ASHRAE AUDIT REPORT

Athol Town Hall

Abstract
This report summarizes the findings from a walk-through and analysis completed by RISE.

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Picture 1: Aerial view of the Athol Town Hall

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The primary purpose of this report is to review the existing heating, cooling and ventilation systems within the Athol Town Hall located at 584 Main Street in Athol, MA. The review of the on-site conditions occurred on June 20th, 2023.

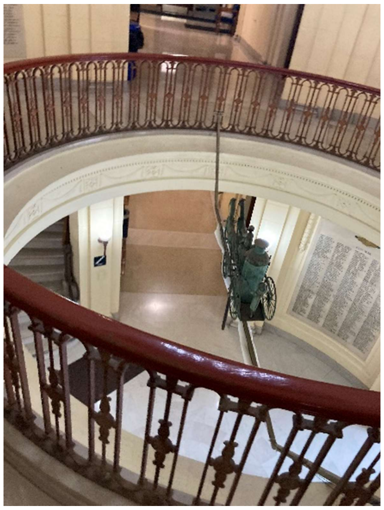
Building Summary

Building Use and Description

The facility is used as the Town Hall for the Town of Athol. The Town Hall was built in 1922 and comprises approximately 40,300 square feet. The builidng has ornate architectural features. The only apparent addition is the small elevator tower at the right side. The boiler room is a one story section with a flat roof at the rear ground level of the building. The building has three (3) levels with one partially below grade. The building serves as office space for the town departments and includes the Memorial Hall. The rear hall is a large meeting and event room with balcony and a high bay stage. Below the Memorial Hall is the Liberty Hall meeting room adjacent to a commercial kitchen which is not used.

Picture 2: Right side of building with walk out lower level.

Picture 3: Rear of building with taller stage section.



Picture 4: Center rotunda balcony.

Picture 5: Memorial Hall

The exterior walls are comprised of several layers of brick and interior plaster. The roof is a six inch built up membrane recently painted white over rigid board insulation. The roof membrane appears to be in good shape and reflects heat away from the building as a benefit to the air conditioning of the top floor. There is an attic crawl space which has an average of six inches of cellulose insulation and several turbine vents to allow roof generated heat and moisture to escape. There are steam supply pipes with what is likely to be asbestos pipe insulation that run through the attic areas. As a result, the sealing of attic chases and the addition of supplementary insulation is not practical until the asbestos is either encapsulated or properly removed. If the pipe insulation is removed, new fiberglass insulation needs to be installed unless the piping will be replaced with new piping in a different location.

There are several ventilation chases which originally exited the roof. These were recently encased with green metal covers. Plastic sheets were installed within the duct work to seal those off.

Most of the doors and windows have thermal pane glass and one skylight exists in the roof. The thermal pane windows have Low Emissivity coating to improve the overall performance. Several exterior doors were weather-stripped within the last few years. Many of the rear stage area section windows are the original wooden framed, double hung, single pane windows. Two of those in the kitchen have an interior storm panel. There are no current plans to replace those windows.

Picture 6: Typical metal framed thermal pane window at the Town Hall.

Picture 7: Typical wooden framed, single pane double hung window.

Picture 8: The slightly sloped white membrane roof over the elevated Memorial Hall section of the building is shown with the upper portion of the stage in the background.

Operations Schedule and Energy Usage

The building is maintained at occupied temperature setpoints on Monday through Thrusday from 6:00 AM – 8:00 PM. The building is generally maintained at 70°F during the heating season occupied hours and 68°F for during the remainder of time.

There is are two (2) 1,500 gallon #2 fuel oil storage tanks on site within the building. In the period from October 2018 through March 2019, a total of 12,024 gallons were delivered. The total cost during that time was $24,938 with an average cost of $2.07 per gallon. The most recent price per gallon for oil delivered to the Town Hall is $3.83.

The #2 oil account for the Town Hall incurred the following usages based upon information provided by the Town:

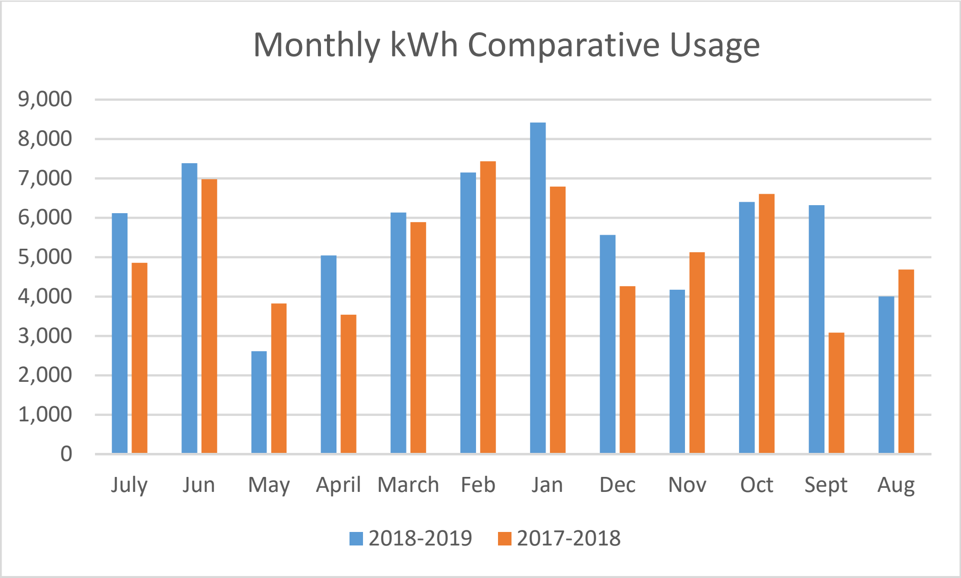
Period of Deliveries	Total Gallons	Total Price (average $/gallon)
November 2017 – March 2019	13,509	
October 2018 – March 2019	12,024	$24,938 ($2.07)

The fuel oil usage pattern is fairly typical for this type of building. The usage per square foot per year is in the normal range expected for a building that is not fully occupied and has limited mechanical ventilation.

The annual electricity usage was 69,283 kWh for the period of August 2018 through July 2019 and 63,283 kWh for the twelve months prior. The annual electric bill cost was only $12,432 for the more recent period and $11,893 for the prior period. National Grid provides the electricity under account number 76033-23018. This account serves both the Town Hall and the adjacent Library building which was built in 2014.

The Town has a method to break down the usage between the two buildings. According to a 2010 report by Trane, the Town Hall used 100,365 kwh per year in 2008-2009 and nearly 18,000 gallons of #2 oil. If the current break down in usage is accurate, the Town has greatly reduced it’s energy usage over the past fifteen years.

This report notes a recent marginal customer cost of 16 cents per kWh and $12.47 per billed kW demand. The use of electricity is in the low range - only 2 kWh/sq.ft./year. This is in part to due to the rear portion of the building seeing intermittent usage and the lack of a comprehensive mechanical ventilation system throughout. The average demand is 81 kW with the range running from 55 to 114 kW.



HVAC Equipment

The building has a cast iron, oil-fired steam boiler. The Weil-McLain model 1288 series boiler has a Power Flame model WCR3-0 oil-fired burner with a two-pipe oil circulation configuration. The boiler is designed to fire at 26 gallons of oil per hour but the burner has a capacity of up to 33.7 GPH. The burner uses a two horsepower electric motor to pump and atomize the oil/air mixture. The steam boiler has an IBR **net** output rating of 2,329,000 Btu/hour. Using the same boiler for forced water hydronic applications, it is rated at a new output of 2,609,000 Btu/hour. This is indicative of the fact that boilers operate more efficiently with hydronic applications. Steam is now considered an outmoded method to heat a building. The condensate return system has two (2) ½ and two (2) 1 ½ horsepower pump motors.

The majority of the supply piping within the boiler room is insulated except those short pipes nearest the boiler. The insulation of that piping is recommended to maximize the creation of dry steam in the system. There are also some condensate returns in the adjacent room which need pipe insulation. The boiler was designed with the intention to have a positive pressure fire with a slide damper at the breeching. The barometric damper controls the vertical chimney draft rate. The condensate and feed tanks could be insulated if the steam system is to be retained.

The boiler has had one cast iron section replaced a couple of years ago. The life of a steam boiler can be compromised by low water levels and/or sediment. Failure can occur sporadically and quickly changing out the boiler in the middle of a winter would be difficult. Therefore, it is recommended that the Town create a plan for the use of an emergency mobile steam boiler. This would include supply and return adapters to enable connection of an outside steam boiler and to the existing fuel supply system. That would give the Town a piece of mind and time to come up with a plan to move away from steam in favor of a different and more efficient method of heating. Keep in mind that replacement of the boiler with another steam boiler will not provide any noticeable energy savings. Steam has a limited efficiency and oil as a fuel has limited environmental advances.

