

HVAC Systems Study



Joshua Hyde Public Library

Sturbridge, MA

October 1, 2021

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General

The Town of Sturbridge has requested an evaluation be performed of the HVAC systems serving the Joshua Hyde Library that explores options for improving occupant comfort control as well as increasing overall energy performance of the systems. Overall building area is approximately 8,300 SF with a conditioned occupied space area of 7,700 SF.

As part of this evaluation, options for equipment replacement and overall system distribution upgrades have been explored that will satisfy the varying deficiencies discovered during the evaluation. In addition to our site visit, the evaluation includes review of existing documentation, analysis of the existing building, HVAC systems and development of preliminary options.

van Zelm has reviewed the existing conditions within the building along with input from facilities staff and provided recommendations for HVAC system upgrades to be reviewed by the Town of Sturbridge.

It was brought to our attention that the Town of Sturbridge is a green community. Therefore, short term goals to consider are as follows:

- Removal of fossil fuel from the site would be preferred moving forward.
- Overall, the town must reduce energy consumption by 20% over a 5 year period.

Although the focus of the study is on the HVAC systems, a couple of envelope upgrades should be considered:

- Removal of existing skylight and replace with vaulted ceiling to match existing on main level.
- Replace old aluminum storm windows on main level of original building.

Summary

The two existing constant volume roof top units and PTAC units which serve library and support areas are past their expected service life, do not consistently provide adequate comfort levels and are in need of replacement for the following reasons:

- All units are past their expected service life and one of the RTU's recently required costly repairs.
- Units do not consistently provide adequate comfort levels year 'round due to minimal temperature control (one thermostat per floor).
- Low energy efficiency due to age of equipment.
- Units use the R-22 refrigerant which has been phased out of production due to it's high global warming and ozone depletion potential.

- In basement level, which is served by two PTAC units, minimal ventilation air is provided to the space.

It should be noted that, because replacement constant volume RTU's similar to existing units are considered a baseline system by current energy codes for comparison to higher energy efficient system options, they would not be eligible for any utility company rebate incentives.

Recommendation summary is as follows:

- Removal and replacement of existing Roof Top and PTAC Units with current state of the art high efficiency RTU's.
 - Roof mounted RTU's with electric cooling and heating or electric cooling and propane heat to both be considered.
 - A single RTU with electric cooling and heating or electric cooling and propane heat mounted on steel dunnage on grade on the north side of the building is also considered.
 - RTU recommendations also include new terminal units, VAV boxes, controls, etc to allow for increased thermal comfort.
- Alternative option includes a Variable Refrigerant Volume (VRV) System coupled with an Energy Recovery Ventilation (ERV) as an all- electric energy efficient solution that also provides increased thermal comfort.
- The two replacement system option recommendations will consider the impact of removing the skylight as an energy saving measure.
- Supplemental heating and ventilation systems to serve smaller areas where heating and ventilation deficiencies exist.
- Considerations for replacement air handling equipment to include high efficiency filtration for infection disease mitigation, such as COVID-19.

Existing Conditions

Main library areas and support spaces are served by the following systems:

Area Served	Unit Type	Supply Air	Vent. Air	Cooling MBH/Tons	Heating MBH	Heating Type
Basement	(2) PTAC	300 ea.	60 ea.	14/1	11.7	Electric
Intermediate	RTU	3,000	600	90/7.5	148	Propane
Main	RTU	6,000	460	180/15	290	Propane

Note: The RTU roof curbs and/or the curb adaptors do not appear to be insulated. This is causing a condensation issue during the cooling season which is staining the ceilings directly below the RTU locations on the roof.



Typical Rooftop Unit



Typical PTAC Unit

The existing propane tank, which serves the two RTU's, is 1,000 gallon capacity. It was brought to our attention that during the peak heating season frequent refills (every two weeks) are required. The tank is buried and it's age isn't known.



Top of Propane Tank

A roof mounted exhaust fan serves the men's and women's rooms located on the intermediate level. Fan is activated by light switch in either room.

A cabinet type exhaust fan serves the toilet room adjacent to the main entry. Fan is activated by light switch.

The elevator machine room has a gravity vent duct that ties into the adjacent elevator shaft. It was brought to our attention that hydraulic oil fumes occasionally build up in the room, especially during minimal elevator use.

Other areas of concern that were brought to our attention:

- There is no ventilation or heat in the basement storage rooms.
- There is no ventilation air (exhaust) serving the Janitor Closet.
- There is no ventilation air or heat in the crawl space below the main floor of the original building.
- The rear three story stairwell has only minimal airflow supplied by the main level RTU and, therefore, additional heat is required.
- There isn't a heater located in the main level entry. Even though new doors were installed inboard of the existing exterior doors, an additional heater is required.

Evaluations

The two existing constant volume roof top units and PTAC units which serve library and support areas are past their expected service life, do not consistently provide adequate comfort levels and are in need of replacement for the following reasons:

- All units are past their expected service life and one of the RTU's recently required costly repairs.
- Units do not consistently provide adequate comfort levels year 'round due to minimal temperature control (one thermostat per floor).
- Low energy efficiency due to age of equipment.
- Units use the R-22 refrigerant which has been phased out of production due to it's high global warming and ozone depletion potential.
- In basement level, which is served by two PTAC units, minimal ventilation air is provided to the space.

We have performed heating, cooling and ventilation load calculations for each level of the building (see Appendix 1).

- A separate load calculation has determined that removal of the skylight above the main level will result in a 5 ton reduction to the cooling load and a 110 MBH reduction to the heating load or a 20% reduction to the building cooling and heating loads overall.

Note: After review of the draft report, the Library does not want to remove the skylight at this time. Cooling and heating load reductions listed below are for future reference.

Our evaluated options for replacement systems are as follows (see also Appendix 2):

Option 1 System Description

- Roof mounted Variable Air Volume (VAV) RTU's. Existing electric service will serve dx cooling and existing underground 1,000 gallon propane tank will serve heaters in each unit.
 - New 15 ton unit would serve the entire main level.
 - A new 10 ton unit would serve the main level in conjunction with the skylight removal.
 - New 7.5 ton unit would serve the intermediate and basement levels.
 - Reuse existing roof mounted curbs and insulate as required to address condensation issue. Provide new insulated curb adaptor to mate new unit footprint to existing curbs.
 - Reuse existing supply and return duct mains on the main and intermediate levels.
 - Provide new supply and return branch ducts off of the intermediate level system and extend down to the basement.
 - Provide new VAV boxes with electric reheat coils and associated temperature sensors to provide additional temperature control zones on each level. Each system has the capability to provide simultaneous heating and cooling. Quantities for budgeting purposes are as follows:
 - Main Level – 6 zones.
 - Intermediate Level – 3 zones.

Basement Level – 2 zones.

- Provide small web-based Building Automation System (BAS) capable of enabling RTU's to run based on a building time schedule and to control zone VAV boxes.

Option 1 A System Description

- Same as option 1 above except replace propane heat with electric heat in order to remove the 1,000 gallon propane tank from the site..
- After review of electric cooling/electric heat unit selections, we have determined the current building electric service cannot support this all electric system and, therefore, is not a viable option.

Option 2 System Description

- As an alternative to roof mounted RTU's, provide a single 20 ton unit mounted on steel dunnage on grade on the north side of the building. Existing electric service will serve dx cooling and existing 1,000 gallon propane tank will serve heater. Extend supply and return duct mains up the side of the building and connect the new mains to existing at the roof level.
 - A new 15 ton unit would be provided in conjunction with the skylight removal.
 - Unit selection information can be provided if it has been determined this option merits further review.

Option 3 System Description

- Provide a new Variable Refrigerant Volume (VRV) electric cooling and heating system coupled with an energy recovery ventilation unit. Existing electric service will serve dx cooling and heating. Therefore, the 1,000 gallon propane tank can be removed from the site.
 - New 20 ton system unit would serve the entire building.
 - A new 15 5ton system would serve the entire building in conjunction with the skylight removal.
- System would consist of the following components:
 - Roof or grade mounted air cooled condensing units. Roof mounted units would be mounted on equipment rails flashed into the roof. Grade mounted units would be mounted on steel dunnage.
 - Provide new fan coil units and associated temperature sensors to provide additional temperature control zones on each level. Fan coil units serving the larger zones would be ducted units recessed above the ceiling. Smaller fan coil units serving the three smaller offices on the main level would be recessed ceiling cassette type. Quantities for budgeting purposes are as follows:
 - Main Level – 6 zones.
 - Intermediate Level – 3 zones.
 - Basement Level – 2 zones.
 - Provide heat recovery boxes to allow for simultaneous heating and cooling capability for the entire system.
 - Provide ACR type copper tubing to connect the outdoor condensing units to the heat recovery boxes and from the boxes to the indoor fan coil units.

- Provide roof mounted Energy Recovery Ventilator (ERV) to provide code required ventilation air to the entire building. Unit will have a total energy recovery heat exchanger to pre-treat incoming outdoor air by using the building exhaust air.
- Reuse/modify existing supply and return ductwork and tie into new ERV.
- Provide small web-based BAS by VRV equipment manufacturer to control air cooled condensing units and zone fan coil units. BAS shall also enable ERV to run based on a building time schedule.

Option 4 System Description

- Same as Option 3 except as noted below:
 - Provide water cooled condensing unit located in a new indoor mechanical space.
 - Provide new vertical type geothermal wells coupled to the condensing unit with condenser water piping and pumps.

Recommendations

Areas of concern that must be corrected and that are separate from Options presented below:

- Provide ventilation and heat in the basement storage rooms.
- Provide ventilation air (exhaust) required by code to serve the Janitor Closet.
- Provide ventilation air and heat in the crawl space below the main floor of the original building or fully insulate the outside walls.
- Provide 2.0 KW cabinet unit heater at basement level of rear stairwell.
 - Provide concealed control to limit adjustment by facilities personnel only.
 - Dedicated heater must be provided in a stairwell by code.
- Provide 0.6 KW cabinet unit heater in main entry vestibule.
 - Provide concealed control to limit adjustment by facilities personnel only.
 - Dedicated heater should be provided to limit operation of main systems during off hours.

Option 1 – **it is a recommended system for a final comparison with the following comments:**

- Has simultaneous cooling and heating capability.
- Less efficient system than Options 3 & 4.
- Requires retaining a propane source for heating.
- Energy rebate incentive appears to be minimal.

Option 2 – not recommended for the following reasons:

- Has a higher installed cost than Option 1 due to grade mounted steel dunnage and duct main connections.
- Visible exterior ductwork would not be desired for this historic district building.
- Less efficient system than Options 3 & 4.
- Requires retaining propane source for heating.
- Energy rebate incentive most likely not available.

Option 3 –**it is a recommended system for a final comparison with the following comments:**

- Lower installed cost than Option 4.
- More efficient than Options 1 & 2.
- Has simultaneous cooling and heating capability.
- Does not require propane for a heating source. Therefore, tank can be removed.
- Energy rebate incentive appears to be minimal.

Option 4 – although it has the highest efficiency, it is not recommended for the following reasons:

- It is the most costly system option due to the drilling and installation of the geothermal wells unless a significant energy rebate incentive is available.
- Will require additional indoor mechanical space for water cooled condenser, condenser water piping and pumps.

Preliminary Cost Estimates

Preliminary Rough Order of Magnitude (ROM) Cost Estimates have been included in attached **Appendix #3.**

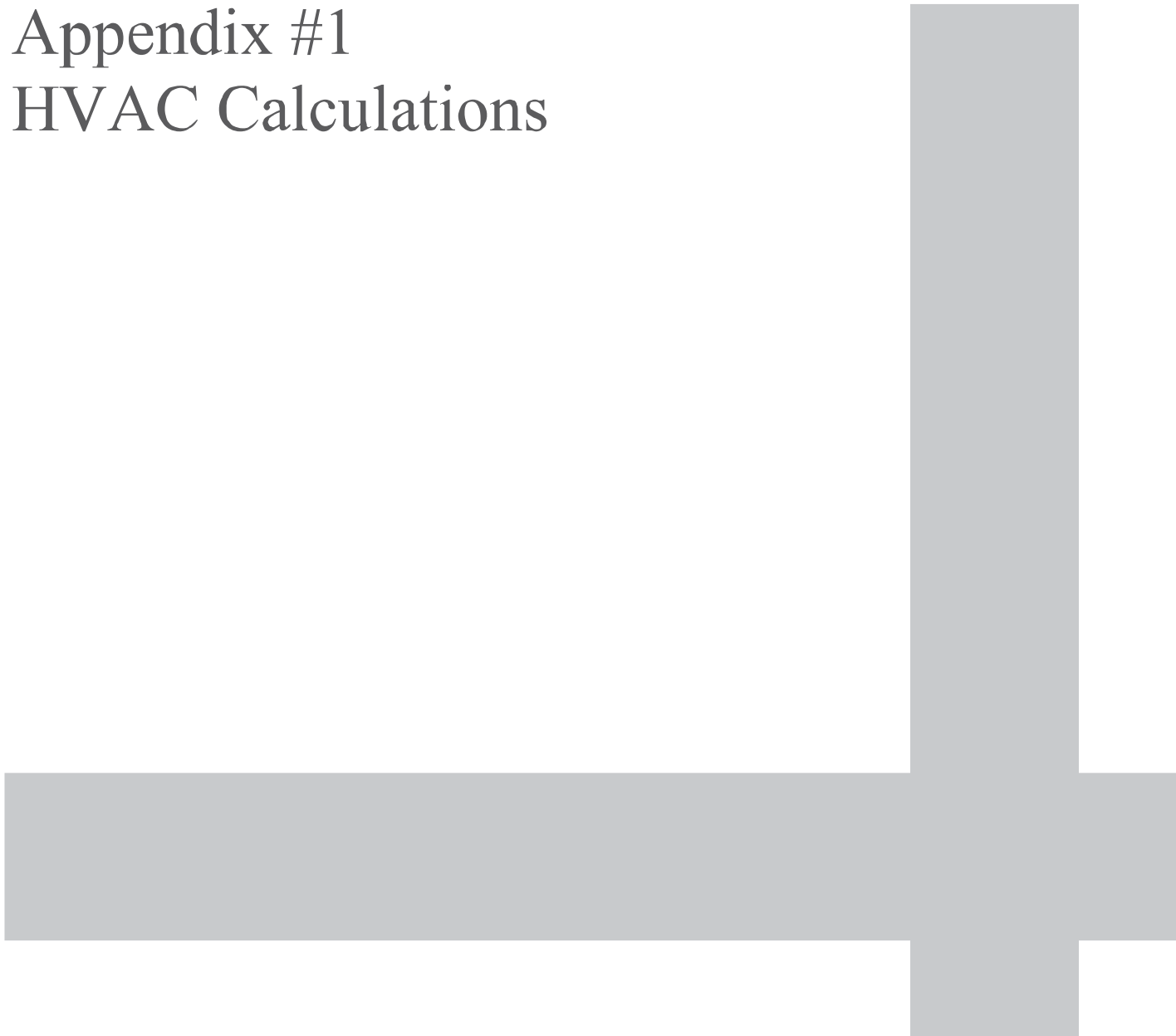
Energy Incentives

Eversource/National Grid Incentives information for HVAC and Heat Pump applications have been included in attached **Appendix #4.**

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Appendix #1

HVAC Calculations



Joshua Hyde Library
HVAC Load Analysis

for



CHVAC COMMERCIAL
HVAC LOADS

Cooling and Heating Load Calculations With Skylight

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Building Summary Loads

Building peaks in August at 3pm.

Bldg Load Descriptions	Area Quan	Sen Loss	%Tot Loss	Lat Gain	Sen Gain	Net Gain	%Net Gain
Roof	3,841	24,195	12.52	0	5,513	5,513	2.49
Wall	4,326	24,224	12.53	0	3,598	3,598	1.62
Glass	1,286	46,764	24.20	0	103,283	103,283	46.57
Floor Slab	0	0	0.00	0	0	0	0.00
Skin Loads		95,183	49.25	0	112,395	112,395	50.67
Lighting	7,648	0	0.00	0	26,096	26,096	11.77
Equipment	1,912	0	0.00	0	6,524	6,524	2.94
Pool Latent	0	0	0.00	0	0	0	0.00
People	93	0	0.00	18,600	23,250	41,850	18.87
Partition	1,136	1,818	0.94	0	909	909	0.41
Cool. Pret.	0	0	0.00	0	0	0	0.00
Heat. Pret.	0	0	0.00	0	0	0	0.00
Cool. Vent.	1,321	0	0.00	-1,025	21,013	19,987	9.01
Heat. Vent.	1,321	96,276	49.81	0	0	0	0.00
Cool. Infil.	0	0	0.00	0	0	0	0.00
Heat. Infil.	0	0	0.00	0	0	0	0.00
Draw-Thru Fan	0	0	0.00	0	14,034	14,034	6.33
Blow-Thru Fan	0	0	0.00	0	0	0	0.00
Reserve Cap.	0	0	0.00	0	0	0	0.00
Reheat Cap.	0	0	0.00	0	0	0	0.00
Supply Duct	0	0	0.00	0	0	0	0.00
Return Duct	0	0	0.00	0	0	0	0.00
Misc. Supply	0	0	0.00	0	0	0	0.00
Misc. Return	0	0	0.00	0	0	0	0.00
Building Totals		193,278	100.00	17,575	204,221	221,795	100.00

Building Summary	Sen Loss	%Tot Loss	Lat Gain	Sen Gain	Net Gain	%Net Gain
Ventilation	96,276	49.81	-1,025	21,013	19,987	9.01
Infiltration	0	0.00	0	0	0	0.00
Pretreated Air	0	0.00	0	0	0	0.00
Room Loads	97,001	50.19	18,600	169,174	187,774	84.66
Plenum Loads	0	0.00	0	0	0	0.00
Fan/Duct/Misc Loads	0	0.00	0	14,034	14,034	6.33
Building Totals	193,278	100.00	17,575	204,221	221,795	100.00

Check Figures

Total Building Supply Air (based on a 20° TD): 9,115 CFM
 Total Building Vent. Air (14.49% of Supply): 1,321 CFM
 Total Conditioned Air Space: 7,648 Sq.ft
 Supply Air Per Unit Area: 1.1918 CFM/Sq.ft
 Area Per Cooling Capacity: 413.8 Sq.ft/Ton



Building Summary Loads (cont'd)

Check Figures

Cooling Capacity Per Area:	0.0024 Tons/Sq.ft
Heating Capacity Per Area:	25.27 Btuh/Sq.ft
Total Heating Required With Outside Air:	193,278 Btuh
Total Cooling Required With Outside Air:	18.48 Tons



Air Handler #1 - Basement - Summary Loads

Rm No	Description Room Peak Time	Area People Volume	Htg.Loss Htg.CFM CFM/Sqft	Sen.Gain Clg.CFM CFM/Sqft	Lat.Gain S.Exh W.Exh	Htg.O.A. Req.CFM Act.CFM	Clg.O.A. Req.CFM Act.CFM
1	Basement 10am August	1,349 30 13,490	10,237 655 0.49	24,628 1,252 0.93	6,000 0 0	Direct 230 230	Direct 230 230
	Room Peak Totals:	1,349	10,237	24,628	6,000		
	Total Rooms: 1	30	655	1,252	0	230	230
	Unique Rooms: 1	13,490	0.49	0.93	0	230	230



Air Handler #1 - Basement - Total Load Summary

Air Handler Description: Basement Variable Air Volume
 Supply Air Fan: Draw-Thru with program estimated horsepower of 0.79 HP
 Fan Input: 75% motor and fan efficiency with 3 in. water across the fan
 Sensible Heat Ratio: 0.82 --- This system occurs 1 time(s) in the building. ---

Air System Peak Time: 10am in August.
 Outdoor Conditions: Clg: 81° DB, 65° WB, 69.85 grains, Htg: 0° DB
 Indoor Conditions: Clg: 75° DB, 50% RH, Htg: 70° DB

Summer: Ventilation controls outside air, ----- Winter: Ventilation controls outside air.

