ASHRAE AUDIT REPORT

Athol Police Station
Athol, MA

Abstract

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

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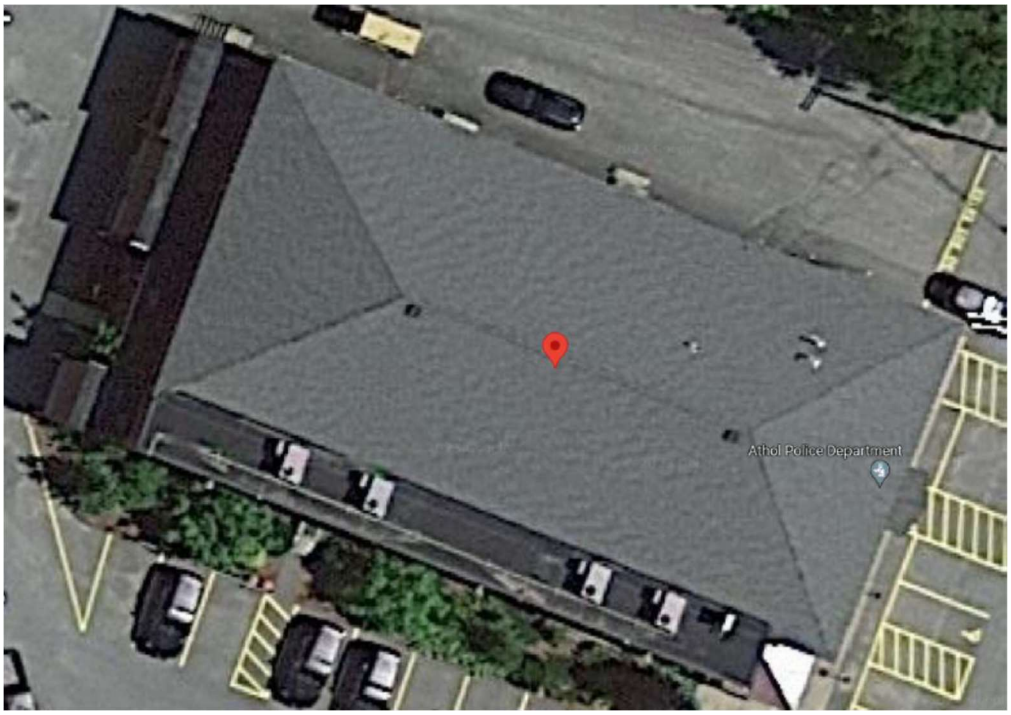
Contents



Picture 1: Aerial view of the Athol Police Station

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The primary purpose of this report is to review the existing heating, cooling and ventilation systems within the Athol Police Station located at 280 Exchange Street in Athol, MA. The review of the on-site conditions occurred on June 20th and August 10th 2023.

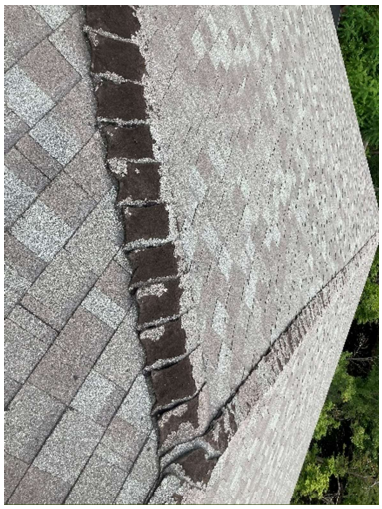
Building Summary

Building Use and Description

The facility is used as the Police Station for the Town of Athol. The Police Station was built in the 1970 as a commercial store and renovated into its current use in 2007. It comprises approximately 20,000 square feet including the main level and the full basement storage.

Picture 2: Right side of building

Most of the exterior walls are comprised of brick over block construction and interior plaster. The front portion of the building has stucco as the exterior wall finish and more elaborate window sills and headers. The majority of the roof is a hip configuration with asphalt shingles. The hip roof was evidently installed over the original flat roof and has an accessible attic area. The asphalt shingles along the hip ridges were found to be prematurely worn. At the southern side there is a flat roof section covering about 1,340 square feet with black membrane over rigid board insulation. There is a former open loading dock area at the rear with a flat roof. There is an attic crawl space which has approx. R-19 existing insulation and two (2) 12" solar photovoltaic electric powered vent fans to allow roof generated heat and moisture to escape. See the ECM #1 in this report to add additional insulation and air sealing.