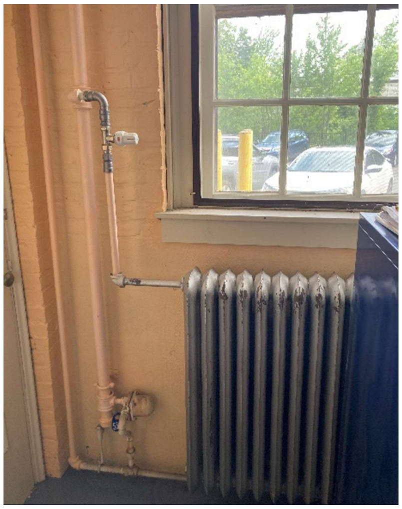
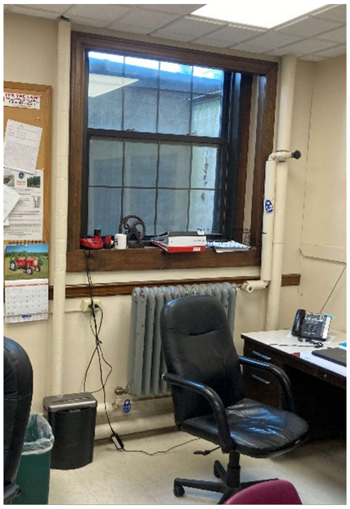
Pictures 9 and 10: The oil-fired steam boiler and the condensate return tank and pumps.

The original coal-fired boiler sits to the right of the operating boiler. It is still connected to the chimney and therefore results in an energy loss to the boiler room. It appears to have encapsulated asbestos insulation on its shell and flue pipe. It was noted that that each boiler's exhaust vents into a very tall (~50 feet) chimney at the rear of the stage section of the building. The chimney height should provide exceptional natural draft. Half of the chimney exterior surface area is exposed to the outside air which could cause condensation within the chimney flue.

There are steam traps on the return piping but no maintenance on the traps has been done during the last two years. The last time the traps were tested was in 2018. The blue tags at each radiator are indicative that steam traps having been surveyed at some point for effectiveness. It is said that no visible steam plume is seen coming out the condensate vent pipe to the outside over the past two years. Surveys for typical steam boiler systems generally indicate that 33% of steam traps leak steam after two to three years of use. Therefore, if the steam system is expected to be retained for another five years, it is recommended that the traps be surveyed again and defective traps replaced.

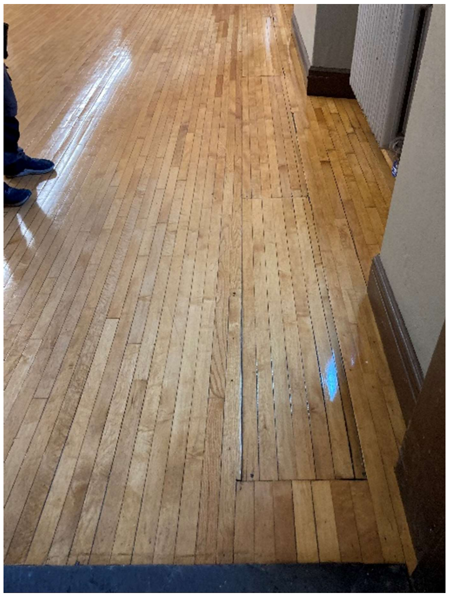
It was noted that the Honeywell Pressuretrol control was set to 4 psig. The differential was set to B which indicates about a 1.8 psig off the 4 psig. Turning the maximum down to 3 psig may work and result in less wear and tear on the distribution system and lower operating costs.

The cast iron steam radiators in the most rooms were found to be set up for two-pipe distribution. That entails the use of a high or low steam supply pipe, and a low connection for condensate return. The top of the steam radiator and bottom are fully manifolded so steam (or water in the case of a hydronic system) adequately heats the entire cast iron surface area.


Picture 11: Kitchen radiator and piping. Pictures 12 & 13: Radiator with insulated piping and recessed radiator.

The steam radiators shown in Pictures 11 - 13 could be used for either steam or forced water hydronic heating system configurations. However, with a forced water system, the supply pipe would normally be a little smaller than steam but the return pipe would be larger than the current condensate return pipe size. Reusing the condensate returns with a hydronic system would not be recommended. The radiators at this building typically have a non-electric thermostatic radiator valve or TRV. These devices typically used a temperature sensitive wax in an element to move the valve open or closed based upon the sensed room temperature and the setting on the dial.

Picture 14: Steel covers over the trench piping. Picture 15: Removable floor sections over trench.

The condensate return water flows through piping within trenches in the perimeter of the floor. Thick steel removal plates provide access to the piping. It flows into the tank in a room adjacent to the boiler room.

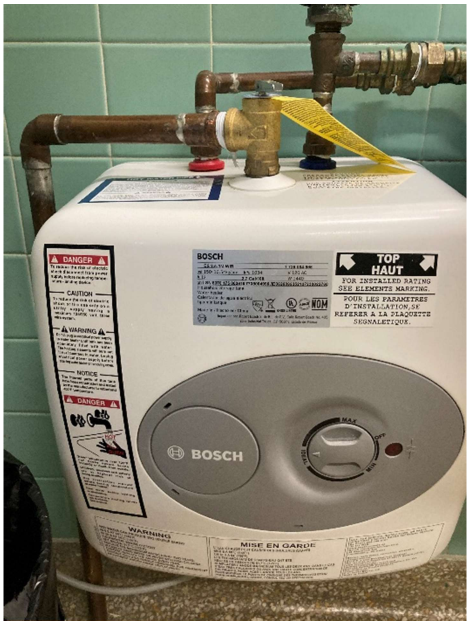
There are many offices which utilize through-the-wall or window mounted unitary air conditioning systems for cooling. The large window units are installed and removed each year. Some are large enough to require two people to accomplish that task. There is at least one portable air conditioner that is direct ducted to an opening at a double hung window. There is no air conditioning in the corridors for this building, but the upper floor corridors would be good applications for ceiling fans. It has been said that the southeast side of the building gets hot in the summer. There is basement room with a server rack.

There is a limited Johnson Controls Metasys Building Management System (BMS) which utilizes six (6) temperature sensor points for use during the heating season. Those points are averaged to determine when to bring the boiler burner on to create steam. Locations of the sensors include the Planning Director's Office, a meeting room, the Memorial Hall, the Town Manager's Office, the Town Clerk's Office, and the Liberty Hall basement room. There is an old air compressor that was once used for the building's earlier pneumatic controls. The clock tower is not heated.

There is a State Select model ES680DORT electric resistance freestanding domestic hot water tank in the commercial kitchen. The kitchen and eighty gallon tank with two (2) 4,500 watt electric heating elements are not used. Kitchen equipment includes a range, stove, exhaust hood with a Tjernlund duct booster fan, model EF-8, and residential and commercial refrigeration equipment. The only appliance used is a residential sized refrigerator/freezer unit.

There are several point of use electric domestic hot water heaters located throughout the building. This includes a Bosch model ES 2.5-1M WIR with a 2.7 gallon tank and a single 1,440 watt heating element located in the Unisex Handicapped restroom. It was noted that the copper hot piping out of the tank is not insulated. Insulation of the piping is recommended.

A State ProLine Commercial Grade model ES6-10-SOMs 200 water heater has one 1,650 watt element within the ten gallon tank located in a Janitor's room. It was noted that the copper hot piping out of the tank is not fully insulated. Insulation of the remainder of the piping is recommended.



Picture 16: Small water heater in a restroom.

Picture 17: Electric water heater in Janitor's Room.

The installation of a single heat pump water heater system would be more efficient and operate at a lower cost than the current individual systems. However, a central water heater would incur distribution losses from piping throughout the building.

Picture 18: Disconnected original heating and ventilation unit for the Memorial Hall.

Picture 19: A wall mounted temperature sensor.

