HEATING SYSTEM OPTIONS

For the

SOUTH CHURCH ANDOVER

Andover, MA

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INTRODUCTION

The following report describes the existing mechanical systems and details recommendations for system replacements that will improve reliability and comfort, while reducing operating costs and environmental impact. Given the long-term nature of your institution, our recommendations primarily follow the logic of lowest life cycle cost over a 20+ year period. We'll all be long gone and we'd expect the church to still be serving the community as it does now and benefit from lowest costs over time. As part of this reporting effort, we have analyzed historical gas consumption records, estimated total building heat loss to inform proper future system sizing, prepared rough construction cost estimates for the recommended systems, considered alternative system approaches, and \estimated operating cost savings and emissions reductions for the proposed heating system options.

Please note that within this report we have used system seasonal efficiencies that are lower than manufacturer published equipment efficiencies. The listed manufacturer efficiencies and efficiencies reported by others are normally representative of instantaneous efficiencies for a device and not for average seasonal system performance.

Along with the helpful tour of the facility, you have provided us with a number of documents that were used to understand the existing conditions and relevant history. The following appendices include additional information and relevant materials to the report body.

Summary of Appendices;

- Appendix-A: Building Photographs
- Appendix-B: Energy Cost & Emissions Analyses for Existing and System
- Appendix-C: Product Information
- Appendix-D: Utility Rebate Information
- Appendix-E: System Diagrams & Graphics
- Appendix-F: Mechanical Boiler Industries – Boiler Replacement Proposal

EXECUTIVE SUMMARY

The Church of South Andover has made great strides in recent years to improve the existing steam system and equipment operation on site. Recent efforts to replace steam traps, improve boiler system controls and insulate exposed piping have helped to improve the steam distribution piping system on site. Although recent maintenance efforts have been beneficial, the existing steam boiler is no longer operational and is need of immediate replacement prior to the 2021 heating season. Therefore, *Option-1: Existing Steam Boiler Replacement* will be required for the heating season space conditioning and should be completed within the near future.

As a result of being impacted by the 2018 Columbia gas explosion, all sections of gas piping and existing gas-fired appliances were replaced in 2019. Included within the system replacements was the gas burner assembly serving the boiler. After replacement of the existing steam boiler, the 1861 & 1956 sections of the Church will be served by a relatively well-maintained steam distribution system. These factors in addition to the recent installation of a Building Management System (BMS) all contribute to having what is essentially a functional steam heating system, which may serve the facility without issue for several years to come (with proper maintenance and routine service inspections). This puts the Church Community in a unique position; the steam boiler and burner systems will be virtually brand-new, however, the existing piping infrastructure

is now 65+ years old and is nearing the end of the typical lifespan for black-steel piping. It is more than likely that the existing piping will have more systemic issues and failures as the system increases with age and use. Given the age of the existing boiler and related equipment, we expect maintenance costs and frequency of failures to increase as the system continues to degrade over time. Appropriately, the church is considering replacement options. See below for a summary of the Church's current fuel use and costs. Maintenance costs are not included in the figures.

GAS FUEL USE & COSTS [1][2]			
Heating Season	Annual Average Gas Cost $/Therm	Annual Gas Consumption Therm/Year	Annual Cost of Gas
2019 – 2020	$ 0.96	12,006	$ 11,621

[1] $/Therm based on Gas Consumption Period of 9/1/2019-5/30/2020 Billing Records
[2] Annual gas consumption estimates exclude Parish Center gas consumption

ELECTRICAL UTILITY RATE [2]	
Billing Period	$/kW
2/1/21 - 3/1/21	0.259

[1] Based on NationalGrid Billing Records.

