Energy Audit

Funded by

Community Center

57 Main Street

Henniker, NH

November 1, 2023

BUILDING STRATEGIES FOR AN AFFORDABLE FUTURE

S.E.E.D.S.

SUSTAINABLE ENERGY EDUCATION DEMONSTRATION SERVICES

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Introduction

This Energy Audit has been funded by Eversource. Funds may, or may not, also be available to help reduce cost for eligible Energy Saving Measures (ESM) including weatherization efforts and equipment upgrades.

The purpose of an energy audit is to identify energy saving measures (ESM) in a building. Computer simulated energy models are developed to estimate energy consumption based on the local climate conditions, physical dimensions and characteristics of a building, mechanical systems, presumed lighting, equipment, and occupancy patterns, in addition to a number of other variables.

With the building modeled in existing conditions, energy savings can be estimated for improvements to the thermal envelope and/or more efficient mechanical systems. The cost of those measures can then be analyzed in terms of predicted energy saved and savings potential from converting to different sources of energy. The primary objective is to evaluate the level of investment warranted by energy and dollars saved from those specific measures.

This audit has been prepared with the best of intentions to assist the Town of Henniker make informed decisions regarding energy saving improvements in keeping with long term goals for the property. We do not make any warranty, expressed or implied, or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product or process disclosed.

Executive Summary

The Community Center is a historic brick building, originally constructed as a Church, and which consists of two floors. It was purchased by the Town in 2002 and now each floor has its own heating and cooling systems and serves two different purposes. A description of the building and a brief history is on pages 8-9.

The ceiling and foundation walls have some insulation, but the above grade brick walls are not insulated and account for an estimated 43% of the building's heat loss. Insulating to the interior of brick walls is not impossible but complicated and often not recommended. An article about the complexity of masonry walls, by New England's premier building scientist, is included in the Appendix.

Four ESM addressing envelope improvements have been recommended, along with making changes to thermostat settings and other controls. The summary on the next page shows that an estimated total investment of $8,554 will result in an estimated annual energy savings of $1,035 in both electricity and propane, based on current energy pricing, and 163 million Btu of source energy.

The upper floor is referred to here as the Meeting Room (MR) and the basement level as the Teen Center (TC). The MR's primary or first stage heating is by (2) propane fired forced warm air furnaces, with a standard air source heat pump (ASHP) as secondary—intended primarily as a quieter source of heating during meetings. The TC has a Hyper Heat ASHP with electric resistance baseboards installed as back up, but were found to be on and serving as primary heating during the site visit. Pages 11-17 go into considerable detail describing the existing systems and how they might be able to be operated or controlled differently to effect energy savings.

Completing the thermal envelope improvements will help both floors rely more on the more efficient heat pumps for heating by making adjustments to thermostat programs and installing programmable thermostats to control the TC's baseboards. Based on the estimated heat loss of that floor, and the published ratings of the heat pump, heating by very costly electric resistance baseboards should be all but eliminated.

Summary of Energy Saving Envelope Measures

The recommended ESM are described in more detail later in this report.

The chart below summarizes the estimated cost of each ESM, estimated annual dollar savings, a simple payback in years, and return on investment (ROI) of each measure based on the service life of the improvement.

ESM #	Energy Saving Measures (ESM)	Cost of Measure	Annual Savings	Simple Payback Years	Life of Measure	Investment Gain	ROI	Annual ROI
MR-1	Put Ceiling Fans on timer	$175	$68	2.6	25	$1,525	871.4%	9.5%
TC-1	Mysa Smart Thermostat	$1,000	$297	3.4	25	$6,425	642.5%	8.4%
MR2/TC-2	Weatherstripping	$450	$45	10.0	15	$225	50.0%	4.1%
TC-3	Rim Joists	$1,360	$160	8.5	25	$2,640	194.1%	4.4%
MR-3	Curved Ceiling Upgrade	$2,400	$241	10.0	25	$3,625	151.0%	3.8%
MR-4	Innerglass	$3,344	$224	14.9	25	$2,256	2256.0%	2.1%
All	TOTALS	$8,554	$1,035	8.3	25	$16,871	197.2%	4.5%

In total, an investment of an estimated $8,554 is predicted to save over $1,000 in annual energy costs at the three year average propane cost per gallon, and $0.13 per kWh. This would result in a simple payback within 8.3 years. Since ESM continue to save energy for the life of each measure, this also results in a minimum annual return on investment (ROI) of 4.5 % over each of the next 25 years. Again, the savings are based on recent average energy prices. If (when) prices increase, so too will the ROI.

This next chart presents the same ESM with resulting annual energy savings from each implemented measure and the annual reduction of CO2 emissions. Potential Eversource incentives are based on energy saved for the cost of the measures. Contact your Eversource representative, Jack Paloulek, to determine if the project is

ESM #	Energy Saving Measures (ESM)	Cost of Measure	LP Gallons Saved	kWh Saved	MMBTU Site Energy Reduction	MMBTU Source Energy Reduction	Tons CO2 Reductions Annually
MR-1	Put Ceiling Fans on timer	$175		523	1.8	5.9	0.23
TC-1	Mysa Smart Thermostat	$1,000		2285	7.8	26.0	1.0
MR 2/TC-2	Weatherstripping	$450	12	192	1.8	3.5	0.2
TC-3	Rim Joists	$1,360		1231	4.2	14.0	0.5
MR-3	Curved Ceiling Upgrade	$2,400	854	769	80.6	98.4	5.6
MR-4	Innerglass	$3,344	116	262	11.5	15.1	0.8
All	TOTALS	$8,554	982	5262	107.6	163	8

Also recommended is replacing the 21 year old 40 gallon electric water heater with a far more efficient heat pump water heater. Savings will be determined by the amount of water consumed as well as the added benefit of dehumidification from the heat pump—somewhat offset by the space cooling. Utility incentives for equipment are not based on predicted savings but by the efficiency of the selected product.

Assessed Values and Other Model Inputs

The thermal envelope is the assembly of materials which form the barrier between inside conditioned space and outdoor weather and climate. Its ability to conserve heat and manage moisture determines, primarily, the heating load or demand of a building. Continuity and thickness of insulation, in direct contact with air barrier, is key to an effective thermal barrier.

Square Feet Area (whole)	4,585	
Volume (ft3) Upper	60,870	
Design Temps	Outdoor Dry	Indoor Dry
Winter	-2	70
Summer	87	75
Reference City	Concord NH	

Summary reports for load calculations of the existing and retrofitted condition has been included at the end of this study. Below is a summary of values for existing and improved envelope components.

Envelope Component	Surface Area FT2	Assessed Effective R-Value	U-Factor	Improved U-factor	Improvement
SP Historic Windows with Ext. Storm	296	1.29	0.78		Inner-Glass
SP Wood Frame 5/4	12	1.1	0.91		
Exterior Wood Door	37	1.85	0.54		Weather-Strip
Exterior Metal Doors	61	2.82	0.35		Weather-Strip
12" Brick Walls, plaster and paint	2412	6.1	0.16		
Framed walls - 2006	264	10.3	0.097		
Basement walls	1335	8.5	0.12	0.091	Dense pack voids
Exposed Foundation & Slab Edge	196	9	0.11		
Rim Joists	160	3	0.33	0.056	3" SPF with intumescent paint
Above Flat Ceilings	1936	42	0.02		
Above Curved Tin Ceiling	600	13.5	0.07	0.02	Blow in or place R38
Volume: 60,870 ft3 Above Grade		Exist		Improved	
CFM Air Leakage Winter		110		80	

Other formulas used in this analysis:

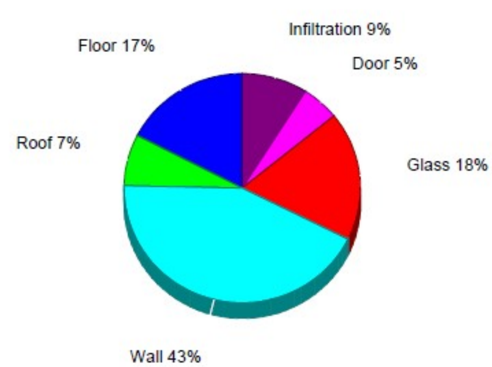
Propane: 91,300 Btu per gallon for site energy
Source energy: 104,995 Btu per gallon (1.15xSite)

Electric: 3412 Btu per kWh site energy.
Source energy: 11,361 Btu per kWh

CO_2 Emissions:

Propane: 12.35 lbs per gallon

Electric: CO_2 lbs = kWh X .89



Heat loss by the thermal envelope component

Historic Energy Use Analysis

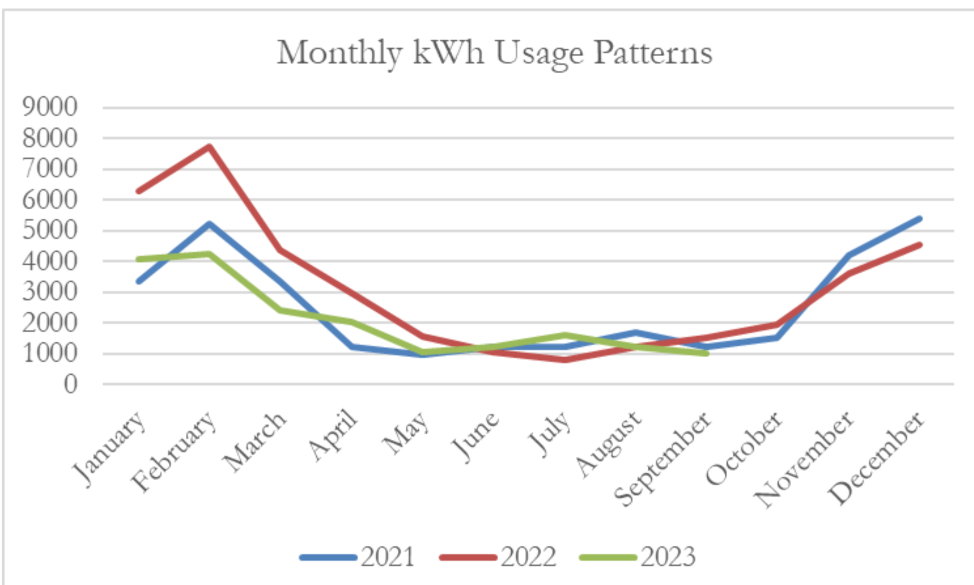
The energy analysis below is based on the energy data provided for 2022.

Energy	Units	Site Btus	Source Btus	$Cost
Electric kWh	34,199	116,686,988	388,534,839	$5,211
Propane	1,281	116,955,300	134,498,595	$2,176
Totals		233,642,288	523,033,434	$7,387
EUI KBtu/FT2	5160	45.3	101.4	$1.43

The Energy Utilization Index (EUI) offers a simple snapshot analysis of a building's energy use by looking at total amount of energy input (converted to Btu's) divided by the floor area of conditioned space. "Site Energy" refers to units of energy delivered to a site. Source energy includes transmission and some allowance for off site generation and other considerations.

Based on the information provided the Site EUI for 2022 was 45.3 KBtu/ft2 for the whole building. Source EUI was 101.4 KBtu/ft2, with a cost per square foot of $1.43per ft2 based on current energy prices. Since the per unit cost for energy can vary greatly over time, converting all forms of energy to Btus is a more useful way of looking at a building's energy demands and potential reductions from energy saving measures.

Monthly patterns of electric consumption can sometimes tell a useful story, though assumptions are never as useful as hard facts. Still, it is most likely that the peak consumption pattern in the winter is due to the use of electric heating, especially in the basement where electric resistance (ER) baseboards are used to supplement, or instead of, the one indoor heat pump unit.



Electric heating is estimated to consumer 25,000 kWh, or over 66%, of the annual electric consumption. In addition to the high efficiency of heat pumps, another significant advantage if the potential to generate clean, renewable energy on, or near to, the site of use.

KW Demand and the Cost of Supply

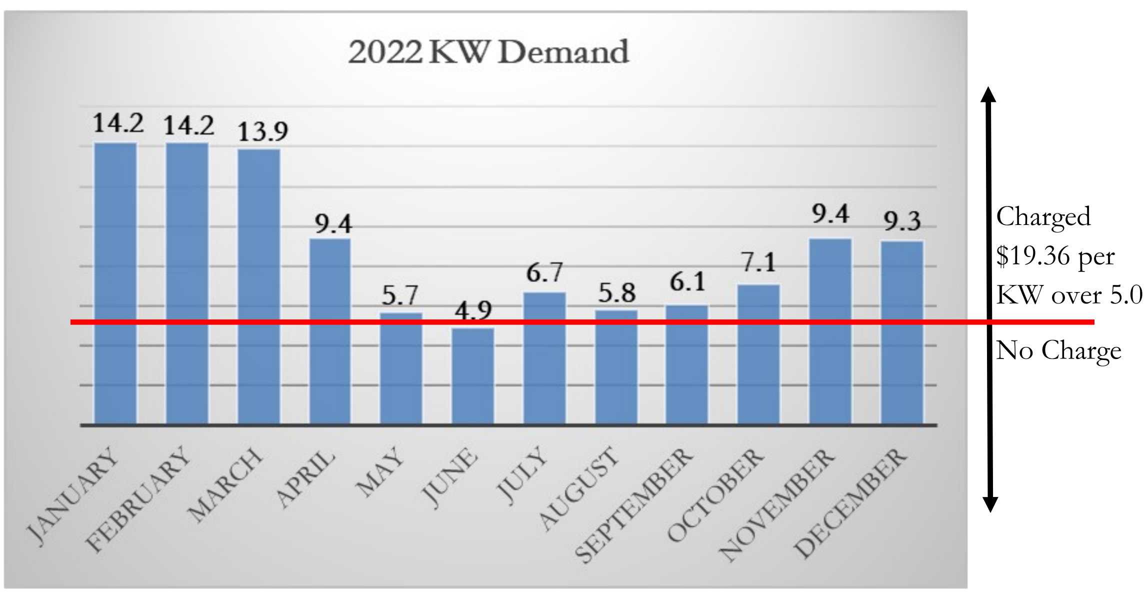
The KW Demand is determined each month by the peak call for power during any 30 minute window within a billing cycle. The total charges for KW Demand in 2022 was $906, or just over 17% of the total cost for electricity in 2022.

Corresponding with the highest usage of kWh, demand for power was highest in the coldest months of the year, due to space heating. Reducing reliance on the electric baseboards would reduce both demand for power and actual consumption. Heat pumps operate most efficiently when left at a stable thermostat setting.

Reducing electric usage saves energy and monthly costs in both the supply side (actual electricity used) and the delivery side (the very real transmission costs of delivering kWh to the meter, maintaining lines, etc).

Lowering peak demand on the regional grid plays a critical part in reducing the need to build more generation plants. It may be impacted by a reduction in kWh consumption, but is mostly determined by time and the appliance used. Customers are allowed a peak use of 5.0KW each month before incurring charges.

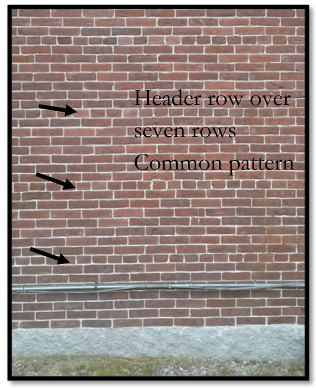
A good explanation about Demand Charges can be found at [Making Sense of Demand Charges: What Are They and How Do They Work? - Renewable Energy World]

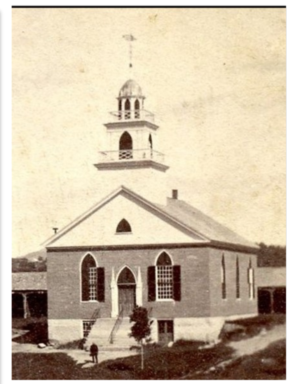


Building Description and Brief History

The one story brick Henniker Community Center was constructed in 1834 as a Church on a large granite block foundation. "The granite was quarried in Henniker, likely by William Smith who obtained the granite from ledge in the eastern part of Henniker."

"The brick walls are laid in the Common or Bond pattern of seven common bond rows and an eight header row. The exact source of the brick is not known…(though) extensive brick making was conducted in Hooksett, the most likely nearby source." A photo from around the 1920's shows the interior walls with likely lathe and plaster finished walls.

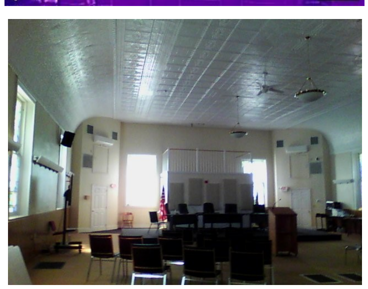


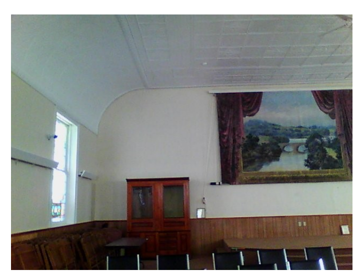


Circa 1870's

Thermographic imaging taken for this study indicates large wood framing, still without any insulation against the brick. Adding insulation in the walls would result in a substantially improved thermal envelope and occupancy comfort with significant energy savings. However insulation would also result in colder brick and the risk of degradation of the bricks and mortar from freezing and thawing. The level of risk depends greatly on the type of brick and mortar—which can only be determined through chemical analysis.

The most effective and risk-free way to dramatically improve the thermal envelope of masonry buildings is to insulate on the exterior of the brick, adding a drainage plane and new exterior brick façade, though this strategy conflicts with current historic preservation goals, of significant interest for this building in particular.





With respect to the goals of energy efficiency and a carbon neutral economy, Dr. Lstiburek's "The Perfect Wall", Building Science Insight 001, is in the appendix.

* Information, and some photos taken, with gratitude, from the Application to the NHDHR, Individual Inventory Form, Completed by Susan Fetzer, August 1, 2023.

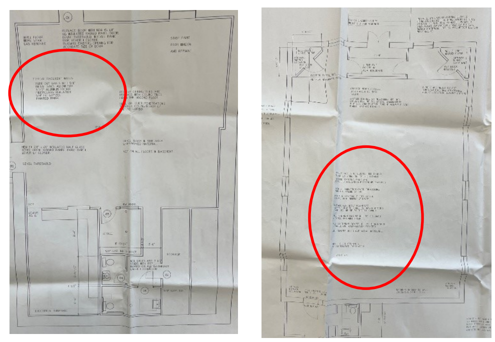
From 1834 till 1969, the building served as a Baptist, then Methodist house of worship on the upper floor with the vestry in the lower, basement level.

Following five years vacancy, it was purchased in 1974 by the Henniker Masonic Association and served as a place for meetings and activities until it was again sold to the Town of Henniker in 2002.

"The sale (to the Town) included three stipulations: the building would be available for use by community organizations without charge, a granite monument with the Masonic emblem would be retained in the building as a representation of its prior use and finally, if the building was ever sold for non-municipal purposes, half the proceeds would be payable to the Masonic Association in Hillsborough."

(Application to the NHDHR, Individual Inventory Form, Completed by Susan Fetzer, 8.1.2023)

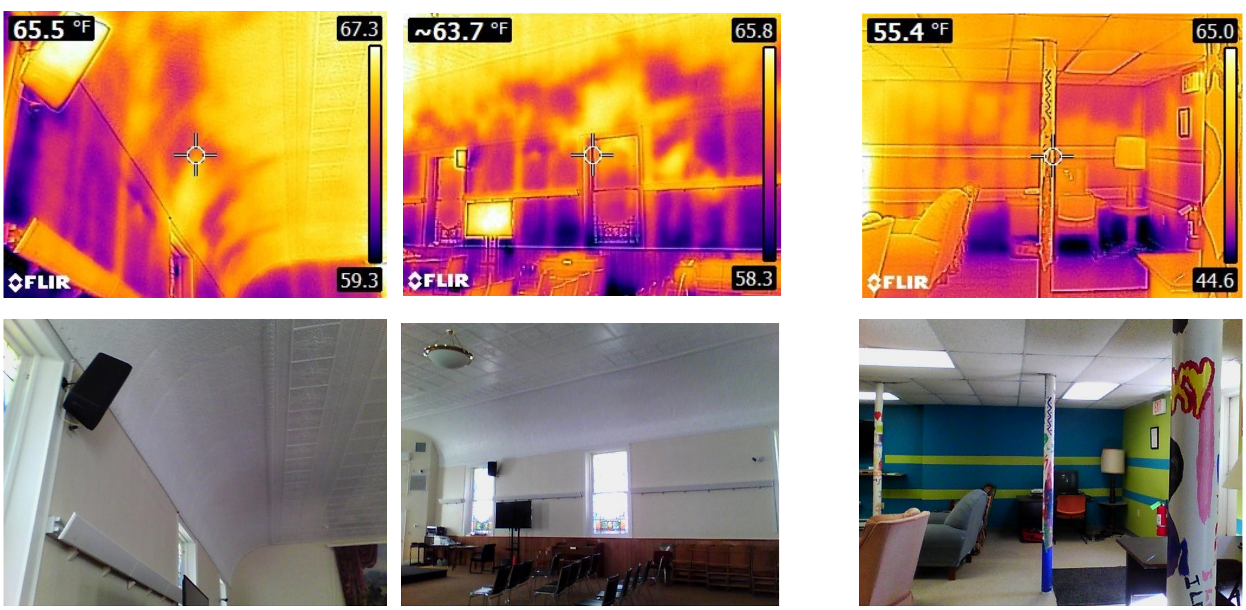
The only drawings available were floor plans made in 2003 by Architectural Link out of Pembroke. Those plans included brief notes regarding insulation.



"remove acoustic ceiling tile and grid, repair existing tin ceiling, blow in insulation over tin ceiling minimum R-value of 38"

Presumably, this was done, though IR images suggest that insulation covering the curvature of the ceiling was minimal at best and offers an opportunity for improvement. There may be access to an attic above the vestibule on the south where the bell rope extends, however accessing the attic was not attempted for this study.

"Typical basement walls: Furr out walls with 1 5/8" metal stud. Allow for 3 1/2" aluminum faced fiberglass insulation. 5/8" FC Gyp Bd, painted finish"



Upper floor walls and ceiling (above) Basement walls (right) show non-continuous fiberglass batts with voids and cold air migration from the floor, indicating a non-continuous air and thermal barrier.

Upper Floor Graphic

Only roughly to scale.

