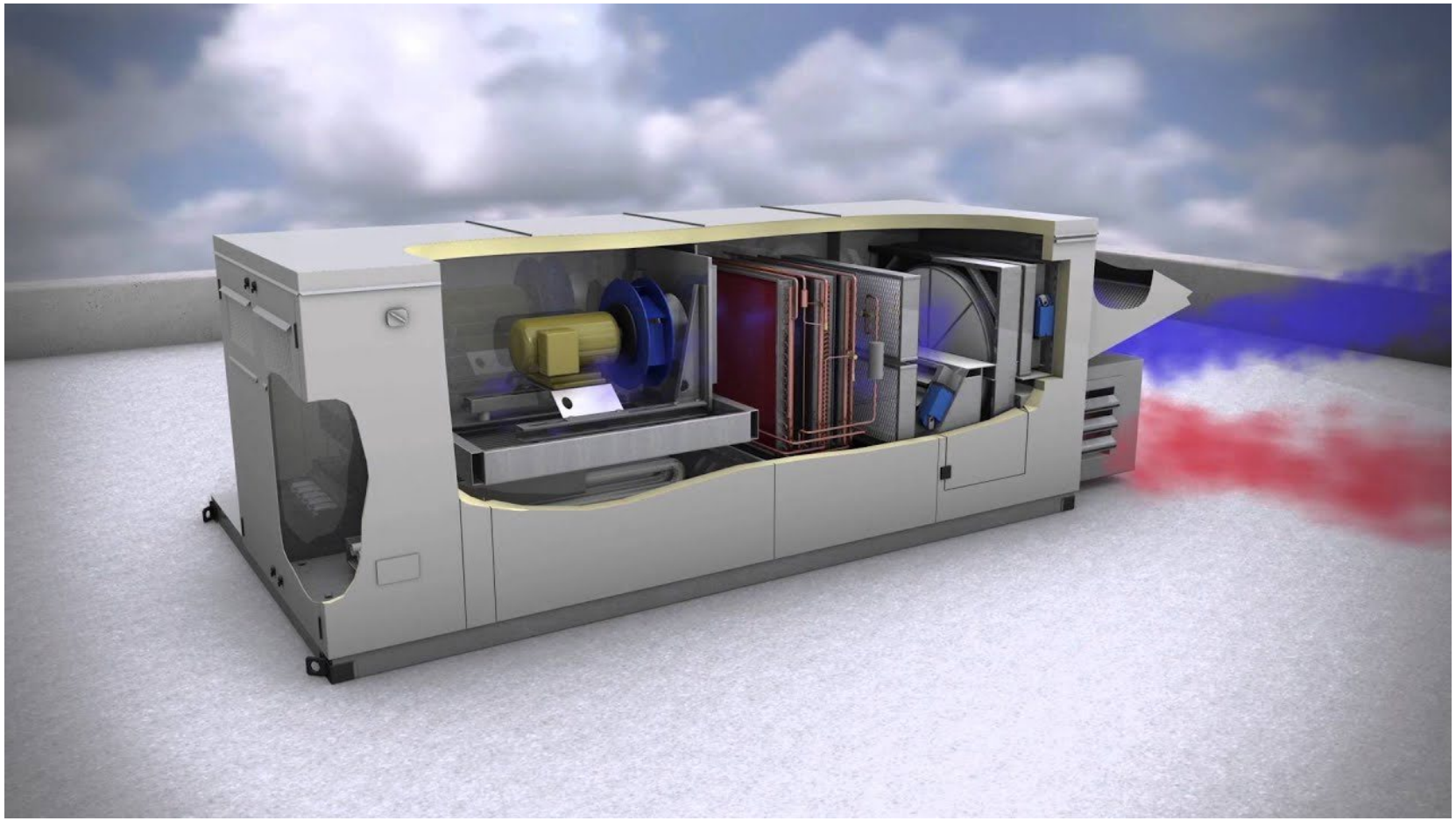
Economizer Mode

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

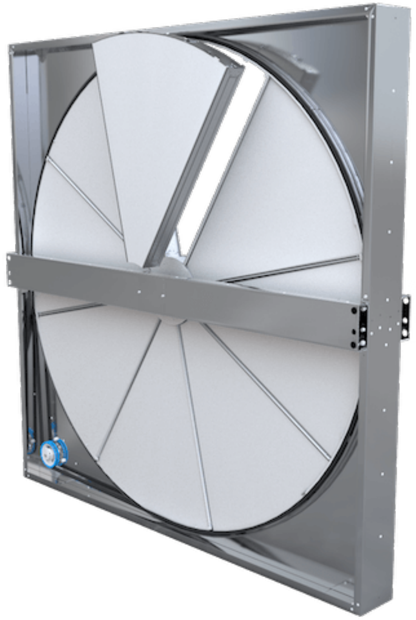
Free Cooling Mode

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

Dehumidification



DEDICATED OUTSIDE AIR SYSTEM (DOAS)



AHRI CERTIFIED®
www.ahridirectory.org

Certificate of Product Ratings

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

Old AHRI Reference Number :

Brand Name : Airxchange

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 (scfm) : 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	0.9	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.

CERTIFICATE VERIFICATION
The information for the model cited on this certificate can be verified at www.ahridirectory.org, click on "Verify Certificate" link and enter the AHRI Certified Reference Number and the date on which the certificate was issued, which is listed above, and the Certificate No., which is listed at bottom right.

AHRI AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE
we make life better™

CERTIFICATE NO.: 132187591191029440

AHRI ERV performance extrapolation - straight line method

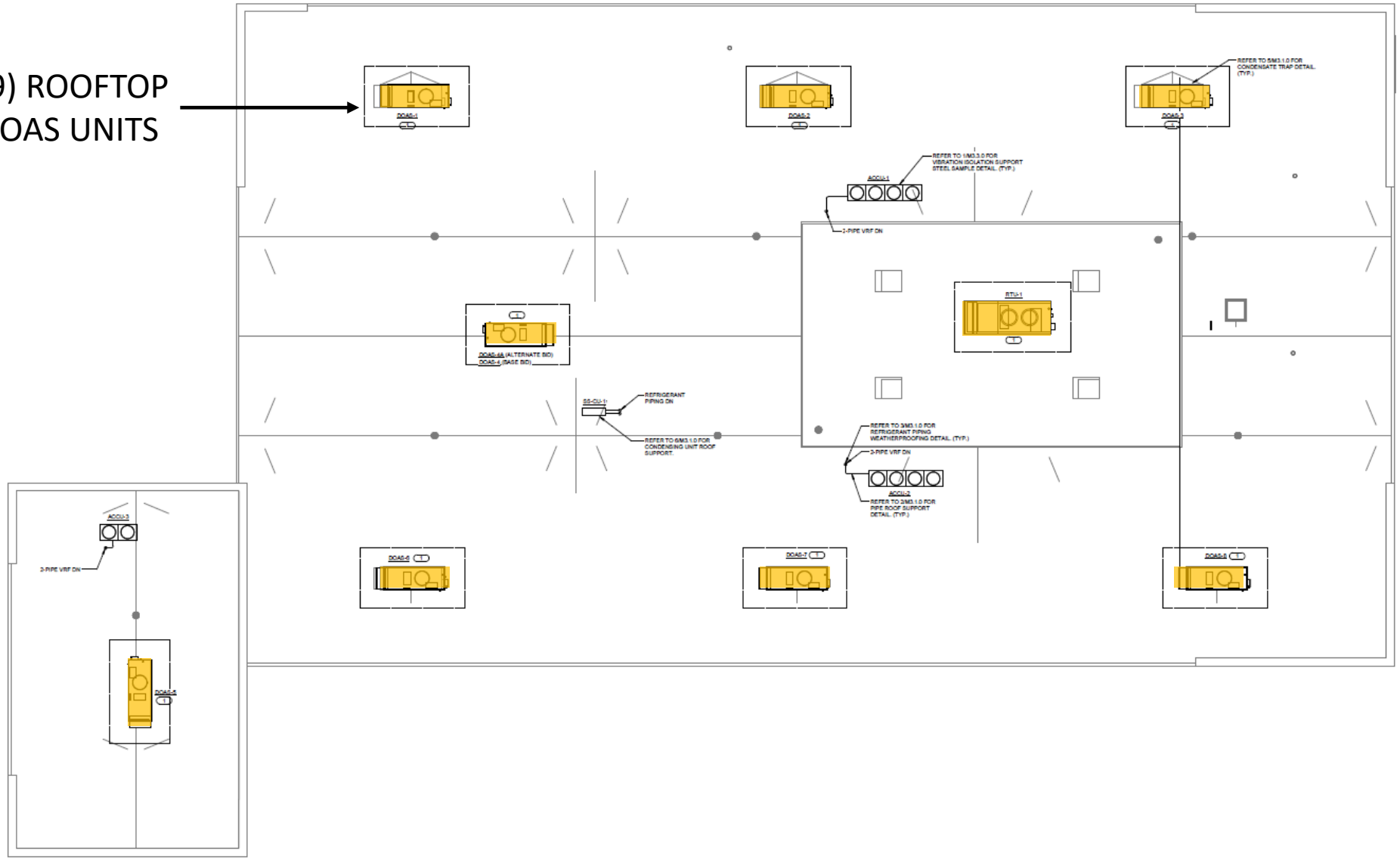
WUFI Inputs
Sensible Recovery Efficiency
0.81
Humidity Recovery Efficiency
0.75