Decisions on system approach for the church, will define and constrain the Church's future energy costs and environmental impact for the better part of 30 years and likely more. We understand your end goals for system replacement are reduced operating and life cycle costs, conserve resources, and reduce environmental impact. With these goals in mind, the following options have been identified:

SYSTEM OPTIONS	INSTALLED COST [1]	OPERATING COST SAVINGS ($/Yr)	CO2e Reduction (lbs)	Air Conditioning Included?
Option 1: Steam Boiler (Replace Existing Steam Boiler)	$49,000 - $ 59,000	$0	0	NO
Option 2: Gas Boilers (3) + New Low Temp Forced Hot Water System	$ 760,000 - $ 1,000,050	$ 1,638	20,006	NO
Option 3**:** Air Source Heat Pump System (ASHP)	$ 860,000 - $ 960,000	$ (15,661) [2]	43,160	YES
Option 4A**:** GSHP ('Water-to-Air' &'Water-to-Water')	$ 975,000 - $1,250,000	$(3,536) [2]	87,081	YES
Option 4B**:** GSHP (Water-to-VRF)	$ 975,000 - $1,250,000	$ (7,866) [2]	71,587	YES

[1] Construction cost with permitting + OH&P; does not include allowance for design fees.
[2] See Appendix- B: Energy Cost & Emissions Analyses for Existing and System Options
Value Represents Operating Cost Increase Compared to Existing Steam Boiler System (Option-1)
[3] Value Represents Operating Cost Increase Compared to Existing Steam Boiler System (Option-1)

Overview of System Replacement Options

At this stage we are not making a specific recommendation for which option suits the church best. The process of evaluating the relationship between first cost, operating cost, and environmental stewardship is one that ultimately the congregation must decide upon together. Instead, we present options and information for use by the congregation so that they can make these decisions coming from an informed understanding of the options worth considering.

We know that lower emissions are generated by using an air source (ASHP) or ground source (GSHP) electric heat pump system compared to even the highest efficiency gas fired system. However, we also know that the gas fired heating approaches will have significantly lower operating cost not just now but potentially for the next 2 or 3 more decades. We can anticipate that Utility billing rates and costs will and can fluctuate considerably. One factor that may play a considerable role in future Utility costs is if a Carbon Tax will be levied on fossil fuel consumption. A carbon-based tax on natural gas would offset some of the potential operating cost savings when compared against electrically operated systems. Another factor that will effect the Church's future energy consumption is that adding air conditioning (A/C) to the building will also increase consumption and emissions if you are now seasonally cooling areas that were previously served by heat-only systems.

It should also be noted that ***both Ground Source and Air Source Heat Pump systems use a great deal of electricity***, they should not be considered renewable energy systems in the same way we understand solar electric and solar thermal systems. The emissions at the power plants that generate a portion of the electrical power consumed testify to their less than benign performance. See the System Operating Costs with Emissions Comparison table in Appendix-B for comparative performance of this option assuming that it would be installed to provide 100% of heating requirements. However, as energy production on the electrical grid shifts away from fossil fuels, the CO2e of this approach is reduced over time.

Option-1: Existing Steam Boiler System

As the existing steam boiler is no longer operational, this option exists out of necessity to maintain heat for the upcoming heating season. The proposed scope includes a replacement cast-iron sectional boiler equivalent to the existing HB Smith 28A boiler, with an approximate capacity of 1,733 MBH steam heat production. The existing 2019 PowerFlame natural-gas burner assembly would be retained to serve the replacement boiler.

This Option allows the facility to retain the existing steam and condensate piping, radiators, valve assemblies, controls and system appurtenances without requiring a complete system replacement. As a result of replacing the boiler and maintaining the older piping systems, future repairs and emergency failures are likely to occur as the piping system degrades over time.

Option-2: High Efficiency Gas Fired Boilers System

This approach includes a high-efficiency, natural gas-fired condensing boiler system which serves a new hydronic system piping with terminal heating units (convectors, baseboards, & fan coils). Modern condensing boiler technology allows the system to be designed around an extra low forced Hot Water Supply (HWS) temperature of 140°F and lower, to increase boiler efficiencies and thereby provide lower operating costs. As a result of designing systems around a lower water temperature, the boiler systems can operate in condensing mode for longer periods of operation. As the current system is steam, the piping is not viable for reuse and should be fully removed and replaced as required new insulated supply and return, hydronic distribution piping.