Key

(2) 4' LED

Ceiling lights

Indoor Unit for heating & cooling

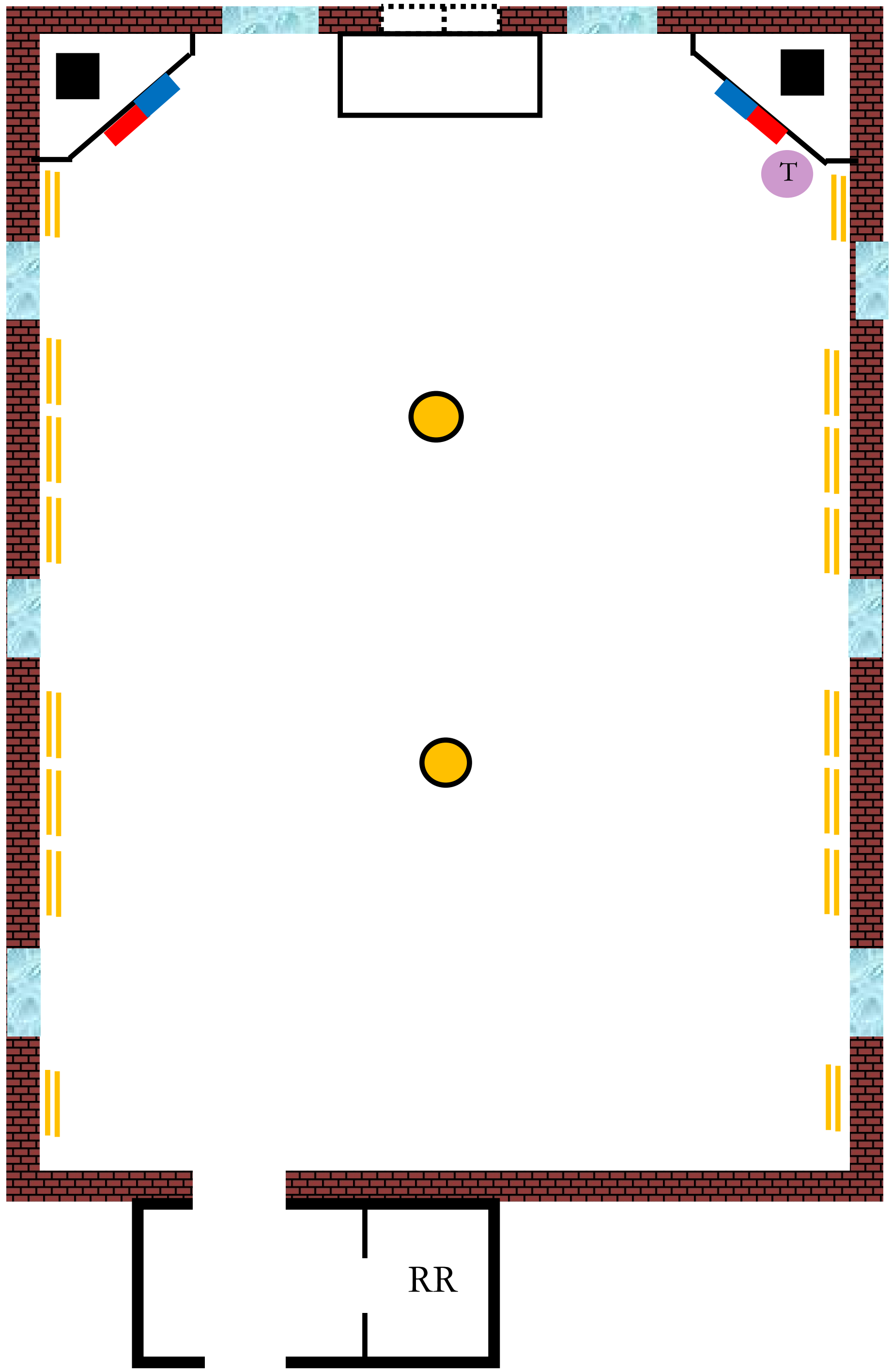
Thermostat

FHA Furnace (s)

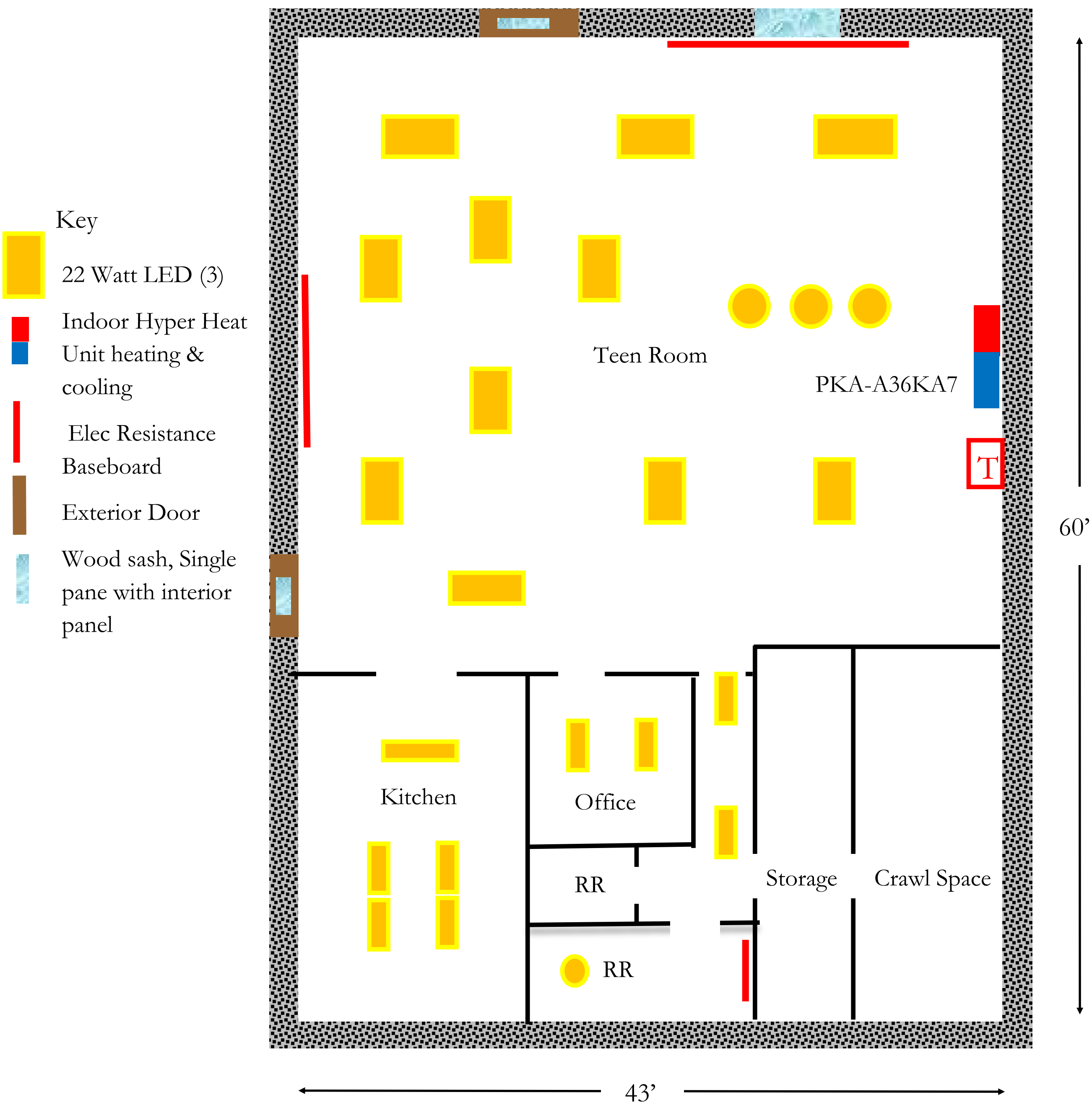
Double Hung Single pane stained glass with exterior storm

Ceiling Fan

Exterior Door



Teen Center—Basement Level



ESM # TC1 and # MR-1

Turning devices off when they are not needed is the simplest and most cost effective way to save energy. In this case, reduce (or eliminate) the number of hours the electric baseboards and ceiling fans run by installing programmable to both controls. Fans can be shut off at least 50% of the time.

Mysa Smart Thermostat for Electric Baseboard Heaters $149 x 3 = $447

- 24/7 mobile app control
- Easy heating Schedules
- Voice control/smart home integration
- Premium design
- Temperature/humidity alerts
- In-app energy use monitoring
- Monthly room-by-room energy cost report
- Touch-screen control
- Group your thermostats in zones
- Temperature range 41°-86°F

BN-Link 7 Day Programmable in wall Timer Switch for Lights, Fan,s and Motors. $26..99 Amazon

- Easily set up to 18 on/off programs, each with 7-day options

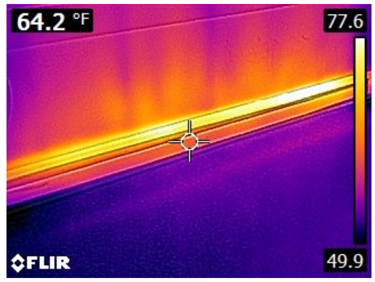
Replacing the Noisy Dehumidifier with a quieter and more efficient model is recommended.

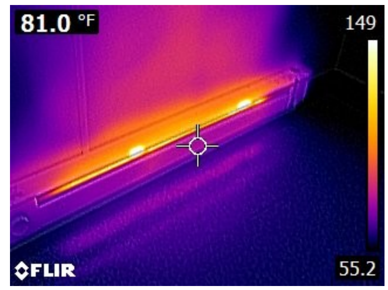
Midea 50 Pint SmartDry Dehumidifier - $260.00

- • Energy Star
- • 50 pints/day
- • Smart Phone compatible
- • Built in Pump

Teen Center Electric Heating

On the day of the CC first site visit, March 27, the outdoor air temperature (OAT) was about 36° F. The heat pump was not running, but all three electric resistance baseboards were on and the indoor air temperature was a comfortable 68°F, though unheated wall surfaces ranged from 52°-58°F. It is impossible to know how the baseboards are controlled, but the presumption is that they are likely relied on more consistently than the heat pumps, possibly because they warm the walls which may provide greater comfort than standing/sitting next to colder walls.





The Bin Analyses below reflects the 30 year average number of hours (for Concord, NH) the OAT falls within 5-degree "bins". It also reflects the estimated heating load for each bin, and whether the heating capacity of the installed heat pump (maximum of 38,000 Btu/hr at 5° OAT) is capable of meeting the heating load without a back up source.

In the top example, the hourly heated load, based on the assessment of the envelope and outdoor temperature, back up heating for the Hyper Heat PUZ-HA36NHA5 would expected to be only needed when the OAT dropped below around –5°F. That means the far more efficient heat pump *should* be able to maintain indoor ambient temperature for all but about 40 hours a year and the cost to run the back up resistance heat during those hours would be an estimated $11.

Based on a number of assumptions, it is estimated that the baseboard may be on far more than necessary which could results in an estimated $500 higher energy bill for the Teen Center.

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Bin Analysis Report - System 3 - Existing BASEMENT. ER OFF

Bin Temp Ranges Degree F	Hours Per Bin	Heating Load Btuh	Adjusted Load (x 0.85)	Heat Pump Output Btuh	H. Pump Run Time Fraction	Backup Output Btuh	H.Pump Heating Cost	Backup Heating Cost	Total Heating Cost
-20 to -15	1	42,146	35,824	0	0.000	35,824	0.00	1.42	1.42
-15 to -10	18	39,751	33,789	33,789	0.534	33,789	10.56	9.62	20.18
-10 to -5	19	37,357	31,753	31,753	0.836	0	16.46	0.00	16.46
-5 to 0	52	34,962	29,718	29,718	0.782	0	39.86	0.00	39.86
0 to 5	136	32,567	27,682	27,682	0.728	0	92.11	0.00	92.11
5 to 10	154	30,173	25,647	25,647	0.675	0	91.90	0.00	91.90
10 to 15	209	27,778	23,611	23,611	0.621	0	109.45	0.00	109.45
15 to 20	312	25,383	21,576	21,576	0.568	0	142.64	0.00	142.64
20 to 25	385	22,989	19,540	19,540	0.514	0	150.15	0.00	150.15
25 to 30	666	20,594	17,505	17,505	0.461	0	194.82	0.00	194.82
30 to 35	878	18,199	15,469	15,469	0.407	0	206.47	0.00	206.47
35 to 40	650	15,805	13,434	13,434	0.354	0	121.75	0.00	121.75
40 to 45	658	13,410	11,399	11,399	0.300	0	96.57	0.00	96.57
45 to 50	679	11,015	9,363	9,363	0.246	0	76.04	0.00	76.04
50 to 55	619	8,621	7,328	7,328	0.193	0	50.65	0.00	50.65
55 to 60	717	6,226	5,292	5,292	0.139	0	39.74	0.00	39.74
60 to 65	685	3,831	3,257	3,257	0.086	0	21.99	0.00	21.99
Totals:	6,838						$1,473.60	$11.04	$1,484.64

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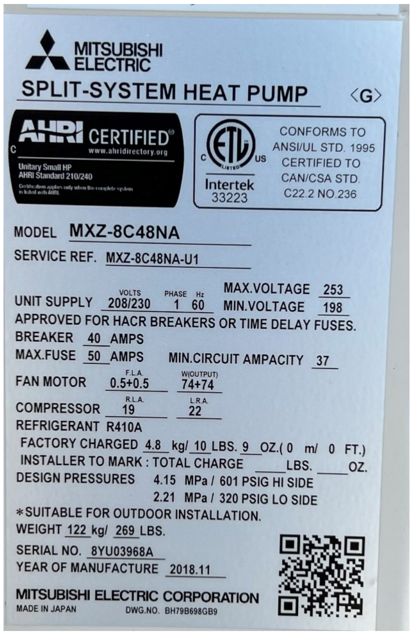
Bin Analysis Report - System 1 - Existing BASEMENT

Bin Temp Ranges Degree F	Hours Per Bin	Heating Load Btuh	Adjusted Load (x 0.85)	Heat Pump Output Btuh	H. Pump Run Time Fraction	Backup Output Btuh	H.Pump Heating Cost	Backup Heating Cost	Total Heating Cost
-20 to -15	1	42,146	35,824	0	0.000	35,824	0.00	1.42	1.42
-15 to -10	18	39,751	33,789	0	0.000	33,789	0.00	24.06	24.06
-10 to -5	19	37,357	31,753	0	0.000	31,753	0.00	23.86	23.86
-5 to 0	52	34,962	29,718	0	0.000	29,718	0.00	61.12	61.12
0 to 5	136	32,567	27,682	0	0.000	27,682	0.00	148.91	148.91
5 to 10	154	30,173	25,647	0	0.000	25,647	0.00	156.23	156.23
10 to 15	209	27,778	23,611	0	0.000	23,611	0.00	195.19	195.19
15 to 20	312	25,383	21,576	0	0.000	21,576	0.00	266.27	266.27
20 to 25	385	22,989	19,540	0	0.000	19,540	0.00	297.57	297.57
25 to 30	666	20,594	17,505	17,505	0.461	0	194.82	0.00	194.82
30 to 35	878	18,199	15,469	15,469	0.407	0	206.47	0.00	206.47
35 to 40	650	15,805	13,434	13,434	0.354	0	121.75	0.00	121.75
40 to 45	658	13,410	11,399	11,399	0.300	0	96.57	0.00	96.57
45 to 50	679	11,015	9,363	9,363	0.246	0	76.04	0.00	76.04
50 to 55	619	8,621	7,328	7,328	0.193	0	50.65	0.00	50.65
55 to 60	717	6,226	5,292	5,292	0.139	0	39.74	0.00	39.74
60 to 65	685	3,831	3,257	3,257	0.086	0	21.99	0.00	21.99
Totals:	6,838						$814.90	$1,174.64	$1,989.53

Upper Floor Heating and Cooling



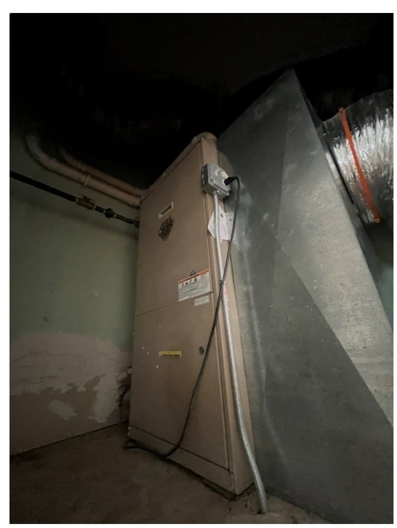
Outdoor Unit: MXZ-8C48NA

Multi Zone Heat Pump with (2) two-ton Indoor Units

MSZ-GL24NA

GENERAL FEATURES • Slim wall-mounted indoor units provide zone comfort control • The outdoor unit powers the indoor unit, and should a power outage occur, the system is automatically restarted when power returns • Multiple fan speed options: Quiet, Low, Medium, High, Super-high, Auto • Multiple control options available: - Hand-held Remote Controller (provided with unit) - kumo cloud® smart device app for remote access - Third-party interface options - Wired or wireless controllers • Hot-Start Technology: no cold air rush at equipment startup or when restarting after Defrost Cycle • Quiet operation • Smart Set: recalls a preferred preset temperature setting at the touch of a button

The multi-split heat pumps installed in the Community Room were intended to supplement the two propane condensing furnaces, located in each corner closet. The furnace blowers make too much noise to be used during meetings so the quiet heat pumps offer more acceptable heating.



Based on the assessed envelope, the estimated hourly 'peak' heat loss is just over 61,000 Btu with a temperature difference of 72 degrees between inside and outside. The capacity of each propane fired furnace is not available, but each of them likely has an output capacity greater than 61,000 Btu/hr.

Getting into the mathematical weeds a bit:

The overall average heat transmission of a building's thermal envelope is calculated by the u factors and gross surface area of each different component (UA).

Based on the assessment conducted in this study, the UA is an estimated 857 Btu/hr. The chart below reflects the heat loss at varying OAT when the indoor temperature is 70ºF.

OATºF	ΔTºF	Heat Loss Btu/Hr
60	10	8570
55	15	12855
50	20	17140
47	23	19711
40	30	25710
35	35	29995
40	30	25710
35	35	29995
30	40	34280
25	45	38565
20	50	42850
17	53	45421

Turning to the stated heating capacities of the outdoor compressor (heat pump) installed for the meeting room, (bottom chart) the maximum capacity at 17º is 35,000 Btu/hr. But the heat loss of the meeting room at 17 ºis 45,421Btu/hr. In other words, the heat pump won't be able to replace the hourly heat loss at that OAT.

We don't know what the heat pump capacities are exactly at different OAT, but its fair to assume that, based on the assessment and the chart to the right, it should be able to be effective at heating the space down to at least 30º OAT when the heat loss is less than 35,000 Btu/hr.

At a temperature difference of 40º degrees between inside and outside air temperature (40°ΔT), ie when its 70°inside and 30° outdoor air temp (OAT), the hourly heat loss is less than 35,000Btu (857 x 40 = 34280).

The efficiency of heat pumps is referred to as the Coefficient of Performance (COP). That is how many kWh worth of heat is moved for every kWh consumed. Since a kWh has 3412Btus, a COP of 2.45 means that 8,359 Btu is made available for space heating. To compare the cost of heating with propane vs heat pumps, we look at how many units of energy is required for one million Btu worth of heating.

1,000,000 / 8,359 = 119 kWh (at a COP of 2.45) 119 kWh x $.13 per kWh = $15.47 per million Btu

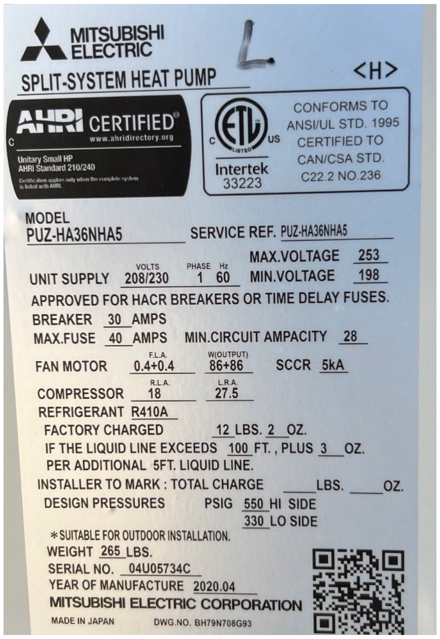
It takes about 12 gallons of LP in these furnaces to create a million Btu—so LP costs $17.52 per million Btu.

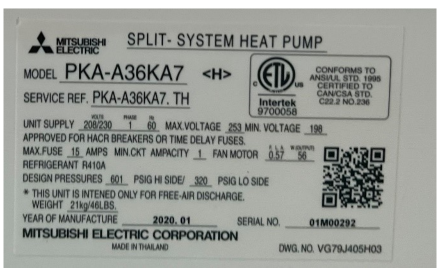
In sum: <u>at current energy prices</u>, it is less expensive to maintain the Meeting Room at 70º with the heat pumps till the OAT drops below 30 degrees, *then* rely on the propane units.

MXZ 8C48NA	Max Capacity BTU/H	Range Capacity BTU/H	Rated Input Watts	Efficiency COP
Heating at 47º OAT	54,000	22,500-54,000	4220/4990	3.75
Heating at 17º OAT	35,000	36,000	3,720	2.45
Heating at 5º OAT				
Cut out OAT				-4
	Max Capacity	Range	Rated Input	
Cooling	BTU/H	BTU/H	Watts	
	48,000	15,500-48,000	4,000-5,050	

Teen Center (Basement) Heating and Cooling

Outdoor Unit





PUZ-HA36NHA5 **H2i Hyper Heat** Production 2007– Retired

Manufactured Aril 2020 Refrigerant R410A

Serial # 04U05734C

- Variable speed INVERTER-driven compressor
- High heating capacity: flash injection circuit maintains 100% heating capacity at 5°F outdoor temperature
- Wide heating range: heating performance down to -13°F (average of 80% heating capacity)
- High speed heating at start up: Hyper-Heating INVERTER® reduces the time for heating at start up by about half compared to standard models
- Suction accumulator pre-charged with refrigerant volume for piping length up to 100 ft.
- Twinning of two indoor units possible with the 36 kBTU/H model
- High pressure/temperature protection

INDOOR UNIT FEATURES

- Sleek, compact design
- Simple installation
- Vane setting for air flow direction control
- Auto fan speed mode

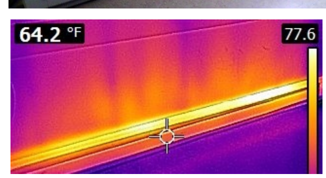
The heat pump for the basement is different. It relies on electric resistance as a back up so the unit selected was a "Hyper Heat" meaning it has greater capacities at lower OAT and it will always be less expensive to rely on maintaining 70° from the heat pump for heating, with no weekday set backs.

Calculated peak heat loss: 34,643 Btu/hr

	Max BTU/H	Rated BTU/H	Rated Watts	Efficiency COP
Heating at 47° OAT	40,000	38,000	3410	3.26
Heating at 17° OAT	38,000	25,000	3330	1.85
Heating at 5° OAT	38,000		6760	1.65
	Max Ca-	Rated Ca-	Rated	SEER
Cooling	33,500	33,500	2790	16.2
Moisture Removal	8.7	pints/hr		

Data from Mitsubishi Submittal

Three electric resistance (ER) baseboards, for a total of 20 linear feet) provide heating of the walls via both convection and radiant heat transfer. Where as heat pumps which transfer heat through compression and a refrigerant, ER generates heat at an efficiency of about .99% or a COP of less than 1. That means every kWh generates about 3378 Btu, ($38.48 per million Btu) where as the heat pump moves between 11,123 and 5,600 Btu per kWh ($11.68-$23.14 per MMBtu).



Thermostat Set Backs

There is a bit of controversy around whether setting a thermostat to a lower temperature saves energy or not.
Two common myths:

1. "Thermostat setbacks during the winter won't save you money. Any energy you saved when the thermostat was turned down will be lost because of the amount of fuel the furnace needed to get you back to a comfortable level."
2. "Setting your thermostat back will save energy, but no more than four degrees." (or 6 or some set number)

The reality is that lowering the indoor air temperature through thermostat setbacks for fuel burning equipment almost always saves heating energy because one of the factors of heat transfer is the temperature difference between inside and outside (aka delta T or ΔT): the lower the ΔT, the slower the rate of heat transfer, therefore heat loss is reduced. While its true that a furnace or boiler will run longer to bring the temperature back up to comfort levels, fossil fuel (and biomass) equipment operates more efficiently when it keeps running as opposed to turning on and off multiple times. For those two reasons, the energy saved from lower setbacks will *almost* always be more than the energy used to bring it back up to temperature. NOTE: This does NOT apply to variable speed heat pumps which operate most efficiently when left at one temperature.

But it is especially true for single stage oil fired equipment which is 'oversized'. That is when its hourly BTU output capacity far exceeds the hourly heat loss. Ideally, peak capacity will equal peak heat lost—ie the BTU/hr heat loss during the coldest hour of the location's winter, occurring 99% of the time on average. But non-modulating furnaces and boilers are frequently oversized—but as much as 50-150% . So when it comes on to satisfy the thermostat setting, it puts out a lot of heat, likely turns off fairly quickly, then on again minutes later. This on and off again is referred to as 'short cycling' and it results in low seasonal efficiency. (There are other maintenance reasons for short cycling, including a damaged flame sensor and dirty or misaligned air filters, so regular maintenance and inspections and can keep a furnace performing as efficiently as possible.)

But when a building is unoccupied overnight or for days at a time, keeping the thermostat set back means that the boiler will be off for many if not most of the winter hours, then run at its highest efficiency to recover.

All that said, there are other considerations with thermostat set backs, especially in a building with minimal insulation levels. As surfaces cool, there is a risk of condensation forming if surface temperatures drop below the dew point, though with low interior humidity, this should be a very low risk. The other common consideration is preventing the risk of freezing pipes on exterior walls, though again, this should not be an issue in the Community Center as long as the baseboard in the meeting room restroom is left on to 45 degrees.

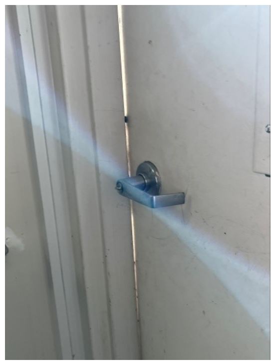
There is likely an 'optimal' set back temperature for the propane and oil systems in these buildings. But it is unique to each building based on the thermal performance of the envelope and which will vary for each hour as the delta T varies. I've asked contractors who recommend specific set back temperatures, why they pick 4º or 6º or whatever and the response has usually been something on the order of "because its complicated and customers won't understand. They just want simple instructions."

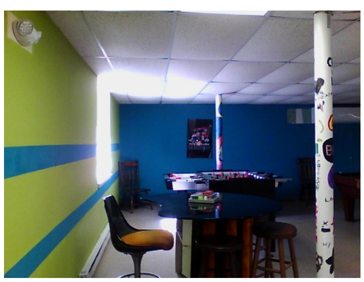
The mission of S.E.E.D.S. is based on the principle that to transition to a low energy, carbon neutral economy, people, as consumers, deserve to at least be offered the opportunity to understand the complexities of physics as they relate to our energy usage. For more information, check out the links below.