Total Design Airflow
10,435

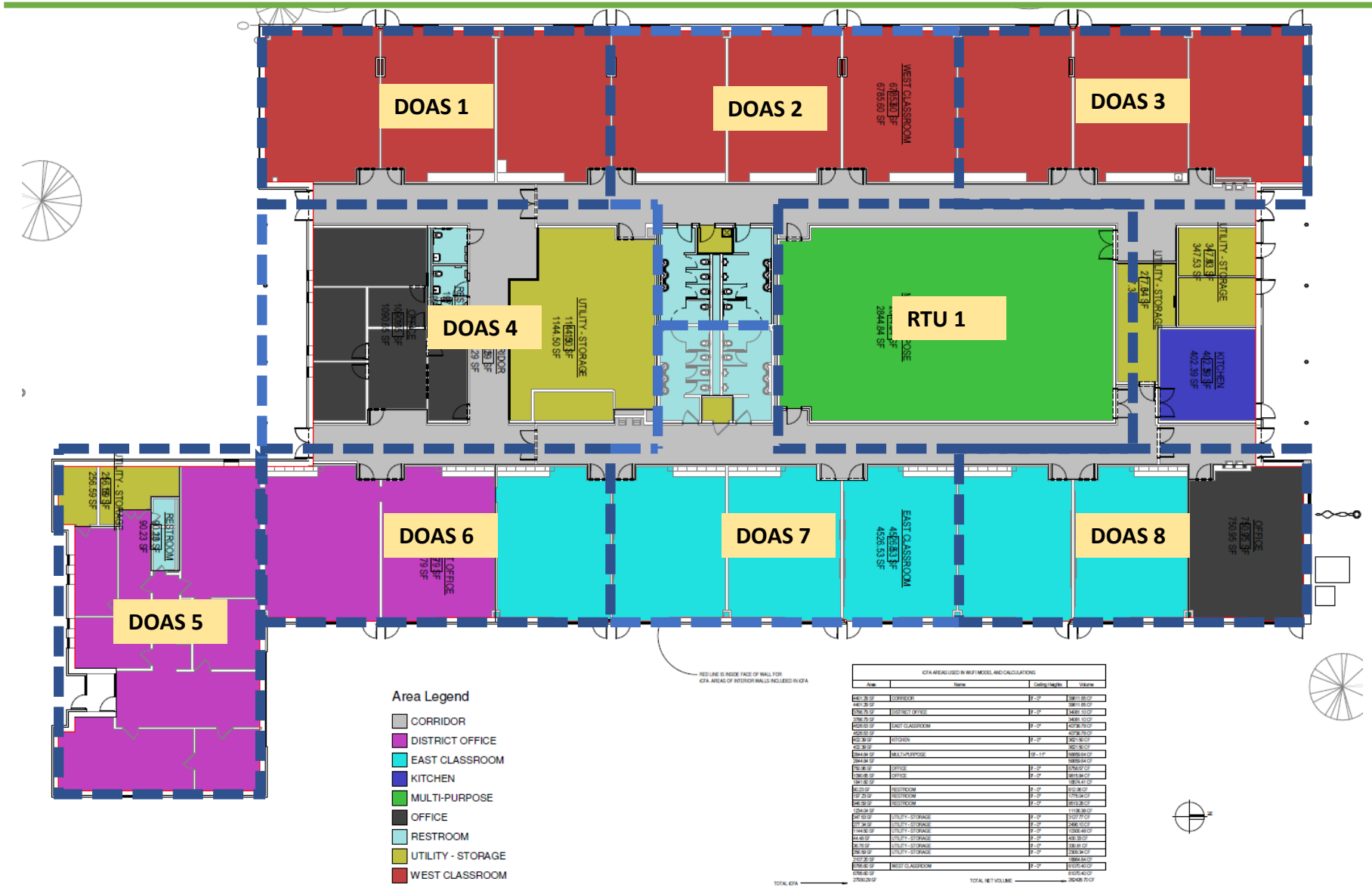
Model	Units	CFM	Net Sensible (%)		Net Latent (%)		Weighted Sensible Recovery	Weighted Humidity Recovery	Net Sensible Slope		Net Latent Slope	
			Heating	Cooling	Heating	Cooling			Heating	Cooling	Heating	Cooling
DOAS-1	100% AHRI Rated Airflow	1,400	76	74	70	69			0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	980	80.8	81.2	76.0	75.0	0.0759	0.0714				
DOAS-2	100% AHRI Rated Airflow	1,400	76	74	70	69			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	0.1114	0.1017				
DOAS-3	100% AHRI Rated Airflow	1,400	76	74	70	69			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	0.0725	0.0684				
DOAS-4	100% AHRI Rated Airflow	1,400	76	74	70	69			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	0.0765	0.0720				
DOAS-5	100% AHRI Rated Airflow	1,400	76	74	70	69			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	0.0712	0.0671				
DOAS-6	100% AHRI Rated Airflow	1,400	76	74	70	69			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	0.0563	0.0537				
DOAS-7	100% AHRI Rated Airflow	1,400	76	74	70	69			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	0.1112	0.1014				
DOAS-8	100% AHRI Rated Airflow	1,400	76	74	70	69			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	0.0739	0.0696				
RTU-1	100% AHRI Rated Airflow	3,200	65	64	61	60			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	0.1626	0.1418				
	100% AHRI Rated Airflow								0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0	0.0000	0.0000				
	100% AHRI Rated Airflow								0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0	0.0000	0.0000				
	100% AHRI Rated Airflow								0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0	0.0000	0.0000				
	100% AHRI Rated Airflow								0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0	0.0000	0.0000				

DEDICATED OUTSIDE AIR SYSTEM (DOAS)