Pictures 3 & 4: Unusual worn asphalt ridge cap pieces at hip roof. Consider mounting two fake owls on roof edge to help prevent birds disturbing roof once caps are replaced.

The doors and windows have thermal pane glass. There is an insulated and weather-stripped overhead door for the sally port and a total of six (6) exit doors at the sides and rear dock in addition to the double front entrance vestibule doors. A portion of the bottom weather-stripping does not make full contact with the concrete floor due to the slope of the floor.

Operations Schedule and Energy Usage

The building is generally maintained at 70°F but is under the control of the Town of Athol.

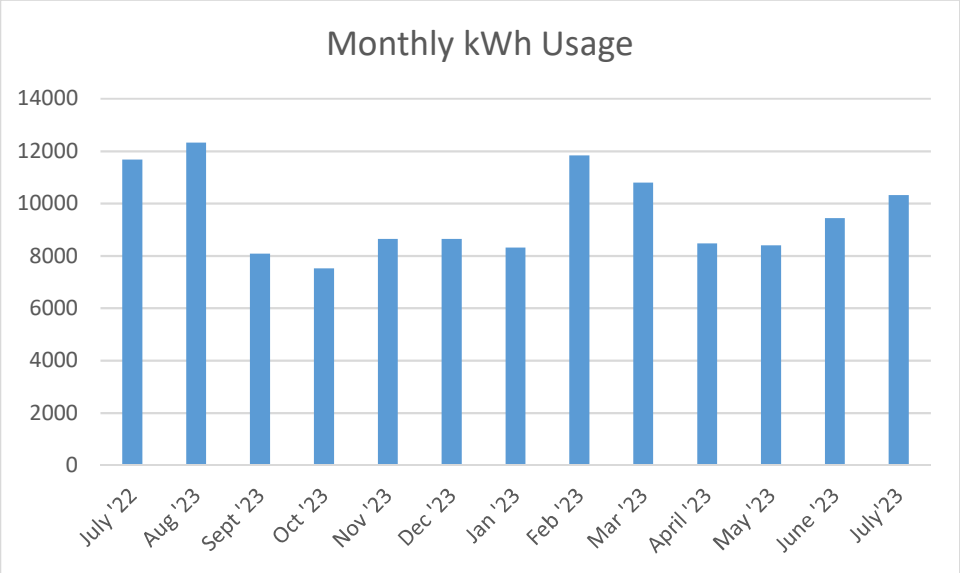
The building is heated by propane and has an underground 1,000 gallon storage tank. A total of 3,403 gallons were delivered in the period from October 7th, 2021 through June 27th, 2022. The total cost during that time was $6,837 with an average cost of $2.01 per gallon. The most recent price per gallon for propane delivered to the site is $1.28 which is comparatively low. The back-up electric generator is diesel fueled.

The propane gas account for the Police Station incurred the following usages:

Period of Deliveries	Total Gallons	Total Price (average $/gallon)
November 2019 – May 2020	2,104	$2,330 ($1.11)
Sept. 2020 – April 2021	2,431	$3,879 ($1.60)
October 2021 – June 2022	3,403	$6,837 ($2.01)

The propane usage pattern is fairly typical for this type of building and the more recent usage is in line with the prior range. The usage per square foot per year is in the normal to low range for this type of building. Keep in mind that there is some electric heat involved in the HVAC system.

Annual energy consumption for the 22-23 period shown below was 112,800 kWh. Available 2023 monthly electric demand ranged from 22.4 to 25.6 kW. Based upon the National Grid Small C/I G-1 General Service customer account number 76053-51001 information, this report estimates a conservative customer cost of 16 cents per kWh. The current distribution demand charge is $12.47 per kW. The use of electricity is in a high range of 11 kWh/sq.ft./year given the twenty four hour a day use of the building.