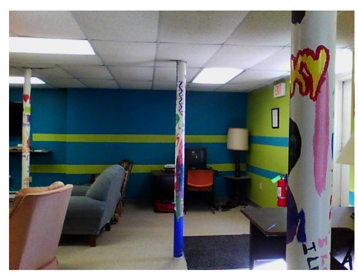
https://cbe.berkeley.edu/research/setpoint-energy-savings-calculator/
https://www.energyvanguard.com/blog/if-you-think-thermostat-setbacks-don-t-save-energy-you-re-wrong/
https://www.thisoldhouse.com/heating-cooling/21016013/how-thermostat-setbacks-save-money

ESM # MR-2 & TC-2

The south facing door to the Teen Center is in worse functional condition and has larger air gaps than the wood door above. Again, adding weather-stripping is a cost effective energy saving improvement, but this door is rusting and hard to open and close and, in my opinion, replacing it with a new insulated door would be a priority over the historic door above it.







ESM # TC-3

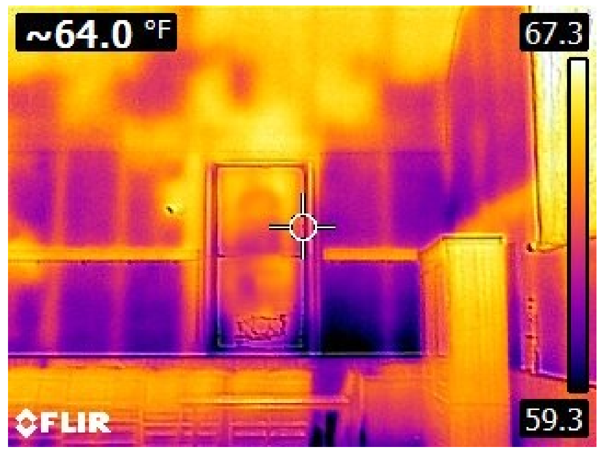
This vapor barrier was installed at some point, presumably to reduce moisture loads from exposed earth or rock. Reducing moisture loads does reduce the amount of vapor that needs to be extracted by a dehumidifier so does save energy. But even greater savings—and load reductions—can result from insulating rim & band joists, foundation walls, and even floors.

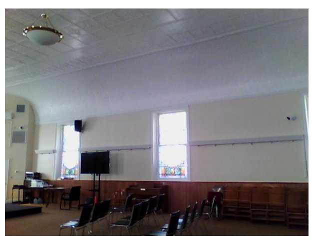
The recommendation is to spray 3” closed cell foam into all accessible rim/band joists (an estimated 160 ft2 here and above suspended ceiling tiles) and onto this membrane from the top of the foundation to 2-3 sloped feet below grade. Also spray at bottom plate of interior wall IF/SO to create a continuous vapor barrier. An intumescent paint needs to be applied over the foam to meet a 15 minute flame barrier, per code.

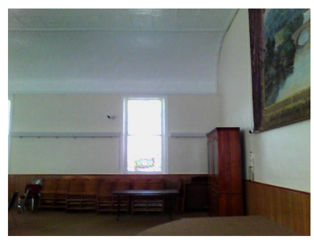
Where possible via raising suspended ceiling tiles, blow in mineral wool insulation into bays with voids or compromised fiberglass batts. Mineral wool is recommended over cellulose as it resists moisture from potential condensation on cold granite.

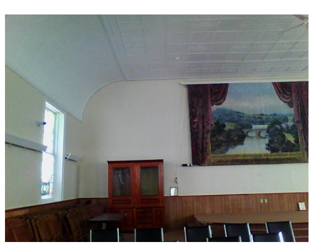
Upper Level Meeting Room—ESM #MR-3

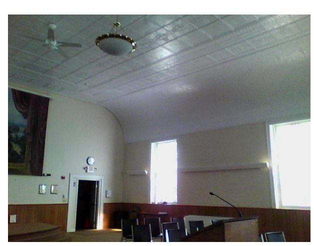
Thermographic (aka Infra Red or IR) images depict differences in surface temperatures. Darker colors indicate cooler surfaces than brighter colors. Dark "blobs" or streaks can indicate cold air leaking into the building on a cold day, or washing through low density insulation such as fiberglass. Though in this case, the voids or uninsulated and narrow wall cavities reflect the highly conductive cold brick of the exterior walls.

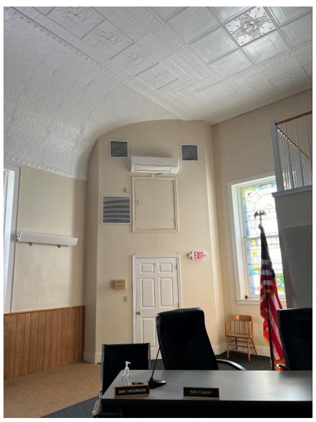


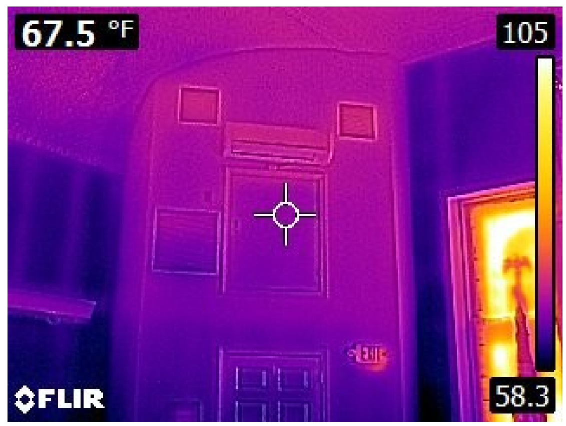


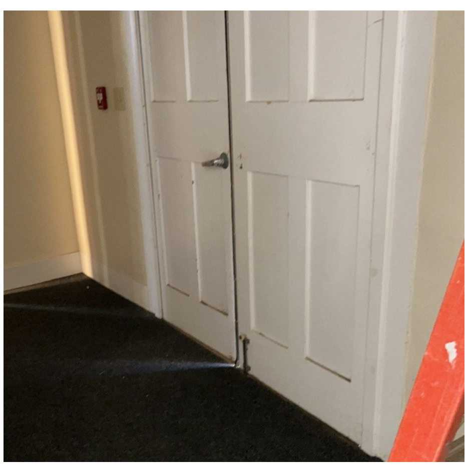












There are apparently plans to replace the double wood paneled door. The most cost effective upgrade would be to install commercial grade weather-stripping to close the gaps around the edges and reduce cold air infiltration. It is true that the door itself has a relatively low resistance to conductive heat transfer (ie low R-value). Even on this cold day in March, the solar gains are actually contributing BTUs into the vestibule. But its also the case that the heat loss of all four exterior doors in the building only accounts for about 5% of the total heat loss. This means that replacing the door will save energy, but the cost vs savings would result in a very long payback, where as just sealing the gaps of all doors for a fraction of the cost would yield greater savings than replacing this door.

ESM # MR-4 Interior Glazing Units

Exterior storm windows do reduce the amount of heat loss through windows to a certain extent, by adding an air space between the single pane of glass and storm. Importantly, they also serve to protect historic window frames and glass. But they do not stop air infiltration because they need 'weep holes' to allow drainage of condensation that forms.

As restoring historic wood windows becomes increasingly popular, many companies now offer a variety of interior options which are less expensive than full replacements and often as, or more, effective at reducing heat loss.

Interior glazing panels are a very effective option. They can be custom made with wood for $800-$2,000, OR a non wood unit can be custom ordered on line and easily installed for less than $300. In this case, a compression fitting unit is estimated to cost $418 per window.

They can be single units and easily removed, or double hung, and left in place.

The statements below were copied in part from stormwindows.com and reference Innerglass Windows specifically, though many of the statements describe any quality interior glazing panel. Advantages include:

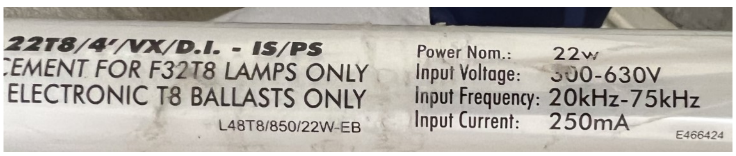
- Uses a concealed stainless steel springing system that requires no all-around track. It conforms to the window opening, automatically compensating for most out of square conditions.
- Custom made to your window dimensions, we can fit any window, no matter how crooked!
- Significantly more effective at insulating your home and lowering your heating and cooling bills than traditional exterior storm windows.
- Much tighter than exterior storms, because outside storm windows must be ventilated (you know, the weep holes) to get rid of the condensation that has already happened.
- So tight it provides a vapor barrier on the warm side that stops condensation in the first place.

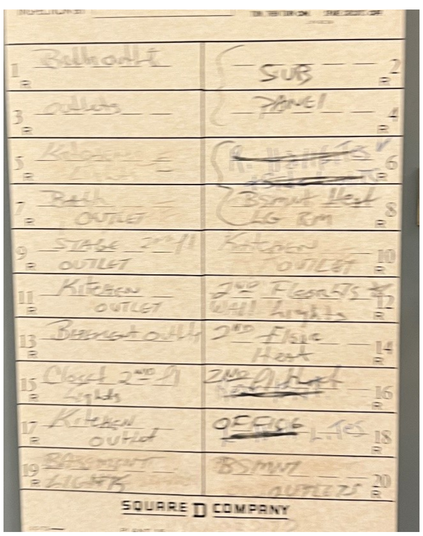
Innerglass Window Systems pioneered the use of high performance Low-E glass in our interior storm windows. Low-E glass doubles the R value of regular glass making you warmer in the winter and cooler in the summer. It also cuts out 2/3 of the ultra-violet rays that damage your rugs and furniture.

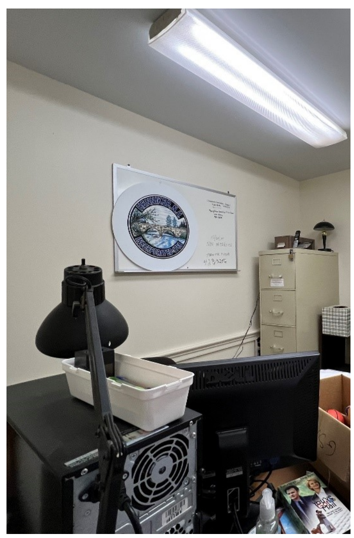
https://stormwindows.com/index.php/storm-windows-how-to-order/

Innerglass	U.I / FT2	Per	Per Unit	# Units	Cost
Compression Unit	152	$2.75	$418.00	8	$3,344

Inventory of Electric Appliances







The Basics of Heat Transfer in a Building

Heat moves in three basic ways in a building: Conduction, convection, and radiation.

Heat **conducts** to coolth or cold in any direction and through physical contact of materials. Insulation can slow the rate of heat loss to the outside. The rate at which it moves is determined by the type and thickness of material and the temperature difference between inside and outside. Compare holding a ceramic mug of hot water vs a glass of hot water, vs a glass of cold water. The skin of your hand will be heated—or cooled—based on the conductivity of the mug, glass, and the temperature difference of the water and your hand.

In a building in our climate, heat moves, or 'is lost' to the outside as it moves from inside heated space to the colder outside through an assembly of materials. For the walls, the assembly may consist of plaster or sheet-rock, brick, or wood framing with insulation in cavities (or not), exterior board sheathing, wood clapboards, or perhaps a thin layer of insulation and vinyl siding. The rate of heat loss varies with the difference between the inside temperature and outside temperature. That is why setting the thermostat back to 55 degrees when the building is unoccupied saves energy; because the rate of heat loss is slowed.

Heat can also be transferred through air or water by **convection.** While heat moves to cold via conduction, warmer air rises because it is lighter, or less dense, than cooler air. This means that insulation can only work well if it doesn't allow air to pass through it. The other way to say it is: Insulation needs to be in contact with an air barrier on all sides to perform as expected. Weatherstripping around doors and windows, for example, can stop cold air infiltration which, when warmed, rises to the ceiling and exfiltrates through any cracks or gaps in the ceiling material.

Insulation is usually described by its R-value, or resistance to allow heat transfer. But R-value doesn't tell the whole story because it only refers to conductive heat loss and doesn't consider convection. Manufactures of insulation test their products in a laboratory by placing it, fully lofted, in a perfectly sealed box, and measure the rate that heat moves from one side to the other to determine what "R-Value" to stamp on the product to be sold. If its not installed in exactly the same way, that R-value has very little meaning.

The third way heat moves is by **radiation**. This happens through space and from a warmer source to cooler surface in visual contact. Think of feeling the warmth of the sun and the immediate difference when a cloud blocks it. The sun still warms the earth surfaces and surrounding air, but direct radiation can be blocked—or shaded. Same thing with a wood stove. A hot stove warms air, but its greatest impact is by radiation which is only felt when one is in visible contact. And the further away, the less heat is felt. Its often tempting to replace windows because we feel so cold when next to them! That's because our body heat radiates to the cold surface. Insulated shades or quilts stops that radiative loss (but also eliminates view and daylight). Interior glazing panels can make a big difference for single pane windows because the air space raises the surface temperature of the inside glass.

In reality, all three mechanisms happen at the same time, though one usually dominates the others in terms of how much heat is moved. The role of heating system is to replace the heat that is lost through the envelope. This is described or measured as replacing BTU per hour (BTU/hr). If the heating system (electric baseboard, heat pump, oil or propane furnace or boiler, etc…) creates or moves more heat (BTU) in an hour than in lost to the outside, the system is considered "over-sized" which can waste energy unnecessarily. On the other hand, if the system cannot generate or move enough heat to replace what is lost in any given hour, the system is "undersized" and will not be able to maintain warm enough inside temperatures for human comfort. So correct sizing is important, most especially in systems which cannot modulate the heat output.

Henniker Community Center EXISTING
HVAC Load Calculations

for

Town Of Henniker

Henniker NH 03242

Elite Software

RHVAC Residential HVAC Loads

Prepared By:

Margaret Dillon
S.E.E.D.S.

603-532-8979
Tuesday, October 31, 2023

Rhvac is an ACCA approved Manual J, D and S computer program.
Calculations are performed per ACCA Manual J 8th Edition, Version 2, and ACCA Manual D.

Project Report

General Project Information

Project Title:	Henniker Community Center EXISTING
Project Date:	Tuesday, October 17, 2023
Client Name:	Town Of Henniker
Client City:	Henniker NH 03242
Company Name:	S.E.E.D.S.
Company Representative:	Margaret Dillon
Company Phone:	603-532-8979
Company E-Mail Address:	mdillon@myfairpoint.net

Design Data

Reference City:		Concord AP, New Hampshire
Building Orientation:		Front door faces North
Daily Temperature Range:		High
Latitude:	43	Degrees
Elevation:	342	ft.
Altitude Factor:	0.988	

	Outdoor Dry Bulb	Outdoor Wet Bulb	Outdoor Rel.Hum	Indoor Rel.Hum	Indoor Dry Bulb	Grains Difference
Winter:	-2	-2.6	n/a	n/a	70	n/a
Summer:	87	70	43%	50%	75	19

Check Figures

Total Building Supply CFM:	2,003	CFM Per Square ft.:	0.437
Square ft. of Room Area:	4,585	Square ft. Per Ton:	1,011
Volume (ft³):	60,870		

Building Loads

Total Heating Required Including Ventilation Air:	95,713	Btuh	95.713	MBH
Total Sensible Gain:	43,523	Btuh	80	%
Total Latent Gain:	10,878	Btuh	20	%
Total Cooling Required Including Ventilation Air:	54,401	Btuh	4.53	Tons (Based On Sensible + Latent)

Notes

Rhvac is an ACCA approved Manual J, D and S computer program.
Calculations are performed per ACCA Manual J 8th Edition, Version 2, and ACCA Manual D.
All computed results are estimates as building use and weather may vary.
Be sure to select a unit that meets both sensible and latent loads according to the manufacturer's performance data at your design conditions.

Miscellaneous Report

System 1 Existing Input Data	Outdoor Dry Bulb	Outdoor Wet Bulb	Outdoor Rel.Hum	Indoor Rel.Hum	Indoor Dry Bulb	Grains Difference
Winter:	-2	-2.6	80%	n/a	70	n/a
Summer:	87	70	43%	50%	75	18.65

Duct Sizing Inputs

	Main Trunk		Runouts	
Calculate:	Yes		Yes	
Use Schedule:	Yes		Yes	
Roughness Factor:	0.00300		0.01000	
Pressure Drop:	0.1000	in.wg./100 ft.	0.1000	in.wg./100 ft.
Minimum Velocity:	0	ft./min	0	ft./min
Maximum Velocity:	900	ft./min	750	ft./min
Minimum Height:	0	in.	0	in.
Maximum Height:	0	in.	0	in.

Outside Air Data

	Winter		Summer	
Infiltration Specified:	0.108	AC/hr	0.108	AC/hr
	110	CFM	110	CFM
Infiltration Actual:	0.108	AC/hr	0.108	AC/hr
Above Grade Volume:	X 60,870	Cu.ft.	X 60,870	Cu.ft.
	6,600	Cu.ft./hr	6,600	Cu.ft./hr
	X 0.0167		X 0.0167	
Total Building Infiltration:	110	CFM	110	CFM
Total Building Ventilation:	0	CFM	0	CFM

---System 1---

Infiltration & Ventilation Sensible Gain Multiplier: 13.04 = (1.10 X 0.988 X 12.00 Summer Temp. Difference)
Infiltration & Ventilation Latent Gain Multiplier: 12.52 = (0.68 X 0.988 X 18.65 Grains Difference)
Infiltration & Ventilation Sensible Loss Multiplier: 78.23 = (1.10 X 0.988 X 72.00 Winter Temp. Difference)
Winter Infiltration Specified: 0.108 AC/hr (110 CFM)
Summer Infiltration Specified: 0.108 AC/hr (110 CFM)

Load Preview Report

Scope	Net Ton	ft.² /Ton	Area	Sen Gain	Lat Gain	Net Gain	Sen Loss	Sys Htg CFM	Sys Clg CFM	Sys Act CFM	Duct Size
Building	4.53	1,011	4,585	43,523	10,878	54,401	95,713	1,259	2,003	2,003	
System 1	4.53	1,011	4,585	43,523	10,878	54,401	95,713	1,259	2,003	2,003	18x18
Zone 1			4,585	43,523	10,878	54,401	95,713	1,259	2,003	2,003	18x18
1-Upper Meeting Room			2,419	35,688	6,941	42,629	61,070	803	1,642	1,642	15--7
2-Basement Level			2,166	7,835	3,937	11,772	34,643	456	361	361	4--6

Total Building Summary Loads

Component Description	Area Quan	Sen Loss	Lat Gain	Sen Gain	Total Gain
SP with Storm: Glazing-Historic windows refurbished with good exterior storms, U-value 0.78, SHGC 0.65	295.7	16,608	0	18,408	18,408
1A-cw-o: Glazing-Single pane, operable window, clear, wood frame, U-value 0.9, SHGC 0.64	12	778	0	471	471
11G: Door-Wood - Panel, U-value 0.54	37.4	1,454	0	364	364
11N: Door-Metal - Polystyrene Core, U-value 0.35	21.8	548	0	137	137
Metal with glass: Door-Wide metal doors with small window, U-value 0.67	61.2	2,952	0	738	738
Brick 12": Wall-Block, Custom, Historic 12" brick walls, lathe&plaster, U-value 0.16	2412.2	27,789	0	3,628	3,628
12B-0bw: Wall-Frame, R-11 insulation in 2 x 4 stud cavity, no board insulation, brick finish, wood studs, U-value 0.097	264	1,844	0	120	120
Block with R9: Wall-Block, Custom, Granite foundation steel studs and 3.5 fg batts, U-value 0.12	1334.8	11,532	0	1,505	1,505
R-38 spec.: Roof/Ceiling-Roof Joists Between Roof Deck and Ceiling or Foam Encapsulated Roof Joists, Custom, Blow in over tin ceiling. min R-38, U-value 0.026	1936	3,625	0	856	856
Slopes.Poor: Roof/Ceiling-Under Attic with Insulation on Attic Floor (also use for Knee Walls and Partition Ceilings), Custom, Slopes Fiberglass, U-value 0.077	600	3,326	0	2,864	2,864
22A-pm: Floor-Slab on grade, No edge insulation, no insulation below floor, any floor cover, passive, heavy dry or light wet soil, U-value 1.18	196	16,652	0	0	0
Subtotals for structure:		87,108	0	29,091	29,091
People:	45		9,000	10,350	19,350
Equipment:			500	125	625
Lighting:	740			2,523	2,523
Ductwork:		0	0	0	0
Infiltration: Winter CFM: 110, Summer CFM: 110		8,605	1,378	1,434	2,812
Ventilation: Winter CFM: 0, Summer CFM: 0		0	0	0	0
Total Building Load Totals:		95,713	10,878	43,523	54,401

Check Figures

Total Building Supply CFM:	2,003	CFM Per Square ft.:	0.437
Square ft. of Room Area:	4,585	Square ft. Per Ton:	1,011
Volume (ft³):	60,870		

Building Loads

Total Heating Required Including Ventilation Air:	95,713	Btuh	95.713	MBH
Total Sensible Gain:	43,523	Btuh	80	%
Total Latent Gain:	10,878	Btuh	20	%
Total Cooling Required Including Ventilation Air:	54,401	Btuh	4.53	Tons (Based On Sensible + Latent)

Notes

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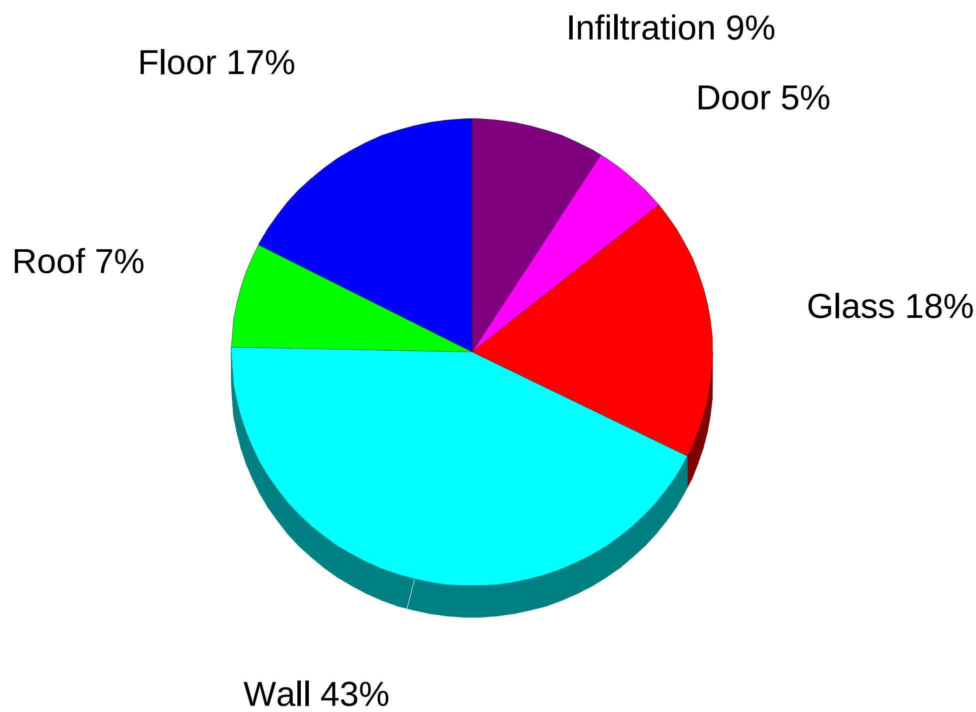
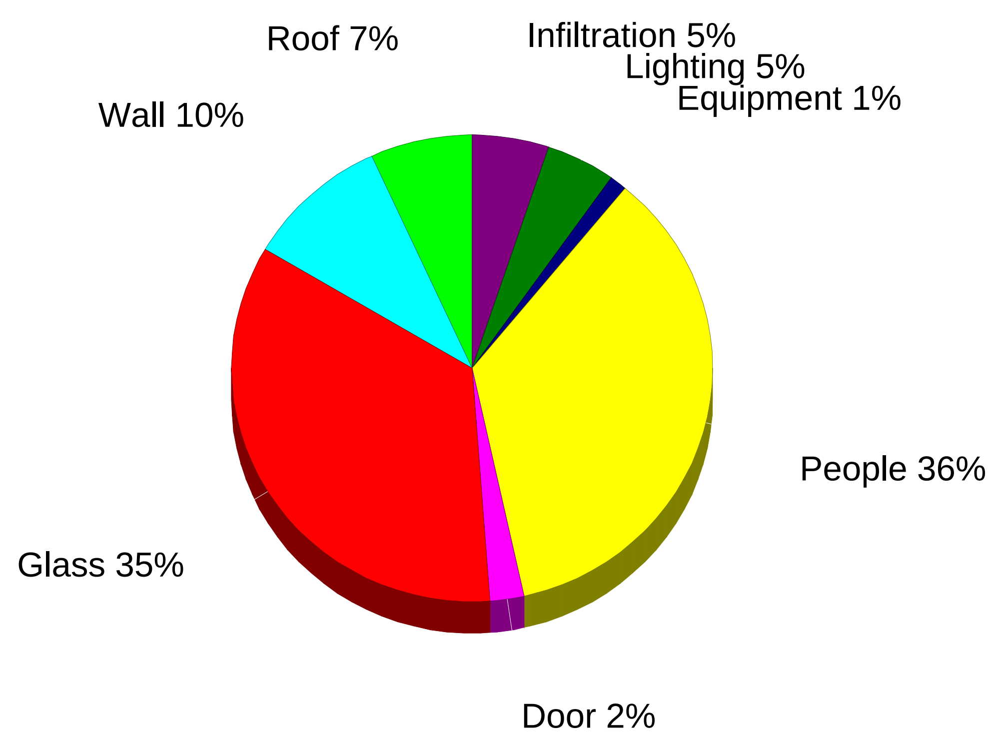
Calculations are performed per ACCA Manual J 8th Edition, Version 2, and ACCA Manual D.
All computed results are estimates as building use and weather may vary.
Be sure to select a unit that meets both sensible and latent loads according to the manufacturer's performance data at your design conditions.