Room Space sensible loss:	10,237 Btuh	
Infiltration sensible loss:	0 Btuh	0 CFM
Outside Air sensible loss:	16,763 Btuh	230 CFM
Supply Duct sensible loss:	0 Btuh	
Return Duct sensible loss:	0 Btuh	
Return Plenum sensible loss:	0 Btuh	
Total System sensible loss:		26,999 Btuh

Heating Supply Air: $10,237 / (.964 \times 1.08 \times 15) =$	655 CFM
Winter Vent Outside Air (35.1% of supply) =	230 CFM

Room space sensible gain:	24,628 Btuh	
Infiltration sensible gain:	0 Btuh	
Draw-thru fan sensible gain:	1,928 Btuh	
Supply duct sensible gain:	0 Btuh	
Total sensible gain on supply side of coil:		26,556 Btuh

Cooling Supply Air: $26,556 / (.964 \times 1.1 \times 20) =$	1,252 CFM
Summer Vent Outside Air (18.4% of supply) =	230 CFM

Return duct sensible gain:	0 Btuh	
Return plenum sensible gain:	0 Btuh	
Outside air sensible gain:	1,220 Btuh	230 CFM
Blow-thru fan sensible gain:	0 Btuh	
Total sensible gain on return side of coil:		1,220 Btuh
Total sensible gain on air handling system:		27,775 Btuh

Room space latent gain:	6,000 Btuh	
Infiltration latent gain:	0 Btuh	
Outside air latent gain:	463 Btuh	
Total latent gain on air handling system:		6,463 Btuh
Total system sensible and latent gain:		34,238 Btuh

Check Figures

Total Air Handler Supply Air (based on a 20° TD):	1,252 CFM
Total Air Handler Vent. Air (18.37% of Supply):	230 CFM
Total Conditioned Air Space:	1,349 Sq.ft
Supply Air Per Unit Area:	0.9281 CFM/Sq.ft
Area Per Cooling Capacity:	472.8 Sq.ft/Ton
Cooling Capacity Per Area:	0.0021 Tons/Sq.ft
Heating Capacity Per Area:	20.01 Btuh/Sq.ft



Air Handler #1 - Basement - Total Load Summary (cont'd)

Check Figures

Total Heating Required With Outside Air:	26,999 Btuh
Total Cooling Required With Outside Air:	2.85 Tons



Air Handler #2 - Intermediate - Summary Loads

Rm No	Description Room Peak Time	Area People Volume	Htg.Loss Htg.CFM CFM/Sqft	Sen.Gain Clg.CFM CFM/Sqft	Lat.Gain S.Exh W.Exh	Htg.O.A. Req.CFM Act.CFM	Clg.O.A. Req.CFM Act.CFM
2	Intermediate 1pm August	2,196 23 21,960	17,393 1,114 0.51	32,467 1,651 0.75	4,600 0 0	Direct 394 394	Direct 394 394
	Room Peak Totals:	2,196	17,393	32,467	4,600		
	Total Rooms: 1	23	1,114	1,651	0	394	394
	Unique Rooms: 1	21,960	0.51	0.75	0	394	394



Air Handler #2 - Intermediate - Total Load Summary

Air Handler Description: Intermediate Variable Air Volume
 Supply Air Fan: Draw-Thru with program estimated horsepower of 1.04 HP
 Fan Input: 75% motor and fan efficiency with 3 in. water across the fan
 Sensible Heat Ratio: 0.88 --- This system occurs 1 time(s) in the building. ---

Air System Peak Time: 1pm in August.
 Outdoor Conditions: Clg: 88° DB, 67° WB, 68.83 grains, Htg: 0° DB
 Indoor Conditions: Clg: 75° DB, 50% RH, Htg: 70° DB

Summer: Ventilation controls outside air, ----- Winter: Ventilation controls outside air.

Room Space sensible loss:	17,393 Btuh	
Infiltration sensible loss:	0 Btuh	0 CFM
Outside Air sensible loss:	28,715 Btuh	394 CFM
Supply Duct sensible loss:	0 Btuh	
Return Duct sensible loss:	0 Btuh	
Return Plenum sensible loss:	0 Btuh	
Total System sensible loss:		46,108 Btuh

Heating Supply Air: $17,393 / (.964 \times 1.08 \times 15) =$	1,114 CFM
Winter Vent Outside Air (35.4% of supply) =	394 CFM

Room space sensible gain:	32,467 Btuh	
Infiltration sensible gain:	0 Btuh	
Draw-thru fan sensible gain:	2,542 Btuh	
Supply duct sensible gain:	0 Btuh	
Total sensible gain on supply side of coil:		35,009 Btuh

Cooling Supply Air: $35,009 / (.964 \times 1.1 \times 20) =$	1,651 CFM
Summer Vent Outside Air (23.9% of supply) =	394 CFM

Return duct sensible gain:	0 Btuh	
Return plenum sensible gain:	0 Btuh	
Outside air sensible gain:	5,432 Btuh	394 CFM
Blow-thru fan sensible gain:	0 Btuh	
Total sensible gain on return side of coil:		5,432 Btuh
Total sensible gain on air handling system:		40,440 Btuh

Room space latent gain:	4,600 Btuh	
Infiltration latent gain:	0 Btuh	
Outside air latent gain:	523 Btuh	
Total latent gain on air handling system:		5,123 Btuh
Total system sensible and latent gain:		45,563 Btuh

Check Figures

Total Air Handler Supply Air (based on a 20° TD):	1,651 CFM
Total Air Handler Vent. Air (23.87% of Supply):	394 CFM
Total Conditioned Air Space:	2,196 Sq.ft
Supply Air Per Unit Area:	0.7516 CFM/Sq.ft
Area Per Cooling Capacity:	578.4 Sq.ft/Ton
Cooling Capacity Per Area:	0.0017 Tons/Sq.ft
Heating Capacity Per Area:	21.00 Btuh/Sq.ft



Air Handler #2 - Intermediate - Total Load Summary (cont'd)

Check Figures

Total Heating Required With Outside Air:	46,108 Btuh
Total Cooling Required With Outside Air:	3.80 Tons



Air Handler #3 - Main New - Summary Loads

Rm No	Description Room Peak Time	Area People Volume	Htg.Loss Htg.CFM CFM/Sqft	Sen.Gain Clg.CFM CFM/Sqft	Lat.Gain S.Exh W.Exh	Htg.O.A. Req.CFM Act.CFM	Clg.O.A. Req.CFM Act.CFM
3	Main New 2pm August	2,736 27 27,360	45,197 2,894 1.06	88,193 4,484 1.64	5,400 0 0	Direct 465 465	Direct 465 465
	Room Peak Totals:	2,736	45,197	88,193	5,400		
	Total Rooms: 1	27	2,894	4,484	0	465	465
	Unique Rooms: 1	27,360	1.06	1.64	0	465	465



Air Handler #3 - Main New - Total Load Summary

Air Handler Description: Main New Variable Air Volume
 Supply Air Fan: Draw-Thru with program estimated horsepower of 2.82 HP
 Fan Input: 75% motor and fan efficiency with 3 in. water across the fan
 Sensible Heat Ratio: 0.94 --- This system occurs 1 time(s) in the building. ---

Air System Peak Time: 2pm in August.
 Outdoor Conditions: Clg: 90° DB, 67° WB, 66.70 grains, Htg: 0° DB
 Indoor Conditions: Clg: 75° DB, 50% RH, Htg: 70° DB

Summer: Ventilation controls outside air, ----- Winter: Ventilation controls outside air.

Room Space sensible loss:	45,197 Btuh	
Infiltration sensible loss:	0 Btuh	0 CFM
Outside Air sensible loss:	33,890 Btuh	465 CFM
Supply Duct sensible loss:	0 Btuh	
Return Duct sensible loss:	0 Btuh	
Return Plenum sensible loss:	0 Btuh	
Total System sensible loss:		79,087 Btuh

Heating Supply Air: $45,197 / (.964 \times 1.08 \times 15) =$	2,894 CFM
Winter Vent Outside Air (16.1% of supply) =	465 CFM

Room space sensible gain:	88,193 Btuh	
Infiltration sensible gain:	0 Btuh	
Draw-thru fan sensible gain:	6,904 Btuh	
Supply duct sensible gain:	0 Btuh	
Total sensible gain on supply side of coil:		95,097 Btuh

Cooling Supply Air: $95,097 / (.964 \times 1.1 \times 20) =$	4,484 CFM
Summer Vent Outside Air (10.4% of supply) =	465 CFM

Return duct sensible gain:	0 Btuh	
Return plenum sensible gain:	0 Btuh	
Outside air sensible gain:	6,903 Btuh	465 CFM
Blow-thru fan sensible gain:	0 Btuh	
Total sensible gain on return side of coil:		6,903 Btuh
Total sensible gain on air handling system:		102,000 Btuh

Room space latent gain:	5,400 Btuh	
Infiltration latent gain:	0 Btuh	
Outside air latent gain:	-361 Btuh	
Total latent gain on air handling system:		5,039 Btuh
Total system sensible and latent gain:		107,039 Btuh

Check Figures

Total Air Handler Supply Air (based on a 20° TD):	4,484 CFM
Total Air Handler Vent. Air (10.37% of Supply):	465 CFM
Total Conditioned Air Space:	2,736 Sq.ft
Supply Air Per Unit Area:	1.6388 CFM/Sq.ft
Area Per Cooling Capacity:	306.7 Sq.ft/Ton
Cooling Capacity Per Area:	0.0033 Tons/Sq.ft
Heating Capacity Per Area:	28.91 Btuh/Sq.ft



Air Handler #3 - Main New - Total Load Summary (cont'd)

Check Figures

Total Heating Required With Outside Air:	79,087 Btuh
Total Cooling Required With Outside Air:	8.92 Tons



Air Handler #4 - Main Old - Summary Loads

Rm No	Description Room Peak Time	Area People Volume	Htg.Loss Htg.CFM CFM/Sqft	Sen.Gain Clg.CFM CFM/Sqft	Lat.Gain S.Exh W.Exh	Htg.O.A. Req.CFM Act.CFM	Clg.O.A. Req.CFM Act.CFM
4	Main Old 5pm August	1,367 13 13,670	24,174 1,548 1.13	33,991 1,728 1.26	2,600 0 0	Direct 232 232	Direct 232 232
	Room Peak Totals:	1,367	24,174	33,991	2,600		
	Total Rooms: 1	13	1,548	1,728	0	232	232
	Unique Rooms: 1	13,670	1.13	1.26	0	232	232



Air Handler #4 - Main Old - Total Load Summary

Air Handler Description: Main Old Variable Air Volume
 Supply Air Fan: Draw-Thru with program estimated horsepower of 1.09 HP
 Fan Input: 75% motor and fan efficiency with 3 in. water across the fan
 Sensible Heat Ratio: 0.93 --- This system occurs 1 time(s) in the building. ---

Air System Peak Time: 5pm in August.
 Outdoor Conditions: Clg: 88° DB, 67° WB, 68.57 grains, Htg: 0° DB
 Indoor Conditions: Clg: 75° DB, 50% RH, Htg: 70° DB

Summer: Ventilation controls outside air, ----- Winter: Ventilation controls outside air.

Room Space sensible loss:	24,174 Btuh	
Infiltration sensible loss:	0 Btuh	0 CFM
Outside Air sensible loss:	16,909 Btuh	232 CFM
Supply Duct sensible loss:	0 Btuh	
Return Duct sensible loss:	0 Btuh	
Return Plenum sensible loss:	0 Btuh	
Total System sensible loss:		41,083 Btuh

Heating Supply Air: $24,174 / (.964 \times 1.08 \times 15) =$	1,548 CFM
Winter Vent Outside Air (15.0% of supply) =	232 CFM

Room space sensible gain:	33,991 Btuh	
Infiltration sensible gain:	0 Btuh	
Draw-thru fan sensible gain:	2,661 Btuh	
Supply duct sensible gain:	0 Btuh	
Total sensible gain on supply side of coil:		36,652 Btuh

Cooling Supply Air: $36,652 / (.964 \times 1.1 \times 20) =$	1,728 CFM
Summer Vent Outside Air (13.4% of supply) =	232 CFM

Return duct sensible gain:	0 Btuh	
Return plenum sensible gain:	0 Btuh	
Outside air sensible gain:	3,198 Btuh	232 CFM
Blow-thru fan sensible gain:	0 Btuh	
Total sensible gain on return side of coil:		3,198 Btuh
Total sensible gain on air handling system:		39,850 Btuh

Room space latent gain:	2,600 Btuh	
Infiltration latent gain:	0 Btuh	
Outside air latent gain:	308 Btuh	
Total latent gain on air handling system:		2,908 Btuh
Total system sensible and latent gain:		42,758 Btuh

Check Figures

Total Air Handler Supply Air (based on a 20° TD):	1,728 CFM
Total Air Handler Vent. Air (13.43% of Supply):	232 CFM
Total Conditioned Air Space:	1,367 Sq.ft
Supply Air Per Unit Area:	1.2642 CFM/Sq.ft
Area Per Cooling Capacity:	383.6 Sq.ft/Ton
Cooling Capacity Per Area:	0.0026 Tons/Sq.ft
Heating Capacity Per Area:	30.05 Btuh/Sq.ft



Air Handler #4 - Main Old - Total Load Summary (cont'd)

Check Figures

Total Heating Required With Outside Air:	41,083 Btuh
Total Cooling Required With Outside Air:	3.56 Tons



Room Detailed Loads (At Room Peak Times)

Load Description	Unit Quan	-SC- CFAC	CLTD SHGF	U.Fac -CLF-	Sen. Gain	Lat. Gain	Htg. Mult.	Htg. Loss
Room 1-Basement peaks (sensible) in August at 10am, Air Handler 1 (Basement), Zone 0, 1.0 x 1,349.0, Construction Type: 1 (Light)								
Wall-1-N-A-L	259	0.65	5.4	0.080	112		5.600	1,449
Wall-2-E-A-L	476	0.65	11.2	0.080	428		5.600	2,667
Wall-3-S-A-L	259	0.65	12.5	0.080	260		5.600	1,449
Partition-4-1	573.75		10/20	0.080	459		1.600	918
Gls-E-1-90-Tran	97.5	1.000	4	0.550	198		38.500	3,754
0%S-0-NS-Solar	97.5	0.830	215	0.570	9,917			
Lights-Prof=0	1,349	1.000			4,603			
Equipment-Prof=0	337	1.000			1,151	0		
People-Prof=0	30.0	1.000			7,500	6,000		
Sub-total					24,628	6,000		10,237
Safety factors:					+0%	+0%		+0%
Total w/ safety factors:					24,628	6,000		10,237

Room 2-Intermediate peaks (sensible) in August at 1pm, Air Handler 2 (Intermediate), Zone 0, 1.0 x 2,196.0, Construction Type: 1 (Light)								
Wall-1-N-A-L	402	0.65	4.7	0.080	152		5.600	2,252
Wall-2-E-A-L	465	0.65	12.5	0.080	466		5.600	2,604
Wall-3-S-A-L	402	0.65	11.9	0.080	382		5.600	2,252
Partition-4-1	562.5		10/20	0.080	450		1.600	900
Gls-N-1-90-Tran	73.1	1.000	12	0.550	471		38.500	2,815
0%S-0-NS-Solar	73.1	0.830	35	0.800	1,699			
Gls-E-1-90-Tran	97.5	1.000	12	0.550	627		38.500	3,754
0%S-0-NS-Solar	97.5	0.830	215	0.370	6,438			
Gls-S-1-90-Tran	73.1	1.000	12	0.550	471		38.500	2,815
0%S-0-NS-Solar	73.1	0.830	157	0.650	6,194			
Lights-Prof=0	2,196	1.000			7,493			
Equipment-Prof=0	549	1.000			1,873	0		
People-Prof=0	23.0	1.000			5,750	4,600		
Sub-total					32,467	4,600		17,393
Safety factors:					+0%	+0%		+0%
Total w/ safety factors:					32,467	4,600		17,393