HVAC Equipment

The building has four (4) sixteen year old heating/cooling rooftop units (RTUs). The Bryant model 580FAU0S0115AB uses propane gas for heating with an output rating of 92,000 Btu/hour. The next three (3) RTUs are Bryant model 580FPU01805AB which have a heating output rating of 59,200 Btu/hour. The size of the units for heating appears to be adequate for the building envelope characteristics – not oversized like many other commercial systems. The RTUs operate at 80% heating thermal efficiency. The RTUs each have one (1) condenser fan motor, one (1) supply fan motor and one (1) combustion air fan motor. Each unit has an outdoor air hood and screen with minimum and economizer mode dampers closed at the time of the site visit.

It was noted that the bases of the RTUs have corrosion in the center which should be monitored over the next few years. One could check inside the units to make sure the condensate pan is properly draining out the PVC trap and not allowing the condensate to flow into other parts of the unit. The propane gas exhaust vent is fairly close to the gas piping and may be the cause of some of the corrosion from acidic droplets in the flue gas. It was noted that some of the exhaust terminations are bent.

Picture 5: There are four (4) RTUs and one (1) ductless split unit located on the flat section of the roof.

The RTUs operate with R-410A refrigerant which is now in the process of being phased out. Given the need for constant air turnover in this type of facility, it is recommended that the RTU fans shall be operated in the "ON" mode for continuous air flow. Each of the units was found with both the minimum outside air dampers and the economizer dampers **closed**. At first it appeared that may have been done given the existence of an Energy Recovery Ventilation (ERV). While the ERV does exhaust the centrally located bathrooms with showers and provides fresh air to the locker rooms, the HVAC equipment schedule originally slated to send about 150 cfm of fresh air to each RTU. The confusing part is that the HVAC plans do not show any duct connection between the ERV and the four (4) RTUs or areas of the building that the RTUs serve. Further on site review and air flow testing will be necessary to confirm how well this system is working.

It is noted that each time a RTU system turns on, something in the air causes multiple personnel to sneeze. It is therefore recommended to restore the units to the minimum air settings as noted below. Additionally, the unit propane heat exchangers should be inspected for rust or cracks and CO detectors should be placed within the building as long as propane is used for heating. Ventilation should occur continuously during occupied hours, not just during a heating or cooling demand fan cycle. The original equipment schedule calls for the following:

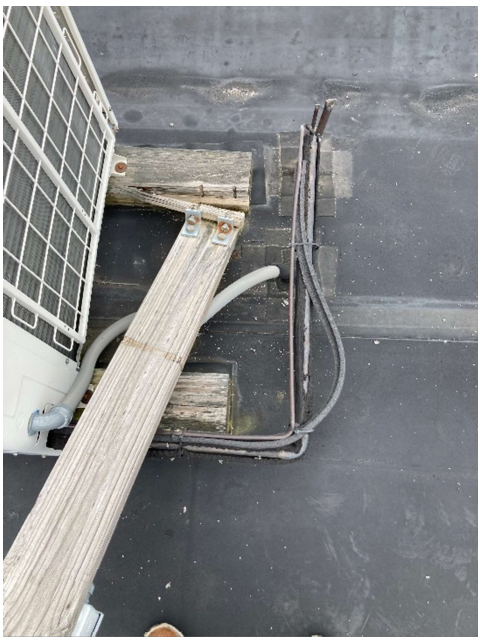
Unit Number	Supply air CFM	Outside air CFM	ERV CFM
RTU-1	1,825	180	150
RTU-2	1,500	150	150
RTU-3	1,575	160	150
RTU-4	1,050	150	150

There are two (2) Warren electric resistance duct heaters which provide post-conditioned heated supply air to the areas the ERV serves. EHC-1 was slated to have a capacity of 6,800 Btu/hour at 150 cfm with an electric draw of 2 kW. EHC-2 was specified to have a capacity of 20,500 Btu/hour at 450 cfm with a 6 kW draw. Put together, these heaters could potentially represent 25% of the building's kW demand. There are three sections of electric resistance baseboard heat with a combined 1.635 kW demand.