Building Pie Chart





Detailed Room Loads - Room 1 - Upper Meeting Room (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	59.0	ft.	System Number:	1	
Room Width:	41.0	ft.	Zone Number:	1	
Area:	2,419.0	sq.ft.	Supply Air:	1,642	CFM
Ceiling Height:	18.0	ft.	Supply Air Changes:	2.3	AC/hr
Volume:	43,542	cu.ft.	Req. Vent. Clg:	0	CFM
Number of Registers:	15		Actual Winter Vent.:	0	CFM
Runout Air:	109	CFM	Percent of Supply.:	0	%
Runout Duct Size:	7	in.	Actual Summer Vent.:	0	CFM
Runout Air Velocity:	410	ft./min.	Percent of Supply:	0	%
Runout Air Velocity:	410	ft./min.	Actual Winter Infil.:	75	CFM
Actual Loss:	0.087	in.wg./100 ft.	Actual Summer Infil.:	75	CFM

Item Description	Area Quantity	-U- Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
E -Wall-Brick 12" 59 X 13	656.1	0.160	11.5	7,559	1.5	0	987
S -Wall-Brick 12" 41 X 16	544.7	0.160	11.5	6,275	1.5	0	819
W -Wall-Brick 12" 59 X 16	833.1	0.160	11.5	9,598	1.5	0	1,253
N -Wall-Brick 12" 25 X 16	378.2	0.160	11.5	4,357	1.5	0	569
N -Wall-12B-0bw 33 X 8	264	0.097	7.0	1,844	0.5	0	120
S -Door-11G 5.5 X 6.8	37.4	0.540	38.9	1,454	9.7	0	364
N -Door-11N 3.2 X 6.8	21.8	0.350	25.2	548	6.3	0	137
E -Gls-SP with Storm shgc-0.65 0%S (3)	110.9	0.780	56.2	6,228	70.3	0	7,791
S -Gls-SP with Storm shgc-0.65 0%S (2)	73.9	0.780	56.2	4,152	38.2	0	2,826
W -Gls-SP with Storm shgc-0.65 0%S (3)	110.9	0.780	56.2	6,228	70.3	0	7,791
UP-Roof-R-38 spec. 60 X 30	1800	0.026	1.9	3,370	0.4	0	796
UP-Ceil-Slopes.Poor 60 X 10	600	0.077	5.5	3,326	4.8	0	2,864
UP-Roof-R-38 spec. 17 X 8	136	0.026	1.9	255	0.4	0	60
Subtotals for Structure:				55,194		0	26,377
Infil.: Win.: 75.1, Sum.: 75.1	3,031		1.939	5,876	0.323	941	979
People: 200 lat/per, 230 sen/per:	30					6,000	6,900
Lighting:	420						1,432
Room Totals:				61,070		6,941	35,688

Detailed Room Loads - Room 2 - Basement Level (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	57.0	ft.	System Number:	1	
Room Width:	38.0	ft.	Zone Number:	1	
Area:	2,166.0	sq.ft.	Supply Air:	361	CFM
Ceiling Height:	8.0	ft.	Supply Air Changes:	1.2	AC/hr
Volume:	17,328	cu.ft.	Req. Vent. Clg:	0	CFM
Number of Registers:	4		Actual Winter Vent.:	0	CFM
Runout Air:	90	CFM	Percent of Supply.:	0	%
Runout Duct Size:	6	in.	Actual Summer Vent.:	0	CFM
Runout Air Velocity:	459	ft./min.	Percent of Supply:	0	%
Runout Air Velocity:	459	ft./min.	Actual Winter Infil.:	35	CFM
Actual Loss:	0.134	in.wg./100 ft.	Actual Summer Infil.:	35	CFM

Item Description	Area Quantity	-U- Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
E -Wall-Block with R9 40 X 8	289.4	0.120	8.6	2,500	1.1	0	326
S -Wall-Block with R9 38 X 8	261.4	0.120	8.6	2,258	1.1	0	295
W -Wall-Block with R9 40 X 8	320	0.120	8.6	2,765	1.1	0	361
E -Wall-Block with R9 20 X 4	80	0.120	8.6	691	1.1	0	90
W -Wall-Block with R9 20 X 4	80	0.120	8.6	691	1.1	0	90
N -Wall-Block with R9 38 X 8	304	0.120	8.6	2,627	1.1	0	343
E -Door-Metal with glass 4.5 X 6.8	30.6	0.670	48.2	1,476	12.1	0	369
S -Door-Metal with glass 4.5 X 6.8	30.6	0.670	48.2	1,476	12.1	0	369
S -Gls-1A-cw-o shgc-0.64 0%S	12	0.900	64.8	778	39.3	0	471
Floor-22A-pm 196 ft..Per.	196	1.180	85.0	16,652	0.0	0	0
Subtotals for Structure:				31,914		0	2,714
Infil.: Win.: 34.9, Sum.: 34.9	1,408		1.938	2,729	0.323	437	455
People: 200 lat/per, 230 sen/per:	15					3,000	3,450
Equipment:						500	125
Lighting:	320						1,091
Room Totals:				34,643		3,937	7,835

Equipment Cooling Loads

Item Name	Continuous Output Sensible Btuh	Continuous Output Latent Btuh	Average In-Use Output	Percent Used per Hour	Sensible Load Btuh	Latent Load Btuh
Miscellaneous Equipment	125	0	100	100	125	0
Moisture loads	0	500	100	100	0	500
Total					125	500

Henniker Community Center IMPROVED
HVAC Load Calculations

for

Town Of Henniker

Henniker NH 03242

RHVAC Residential HVAC Loads

Prepared By:

Margaret Dillon
S.E.E.D.S.

603-532-8979

Tuesday, October 31, 2023

Rhvac is an ACCA approved Manual J, D and S computer program.
Calculations are performed per ACCA Manual J 8th Edition, Version 2, and ACCA Manual D.

Project Report

General Project Information

Project Title:	Henniker Community Center IMPROVED
Project Date:	Tuesday, October 17, 2023
Client Name:	Town Of Henniker
Client City:	Henniker NH 03242
Company Name:	S.E.E.D.S.
Company Representative:	Margaret Dillon
Company Phone:	603-532-8979
Company E-Mail Address:	mdillon@myfairpoint.net

Design Data

Reference City:		Concord AP, New Hampshire
Building Orientation:		Front door faces North
Daily Temperature Range:		High
Latitude:	43	Degrees
Elevation:	342	ft.
Altitude Factor:	0.988	

	Outdoor Dry Bulb	Outdoor Wet Bulb	Outdoor Rel.Hum	Indoor Rel.Hum	Indoor Dry Bulb	Grains Difference
Winter:	-2	-2.6	n/a	n/a	70	n/a
Summer:	87	70	43%	50%	75	19

Check Figures

Total Building Supply CFM:	1,638	CFM Per Square ft.:	0.357
Square ft. of Room Area:	4,585	Square ft. Per Ton:	1,184
Volume (ft³):	60,870		

Building Loads

Total Heating Required Including Ventilation Air:	82,729	Btuh	82.729	MBH
Total Sensible Gain:	35,589	Btuh	77	%
Total Latent Gain:	10,878	Btuh	23	%
Total Cooling Required Including Ventilation Air:	46,467	Btuh	3.87	Tons (Based On Sensible + Latent)

Notes

Rhvac is an ACCA approved Manual J, D and S computer program.
Calculations are performed per ACCA Manual J 8th Edition, Version 2, and ACCA Manual D.
All computed results are estimates as building use and weather may vary.
Be sure to select a unit that meets both sensible and latent loads according to the manufacturer's performance data at your design conditions.

Miscellaneous Report

System 1 Existing Input Data	Outdoor Dry Bulb	Outdoor Wet Bulb	Outdoor Rel.Hum	Indoor Rel.Hum	Indoor Dry Bulb	Grains Difference
Winter:	-2	-2.6	80%	n/a	70	n/a
Summer:	87	70	43%	50%	75	18.65

Duct Sizing Inputs

	Main Trunk		Runouts	
Calculate:	Yes		Yes	
Use Schedule:	Yes		Yes	
Roughness Factor:	0.00300		0.01000	
Pressure Drop:	0.1000	in.wg./100 ft.	0.1000	in.wg./100 ft.
Minimum Velocity:	0	ft./min	0	ft./min
Maximum Velocity:	900	ft./min	750	ft./min
Minimum Height:	0	in.	0	in.
Maximum Height:	0	in.	0	in.

Outside Air Data

	Winter		Summer	
Infiltration Specified:	0.108	AC/hr	0.108	AC/hr
	110	CFM	110	CFM
Infiltration Actual:	0.108	AC/hr	0.108	AC/hr
Above Grade Volume:	X 60,870	Cu.ft.	X 60,870	Cu.ft.
	6,600	Cu.ft./hr	6,600	Cu.ft./hr
	X 0.0167		X 0.0167	
Total Building Infiltration:	110	CFM	110	CFM
Total Building Ventilation:	0	CFM	0	CFM

---System 1---

Infiltration & Ventilation Sensible Gain Multiplier: 13.04 = (1.10 X 0.988 X 12.00 Summer Temp. Difference)
Infiltration & Ventilation Latent Gain Multiplier: 12.52 = (0.68 X 0.988 X 18.65 Grains Difference)
Infiltration & Ventilation Sensible Loss Multiplier: 78.23 = (1.10 X 0.988 X 72.00 Winter Temp. Difference)
Winter Infiltration Specified: 0.108 AC/hr (110 CFM)
Summer Infiltration Specified: 0.108 AC/hr (110 CFM)

Load Preview Report

Scope	Net Ton	ft.² /Ton	Area	Sen Gain	Lat Gain	Net Gain	Sen Loss	Sys Htg CFM	Sys Clg CFM	Sys Act CFM	Duct Size
Building	3.87	1,184	4,585	35,589	10,878	46,467	82,729	1,088	1,638	1,638	
System 1	3.87	1,184	4,585	35,589	10,878	46,467	82,729	1,088	1,638	1,638	14x19
Zone 1			4,585	35,589	10,878	46,467	82,729	1,088	1,638	1,638	14x19
1-Upper Meeting Room			2,419	28,021	6,941	34,962	50,139	659	1,290	1,290	12--7
2-Basement Level			2,166	7,568	3,937	11,505	32,590	429	348	348	4--6

Total Building Summary Loads

Component Description	Area Quan	Sen Loss	Lat Gain	Sen Gain	Total Gain
Historic St & IP: Glazing-Historic single pane with exterior storms and interior glazing panels, U-value 0.37, SHGC 0.5	295.7	7,880	0	13,340	13,340
1A-cw-o: Glazing-Single pane, operable window, clear, wood frame, U-value 0.9, SHGC 0.64	12	778	0	471	471
11G: Door-Wood - Panel, U-value 0.54	37.4	1,454	0	364	364
11N: Door-Metal - Polystyrene Core, U-value 0.35	21.8	548	0	137	137
Metal with glass: Door-Wide metal doors with small window, U-value 0.67	61.2	2,952	0	738	738
Brick 12": Wall-Block, Custom, Historic 12" brick walls, lathe&plaster, U-value 0.16	2412.2	27,789	0	3,628	3,628
12B-0bw: Wall-Frame, R-11 insulation in 2 x 4 stud cavity, no board insulation, brick finish, wood studs, U-value 0.097	264	1,844	0	120	120
Block with R9: Wall-Block, Custom, Granite foundation steel studs and 3.5 fg batts, U-value 0.09	950.8	6,161	0	805	805
Block with R9: Wall-Block, Custom, Granite foundation steel studs and 3.5 fg batts, U-value 0.12	384	3,318	0	433	433
R-38 spec.: Roof/Ceiling-Roof Joists Between Roof Deck and Ceiling or Foam Encapsulated Roof Joists, Custom, Blow in over tin ceiling. min R-38, U-value 0.026	2536	4,748	0	1,121	1,121
22A-pm: Floor-Slab on grade, No edge insulation, no insulation below floor, any floor cover, passive, heavy dry or light wet soil, U-value 1.18	196	16,652	0	0	0
Subtotals for structure:		74,124	0	21,157	21,157
People:	45		9,000	10,350	19,350
Equipment:			500	125	625
Lighting:	740			2,523	2,523
Ductwork:		0	0	0	0
Infiltration: Winter CFM: 110, Summer CFM: 110		8,605	1,378	1,434	2,812
Ventilation: Winter CFM: 0, Summer CFM: 0		0	0	0	0
Total Building Load Totals:		82,729	10,878	35,589	46,467

Check Figures

Total Building Supply CFM:	1,638	CFM Per Square ft.:	0.357
Square ft. of Room Area:	4,585	Square ft. Per Ton:	1,184
Volume (ft³):	60,870		

Building Loads

Total Heating Required Including Ventilation Air:	82,729	Btuh	82.729	MBH
Total Sensible Gain:	35,589	Btuh	77	%
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Total Cooling Required Including Ventilation Air:	46,467	Btuh	3.87	Tons (Based On Sensible + Latent)

Notes

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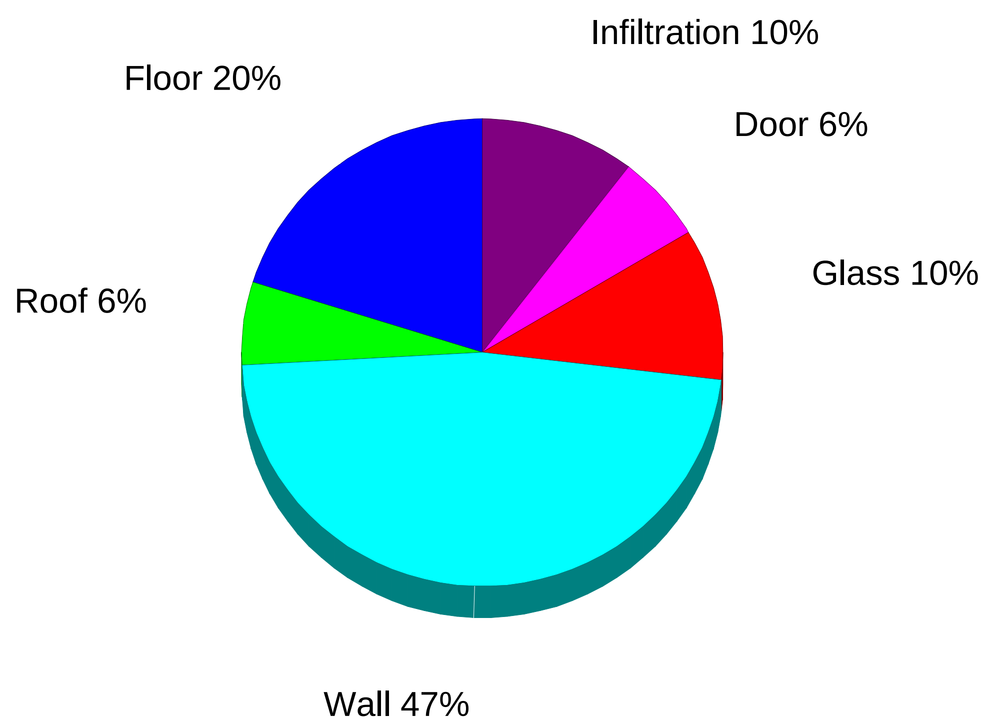
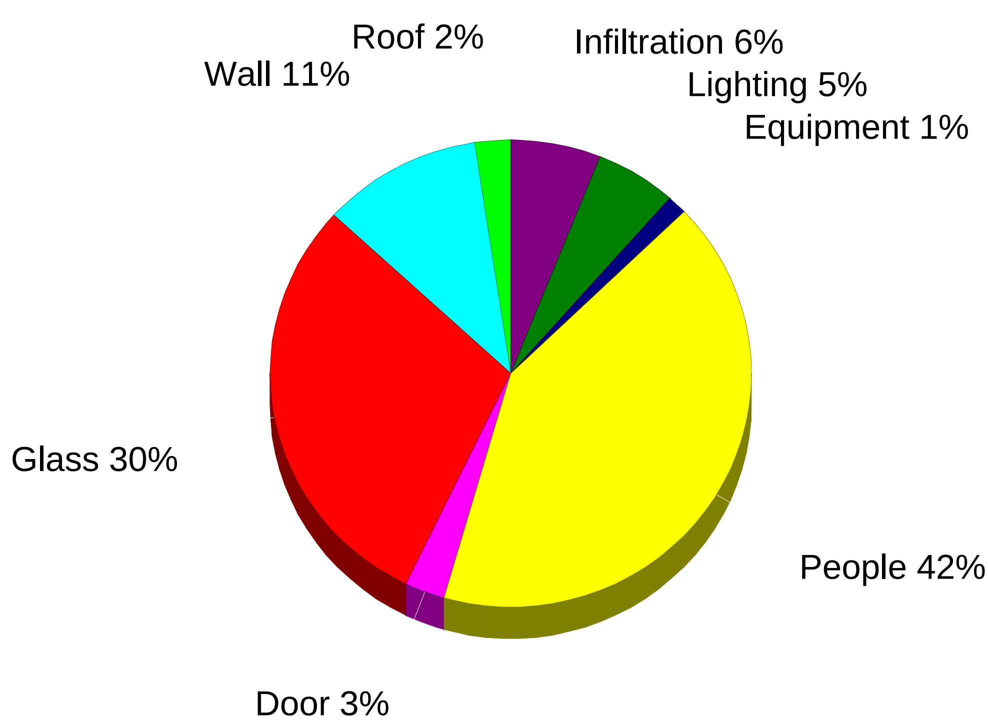
Building Pie Chart





Detailed Room Loads - Room 1 - Upper Meeting Room (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	59.0	ft.	System Number:	1	
Room Width:	41.0	ft.	Zone Number:	1	
Area:	2,419.0	sq.ft.	Supply Air:	1,290	CFM
Ceiling Height:	18.0	ft.	Supply Air Changes:	1.8	AC/hr
Volume:	43,542	cu.ft.	Req. Vent. Clg:	0	CFM
Number of Registers:	12		Actual Winter Vent.:	0	CFM
Runout Air:	107	CFM	Percent of Supply.:	0	%
Runout Duct Size:	7	in.	Actual Summer Vent.:	0	CFM
Runout Air Velocity:	402	ft./min.	Percent of Supply:	0	%
Runout Air Velocity:	402	ft./min.	Actual Winter Infil.:	75	CFM
Actual Loss:	0.083	in.wg./100 ft.	Actual Summer Infil.:	75	CFM

Item Description	Area Quantity	-U- Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
E -Wall-Brick 12" 59 X 13	656.1	0.160	11.5	7,559	1.5	0	987
S -Wall-Brick 12" 41 X 16	544.7	0.160	11.5	6,275	1.5	0	819
W -Wall-Brick 12" 59 X 16	833.1	0.160	11.5	9,598	1.5	0	1,253
N -Wall-Brick 12" 25 X 16	378.2	0.160	11.5	4,357	1.5	0	569
N -Wall-12B-0bw 33 X 8	264	0.097	7.0	1,844	0.5	0	120
S -Door-11G 5.5 X 6.8	37.4	0.540	38.9	1,454	9.7	0	364
N -Door-11N 3.2 X 6.8	21.8	0.350	25.2	548	6.3	0	137
E -Gls-Historic St & IP shgc-0.5 0%S (3)	110.9	0.370	26.6	2,955	51.3	0	5,685
S -Gls-Historic St & IP shgc-0.5 0%S (2)	73.9	0.370	26.6	1,970	26.7	0	1,970
W -Gls-Historic St & IP shgc-0.5 0%S (3)	110.9	0.370	26.6	2,955	51.3	0	5,685
UP-Roof-R-38 spec. 60 X 30	1800	0.026	1.9	3,370	0.4	0	796
UP-Roof-R-38 spec. 60 X 10	600	0.026	1.9	1,123	0.4	0	265
UP-Roof-R-38 spec. 17 X 8	136	0.026	1.9	255	0.4	0	60
Subtotals for Structure:				44,263		0	18,710
Infil.: Win.: 75.1, Sum.: 75.1	3,031		1.939	5,876	0.323	941	979
People: 200 lat/per, 230 sen/per:	30					6,000	6,900
Lighting:	420						1,432
Room Totals:				50,139		6,941	28,021

Detailed Room Loads - Room 2 - Basement Level (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	57.0	ft.	System Number:	1	
Room Width:	38.0	ft.	Zone Number:	1	
Area:	2,166.0	sq.ft.	Supply Air:	348	CFM
Ceiling Height:	8.0	ft.	Supply Air Changes:	1.2	AC/hr
Volume:	17,328	cu.ft.	Req. Vent. Clg:	0	CFM
Number of Registers:	4		Actual Winter Vent.:	0	CFM
Runout Air:	87	CFM	Percent of Supply.:	0	%
Runout Duct Size:	6	in.	Actual Summer Vent.:	0	CFM
Runout Air Velocity:	443	ft./min.	Percent of Supply:	0	%
Runout Air Velocity:	443	ft./min.	Actual Winter Infil.:	35	CFM
Actual Loss:	0.125	in.wg./100 ft.	Actual Summer Infil.:	35	CFM

Item Description	Area Quantity	-U- Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
E -Wall-Block with R9 40 X 8	289.4	0.090	6.5	1,875	0.8	0	245
S -Wall-Block with R9 38 X 8	261.4	0.090	6.5	1,694	0.8	0	221
W -Wall-Block with R9 40 X 8	320	0.090	6.5	2,074	0.8	0	271
E -Wall-Block with R9 20 X 4	80	0.090	6.5	518	0.8	0	68
W -Wall-Block with R9 20 X 4	80	0.120	8.6	691	1.1	0	90
N -Wall-Block with R9 38 X 8	304	0.120	8.6	2,627	1.1	0	343
E -Door-Metal with glass 4.5 X 6.8	30.6	0.670	48.2	1,476	12.1	0	369
S -Door-Metal with glass 4.5 X 6.8	30.6	0.670	48.2	1,476	12.1	0	369
S -Gls-1A-cw-o shgc-0.64 0%S	12	0.900	64.8	778	39.3	0	471
Floor-22A-pm 196 ft..Per.	196	1.180	85.0	16,652	0.0	0	0
Subtotals for Structure:				29,861		0	2,447
Infil.: Win.: 34.9, Sum.: 34.9	1,408		1.938	2,729	0.323	437	455
People: 200 lat/per, 230 sen/per:	15					3,000	3,450
Equipment:						500	125
Lighting:	320						1,091
Room Totals:				32,590		3,937	7,568

Equipment Cooling Loads

Item Name	Continuous Output Sensible Btuh	Continuous Output Latent Btuh	Average In-Use Output	Percent Used per Hour	Sensible Load Btuh	Latent Load Btuh
Miscellaneous Equipment	125	0	100	100	125	0
Moisture loads	0	500	100	100	0	500
Total					125	500

Community Center Energy Analysis
Energy Cost Analysis

for

Town Of Henniker

Henniker NH 03242

Elite Software

Energy Audit

Residential and Light Commercial Energy Analysis

Prepared By:

Margaret Dillon
S.E.E.D.S.