Room 3-Main New peaks (sensible) in August at 2pm, Air Handler 3 (Main New), Zone 0, 1.0 x 2,736.0, Construction Type: 1 (Light)								
Roof-1-10-No.Clg-L	2,474	0.50	12.5	0.090	2,772		6.300	15,583
Wall-1-N-A-L	338	0.65	4.7	0.080	128		5.600	1,890
Wall-2-E-A-L	452	0.65	13.2	0.080	477		5.600	2,531
Wall-3-S-A-L	338	0.65	11.9	0.080	321		5.600	1,890



Room Detailed Loads (At Room Peak Times) (cont'd)

Load Description	Unit Quan	-SC- CFAC	CLTD SHGF	U.Fac -CLF-	Sen. Gain	Lat. Gain	Htg. Mult.	Htg. Loss
Gls-N-1-90-Tran	146.3	1.000	13	0.550	1,022		38.500	5,631
0%S-0-NS-Solar	146.3	0.830	35	0.820	3,484			
Gls-E-1-90-Tran	121.9	1.000	13	0.550	851		38.500	4,692
0%S-0-NS-Solar	121.9	0.830	215	0.320	6,960			
Gls-S-1-90-Tran	146.3	1.000	13	0.550	1,022		38.500	5,631
0%S-0-NS-Solar	146.3	0.830	157	0.650	12,388			
Gls-Sky-2-150-Tran	262.5	1.000	13	0.400	1,334		28.000	7,350
0%S-0-NS-Solar	262.5	0.830	242	0.740	39,017			
Lights-Prof=0	2,736	1.000			9,336			
Equipment-Prof=0	684	1.000			2,334	0		
People-Prof=0	27.0	1.000			6,750	5,400		
Sub-total					88,193	5,400		45,197
Safety factors:					+0%	+0%		+0%
Total w/ safety factors:					88,193	5,400		45,197

Room 4-Main Old peaks (sensible) in August at 5pm, Air Handler 4 (Main Old), Zone 0, 1.0 x 1,367.0, Construction Type: 1 (Light)

Roof-1-10-No.Clg-L	1,367	0.50	21.0	0.090	2,577		6.300	8,612
Wall-1-N-A-L	242	0.65	5.4	0.080	104		5.600	1,355
Wall-2-W-A-L	452	0.65	11.2	0.080	406		5.600	2,531
Wall-3-S-A-L	242	0.65	13.2	0.080	255		5.600	1,355
Gls-N-1-90-Tran	73.1	1.000	13	0.550	511		38.500	2,815
0%S-0-NS-Solar	73.1	0.830	35	0.790	1,678			
Gls-W-1-90-Tran	121.9	1.000	13	0.550	851		38.500	4,692
0%S-0-NS-Solar	121.9	0.830	215	0.640	13,919			
Gls-S-1-90-Tran	73.1	1.000	13	0.550	511		38.500	2,815
0%S-0-NS-Solar	73.1	0.830	157	0.430	4,097			
Lights-Prof=0	1,367	1.000			4,664			
Equipment-Prof=0	342	1.000			1,166	0		
People-Prof=0	13.0	1.000			3,250	2,600		
Sub-total					33,991	2,600		24,174
Safety factors:					+0%	+0%		+0%
Total w/ safety factors:					33,991	2,600		24,174

Joshua Hyde Library
HVAC Load Analysis

for



CHVAC COMMERCIAL
HVAC LOADS

Cooling and Heating Load Calculations Without Skylight

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October 1, 2021



Building Summary Loads

Building peaks in August at 3pm.

Bldg Load Descriptions	Area Quan	Sen Loss	%Tot Loss	Lat Gain	Sen Gain	Net Gain	%Net Gain
Roof	4,103	25,849	13.78	0	5,890	5,890	3.29
Wall	4,326	24,224	12.91	0	3,598	3,598	2.01
Glass	1,024	39,414	21.01	0	63,355	63,355	35.37
Floor Slab	0	0	0.00	0	0	0	0.00
Skin Loads		89,487	47.71	0	72,843	72,843	40.67
Lighting	7,648	0	0.00	0	26,096	26,096	14.57
Equipment	1,912	0	0.00	0	6,524	6,524	3.64
Pool Latent	0	0	0.00	0	0	0	0.00
People	93	0	0.00	18,600	23,250	41,850	23.37
Partition	1,136	1,818	0.97	0	909	909	0.51
Cool. Pret.	0	0	0.00	0	0	0	0.00
Heat. Pret.	0	0	0.00	0	0	0	0.00
Cool. Vent.	1,321	0	0.00	-1,025	21,013	19,987	11.16
Heat. Vent.	1,321	96,276	51.33	0	0	0	0.00
Cool. Infil.	0	0	0.00	0	0	0	0.00
Heat. Infil.	0	0	0.00	0	0	0	0.00
Draw-Thru Fan	0	0	0.00	0	10,900	10,900	6.09
Blow-Thru Fan	0	0	0.00	0	0	0	0.00
Reserve Cap.	0	0	0.00	0	0	0	0.00
Reheat Cap.	0	0	0.00	0	0	0	0.00
Supply Duct	0	0	0.00	0	0	0	0.00
Return Duct	0	0	0.00	0	0	0	0.00
Misc. Supply	0	0	0.00	0	0	0	0.00
Misc. Return	0	0	0.00	0	0	0	0.00
Building Totals		187,581	100.00	17,575	161,534	179,109	100.00

Building Summary	Sen Loss	%Tot Loss	Lat Gain	Sen Gain	Net Gain	%Net Gain
Ventilation	96,276	51.33	-1,025	21,013	19,987	11.16
Infiltration	0	0.00	0	0	0	0.00
Pretreated Air	0	0.00	0	0	0	0.00
Room Loads	91,305	48.67	18,600	129,622	148,222	82.76
Plenum Loads	0	0.00	0	0	0	0.00
Fan/Duct/Misc Loads	0	0.00	0	10,900	10,900	6.09
Building Totals	187,581	100.00	17,575	161,534	179,109	100.00

Check Figures

Total Building Supply Air (based on a 20° TD): 7,079 CFM
 Total Building Vent. Air (18.66% of Supply): 1,321 CFM
 Total Conditioned Air Space: 7,648 Sq.ft
 Supply Air Per Unit Area: 0.9256 CFM/Sq.ft
 Area Per Cooling Capacity: 512.4 Sq.ft/Ton



Building Summary Loads (cont'd)

Check Figures

Cooling Capacity Per Area:	0.0020	Tons/Sq.ft
Heating Capacity Per Area:	24.53	Btuh/Sq.ft
Total Heating Required With Outside Air:	187,581	Btuh
Total Cooling Required With Outside Air:	14.93	Tons



Air Handler #1 - Basement - Summary Loads

Rm No	Description Room Peak Time	Area People Volume	Htg.Loss Htg.CFM CFM/Sqft	Sen.Gain Clg.CFM CFM/Sqft	Lat.Gain S.Exh W.Exh	Htg.O.A. Req.CFM Act.CFM	Clg.O.A. Req.CFM Act.CFM
1	Basement 10am August	1,349 30 13,490	10,237 655 0.49	24,628 1,252 0.93	6,000 0 0	Direct 230 230	Direct 230 230
	Room Peak Totals:	1,349	10,237	24,628	6,000		
	Total Rooms: 1	30	655	1,252	0	230	230
	Unique Rooms: 1	13,490	0.49	0.93	0	230	230



Air Handler #1 - Basement - Total Load Summary

Air Handler Description: Basement Variable Air Volume
Supply Air Fan: Draw-Thru with program estimated horsepower of 0.79 HP
Fan Input: 75% motor and fan efficiency with 3 in. water across the fan
Sensible Heat Ratio: 0.82 --- This system occurs 1 time(s) in the building. ---

Air System Peak Time: 10am in August.
Outdoor Conditions: Clg: 81° DB, 65° WB, 69.85 grains, Htg: 0° DB
Indoor Conditions: Clg: 75° DB, 50% RH, Htg: 70° DB

Summer: Ventilation controls outside air, ----- Winter: Ventilation controls outside air.

Room Space sensible loss:	10,237 Btuh	
Infiltration sensible loss:	0 Btuh	0 CFM
Outside Air sensible loss:	16,763 Btuh	230 CFM
Supply Duct sensible loss:	0 Btuh	
Return Duct sensible loss:	0 Btuh	
Return Plenum sensible loss:	0 Btuh	
Total System sensible loss:		26,999 Btuh

Heating Supply Air: $10,237 / (.964 \times 1.08 \times 15) =$	655 CFM
Winter Vent Outside Air (35.1% of supply) =	230 CFM

Room space sensible gain:	24,628 Btuh	
Infiltration sensible gain:	0 Btuh	
Draw-thru fan sensible gain:	1,928 Btuh	
Supply duct sensible gain:	0 Btuh	
Total sensible gain on supply side of coil:		26,556 Btuh

Cooling Supply Air: $26,556 / (.964 \times 1.1 \times 20) =$	1,252 CFM
Summer Vent Outside Air (18.4% of supply) =	230 CFM

Return duct sensible gain:	0 Btuh	
Return plenum sensible gain:	0 Btuh	
Outside air sensible gain:	1,220 Btuh	230 CFM
Blow-thru fan sensible gain:	0 Btuh	
Total sensible gain on return side of coil:		1,220 Btuh
Total sensible gain on air handling system:		27,775 Btuh

Room space latent gain:	6,000 Btuh	
Infiltration latent gain:	0 Btuh	
Outside air latent gain:	463 Btuh	
Total latent gain on air handling system:		6,463 Btuh
Total system sensible and latent gain:		34,238 Btuh

Check Figures

Total Air Handler Supply Air (based on a 20° TD):	1,252 CFM
Total Air Handler Vent. Air (18.37% of Supply):	230 CFM
Total Conditioned Air Space:	1,349 Sq.ft
Supply Air Per Unit Area:	0.9281 CFM/Sq.ft
Area Per Cooling Capacity:	472.8 Sq.ft/Ton
Cooling Capacity Per Area:	0.0021 Tons/Sq.ft
Heating Capacity Per Area:	20.01 Btuh/Sq.ft



Air Handler #1 - Basement - Total Load Summary (cont'd)

Check Figures

Total Heating Required With Outside Air:	26,999 Btuh
Total Cooling Required With Outside Air:	2.85 Tons



Air Handler #2 - Intermediate - Summary Loads

Rm No	Description Room Peak Time	Area People Volume	Htg.Loss Htg.CFM CFM/Sqft	Sen.Gain Clg.CFM CFM/Sqft	Lat.Gain S.Exh W.Exh	Htg.O.A. Req.CFM Act.CFM	Clg.O.A. Req.CFM Act.CFM
2	Intermediate 1pm August	2,196 23 21,960	17,393 1,114 0.51	32,467 1,651 0.75	4,600 0 0	Direct 394 394	Direct 394 394
	Room Peak Totals:	2,196	17,393	32,467	4,600		
	Total Rooms: 1	23	1,114	1,651	0	394	394
	Unique Rooms: 1	21,960	0.51	0.75	0	394	394



Air Handler #2 - Intermediate - Total Load Summary

Air Handler Description: Intermediate Variable Air Volume
 Supply Air Fan: Draw-Thru with program estimated horsepower of 1.04 HP
 Fan Input: 75% motor and fan efficiency with 3 in. water across the fan
 Sensible Heat Ratio: 0.88 --- This system occurs 1 time(s) in the building. ---

Air System Peak Time: 1pm in August.
 Outdoor Conditions: Clg: 88° DB, 67° WB, 68.83 grains, Htg: 0° DB
 Indoor Conditions: Clg: 75° DB, 50% RH, Htg: 70° DB

Summer: Ventilation controls outside air, ----- Winter: Ventilation controls outside air.

Room Space sensible loss:	17,393 Btuh	
Infiltration sensible loss:	0 Btuh	0 CFM
Outside Air sensible loss:	28,715 Btuh	394 CFM
Supply Duct sensible loss:	0 Btuh	
Return Duct sensible loss:	0 Btuh	
Return Plenum sensible loss:	0 Btuh	
Total System sensible loss:		46,108 Btuh

Heating Supply Air: $17,393 / (.964 \times 1.08 \times 15) =$	1,114 CFM
Winter Vent Outside Air (35.4% of supply) =	394 CFM

Room space sensible gain:	32,467 Btuh	
Infiltration sensible gain:	0 Btuh	
Draw-thru fan sensible gain:	2,542 Btuh	
Supply duct sensible gain:	0 Btuh	
Total sensible gain on supply side of coil:		35,009 Btuh

Cooling Supply Air: $35,009 / (.964 \times 1.1 \times 20) =$	1,651 CFM
Summer Vent Outside Air (23.9% of supply) =	394 CFM

Return duct sensible gain:	0 Btuh	
Return plenum sensible gain:	0 Btuh	
Outside air sensible gain:	5,432 Btuh	394 CFM
Blow-thru fan sensible gain:	0 Btuh	
Total sensible gain on return side of coil:		5,432 Btuh
Total sensible gain on air handling system:		40,440 Btuh

Room space latent gain:	4,600 Btuh	
Infiltration latent gain:	0 Btuh	
Outside air latent gain:	523 Btuh	
Total latent gain on air handling system:		5,123 Btuh
Total system sensible and latent gain:		45,563 Btuh

Check Figures

Total Air Handler Supply Air (based on a 20° TD):	1,651 CFM
Total Air Handler Vent. Air (23.87% of Supply):	394 CFM
Total Conditioned Air Space:	2,196 Sq.ft
Supply Air Per Unit Area:	0.7516 CFM/Sq.ft
Area Per Cooling Capacity:	578.4 Sq.ft/Ton
Cooling Capacity Per Area:	0.0017 Tons/Sq.ft
Heating Capacity Per Area:	21.00 Btuh/Sq.ft



Air Handler #2 - Intermediate - Total Load Summary (cont'd)

Check Figures

Total Heating Required With Outside Air:	46,108 Btuh
Total Cooling Required With Outside Air:	3.80 Tons



Air Handler #3 - Main New - Summary Loads

Rm No	Description Room Peak Time	Area People Volume	Htg.Loss Htg.CFM CFM/Sqft	Sen.Gain Clg.CFM CFM/Sqft	Lat.Gain S.Exh W.Exh	Htg.O.A. Req.CFM Act.CFM	Clg.O.A. Req.CFM Act.CFM
3	Main New 1pm August	2,736 27 27,360	39,501 2,529 0.92	48,149 2,448 0.89	5,400 0 0	Direct 465 465	Direct 465 465
	Room Peak Totals:	2,736	39,501	48,149	5,400		
	Total Rooms: 1	27	2,529	2,448	0	465	465
	Unique Rooms: 1	27,360	0.92	0.89	0	465	465



Air Handler #3 - Main New - Total Load Summary

Air Handler Description: Main New Variable Air Volume
 Supply Air Fan: Draw-Thru with program estimated horsepower of 1.54 HP
 Fan Input: 75% motor and fan efficiency with 3 in. water across the fan
 Sensible Heat Ratio: 0.91 --- This system occurs 1 time(s) in the building. ---

Air System Peak Time: 1pm in August.
 Outdoor Conditions: Clg: 88° DB, 67° WB, 68.83 grains, Htg: 0° DB
 Indoor Conditions: Clg: 75° DB, 50% RH, Htg: 70° DB

Summer: Ventilation controls outside air, ----- Winter: Ventilation controls outside air.

Room Space sensible loss:	39,501 Btuh	
Infiltration sensible loss:	0 Btuh	0 CFM
Outside Air sensible loss:	33,890 Btuh	465 CFM
Supply Duct sensible loss:	0 Btuh	
Return Duct sensible loss:	0 Btuh	
Return Plenum sensible loss:	0 Btuh	
Total System sensible loss:		73,391 Btuh

Heating Supply Air: $39,501 / (.964 \times 1.08 \times 15) =$	2,529 CFM
Winter Vent Outside Air (18.4% of supply) =	465 CFM

Room space sensible gain:	48,149 Btuh	
Infiltration sensible gain:	0 Btuh	
Draw-thru fan sensible gain:	3,769 Btuh	
Supply duct sensible gain:	0 Btuh	
Total sensible gain on supply side of coil:		51,918 Btuh

Cooling Supply Air: $51,918 / (.964 \times 1.1 \times 20) =$	2,448 CFM
Summer Vent Outside Air (19.0% of supply) =	465 CFM

Return duct sensible gain:	0 Btuh	
Return plenum sensible gain:	0 Btuh	
Outside air sensible gain:	6,410 Btuh	465 CFM
Blow-thru fan sensible gain:	0 Btuh	
Total sensible gain on return side of coil:		6,410 Btuh
Total sensible gain on air handling system:		58,328 Btuh

Room space latent gain:	5,400 Btuh	
Infiltration latent gain:	0 Btuh	
Outside air latent gain:	617 Btuh	
Total latent gain on air handling system:		6,017 Btuh
Total system sensible and latent gain:		64,345 Btuh

Check Figures

Total Air Handler Supply Air (based on a 20° TD):	2,448 CFM
Total Air Handler Vent. Air (19.00% of Supply):	465 CFM
Total Conditioned Air Space:	2,736 Sq.ft
Supply Air Per Unit Area:	0.8947 CFM/Sq.ft
Area Per Cooling Capacity:	510.2 Sq.ft/Ton
Cooling Capacity Per Area:	0.0020 Tons/Sq.ft
Heating Capacity Per Area:	26.82 Btuh/Sq.ft



Air Handler #3 - Main New - Total Load Summary (cont'd)

Check Figures

Total Heating Required With Outside Air:	73,391 Btuh
Total Cooling Required With Outside Air:	5.36 Tons



Air Handler #4 - Main Old - Summary Loads

Rm No	Description Room Peak Time	Area People Volume	Htg.Loss Htg.CFM CFM/Sqft	Sen.Gain Clg.CFM CFM/Sqft	Lat.Gain S.Exh W.Exh	Htg.O.A. Req.CFM Act.CFM	Clg.O.A. Req.CFM Act.CFM
4	Main Old 5pm August	1,367 13 13,670	24,174 1,548 1.13	33,991 1,728 1.26	2,600 0 0	Direct 232 232	Direct 232 232
	Room Peak Totals:	1,367	24,174	33,991	2,600		
	Total Rooms: 1	13	1,548	1,728	0	232	232
	Unique Rooms: 1	13,670	1.13	1.26	0	232	232



Air Handler #4 - Main Old - Total Load Summary

Air Handler Description: Main Old Variable Air Volume
 Supply Air Fan: Draw-Thru with program estimated horsepower of 1.09 HP
 Fan Input: 75% motor and fan efficiency with 3 in. water across the fan
 Sensible Heat Ratio: 0.93 --- This system occurs 1 time(s) in the building. ---

Air System Peak Time: 5pm in August.
 Outdoor Conditions: Clg: 88° DB, 67° WB, 68.57 grains, Htg: 0° DB
 Indoor Conditions: Clg: 75° DB, 50% RH, Htg: 70° DB

Summer: Ventilation controls outside air, ----- Winter: Ventilation controls outside air.