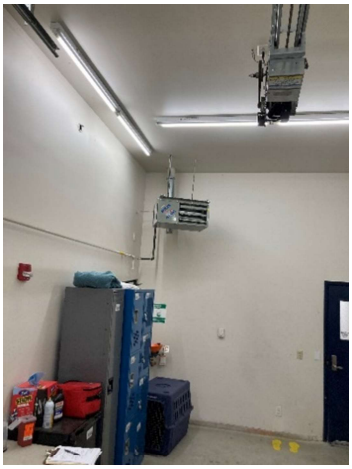
Pictures 6 & 7: Warren electric resistance duct reheat coils located above the drop ceiling.

The Daikin Industries VRV outdoor unit (ODU) heat pump model number RXYMQ48MVJU is located on the flat roof. It has a 48,000 Btu/hour cooling and a 54,000 Btu/heating capacity. As originally slated, it had a 10.1 SEER air conditioning efficiency rating. It operates using R-410A refrigerant. The support for the disconnect box needs repair before it does damage to the roof membrane. The refrigerant pipe insulation should be replaced with ultraviolet ray resistant material with the proper thickness.

The Daikin unit is associated with HP-1.1 with is a ducted unit serving the front left conference room. It also is connected to the basement server unit HP-1.2 wall unit.



Pictures 8 & 9: The broken disconnect support at the Daikin ODU and the deteriorated pipe insulation.



Left Picture 10: The Sally Port garage has a small propane gas-fired, mid-efficiency Hot Dawg suspended unit heater. This 40,000 Btu/hour output unit has an induced draft exhaust blower and electric ignition.

Right Picture 11: One of the two high efficiency propane gas-fired furnaces in the basement.

The two (2) Bryant Plus 90 high efficiency, sealed combustion, condensing propane gas furnaces are located in and serving the basement. Each unit has minimal supply and return duct work, a condensate pump, and return air filter plenum. Each furnace has an input of 100,000 Btu/hour and have the highest efficiency (94%) of any combustion equipment at the Police Station. No air conditioning is provided to most of the basement which is just used for storage.

Picture 12: Thermostat for Daikin unit

Picture 13: Direct vent propane-fired water heater.

Like other Town of Athol buildings, there are Johnson Controls temperature controls with digital readouts for each of the four (4) RTUs. No one at the Police Station has full control of the RTUs. The rear conference room thermostat is said to not work. It is noted that the rear gym/storage thermostat has not worked locally in several years. The Dispatch area has its own thermostat and it tends to be too hot or too cold. It is difficult to reach a happy medium. Therefore, the current thermostat dead band settings should be reviewed. The right rear Meeting Room has two (2) sections of perimeter electric baseboard heat to supplement the RTU heating capacity.

There is a freestanding propane gas-fired water heater located in the front of the basement. The Bradford White Corporation model number RG2PV75H6X has a 75 gallon capacity and an input of 75,000 Btu/hour. This tank supplies building fixtures without a central mixing valve. It was noted that short lengths of the copper hot piping out of the tank were not all insulated. Insulation of the remainder of the piping is recommended and this could be accomplished for approximately $200 if done with the attic insulation There are bronze potable water recirculation pumps which keep the hot water piping warm.

The installation of a heat pump water heater system would be more efficient and operate at a lower cost than the current tank system. Some condensate and basement dehumidification would be by-products of its operation.

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.

Ventilation Systems Assessment

Ventilation is required by code in this building. 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 air stream, 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 actually 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.

The current system has a Lifebreath 1200-DF unit with a 1,000 cfm ERV exchanger to recoup approximately 70% of the heat from the exhaust to preheat the fresh incoming airflow. 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 cfm air rate is not reduced, just the energy used to heat or cool it before it reaches the space.

The current system does not address the entire building. There are seven (7) exhaust fans which exhaust from restrooms, cells, and other areas putting the building under a slight negative air pressure since there is very little fresh air coming in through the RTUs. The existing ERV location is very difficult to access for regular filter changes. **A permanent means to access the ERV is recommended to be installed to ensure it performs efficiently and effectively over the long run.**

With a properly engineered system, the replacement of the existing RTU with a heat pump RTU system could directly convert a major portion of the building's energy use to carbon free electric energy if a significantly sized battery storage system and solar PV (photovoltaic) array were installed at the same time.