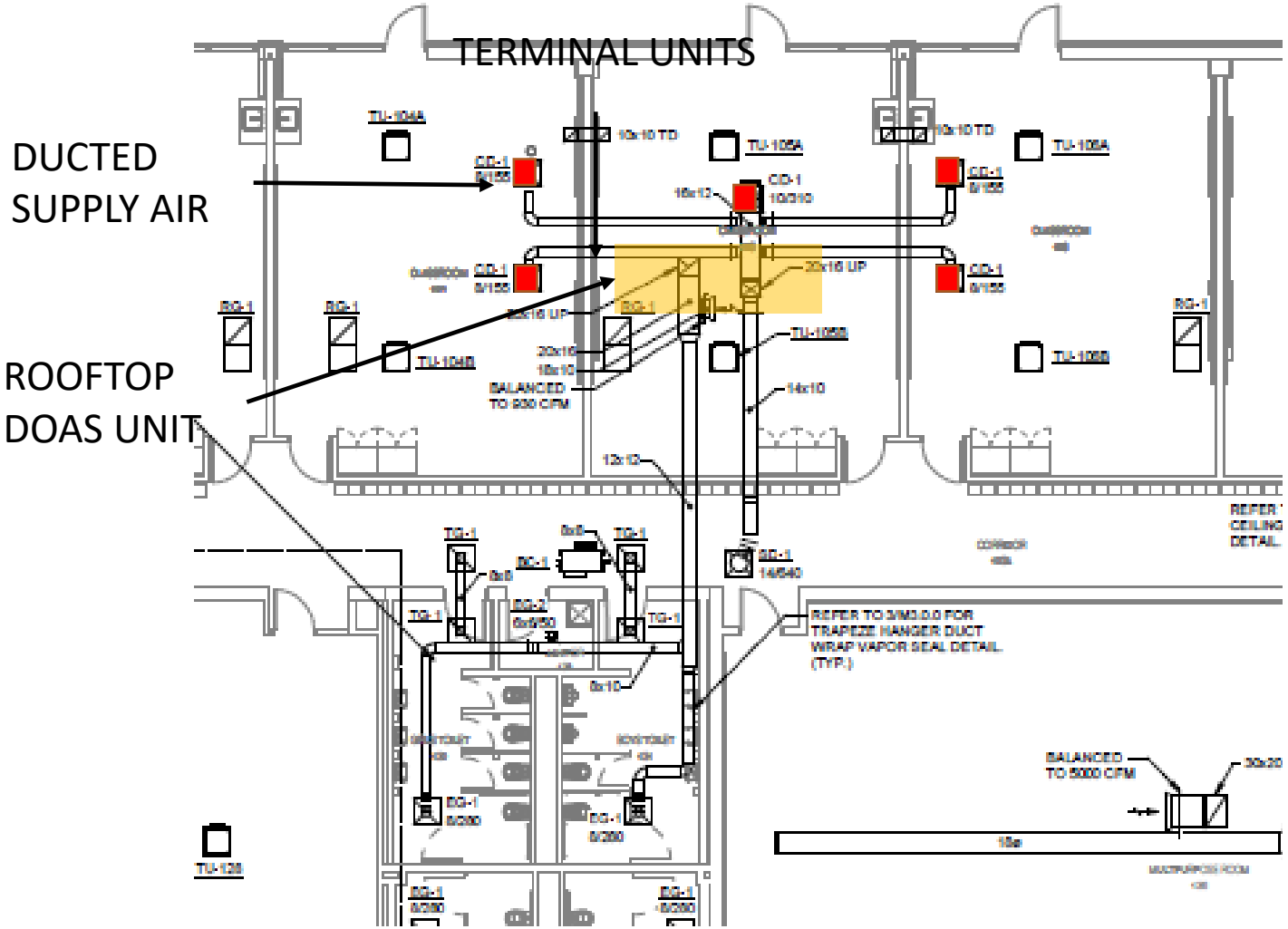
(9) ROOFTOP DOAS UNITS



DEDICATED OUTSIDE AIR SYSTEM (DOAS)



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

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

Variable Refrigerant Flow System (VRF)

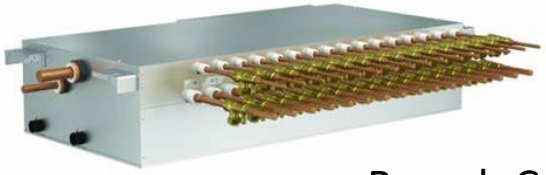
VRF System Components:

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.

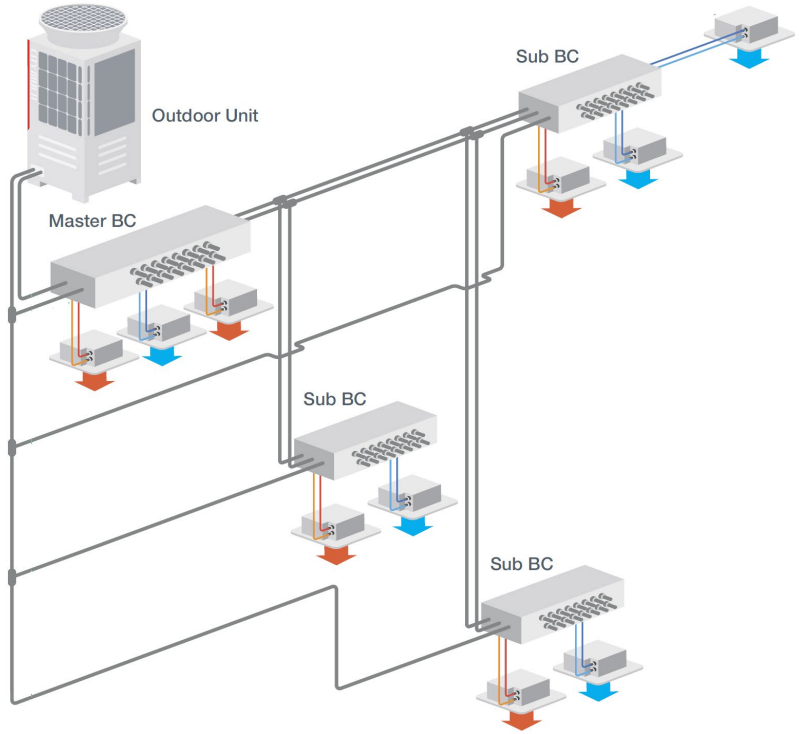
Terminal Units
Located in each conditioned space.