Option-3: Air Source Heat Pumps (ASHP)
An electrically powered Air Source Heat Pump (ASHP) system produces lower emissions than oil or gas systems assuming the current utility's mix of power on the power grid. This approach would be the most affordable way to bring air conditioning to the building, while also providing space heating. An Air Source Heat Pump system come in many types and sizes. We believe that then more commercial scale centralized VRF (Variable Refrigerant Flow) systems that can be configured in various ways based on interior architectural requirements is appropriate for your needs. The exterior mounted heat pump units would be piped to a BC Controller or manifold, which would serve a combination of indoor FCU's. The indoor FCU systems could be either ducted systems or ductless systems to provide heating and cooling to the various areas in the church. Indoor FCU systems would be designed to be integrated within the existing interior architecture to preserve the beautiful aesthetic. Each FCU system can be separately controlled to provide a separate zone of temperature control or a group can function as one zone. The Church interior would require additional architectural accommodations for routing and concealing refrigerant piping, condensate piping, electrical wiring, control wiring as well as the terminal Fan Coil Units (FCU's).

Options- 4A & 4B: Ground Source Heat Pumps (GSHP)
This system approach and the variations we describe, provides the lowest operating cost and the lowest emissions of any option and therefore best addresses the serious global challenge of climate change. A Ground Source Heat Pump System (GSHP) can vary in complexity and system design. GSHP systems uses a buried, piped & pumped geothermal 'ground coupling' system that serves as a heat sink during cooling season and supply of heat during heating season. This ground coupling is connected with required piping manifolds, heat exchangers, system pumps and connections to a 2nd separate interior hydronic loop. The interior piping loop would then provide thermal exchange from the ground coupling system to the heat pump systems. The heat pumps come in many types and are compressor, refrigerant equipped devices that ultimately consume most of the power and exchange energy (heat) between the ground system and the interior systems that are heating or cooling the spaces.

For our Northeastern region, ground temperature remains at approx. 45F year-round at a depth of approx. 48"+ (48" is the typical frost depth for NE). This allows the GSHP system to use the earth as either a 'heat-source' or 'heat-sink' depending on if the system is in heating or cooling with a constant baseline temperature for thermal exchange.

Two different GSHP system approaches are viable and both use vertical wells to provide the geothermal 'ground coupling'; Option-4A: Water-to-Air GSHP's or Option-4B: Water-to-VRF GSHP's. Either approach would include a number of exterior drilled wells each with a pair of plastic pipes thermal grouted into the well bore and piped into the indoor mechanical room.

Option-4A: Ground Source Heat Pumps (GSHP) 'Water-to-Air' & 'Water-to-Water'
In this option the heating and cooling system would consist of both 'water-to-air' and 'water-to-water' ground source heat pump systems. 'Water-to-Air' GSHP terminal heat/cool units are typically ducted air handling systems that are equipped with internal heat pump chassis and blower fan assemblies. 'Water-to-Water' GSHP's utilize the heat pump operation to temper an interior hydronic piping closed loop to serve traditional baseboard and perimeter convector systems, similar to how a boiler perimeter heating system would operate. The exterior 'ground-coupling' loop is indirectly connected to electrically-operated terminal units which house a blower

motor and internal refrigerant compressor system that operates to provide either heating or cooling. When the dedicated thermostat senses a call for either heating or cooling, the terminal unit operates to satisfy the local thermostat set-point and uses the common loop or 'condenser loop' for either heat extraction or heat rejection.

Option-4B: Ground Source Heat Pumps (GSHP) Water-to VRF

Similar to Option-4A, Option-4B consists of an exterior ground coupling piping system for heat-extraction and rejection. However, in lieu of terminal units that have internal refrigerant systems with blower motors, the geothermal heat exchange system is now serving a refrigerant based Water Source VRF Heat Pump system. This allows the system to further increase efficiency by utilizing 'heat-recovery' or 'heat-sharing' when conditions allow and there is diversity on the systems. This option is a Hybrid of VRF Air Source Heat Pump systems described in Option-3 and a Ground Source Heat Pump System, with the exception that the VRF system now utilizes the earth for heat extraction/rejection and not the ambient surrounding air.