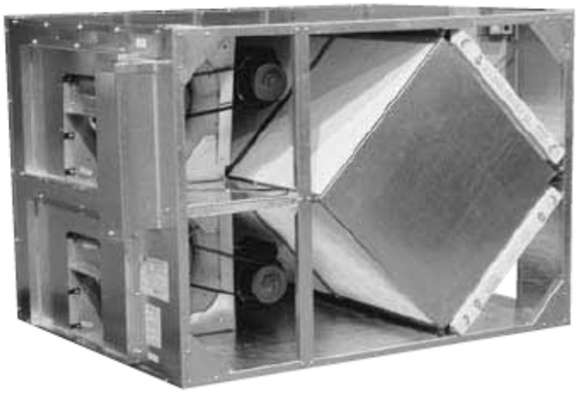
The basement Men's Room has an occupancy sensor for the control of the exhaust fan. The Town Clerk's, Town Manager's and Tax Collector's offices each have ceiling fans. Those first floor ceilings are thirteen feet high; the second floor ceilings have a height of ten feet.

Ventilation Systems

Ventilation is required by code in this building. Given the need for constant air turnover in this type of facility, it is recommended that the new ventilation be designed and installed for continuous air flow during occupied hours. Effective ventilation during the primary months of heating or cooling are best provided by mechanical equipment. Mechanical ventilation, as defined by the MA building code, takes the form of fresh Outdoor Air (OA) brought in and conditioned (heated or cooled) and exhaust air (EA) ventilation being sent out. For each OA and EA airstream, the code refers to specific rates of cubic feet of air per minute (cfm) for each particular use classification within the building.

Ventilation effectiveness considers the position of the supply and return grilles and the mixing of the ventilation air with the heating and cooling air. When short circuiting occurs, ventilation effectiveness decreases and therefore more airflow is required to ensure that the necessary amount of ventilation gets to the intended room. Ultimately, a room-by-room ventilation calculation is required to finalize the fresh air ventilation rate that is necessary. Such ventilation will only be effective if the total of the exhaust air rate is just a little higher than the intake air flow rate during occupied hours.

Incorporating an Energy Recovery Ventilation (ERV) exchanger to recoup approximately 70% of the heat from the exhaust to preheat the fresh incoming airflow brings the building up near to state-of-the-art for the current system. Since a standalone ERV recovers heating and cooling energy, they also reduce the size of the new HVAC equipment necessary to meet building loads. The ventilation airflow rate is not reduced, just the energy used to heat or cool it before it reaches the space. Additional information regarding the RenewAire ERVs is shown in the Appendix at the end of this report.



Picture 20: An example of RenewAire Energy Recovery Ventilator

As might be expected, the implementation of ERVs will have a positive impact on operating costs for years to come. There are two (2) types of ERV exchangers: the wheel and fixed plate types. For this application the fixed plate type would provide reliable and efficient operation. It should be noted that opening windows is not a recommended method of increasing ventilation except on temporary basis in specific cases. Opening windows usually leads to short cycling the air, and not allowing the air to travel properly across the room and eventually decreases ventilation effectiveness and efficiency.

Heat Pump based HVAC System

Installing a more permanent and efficient air conditioning system for the Athol Town Hall is part of the comprehensive system needed for the building. R-410A refrigerant is in the process of being phased out since it has a negative impact on the environment. No new HVAC systems will likely be available to be installed in the near future using R-410A. Existing systems with the refrigerant can continue to use R-410A as long as it is available. The new A2L class of refrigerants to replace R-410A includes R-32 and R-454-B. These refrigerants have higher efficiency and a lower Global Warming Potential than R-410A. **The main ingredient in R32 is propane gas and the A2L class gases are generally mildly flammable.** This presents a new set of safety considerations for HVAC professionals when using the products and for the end user to consider when deciding on a type of HVAC system. Some systems have literally dozens of pipes containing the refrigerant running through the building. However, there are heat pump systems available which are configured to have no refrigerant within the building.

It is recommended that a comprehensive and efficient mode of HVAC be installed with full heat pump electrification to reduce global warming potential of the new system. The installation of a new **Air to Water Heat Pump (AWHP)** system incorporating the new ERV units and new hydronic fan coil wall units where possible addresses the global warming reduction goal. It also eliminates refrigerant from within the building and uses a comparatively small amount of refrigerant in the AWHP outside unit.

A major advantage of AWHP system or other heat pump systems is the increased flexibility of using hydronic coupled inside units without concern for a proprietary link to the unit. Unlike other split heat pump systems, AWHPs are not proprietarily interconnected to the inside units. Therefore, individual components can be replaced without having to replace the entire system. If one fan coil fails, one can replace it with their choice of about a dozen brands (Trane, Carrier, York/JCI, Airtherm, First Company, Chiltrix, Artic, Spacepak, Daiken/McQuay, Magic Aire, Apollo, HydroSolar, Aermec, etc.). One could replace the inside unit with a valance convector, chilled beam, ductless fan coil or ducted air handler. If the outside unit fails, there are now an equal number of brand and model choices for replacement that have nothing to do with the brand of the inside unit.

A valance hydronic convector is unique in that it provides heating and cooling without the use of any mechanical fan. It works on the principle of convective air flow within the room. Multiple row coils are used for a large surface area. The convectors are hidden by a valence and the devices typically run along the upper wall for the entire length of the room. Without the use of a fan, the system has very low parasitic distribution cost of operation and less moving parts to break.

Most of the ductless split and VRF system hardware components are proprietary. A VRF system was installed at the Town Library located next door to the Town Hall. With a proprietary system only one brand choice for repair or replacement of individual matched components is available. Often times, by the time such a system is fifteen years old, if one component needs replacement, all components may have to be changed in order to maintain system compatibility.

For example, a VRF system which is configured with multiple inside units served by one outside unit could have one inside blower unit fail after fifteen years. The Town could be faced with $10,000 to $150,000 of replacement costs due to the failure of just one part if the manufacturer did not offer compatible parts replacement for a unit model that has been superseded. There are other long-term alternatives to move forward using heat pump technology to meet carbon reduction goals. Proprietary components can also make the system more complex.

While non-VRF ductless split systems refrigerant piping operate at a pressure of 100 to 300 psig, VRF systems operate at up to 550 psig. That high pressure puts the onus on the connection method to perform well for a very long time. The recommended traditional method is brazing. On the other hand, an AWHP system can use various connection types since the operating pressure would be less than 60 psig for this application. The below chart makes comparisons between several types of heat pump systems.

RISE Engineering 2023
Heat Pump System Type Comparative Chart

Item	AWHP Unitary	AWHP Split	Ductless Split AAHP	VRF HP
Refrigerant in the building to be mitigated per ASHRAE Standard 15	N	Y limited	Y	Y
Refrigerant quantity and impact on environment	Relatively Low	Low to Med.	Medium	High
Field installed piping pressure/applicability for mechanical fittings	Typ.<100 psi*/Y	Typ.<100 psi*/Y	100-300 psi/ **N**	100-550 psi/ **N**
Ability to replace individual components with diferent brand	Y	Y	N	N
Proprietary refrigerant interfaces with terminal units	N	N	Y	Y
Proprietary controls	N	N, Some Limits	Y	Y
Ability to mix and match terminal units with different brands	Y full	Y full	Must be compatible brand/model	With compatible brand/model
Maximum distance between ODU & term. unit	No limit	No limit	100-150 feet	~200'
Piping configuration	Any type	Any type	Parallel	Branch
Ability to resist decreased heat output during defrost cycle	Y thru TES &MM	Y thru TES &MM	N	Some
Ability to provide h/c during peak power increased rate & DR	Y thru TES	Y thru TES	Requires batteries	Requires batteries
How much flexibility to provide precise latent cooling load portion?	Y	Y	Limited	Limited
Is glycol required to be used in the system?	Y	N	N	N
Can one ODU heat and cool at the same time?	Y w/HR or 4 pipe	Y w/HR or 4 pipe	Y w/HR	Y w/HR
First cost range	Med. To High	Med. To High	Medium	High
Repair cost range	Low to Med.	Low to Med.	Medium	High
Compatibility with DOAS ventilation systems	Y	Y	Possible	Possible
Limitations on using larger systems	None	None	Some	Some
Variable speed compressor	Y most	Y most	Some	Y
Smallest A/C outside unit ton capacity	2.4	3.5	0.75	3
Smallest heating ODU Btu/hr. capacity	22,237	47,200	0.75	
Largest A/C outside unit ton capacity	230	8		42
Largest heating ODU Btu/hr. total capacity	2,500,000	107,500		
Range of Quantity of inside units on one ODU	1 to ∞	1 to ∞	1 to 3	48
Inside unit compatibility - wall hung hi or low	Y	Y	Y	Y
Inside unit compatibility - console floor mount	Y	Y	Y	Y
Inside unit compatibility - horiz. ceiling mount	Y	Y		
Inside unit compatibility - ceiling cassette	Concentric ICB	Concentric ICB	Y	Y
Inside unit compatibility - ducted air handler	Y	Y	Y	Y
Inside unit compatibility - hydronic fan coil	Y	Y		N
Inside unit compatibility - fin-tube heat	Y	Y		N
Inside unit compatibility - radiant hydronics ht.	Y	Y		Possible with HK
Inside unit compatibility - valance convector	Y	Y		N
Inside unit compatibility - chilled beam	Y	Y		Possible with HK
Color key:	Pertains to cooling		Pertains to heating	Pertains to both

Key: AHU=Air Handler Unit; AWHP = Air-to-water- heat pump; AAHP= Air-to-air heat pump; DR=Demand Response; Geo=Geothermal well or horizontal ground system; HK - Hydro Kit, HP = Heat Pump, HR = Heat Recovery (refrigerant to water); HYD=Hydronic distribution system; ICB=Induction Chilled Beam, MM=Multiple modules piped in parallel, TES=Thermal Energy Storage; VRF = Variable Refrigerant Flow. *Psi shown for hydronic piping for this option.