Air Source Condensing Unit



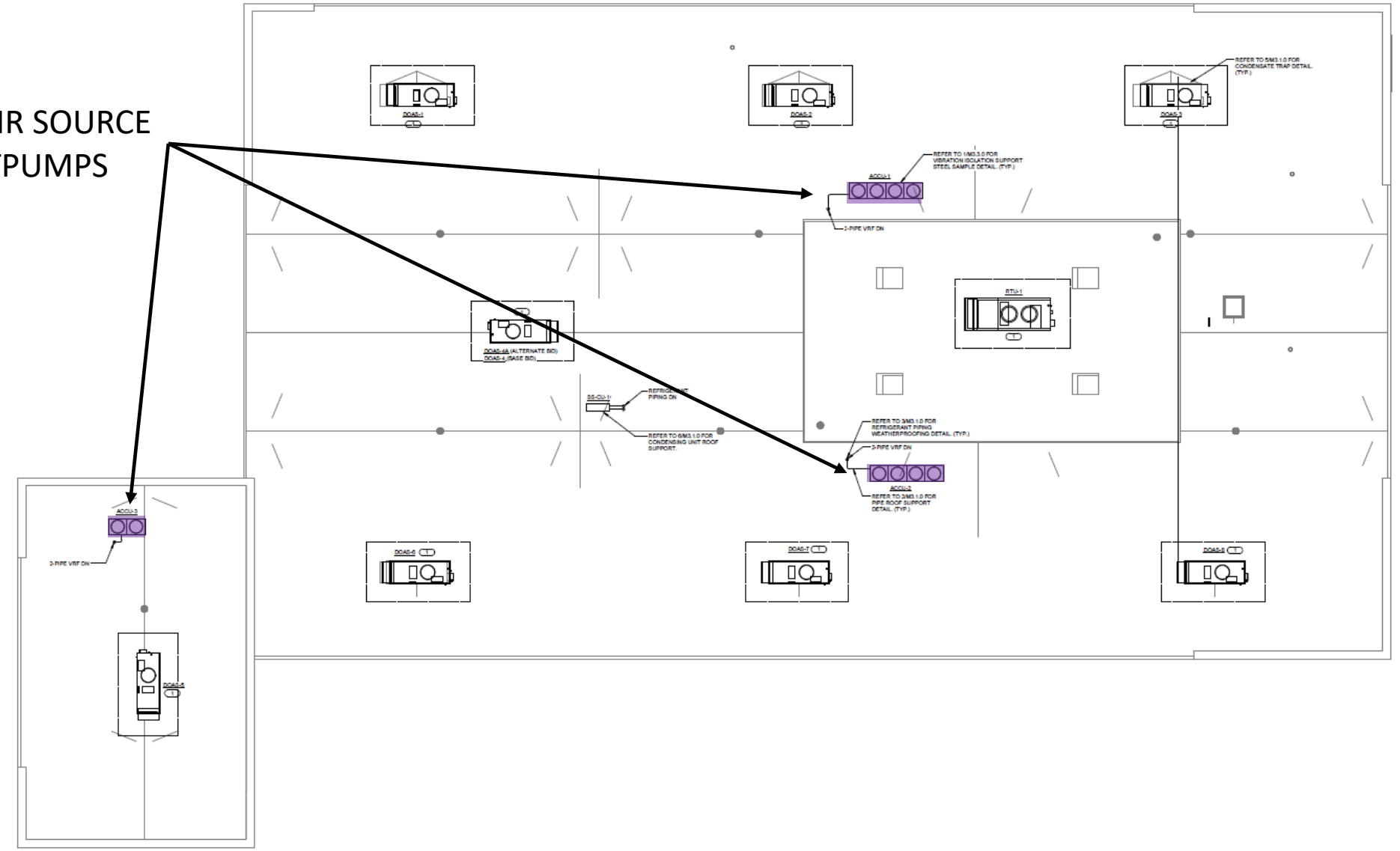
Branch Controller

Terminal Unit - Cassette

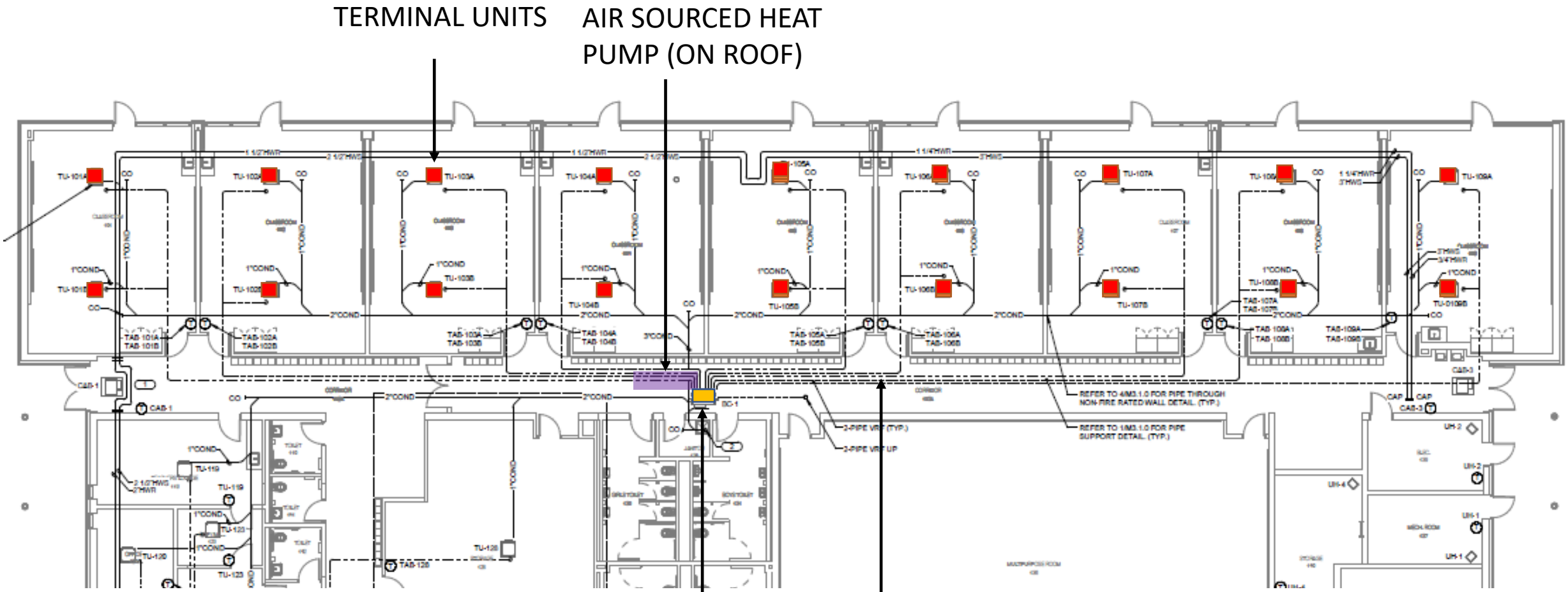


Variable Refrigerant Flow System (VRF)

(3) AIR SOURCE HEATPUMPS

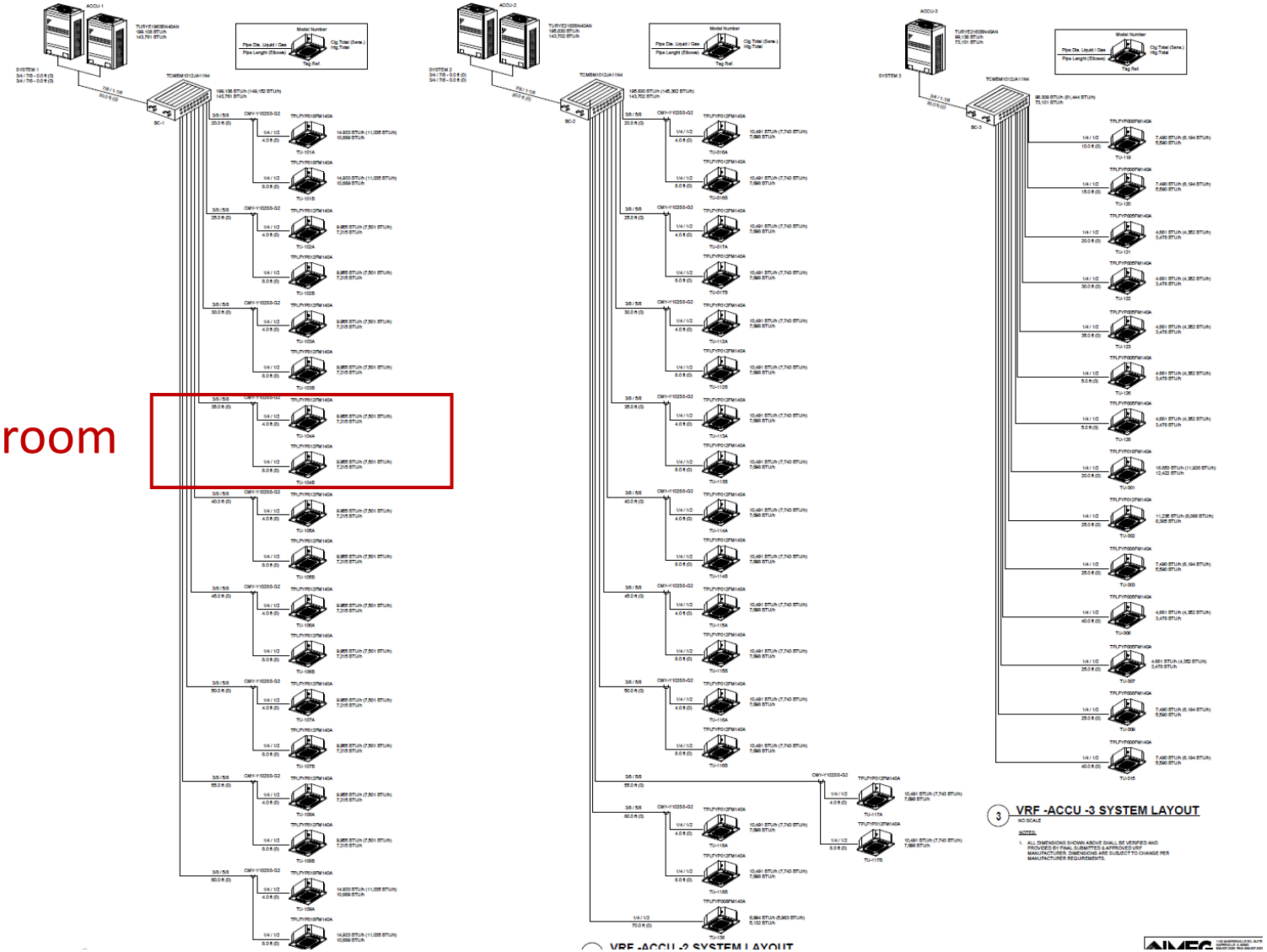


Variable Refrigerant Flow System (VRF)



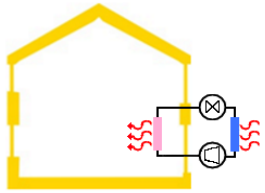
Variable Refrigerant Flow System (VRF)

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.