The building's electrical system infrastructure is likely to be able to handle the replacement. The current 208/3/60 MP electrical panel is rated at 800 Amperes. Once the final equipment configuration is selected, the verification of the electrical system capacity relative to the specific models chosen can occur during the engineering design process.

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.

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.

Recommendations

Thermal Insulation and Sealing

Given the existence of by-passes of the existing thermal insulation in the attic area, it is recommended to seal such chases, plumbing and wiring penetrations, access openings and other leakage points to reduce heat loss. Once that is done, the addition of an additional R-19 Class 1 cellulose insulation over the attic area is also recommended. The attic hatch could be weather-stripped and insulated to R-13 as part of the scope of work. Although this measure has a long payback period, it is worth implementing it for improved comfort and for reducing the size of new HVAC systems upon replacement.

ECM #1 Details:
Estimated cost: $ 31,000
Estimated incentive: N/A
Estimated annual savings: $648
Simple Payback without incentive: 48 (Years)

Assumptions:
#2 Propane rate: $1.28/Gallon
Electric rate: $0.16/kWh
Estimated gallons of propane saved: 457
Estimated kWh of electricity saved: 392

HVAC System

If desired, replacement of the existing propane gas/electric RTUs with a new air-to-air heat pump RTUs could be considered. Although another option would be the installation of a new RTU with a high efficiency propane heating component, that does not help to reduce the environmental impact of the building to the same degree. Heat pump RTUs have been available for decades in the domestic market and are the least expensive way to potentially reduce the carbon footprint of this particular building. The electrification system would not be complete without a solar PV system mounted on the roof or ground along with battery storage.

To provide the most impact, a unit which can be operated down to zero degrees F should be considered. For example, Daikin offers heat pump RTUs with IEER values of up to 20.6 and in the range of three to twenty-eight tons of cooling capacity. The use of variable speed fans within the new variable speed heat

pump RTU should be combined with the replacement of the existing duct heaters with a different configuration to provide reheat. One option to eliminate the electric resistance heaters is the use of a small air-to-water heat pump (AWHP) with hydronic reheat coils. The new RTU should use an economizer during the mild weather and reusing the existing ERV to precondition the outside air are each important features suggested to be incorporated. If there is a desire to have no potential refrigerant impact to the building, the replacement of the RTUs with four (4) rooftop air handlers with hydronic coils off an AWHP system is a second, albeit higher cost option.

The above is an Illustration of a Daikin heat pump RTU system incorporating an ERV wheel in case the existing ERV is also in need of replacement at the same time.

ECM #2 Details:
Estimated cost: $ 225,000 (To be fine-tuned after design engineering.)
Estimated incentive: $ TBD
Estimated net cost after incentive: $ TBD
Estimated annual savings: $1,865
(Current low propane costs result in very little cost savings for this electrification measure.)
Simple Payback with incentive: 120 years - When the RTU is determined to be ready for replacement, the incremental cost of replacement with like RTU versus the heat pump RTU is suggested to be reviewed.

Assumptions:
Electric rate: $ 0.16/kWh
Propane gas rate: $ 1.28/Gallon
Estimated gallons of propane energy reduction: 3,500 for a total elimination of propane equipment
Estimated net kWh energy increase: 16,301

Heat pump RTUs, ductless split heat pump units and other options will not provide enough electricity and propane gas savings to pay back within their average lifespan for this application at this time. Solar PV and battery storage would be an additional cost but would bring down the average cost of electricity and improve the cost effectiveness of this measure.

RTUs and air-to-air ducted heat pump systems each have a 20 year estimated life, while ductless split units are estimated to have a 15 year life span. Generally, 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.
3. The degree to which the existing equipment is ready for replacement. The RTUs are approaching their 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. It is unknown if the existing system is controlled to automatically 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.

If the goal is building electrification, it is recommended that the customer consider carefully how to proceed pending 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 particular 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.**

Lighting Systems

The interior lighting consists of efficient LEDs. Only the restrooms could slightly benefit from screw-in LEDs and the hours are low for those rooms. There is one (1) exterior LED with the photocell covered up so the fixture is constantly on. There is one (1) exterior entryway wall pack which has a two-lamp, 32 watt plug-in fixture.