RSH 5/23/23

Other advantages of AWHPs include improved heat pump outdoor unit (ODU) defrost management, system redundancy, and the ability to use hydronic fluid as a thermal battery with lower overall environmental impact and longer durability than air to air heat pump methods of electrical energy storage.

The piping arrangement of the AWHP system is different from other types of heat pumps. Typically, AWHP outside units are piped together with hydronic supply and return header. That main piping then serves all inside units. Therefore, if one outside unit fails, during the vast majority of weather conditions, all of the inside units will continue to operate seamlessly.

Through the use of well-insulated buffer tanks and modular piping configurations, the AWHP system can minimize the impact of the heat pump defrost cycle on the comfort of the building occupants. In the colder weather, the VRF or ductless split system must shut down all inside units when it goes into defrost mode for a number of minutes. The ODU essentially runs in the cooling mode and no heat is delivered to the connected inside units. There is no means for thermal storage to continue the deliverance of heat during the VRF defrost mode.

Disadvantages of an AWHP system include a higher overall installed cost and the eventual maintenance of changing glycol fluid for unitary AWHP systems. The full new HVAC system could cost in the range of $600,000 to $900,000 to install considering it addresses ventilation needs of the building. As part of the HVAC system design process, the building's electrical system infrastructure needs an engineering review to see if it will be able to handle the replacement.

Ductless split heat pump systems

There are a few areas of the building in which ductless split heat pump systems could be installed to supplement the existing system. However, ductless split systems are not recommended as a building wide solution for several reasons explained below.

A network of efficient, wall mounted ductless split heating and air conditioning blower units could be connected to outside heat pump condensing units. This system heats and cools the building without the inherent penalty of moving a large volume of hot moist air though a duct system for which there would need to be a sizable distribution fan to overcome duct friction loss. In fact, ductless split blower motors typically only use 50 to 60 watts or less of power making them many times more cost effective in distributing the cooling than a central ducted system using a larger motor.

The typical ductless split wall or console mounted units are **not designed for conditioning ventilation air which is necessary throughout this building.** Therefore, a separate air handler or RTU system would still be required. A second issue is the expected shorter effective lifespan of those units as compared to other options. Down the road, there is the potential for incompatibility of replacement inside units with older outside condensing units. For example, if one was to install a system wherein four (4) inside units were connected to one (1) outside condensing unit, the failure of one (1) of the five (5) components may require the replacement of entire five-piece system. That is, in part, because the ductless split inside units are powered and controlled with the outside units in a proprietary manner. Therefore, ductless split systems were eliminated from consideration for this application.

High-efficiency condensing propane-fired boilers and a new heating distribution system.

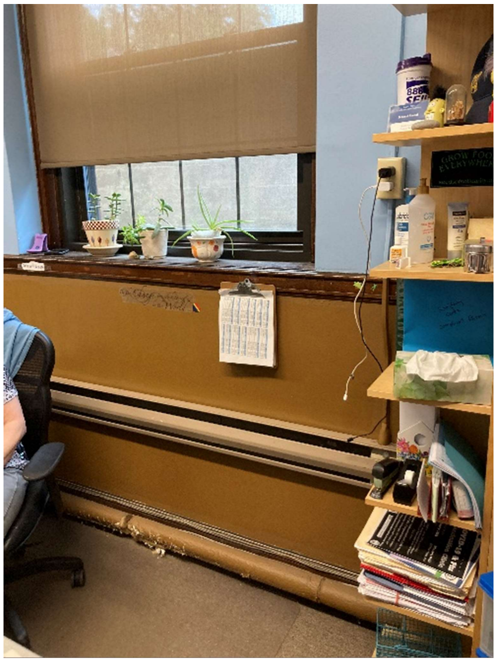
While the combustion efficiency of the existing steam boiler is likely to be around 80%, the seasonal efficiency is estimated to be in the range of 68% to 70%. The other drawbacks include the steam distribution system and the lack of an ability to extract the latent heat of combustion.

Modern hydronic, stainless steel, condensing boilers would normally be installed and controlled to only have water flow through the boiler when it is operating. Such 94% to 98% efficient boilers would typically be sealed combustion units having a direct combustion air duct to the boiler. Condensing boilers have modulating burners to provide the right amount of heat to serve the building's load given the weather conditions. This option is not available with a steam boiler system.

The stainless steel heat exchangers are designed to extract the latent heat from combustion when the return water temperature is at 130°F or less. The new installation would also allow for the decoupling of the boiler(s) from the existing distribution system through primary-secondary piping and pumping. The disadvantage of such a system is that it is not an electrification heat pump which can heat and cool using the same distribution system.

One of the considerations for electrification of the building HVAC system is the existing electrical service capacity and type. The main disconnect switch is a Federal Pacific three pole device rated at 230 volts and 50 horsepower. The Amperage figure is not discernable from the tag. Usually, if any changes occur to the connected power to Federal Pacific components, the local electrical inspector requires replacement of the brand with new. During an earlier visit to the Town Hall, it was indicated by the Building Inspector, Robert Legare, that there have been electrical issues within the building.

There are several wiring circuits for electric heat including the three phase #25/27/29, #46/48 and #51/53 in the Bull Dog PP1 panel. Electric baseboard heat is used to supplement the steam heat or in lieu of it in several rooms, especially in the basement. Those include the Elevator Machine Room, the Facilities Manager's office, Room 2 Board of Health and several other offices. There are also three (3) electric wall heaters adjacent to the elevator on each floor.



Picture 21: Electric baseboard heat

ECM #1 AWHP Details:

Estimated cost: $900,000 (To be fine-tuned after design engineering.)
Estimated incentive: $250,000
Estimated annual savings: $48,833,oil -$17,281 electric = $31,551.
Estimated Simple Payback before incentive: 28 (Years)
Estimated Payback with estimated incentive: 20 (Years)
Please note payback period will be higher with a higher electric rate and/or a lower price per gallon of fuel oil.

Assumptions:
Electric rate: $0.16/kWh
#2 Fuel Oil rate: $3.83/Gallon
Estimated gallons energy reduction: 12,750
Estimated net kWh energy impact: (108,008) There will be an net increase in electric usage with the heat pump system.

Based on the site, most heat pump systems will not provide enough electricity and #2 fuel oil savings to pay back within their average lifespan at this time. Solar PV and battery storage, which would complement a heat pump system, would be an additional cost. Part of the reason for this is that the building does not have full occupancy, the kitchen is not used and the halls see intermittent use. Another part is that you can only save what is used. Since this building is not currently ventilated per the building code, it does not reap the savings from using more efficient ERV systems. See the Appendix for information on Aermec and LG AWHP units.

Air-to-air ducted heat pump systems each have a 20 year estimated life, while VRF and ductless split units are estimated to have a 15 year life span. Generally, AWHPs, ERVs and air handlers may have up to 25 year estimated life expectancies.

Here are some additional factors to consider:

1. The long range plans for the building and available funds to invest in this building.
2. The degree of redundancy required for the HVAC systems and whether it is time for a new back up generator to prevent the building from a freeze up.
3. The degree to which the existing equipment is ready for replacement. The boiler system is already past its expected lifespan.
4. Maintenance varies between each system. Most systems require regular air filter changes or minimally cleaning of the outside air filter screen.
5. The economizer cycle is required by the building code to be utilized in conditions during the spring and fall when the building does not need heating or mechanical cooling. There is currently no automatic means to bring in fresh air and exhaust stale air to cool the building during those conditions. This could be accomplished by installing an ERV system with a by-pass control option as integral to new heat pump RTUs.