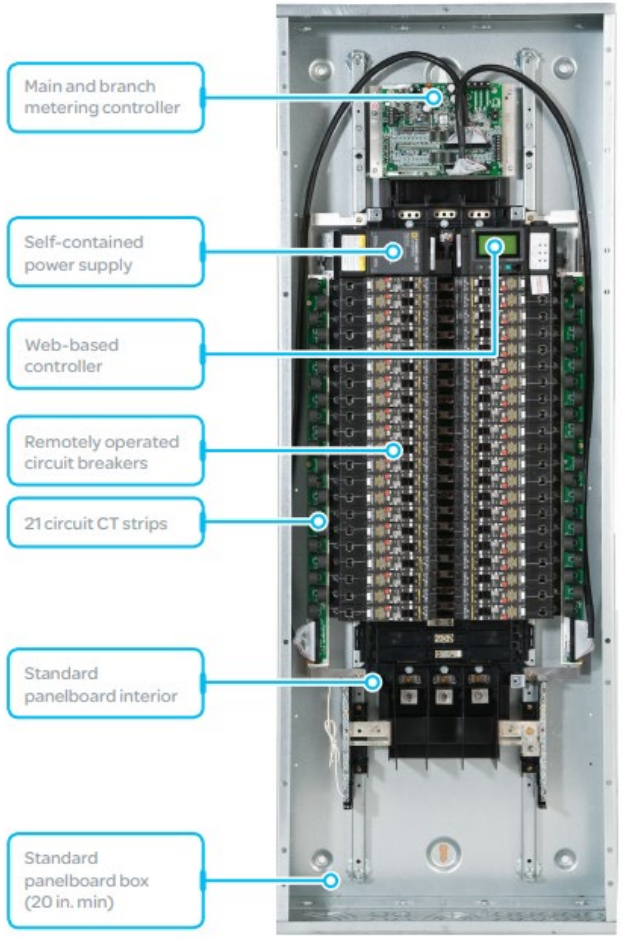
Variable Refrigerant Flow System (VRF)

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.

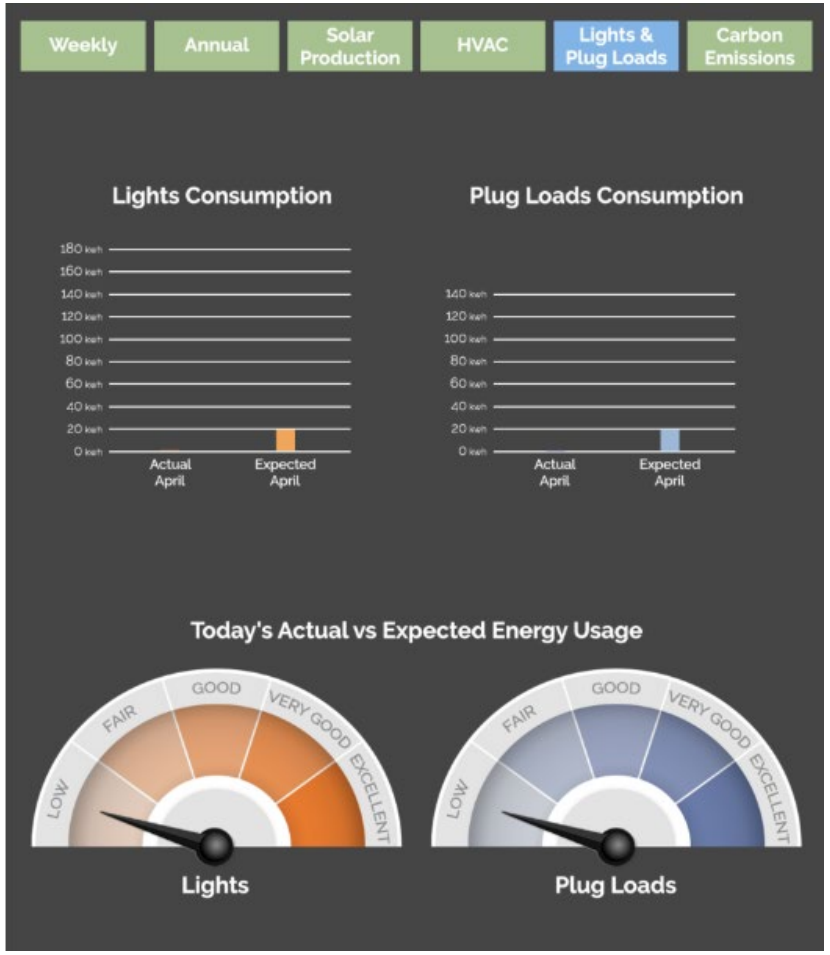
Consider implications of running refrigerant lines throughout the interior space.

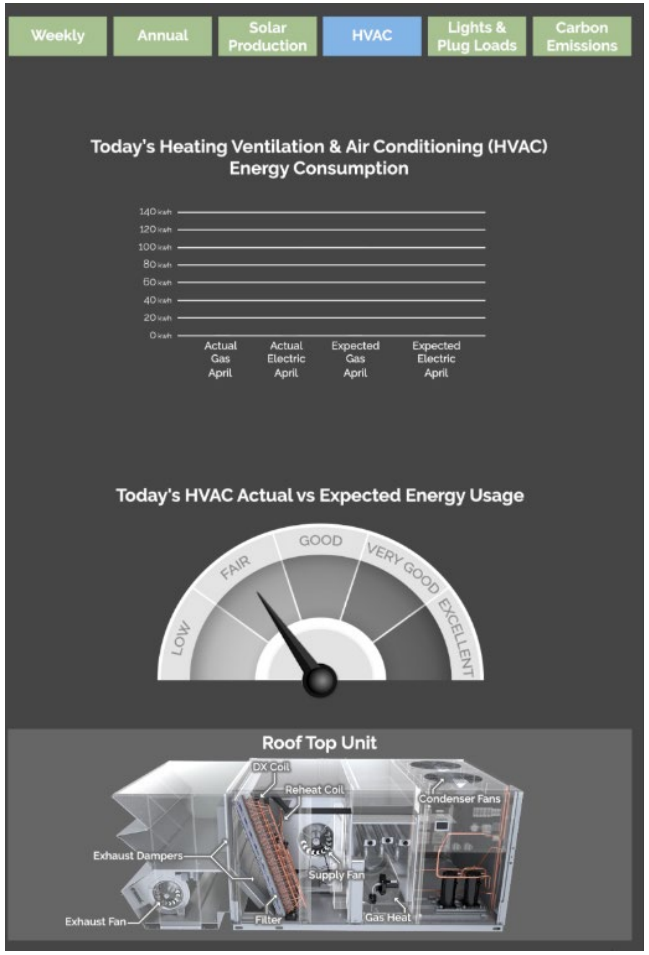
Energy Efficient Lighting and DHW Systems

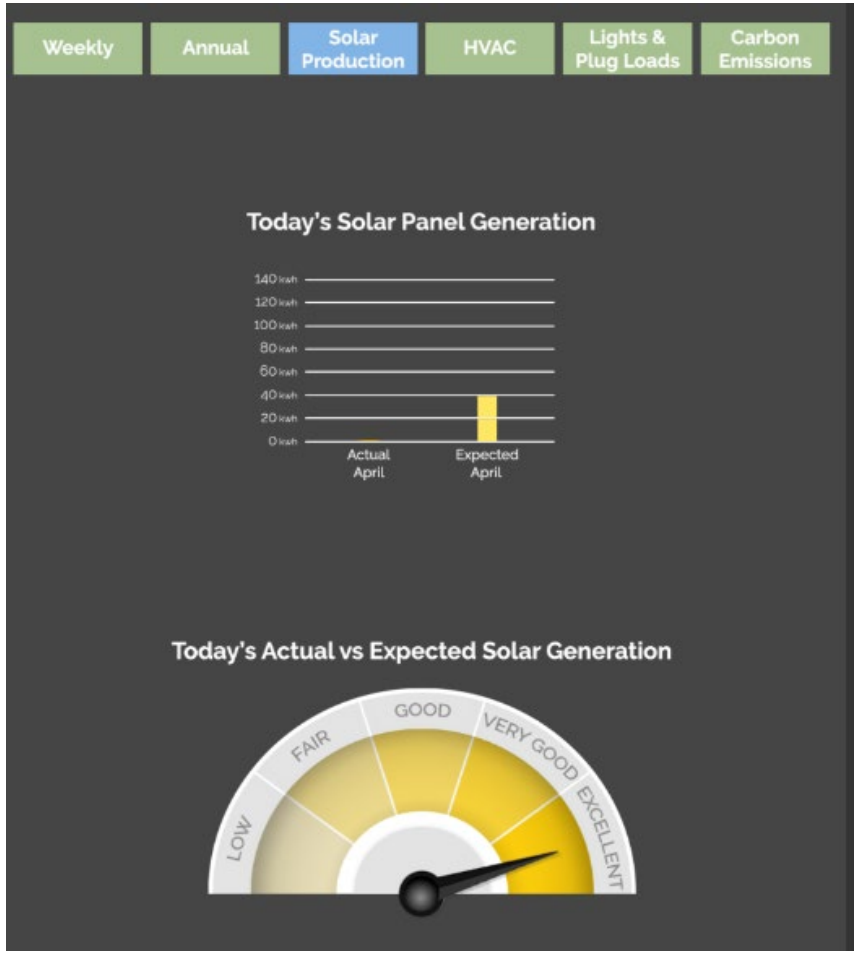
- All LED Lighting
- All lighting on “Vacancy” Sensors or “Occupancy” Sensor where possible.
- DHW loop on thermostat controlled “On Demand” System.
- Measurement and Verification Electrical Panels for energy monitoring