603-532-8979
Tuesday, October 31, 2023

Project Information

Project Title:	Community Center Energy Analysis	Company Name:	S.E.E.D.S.
Designed By:		Company Rep.:	Margaret Dillon
Project Date:	Monday, October 30, 2023	Company Address:	
Project Comment:		Company City:	
Client Name:	Town Of Henniker	Company Phone:	603-532-8979
Client Address:		Company Fax:	
Client City:	Henniker NH 03242	Company Comment:	
Client Phone:			
Client Fax:			
Client Comment:			

Cooling Equipment — System 1

Model Type: Air Source Heat Pump
Model Number:
Capacity: 36,000 Btuh
Efficiency: 16.2 SEER

Heating Equipment — System 1

Model Type: Air Source Heat Pump
Model Number:
Capacity: 36,000 Btuh
Efficiency: 10 HSPF

System Description: Existing BASEMENT

Cooling Equipment — System 2

Model Type: Air Source Heat Pump
Model Number:
Capacity: 36,000 Btuh
Efficiency: 16.2 SEER

Heating Equipment — System 2

Model Type: Air Source Heat Pump
Model Number:
Capacity: 36,000 Btuh
Efficiency: 10 HSPF

System Description: Existing BASEMENT. ER OFF

Cooling Equipment — System 3

Model Type: Air Source Heat Pump
Model Number:
Capacity: 36,000 Btuh
Efficiency: 16.2 SEER

Heating Equipment — System 3

Model Type: Air Source Heat Pump
Model Number:
Capacity: 36,000 Btuh
Efficiency: 10 HSPF

System Description: Improved BASEMENT. ER OFF

Cooling Equipment — System 4

Model Type: Air Source Heat Pump
Model Number:
Capacity: 48,000 Btuh
Efficiency: 18.9 SEER

Heating Equipment — System 4

Heating Equipment	System 4
Model Type:	Air Source Heat Pump
Model Number:	
Capacity:	100,000 Btuh
Efficiency:	11.4 HSPF
System Description:	Existing Community Room

Cooling Equipment	System 5
Model Type:	Air Source Heat Pump
Model Number:	
Capacity:	48,000 Btuh
Efficiency:	18.9 SEER

Heating Equipment	System 5
Model Type:	Air Source Heat Pump
Model Number:	
Capacity:	100,000 Btuh
Efficiency:	11.4 HSPF
System Description:	Improved Community Room

Project Summary

General Project Information

Project Title:	Community Center Energy Analysis	Company Name:	S.E.E.D.S.
Project Date:	Monday, October 30, 2023	Company Rep:	Margaret Dillon
Client Name:	Town Of Henniker	Company Phone:	603-532-8979
Client City:	Henniker NH 03242	Company E-Mail Address:	mdillon@myfairpoint.net

Design Data

Building Area:	4,585 sq.ft.	Cooling Load:	58,155 Btuh
People:	45	Heating Load:	95,957 Btuh
Occupancy:	0	Loads Adj. Factor:	0.85
		AC On Temp.:	0 °F
Actual City:	Concord AP, New Hampshire		
Weather Ref. City:	Concord, New Hampshire		
Summer Outdoor:	87 °F	Winter Outdoor:	-3 °F
Summer Indoor:	75 °F	Winter Indoor:	70 °F
Cooling Hours:	775	Degree Days:	7,471

Annual Operating Cost Estimate

System Description	Fuel Rates Set	Total Heating Cost	Total Cooling Cost	Water Heating Cost	Domes. Energy Cost	Annual Service Charges	Total Oper. Cost	Average Monthly Cost
Existing BASEMENT	1	$1,971	$76	$60	$902	$0	$3,010	$251
Existing BASEMENT. ER OFF	1	$1,485	$77	$60	$902	$0	$2,524	$210
Improved BASEMENT. ER OFF	1	$1,384	$74	$11	$831	$0	$2,300	$192
Existing Community Room	1	$2,519	$236	$0	$0	$0	$2,755	$230
Improved Community Room	1	$2,071	$194	$0	$0	$0	$2,264	$189

Monthly Costs - System 1 - Existing BASEMENT

Monthly System Cost

	Cooling		Heating		Appliances		Hot Water		Total
Month	Cost	%	Cost	%	Cost	%	Cost	%	Cost
January	$0.00	0.0%	$466.77	85.3%	$75.18	13.7%	$5.01	0.9%	$546.96
February	$0.00	0.0%	$353.66	81.5%	$75.18	17.3%	$5.01	1.2%	$433.85
March	$0.00	0.0%	$252.18	75.9%	$75.18	22.6%	$5.01	1.5%	$332.37
April	$0.66	0.4%	$100.86	55.5%	$75.18	41.4%	$5.01	2.8%	$181.71
May	$7.06	5.2%	$48.98	36.0%	$75.18	55.2%	$5.01	3.7%	$136.22
June	$17.10	14.4%	$21.15	17.9%	$75.18	63.5%	$5.01	4.2%	$118.45
July	$24.93	21.7%	$9.76	8.5%	$75.18	65.4%	$5.01	4.4%	$114.88
August	$18.98	16.0%	$19.18	16.2%	$75.18	63.5%	$5.01	4.2%	$118.36
September	$6.21	4.9%	$39.96	31.6%	$75.18	59.5%	$5.01	4.0%	$126.36
October	$1.09	0.7%	$81.94	50.2%	$75.18	46.1%	$5.01	3.1%	$163.22
November	$0.00	0.0%	$160.01	66.6%	$75.18	31.3%	$5.01	2.1%	$240.20
December	$0.00	0.0%	$416.93	83.9%	$75.18	15.1%	$5.01	1.0%	$497.12
Total	$76.03	2.5%	$1,971.38	65.5%	$902.18	30.0%	$60.13	2.0%	$3,009.72

Monthly Fuel Usage and Cost

	Electricity		Natural Gas		Propane		Fuel Oil	
Month	Cost	kWh	Cost	Therm	Cost	Gallons	Cost	Gallons
January	$546.96	4,051.6	$0.00	0.0	$0.00	0.0	$0.00	0.0
February	$433.85	3,213.7	$0.00	0.0	$0.00	0.0	$0.00	0.0
March	$332.37	2,462.0	$0.00	0.0	$0.00	0.0	$0.00	0.0
April	$181.71	1,346.0	$0.00	0.0	$0.00	0.0	$0.00	0.0
May	$136.22	1,009.1	$0.00	0.0	$0.00	0.0	$0.00	0.0
June	$118.45	877.4	$0.00	0.0	$0.00	0.0	$0.00	0.0
July	$114.88	850.9	$0.00	0.0	$0.00	0.0	$0.00	0.0
August	$118.36	876.7	$0.00	0.0	$0.00	0.0	$0.00	0.0
September	$126.36	936.0	$0.00	0.0	$0.00	0.0	$0.00	0.0
October	$163.22	1,209.0	$0.00	0.0	$0.00	0.0	$0.00	0.0
November	$240.20	1,779.3	$0.00	0.0	$0.00	0.0	$0.00	0.0
December	$497.12	3,682.4	$0.00	0.0	$0.00	0.0	$0.00	0.0
Total	$3,009.72	22,294.2	$0.00	0.0	$0.00	0.0	$0.00	0.0

Average Electric Cost Per kWh:	$0.135/kWh
Total annual cooling load energy:	9,123,300 BTU
Total annual heating load energy:	102,687,560 BTU

Monthly Costs - System 2 - Existing BASEMENT. ER OFF

Monthly System Cost

	Cooling		Heating		Appliances		Hot Water		Total
Month	Cost	%	Cost	%	Cost	%	Cost	%	Cost
January	$0.00	0.0%	$299.97	78.9%	$75.18	19.8%	$5.01	1.3%	$380.16
February	$0.00	0.0%	$247.84	75.6%	$75.18	22.9%	$5.01	1.5%	$328.03
March	$0.00	0.0%	$194.60	70.8%	$75.18	27.4%	$5.01	1.8%	$274.79
April	$0.67	0.4%	$97.66	54.7%	$75.18	42.1%	$5.01	2.8%	$178.53
May	$7.12	5.2%	$49.43	36.1%	$75.18	55.0%	$5.01	3.7%	$136.74
June	$17.27	14.5%	$21.35	18.0%	$75.18	63.3%	$5.01	4.2%	$118.81
July	$25.16	21.8%	$9.85	8.5%	$75.18	65.3%	$5.01	4.3%	$115.20
August	$19.16	16.1%	$19.36	16.3%	$75.18	63.3%	$5.01	4.2%	$118.71
September	$6.27	4.9%	$40.33	31.8%	$75.18	59.3%	$5.01	4.0%	$126.79
October	$1.10	0.7%	$82.69	50.4%	$75.18	45.8%	$5.01	3.1%	$163.98
November	$0.00	0.0%	$139.76	63.5%	$75.18	34.2%	$5.01	2.3%	$219.96
December	$0.00	0.0%	$281.82	77.8%	$75.18	20.8%	$5.01	1.4%	$362.01
Total	$76.75	3.0%	$1,484.64	58.8%	$902.18	35.7%	$60.13	2.4%	$2,523.71

Monthly Fuel Usage and Cost

	Electricity		Natural Gas		Propane		Fuel Oil	
Month	Cost	kWh	Cost	Therm	Cost	Gallons	Cost	Gallons
January	$380.16	2,816.0	$0.00	0.0	$0.00	0.0	$0.00	0.0
February	$328.03	2,429.8	$0.00	0.0	$0.00	0.0	$0.00	0.0
March	$274.79	2,035.5	$0.00	0.0	$0.00	0.0	$0.00	0.0
April	$178.53	1,322.4	$0.00	0.0	$0.00	0.0	$0.00	0.0
May	$136.74	1,012.9	$0.00	0.0	$0.00	0.0	$0.00	0.0
June	$118.81	880.1	$0.00	0.0	$0.00	0.0	$0.00	0.0
July	$115.20	853.3	$0.00	0.0	$0.00	0.0	$0.00	0.0
August	$118.71	879.4	$0.00	0.0	$0.00	0.0	$0.00	0.0
September	$126.79	939.2	$0.00	0.0	$0.00	0.0	$0.00	0.0
October	$163.98	1,214.7	$0.00	0.0	$0.00	0.0	$0.00	0.0
November	$219.96	1,629.3	$0.00	0.0	$0.00	0.0	$0.00	0.0
December	$362.01	2,681.6	$0.00	0.0	$0.00	0.0	$0.00	0.0
Total	$2,523.71	18,694.1	$0.00	0.0	$0.00	0.0	$0.00	0.0

Average Electric Cost Per kWh:	$0.135/kWh
Total annual cooling load energy:	9,210,100 BTU
Total annual heating load energy:	103,633,160 BTU

Monthly Costs - System 3 - Improved BASEMENT. ER OFF

Monthly System Cost

	Cooling		Heating		Appliances		Hot Water		Total
Month	Cost	%	Cost	%	Cost	%	Cost	%	Cost
January	$0.00	0.0%	$279.61	79.9%	$69.28	19.8%	$0.88	0.3%	$349.77
February	$0.00	0.0%	$231.02	76.7%	$69.28	23.0%	$0.88	0.3%	$301.17
March	$0.00	0.0%	$181.39	72.1%	$69.28	27.5%	$0.88	0.3%	$251.55
April	$0.65	0.4%	$91.04	56.3%	$69.28	42.8%	$0.88	0.5%	$161.84
May	$6.90	5.6%	$46.07	37.4%	$69.28	56.3%	$0.88	0.7%	$123.12
June	$16.72	15.7%	$19.90	18.6%	$69.28	64.9%	$0.88	0.8%	$106.77
July	$24.36	23.5%	$9.18	8.9%	$69.28	66.8%	$0.88	0.8%	$103.69
August	$18.55	17.4%	$18.05	16.9%	$69.28	64.9%	$0.88	0.8%	$106.75
September	$6.07	5.3%	$37.59	33.0%	$69.28	60.9%	$0.88	0.8%	$113.81
October	$1.06	0.7%	$77.08	52.0%	$69.28	46.7%	$0.88	0.6%	$148.30
November	$0.00	0.0%	$130.28	65.0%	$69.28	34.6%	$0.88	0.4%	$200.43
December	$0.00	0.0%	$262.70	78.9%	$69.28	20.8%	$0.88	0.3%	$332.85
Total	$74.30	3.2%	$1,383.92	60.2%	$831.30	36.1%	$10.52	0.5%	$2,300.05

Monthly Fuel Usage and Cost

	Electricity		Natural Gas		Propane		Fuel Oil	
Month	Cost	kWh	Cost	Therm	Cost	Gallons	Cost	Gallons
January	$349.77	2,590.9	$0.00	0.0	$0.00	0.0	$0.00	0.0
February	$301.17	2,230.9	$0.00	0.0	$0.00	0.0	$0.00	0.0
March	$251.55	1,863.3	$0.00	0.0	$0.00	0.0	$0.00	0.0
April	$161.84	1,198.8	$0.00	0.0	$0.00	0.0	$0.00	0.0
May	$123.12	912.0	$0.00	0.0	$0.00	0.0	$0.00	0.0
June	$106.77	790.9	$0.00	0.0	$0.00	0.0	$0.00	0.0
July	$103.69	768.1	$0.00	0.0	$0.00	0.0	$0.00	0.0
August	$106.75	790.7	$0.00	0.0	$0.00	0.0	$0.00	0.0
September	$113.81	843.1	$0.00	0.0	$0.00	0.0	$0.00	0.0
October	$148.30	1,098.5	$0.00	0.0	$0.00	0.0	$0.00	0.0
November	$200.43	1,484.7	$0.00	0.0	$0.00	0.0	$0.00	0.0
December	$332.85	2,465.5	$0.00	0.0	$0.00	0.0	$0.00	0.0
Total	$2,300.05	17,037.4	$0.00	0.0	$0.00	0.0	$0.00	0.0

Average Electric Cost Per kWh:	$0.135/kWh
Total annual cooling load energy:	8,916,375 BTU
Total annual heating load energy:	96,602,104 BTU

Monthly Costs - System 4 - Existing Community Room

Monthly System Cost

	Cooling		Heating		Appliances		Hot Water		Total
Month	Cost	%	Cost	%	Cost	%	Cost	%	Cost
January	$0.00	0.0%	$509.43	100.0%	$0.00	0.0%	$0.00	0.0%	$509.43
February	$0.00	0.0%	$416.74	100.0%	$0.00	0.0%	$0.00	0.0%	$416.74
March	$0.00	0.0%	$355.41	100.0%	$0.00	0.0%	$0.00	0.0%	$355.41
April	$2.06	1.3%	$158.96	98.7%	$0.00	0.0%	$0.00	0.0%	$161.02
May	$21.90	22.2%	$76.65	77.8%	$0.00	0.0%	$0.00	0.0%	$98.55
June	$53.09	61.8%	$32.87	38.2%	$0.00	0.0%	$0.00	0.0%	$85.96
July	$77.37	83.5%	$15.30	16.5%	$0.00	0.0%	$0.00	0.0%	$92.67
August	$58.92	66.4%	$29.80	33.6%	$0.00	0.0%	$0.00	0.0%	$88.72
September	$19.27	23.1%	$64.13	76.9%	$0.00	0.0%	$0.00	0.0%	$83.40
October	$3.38	2.4%	$138.18	97.6%	$0.00	0.0%	$0.00	0.0%	$141.56
November	$0.00	0.0%	$244.78	100.0%	$0.00	0.0%	$0.00	0.0%	$244.78
December	$0.00	0.0%	$476.71	100.0%	$0.00	0.0%	$0.00	0.0%	$476.71
Total	$235.98	8.6%	$2,518.97	91.4%	$0.00	0.0%	$0.00	0.0%	$2,754.95

Monthly Fuel Usage and Cost

	Electricity		Natural Gas		Propane		Fuel Oil	
Month	Cost	kWh	Cost	Therm	Cost	Gallons	Cost	Gallons
January	$35.21	260.8	$0.00	0.0	$474.23	280.6	$0.00	0.0
February	$45.66	338.3	$0.00	0.0	$371.08	219.6	$0.00	0.0
March	$82.63	612.1	$0.00	0.0	$272.77	161.4	$0.00	0.0
April	$118.40	877.0	$0.00	0.0	$42.62	25.2	$0.00	0.0
May	$93.95	695.9	$0.00	0.0	$4.60	2.7	$0.00	0.0
June	$85.96	636.8	$0.00	0.0	$0.00	0.0	$0.00	0.0
July	$92.67	686.5	$0.00	0.0	$0.00	0.0	$0.00	0.0
August	$88.72	657.2	$0.00	0.0	$0.00	0.0	$0.00	0.0
September	$75.91	562.3	$0.00	0.0	$7.49	4.4	$0.00	0.0
October	$100.62	745.4	$0.00	0.0	$40.93	24.2	$0.00	0.0
November	$110.37	817.6	$0.00	0.0	$134.41	79.5	$0.00	0.0
December	$44.86	332.3	$0.00	0.0	$431.84	255.5	$0.00	0.0
Total	$974.97	7,222.0	$0.00	0.0	$1,779.98	1,053.2	$0.00	0.0

Average Electric Cost Per kWh:	$0.135/kWh
Average Propane Cost Per Gallon:	$1.690/Gallon
Total annual cooling load energy:	33,037,476 BTU
Total annual heating load energy:	181,021,552 BTU

Monthly Costs - System 5 - Improved Community Room

Monthly System Cost

	Cooling		Heating		Appliances		Hot Water		Total
Month	Cost	%	Cost	%	Cost	%	Cost	%	Cost
January	$0.00	0.0%	$418.79	100.0%	$0.00	0.0%	$0.00	0.0%	$418.79
February	$0.00	0.0%	$342.63	100.0%	$0.00	0.0%	$0.00	0.0%	$342.63
March	$0.00	0.0%	$292.38	100.0%	$0.00	0.0%	$0.00	0.0%	$292.38
April	$1.69	1.3%	$130.62	98.7%	$0.00	0.0%	$0.00	0.0%	$132.32
May	$17.96	22.2%	$62.95	77.8%	$0.00	0.0%	$0.00	0.0%	$80.91
June	$43.54	61.7%	$26.99	38.3%	$0.00	0.0%	$0.00	0.0%	$70.53
July	$63.45	83.5%	$12.57	16.5%	$0.00	0.0%	$0.00	0.0%	$76.02
August	$48.32	66.4%	$24.47	33.6%	$0.00	0.0%	$0.00	0.0%	$72.79
September	$15.80	23.1%	$52.68	76.9%	$0.00	0.0%	$0.00	0.0%	$68.48
October	$2.77	2.4%	$113.59	97.6%	$0.00	0.0%	$0.00	0.0%	$116.36
November	$0.00	0.0%	$201.31	100.0%	$0.00	0.0%	$0.00	0.0%	$201.31
December	$0.00	0.0%	$391.92	100.0%	$0.00	0.0%	$0.00	0.0%	$391.92
Total	$193.54	8.5%	$2,070.90	91.5%	$0.00	0.0%	$0.00	0.0%	$2,264.44

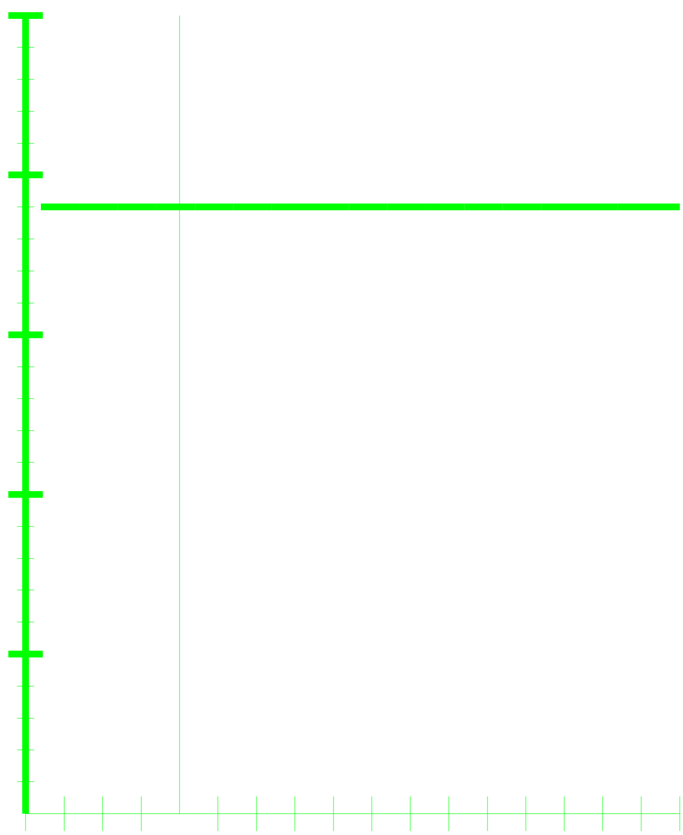
Monthly Fuel Usage and Cost

	Electricity		Natural Gas		Propane		Fuel Oil	
Month	Cost	kWh	Cost	Therm	Cost	Gallons	Cost	Gallons
January	$28.90	214.1	$0.00	0.0	$389.89	230.7	$0.00	0.0
February	$37.49	277.7	$0.00	0.0	$305.14	180.6	$0.00	0.0
March	$67.84	502.5	$0.00	0.0	$224.54	132.9	$0.00	0.0
April	$97.20	720.0	$0.00	0.0	$35.11	20.8	$0.00	0.0
May	$77.11	571.2	$0.00	0.0	$3.80	2.2	$0.00	0.0
June	$70.53	522.5	$0.00	0.0	$0.00	0.0	$0.00	0.0
July	$76.02	563.1	$0.00	0.0	$0.00	0.0	$0.00	0.0
August	$72.79	539.2	$0.00	0.0	$0.00	0.0	$0.00	0.0
September	$62.31	461.5	$0.00	0.0	$6.18	3.7	$0.00	0.0
October	$82.61	611.9	$0.00	0.0	$33.75	20.0	$0.00	0.0
November	$90.62	671.2	$0.00	0.0	$110.69	65.5	$0.00	0.0
December	$36.83	272.8	$0.00	0.0	$355.09	210.1	$0.00	0.0
Total	$800.25	5,927.8	$0.00	0.0	$1,464.19	866.4	$0.00	0.0

Average Electric Cost Per kWh:	$0.135/kWh
Average Propane Cost Per Gallon:	$1.690/Gallon
Total annual cooling load energy:	27,095,550 BTU
Total annual heating load energy:	148,620,304 BTU

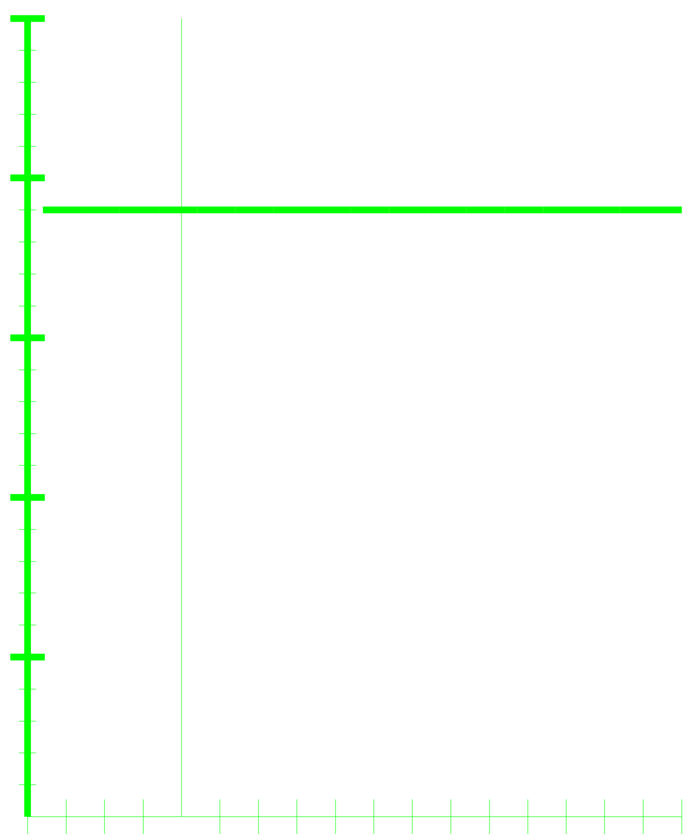
Bin Analysis Report - System 1 - Existing BASEMENT

Bin Temp Ranges Degree F	Hours Per Bin	Heating Load Btuh	Adjusted Load (x 0.85)	Heat Pump Output Btuh	H. Pump Run Time Fraction	Backup Output Btuh	H.Pump Heating Cost	Backup Heating Cost	Total Heating Cost
-20 to -15	1	41,761	35,497	0	0.000	35,497	0.00	1.40	1.40
-15 to -10	18	39,389	33,480	0	0.000	33,480	0.00	23.84	23.84
-10 to -5	19	37,016	31,463	0	0.000	31,463	0.00	23.65	23.65
-5 to 0	52	34,643	29,447	0	0.000	29,447	0.00	60.57	60.57
0 to 5	136	32,270	27,430	0	0.000	27,430	0.00	147.56	147.56
5 to 10	154	29,897	25,413	0	0.000	25,413	0.00	154.80	154.80
10 to 15	209	27,525	23,396	0	0.000	23,396	0.00	193.41	193.41
15 to 20	312	25,152	21,379	0	0.000	21,379	0.00	263.84	263.84
20 to 25	385	22,779	19,362	0	0.000	19,362	0.00	294.86	294.86
25 to 30	666	20,406	17,345	17,345	0.456	0	193.04	0.00	193.04
30 to 35	878	18,033	15,328	15,328	0.403	0	204.59	0.00	204.59
35 to 40	650	15,661	13,311	13,311	0.350	0	120.64	0.00	120.64
40 to 45	658	13,288	11,295	11,295	0.297	0	95.69	0.00	95.69
45 to 50	679	10,915	9,278	9,278	0.244	0	75.35	0.00	75.35
50 to 55	619	8,542	7,261	7,261	0.191	0	50.19	0.00	50.19
55 to 60	717	6,169	5,244	5,244	0.138	0	39.38	0.00	39.38
60 to 65	685	3,796	3,227	3,227	0.085	0	21.79	0.00	21.79
Totals:	6,838						$807.46	$1,163.92	$1,971.38