The central VRF systems would be connected to indoor Fan Coil Units (FCU's) which include a refrigerant coil and blower motor assembly. On call from a local thermostat the FCU's operate in either heating or cooling mode. Indoor FCU's are available in various types; ductless wall-mounted, ducted vertical, ducted horizontal, ceiling cassette, and floor console units are the most common system types and each has a different set of requirements for installation. Each of these heat pump units would be able to provide heating or cooling as an independent zone of temperature control.

General Construction Overview & Impact to Facilities

Each system replacement Option stated will have a different set of construction challenges and impact to the Facilities use. Option-1 & Option-2 utilize natural gas as a source of fuel and will be able to reconnect to the existing gas piping and burner systems currently in place. Option-3, and Options 4A & 4B utilize electricity as a source of energy to power heating and cooling systems and will require a new, increased electrical service on site. To complete this, the Utility provider will have to temporarily shut down of power to the site (this situation is common and can be coordinated within the Electrical Contractor to minimize downtime on site). The proposed system options range in complexity with some more flexible with regard to impacting ongoing services. For instance the Parish House could be used as a temporary gathering space for meetings if the Fellowship Hall is under construction (Parish House systems will be retained as these spaces are currently served by the existing Daikin RTU's). Impact on the interior finishes can vary greatly depending on the Heating/Cooling system basis of design and Owner's requirements.

Option-1 represents the least intrusive system installation as it is replacing the existing boiler within the boiler room and retain the existing piping and terminal radiation throughout the space.

Option-2 will require new terminal radiators, convectors and possibly heating air handlers to replace the steam systems. The hydronic piping will be concealed within ceiling and wall assemblies and where possible, follow the existing steam pipe routing to re-use existing penetrations.

Option-3 Air Source Heat Pump systems will include new interior terminal Fan Coil Unit (FCU's) to be provided power, controls and piping connections. How the piping is concealed and how the new FCU's integrate within the existing Architecture can vary in complexity and scope. A benefit of ASHP systems is that the systems use flexible copper piping for the refrigerant lines, making

some piping installations easier when compared against typical hydronic radiator piping installations which utilize rigid copper piping.

Options 4A & 4B will have the greatest impact to Facility as they will require extensive site exterior work to install the vertical wells required by the GSHP systems. Site work includes, excavation, boring the wells, installing the piping from the wells to the manifolds at the Building interior, in-fill and paving completion. Exterior piping installations may require substantial portions of the parking lot to be excavated and re-paved which will disrupt traffic patterns and reduce the amount of on-site parking during system installations.

Decision Making

We believe it is important for the Church decision makers to reach a consensus regarding the two value systems at play. Lower installation costs and lower operating costs result in more dollars being available for the Church to fund various elements of your 'mission'. However, using options that produce lower emissions provides greater environmental stewardship results immediately. Keep in mind that both operating cost and emissions reductions repeat each year. See Appendix-B: Energy Cost & Emissions Analyses for Existing and System Options for the numbers on both.

Next Steps

Ideally this project can be funded and implemented to occur in one phase of construction. Completing this in a single phase will cost less to implement in the long run and will provide the maximum savings available from system replacement in the first year and all subsequent years. Construction costs in this report include permitting + OH&P; they do not include allowance for design fees (roughly 9%-12% of construction.)

This reporting effort provides the South Church community with information and detail that hopefully helps make a final decision for how to replace the heating system. Once a system approach decision has been made, we recommend that the design effort continue through creation of final Construction Documents (CD's), the project can then be put out to competitive bid to multiple mechanical contractors. The CD's normally include drawings and specifications. The drawing set should include floor plans, schematics, equipment schedules, and details. The specifications should include invitation to bid, bid forms, a sample contract between Owner and Contractor, administrative requirements for the project and technical specifications for equipment, systems, and installation requirements. The consulting engineer can help review the bids, review references and make a recommendation for which Mechanical Contractor (MC) should be selected to enter into a contract with the Church to complete the installation work during the summer. During construction the consulting engineer normally provides construction administration services including equipment submittals review, site visits, review of applications for payment, etc.

OPERATING COSTS & SAVINGS

Please refer to:

- Appendix-B: Table 1 for the Existing Space Heat Consumption Analysis table showing historical consumption and historical climate data and the 'average' annual consumption used for analyzing the performance of alternative system types.