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

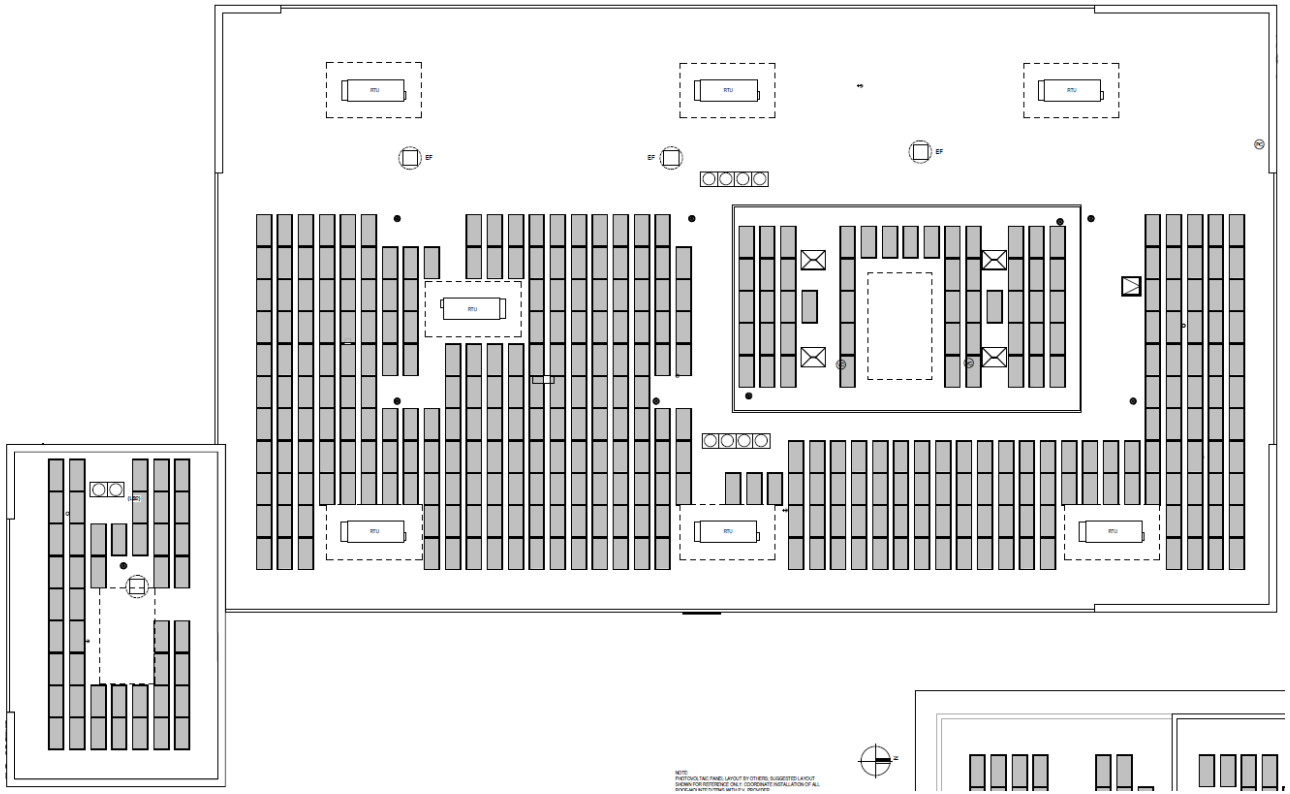
Occupancy Summary for WUFI	Occupant Type	Occupancy	Start Time	End Time	Hours	Days/Year	Include in Max (only concurrent uses)	Max	Occupant Hours per Year	Average Occupancy (= Occupant Hours per yr / 8760 hrs per yr)
School Year (Heating Season)										
Educational										
Classrooms	Children (age 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
Extracuricular 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
					0.00					
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

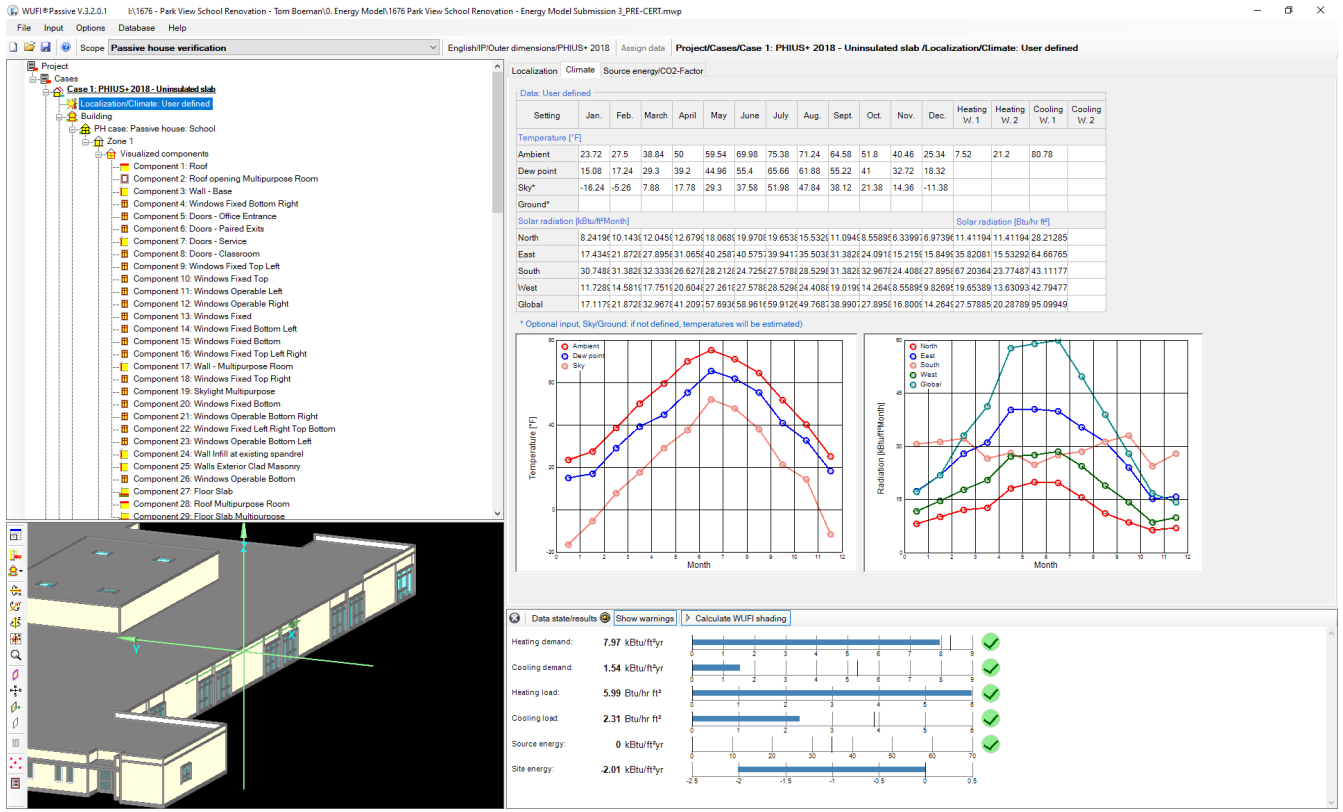
Tighten the Schedule and Make sure the owner and operating engineer are on board with the ventilation strategy.

Offset Site Energy with Renewables.