Recommendations

HVAC System Recommendations

If the goal is building electrification, it is recommended that the customer consider implementing an AWHP system as described in ECM#1, depending on the availability of funds, space and capability to include a solar PV and battery system. **Clearly, the long energy savings payback period for any option results in an extended investment term. For this building, the investment in a new system should be viewed as a capital improvement, betterment of human comfort, a potential for a reduced carbon footprint and improved indoor air quality rather than a source of energy savings resulting in a quick monetary return on investment.**

Domestic Hot Water System Recommendations

While considering the HVAC electrification measures, the installation of a high efficiency, air-to-water domestic hot water heat pump could be considered. Consideration of the use of a multi-stage commercially sized heat pump water heater utilizing stainless steel storage tank(s) has a long payback period at the current rate of energy. The use of a stainless steel tank should improve upon the measure lifespan. There is also the negative impact of piping distribution losses as compared to the current decentralized system systems.

Lighting Systems

Most of the fixtures were converted or replaced with LED lighting within the last few years. The offices and restrooms have lighting occupancy sensor controls. The exterior lights are controlled to turn off during the day by individual photocells. The remaining fixtures which typically are not used often, are being replaced by screw-in LED bulbs when the old bulb burns out. To the extent that more LED fixtures are installed, the cooling load of the building would slightly decrease. This should be considered in the sizing of new HVAC systems.

The following two rooms would have modest energy savings from installing occupancy sensors to control the lighting: Room #4, Building Department and Room #21, Board of Selectman Meeting Room.

Other systems

There is an ThyssenKnupp model TAC20 elevator operating device. There is a Winco standby generator fueled by propane located within the building but it was deemed unsafe to operate.

Summary of Findings

Measure Description	Annual Energy and Cost Savings				Payback Period		
	Peak Demand Savings (kW)	Electricity Savings (kWh)	Fuel Oil Savings (therms)	Net Total Cost Savings	Gross Measure Cost	Measure Life (years)	Simple Payback (yr)
ECM#1 – AWHP System with an ERV System	-	(108,008) -	12,750	$31,551	$900,000	25	28
TOTALS (Recommended Measure)	-	(108.008) -	12,750	$31,551	$900,000	25	28

Given the network of complex HVAC systems involved, recommendations for one portion of the system may interact with other portions of the system if all defects are not addressed concurrently.

RISE stands ready and able oversee the necessary changes and to revisit the site after improvements have been made to conduct some additional functional tests as a separate phase two of this project to ensure the issues have been adequately addressed.

RISE

Founded in 1977, RISE is nationally recognized for their innovative delivery of conservation services over the past 45 years and have arranged the installation for over $1.4 billion in energy improvements. The RISE Group is a 100% employee-owned multi-disciplinary engineering and technical services firm. They offer professional process, electrical, HVAC, and metallurgical engineering services, as well as comprehensive environmental, microbiological, and non-destructive laboratory testing services. RISE became a part of the organization in 1995, after having operated for eighteen (18) years as an independent, non-profit energy services firm. The RISE project team is also complemented by the resources of Creative Environment. This full-service MEP/FP design firm offers important design support when plans and specifications may be required to complete projects.

RISE staff work directly with energy end-users in all building sectors on behalf of utilities, government agencies, and other program sponsors to deliver efficiency services for their customers in a professional, responsive, and cost-effective manner. They offer energy users comprehensive efficiency services that reduce their environmental footprint and operating expenses.

Disclaimer

Recommendations made in this report are based on engineering estimates and an on-site review of HVAC equipment. It is recommended that you contact the engineer who prepared your report to answer any of your questions.

This report and analysis are based upon cursory observations of the visible and apparent conditions and is not intended to serve as a comprehensive evaluation of all aspects of the distribution system and equipment. Although care has been taken in the performance of these observations, RISE (and/or its representatives) make no representations regarding latent, unobserved, or concealed defects which may exist and no warranty or guarantee is expressed or implied. This report is made only in the best exercise of our ability and judgment.

RISE assumes no responsibility for the safety of the facilities' mechanical or electrical distribution systems and equipment and their compliance with all applicable federal, state and local requirements and shall not be liable under any legal or equitable theory for any claims for direct, indirect, consequential or other damages of any nature, including, but not limited to damages for personal injury, property damage, or lost profits connected with the performance of these services.

Conclusions within this report are based on estimates of the age and normal working life of various items of equipment. Predictions of life expectancy and the balance of life remaining are necessarily based on opinion. It is essential to understand that actual conditions can alter the remaining life of any item. The previous use/misuse, irregularity of servicing, faulty manufacture, unfavorable conditions, acts of God, and unforeseen circumstances make it impossible to state precisely when each item would require replacement. The client herein should be aware that certain components may function consistent with their purpose at the time of our observations, but due to their nature are subject to deterioration without notice.

Estimates of Construction Costs, if any, prepared by the Engineer represent the Engineer's best judgment as a design professional familiar with the construction industry. However, it is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment; over the Contractor's methods of determining bid prices; or over competitive bidding, market or negotiating conditions. Accordingly, the Engineer cannot and does not warrant or represent that bids or negotiated prices will not vary from the estimate.

Appendix

Why RenewAire?

The Static-Plate Core is the Key!

Since the early 1980's, RenewAire has pioneered the use of the patented Lossnay* exchange core throughout the Americas. Listed below are some of the many reasons why this technology has become the ERV system preferred by leading HVAC professionals around the world.

Positive Airsteam Separation

In the RenewAire core, fresh air never comes in contact with exhaust air passages. Hydroscopic resin plates separate the two airsteams so effectively that ARI certifies zero exhaust air transfer at normal, balanced operating conditions. As a result, RenewAire is perfect for controlled exhaust applications such as toilet areas, as well as for food service and health care occupancies.

No Condensate or Active Defrost

Direct water vapor transfer, driven by vapor pressure, eliminates condensation - and frosting - in virtually all applications and climate zones. No condensation allows for closer plate spacing, resulting in higher efficiencies and easier installations. It also means no need for the dampers or electrical defrost elements that reduce ventilation and rob energy efficiency in competing technologies.

Maintenance - Nothing Could Be Easier

The scheduled maintenance for RenewAire is so simple, it can be performed by any janitorial staff. No expensive service contracts are necessary because there is no wheel disassembly and washing, no seal or belt adjustments and no complex controls to calibrate. The result is the lowest maintenance cost of any ERV.

The Unbeatable RenewAire Warranty

An investment in RenewAire is protected by a 10-year core warranty (2 years on balance of the unit). This commitment - twice as long as coverage on the best wheel products – speaks volumes about RenewAire's reliability, durability and consistent high performance.

Award-Winning Service and Support

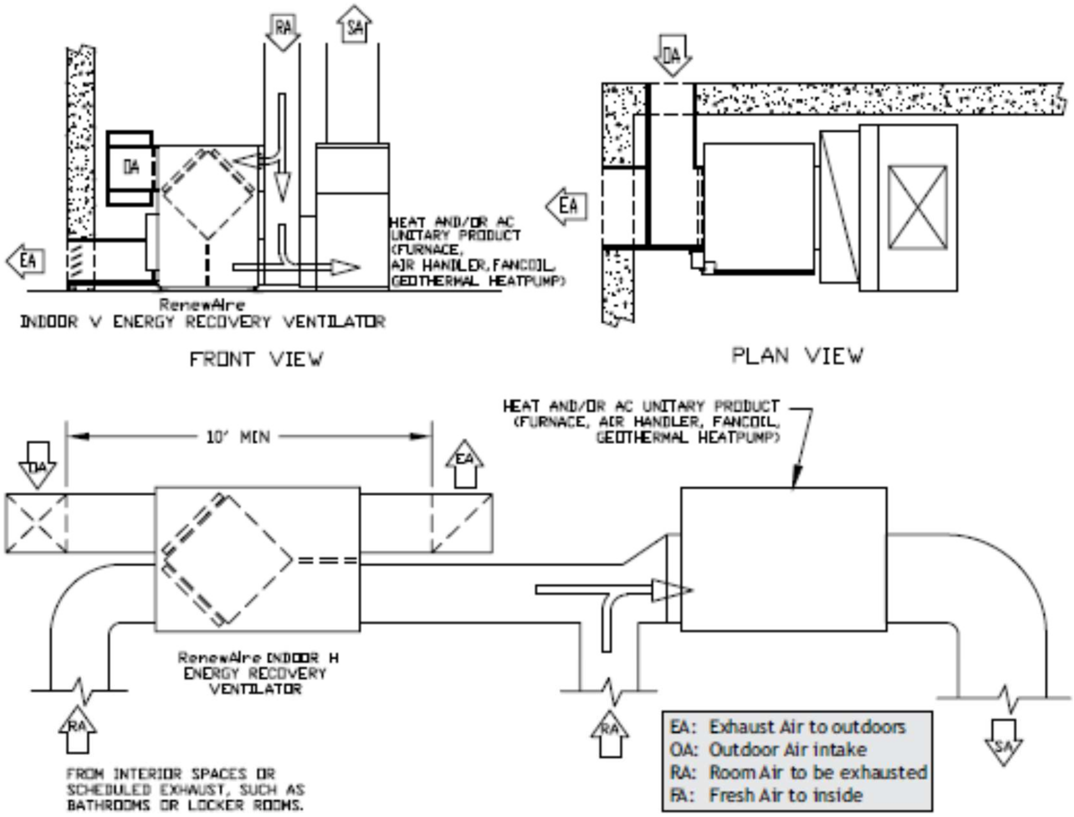
RenewAire's team of professionals knows ERV. And our nationwide network of Sales Reps and quality Distributors are ready to serve you locally. When you call our support number, you'll talk to a knowledgeable factory expert - someone who knows not only our product line, but the best ways to integrate RenewAire with your preferred lines of heating and air conditioning equipment.