Room Space sensible loss:	24,174 Btuh	
Infiltration sensible loss:	0 Btuh	0 CFM
Outside Air sensible loss:	16,909 Btuh	232 CFM
Supply Duct sensible loss:	0 Btuh	
Return Duct sensible loss:	0 Btuh	
Return Plenum sensible loss:	0 Btuh	
Total System sensible loss:		41,083 Btuh

Heating Supply Air: $24,174 / (.964 \times 1.08 \times 15) =$	1,548 CFM
Winter Vent Outside Air (15.0% of supply) =	232 CFM

Room space sensible gain:	33,991 Btuh	
Infiltration sensible gain:	0 Btuh	
Draw-thru fan sensible gain:	2,661 Btuh	
Supply duct sensible gain:	0 Btuh	
Total sensible gain on supply side of coil:		36,652 Btuh

Cooling Supply Air: $36,652 / (.964 \times 1.1 \times 20) =$	1,728 CFM
Summer Vent Outside Air (13.4% of supply) =	232 CFM

Return duct sensible gain:	0 Btuh	
Return plenum sensible gain:	0 Btuh	
Outside air sensible gain:	3,198 Btuh	232 CFM
Blow-thru fan sensible gain:	0 Btuh	
Total sensible gain on return side of coil:		3,198 Btuh
Total sensible gain on air handling system:		39,850 Btuh

Room space latent gain:	2,600 Btuh	
Infiltration latent gain:	0 Btuh	
Outside air latent gain:	308 Btuh	
Total latent gain on air handling system:		2,908 Btuh
Total system sensible and latent gain:		42,758 Btuh

Check Figures

Total Air Handler Supply Air (based on a 20° TD):	1,728 CFM
Total Air Handler Vent. Air (13.43% of Supply):	232 CFM
Total Conditioned Air Space:	1,367 Sq.ft
Supply Air Per Unit Area:	1.2642 CFM/Sq.ft
Area Per Cooling Capacity:	383.6 Sq.ft/Ton
Cooling Capacity Per Area:	0.0026 Tons/Sq.ft
Heating Capacity Per Area:	30.05 Btuh/Sq.ft



Air Handler #4 - Main Old - Total Load Summary (cont'd)

Check Figures

Total Heating Required With Outside Air:	41,083 Btuh
Total Cooling Required With Outside Air:	3.56 Tons



Room Detailed Loads (At Room Peak Times)

Load Description	Unit Quan	-SC- CFAC	CLTD SHGF	U.Fac -CLF-	Sen. Gain	Lat. Gain	Htg. Mult.	Htg. Loss
Room 1-Basement peaks (sensible) in August at 10am, Air Handler 1 (Basement), Zone 0, 1.0 x 1,349.0, Construction Type: 1 (Light)								
Wall-1-N-A-L	259	0.65	5.4	0.080	112		5.600	1,449
Wall-2-E-A-L	476	0.65	11.2	0.080	428		5.600	2,667
Wall-3-S-A-L	259	0.65	12.5	0.080	260		5.600	1,449
Partition-4-1	573.75		10/20	0.080	459		1.600	918
Gls-E-1-90-Tran	97.5	1.000	4	0.550	198		38.500	3,754
0%S-0-NS-Solar	97.5	0.830	215	0.570	9,917			
Lights-Prof=0	1,349	1.000			4,603			
Equipment-Prof=0	337	1.000			1,151	0		
People-Prof=0	30.0	1.000			7,500	6,000		
Sub-total					24,628	6,000		10,237
Safety factors:					+0%	+0%		+0%
Total w/ safety factors:					24,628	6,000		10,237

Room 2-Intermediate peaks (sensible) in August at 1pm, Air Handler 2 (Intermediate), Zone 0, 1.0 x 2,196.0, Construction Type: 1 (Light)								
Wall-1-N-A-L	402	0.65	4.7	0.080	152		5.600	2,252
Wall-2-E-A-L	465	0.65	12.5	0.080	466		5.600	2,604
Wall-3-S-A-L	402	0.65	11.9	0.080	382		5.600	2,252
Partition-4-1	562.5		10/20	0.080	450		1.600	900
Gls-N-1-90-Tran	73.1	1.000	12	0.550	471		38.500	2,815
0%S-0-NS-Solar	73.1	0.830	35	0.800	1,699			
Gls-E-1-90-Tran	97.5	1.000	12	0.550	627		38.500	3,754
0%S-0-NS-Solar	97.5	0.830	215	0.370	6,438			
Gls-S-1-90-Tran	73.1	1.000	12	0.550	471		38.500	2,815
0%S-0-NS-Solar	73.1	0.830	157	0.650	6,194			
Lights-Prof=0	2,196	1.000			7,493			
Equipment-Prof=0	549	1.000			1,873	0		
People-Prof=0	23.0	1.000			5,750	4,600		
Sub-total					32,467	4,600		17,393
Safety factors:					+0%	+0%		+0%
Total w/ safety factors:					32,467	4,600		17,393

Room 3-Main New peaks (sensible) in August at 1pm, Air Handler 3 (Main New), Zone 0, 1.0 x 2,736.0, Construction Type: 1 (Light)								
Roof-1-10-No.Clg-L	2,736	0.50	9.5	0.090	2,327		6.300	17,237
Wall-1-N-A-L	338	0.65	4.7	0.080	128		5.600	1,890
Wall-2-E-A-L	452	0.65	12.5	0.080	453		5.600	2,531
Wall-3-S-A-L	338	0.65	11.9	0.080	321		5.600	1,890



Room Detailed Loads (At Room Peak Times) (cont'd)

Load Description	Unit Quan	-SC- CFAC	CLTD SHGF	U.Fac -CLF-	Sen. Gain	Lat. Gain	Htg. Mult.	Htg. Loss
Gls-N-1-90-Tran	146.3	1.000	12	0.550	941		38.500	5,631
0%S-0-NS-Solar	146.3	0.830	35	0.800	3,399			
Gls-E-1-90-Tran	121.9	1.000	12	0.550	784		38.500	4,692
0%S-0-NS-Solar	121.9	0.830	215	0.370	8,047			
Gls-S-1-90-Tran	146.3	1.000	12	0.550	941		38.500	5,631
0%S-0-NS-Solar	146.3	0.830	157	0.650	12,388			
Lights-Prof=0	2,736	1.000			9,336			
Equipment-Prof=0	684	1.000			2,334	0		
People-Prof=0	27.0	1.000			6,750	5,400		
Sub-total					48,149	5,400		39,501
Safety factors:					+0%	+0%		+0%
Total w/ safety factors:					48,149	5,400		39,501

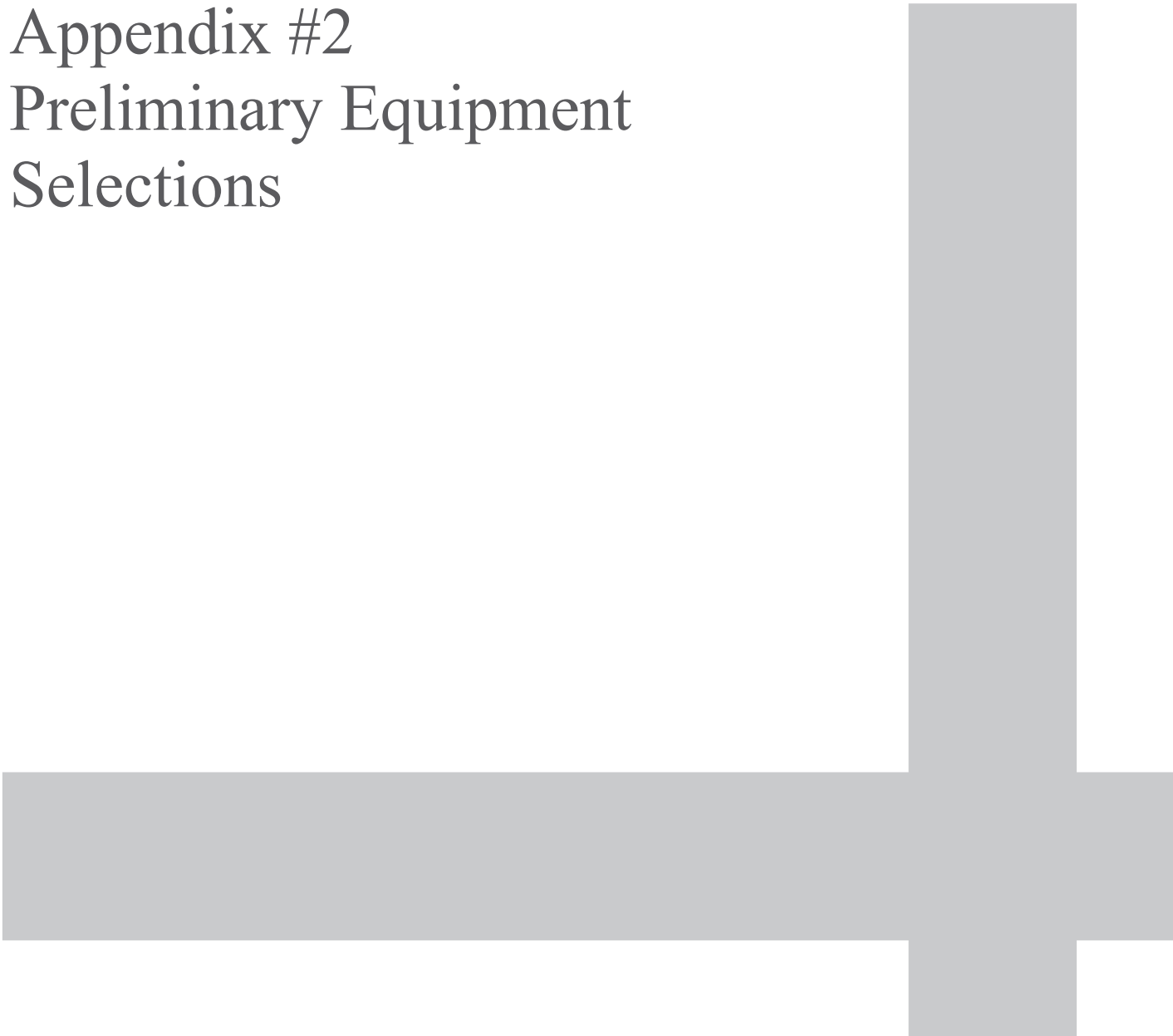
Room 4-Main Old peaks (sensible) in August at 5pm, Air Handler 4 (Main Old), Zone 0, 1.0 x 1,367.0, Construction Type: 1 (Light)

Roof-1-10-No.Clg-L	1,367	0.50	21.0	0.090	2,577		6.300	8,612
Wall-1-N-A-L	242	0.65	5.4	0.080	104		5.600	1,355
Wall-2-W-A-L	452	0.65	11.2	0.080	406		5.600	2,531
Wall-3-S-A-L	242	0.65	13.2	0.080	255		5.600	1,355
Gls-N-1-90-Tran	73.1	1.000	13	0.550	511		38.500	2,815
0%S-0-NS-Solar	73.1	0.830	35	0.790	1,678			
Gls-W-1-90-Tran	121.9	1.000	13	0.550	851		38.500	4,692
0%S-0-NS-Solar	121.9	0.830	215	0.640	13,919			
Gls-S-1-90-Tran	73.1	1.000	13	0.550	511		38.500	2,815
0%S-0-NS-Solar	73.1	0.830	157	0.430	4,097			
Lights-Prof=0	1,367	1.000			4,664			
Equipment-Prof=0	342	1.000			1,166	0		
People-Prof=0	13.0	1.000			3,250	2,600		
Sub-total					33,991	2,600		24,174
Safety factors:					+0%	+0%		+0%
Total w/ safety factors:					33,991	2,600		24,174

Joshua Hyde Library - HVAC Study - Ventilation Calculations

Room	Area (ft^2)	People Count	Vent. CFM
Basement	1349	30	230.94
Intermediate	2322	23.22	394.74
Main New	2736	27.36	465.12
Main Old	1367	13.67	232.39
	7774	94.25	1323.19

Appendix #2
Preliminary Equipment
Selections



Rebel® Packaged Rooftop System



Job Information		Technical Data Sheet	
Job Name	Sturbridge Library		
Date	6/28/2021		
Submitted By	Anthony Maisano		
Software Version	09.00		
Unit Tag	RTU-1 (7.5 Tons)		



Unit Overview					
Model Number	Voltage V/Hz/Phase	Design Cooling Capacity UOM_OSelected_CoiT otal	AHRI360 Standard Efficiency		ASHRAE 90.1
			EER	IEER	
DPS007A	208/60/3	95066	12.3	20.1	ASHRAE 90.1-2016 compliant

Unit	
Model Number:	DPS007A
Model Type:	Cooling
Heat Type:	Liquid Propane
Hot Gas Reheat:	MHGRH with Field Provided Humidity Sensor
Energy Recovery:	None
Application:	Variable Air Volume, Duct SP Control (Mixed Air or 100% OA)
Controls:	Microtech III
Outside Air:	0-100% Economizer with Comparative Enthalpy Control
Altitude:	0 ft
Approval	cETLus

Physical				
Dimensions and Weight				
Length	Height	Width	Weight	
91.0 in	56.8 in	96.5 in	2360 lb	
Corner Weights				
L1	L2	L3	L4	
424 lb	374 lb	732 lb	829 lb	
Construction				
Exterior	Insulation and Liners	Air Opening Location		
		Return	Supply	
Painted Galvanized Steel	1" Injected Foam, R-7, Galvanized Steel Liner	Bottom	Bottom	

Electrical				
Unit FLA	MCA	MROPD	SCCR	
39.7 A	42.7 A	50 A	5 kAIC	
Note:	Use only copper supply wires with ampacity based on 75° C conductor rating. Connections to terminals must be made with copper lugs and copper wire.			

Basement and Intermediate Levels RTU

Return/Outside/Exhaust Air			
Outside Air Option			
Type	Damper Pressure Drop	Exhaust Air Type	
90.1 and California Title 24 Compliant Economizer	0.07 inH ₂ O	Powered, Modulating with Building Pressure Control	
Exhaust Fan			
Type	Drive Type	Wheel Diameter	
SWSI AF	Direct Drive	14 in	
Motor			
(Qty) Horsepower	Type	Efficiency	Full Load Current (Each)
(1) 2.3 HP	ECM	Premium	5.0 A
Performance			
Air Flow CFM	External Static Pressure inH ₂ O	Fan Speed RPM	Brake Horsepower HP
3000	0.50	2187	0.89

Filter Section				
Physical				
Type	Quantity / Size	Face Area	Face Velocity	Air Pressure Drop
2" MERV 8 & 4" MERV 14 Filters	6 / 18 in x 24 in x 2 in & 6 / 18 in x 24 in x 4 in	18.0 ft ²	166.7 ft/min	0.22

DX Cooling Coil								
Physical								
Coil Type	Refrigerant Type	Fins per Inch	Rows	Face Area	Face Velocity	Air Pressure drop	Drain Pan Material	
Cu Tube/ Al Fin	R410A	15	3	14.0 ft ²	214.0 ft/min	0.15 inH ₂ O	Stainless Steel	
Cooling Performance								
Capacity			Indoor Air Temperature					Ambient air Temperature °F
Total Btu/hr	Sensible Btu/hr	Moisture Removal lb/h	Entering		Leaving			
			Dry Bulb °F	Wet Bulb °F	Dry Bulb °F	Wet Bulb °F	Dewpoint °F	
95066	75176	16.9	80.0	67.0	57.1	57.0	56.9	95.0
Condensate Connection Size:		3/4 in. Male NPT						

Hot Gas Reheat Coil Section					
Type	Face Area	Air Pressure Drop	Total Capacity	Leaving Air Temperature	
				Dry Bulb	Wet Bulb
Aluminum Tube Micro-Channel	13.2 ft ²	0.05 inH ₂ O	42042 Btu/hr	70.0 °F	61.6 °F

Fan Section				
Fan				
Type	Fan Wheel Diameter	Fan Isolation		
SWSI AF	22 in	None		
Performance				
Airflow	Total Static Pressure	Fan Speed	Brake Horsepower	Altitude
3000 CFM	2.5 inH ₂ O	1269 rpm	1.99 HP	0 ft
Motor				Drive
Type	Horsepower	Efficiency	FLA	Type
ECM Motor	4.0	Premium	8.8 A	Direct Drive

Gas Heat Section						
Physical						
Airflow	Max Allowable Burner Temp Rise	Size	Connection (Qty) Size	Heat Exchanger Material		
3000 CFM	60.0 °F	200 MBH	(1) 0.75 in. Female NPT	Stainless Steel		
Performance						
Capacity Btu/hr	Air Temperature Dry Bulb		Air Pressure Drop inH ₂ O	Gas Pressure		Modulation
	Entering °F	Leaving °F		Minimum inH ₂ O	Maximum inH ₂ O	
160000	40.0	89.2	0.02	7	14	Modulating 10:1 Turndown