Bin Analysis Report - System 2 - Existing BASEMENT. ER OFF

Bin Temp Ranges Degree F	Hours Per Bin	Heating Load Btuh	Adjusted Load (x 0.85)	Heat Pump Output Btuh	H. Pump Run Time Fraction	Backup Output Btuh	H.Pump Heating Cost	Backup Heating Cost	Total Heating Cost
-20 to -15	1	42,146	35,824	0	0.000	35,824	0.00	1.42	1.42
-15 to -10	18	39,751	33,789	33,789	0.534	33,789	10.56	9.62	20.18
-10 to -5	19	37,357	31,753	31,753	0.836	0	16.46	0.00	16.46
-5 to 0	52	34,962	29,718	29,718	0.782	0	39.86	0.00	39.86
0 to 5	136	32,567	27,682	27,682	0.728	0	92.11	0.00	92.11
5 to 10	154	30,173	25,647	25,647	0.675	0	91.90	0.00	91.90
10 to 15	209	27,778	23,611	23,611	0.621	0	109.45	0.00	109.45
15 to 20	312	25,383	21,576	21,576	0.568	0	142.64	0.00	142.64
20 to 25	385	22,989	19,540	19,540	0.514	0	150.15	0.00	150.15
25 to 30	666	20,594	17,505	17,505	0.461	0	194.82	0.00	194.82
30 to 35	878	18,199	15,469	15,469	0.407	0	206.47	0.00	206.47
35 to 40	650	15,805	13,434	13,434	0.354	0	121.75	0.00	121.75
40 to 45	658	13,410	11,399	11,399	0.300	0	96.57	0.00	96.57
45 to 50	679	11,015	9,363	9,363	0.246	0	76.04	0.00	76.04
50 to 55	619	8,621	7,328	7,328	0.193	0	50.65	0.00	50.65
55 to 60	717	6,226	5,292	5,292	0.139	0	39.74	0.00	39.74
60 to 65	685	3,831	3,257	3,257	0.086	0	21.99	0.00	21.99
Totals:	6,838						$1,473.60	$11.04	$1,484.64

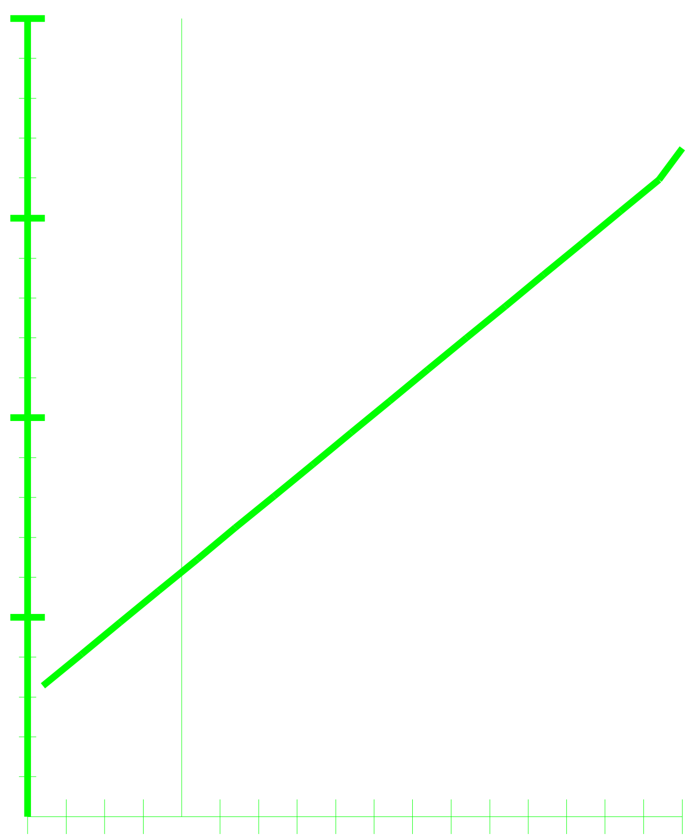


Bin Analysis Report - System 3 - Improved BASEMENT. ER OFF

Bin Temp Ranges Degree F	Hours Per Bin	Heating Load Btuh	Adjusted Load (x 0.85)	Heat Pump Output Btuh	H. Pump Run Time Fraction	Backup Output Btuh	H.Pump Heating Cost	Backup Heating Cost	Total Heating Cost
-20 to -15	1	39,287	33,394	0	0.000	33,394	0.00	1.32	1.32
-15 to -10	18	37,054	31,496	31,496	0.497	31,496	9.85	8.97	18.81
-10 to -5	19	34,822	29,599	29,599	0.779	0	15.34	0.00	15.34
-5 to 0	52	32,590	27,702	27,702	0.729	0	37.16	0.00	37.16
0 to 5	136	30,358	25,804	25,804	0.679	0	85.86	0.00	85.86
5 to 10	154	28,126	23,907	23,907	0.629	0	85.66	0.00	85.66
10 to 15	209	25,893	22,009	22,009	0.579	0	102.03	0.00	102.03
15 to 20	312	23,661	20,112	20,112	0.529	0	132.97	0.00	132.97
20 to 25	385	21,429	18,215	18,215	0.479	0	139.96	0.00	139.96
25 to 30	666	19,197	16,317	16,317	0.429	0	181.60	0.00	181.60
30 to 35	878	16,965	14,420	14,420	0.379	0	192.46	0.00	192.46
35 to 40	650	14,732	12,523	12,523	0.330	0	113.49	0.00	113.49
40 to 45	658	12,500	10,625	10,625	0.280	0	90.02	0.00	90.02
45 to 50	679	10,268	8,728	8,728	0.230	0	70.88	0.00	70.88
50 to 55	619	8,036	6,831	6,831	0.180	0	47.22	0.00	47.22
55 to 60	717	5,804	4,933	4,933	0.130	0	37.04	0.00	37.04
60 to 65	685	3,572	3,036	3,036	0.080	0	20.50	0.00	20.50
Totals:	6,838						$1,373.63	$10.29	$1,383.92

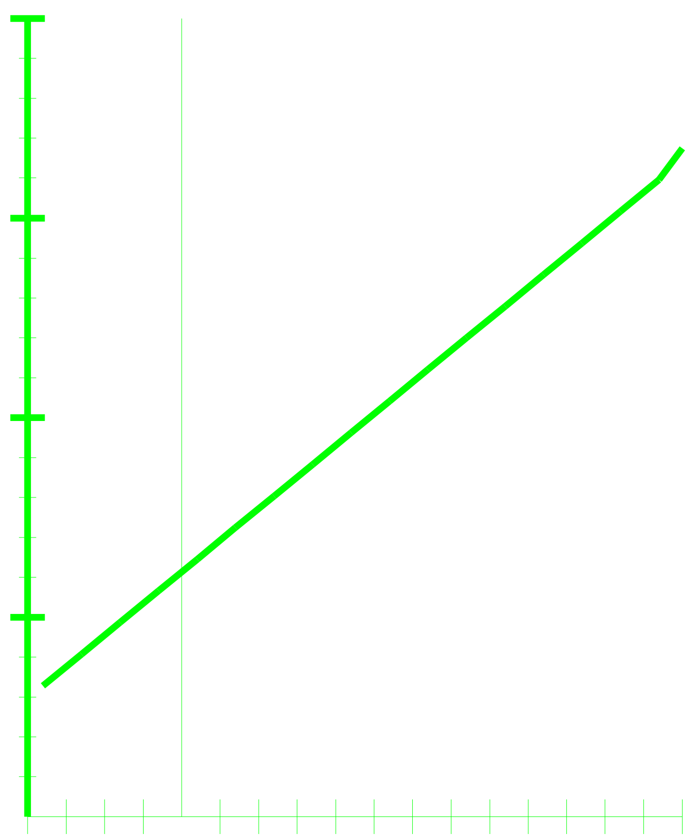
Bin Analysis Report - System 4 - Existing Community Room

Bin Temp Ranges Degree F	Hours Per Bin	Heating Load Btuh	Adjusted Load (x 0.85)	Heat Pump Output Btuh	H. Pump Run Time Fraction	Backup Output Btuh	H.Pump Heating Cost	Backup Heating Cost	Total Heating Cost
-20 to -15	1	73,619	62,576	0	0.000	62,576	0.00	1.29	1.29
-15 to -10	18	69,436	59,020	0	0.000	59,020	0.00	21.85	21.85
-10 to -5	19	65,253	55,465	0	0.000	55,465	0.00	21.67	21.67
-5 to 0	52	61,070	51,910	0	0.000	51,910	0.00	55.52	55.52
0 to 5	136	56,887	48,354	0	0.000	48,354	0.00	135.26	135.26
5 to 10	154	52,704	44,799	0	0.000	44,799	0.00	141.90	141.90
10 to 15	209	48,521	41,243	0	0.000	41,243	0.00	177.31	177.31
15 to 20	312	44,338	37,688	0	0.000	37,688	0.00	241.90	241.90
20 to 25	385	40,156	34,132	0	0.000	34,132	0.00	270.42	270.42
25 to 30	666	35,973	30,577	0	0.000	30,577	0.00	419.33	419.33
30 to 35	878	31,790	27,021	27,021	0.239	27,021	119.42	293.54	412.96
35 to 40	650	27,607	23,466	23,466	0.486	0	179.56	0.00	179.56
40 to 45	658	23,424	19,910	19,910	0.387	0	144.89	0.00	144.89
45 to 50	679	19,241	16,355	16,355	0.299	0	115.80	0.00	115.80
50 to 55	619	15,058	12,800	12,800	0.221	0	78.15	0.00	78.15
55 to 60	717	10,875	9,244	9,244	0.152	0	62.03	0.00	62.03
60 to 65	685	6,693	5,689	5,689	0.089	0	34.69	0.00	34.69
Totals:	6,838						$738.99	$1,779.98	$2,518.97



Bin Analysis Report - System 5 - Improved Community Room

Bin Temp Ranges Degree F	Hours Per Bin	Heating Load Btuh	Adjusted Load (x 0.85)	Heat Pump Output Btuh	H. Pump Run Time Fraction	Backup Output Btuh	H.Pump Heating Cost	Backup Heating Cost	Total Heating Cost
-20 to -15	1	60,442	51,375	0	0.000	51,375	0.00	1.06	1.06
-15 to -10	18	57,007	48,456	0	0.000	48,456	0.00	17.94	17.94
-10 to -5	19	53,573	45,537	0	0.000	45,537	0.00	17.80	17.80
-5 to 0	52	50,139	42,618	0	0.000	42,618	0.00	45.58	45.58
0 to 5	136	46,705	39,699	0	0.000	39,699	0.00	111.06	111.06
5 to 10	154	43,271	36,780	0	0.000	36,780	0.00	116.53	116.53
10 to 15	209	39,836	33,861	0	0.000	33,861	0.00	145.64	145.64
15 to 20	312	36,402	30,942	0	0.000	30,942	0.00	198.77	198.77
20 to 25	385	32,968	28,023	0	0.000	28,023	0.00	222.36	222.36
25 to 30	666	29,534	25,104	0	0.000	25,104	0.00	345.24	345.24
30 to 35	878	26,100	22,185	22,185	0.197	22,185	98.04	242.21	340.25
35 to 40	650	22,666	19,266	19,266	0.399	0	147.42	0.00	147.42
40 to 45	658	19,231	16,347	16,347	0.318	0	118.95	0.00	118.95
45 to 50	679	15,797	13,428	13,428	0.246	0	95.07	0.00	95.07
50 to 55	619	12,363	10,509	10,509	0.182	0	64.16	0.00	64.16
55 to 60	717	8,929	7,590	7,590	0.124	0	50.93	0.00	50.93
60 to 65	685	5,495	4,670	4,670	0.073	0	28.48	0.00	28.48
Totals:	6,838						$606.71	$1,464.19	$2,070.90



Appliance Report - System 1 - Existing BASEMENT

Appliance Set 1 - Teen Center

		Estimated Cost
Lighting		
Indoor:	2.5 Watts/Sq.ft.	
Indoor Annual Electrical Usage:	4,183.8 kWh	
Outdoor Lighting:	0.0 Watts	
Outdoor Lighting Use:	0 Hrs/Night	
Outdoor Lighting Annual Use:	0.0 kWh	
Annual Total Lighting Costs:		$564.81
Cooking		
Range Type:	Electricity	
Range Efficiency:	0%	
Range Electricity Usage:	0.00 kWh	
Annual Cooking Costs:		$0.00
Laundry		
Dryer Type:	Electricity	
Dryer Efficiency:	0%	
Dryer Electricity Usage:	0.00 kWh	
Annual Laundry Costs:		$0.00
Hot Water		
Water Heater Type:	Electricity	
Model Number:	Hotpoint Model HE40M1A	
Water Heater Efficiency:	70%	
Water Heater Usage Level:	Calculated	
Water Heater Daily Usage:	5 Gallons	
Water Heater Peak Usage:	0 Gallons	
Temperature Difference:	70°F	
Electricity Usage:	445.42 kWh	
Annual Hot Water Costs:		$60.13
Gas Appliances		
Gas Appliances Annual Cost:		$0.00
Miscellaneous Appliances		
Refrigerator Usage, Cost:	875 kWh, $118.13	
Stereo Usage, Cost:	75 kWh, $10.13	
TV Usage, Cost:	200 kWh, $27.00	
Dehumidifier Usage, Cost:	450 kWh, $60.75	
Microwave Usage, Cost:	200 kWh, $27.00	
Diswasher Usage, Cost:	150 kWh, $20.25	
Hot Plate Usage, Cost:	164 kWh, $22.14	
Coffee Maker Usage, Cost:	200 kWh, $27.00	
Computer Usage, Cost:	185 kWh, $24.98	
Miscellaneous Appliances Annual Cost:		$337.37
Total		
Appliances Plus Hot Water Annual Cost:		$962.31

Appliance Report - System 2 - Existing BASEMENT. ER OFF

Appliance Set 1 - Teen Center

		Estimated Cost
Lighting		
Indoor:	2.5 Watts/Sq.ft.	
Indoor Annual Electrical Usage:	4,183.8 kWh	
Outdoor Lighting:	0.0 Watts	
Outdoor Lighting Use:	0 Hrs/Night	
Outdoor Lighting Annual Use:	0.0 kWh	
Annual Total Lighting Costs:		$564.81
Cooking		
Range Type:	Electricity	
Range Efficiency:	0%	
Range Electricity Usage:	0.00 kWh	
Annual Cooking Costs:		$0.00
Laundry		
Dryer Type:	Electricity	
Dryer Efficiency:	0%	
Dryer Electricity Usage:	0.00 kWh	
Annual Laundry Costs:		$0.00
Hot Water		
Water Heater Type:	Electricity	
Model Number:	Hotpoint Model HE40M1A	
Water Heater Efficiency:	70%	
Water Heater Usage Level:	Calculated	
Water Heater Daily Usage:	5 Gallons	
Water Heater Peak Usage:	0 Gallons	
Temperature Difference:	70°F	
Electricity Usage:	445.42 kWh	
Annual Hot Water Costs:		$60.13
Gas Appliances		
Gas Appliances Annual Cost:		$0.00
Miscellaneous Appliances		
Refrigerator Usage, Cost:	875 kWh, $118.13	
Stereo Usage, Cost:	75 kWh, $10.13	
TV Usage, Cost:	200 kWh, $27.00	
Dehumidifier Usage, Cost:	450 kWh, $60.75	
Microwave Usage, Cost:	200 kWh, $27.00	
Diswasher Usage, Cost:	150 kWh, $20.25	
Hot Plate Usage, Cost:	164 kWh, $22.14	
Coffee Maker Usage, Cost:	200 kWh, $27.00	
Computer Usage, Cost:	185 kWh, $24.98	
Miscellaneous Appliances Annual Cost:		$337.37
Total		
Appliances Plus Hot Water Annual Cost:		$962.31

Appliance Report - System 3 - Improved BASEMENT. ER OFF

Appliance Set 2 - Teen Center

		Estimated Cost
Lighting		
Indoor:	2.5 Watts/Sq.ft.	
Indoor Annual Electrical Usage:	4,183.8 kWh	
Outdoor Lighting:	0.0 Watts	
Outdoor Lighting Use:	0 Hrs/Night	
Outdoor Lighting Annual Use:	0.0 kWh	
Annual Total Lighting Costs:		$564.81
Cooking		
Range Type:	Electricity	
Range Efficiency:	0%	
Range Electricity Usage:	0.00 kWh	
Annual Cooking Costs:		$0.00
Laundry		
Dryer Type:	Electricity	
Dryer Efficiency:	0%	
Dryer Electricity Usage:	0.00 kWh	
Annual Laundry Costs:		$0.00
Hot Water		
Water Heater Type:	Electricity	
Model Number:	Hotpoint Model HE40M1A	
Water Heater Efficiency:	3.20 COP	
Water Heater Usage Level:	Calculated	
Water Heater Daily Usage:	4 Gallons	
Water Heater Peak Usage:	0 Gallons	
Temperature Difference:	70°F	
Electricity Usage:	77.95 kWh	
Annual Hot Water Costs:		$10.52
Gas Appliances		
Gas Appliances Annual Cost:		$0.00
Miscellaneous Appliances		
Refrigerator Usage, Cost:	550 kWh, $74.25	
Stereo Usage, Cost:	75 kWh, $10.13	
TV Usage, Cost:	200 kWh, $27.00	
Dehumidifier Usage, Cost:	250 kWh, $33.75	
Microwave Usage, Cost:	200 kWh, $27.00	
Diswasher Usage, Cost:	150 kWh, $20.25	
Hot Plate Usage, Cost:	164 kWh, $22.14	
Coffee Maker Usage, Cost:	200 kWh, $27.00	
Computer Usage, Cost:	185 kWh, $24.98	
Miscellaneous Appliances Annual Cost:		$266.49
Total		
Appliances Plus Hot Water Annual Cost:		$841.83

P-SERIES

SUBMITTAL DATA: PKA-A36KA7 & PUZ-HA36NHA5
36,000 BTU/H WALL-MOUNTED HEAT PUMP SYSTEM

MITSUBISHI ELECTRIC

Job Name:	
System Reference:	Date:

Indoor Unit: PKA-A36KA7	Outdoor Unit: PUZ-HA36NHA5
	

INDOOR UNIT FEATURES
- Sleek, compact design
- Simple installation
- Vane setting for air flow direction control
- Auto fan speed mode
- Ideal for spaces such as server rooms, daycare centers, classrooms, churches, small offices, and more

OUTDOOR UNIT FEATURES
- Variable speed INVERTER-driven compressor
- High heating capacity: flash injection circuit maintains 100% heating capacity at 5°F outdoor temperature
- Wide heating range: heating performance down to -13°F (average of 80% heating capacity)
- High speed heating at start up: Hyper-Heating INVERTER® reduces the time for heating at start up by about half compared to standard models
- Suction accumulator pre-charged with refrigerant volume for piping length up to 100 ft.
- Twinning of two indoor units possible with the 36 kBTU/H model
- High pressure/temperature protection

SPECIFICATIONS: PKA-A36KA7 & PUZ-HA36NHA5

Cooling[1]	Maximum Capacity	BTU/H	33,500
	Rated Capacity	BTU/H	33,500
	Minimum Capacity	BTU/H	18,000
	Maximum Power Input	W	3,130
	Rated Power Input	W	2,790
	Moisture Removal	Pints/h	8.7
	Sensible Heat Factor		0.71
	Power Factor	%	96.3
Heating at 47°F[2]	Maximum Capacity	BTU/H	40,000
	Rated Capacity	BTU/H	38,000
	Minimum Capacity	BTU/H	18,000
	Maximum Power Input	W	4,150
	Rated Power Input	W	3,410
	Power Factor	%	96.3
Heating at 17°F[3]	Maximum Capacity	BTU/H	38,000
	Rated Capacity	BTU/H	25,000
	Maximum Power Input	W	6,010
	Rated Power Input	W	3,330
Heating at 5°F[4]	Maximum Capacity	BTU/H	38,000
	Maximum Power Input	W	6,760
Efficiency	SEER		16.2
	EER[1]		12.0
	HSPF (IV)		10.0
	COP at 47°F[2]		3.26
	COP at 17°F in Maximum Capacity		1.85
	COP at 5°F in Maximum Capacity		1.65
Electrical	Voltage, Phase, Frequency		208 / 230V, 1-phase, 60 Hz
	Guaranteed Voltage Range	V AC	198 – 253
	Voltage: Indoor - Outdoor, S1-S2	V AC	208V / 230
	Voltage: Indoor - Outdoor, S2-S3	V DC	24
	Voltage: Indoor - Remote controller	V DC	12
	Recommended Fuse/Breaker Size (Outdoor)	A	30
	Recommended Wire Size (Indoor - Outdoor)	AWG	14
Indoor Unit	MCA	A	1.00
	Fan Motor Full Load Amperage	A	0.57
	Fan Motor Output	W	56
	Airflow Rate, Dry	CFM	705-810-920
	Airflow Rate, Wet	CFM	635-730-830
	External Static Pressure	in.WG	n/a
	Sound Pressure Level	dB(A)	43-46-49
	Drain Pipe Size	In. (mm)	5/8 (16)
	Condensate Lift Mechanism, Maximum Distance	Ft. (m)	n/a
	Heat Exchanger Type		Plate fin coil
	External Finish Color		White Munsell 1.0Y 9.2/0.2
	Unit Dimensions // Grille Dimensions	W: In. (mm)	46-1/16 (1170)
		D: In. (mm)	11-5/8 (295)
		H: In. (mm)	14-3/8 (365)
	Package Dimensions // Grille Dimensions	W: In. (mm)	51
		D: In. (mm)	18-8/16
		H: In. (mm)	14-4/16

SPECIFICATIONS: PKA-A36KA7 & PUZ-HA36NHA5

	Unit Weight	Lbs. (kg)	46 (21)
	Package Weight	Lbs. (kg)	53
Indoor Unit Operating Temperature Range	Cooling Intake Air Temp (Maximum / Minimum)	°F	90 DB, 73 WB / 66 DB, 59 WB
	Heating Intake Air Temp (Maximum / Minimum)	°F	82 DB / 50 DB
Outdoor Unit	MCA	A	28
	MOCP	A	40
	Fan Motor Full Load Amperage	A	0.4+0.4
	Fan Motor Output	W	86+86
	Airflow Rate	CFM	3,530
	Refrigerant Control		Electronic Expansion Valve
	Defrost Method		Reverse Cycle
	Heat Exchanger Type		Cross fin
	Sound Pressure Level, Cooling[1]	dB(A)	52
	Sound Pressure Level, Heating[2]	dB(A)	53
	Compressor Type		INVERTER-Driven Twin Rotary
	Compressor Model		ANB33FJEMT
	Compressor Rated Load Amps	A	18
	Compressor Locked Rotor Amps	A	27.5
	Compressor Oil Type // Charge	oz.	FV50S // 45
	External Finish Color		Ivory Munsell 3Y 7.8/1.1
	Base Pan Heater		n/a
	Unit Dimensions	W: In. (mm)	37-3/8 (950)
		D: In. (mm)	13 + 1-3/16 (330 + 30)
		H: In. (mm)	53-1/8 (1,350)
	Package Dimensions	W: In. (mm)	40-15/16 (1,040)
		D: In. (mm)	17-11/16 (450)
		H: In. (mm)	56-11/16 (1,440)
	Unit Weight	Lbs. (kg)	265 (120)
	Package Weight	Lbs. (kg)	289 (131)
Outdoor Unit Operating Temperature Range	Cooling Intake Air Temp (Maximum / Minimum)	°F	115 DB / 0* DB
	Heating Intake Air Temp (Maximum / Minimum)	°F	70 DB, 59 WB / -13 DB, -13 WB
	Thermal Lock-out / Re-start Temperatures**	°F	n/a
Refrigerant	Type		R410A
	Charge	Lbs, oz	12
Piping	Gas Pipe Size O.D. (Flared)	In.(mm)	5/8 (15.88)
	Liquid Pipe Size O.D. (Flared)	In.(mm)	3/8 (9.52)
	Maximum Piping Length	Ft. (m)	245 (75)
	Maximum Height Difference	Ft. (m)	100 (30)
	Maximum Number of Bends		15

Notes

AHRI Rated Conditions (Rated data is determined at a fixed compressor speed)	[1]Cooling (Indoor // Outdoor)	°F	80 DB, 67 WB // 95 DB, 75 WB
	[2]Heating at 47°F (Indoor // Outdoor)	°F	70 DB, 60 WB // 47 DB, 43 WB
	[3]Heating at 17°F (Indoor // Outdoor)	°F	70 DB, 60 WB // 17 DB, 15 WB
Conditions	[4]Heating at 5°F (Indoor // Outdoor)	°F	70 DB, 60 WB // -4 DB, -5 WB

*Wind baffles required to operate below 23°F DB in cooling mode. PUZ with wind baffle: 0°F - 115°F.
**System cuts out in heating mode to avoid thermistor error and automatically restarts at these temperatures.