Summary of Findings

Measure Description	Annual Energy and Cost Savings				Payback Period		
	Peak Demand Savings (kW)	Electricity Savings (kWh)	Propane Savings (gallons)	Total Cost Savings	Gross Measure Cost	Measure Life (years)	Simple Payback (yr)
ECM#1 – Attic air sealing and Additional Insulation	-	352	457	$648	$31,000	25	48
ECM#2 – High Efficiency Heat Pump RTUs with ERV Modifications	-	-16,301	3,500	$1,865	$225,000	20	170
TOTALS	-	-15,949	3,957	$2,513	$256,000	25	102

RISE stands ready and able oversee the necessary changes and to revisit the site after improvements have been made to conduct some 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.

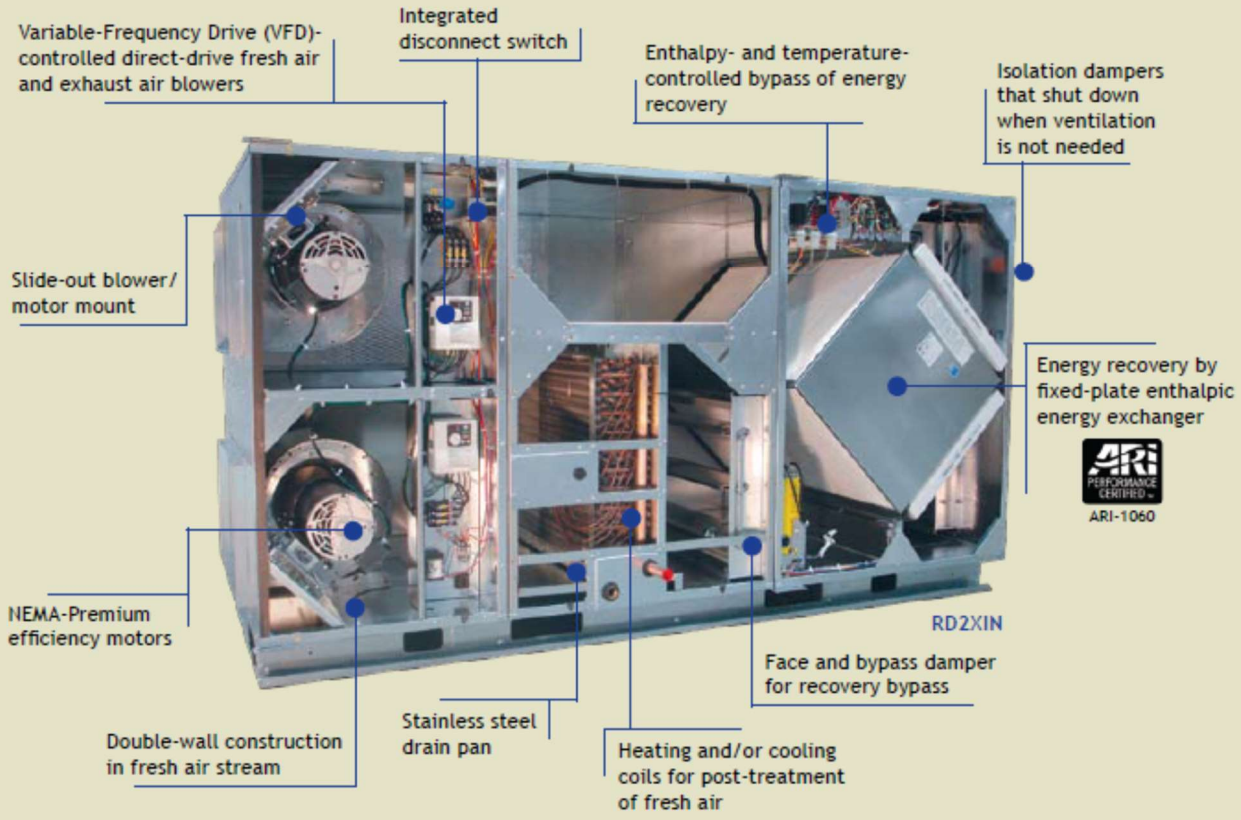
Estimates of Construction Costs, if any, prepared by the Engineer represent the Engineer's best judgment as a design professional familiar with the construction industry. However, it is recognized that neither the Engineer nor the Owner has control over the cost of labor, materials or equipment; over 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