RenewAire VENTILATION
Think Greener. Breathe Better.

COMMERCIAL INDOOR PRODUCTS

- Horizontal and vertical configuration.
- Wide range of airflow and static capacities.
- ARI certified performance data for efficiency and cross leakage.
- UL tested flammability and smoke generation that meets NFPA 90A and 90B test standards for commercial applications.
- Easy installation and service.
- Ten year core warranty.

RenewAire means *Trouble-Free* ERV.



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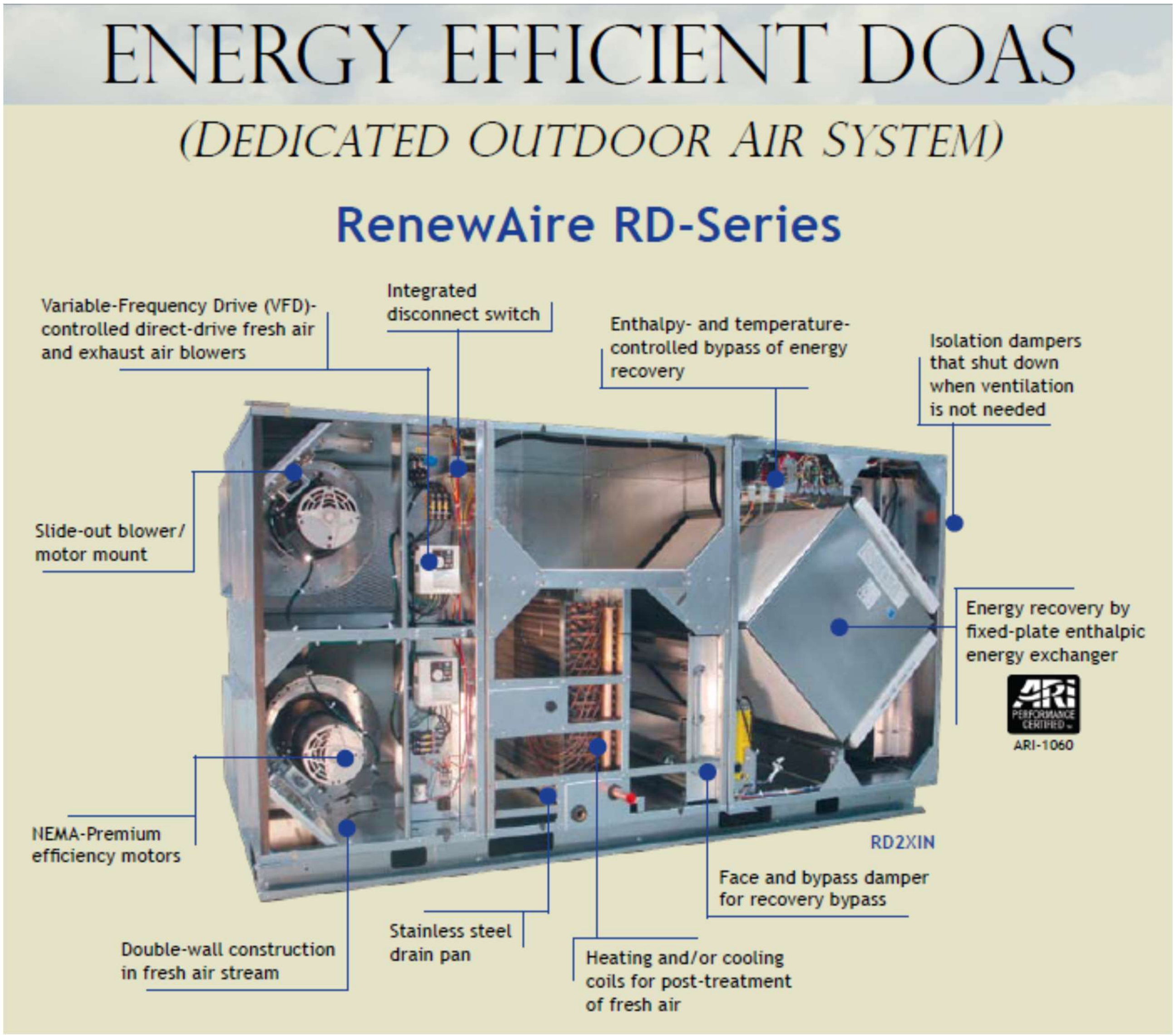


ENERGY EFFICIENT DOAS
(DEDICATED OUTDOOR AIR SYSTEM)
RenewAire RD-Series
Variable-Frequency Drive (VFD)-controlled direct-drive fresh air and exhaust air blowers
Integrated disconnect switch
Enthalpy- and temperature-controlled bypass of energy recovery
Isolation dampers that shut down when ventilation is not needed
Slide-out blower/ motor mount
Energy recovery by fixed-plate enthalpic energy exchanger
ARI-1060
NEMA-Premium efficiency motors
RD2XIN
Face and bypass damper for recovery bypass
Stainless steel drain pan
Double-wall construction in fresh air stream
Heating and/or cooling coils for post-treatment of fresh air

ECM Fan Technology

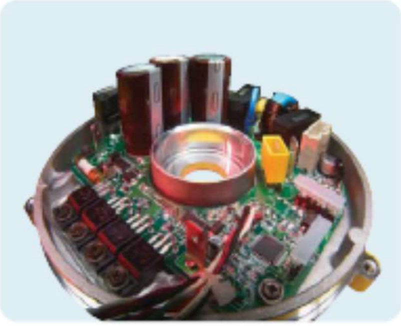
Airtherm introduces a new level of energy efficiency to our Unitaire fan coil units.

Go Green

Already the industry leader in energy efficient fan coil products, Airtherm has taken a leap forward with new ***energy saving*** motor technology that can offer our customers the highest level of energy efficiency which may also qualify for LEED points and utility rebates. In addition to the energy saving benefits, this technology offers building owners ultra quiet operation, enhanced system control and retrofit capabilities with existing Airtherm fan coil installations.

Upgrade and Save

Electronically Commutated Motors (ECM) are highly efficient at full and part load with efficiencies up to 85% compared to 40% with traditionally 3-speed PSC motors. Fan coils are often overlooked by energy conservation professionals because of their fractional horsepower and low power consumption, however Airtherm's solution will allow cost effective energy savings which will satisfy green building initiatives.



Retrofit and Save

Airtherm has engineered their ECM offering so that it is backward compatible with their Unitaire products installed over the years. Simply replacing the existing fan deck with a new ECM fan deck in the existing piped cabinet is easy and quick.

Airtherm Unitaire fan coils can enjoy the energy savings without re-piping or replacing whole units. This allows them to reap the benefits of improved energy efficiency without the mess of remodeling an entire building.

Benefits of Airtherm Fan Coil Units

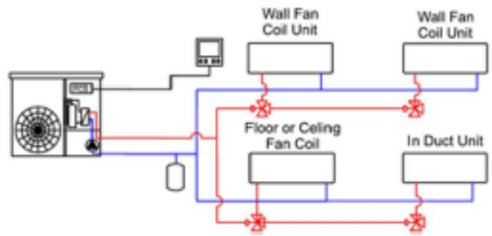
- A special bonding process provides the sturdy cabinets with an attractive powder coat finish.
- Our exclusive Condensate Removal System (CRS) eliminates standing water, improving IAQ by reducing odors and decreasing humidity.
- Two 9" deep end pockets and removable panels provide easy access, saving time and money during installation and maintenance.
- Resilient motor mounts and insulated discharge panels dampen air sounds for quiet operation.
- Reversible coils give added flexibility when piping and installing units.