Unit Discharge Conditions				
Air Temperature				
Motor Heat Btu/hr	Moisture Removal lb/h	Unit Leaving Dry Bulb °F	Unit Leaving Wet Bulb °F	Unit Leaving Dewpoint °F
6097	16.9	59.0	57.6	56.9

Condensing Section					
Compressor					
Type	Quantity	Refrigerant Charge lb	Total Power	Capacity Control	Compressor Isolation
Inverter Scroll + Fixed Scroll	2	17.8	5.56 kW	Mod Control with Inverter Compressors	Rubber in Shear
Compressor Amps:					
Compressor 1			11.9 A		
Compressor 2			8.6 A		
Condenser Coil					
Type	Fins per Inch		Fin Material		
Aluminum Microchannel	21		Aluminum		
Condenser Fan Motors					
Number of Motors			Full Load Current (Total)		
2			4.0 A		
AHRI 360 Certified Data at AHRI 360 Standard Conditions					
Net Capacity	EER	IEER	ASHRAE 90.1		
89000 Btu/hr	12.3	20.1	ASHRAE 90.1-2016 compliant		

Internal Pressure Drop Calculation

External Static Pressure:	1.50 inH ₂ O
Filter:	0.22 inH ₂ O
Dirty Filter:	0.50 inH ₂ O
Outside Air:	0.07 inH ₂ O
DX Coil:	0.15 inH ₂ O
Hot Gas Reheat:	0.05 inH ₂ O
Gas Heat:	0.02 inH ₂ O
Total Static Pressure:	2.51 inH₂O

Sound

Frequency	Sound Power (db)							
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Inlet	81	82	78	79	74	71	65	60
Discharge	81	85	81	84	80	77	73	68
Radiated	85	85	81	78	76	71	64	57

Options

Electrical

Field Connection:	Non-Fused Disconnect Switch
Powered Receptacle:	Unit powered 115V GFI outlet
Power Options:	Phase Failure Monitor

Controls

Communication Card:	BACnet/MSTP card, Factory installed
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Factory Installed Sensors

- Leaving Coil/Entering Fan Temperature Sensor
- Duct High Limit Switch
- Duct Static Pressure Sensor
- BACnet/MSTP Card
- Return Air Temperature Sensor
- Discharge Air Temperature sensor – Wired in unit, mounted in supply duct
- Outside Air Temperature Sensor
- Return Air Enthalpy Sensor
- Outside Air Enthalpy Sensor
- Dirty Filter On/Off Switch
- Supply Fan Air Proving Via Modbus
- Building Static Pressure Sensor

Warranty

Parts:	Standard One Year
Compressor:	Additional Four Year, Five Year Total
Gas Heat Exchanger:	Extended Nine Year, Ten Year Total

AHRI Certification



All equipment is rated and certified in accordance with AHRI 360.

Notes

Job Information		Technical Data Sheet	
Job Name	Sturbridge Library		
Date	6/28/2021		
Submitted By	Anthony Maisano		
Software Version	09.00		
Unit Tag	RTU-1 (15 Tons)		



Unit Overview					
Model Number	Voltage V/Hz/Phase	Design Cooling Capacity UOM_OSelected_CoiT otal	AHRI360 Standard Efficiency		ASHRAE 90.1
			EER	IEER	
DPS015A	208/60/3	181937	10.8	17.5	ASHRAE 90.1-2016 compliant

Unit	
Model Number:	DPS015A
Model Type:	Cooling
Heat Type:	Liquid Propane
Hot Gas Reheat:	MHGRH with Field Provided Humidity Sensor
Energy Recovery:	None
Application:	Variable Air Volume, Duct SP Control (Mixed Air or 100% OA)
Controls:	Microtech III
Outside Air:	0-100% Economizer with Comparative Enthalpy Control
Altitude:	0 ft
Approval	cETLus

Physical				
Dimensions and Weight				
Length	Height	Width	Weight	
91.0 in	56.8 in	96.5 in	2711 lb	
Corner Weights				
L1	L2	L3	L4	
435 lb	384 lb	887 lb	1005 lb	
Construction				
Exterior	Insulation and Liners	Air Opening Location		
		Return	Supply	
Painted Galvanized Steel	1" Injected Foam, R-7, Galvanized Steel Liner	Bottom	Bottom	

Electrical				
Unit FLA	MCA	MROPD	SCCR	
73.5 A	80.6 A	100 A	5 kAIC	
Note:	Use only copper supply wires with ampacity based on 75° C conductor rating. Connections to terminals must be made with copper lugs and copper wire.			

Main Level RTU With Skylight

Return/Outside/Exhaust Air			
Outside Air Option			
Type	Damper Pressure Drop	Exhaust Air Type	
90.1 and California Title 24 Compliant Economizer	0.29 inH ₂ O	Powered, Modulating with Building Pressure Control	
Exhaust Fan			
Type	Drive Type	Wheel Diameter	
SWSI AF	Direct Drive	18 in	
Motor			
(Qty) Horsepower	Type	Efficiency	Full Load Current (Each)
(1) 4.0 HP	ECM	Premium	8.8 A
Performance			
Air Flow CFM	External Static Pressure inH ₂ O	Fan Speed RPM	Brake Horsepower HP
6000	0.50	1989	2.33

Filter Section				
Physical				
Type	Quantity / Size	Face Area	Face Velocity	Air Pressure Drop
2" MERV 8 & 4" MERV 14 Filters	6 / 18 in x 24 in x 2 in & 6 / 18 in x 24 in x 4 in	18.0 ft ²	333.3 ft/min	0.47

DX Cooling Coil								
Physical								
Coil Type	Refrigerant Type	Fins per Inch	Rows	Face Area	Face Velocity	Air Pressure drop	Drain Pan Material	
Cu Tube/ Al Fin	R410A	15	6	15.4 ft ²	388.9 ft/min	0.53 inH ₂ O	Stainless Steel	
Cooling Performance								
Capacity			Indoor Air Temperature					Ambient air Temperature °F
Total Btu/hr	Sensible Btu/hr	Moisture Removal lb/h	Entering		Leaving			
			Dry Bulb °F	Wet Bulb °F	Dry Bulb °F	Wet Bulb °F	Dewpoint °F	
181937	147485	29.0	80.0	67.0	57.5	57.5	57.4	95.0
Condensate Connection Size:		3/4 in. Male NPT						

Hot Gas Reheat Coil Section					
Type	Face Area	Air Pressure Drop	Total Capacity	Leaving Air Temperature	
				Dry Bulb	Wet Bulb
Aluminum Tube Micro-Channel	14.6 ft ²	0.15 inH ₂ O	81239 Btu/hr	70.0 °F	61.9 °F

Fan Section				
Fan				
Type	Fan Wheel Diameter	Fan Isolation		
SWSI AF	22 in	None		
Performance				
Airflow	Total Static Pressure	Fan Speed	Brake Horsepower	Altitude
6000 CFM	3.7 inH ₂ O	1726 rpm	5.49 HP	0 ft
Motor				Drive
Type	Horsepower	Efficiency	FLA	Type
ECM Motor	8.0	Premium	13.5 A	Direct Drive

Gas Heat Section						
Physical						
Airflow	Max Allowable Burner Temp Rise	Size	Connection (Qty) Size	Heat Exchanger Material		
6000 CFM	60.0 °F	400 MBH	(1) 0.75 in. Female NPT	Stainless Steel		
Performance						
Capacity Btu/hr	Air Temperature Dry Bulb		Air Pressure Drop inH ₂ O	Gas Pressure		Modulation
	Entering °F	Leaving °F		Minimum inH ₂ O	Maximum inH ₂ O	
320000	40.0	89.2	0.25	7	14	Modulating 10:1 Turndown

Unit Discharge Conditions				
Air Temperature				
Motor Heat Btu/hr	Moisture Removal lb/h	Unit Leaving Dry Bulb °F	Unit Leaving Wet Bulb °F	Unit Leaving Dewpoint °F
16007	29.0	60.0	58.3	57.4

Condensing Section					
Compressor					
Type	Quantity	Refrigerant Charge lb	Total Power	Capacity Control	Compressor Isolation
Inverter Scroll + Fixed Scroll	2	30.2	12.62 kW	Mod Control with Inverter Compressors	Rubber in Shear
Compressor Amps:					
Compressor 1			17.5 A		
Compressor 2			28.3 A		
Condenser Coil					
Type	Fins per Inch		Fin Material		
Aluminum Microchannel	21		Aluminum		
Condenser Fan Motors					
Number of Motors			Full Load Current (Total)		
2			4.0 A		
AHRI 360 Certified Data at AHRI 360 Standard Conditions					
Net Capacity	EER	IEER	ASHRAE 90.1		
168000 Btu/hr	10.8	17.5	ASHRAE 90.1-2016 compliant		

Internal Pressure Drop Calculation

External Static Pressure:	1.50 inH ₂ O
Filter:	0.47 inH ₂ O
Dirty Filter:	0.50 inH ₂ O
Outside Air:	0.29 inH ₂ O
DX Coil:	0.53 inH ₂ O
Hot Gas Reheat:	0.15 inH ₂ O
Gas Heat:	0.25 inH ₂ O
Total Static Pressure:	3.69 inH₂O

Sound

Frequency	Sound Power (db)							
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Inlet	85	86	82	83	78	75	69	64
Discharge	85	89	85	88	84	81	77	72
Radiated	85	85	81	78	76	71	64	57

Options

Electrical

Field Connection:	Non-Fused Disconnect Switch
Powered Receptacle:	Unit powered 115V GFI outlet
Power Options:	Phase Failure Monitor

Controls

Communication Card:	BACnet/MSTP card, Factory installed
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Factory Installed Sensors

- Leaving Coil/Entering Fan Temperature Sensor
- Duct High Limit Switch
- Duct Static Pressure Sensor
- BACnet/MSTP Card
- Return Air Temperature Sensor
- Discharge Air Temperature sensor – Wired in unit, mounted in supply duct
- Outside Air Temperature Sensor
- Return Air Enthalpy Sensor
- Outside Air Enthalpy Sensor
- Dirty Filter On/Off Switch
- Supply Fan Air Proving Via Modbus
- Building Static Pressure Sensor

Warranty

Parts:	Standard One Year
Compressor:	Additional Four Year, Five Year Total
Gas Heat Exchanger:	Extended Nine Year, Ten Year Total

AHRI Certification



All equipment is rated and certified in accordance with AHRI 360.

Notes

Rebel® Packaged Rooftop System



Job Information		Technical Data Sheet	
Job Name	Sturbridge Library		
Date	6/28/2021		
Submitted By	Anthony Maisano		
Software Version	09.00		
Unit Tag	RTU-1 (10 Tons)		



Unit Overview					
Model Number	Voltage V/Hz/Phase	Design Cooling Capacity UOM_OSelected_CoiT otal	AHRI360 Standard Efficiency		ASHRAE 90.1
			EER	IEER	
DPS010A	208/60/3	125176	12.1	18.8	ASHRAE 90.1-2016 compliant

Unit	
Model Number:	DPS010A
Model Type:	Cooling
Heat Type:	Liquid Propane
Hot Gas Reheat:	MHGRH with Field Provided Humidity Sensor
Energy Recovery:	None
Application:	Variable Air Volume, Duct SP Control (Mixed Air or 100% OA)
Controls:	Microtech III
Outside Air:	0-100% Economizer with Comparative Enthalpy Control
Altitude:	0 ft
Approval	cETLus

Physical				
Dimensions and Weight				
Length	Height	Width	Weight	
91.0 in	56.8 in	96.5 in	2538 lb	
Corner Weights				
L1	L2	L3	L4	
421 lb	363 lb	813 lb	941 lb	
Construction				
Exterior	Insulation and Liners	Air Opening Location		
		Return	Supply	
Painted Galvanized Steel	1" Injected Foam, R-7, Galvanized Steel Liner	Bottom	Bottom	

Electrical				
Unit FLA	MCA	MROPD	SCCR	
50.5 A	54.9 A	70 A	5 kAIC	
Note:	Use only copper supply wires with ampacity based on 75° C conductor rating. Connections to terminals must be made with copper lugs and copper wire.			

Main Level RTU Without Skylight

Return/Outside/Exhaust Air			
Outside Air Option			
Type	Damper Pressure Drop	Exhaust Air Type	
90.1 and California Title 24 Compliant Economizer	0.13 inH ₂ O	Powered, Modulating with Building Pressure Control	
Exhaust Fan			
Type	Drive Type	Wheel Diameter	
SWSI AF	Direct Drive	16 in	
Motor			
(Qty) Horsepower	Type	Efficiency	Full Load Current (Each)
(1) 4.0 HP	ECM	Premium	8.8 A
Performance			
Air Flow CFM	External Static Pressure inH ₂ O	Fan Speed RPM	Brake Horsepower HP
4000	0.50	2033	1.32

Filter Section				
Physical				
Type	Quantity / Size	Face Area	Face Velocity	Air Pressure Drop
2" MERV 8 & 4" MERV 14 Filters	6 / 18 in x 24 in x 2 in & 6 / 18 in x 24 in x 4 in	18.0 ft ²	222.2 ft/min	0.30

DX Cooling Coil								
Physical								
Coil Type	Refrigerant Type	Fins per Inch	Rows	Face Area	Face Velocity	Air Pressure drop	Drain Pan Material	
Cu Tube/ Al Fin	R410A	15	4	15.4 ft ²	259.2 ft/min	0.25 inH ₂ O	Stainless Steel	
Cooling Performance								
Capacity			Indoor Air Temperature					Ambient air Temperature °F
Total Btu/hr	Sensible Btu/hr	Moisture Removal lb/h	Entering		Leaving			
			Dry Bulb °F	Wet Bulb °F	Dry Bulb °F	Wet Bulb °F	Dewpoint °F	
125176	98310	22.9	80.0	67.0	57.5	57.1	56.9	95.0
Condensate Connection Size:		3/4 in. Male NPT						

Hot Gas Reheat Coil Section					
Type	Face Area	Air Pressure Drop	Total Capacity	Leaving Air Temperature	
				Dry Bulb	Wet Bulb
Aluminum Tube Micro-Channel	14.6 ft ²	0.06 inH ₂ O	54147 Btu/hr	70.0 °F	61.6 °F

Fan Section				
Fan				
Type	Fan Wheel Diameter	Fan Isolation		
SWSI AF	22 in	None		
Performance				
Airflow	Total Static Pressure	Fan Speed	Brake Horsepower	Altitude
4000 CFM	2.8 inH ₂ O	1390 rpm	2.80 HP	0 ft
Motor				Drive
Type	Horsepower	Efficiency	FLA	Type
ECM Motor	4.0	Premium	8.8 A	Direct Drive

Gas Heat Section						
Physical						
Airflow	Max Allowable Burner Temp Rise	Size	Connection (Qty) Size	Heat Exchanger Material		
4000 CFM	60.0 °F	200 MBH	(1) 0.75 in. Female NPT	Stainless Steel		
Performance						
Capacity Btu/hr	Air Temperature Dry Bulb		Air Pressure Drop inH ₂ O	Gas Pressure		Modulation
	Entering °F	Leaving °F		Minimum inH ₂ O	Maximum inH ₂ O	
160000	40.0	76.9	0.04	7	14	Modulating 10:1 Turndown

Unit Discharge Conditions				
Air Temperature				
Motor Heat Btu/hr	Moisture Removal lb/h	Unit Leaving Dry Bulb °F	Unit Leaving Wet Bulb °F	Unit Leaving Dewpoint °F
8141	22.9	59.4	57.8	56.9

Condensing Section					
Compressor					
Type	Quantity	Refrigerant Charge lb	Total Power	Capacity Control	Compressor Isolation
Inverter Scroll + Fixed Scroll	2	25.8	8.20 kW	Mod Control with Inverter Compressors	Rubber in Shear
Compressor Amps:					
Compressor 1			10.0 A		
Compressor 2			17.5 A		
Condenser Coil					
Type	Fins per Inch		Fin Material		
Aluminum Microchannel	23		Aluminum		
Condenser Fan Motors					
Number of Motors			Full Load Current (Total)		
2			4.0 A		
AHRI 360 Certified Data at AHRI 360 Standard Conditions					
Net Capacity	EER	IEER	ASHRAE 90.1		
121000 Btu/hr	12.1	18.8	ASHRAE 90.1-2016 compliant		

Internal Pressure Drop Calculation

External Static Pressure:	1.50 inH ₂ O
Filter:	0.30 inH ₂ O
Dirty Filter:	0.50 inH ₂ O
Outside Air:	0.13 inH ₂ O
DX Coil:	0.25 inH ₂ O
Hot Gas Reheat:	0.06 inH ₂ O
Gas Heat:	0.04 inH ₂ O
Total Static Pressure:	2.79 inH₂O

Sound

Frequency	Sound Power (db)							
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Inlet	81	82	78	79	74	71	65	60
Discharge	81	85	81	84	80	77	73	68
Radiated	85	85	81	78	76	71	64	57

Options

Electrical

Field Connection:	Non-Fused Disconnect Switch
Powered Receptacle:	Unit powered 115V GFI outlet
Power Options:	Phase Failure Monitor

Controls

Communication Card:	BACnet/MSTP card, Factory installed
---------------------	-------------------------------------

Factory Installed Sensors

- Leaving Coil/Entering Fan Temperature Sensor
- Duct High Limit Switch
- Duct Static Pressure Sensor
- BACnet/MSTP Card
- Return Air Temperature Sensor
- Discharge Air Temperature sensor – Wired in unit, mounted in supply duct
- Outside Air Temperature Sensor
- Return Air Enthalpy Sensor
- Outside Air Enthalpy Sensor
- Dirty Filter On/Off Switch
- Supply Fan Air Proving Via Modbus
- Building Static Pressure Sensor

Warranty

Parts:	Standard One Year
Compressor:	Additional Four Year, Five Year Total
Gas Heat Exchanger:	Extended Nine Year, Ten Year Total

AHRI Certification



All equipment is rated and certified in accordance with AHRI 360.