SUBMITTAL DATA: MXZ-8C48NA
MULTI-INDOOR INVERTER HEAT-PUMP SYSTEM

MITSUBISHI ELECTRIC

Job Name:	
System Reference:	Date:

Outdoor Unit: MXZ-8C48NA

GENERAL FEATURES
Quiet Operation
Optional base pan heater to prevent ice in drain pan
Limited warranty: five years parts and seven years compressors

ACCESSORIES
☐ Three-port Branch Box (PAC-MKA30BC)
☐ Five-port Branch Box (PAC-MKA50BC)
☐ Distribution Pipe for Flare Connection
- (MSDD-50AR; necessary for installing two branch boxes)

☐ Distribution Pipe for Brazed Connection
- (MSDD-50BR; necessary for installing two branch boxes)

☐ 3/8" x 1/2" Port Adapter (MAC-A454JP)
☐ 1/2" x 3/8" Port Adapter (MAC-A455JP)
☐ 1/2" x 5/8" Port Adapter (MAC-A456JP)
☐ 1/4" x 3/8" Port Adapter (PAC-493PI)
☐ 3/8" x 5/8" Port Adapter (PAC-SG76RJ)
☐ Base Heater (PAC-SJ20BH-E)

(For data on specific indoor units, see the MXZ-C Technical and Service Manual.)

Specifications			Model Name
Unit Type			MXZ-8C48NA
Cooling* (Non-ducted / Ducted)	Rated Capacity	Btu/h	48,000 / 48,000
	Capacity Range	Btu/h	15,500 - 48,000
	Rated Total Input	W	4,000 / 5,050
Heating at 47°F* (Non-ducted / Ducted)	Rated Capacity	Btu/h	54,000 / 54,000
	Capacity Range	Btu/h	22,500 - 54,000
	Rated Total Input	W	4,220 / 4,990
Heating at 17°F* (Non-ducted/Ducted)	Rated Capacity	Btu/h	35,000 / 35,000
	Maximum Capacity	Btu/h	36,600 / 36,600
	Rated Total Input	W	3,720 / 4,420
Connectable Capacity		Btu/h	12,000 - 62,400
Electrical Requirements	Power Supply	Voltage, Phase, Hertz	208 / 230V, 1-Phase, 60 Hz
	Recommended Fuse/Breaker Size	A	40
	MCA	A	37
Voltage	Indoor - Outdoor S1-S2	V	AC 208 / 230
	Indoor - Outdoor S2-S3	V	DC ±24
Compressor			Hermetic
Fan Motor (ECM)		F.L.A.	0.4+0.4
Sound Pressure Level	Cooling	dB(A)	51
	Heating	dB(A)	54
External Dimensions (H x W x D)		In mm	52-11/16 x 41-11/32 x 13+1 (1338 x 1050 x 330+25)
Net Weight		Lbs / kg	269 (122)
External Finish			Munsell No. 3Y 7.8/11
Refrigerant Pipe Size O.D.	Liquid (High Pressure)	In / mm	3/8 (9.52)
	Gas (Low Pressure)	In / mm	5/8 (15.88)
Max. Refrigerant Line Length		Ft / m	492 (150)
Max. Piping Length between outdoor unit and branch boxes		Ft / m	180 (55)
Max. Piping Length after branch box		Ft / m	82 (25)
Max. Total Piping Length between branch boxes and indoor units		Ft / m	311 (95)
Max. Refrigerant Pipe Height Difference	If IDU is Above ODU	Ft / m	131 (40)
	If IDU is Below ODU	Ft / m	164 (50)
Connection Method			Flared/Flared
Refrigerant			R410A

* Rating Conditions per AHRI Standard:
Cooling | Indoor: 80° F (27° C) DB / 67° F (19° C) WB
Cooling | Outdoor: 95° F (35° C) DB / 23.9° C (75° F) WB
Heating at 47°F | Indoor: 70° F (21° C) DB / 60° F (16° C) WB
Heating at 47°F | Outdoor: 47° F (8° C) DB / 43° F (6° C) WB
Heating at 17° F | Indoor: 70° F (21° C) DB
Heating at 17° F | Outdoor: 17° F (-8° C) DB / 15° F (-9° C) WB

Specifications are subject to change without notice.

SPECIFICATIONS: MXZ-8C48NA

OPERATING RANGE:

	Outdoor
Cooling	23 to 115° F (−5 to 46° C) DB*1
Heating	−4 to 59° F (−20 to 15° C) WB

*1. D.B. 5 to 115° F [D.B. −15 to 46° C], when an optional Air Outlet Guide is installed.

ENERGY EFFICIENCIES:

Indoor Unit Type	SEER	EER	HSPF	COP @ 47°F	COP @ 17°F
Non-ducted	18.9	12.00	11.4	3.75	2.60
Ducted and Non-ducted	16.8	10.75	10.8	3.46	2.45
Ducted	14.7	9.50	10.1	3.17	2.30

NOTES:

- Minimum of two Indoor Units must be connected to the MXZ-8C48NA.
- Minimum installed capacity cannot be less than 12,000 Btu/h.
- Total connected capacity must not exceed 130% of outdoor unit capacity.
- System can operate with only one Indoor Unit turned on.
- Information provided at 208/230V.
- For Reference:
  - MXZ-C Technical & Service Manual for detailed specifications and additional information per Indoor Unit Combination.
  - MXZ Series Multi-Zone Indoor/Outdoor Combination Table for allowed unit combinations.

MVZ CONNECTION RULES:

- Up to 2 MVZ's may be connected to this system*.
- When 2 MVZ's are connected, no additional indoor units can be used*.
- When 1 MVZ is connected, additional indoor units can be connected.
- When 1 MVZ is connected, total connected capacity must not exceed 130%.

*No limitation to the number of units connected when the SPTB1 accessory is used, total connected capacity must not exceed 130% (refer to SPTB1 documentation for more information).

NOTES:

8. PERFORMANCE CHART

PKA-A30KA6/PUZ-HA30NHA5

CAPACITY (BTU/H): 30,000 INPUT (kW): 2.50 SHF: 0.70

Indoor intake air D.B.(°C)	Indoor intake air D.B.(°F)	Indoor intake air W.B.(°C)	Indoor intake air W.B.(°F)	Outdoor intake air °C/°F D.B.																	
				20/68			25/77			30/86			35/95			40/104			45/115		
				CA	SHC	P.C.	CA	SHC	P.C.	CA	SHC	P.C.	CA	SHC	P.C.	CA	SHC	P.C.	CA	SHC	P.C.
20	68	16	61	29,700	18,889	2.02	28,800	18,317	2.12	27,900	17,744	2.24	26,700	16,981	2.40	25,500	16,218	2.58	24,000	15,264	2.82
20	68	18	64	31,800	16,409	2.08	30,900	15,944	2.18	30,000	15,480	2.32	29,100	15,016	2.48	27,900	14,396	2.62	26,100	13,468	2.88
22	72	16	61	29,700	21,265	2.02	28,800	20,621	2.12	27,900	19,976	2.24	26,700	19,117	2.40	25,500	18,258	2.58	24,000	17,184	2.82
22	72	18	64	31,800	18,953	2.08	30,900	18,416	2.18	30,000	17,880	2.32	29,100	17,344	2.48	27,900	16,628	2.62	26,100	15,556	2.88
22	72	20	68	34,200	16,279	2.12	33,600	15,994	2.24	32,700	15,565	2.38	31,500	14,994	2.52	30,300	14,423	2.70	27,900	13,280	2.96
24	75	16	61	29,700	23,641	2.02	28,800	22,925	2.12	27,900	22,208	2.24	26,700	21,253	2.40	25,500	20,298	2.58	24,000	19,104	2.82
24	75	18	64	31,800	21,497	2.08	30,900	20,888	2.18	30,000	20,280	2.32	29,100	19,672	2.48	27,900	18,860	2.62	26,100	17,644	2.88
24	75	20	68	34,200	19,015	2.12	33,600	18,682	2.24	32,700	18,181	2.38	31,500	17,514	2.52	30,300	16,847	2.70	27,900	15,512	2.96
24	75	22	72	36,300	15,827	2.18	35,700	15,565	2.28	34,800	15,173	2.42	33,900	14,780	2.58	32,700	14,257	2.78	30,300	13,211	3.06
26	79	16	61	29,700	26,017	2.02	28,800	25,229	2.12	27,900	24,440	2.24	26,700	23,389	2.40	25,500	22,338	2.58	24,000	21,024	2.82
26	79	18	64	31,800	24,041	2.08	30,900	23,360	2.18	30,000	22,680	2.32	29,100	22,000	2.48	27,900	21,092	2.62	26,100	19,732	2.88
26	79	20	68	34,200	21,751	2.12	33,600	21,370	2.24	32,700	20,797	2.38	31,500	20,034	2.52	30,300	19,271	2.70	27,900	17,744	2.96
26	79	22	72	36,300	18,731	2.18	35,700	18,421	2.28	34,800	17,957	2.42	33,900	17,492	2.58	32,700	16,873	2.78	30,300	15,635	3.06
27	81	16	61	29,700	27,205	2.02	28,800	26,381	2.12	27,900	25,556	2.24	26,700	24,457	2.40	25,500	23,358	2.58	24,000	21,984	2.82
27	81	18	64	31,800	25,313	2.08	30,900	24,596	2.18	30,000	23,880	2.32	29,100	23,164	2.48	27,900	22,208	2.62	26,100	20,776	2.88
27	81	20	68	34,200	23,119	2.12	33,600	22,714	2.24	32,700	22,105	2.38	31,500	21,294	2.52	30,300	20,483	2.70	27,900	18,860	2.96
27	81	22	72	36,300	20,183	2.18	35,700	19,849	2.28	34,800	19,349	2.42	33,900	18,848	2.58	32,700	18,181	2.78	30,300	16,847	3.06
28	82	16	61	29,700	28,393	2.02	28,800	27,533	2.12	27,900	26,672	2.24	26,700	25,525	2.40	25,500	24,378	2.58	24,000	22,944	2.82
28	82	18	64	31,800	26,585	2.08	30,900	25,832	2.18	30,000	25,080	2.32	29,100	24,328	2.48	27,900	23,324	2.62	26,100	21,820	2.88
28	82	20	68	34,200	24,487	2.12	33,600	24,058	2.24	32,700	23,413	2.38	31,500	22,554	2.52	30,300	21,695	2.70	27,900	19,976	2.96
28	82	22	72	36,300	21,635	2.18	35,700	21,277	2.28	34,800	20,741	2.42	33,900	20,204	2.58	32,700	19,489	2.78	30,300	18,059	3.06
30	86	16	61	29,700	29,700	2.02	28,800	28,800	2.12	27,900	27,900	2.24	26,700	26,700	2.40	25,500	25,500	2.58	24,000	24,000	2.82
30	86	18	64	31,800	29,129	2.08	30,900	28,304	2.18	30,000	27,480	2.32	29,100	26,656	2.48	27,900	25,556	2.62	26,100	23,908	2.88
30	86	20	68	34,200	27,223	2.12	33,600	26,746	2.24	32,700	26,029	2.38	31,500	25,074	2.52	30,300	24,119	2.70	27,900	22,208	2.96
30	86	22	72	36,300	24,539	2.18	35,700	24,133	2.28	34,800	23,525	2.42	33,900	22,916	2.58	32,700	22,105	2.78	30,300	20,483	3.06
32	90	16	61	29,700	29,700	2.02	28,800	28,800	2.12	27,900	27,900	2.24	26,700	26,700	2.40	25,500	25,500	2.58	24,000	24,000	2.82
32	90	18	64	31,800	31,673	2.08	30,900	30,776	2.18	30,000	29,880	2.32	29,100	28,984	2.48	27,900	27,788	2.62	26,100	25,996	2.88
32	90	20	68	34,200	29,959	2.12	33,600	29,434	2.24	32,700	28,645	2.38	31,500	27,594	2.52	30,300	26,543	2.70	27,900	24,440	2.96
32	90	22	72	36,300	27,443	2.18	35,700	26,989	2.28	34,800	26,309	2.42	33,900	25,628	2.58	32,700	24,721	2.78	30,300	22,907	3.06
34	93	16	61	29,700	29,700	2.02	28,800	28,800	2.12	27,900	27,900	2.24	26,700	26,700	2.40	25,500	25,500	2.58	24,000	24,000	2.82
34	93	18	64	31,800	31,800	2.08	30,900	30,900	2.18	30,000	30,000	2.32	29,100	29,100	2.48	27,900	27,900	2.62	26,100	26,100	2.88
34	93	20	68	34,200	32,695	2.12	33,600	32,122	2.24	32,700	31,261	2.38	31,500	30,114	2.52	30,300	28,967	2.70	27,900	26,672	2.96
34	93	22	72	36,300	30,347	2.18	35,700	29,845	2.28	34,800	29,093	2.42	33,900	28,340	2.58	32,700	27,337	2.78	30,300	25,331	3.06

PKA-A36KA6/PUZ-HA36NHA5

CAPACITY (BTU/H): 33,500 INPUT (kW): 2.79 SHF: 0.71

Indoor intake air D.B.(°C)	Indoor intake air D.B.(°F)	Indoor intake air W.B.(°C)	Indoor intake air W.B.(°F)	Outdoor intake air °C/°F D.B.																	
				20/68			25/77			30/86			35/95			40/104			45/115		
				CA	SHC	P.C.	CA	SHC	P.C.	CA	SHC	P.C.	CA	SHC	P.C.	CA	SHC	P.C.	CA	SHC	P.C.
20	68	16	61	33,165	21,425	2.26	32,160	20,775	2.37	31,155	20,126	2.50	29,815	19,260	2.68	28,475	18,395	2.88	26,800	17,313	3.14
20	68	18	64	35,510	18,678	2.33	34,505	18,150	2.44	33,500	17,621	2.59	32,495	17,092	2.77	31,155	16,388	2.92	29,145	15,330	3.21
22	72	16	61	33,165	24,078	2.26	32,160	23,348	2.37	31,155	22,619	2.50	29,815	21,646	2.68	28,475	20,673	2.88	26,800	19,457	3.14
22	72	18	64	35,510	21,519	2.33	34,505	20,910	2.44	33,500	20,301	2.59	32,495	19,692	2.77	31,155	18,880	2.92	29,145	17,662	3.21
22	72	20	68	38,190	18,560	2.37	37,520	18,235	2.50	36,515	17,746	2.66	35,175	17,095	2.81	33,835	16,444	3.01	31,155	15,141	3.30
24	75	16	61	33,165	26,731	2.26	32,160	25,921	2.37	31,155	25,111	2.50	29,815	24,031	2.68	28,475	22,951	2.88	26,800	21,601	3.14
24	75	18	64	35,510	24,360	2.33	34,505	23,670	2.44	33,500	22,981	2.59	32,495	22,292	2.77	31,155	21,372	2.92	29,145	19,993	3.21
24	75	20	68	38,190	21,616	2.37	37,520	21,236	2.50	36,515	20,667	2.66	35,175	19,909	2.81	33,835	19,151	3.01	31,155	17,634	3.30
24	75	22	72	40,535	18,079	2.44	39,865	17,780	2.55	38,860	17,332	2.70	37,855	16,883	2.88	36,515	16,286	3.10	33,835	15,090	3.41
26	79	16	61	33,165	29,384	2.26	32,160	28,494	2.37	31,155	27,603	2.50	29,815	26,416	2.68	28,475	25,229	2.88	26,800	23,745	3.14
26	79	18	64	35,510	27,201	2.33	34,505	26,431	2.44	33,500	25,661	2.59	32,495	24,891	2.77	31,155	23,865	2.92	29,145	22,325	3.21
26	79	20	68	38,190	24,671	2.37	37,520	24,238	2.50	36,515	23,589	2.66	35,175	22,723	2.81	33,835	21,857	3.01	31,155	20,126	3.30
26	79	22	72	40,535	21,321	2.44	39,865	20,969	2.55	38,860	20,440	2.70	37,855	19,912	2.88	36,515	19,207	3.10	33,835	17,797	3.41
27	81	16	61	33,165	30,711	2.26	32,160	29,780	2.37	31,155	28,850	2.50	29,815	27,609	2.68	28,475	26,368	2.88	26,800	24,817	3.14
27	81	18	64	35,510	28,621	2.33	34,505	27,811	2.44	33,500	27,001	2.59	32,495	26,191	2.77	31,155	25,111	2.92	29,145	23,491	3.21
27	81	20	68	38,190	26,198	2.37	37,520	25,739	2.50	36,515	25,049	2.66	35,175	24,130	2.81	33,835	23,211	3.01	31,155	21,372	3.30
27	81	22	72	40,535	22,943	2.44	39,865	22,564	2.55	38,860	21,995	2.70	37,855	21,426	2.88	36,515	20,667	3.10	33,835	19,151	3.41
28	82	16	61	33,165	32,037	2.26	32,160	31,067	2.37	31,155	30,096	2.50	29,815	28,801	2.68	28,475	27,507	2.88	26,800	25,889	3.14
28	82	18	64	35,510	30,041	2.33	34,505	29,191	2.44	33,500	28,341	2.59	32,495	27,491	2.77	31,155	26,357	2.92	29,145	24,657	3.21
28	82	20	68	38,190	27,726	2.37	37,520	27,240	2.50	36,515	26,510	2.66	35,175	25,537	2.81	33,835	24,564	3.01	31,155	22,619	3.30
28	82	22	72	40,535	24,564	2.44	39,865	24,158	2.55	38,860	23,549	2.70	37,855	22,940	2.88	36,515	22,128	3.10	33,835	20,504	3.41
30	86	16	61	33,165	33,165	2.26	32,160	32,160	2.37	31,155	31,155	2.50	29,815	29,815	2.68	28,475	28,475	2.88	26,800	26,800	3.14
30	86	18	64	35,510	32,882	2.33	34,505	31,952	2.44	33,500	31,021	2.59	32,495	30,090	2.77	31,155	28,850	2.92	29,145	26,988	3.21
30	86	20	68	38,190	30,781	2.37	37,520	30,241	2.50	36,515	29,431	2.66	35,175	28,351	2.81	33,835	27,271	3.01	31,155	25,111	3.30
30	86	22	72	40,535	27,807	2.44	39,865	27,347	2.55	38,860	26,658	2.70	37,855	25,969	2.88	36,515	25,049	3.10	33,835	23,211	3.41
32	90	16	61	33,165	33,165	2.26	32,160	32,160	2.37	31,155	31,155	2.50	29,815	29,815	2.68	28,475	28,475	2.88	26,800	26,800	3.14
32	90	18	64	35,510	35,510	2.33	34,505	34,505	2.44	33,500	33,500	2.59	32,495	32,495	2.77	31,155	31,155	2.92	29,145	29,145	3.21
32	90	20	68	38,190	33,836	2.37	37,520	33,243	2.50	36,515	32,352	2.66	35,175	31,165	2.81	33,835	29,978	3.01	31,155	27,603	3.30
32	90	22	72	40,535	31,050	2.44	39,865	30,537	2.55	38,860	29,767	2.70	37,855	28,997	2.88	36,515	27,970	3.10	33,835	25,918	3.41
34	93	16	61	33,165	33,165	2.26	32,160	32,160	2.37	31,155	31,155	2.50	29,815	29,815	2.68	28,475	28,475	2.88	26,800	26,800	3.14
34	93	18	64	35,510	35,510	2.33	34,505	34,505	2.44	33,500	33,500	2.59	32,495	32,495	2.77	31,155	31,155	2.92	29,145	29,145	3.21
34	93	20	68	38,190	36,892	2.37	37,520	36,244	2.50	36,515	35,273	2.66	35,175	33,979	2.81	33,835	32,685	3.01	31,155	30,096	3.30
34	93	22	72	40,535	34,293	2.44	39,865	33,726	2.55	38,860	32,876	2.70	37,855	32,025	2.88	36,515	30,892	3.10	33,835	28,624	3.41

Note: CA : Capacity (Btu/h) SHC : Sensible heat capacity (Btu/h) P.C. : Power consumption (kW)
D.B. : Dry-bulb temperature W.B. : Wet-bulb temperature

MITSUBISHI ELECTRIC CORPORATION

Innerglass Window Systems LLC
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800-743-6207 860-651-3951 Fax 860-651-4789
www.stormwindows.com
David@Stormwindows.com

Price and Order Form

We price the Innerglass Window by the United Inch. The formula is **Width + Height = U.I.**

1. Please round to the nearest whole inch, then **add** the window width and height and write it on the sheet
2. Please write the color, window type code, and glazing code in the box on the measurement worksheet.
3. Square feet for glazing are Width x Height (in inches) divide by 144 to get Ft^2 and round up.

Storm Window Type	Code	# Of Windows	United Inches	X Price Per U.I.	=	Price
Compression	(CP)			X $3.25	=	$
Double Hung	(DH)			X $3.55	=	$
Double Slider	(SL)			X $3.55	=	$
Triple Slider	(TL)			X $4.15	=	$
Surface Mount	(SM)			X $3.25	=	$
				X	=	$
				X	=	$

Glazing	Code		Square Feet	X Price Per Ft^2	=	Price
1/8 " Clear Glass	(DS)	Standard		X $3.00	=	$
1/8" Low E Glass	(LE)	High Performance		X $6.00	=	$
1/8' Acrylic	(AC)			X $7.00	=	$
Other				X	=	$
Call for price			Connecticut Residents add 6.35% Tax		=	$

Compression Window in Low E glass is Energy Star and qualifies for Tax Credits!

Please call for a truck freight estimate.

Shipping Total $

Total Sale $

You can pick up at the factory and avoid shipping charges.

Terms: 50% Deposit with your order. 50% paid when your windows are ready to ship. We must have full payment in order to ship your windows. We will send an order acknowledgment and the estimated ship date when we receive your order. We accept checks, money orders, VISA, MASTERCARD, AMERICAN EXPRESS and DISCOVER CARD.

ACCEPTANCE- The above prices, specifications and conditions are satisfactory, and are hereby accepted. I agree that I am responsible for correctly measuring my window openings, and that Innerglass Window Systems will not be responsible for any errors in the dimensions I have given them.

If Innerglass Window Systems measures we are responsible. Because these are custom sized, no refunds or returns are possible. Payment will be made as outlined above. When delivery or pickup of completed order is delayed by customer, balance is due. When delay is more than 30 days, storage charges may accrue.

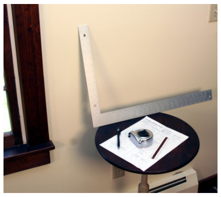
Order Date____________ Signature________________________ Name____

Address____ State____ Zip________

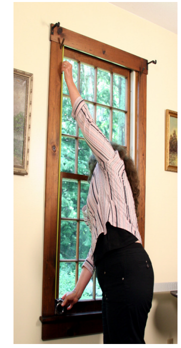
Home Phone____ Work or Cell____

Email address____

Credit Card # ____ Expiration Date___________ Billing Zip____________



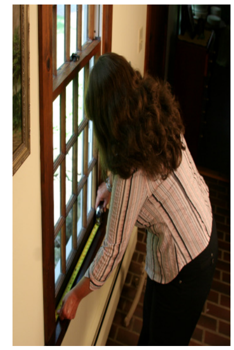
Innerglass Window Systems Measuring Guidelines



Tools needed

- 3” Case Dimension Locking tape measure
- 16”x 24” framing square (to check for out of square)
- 6” or 12” ruler
- Window Worksheet to record measurements

1. Measure all 4 sides to 1/16” and record the actual measurement. Do not average. Don't bend the tape into the corner. Instead add the tape case dimension to your measurement. Measure exactly where the window will be mounted.



2. The Innerglass Compression-Fit window needs 3/4 "depth in the window opening for mounting, 5/8” is possible but call us. The double hung and horizontal sliding interior storms need 1 1/8” depth in the window opening. Watch for obstructions such as window hardware. Screw heads and recessed pockets for the window stops are generally not a problem if they don't stick out more than 1/16".

3. To check for out of square, notice the framing squares at the left and right bottom corners and the 2 lines under each framing square where you record the gap on the worksheet. Start tight to the left side and slide the 24” side down until it touches the sill at either the corner or the end. The framing square is always held tight against the side so that any gap will show up at the bottom. If the window is square at the bottom you would record a “0” at each of the 4 lines under the framing squares. If the gap is 1/16 or less it is effectively square. For example: If a window sags down to the right the gap measurements could be 0 ¼, 0 ¼. Place the framing square against the right side of window and repeat the procedure. Think of this as a snapshot of each bottom corner. In reality they overlap but for clarity they are separated and are not to scale. Next lay the 24” side of the framing square on the sill to check if the sill is bowed up or down, if so give us a center vertical measurement and draw an arc showing the bow.

4. Innerglass Windows will accommodate 3/16” vertical and ½” horizontal play. On deep openings measure where you want the window to be and measure the opening at the wall to check that is does not get smaller than these tolerances. If the opening is smaller or the bottom of the opening is obstructed call us.

Mullions for dividing up large windows

5. If you are measuring for a double hung storm or are doing a large opening as separate upper & lower windows with a mullion, measure from the sill to the top of the meeting rail. (Where the dust collects.) This is where the top of the mullion will be. A window opening may be done as one window or two windows with a mullion. Generally double hung windows taller than 72" inches should be done as 2 windows with a horizontal mullion. Measure the length for the mullion where it is to be installed. The dimensions of the vinyl covered wood vertical mullions are 1 5/8” deep x 1 1/8" wide. The vinyl color will match the window. The horizontal mullion is ¾” thick x 1" wide. Measure the width and height of the entire opening.