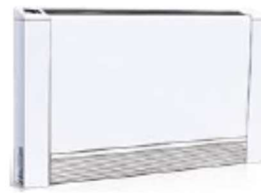
Chiltrix

High Efficiency Chiller Fan Coil Units

CXI DC Inverter Fan Coil Units

3,379 BTU to 11,877 BTU Cooling
3,347 BTU to 9,727 BTU Heating
High Efficiency DC-Inverter Motors





DC-Inverter

The Chiltrix CXI-series FCUs (Fan Coil Units) are available in four different sizes from .28 ton to 1 ton. These DC-Inverter fan motor FCUs are the most efficient fan coils available on the market, using far less energy at any given speed than a standard fan coil unit. The ability to adjust the speed of the motor without compromising efficiency is a crucial additional benefit. Designed for the Chiltrix CX-series chillers of ultra-efficient chillers, these fan coils are also compatible with all chiller systems.

Super-Slim & Universal Mounting

The Chiltrix CXI DC-Inverter FCUs are an incredible 5.1" thin. These universal mount fan coil units can attach flat against the ceiling, stand on the floor, or mount flat on a wall. These units are the thinnest fan coils available yet produce more BTU/CFM per watt of power than any standard fan coil unit.

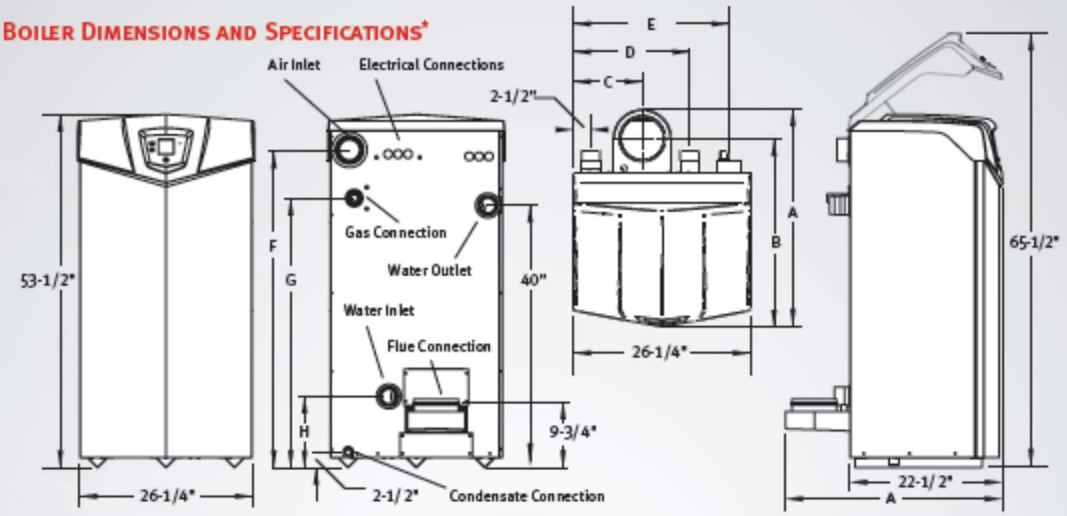
Quiet & Long Lasting

DC-Inverter fan motors last longer and produce far lower sound levels than a standard fan motor with sound levels as low as 24dB. The Chiltrix fan motors are hermetically sealed brushless DC motors that use permanent rare-earth magnets. The DC motors are essentially vibration-free and avoid the "hum" of conventional motors. Get more BTU/CFM per decibel than from any available unit. Standing next to the unit you cannot hear the motor operating, even on high speed.

Chiltrix Model	Cooling BTU*	Heating BTU*	Water GPM	Pressure Drop PSI	Air CFM Volume	Noise dB High	Noise dB Low	Power Watts	Power Supply	Net Dimensions Inches
CXI120	11,877	9,727	2.4	4.05	340	39	28	22	115v 60Hz	51.2W x 5.1D x 25.8H
CXI85	8,498	8,079	1.8	3.98	270	37	28	21	115v 60Hz	43.3W x 5.1D x 25.8H
CXI65	6,451	5,666	1.6	1.89	188	32	27	18	115v 60Hz	35.4W x 5.1D x 25.8H
CXI34	3,379	3,347	1.2	1.57	94	30	24	14	115v 60Hz	27.6W x5.1D x 25.8H
HW72	7,200	7,200	1.9	3.62	512	46	35	40	220 50/60Hz	31W x 9D x 11H

*Maximum values. See capacity test data and sizing guide for varying conditions at www.chiltrix.com/documents/CXI-capacity-test.pdf
Note* Above Heights are without the foot kit. With feet, height is 29 3/8"

FTXL® Boiler Dimensions and Specifications*



FTXL Boiler										Dimensions and Specifications												
Model Number	Input Min MBH	Input Max MBH	Thermal Efficiency	Gross Output MBH	NET AHRI Rating MBH	Turn down	Flow (GPM) Min	Flow (GPM) Max	HEX Water Volume	A	B	C	D	E	F	G	H	Water Conn.	Vent Size	Air Intake	Gas Conn.	Shipping Wt. (lbs.)
FTX400(N,L)	40.0	399.9	98.0%	392	341	10:1	10	105	13	30-1/2"	27-1/2"	10-1/4"	17"	23-1/4"	46-1/4"	39-1/2"	18-3/4"	2"	4"	4"	1"	435
FTX500(N,L)	50.0	500.0	97.7%	488	425	10:1	15	105	12	30-1/2"	27-1/2"	10-1/4"	17"	23-1/4"	46-1/4"	39-1/2"	18-3/4"	2"	4"	4"	1"	468
FTX600(N,L)	85.0	600.0	97.5%	585	509	7:1	15	105	12	30-1/2"	27-1/2"	10-1/4"	17"	23-1/4"	46-1/4"	39-1/2"	18-3/4"	2"	4"	4"	1"	478
FTX725(N,L)	108.5	725.0	97.2%	705	613	7:1	20	150	17	33"	28-1/2"	10-1/2"	17-1/2"	23-1/2"	48-1/2"	41-1/4"	11"	2-1/2"	6"	4"	1"	510
FTX850(N,L)	121.5	850.0	97.0%	825	717	7:1	25	150	16	33"	28-1/2"	10-1/2"	17-1/2"	23-1/2"	48-1/2"	41-1/4"	11"	2-1/2"	6"	4"	1"	535

*Information subject to change without notice Dimensions are in inches. Select "N" or "L" for Natural or LP gas. *The Net AHRI Water Ratings shown are based on a piping and pickup allowancof 1.15. *Lochinvar should be consulted before selecting a boiler for installations having unusual piping and pickup requirements, such as intermittent system operation, extensive piping systems, etc. *The ratings have been determined under the provisions governing forced draft burners.

Smart System Features

- **Smart System Digital Operating Control**
  - Multi-Color Graphic LCD Display w/Navigation Dial
- **Loch-N-Link® USB Thumb Drive Port for Easy Programming**
- **Cascading Sequencer with Built-in Redundancy**
  - Selectable Cascade Type:
    - Lead Lag/Efficiency Optimization
  - Multiple Size Boilers
  - Front-End Loading
- **3 Reset Temperatures Inputs w/Independent Outdoor Reset Curves for Each**
  - Outdoor Sensor
- **Four-Pump Control**
  - System Pump with Parameter for Continuous Operation
  - Boiler Pump with Variable-Speed Control
  - Domestic Hot Water Boiler Pump
  - Domestic Hot Water Recirculation Pump Control with Sensor
- **Building Management System Integration**
  - 0-10VDC Input to Control Modulation or Setpoint
  - 0-10VDC Input from Variable-Speed System Pump
  - 0-10VDC Modulation Rate Output Signal
  - 0-10VDC Enable/Disable Signal
- **Programmable System Efficiency Optimizers**
  - Space Heating Night Setback
  - DHW Night Setback
  - Anti-Cycling
  - Ramp Delay
  - Boost Time and Temperature
- **High-Voltage Terminal Strip**
  - 120 VAC/60 Hertz/1 Phase
  - Pump Contacts for 3 Pumps
- **Low-Voltage Terminal Strip**
  - Building Recirculation Pump Start/Stop
  - Proving Switch Contacts
  - Flow Switch Contacts
  - Alarm Contacts
  - Runtime Contacts
  - 3 Space Heat Thermostat Contacts
  - Tank Thermostat Contacts
  - System Sensor Contacts
  - Tank Sensor Contacts
  - Cascade Contacts
  - 0-10 VDC BMS Contacts
  - 0-10 VDC Boiler Rate Output Contacts
  - 0-10 VDC Boiler Pump Speed Contacts
  - 0-10 VDC System Pump Speed Contacts
  - ModBus Contacts
- **Time Clock**
- **Data Logging**
  - Ignition Attempts
  - Last 10 Lockouts
  - Space Heat Run Hours
  - Domestic Hot Water Run Hours