ENERGY EFFICIENT DOAS

(DEDICATED OUTDOOR AIR SYSTEM)

RenewAire RD-Series



Rebel™ Packaged Singlezone Heating and Cooling Units—Features and Options

1 Variable speed Daikin inverter compressor
- Modulating capacity allows for optimum comfort control
- Best part-load efficiency in the industry
- Dependable and quiet operation
- Superior discharge air temperature control

2 Variable speed Daikin heat pump
- More economic than gas heat during winter
- Hybrid backup heat options for extreme cold weather and defrost operation
- Modulating capacity delivers the industry's best heat pump control

3 Electronic expansion valves
- Optimum control of superheat
- Protects compressor from liquid refrigerant
- Increases efficiency by safely lowering head pressure

4 MicroTech® III unit controller
- Open Choices™ feature provides interoperability with BACnet®, Daikin D3 and LonWorks® communication options for easy integration with building automation systems
- Unit diagnostics for easy serviceability
- Outdoor air and humidity control logic maintains minimum fresh air intake and optimum humidity levels
- Optionally add the SiteLine™ Building Controls solution, which provides real-time data streams for benchmarking performance, monitoring system operations and implementing remote diagnostics and control

5 Hinged access doors
- ¼–turn latch door provide easy access to system components for maintenance and service

6 Ultra-quiet Daikin condenser fans
- UV and corrosion resistant
- Variable speed ECM motors provide tremendous energy savings at lower ambient

7 Variable speed ECM motors or VFDs on all fans
- Greatly increases system reliability and efficiency eliminates belts and bearing setscrews
- Saves energy at light load
- Built-in inverter eliminates control panel heat

8 Hybrid backup heat options
- Gas furnace with turndowns as high as 12:1
- Electric heat option with SCR for precise temperature control
- Hot water heat

9 Refrigeration only controller
- Allows for the use of a third-party RTU controller to run the Rebel's functions while Daikin optimizes and protects the refrigeration system

Rebel™ Packaged Singlezone Heating and Cooling Units—Features and Options

10 Double-wall foam cabinet
- No exposed insulation to the air stream
- Better thermal seal than fiberglass

11 Dehumidification Control
- Hot gas used for "free" reheat
- Tight humidity control without over cooling the space
- Modulating hot gas reheat coil
- Independent reheat and cooling control

12 Stainless steel, double sloped drain pan
- Prevents corrosion
- Avoids standing water for high IAQ

13 100% outdoor air option
- Low-leak dampers
- Double-wall blades, edge and jam seals
- Modulating 100° temperature rise furnace
- Modulating compressor
- Modulating hot gas reheat

14 Durable construction
- Foam-injected panels with an R-value of 7 (3–15) or 13 (16–28)
- Increased insulation value for increased system efficiency
- Double-wall construction for increased indoor air quality

15 Low radiated noise
- Enclosed compressor
- Quiet outdoor fan
- Exellent acoustics at lower speeds

16 Economizer
- Provides free-cooling when outdoor conditions are suitable
- Provides fresh air to meet local requirements
- Integrated economizer operating with mechanical cooling
- Optional demand control ventilation for increased system efficiency

17 2" and 4" slide-out filter racks
- Easy filter changeouts for quick serviceability
- 2" MERV 8 filters are provided

18 Optional energy wheel
- Meets ASHRAE 90.1 2016 effectiveness requirements
- Factory installed and tested
- Single-point power and controls

19 Optional energy CORE®
- Meets ASHRAE 90.1 2016 effectiveness requirement
- Less than 0.5% EATR
- No moving parts
- Factory installed and tested
- Single-point power and control

AHRI 340/360 Certified

Rebel capacity and efficiency is independently certified by rigorous annual witness testing.