Notes



Submittal Data Sheet

2.0-Ton MSP Concealed Ducted Unit

FXSQ24TAVJU

FEATURES

- Eleven capacity options from 5,800 Btu/h to 54,000 Btu/h
- External static pressure up to 0.6 in. w.g. (150 Pa)
- Low profile height of 9-5/8" (245 mm) for all models
- 5-speed DC fan motor with selectable Auto fan speed
- Ease of installation with auto adjusting airflow at commissioning based on external static pressure
- Independently configurable auxiliary heat on/off temperature settings
- Factory rear-return, field convertible to bottom-return
- Integral condensate pump with up 25-5/16" (643 mm) of lift from the drain outlet
- Drain pan inspection port
- Standard Limited Warranty: 10-year limited parts warranty



BENEFITS

- Requires as little as 11-1/4" (285 mm) of clearance above the ceiling thanks to the low profile design.
- Auto fan speed control optimizes fan energy use by automatically adjusting the unit's fan speed as the room temperature approaches the set point.
- The drain pan inspection port simplifies maintenance by allowing for simple and easy inspection of the drain pan conditions.
- Designed for quiet operation, with sound levels as low as 28 dB(A).



VRV



Typical VRV System Ducted Fan Coil Unit



Submittal Data Sheet

2.0-Ton MSP Concealed Ducted Unit

FXSQ24TAVJU

PERFORMANCE

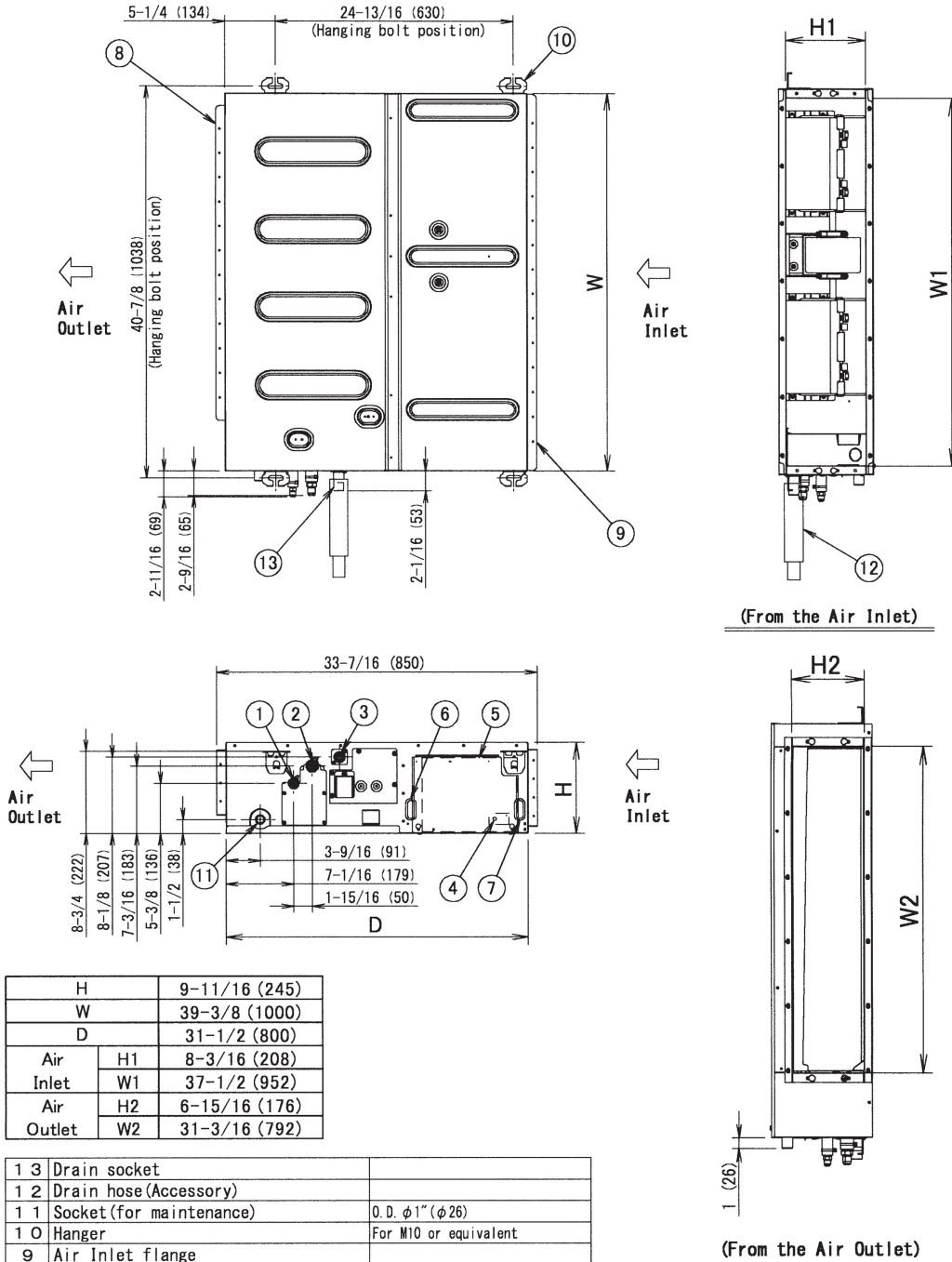
Indoor Unit Model No.	FXSQ24TAVJU	Indoor Unit Name:	2.0-Ton MSP Concealed Ducted Unit
Type:	Concealed Ducted	Rated Cooling Conditions:	Indoor (°F DB/WB): 80 / 67 Ambient (°F DB/WB): 95 / 75
Rated Cooling Capacity (Btu/hr):	24,000	Rated Heating Conditions:	Indoor (°F DB/WB): 70 / 60 Ambient (°F DB/WB): 47 / 43
Sensible Capacity (Btu/hr):	17,100	Rated Piping Length(ft):	
Cooling Input Power (kW):	0.222	Rated Height Separation (ft):	
Rated Heating Capacity (Btu/hr):	27,000		
Heating Input Power (kW):	0.22		

INDOOR UNIT DETAILS

Power Supply (V/Hz/Ph):	208/230 / 60 / 1	Airflow Rate (H/M/L) (CFM):	742/618/512
Power Supply Connections:	L1, L2, G	Moisture Removal (Gal/hr):	
Min. Circuit Amps MCA (A):	1.8	Gas Pipe Connection (inch):	5/8
Max Overcurrent Protection (MOP) (A):	15	Liquid Pipe Connection (inch):	3/8
Dimensions (HxWxD) (in):	9-11/16 x 39-3/8 x 31-1/2	Condensate Connection (inch):	1
Net Weight (lb):	77	Sound Pressure (H/M/L) (dBA):	36/32/29
Ext. Static Pressure (Rated/Max) (inWg):	0.2 / 0.6	Sound Power Level (dBA):	64

Submittal Data Sheet
 2.0-Ton MSP Concealed Ducted Unit
 FXSQ24TAVJU

DIMENSIONAL DRAWING



Note: For additional dimensional data and clearance information, refer to Engineering Data



Submittal Data Sheet

2.0-Ton Round Flow Sensing Cassette

FXFQ24TVJU

FEATURES

- True 360° airflow distribution and three room sensors enables optimized occupant comfort and efficiency
- Optional self-cleaning filter panel to further increase efficiency and reduce maintenance costs
- Individually controlled supply air louvers for comfortable air supply
- Improved efficiency with new DC fan motor and auto logic that adjusts fan speed based on space load
- Industry leading flexibility with 23 possible airflow patterns
- Integral condensate pump with up to 26-1/2" lift
- Standard Limited Warranty: 10-year warranty on compressor and all parts

BENEFITS

- Compact design to allow for installation in small ceiling voids
- Very low sound levels increases flexibility regarding location of the unit
- Increased indoor air quality with high efficiency filter options & ventilation connection kit
- Automatic occupancy dependant Set back function to save energy



Typical VRV System Office Fan Coil Unit



Submittal Data Sheet
2.0-Ton Round Flow Sensing Cassette
FXFQ24TVJU

PERFORMANCE

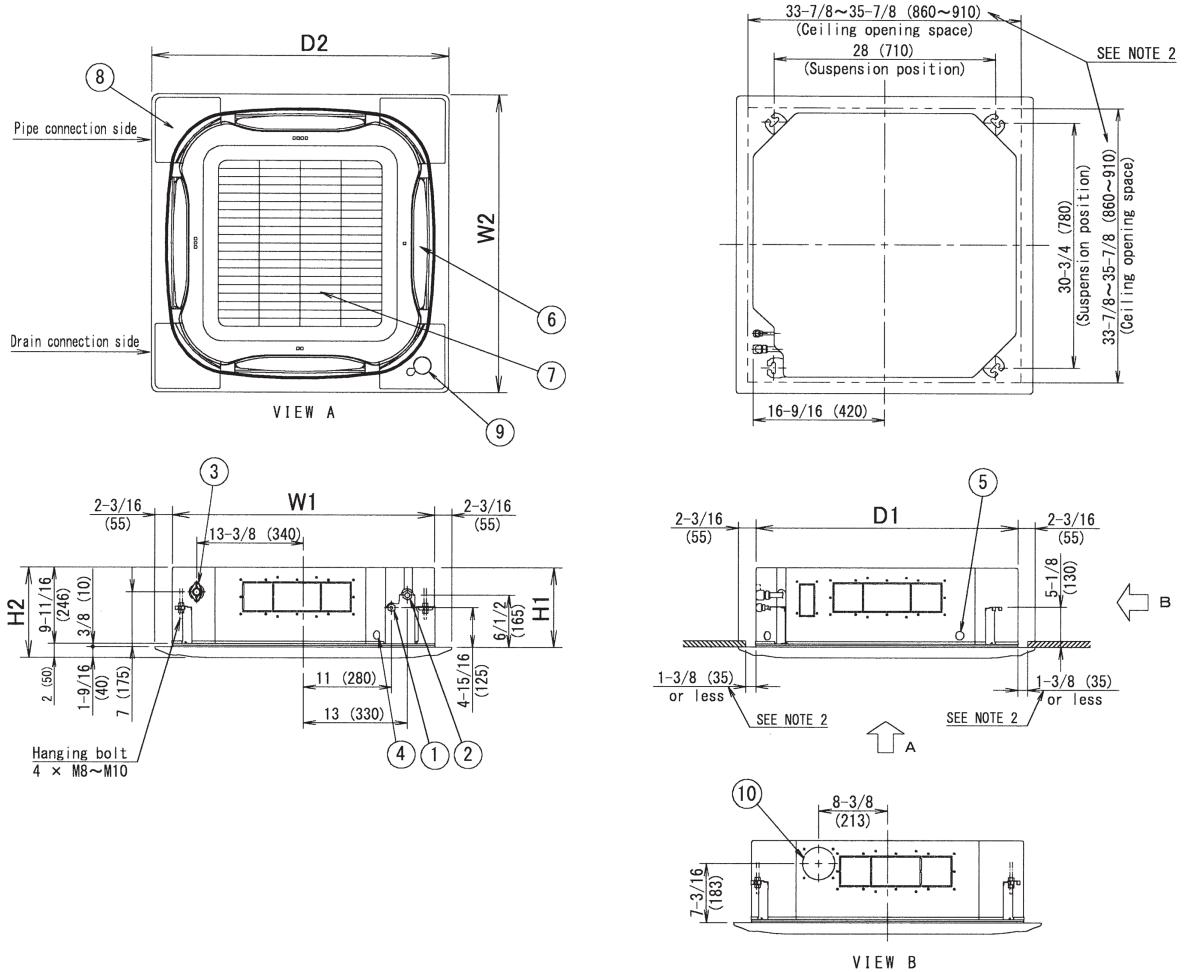
Indoor Unit Model No.	FXFQ24TVJU	Indoor Unit Name:	2.0-Ton Round Flow Sensing Cassette
Type:	Cassette	Rated Cooling Conditions:	Indoor (°F DB/WB): 80 / 67 Ambient (°F DB/WB): 95 / 75
Rated Cooling Capacity (Btu/hr):	23,000	Rated Heating Conditions:	Indoor (°F DB/WB): 70 / 60 Ambient (°F DB/WB): 47 / 43
Sensible Capacity (Btu/hr):	20,000	Rated Piping Length(ft):	
Cooling Input Power (kW):	0.080	Rated Height Separation (ft):	
Rated Heating Capacity (Btu/hr):	27,000		
Heating Input Power (kW):	0.08		

INDOOR UNIT DETAILS

Power Supply (V/Hz/Ph):	208-230 / 60 / 1	Airflow Rate (HH/H/L) (CFM):	777/618/477
Power Supply Connections:	L1, L2, Ground	Moisture Removal (Gal/hr):	
Min. Circuit Amps MCA (A):	0.7	Gas Pipe Connection (inch):	5/8
Max Overcurrent Protection (MOP) (A):	15	Liquid Pipe Connection (inch):	3/8
Dimensions (HxWxD) (in):	9-11/16 x 33-1/16 x 33-1/16	Condensate Connection (inch):	1-1/4
Net Weight (lb):	51	Sound Pressure (H/L) (dBA):	32/28
Ext. Static Pressure (Rated/Max) (inWg):	/	Sound Power Level (dBA):	

Submittal Data Sheet
 2.0-Ton Round Flow Sensing Cassette
 FXFQ24TVJU

DIMENSIONAL DRAWING



Unit : in. (mm)

ITEM	PART NAME	REMARK
1	Liquid pipe connection	φ3/8 (φ9.5) Flare connection
2	Gas pipe connection	φ5/8 (φ15.9) Flare connection
3	Drain pipe connection	VP25 (O. D. φ1-1/4 (φ32), I. D. φ1 (φ25))
4	Power supply entry hole	
5	Transmission wiring entry hole	
6	Air Outlet	
7	Air Inlet grille	
8	Corner decoration cover	
9	Sensor	Infrared presence sensor Infrared floor sensor
10	Knock out hole	φ3-15/16 (φ100)

Without panel	H1	10 (256)
	W1	33-1/16 (840)
	D1	33-1/16 (840)
With panel	H2	11-11/16 (296)
	D2	37-3/8 (950)

Notes) 1. Location of the nameplates:

- Unit body: on the control box cover.
- Decoration panel: on the panel frame at the motor side under the corner cover.

2. Make sure the spacing between the ceiling and the cassette is no more than 1-3/8" (35mm).
 MAX ceiling opening: 35-7/8" (910mm).

3. When the conditions exceed 86°F (30°C) and RH 80% in the ceiling or fresh air is inducted into the ceiling an additional insulation is required (polyethylene foam, thickness 3/8" (10mm) or more).

Note: For additional dimensional data and clearance information, refer to Engineering Data

Daikin North America LLC, 5151 San Felipe, Suite 500, Houston, TX, 77056



Submittal Data Sheet

20 Ton, 230V, VRV IV HR

REYQ240TATJA

FEATURES

- Larger capacity single modules ranging up to 14 tons and systems up to 38 tons allow for a more flexible system design
- Variable Refrigerant Temperature (VRT) control allows the VRV IV to deliver up to 28% of improvement in seasonal cooling efficiency compared to previous Daikin VRV heat pump systems
- Modular and lightweight enables flexibility in system layout and installation with larger capacity single modules reducing electrical, piping connections
- Compatible with Daikin DVS series of Dedicated Outdoor Air Systems (DOAS)
- System wide auto-climate adjustment technology to increase the energy efficiency
- Improved efficiency with IEER values now up to 29.3
- Can provide heating down to -13°F WB as standard
- All inverter compressors to increase the efficiency and avoid starting current inrush
- Same product structure for 230V and 460V simplifies ordering
- New configurator software designed to simplify the commissioning and maintenance of the system
- Factory standard coil guards
- Assembled in the US to increase flexibility and reduce lead times
- Standard Limited Warranty: 10-year limited parts warranty



VRV IV



BENEFITS

- Can operate up to 41 indoor units on a single piping network
- Modular and lightweight - enables flexibility in system layout and installation
- Refrigerant cooled inverted technology to avoid influence from ambient temperatures
- Integrated inverter technology deliver maximum efficiency during part load conditions and provide precise individual zone control
- Heat exchanger coil wraps around on all 4 sides of the unit to increase the surface area and efficiency
- Continuous heating during defrost and oil return allows constant comfort control
- Corrosion resistance 1000hr salt spray tested Daikin PE blue fin heat exchanger
- Design flexibility with long piping lengths up to 3,280 ft. total and 100 ft. vertical separation between indoor units
- Designed with reduced MOP to optimize installation cost
- Digital display on the unit for improved and faster configuration, commissioning, and trouble shooting

VRV System Condensers With Skylight



Submittal Data Sheet

20 Ton, 230V, VRV IV HR

REYQ240TATJA

PERFORMANCE

Outdoor Unit Model No.	REYQ240TATJA	Outdoor Unit Name:	20 Ton, 230V, VRV IV HR
Type:	Heat Recovery	Unit Combination:	REYQ144TATJA + REYQ96TATJA
Rated Cooling Conditions:	Indoor (°F DB/WB): 80 / 67 Ambient (°F DB/WB): 95 / 75	Rated Heating Conditions:	Indoor (°F DB/WB): 70 / 60 Ambient (°F DB/WB): 47 / 43
Rated Piping Length(ft):			
Rated Height Difference (ft):			
Rated Cooling Capacity (Btu/hr):	228,000	Rated Heating Capacity (Btu/hr):	250,000
Nom Cooling Capacity (Btu/hr):	240,000	Nom Heating Capacity (Btu/hr):	270,000
Cooling Input Power (kW):	18.20	Heating Input Power (kW):	19.20
EER (Non-Ducted/Ducted):	11.90 / 11.60	Heating COP (Non-Ducted/Ducted):	3.7 / 3.5
IEER (Non-Ducted/Ducted):	21.90 / 19.80	Heating COP 17F (Non-Ducted/Ducted):	2.2 / 2.1
		SCHE (Non-Ducted/Ducted):	25.60 / 22.70