Standard Features

- **97%-98% Thermal Efficiency**
- **Modulating Burner with up to 10:1 Turndown**
  - Direct Spark Ignition
  - Low NOx Operation
  - Sealed Combustion
  - Low Gas Pressure Operation
- **Stainless Steel Fire-Tube Heat Exchanger**
  - ASME-Certified, "H" Stamped
  - 160 psi Working Pressure
  - 50 psi Relief Valve
  - Combustion Analyzer Test Port
  - Fully Welded Design
- **Vertical and Horizontal Direct Vent**
  - Direct Vent up to 100 feet
  - PVC, CPVC, Polypropylene or AL29-4C
  - Factory Supplied Sidewall Vent Termination
- **Smart System Control**
- **Other Features**
  - On/Off Switch
  - Adjustable High Limit with Manual Reset
  - Automatic Reset High Limit
  - Manual Reset Low Water Cutoff
  - Flue Temperature Sensor
  - Low Air Pressure Switch
  - Temperature and Pressure Gauge
  - Condensate Trap
  - Zero Service Clearances
  - 10-Year Limited Warranty (See Warranty)
  - Custom Maintenance Reminder with Contact Info
  - Password Security
  - Customizable Freeze Protection Parameters

Optional Equipment

- CON-X-US® Remote Connectivity
- Motorized Isolation Valve
- Wireless Outdoor Temperature Sensor
- Multi-Temperature Loop Control
- Variable-Speed Boiler Circulator
- Constant-Speed Boiler Circulator
- ModBus Communication
- Alarm Bell
- Condensate Neutralization Kit
- Concentric Vent Kit (FTX400-FTX600)
- BMS Gateway to BACnet or LonWorks
- High and Low Gas Pressure Switches w/Manual Reset (FTX500-FTX850)
- **Firing Controls**
  - M9-Standard Construction
  - M13-CSD-1/FM/GE Gap (FTX500-FTX850)

Lochinvar®
HIGH EFFICIENCY BOILERS & WATER HEATERS

Lochinvar, LLC
300 Maddox Simpson Parkway
Lebanon, Tennessee 37090
P: 615.889.8900 / F: 615.547.1000
Lochinvar.com


ANK reversible heat PUMP
all the heat you want,
with extremely high
efficiency levels
Aermec
adheres to the EUROVENT Certification Programme:
LCP/A/P/R
The products concerned appear in the EUROVENT web site
www.eurovent-certification.com
EUROVENT
CERTIFIED
PERFORMANCE
■ optimized for heat pump operation
■ production of hot water up to 140°F
■ production of hot water with outdoor temperatures between -4°F and 107.6°F
■ reduces heating costs by up to 30% compared with the best conventional systems (condensing boilers)
■ can be combined with all terminals (radiant panels, fancoils and radiators) and is able to produce domestic hot water.
■ reduced weight and dimensions, thanks to the use of R410A refrigerant
■ offers greater temperature and acoustic comfort
■ high efficiency compressors
■ also available with circulation pump only, or with storage tank and circulation pump
-30%
ANNUAL ELECTRICITY SAVINGS COMPARED WITH THE BEST CONDENSING BOILERS
CONDENSING BOILER
NEW ANK HEAT PUMP
-30%
REDUCTION IN EMISSIONS OF CO_2, THE CARBON DIOXIDE RESPONSIBLE FOR THE GREENHOUSE EFFECT
AERMEC
ANK is subjected to the strict energy efficiency tests needed in order to obtain NF certification on the French market, and EHPA on the German, Austrian and Swiss markets.

The Power of MORE

LG Inverter Scroll Heat Pump Chiller

The Power of MORE

MORE efficiency

MORE reliability

MORE redundancy

MORE comfort and control

MORE choices for modular flexibility

Inverter Scroll Heat Pump Chiller

Features and Benefits:

- Condenser Coil Coating Rated at 10,000 HRS[1]
- Variable Speed Condenser Fan Motors
- Variable Speed Compressors
- Cooling Operation from 5 °F to 125 °F
- Heating Operating from -22 °F to 95 °F
- Cooling Water Side Delta from 4 °F to 20 °F
- Heating Water Side Delta from 4 °F to 20 °F
- Cooling LWT from 14 °F to 68 °F
- Heating LWT from 86 °F to 131 °F
- 65 SCCR Standard on 460V-3PH[2]
- 56 SCCR Standard on 208-230V-3PH[2]
- Rated Sound Pressure at 30' is 51-60 db(A)[3]
- 100% Heating Capacity down to 32 °F
- 120F LWT at 17 °F – 80% of Full Capacity

1. Tested per ASTM B-117 2. Approved per CSA (C-US/162279) 3. Tested per ANSI/AHRI Standard 370-2015

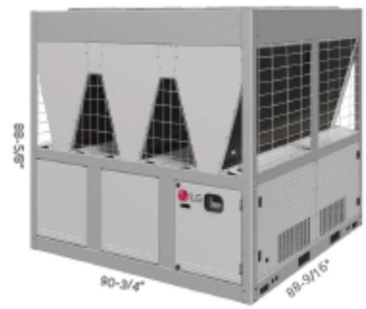
www.lghvac.com

LG Air Conditioning Technologies

Inverter Scroll Heat Pump Chiller

Single Frame
ACHH017*BAB
ACHH020*BAB

Double Frame
ACHH033*BAB
ACHH040*BAB



Triple Frame
ACHH050*BAB
ACHH060*BAB

		ACHH***VBAB 208-230V/60Hz/3PH						ACHH***HBAB 460V/60Hz/3PH					
Model Number		017	020	033	040	050	060	017	020	033	040	050	060
Cooling Capacity[1]	(TR)	16.12	18.48	32.42	36.96	48.62	55.45	16.21	18.48	33.42	36.96	48.62	55.45
Power Input[1]	(kW)	18.10	21.50	36.19	43.00	54.29	64.50	18.10	21.52	36.19	43.04	54.29	64.56
EER[1]	(Btu/kW)	10.75	10.32	10.75	10.32	10.75	10.32	10.75	10.30	10.75	10.30	10.75	10.30
IPLV[1]	(EER)	19.46	19.46	19.46	19.46	19.46	19.46	19.46	19.46	19.46	19.46	19.46	19.46
Energy Efficiency	(kW/TR)	0.617	0.617	0.617	0.617	0.617	0.617	0.617	0.617	0.617	0.617	0.617	0.617
Heating Capacity 47°F /105°F LWT	(MBH)	204.7	238.8	409.4	477.6	614.1	716.4	204.7	238.8	409.4	477.6	614.1	716.4
COP 47°F /105°F LWT[2]	(W/W)	3.65	3.59	3.65	3.59	3.65	3.59	3.65	3.59	3.65	3.59	3.65	3.59
Heating Capacity 17°F /105°F LWT	(MBH)	163.8	203.0	327.6	406.0	491.4	609.0	163.8	203.0	327.6	406.0	491.4	609.0
COP 17°F /105°F LWT[2]	(W/W)	2.22	2.16	2.22	2.16	2.22	2.16	2.22	2.16	2.22	2.16	2.22	2.16
Heating Capacity 47°F /120°F LWT	(MBH)	204.7	238.8	409.4	477.6	614.1	716.4	204.7	308.8	409.4	617.6	614.1	716.4
COP 47°F /120°F LWT[2]	(W/W)	3.15	3.10	3.15	3.10	3.15	3.10	3.15	3.10	3.65	3.10	3.65	3.10
Heating Capacity 17°F /120°F LWT	(MBH)	153.5	191.1	307.0	382.2	460.5	573.3	153.5	191.1	307.0	382.2	460.5	573.3
COP 17°F /120°F LWT[2]	(W/W)	2.01	1.96	2.01	1.96	2.01	1.96	2.01	1.96	2.01	1.96	2.01	1.96
Sound Pressure Cooling at 30 feet[3]	db(A)	51	51	54	54	56	56	51	51	54	54	56	56
Sound Pressure Heating at 30 feet[3]	db(A)	55	55	58	58	60	60	55	55	58	58	60	60
Frames		Single	Single	Double	Double	Triple	Triple	Single	Single	Double	Double	Triple	Triple

1. Certified to AHRI 550/590 2. Full Load Heating Performance Tested to AHRI Standard 550/590 3. Tested per ANSI/AHRI Standard 370-2015