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



Model Results

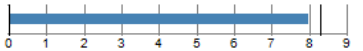


PASSIVEHOUSE REQUIREMENTS

Certificate criteria: PHIUS+ 2018

Heating demand

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

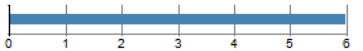


Cooling demand

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

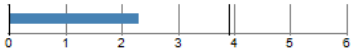
Heating load

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



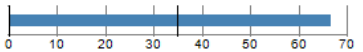
Cooling load

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



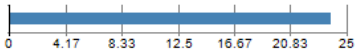
Source energy

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



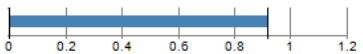
Site energy

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

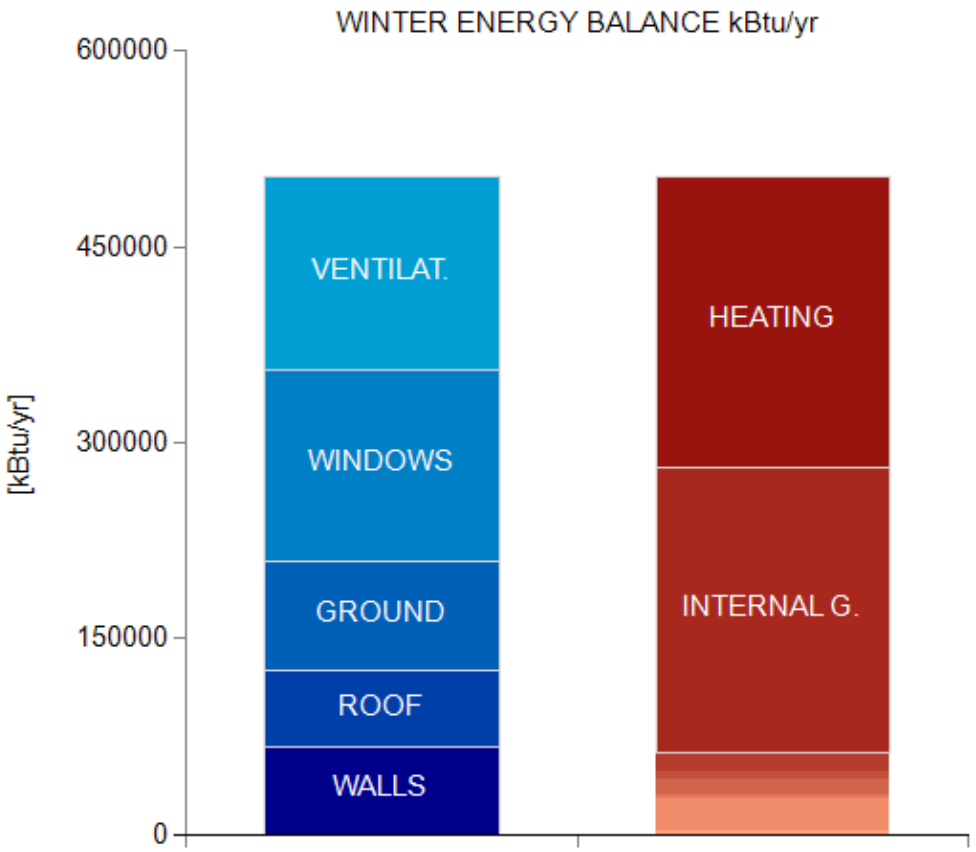