OUTDOOR UNIT DETAILS

Power Supply (V/Hz/Ph):	208-230 / 60 / 3	Compressor Stage:	Inverter
Power Supply Connections:	L1, L2, L3 Ground	Capacity Control Range (%):	5 - 100
Min. Circuit Amps MCA (A):	38.0+55.0	Capacity Index Limit:	120.0 - 312.0
Max Overcurrent Protection (MOP) (A):	45+70	Airflow Rate (H) (CFM):	5827+8228
Max Starting Current MSC(A):		Gas Pipe Connection (inch):	1-3/8
Rated Load Amps RLA(A):	(13.7+13.7)+(16.2+22.6)	Liquid Pipe Connection (inch):	5/8
Dimensions (Height) (in):	66-11/16	H/L Pressure Connection (inch)	1-1/8
Dimensions (Width) (in):	48-7/8+48-7/8	H/L Equalizing Connection (inch)	
Dimensions (Depth) (in):	30-3/16	Sound Pressure (H) (dBA):	66
Net Weight (lb):	703+780	Sound Power Level (dBA):	87
		Max. No. of Indoor Units:	41

Submittal Data Sheet

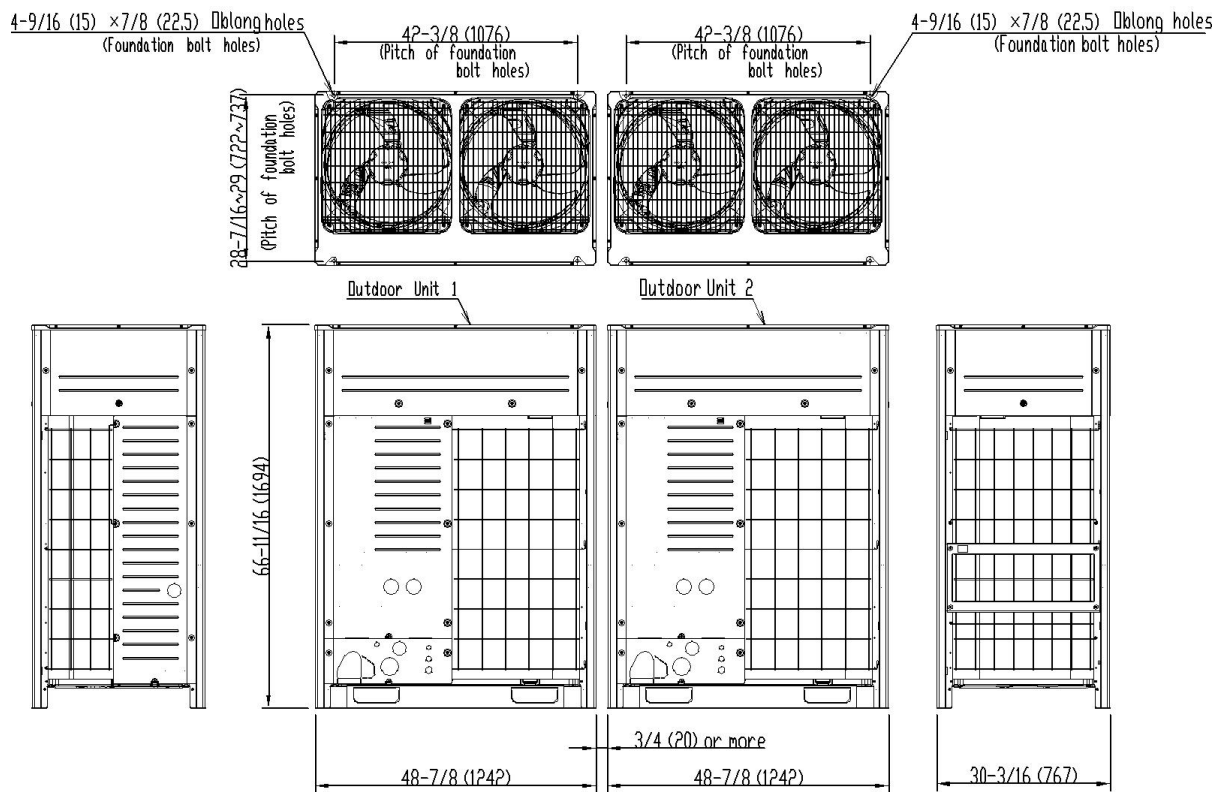
20 Ton, 230V, VRV IV HR

REYQ240TATJA

SYSTEM DETAILS

Refrigerant Type:	R-410A	Cooling Operation Range (°F DB):	23 - 122
Holding Refrigerant Charge (lbs):	25.8+25.8	Heating Operation Range (°F WB):	-13 - 60
Additional Charge (lb/ft):		Max. Pipe Length (Vertical) (ft):	295
Pre-charge Piping (Length) (ft):		Cooling Range w/Baffle (°F DB):	-
Max. Pipe Length (Total) (ft):	540	Heating Range w/Baffle (°F WB):	-
Max Height Separation (Ind to Ind ft):			

DIMENSIONAL DRAWING





Submittal Data Sheet

16 Ton, 230V, VRV IV HR

REYQ192TATJA

FEATURES

- Larger capacity single modules ranging up to 14 tons and systems up to 38 tons allow for a more flexible system design
- Variable Refrigerant Temperature (VRT) control allows the VRV IV to deliver up to 28% of improvement in seasonal cooling efficiency compared to previous Daikin VRV heat pump systems
- Modular and lightweight enables flexibility in system layout and installation with larger capacity single modules reducing electrical, piping connections
- Compatible with Daikin DVS series of Dedicated Outdoor Air Systems (DOAS)
- System wide auto-climate adjustment technology to increase the energy efficiency
- Improved efficiency with IEER values now up to 29.3
- Can provide heating down to -13°F WB as standard
- All inverter compressors to increase the efficiency and avoid starting current inrush
- Same product structure for 230V and 460V simplifies ordering
- New configurator software designed to simplify the commissioning and maintenance of the system
- Factory standard coil guards
- Assembled in the US to increase flexibility and reduce lead times
- Standard Limited Warranty: 10-year limited parts warranty



VRV IV



BENEFITS

- Can operate up to 33 indoor units on a single piping network
- Modular and lightweight - enables flexibility in system layout and installation
- Refrigerant cooled inverted technology to avoid influence from ambient temperatures
- Integrated inverter technology deliver maximum efficiency during part load conditions and provide precise individual zone control
- Heat exchanger coil wraps around on all 4 sides of the unit to increase the surface area and efficiency
- Continuous heating during defrost and oil return allows constant comfort
- Corrosion resistance 1000hr salt spray tested Daikin PE blue fin heat exchanger
- Design flexibility with long piping lengths up to 3,280 ft. total and 100 ft. vertical separation between indoor units
- Designed with reduced MOP to optimize installation cost
- Digital display on the unit for improved and faster configuration, commissioning, and trouble shooting

VRV System Condensers Without Skylight



Submittal Data Sheet

16 Ton, 230V, VRV IV HR

REYQ192TATJA

PERFORMANCE

Outdoor Unit Model No.	REYQ192TATJA	Outdoor Unit Name:	16 Ton, 230V, VRV IV HR
Type:	Heat Recovery	Unit Combination:	REYQ120TATJA + REYQ72TATJA
Rated Cooling Conditions:	Indoor (°F DB/WB): 80 / 67 Ambient (°F DB/WB): 95 / 75	Rated Heating Conditions:	Indoor (°F DB/WB): 70 / 60 Ambient (°F DB/WB): 47 / 43
Rated Piping Length(ft):			
Rated Height Difference (ft):			
Rated Cooling Capacity (Btu/hr):	184,000	Rated Heating Capacity (Btu/hr):	200,000
Nom Cooling Capacity (Btu/hr):	192,000	Nom Heating Capacity (Btu/hr):	216,000
Cooling Input Power (kW):	13.90	Heating Input Power (kW):	15.30
EER (Non-Ducted/Ducted):	12.50 / 12.50	Heating COP (Non-Ducted/Ducted):	3.9 / 3.7
IEER (Non-Ducted/Ducted):	22.90 / 21.10	Heating COP 17F (Non-Ducted/Ducted):	2.4 / 2.3
		SCHE (Non-Ducted/Ducted):	26.60 / 23.10

OUTDOOR UNIT DETAILS

Power Supply (V/Hz/Ph):	208-230 / 60 / 3	Compressor Stage:	Inverter
Power Supply Connections:	L1, L2, L3 Ground	Capacity Control Range (%):	5 - 100
Min. Circuit Amps MCA (A):	30.2+43.0	Capacity Index Limit:	96.0 - 249.0
Max Overcurrent Protection (MOP) (A):	35+50	Airflow Rate (H) (CFM):	5544+6286
Max Starting Current MSC(A):		Gas Pipe Connection (inch):	1-1/8
Rated Load Amps RLA(A):	20.7+(15.0+15.0)	Liquid Pipe Connection (inch):	5/8
Dimensions (Height) (in):	66-11/16	H/L Pressure Connection (inch)	1-1/8
Dimensions (Width) (in):	36-11/16+48-7/8	H/L Equalizing Connection (inch)	
Dimensions (Depth) (in):	30-3/16	Sound Pressure (H) (dBA):	63
Net Weight (lb):	507+703	Sound Power Level (dBA):	83
		Max. No. of Indoor Units:	33

Submittal Data Sheet

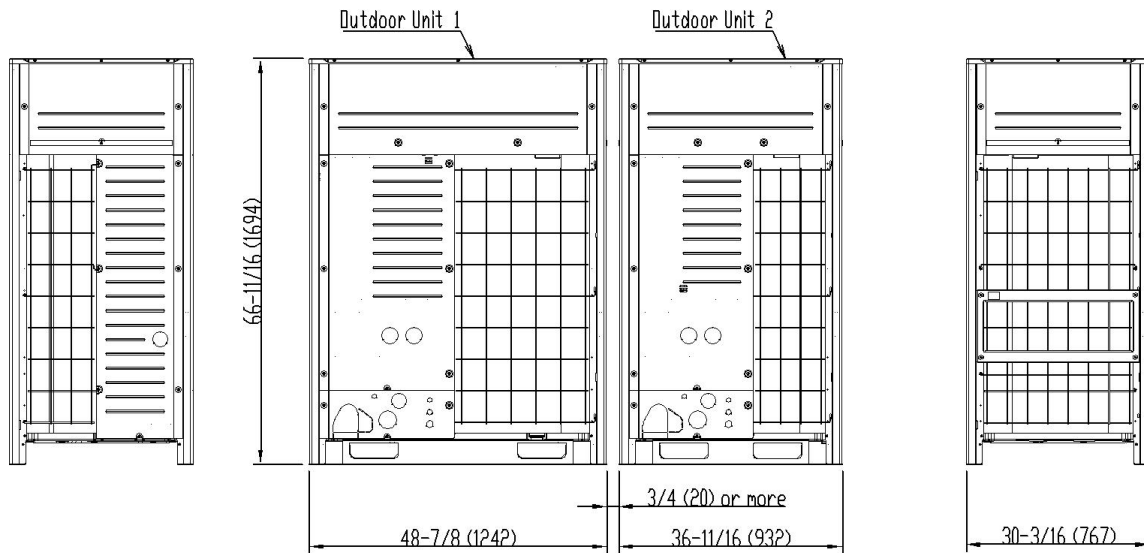
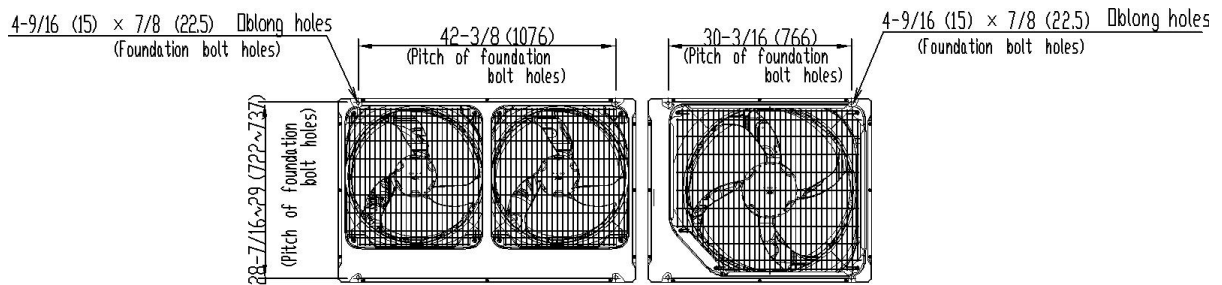
16 Ton, 230V, VRV IV HR

REYQ192TATJA

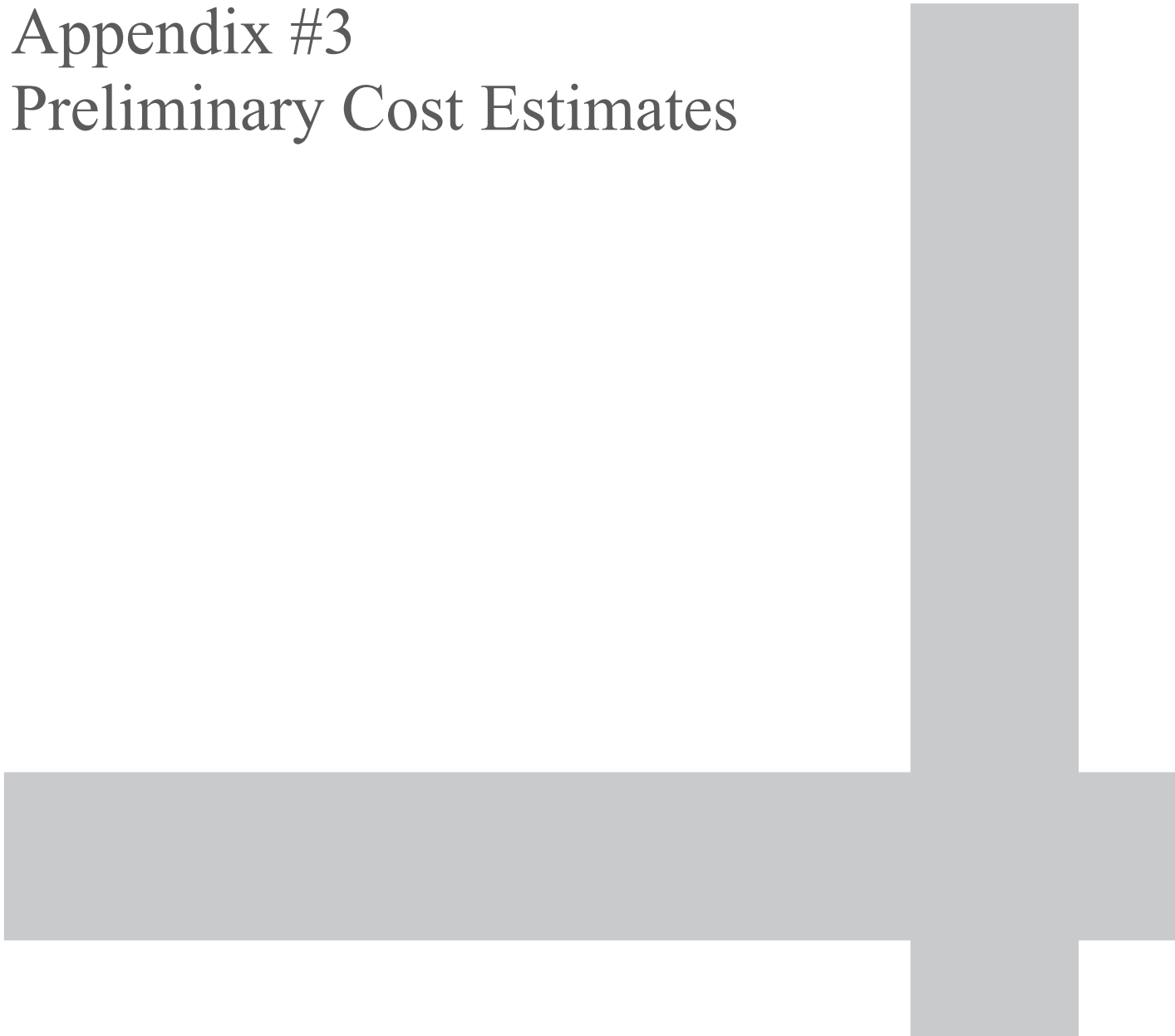
SYSTEM DETAILS

Refrigerant Type:	R-410A	Cooling Operation Range (°F DB):	23 - 122
Holding Refrigerant Charge (lbs):	21.9+25.8	Heating Operation Range (°F WB):	-13 - 60
Additional Charge (lb/ft):		Max. Pipe Length (Vertical) (ft):	295
Pre-charge Piping (Length) (ft):		Cooling Range w/Baffle (°F DB):	-
Max. Pipe Length (Total) (ft):	540	Heating Range w/Baffle (°F WB):	-
Max Height Separation (Ind to Ind ft):			

DIMENSIONAL DRAWING



Appendix #3 Preliminary Cost Estimates





Joshua Hyde Library
HVAC Systems Study
October 1, 2021

Estimated Rough Order of Magnitude (ROM) Pricing Rev 2

Option #1 – Replacement Roof Mounted RTU’s with VAV’s

Materials:	\$217,475.00
Labor:	<u>\$127,700.00</u>
MEP Sub Total:	\$345,175.00
General Conditions:	\$43,150.00
O&P:	<u>\$58,250.00</u>
Option #1 Total:	\$446,575.00*

Option #2 – Grade Mounted RTU’s with VAV’s

Materials:	\$189,600.00
Labor:	<u>\$156,900.00</u>
MEP Sub Total:	\$346,500.00
General Conditions:	\$43,300.00
O&P:	<u>\$58,500.00</u>
Option#2 Total:	\$448,300.00*

Option #3 – VRF System with Roof Mounted ERV

Materials:	\$200,725.00
Labor:	<u>\$135,200.00</u>
MEP Sub Total:	\$335,925.00
General Conditions:	\$41,900.00
O&P:	<u>\$56,500.00</u>
Total:	\$434,325.00*

** Excludes Architectural and Accessibility Improvements- This MEP Subtotal (and Grand Total) triggers M.G.L. c.7C §§44-58 for Design Services, M.G.L. c. 149 over \$150,000 for general and filed sub-bidding, and as of October 1, 2021, triggers full compliance with 521 CMR for accessibility. The costs of these triggered requirements are EXCLUDED from this Grand Total as they are beyond the scope of this study.*

Notes:

1. Estimates are for ROM pricing comparisons only.
2. Pricing does not include market fluctuations due to COVID-19
3. Pricing in Sub Totals has included estimates for the following as required:
 - a. Installation of equipment, including steel dunnage and catwalk (if required)
 - b. Equipment Costs
 - c. Modifications to existing ductwork
 - d. New ductwork and diffusers, and insulation
 - e. Ceiling modifications
 - f. Electrical feeds to new equipment. Electrical infrastructure upgrades have not been included.
 - g. Sitework modifications
 - h. Building Automation System tie-in
 - i. Testing and balancing

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VAN ZELM HEYWOOD & SHADFORD, INC.