Do not make allowance for the mullion size. We will do that. For pricing purposes, remember that it is one opening but TWO windows, so the width & height of each needs to be added together to come up with the united inch measurement.

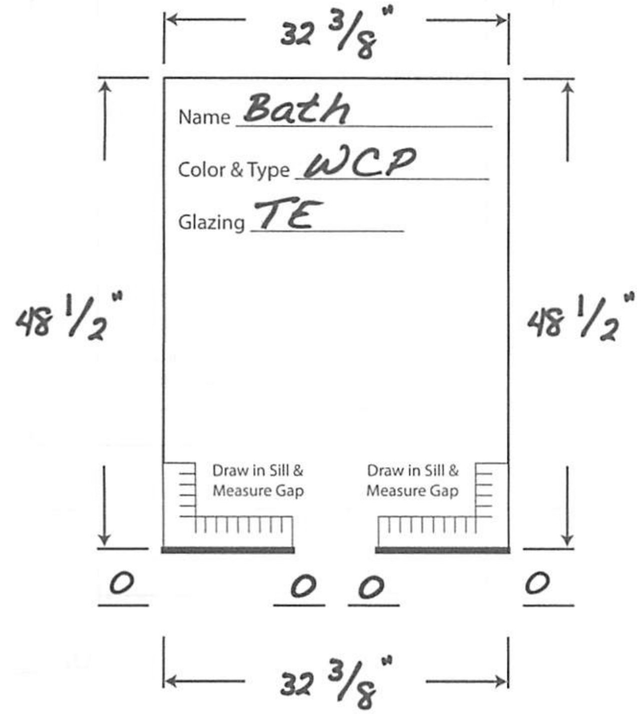
Maximum size for double strength glass is 25 sq ft or 125 united inches.
Larger than that 3/16" or 1/4" laminated or tempered glass will be used at extra cost.
Within 12" of a door or 18" of the floor, Acrylic or tempered glass must be used at extra cost.

Please call us at 860-651-3951 or 800-743-6207 with any questions.

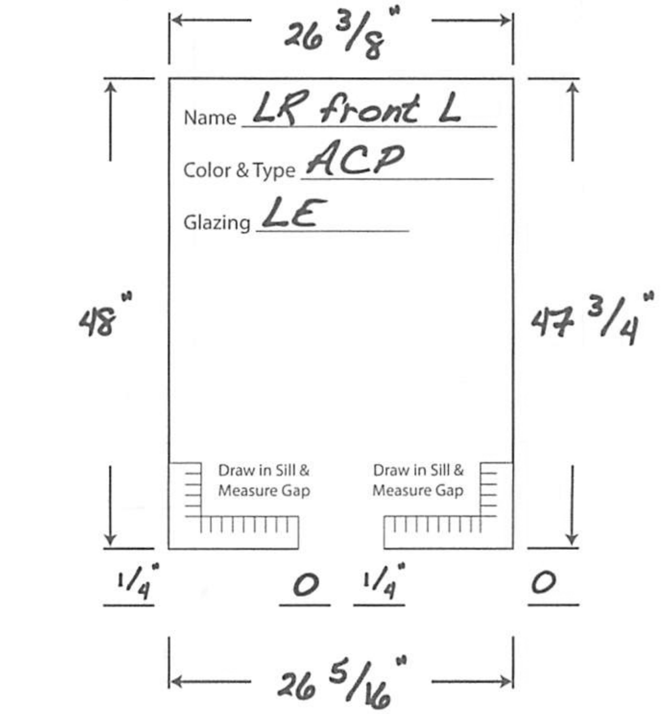
Code Key

Color	Window Type	Glazing	United Inches = Width + Height
A = Almond B = Brown W = White	CP = Compression DH = Double Hung SL = Sliding TL = Triple Slider SCR = Exterior Screen	DS = Regular LE = Low E LA = Laminated Glass AC = Acrylic TG = Tempered Glass TE = Tempered Low E	• Round to the nearest whole number before **adding** width and height • 1/2" and over, round up • Under 1/2", round down

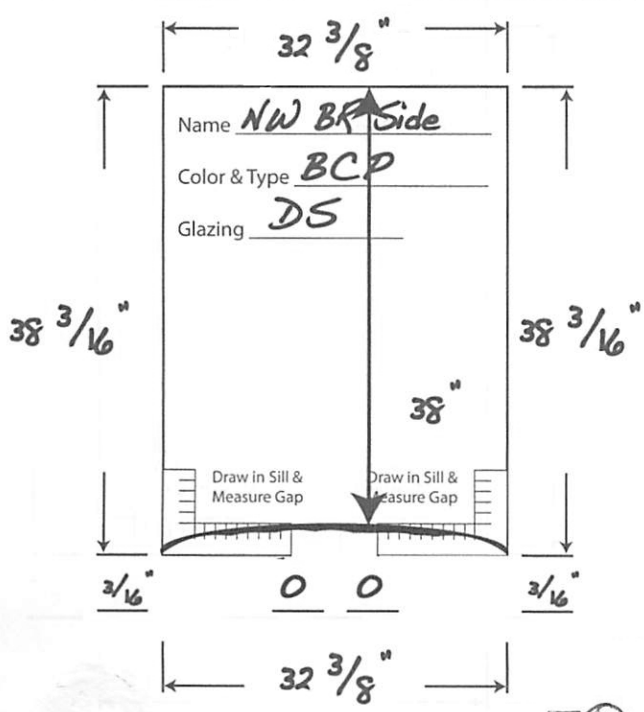
WORKSHEET EXAMPLES



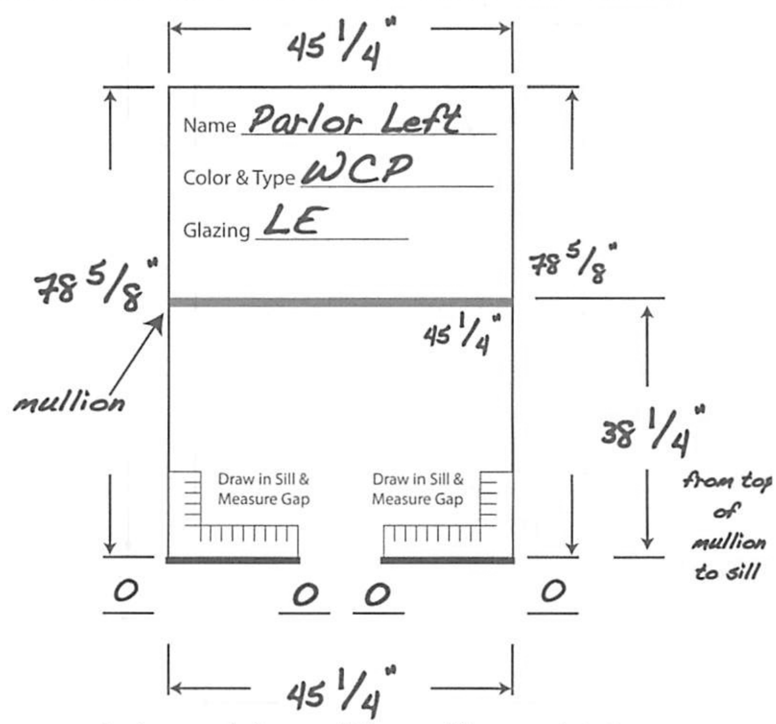
Ft² 11 Square Window White Compression Tempered LE UI 81



Ft² 9 Almond Compression Window Low E sill down to the left 1/4 UI 74



Ft² 9 Brown Compression Window Regular glass Sill bowed up UI 70



Ft² 25 2 windows with a mullion UI 169

Innerglass Window Systems

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Fax 860-651-4789
www.stormwindows.com • david@stormwindows.com

Customer Name ______________________

Window Worksheet
Page _____ **of** _____
(please make a copy for your use)

Totals This Page
Ft² _______ **UI** _______

Name ____________________
Color & Type ________________
Glazing ____________
Draw in Sill & Measure Gap
Draw in Sill & Measure Gap
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Insight
The Perfect Wall

An edited version of this Insight first appeared in the ASHRAE Journal.

By Joseph W. Lstiburek, Ph.D., P.Eng., Fellow ASHRAE

The perfect wall is an environmental separator – it has to keep the outside out and the inside in. In order to do this the wall assembly has to control rain, air, vapor and heat. In the old days we had one material to do this: rocks. We would pile a bunch or rocks up and have the rocks do it all. But over time rocks lost their appeal. They were heavy and fell down a lot. Heavy means expensive and falling down is annoying. So construction evolved. Today walls need four principal control layers – especially if we don't build out of rocks. They are presented in order of importance:

- a rain control layer
- an air control layer
- a vapor control layer
- a thermal control layer

A point to this importance thing here, if you can't keep the rain out don't waste your time on the air. If you can't keep the air out don't waste your time on the vapor.

The best place for the control layers is to locate them on the outside of the structure in order to protect the structure (**Figure 1**). When we built out of rocks the rocks didn't need much protection. When we build out of steel and wood we need to protect the steel and wood. And since most of the bad stuff comes from outside the best place to control the bad stuff is on the outside of the structure before it gets to the structure.

Also, after generations of building out of rocks folks somehow got the idea that they wanted to be comfortable – and they figured out that rocks were not the best insulation. I mean rocks are not that bad compared to windows – memo to architects: you can't build an energy efficient green building out of glass, but you can get design awards and we all know which is more important. Back to rocks, they are heavy and you need a lot of them to make the wall have any decent thermal resistance so we invented thermal insulation.

But where to put the insulation? If we put the insulation on the inside of the structure the insulation does not protect the structure from heat and cold. Remember we really do want to protect that darn structure – especially for the sake of making the structural engineers life more happy. Expansion, contraction, corrosion, decay, ultra violet radiation, and almost all bad things all are functions of temperature. So all the control layers go on the outside. Keep the structure from going through temperature extremes and protect it from water in its various forms and ultra violet radiation and life is good.

What about this air control thing? Well air can carry a lot of water and water is bad for the structure. So we have to keep air out of the structure as well because of the air-water thing – or if we let it get into the structure we have to make sure it does not get cold enough to drop its water. Now, just one other thing, tends to be important if you intend on living in the building or working in the building or keeping things safe in the building, we might want to control the interior environment. We especially ought to be concerned about what is in the interior air because when we are in the interior we tend to breathe it. Well, it turns out that we can't control air until we enclose air. So we need an honest to god airtight enclosure in order to provide conditioning such as filtration and air change and temperature and humidity

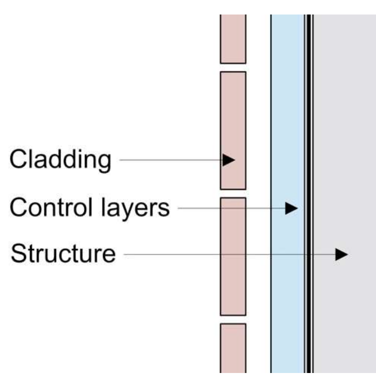

Figure 1: "The Perfect Wall"

In concept the perfect wall has the rainwater control layer, the air control layer, the vapor control layer and the thermal control layer on the exterior of the structure. The claddings function is principally to act a an ultra-violet screen. Oh, and architects might consider the aesthetics of the cladding to be important.

control. And once again the best place to control this air thing is on the outside of the structure – but under the insulation layer so the air does not change temperature. Presto: the perfect wall. A water control layer, air control layer and vapor control layer directly on the structure and a thermal control layer over the top of the other control layers (see **Figure 1** again).

This was figured out long before I was born – I think the Canadians figured it out first (1), but the Norwegians have some claims to this plus the Russians. I am going to go with the Canadians on this one because I am biased and proud of it. Also, I met Professor Hutcheon, and that is a story for the grandkids when I get some – memo to Christy and Andrew: so what's the delay here? For a more detailed discussion of the physics of all of this go to the old masters: Hutcheon and Handegord (2) and the new kids on the block Burnett and Straube (3).

In a beautiful bit of elegance and symmetry if you lie the perfect wall down you get the perfect roof (**Figure 2**) and then when you flip it the other way you get the perfect slab (**Figure 3**). The physics of walls, roofs and slabs are pretty much the same – no surprise (**Figure 4**). This insight was shone into a whole generation of practioners by Max Baker (4) when I was first getting started.

Notice in the perfect roof assembly the critical control layer or membrane for rainwater control and air control and vapor control is located under the thermal insulation layer and the stone ballast (i.e. "roof cladding") so that it is protected from the principle damage functions of water, heat and ultra violet radiation. Arrhanius* would be proud. Why we put the most critical control layers on roofs on the very, very top where they can be trashed by these damage functions never fails to amaze me. Yes, I know, they are easier to replace when they are located there. Standard answer for our disposable, unlimited resource available society.

Most problems in building enclosures occur where roofs meet walls. The classic roof-wall intersection is presented in **Figure 5** (will both credit and apologies to Max Baker). Notice that the control layer for rain on the roof is connected to the control layer for rain on the wall, the control layer for air on the roof is connected to the control layer for air on the wall…..and so it goes. Beautiful. And when it is not so…ugly.

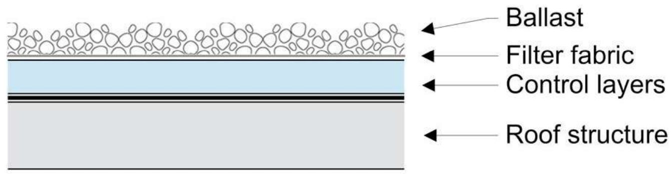

Figure 2: "The Perfect Roof"

The perfect roof is sometime referred to as an "inverted roof" since the rainwater control layer is under the insulation and ballast (i.e. roof cladding). Personally I don't view it as inverted. Those other folks got it wrong by locating the membrane exposed on the top of the insulation – it is they that are inverted.

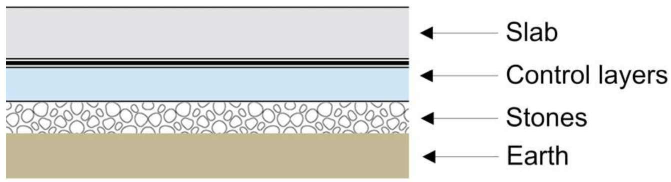

Figure 3: "The Perfect Slab"

The perfect slab has a stone layer that separates it from the earth that acts as a capillary break and a ground water control layer. This stone layer should be drained and vented to the atmosphere – just as you would drain and vent a wall cladding.

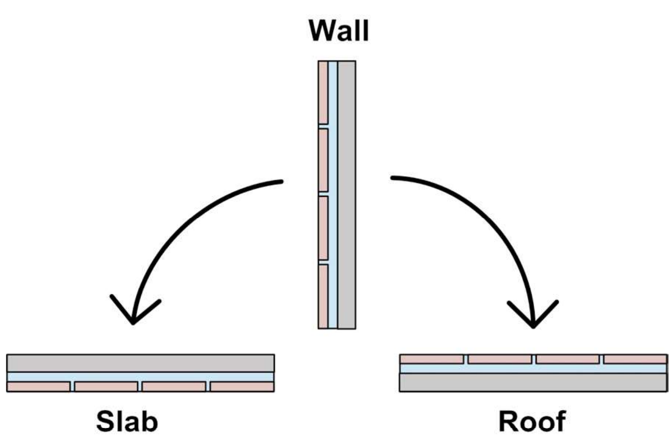

Figure 4: A Wall Is A Roof Is A Slab

The physics of walls, roofs and slabs are conceptually the same.

Time to put some meat on the bones of **Figure 1**. How should this perfect "conceptual" wall actually be built? Three ways. The best of the best of the best

* Dead, Nobel Prize Winner, no longer fashionable to study.

can be found in **Figure 6**. This is a very special wall. I refer to it as the 500-year wall for three reasons:

- it represents 500 years of evolution
- it will last 500 years
- and it will take 500 years for you clients to pay for it

It is the type of wall that you save for special buildings. Buildings that are passed down from one generation to the next. Museums, art galleries, courthouses, libraries. Institutional buildings, because institutions are the only folks that can afford them. I call this wall the "institutional wall." Perhaps once or twice in an entire career you may be fortunate enough to employ it. It is sweet in that it can be constructed in any climate zone. The only thing that may be changed is the level of thermal insulation. My advice here is very simple: what ever you think the right amount of thermal insulation should be double it and shut up. If you love your kids don't argue with me.

The second wall should be the "meat and potatoes" wall for commercial buildings. The wall every commercial building should use. The base wall that our infrastructure should depend on. So, no surprise I call it, yes you guessed it: the "commercial wall." It has a conductive structure – metal studs. All of the insulation should – and must be located on the outside. It is a thermodynamic obscenity to insulate within a conductive structural frame. Again, you can build it anywhere in any climate location. Just consider the insulation levels (see above – particularly the part about loving your kids).

The third wall is the "residential wall." Notice the structural cavity is insulated. That is because we are using a relatively non-conductive structural frame – the structure is wood and wood material based. Wood is not particularly conductive – that is why we do not have wood frying pans.

For this third wall to work almost everywhere (except Alaska and north of Flyn Flon** where we would not insulate even within a relatively non-conductive wood structural frame) we would split the thermal resistance of the insulation on the exterior of the structural frame with this insulation within the structural fame at least 50:50. So in an R-20 wall – at least R-10 or more on the outside of the non-conductive structural frame. And no vapor barrier on the inside of the assembly. Repeat after me, no vapor barrier on the inside of the assembly. We want the assembly to dry inwards from the control layers – and to dry outwards from the control layers. Always. Everywhere.

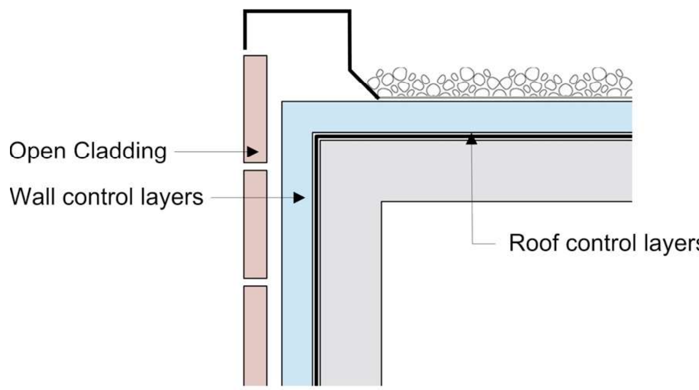

Figure 5: "The Roof-Wall Connection"

Notice that the control layer for rain on the roof is connected to the control layer for rain on the wall, the control layer for air on the roof is connected to the control layer for air on the wall…..and so it goes.

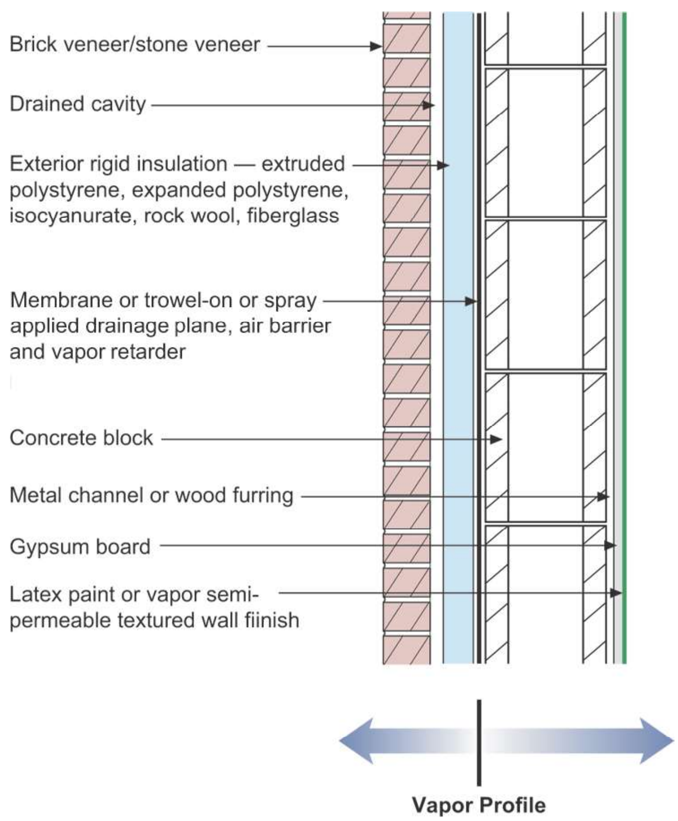

Figure 6: "The Institutional Wall"

The best wall that we know how to construct. Works everywhere in all climate zones.

** Home of Bobby Clark, hockey legend, no teeth

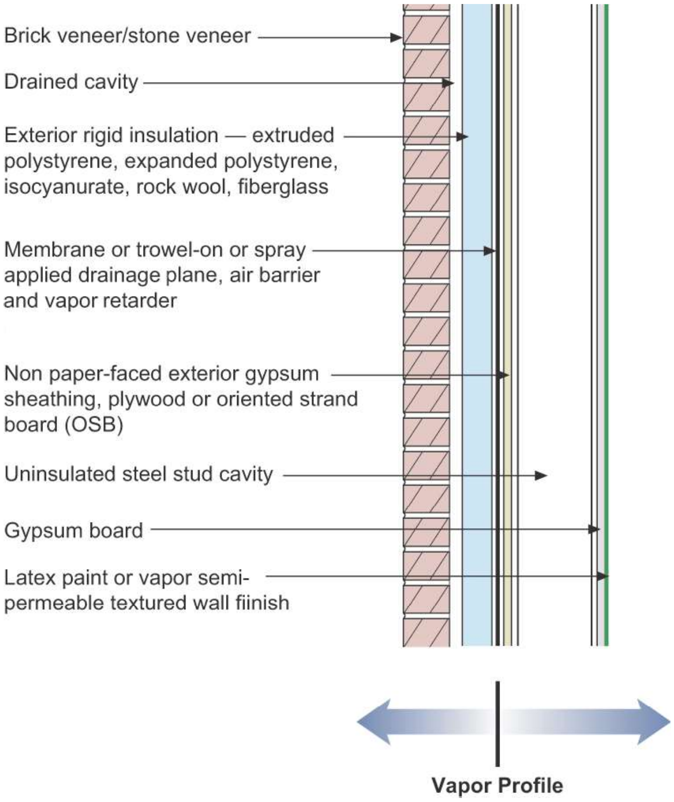

Figure 7: "The Commercial Wall"

The almost best wall we know how to construct. Affordable. Works everywhere in all climate zones.

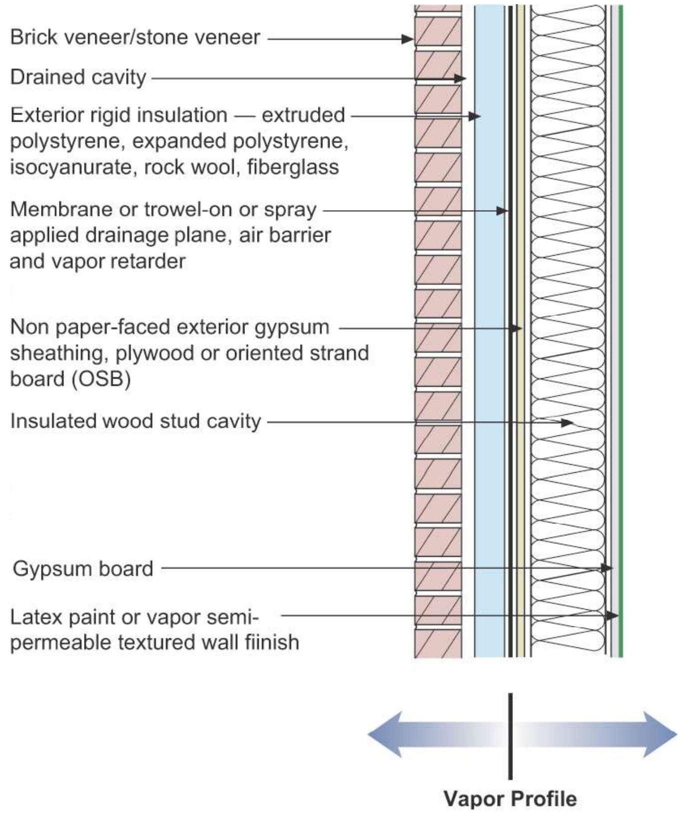

Figure 8: "The Residential Wall"

The best residential wall we know how to construct. Not cheep. Works almost everywhere – except in extreme cold climates where we would not insulate within the wood structural fame.

References

(1) Hutcheon, N. B., CBD-50 Principles Applied to an Masonry Wall, Canadian Building Digest, National Research Council Canada, Ottawa, Ontario, Canada, February 1964.

(2) Hutcheon, N.B. and Handegord, G.O.; Building Science for a Cold Climate, National Research Council of Canada, 1983.

(3) J.F. Straube and Burnett, E.F.P.; Building Science for Building Enclosures, Building Science Press, Westford, MA, 2005 (www.buildingsciencepress.com)

(4) Baker, M.; Roofs, Multi-Science Publications, Ltd., Montreal, 1980.