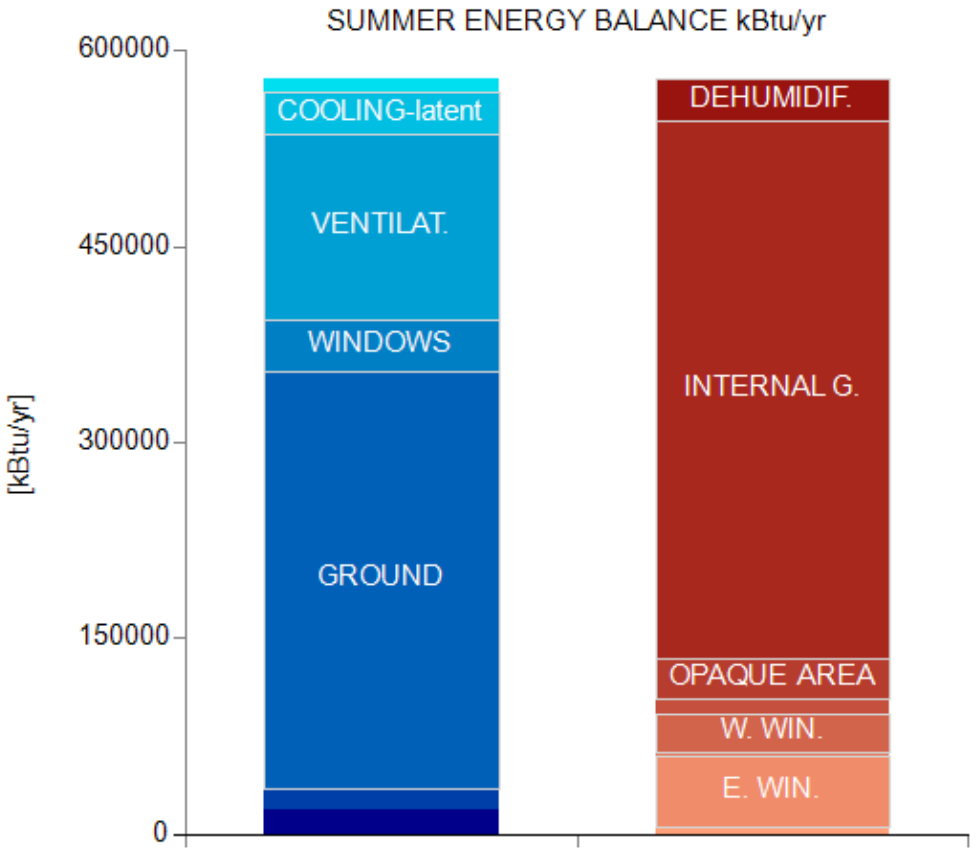
Air tightness

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



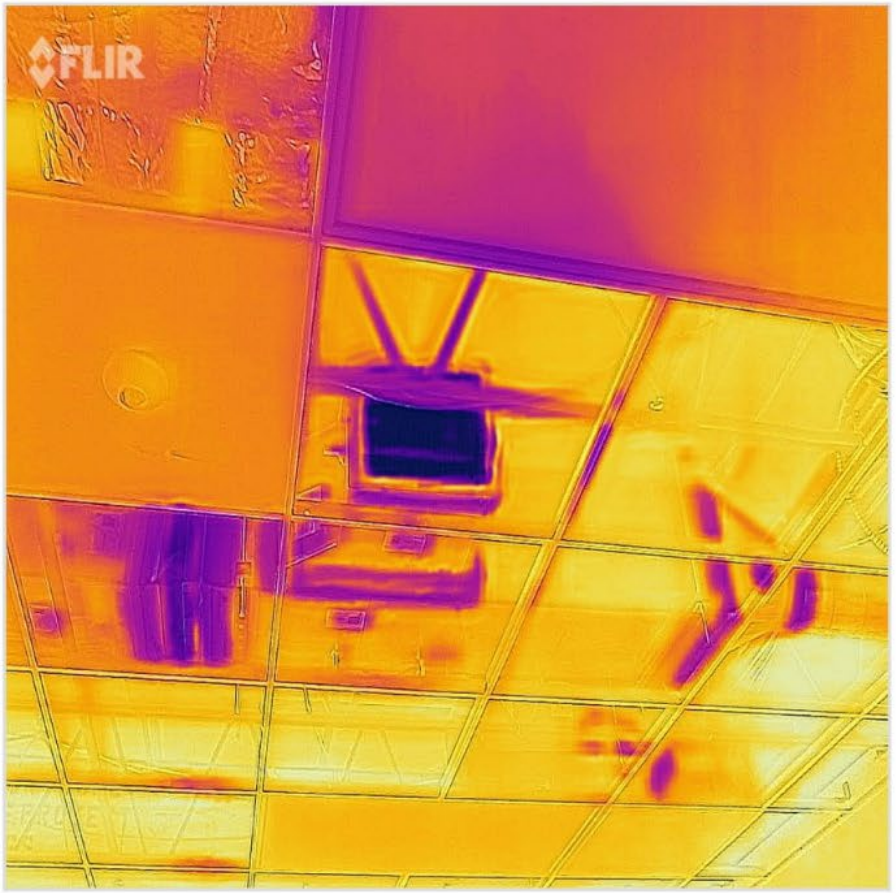
Model Results





Field Verification

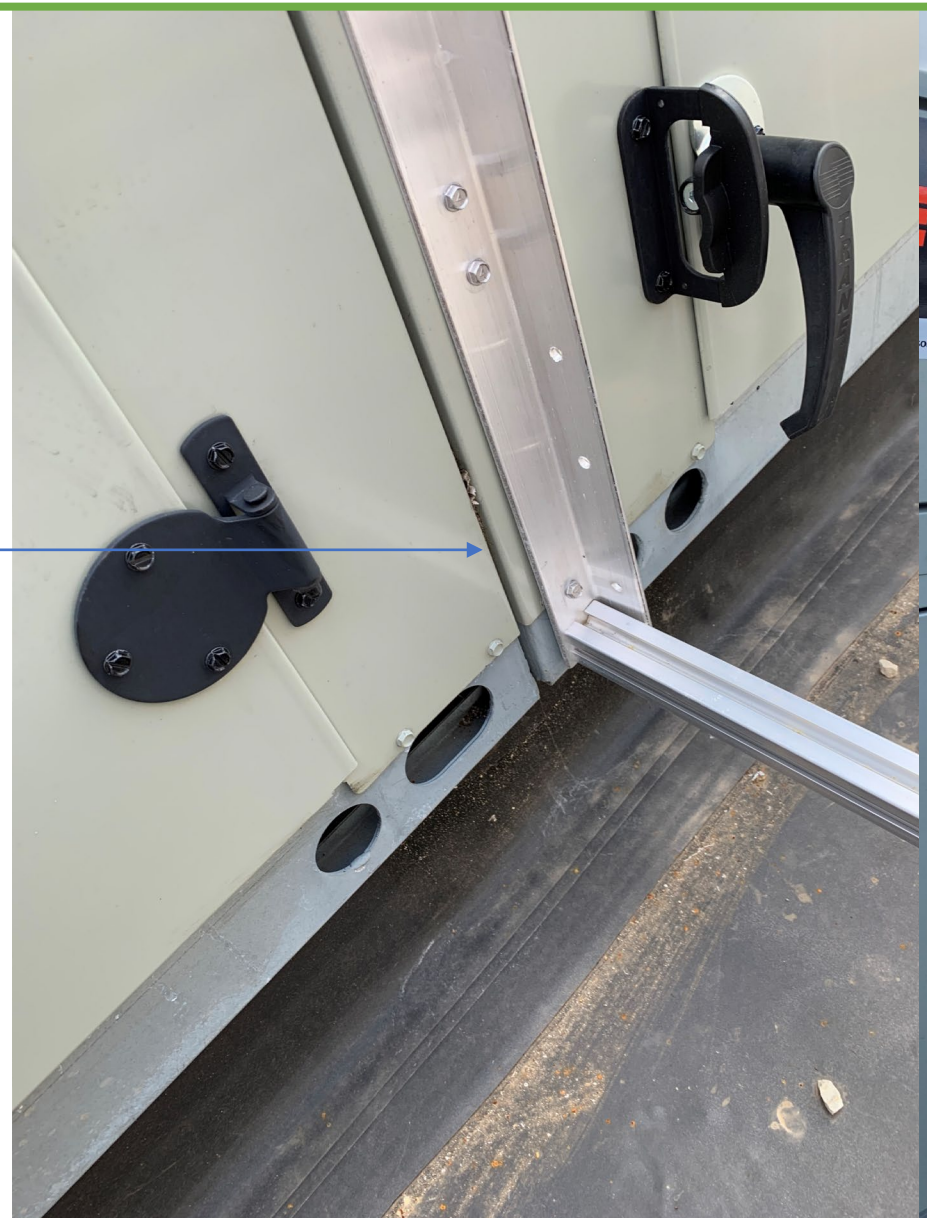
Field Verification



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

Field Verification

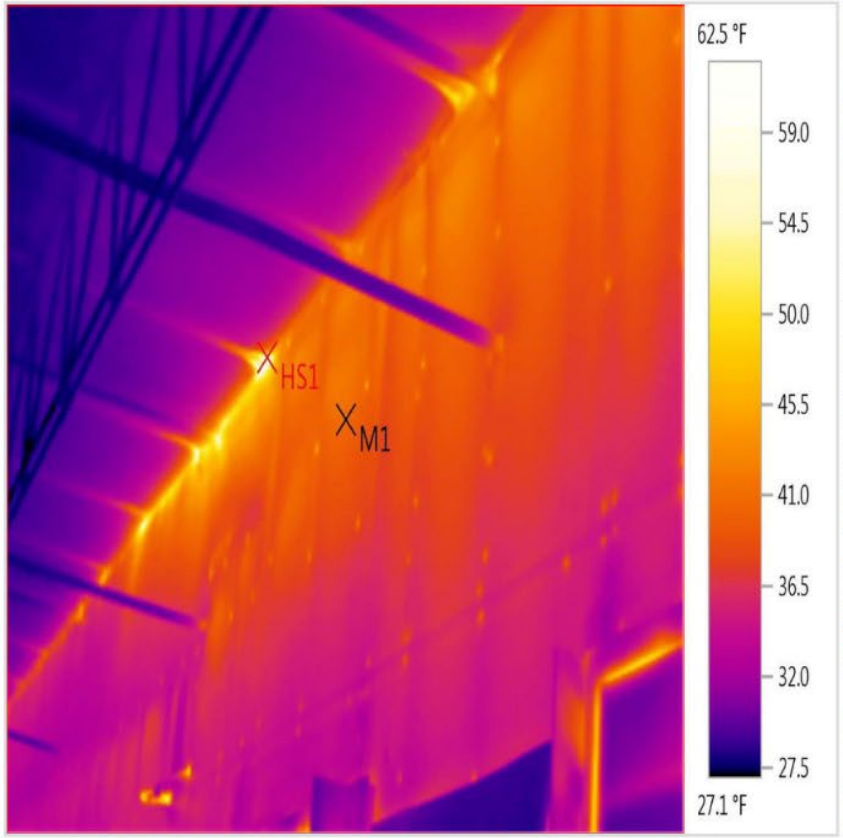
Loose joint between DOAS main enclosure and ERV module



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.

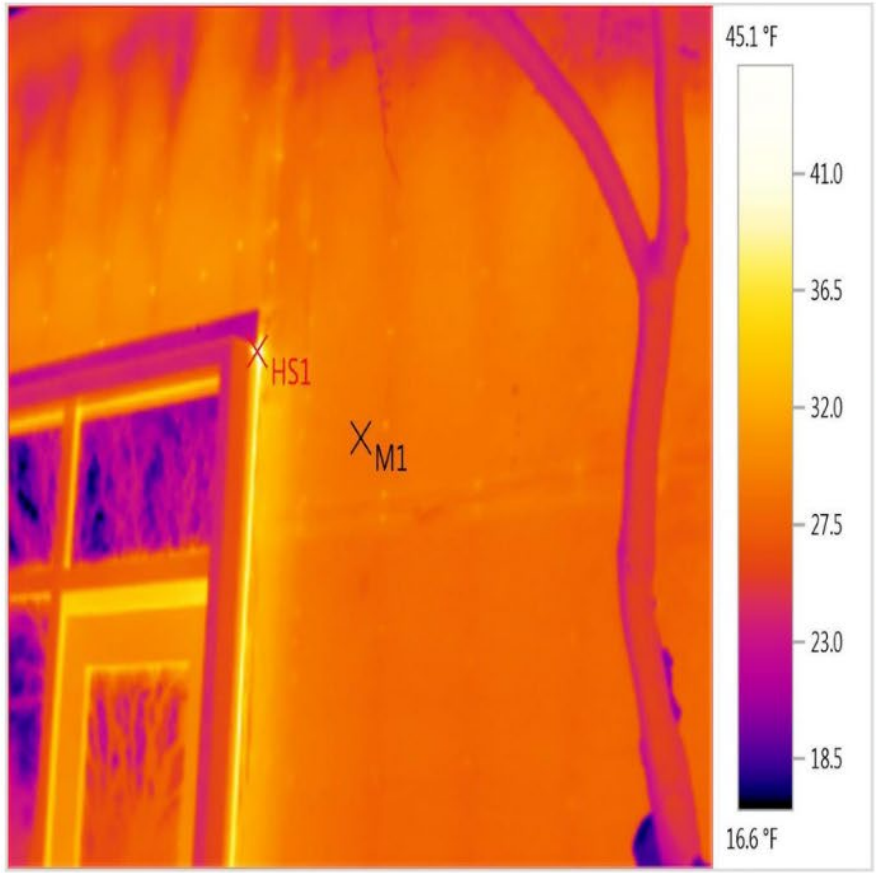
Field Verification



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 recommending 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.

Field Verification

PV Framing going in

The Final Product

The Final Product

The Final Product

The Final Product

The Final Product

THANK YOU!