Joshua Hyde Library
Preliminary Cost Estimates - (Rough Order Magintude)
10/1/2022

#	Description	Material	Labor	Total	Notes
1	Option 1-Roof Mounted RTU's & VAV's				
	Install Roof Mounted RTU' & VAV's	\$159,375.00	\$50,000.00	\$209,375.00	15-ton, 7.5-ton
	Modifications to existing ductwork	\$3,000.00	\$8,500.00	\$11,500.00	
	New Ductwork and diffusers	\$8,500.00	\$19,500.00	\$28,000.00	
	Duct Inulation	\$3,500.00	\$3,500.00	\$7,000.00	
	Ceiling Removal and Replacement	\$9,500.00	\$9,800.00	\$19,300.00	
	Electrical Feeds to new equipment	\$4,000.00	\$5,500.00	\$9,500.00	
	Roof Modifications	\$2,000.00	\$2,500.00	\$4,500.00	
	Building Automation System (BAS)	\$20,000.00	\$20,000.00	\$40,000.00	
	TAB	\$100.00	\$1,500.00	\$1,600.00	One day
	3 Electric Heaters	\$2,500.00	\$1,900.00	\$4,400.00	
	Misc	\$5,000.00	\$5,000.00	\$10,000.00	
	Grand Totals	\$217,475.00	\$127,700.00	\$345,175.00	

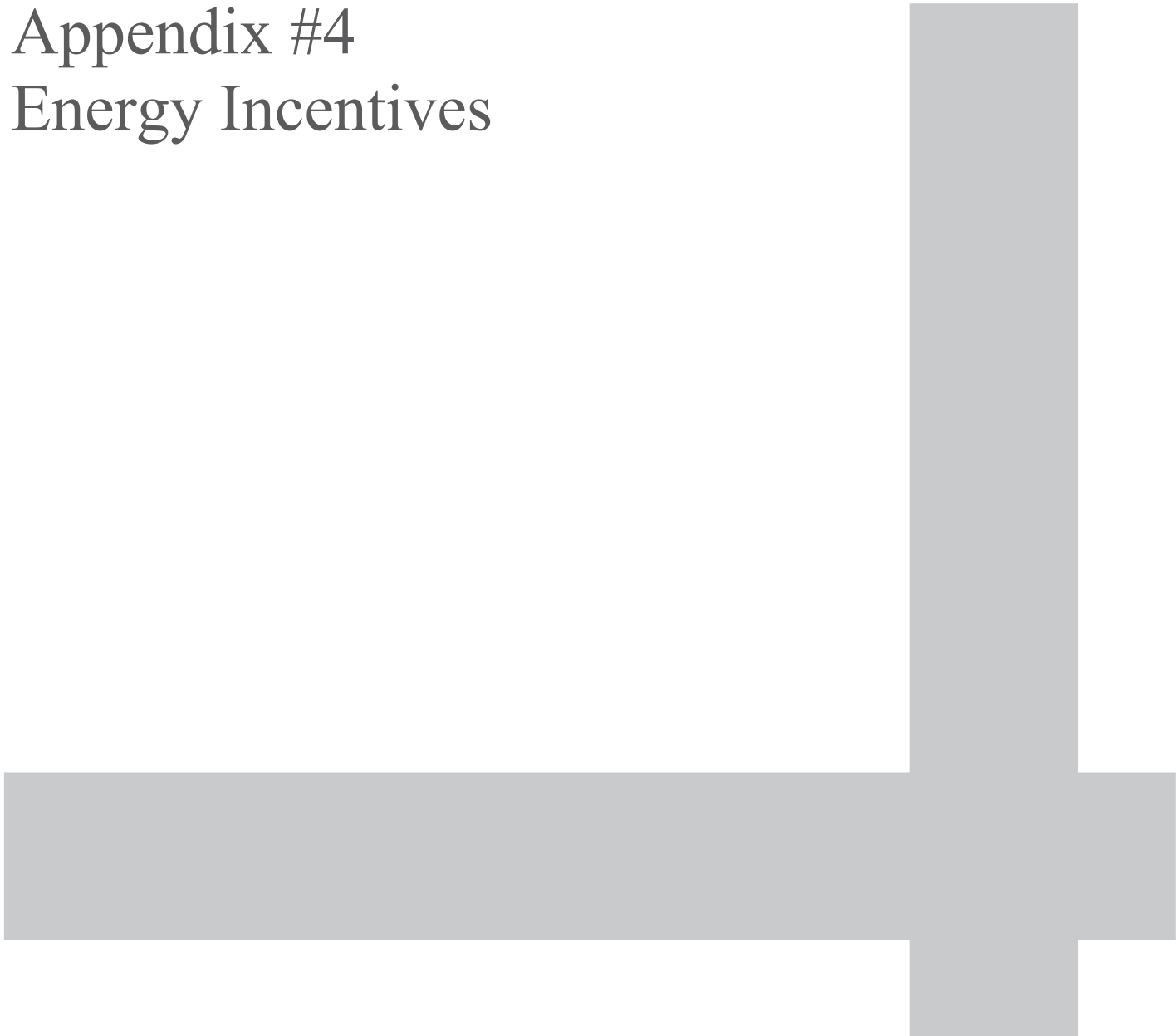
Joshua Hyde Library
Preliminary Cost Estimates - (Rough Order Magintude)
10/1/2022

#	Description	Material	Labor	Total	Notes
2	Option 2-Grade Mounted RTU & VAV's				
	Install Grade Mounted RTU & VAV's	\$95,000.00	\$50,000.00	\$145,000.00	20-ton unit
	Modifications to existing ductwork	\$10,000.00	\$12,500.00	\$22,500.00	
	New Ductwork and diffusers	\$11,500.00	\$24,000.00	\$35,500.00	Includes Exterior risers to roof
	Decorative Duct Chase for Exterior Duct	\$8,500.00	\$7,000.00	\$15,500.00	
	Duct Inulation	\$6,000.00	\$4,200.00	\$10,200.00	
	Ceiling Removal and Replacement	\$9,500.00	\$9,800.00	\$19,300.00	
	Electrical Feeds to new equipment	\$4,000.00	\$5,500.00	\$9,500.00	
	Sitework Modifications	\$5,000.00	\$7,500.00	\$12,500.00	
	Structural steel for RTU	\$12,500.00	\$8,000.00	\$20,500.00	
	Building Automation System (BAS)	\$20,000.00	\$20,000.00	\$40,000.00	
	TAB	\$100.00	\$1,500.00	\$1,600.00	One day
	3 Electric Heaters	\$2,500.00	\$1,900.00	\$4,400.00	
	Misc	\$5,000.00	\$5,000.00	\$10,000.00	
	Grand Totals	\$189,600.00	\$156,900.00	\$346,500.00	

Joshua Hyde Library
Preliminary Cost Estimates - (Rough Order Magintude)
10/1/2022

#	Description	Material	Labor	Total	Notes
3	Option 3-VRF with Roof Mounted ERV				
	Install new ERV on Roof	\$28,500.00	\$16,500.00	\$45,000.00	connect to 2 new systems
	VRF System	\$110,625.00	\$40,000.00	\$150,625.00	
	Modifications to existing ductwork	\$3,000.00	\$8,500.00	\$11,500.00	
	New Ductwork and diffusers	\$11,500.00	\$19,500.00	\$31,000.00	
	Duct Inulation	\$6,500.00	\$7,500.00	\$14,000.00	
	Ceiling Removal and Replacement	\$9,500.00	\$9,800.00	\$19,300.00	
	Electrical Feeds to new equipment	\$5,500.00	\$8,500.00	\$14,000.00	
	Sitework Modifications	\$2,000.00	\$2,500.00	\$4,500.00	condensing units
	Structural steel for Condensing Units	\$2,500.00	\$4,000.00	\$6,500.00	
	Provide catwalks and Acoustical Screen for CU's	\$5,000.00	\$5,000.00	\$10,000.00	
	Building Automation System (BAS)	\$8,500.00	\$5,000.00	\$13,500.00	standalone daikin
	TAB	\$100.00	\$1,500.00	\$1,600.00	One day
	3 Electric Heaters	\$2,500.00	\$1,900.00	\$4,400.00	
	Misc	\$5,000.00	\$5,000.00	\$10,000.00	
	Grand Totals	\$200,725.00	\$135,200.00	\$335,925.00	

Appendix #4 Energy Incentives



Massachusetts Commercial Upstream HVAC and Heat Pump Initiative

Qualifying Minimum Efficiency and Incentive Levels

Effective April 1, 2021

The Sponsors of Mass Save® have connected with HVAC distributors in Massachusetts to offer high-efficiency commercial HVAC equipment to our customers. Our Upstream HVAC program covers several types of commercial air conditioning and heat pump units in various sizes, so you can find a system that's right for you. Eligible equipment criteria and instant discount incentives are listed below. By choosing a high-efficiency system, the average commercial customer can save up to \$2,600 in lifetime energy costs. Visit MassSave.com/CI-HVAC to find a distributor near you and start saving today.

WE ARE MASS SAVE®:



Variable Refrigerant Flow (VRF)										
Equipment Type	Unit Type	Tier	Size Category ¹	Sub Category	Full Load Cooling Efficiency		Part Load Cooling Efficiency (SEER/IEER)		Heating Efficiency ²	Customer Discount (\$/Ton)
Air-Cooled	VRF	1	≥ 65 kBtuh and < 135 kBtuh (≥ 5.4 Tons and < 11.3 Tons)	Split System	11.5 EER	and	20.0	and	3.4 COP	\$125.00
		2			11.5 EER	and	24.0	and	3.8 COP	\$175.00
Air-Cooled	VRF	1	≥ 135 kBtuh and < 240 kBtuh (≥ 11.3 Tons and < 20 Tons)	Split System	11.0 EER	and	18.0	and	3.3 COP	\$125.00
		2			11.0 EER	and	24.0	and	3.6 COP	\$175.00
Air-Cooled	VRF	1	≥ 240 kBtuh ≥ 20 Tons	Split System	9.6 EER	and	18.0	and	3.3 COP	\$125.00
		2			9.6 EER	and	24.0	and	3.6 COP	\$175.00
Water-Cooled	VRF	1	≥ 65 kBtuh and < 135 kBtuh (≥ 5.4 Tons and < 11.3 Tons)	Split System	12.5 EER	and	22.0	and	4.4 COP	\$125.00
		2			12.5 EER	and	26.0	and	4.8 COP	\$175.00
Water-Cooled	VRF	1	≥ 135 kBtuh and < 240 kBtuh (≥ 11.3 Tons and < 20 Tons)	Split System	11.0 EER	and	20.0	and	4.2 COP	\$125.00
		2			11.0 EER	and	24.0	and	4.8 COP	\$175.00
Water-Cooled	VRF	1	≥ 240 kBtuh ≥ 20 Tons	Split System	11.0 EER	and	17.0	and	4.0 COP	\$125.00
		2			11.0 EER	and	20.0	and	4.6 COP	\$175.00

Dual Enthalpy Economizer Controls (when installed with new qualifying equipment)

Equipment	Customer Incentive/Unit
Outside Air Economizer Utilizing 2 Enthalpy Sensors	\$125.00

Electronically Commutated Motor (ECM) Circulator Pumps for Hydronic Heating or Service Hot Water Installations

Commercial Pump Size	Customer Incentive/Unit
≤ 1/6 HP	\$100.00
> 1/6 HP and ≤ 3/4 HP	\$100.00
> 3/4 HP and ≤ 3 HP	\$200.00

High-Efficiency Condensing Units (HECU) for Refrigeration

Equipment Size	Customer Incentive/HP
≥ 1 and ≤ 3 HP	\$400.00
> 3 and ≤ 6 HP	\$200.00

Note: Pre-approval may be required based on quantity of units purchased or incentives received.

¹Equipment capacity is AHRI rated capacity or capacity at AHRI rating conditions for units without an AHRI rating.

²Heating efficiency applies only to heat pumps.

Instant discount is expected to be passed down to the end-use customer. Onsite verifications may be required.

By receiving the incentive during the purchase from an enrolled distributor, the equipment cannot be considered for any other incentive program from the Sponsors of Mass Save®. Incentives and qualifying equipment are subject to change at any time. For more program information, please visit MassSave.com/CI-HVAC. Commercial & Industrial facilities in Rhode Island are also eligible for the same incentives as listed above.



Massachusetts Commercial Upstream HVAC and Heat Pump Initiative

Qualifying Minimum Efficiency and Incentive Levels

Effective April 1, 2021

Air-Cooled Air Conditioners										
Equipment Type	Unit Type	Tier	Size Category ¹	Sub Category	Full Load Cooling Efficiency		Part Load Cooling Efficiency (SEER/IEER)		Heating Efficiency ²	Customer Discount (\$/Ton)
Air-Cooled	AC	1	< 65 kBtuh (<5.4 tons)	Split System and Single Package	12.0 EER	and	15.0 SEER		-	\$30.00
		2			12.0 EER	and	17.0 SEER		-	\$90.00
Air-Cooled	AC	1	≥ 65 kBtuh and < 135 kBtuh (≥ 5.4 Tons and < 11.3 Tons)	Split System and Single Package	12.0 EER	and	13.5 IEER		-	\$30.00
		2			12.0 EER	and	18.0 IEER		-	\$100.00
Air-Cooled	AC	1	≥ 135 kBtuh and < 240 kBtuh (≥ 11.3 Tons and < 20 Tons)	Split System and Single Package	11.5 EER	and	13.0 IEER		-	\$25.00
		2			11.5 EER	and	17.5 IEER		-	\$75.00
Air-Cooled	AC	1	≥ 240 kBtuh and < 760 kBtuh (≥ 20 Tons and < 63.3 Tons)	Split System and Single Package	10.1 EER	and	12.0 IEER		-	\$25.00
		2			10.1 EER	and	16.0 IEER		-	\$75.00
Air-Cooled	AC	1	≥ 760 kBtuh (≥ 63.3 Tons)	Split System and Single Package	9.8 EER	and	13.0 IEER		-	\$25.00
		2			9.8 EER	and	16.0 IEER		-	\$75.00
Air-Cooled Heat Pumps										
Air-Cooled	HP	1	≥ 65 kBtuh and < 135 kBtuh (≥ 5.4 Tons and < 11.3 Tons)	Split System and Single Package	11.1 EER	and	13.5 SEER	and	3.4 COP	\$50.00
		2			11.1 EER	and	18.0 SEER	and	3.4 COP	\$112.50
Air-Cooled	HP	1	≥ 135 kBtuh and < 240 kBtuh (≥ 11.3 Tons and < 20 Tons)	Split System and Single Package	10.7 EER	and	12.5 IEER	and	3.3 COP	\$40.00
		2			10.7 EER	and	17.0 IEER	and	3.3 COP	\$100.00
Air-Cooled	HP	1	≥ 240 kBtuh and < 760 kBtuh (≥ 20 Tons and < 63.3 Tons)	Split System and Single Package	9.6 EER	and	12.0 IEER	and	3.3 COP	\$20.00
		2			9.6 EER	and	16.0 IEER	and	3.3 COP	\$75.00
Water/Evaporatively-Cooled Air Conditioners and Heat Pumps										
Equipment Type	Unit Type	Tier	Size Category ¹	Sub Category	Full Load Cooling Efficiency		Seasonal/Part Load Cooling Efficiency (SEER/IEER)		Heating Efficiency ²	Customer Discount (\$/Ton)
Water-Cooled	Water Source HP	1	Any Size	Split System and Single Package	14.0 EER		-	and	4.6 COP	\$37.50
		2			17.0 EER		-	and	4.6 COP	\$100.00
Water-Cooled	Ground Source Closed Loop HP	1	Any Size	Split System and Single Package	15.0 EER		-	and	3.4 COP	\$75.00
Water-Cooled	Ground Source Open Loop HP	1	Any Size	Split System and Single Package	19.0 EER		-	and	4.0 COP	\$75.00
Water Cooled or Evaporatively-Cooled	AC	1	< 65 kBtuh (<5.4 tons)	Split System and Single Package	13.5 EER	and	14.0 IEER		-	\$25.00
Water Cooled or Evaporatively-Cooled	AC	1	≥ 65 kBtuh and < 240 kBtuh (≥ 5.4 Tons and < 20 Tons)	Split System and Single Package	13.0 EER	and	15.5 IEER		-	\$25.00
Water Cooled or Evaporatively-Cooled	AC	1	≥ 240 kBtuh (≥ 20 Tons)	Split System and Single Package	12.5 EER	and	14.5 IEER		-	\$20.00

Note: Pre-approval may be required based on quantity of units purchased or incentives received.

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