- Appendix-B: Table 2 for the System Operating Costs & Emission Comparison tables that compares the existing system annual 'average' fuel consumption to the operating costs and emissions for each of the Options described as well as some options that have not been recommended but are included for basic reference.

We used the 2019-2020 historic natural gas consumption as a basis for understanding your current energy consumption and have analyzed it using the record of climate during that period to best predict an "average" year's consumption. Typically, we would analyze three to five years of consumption data, however the Columbia gas service interruption in 2018 created an incomplete data set for the 2018-2019 seasons.

Using the historical consumption corrected for weather, we then use appropriate assumptions for system efficiencies, fuel costs, and emissions to calculate the performance for each of the systems identified. With this approach the differences in cost and emissions between system options are quantified.

Current heating system costs include only gas consumption, and do not include annual maintenance or annual repair costs. We have also estimated the Annual Gas Consumption for the Parish Center in order to determine how much energy is consumed by the Steam Systems that are in need of replacement. Based on previous conversations, the RTU's are existing to remain in service for the near future. Using recent 2021 Utility supplier's charge of $0.968/therm for natural gas, the average annual fuel cost for heating natural gas is approximately $11,621/Year assuming continued use of the current gas-fired steam boiler. Note that this cost does not include the electric power costs that may be associated with the existing condensate pumps or pneumatic controls.

EXISTING CONDITIONS

Building Overview

South Church in Andover, MA is composed of three (3) substantial phases of construction which have taken place periodically over the past 160+years. The facility includes a wide range of program and services spaces that range from office, classroom, and supportive service spaces that are located throughout the Basement, First Floor and Second Floor areas. The original Sanctuary and Fellowship Hall and adjacent lower level spaces date to 1861. In circa 1956 the rear portion of the Sanctuary was modified to facilitate a new addition consisting of additional community spaces, classrooms, office and nursery spaces for the Church community. In 2005 the Church added the Parish Hall; a modern three level structure which includes additional classrooms, offices and choir spaces and the installation of an elevator. We will refer to the three sections of the church as the 1861 'Original Section', the '1956 Addition', and the '2005 Parish Hall Addition'.

The 1861 Original Sanctuary construction is a wood framed structure with a still-functional, steel reinforced bell-tower. Typical wall assembly at the Sanctuary consists of wood framed walls with wood cladding. The Sanctuary ceiling is a flat plaster assembly which is supported by a unique truss roof structure concealed above the Sanctuary ceiling assembly. The 1956 Addition consists of CMU block and wood frame construction that varies from lower to upper levels. The 2005 Parish Hall is constructed of a steel frame assembly and metal stud framing, with fiberglass batt

insulation. The Parish Hall addition includes current code egress stairwell and elevator system at the rear corridor and lobby spaces of the facility.

As a result of the Columbia gas explosion in September of 2018, the facility has undergone considerable HVAC, DHW and Kitchen gas-fired equipment replacements as well as increased facility and system maintenance. South Church was subject to equipment and pipe infrastructure damage as a result of the utility explosion and existing gas-fired systems and piping on site were deemed unsafe and were replaced in kind. Here is a brief summary of the equipment replaced in the fall of 2018/2019:

- Power Flame Gas Burner serving existing Steam Boiler, 2,718 MBH input (Steam Cast Iron Sectional Boiler was not replaced)
- RUUD 50 Gallon DHW Heater, 36MBH Input
- Kitchen Range/Griddle
- Kitchen Convection Ovens
- Kitchen Type-1 Hood, Grease Exhaust Fan and Controls
- (2) 10-Ton Daikin Roof Top Units serving the Parish Hall spaces

In addition to the replacement of the gas-fired equipment, the facility was also provided with new gas piping throughout the building. The Utility brought in a new gas service and meter assembly as well as new gas piping throughout.

Boiler Heating System

The majority of the Church is currently heated via a Smith Cast Iron Sectional Steam Boiler which is equipped with a 750 – 2,718 MBH Power Flame, 'Low-High-Low' Gas Burner. The Cast Iron Sectional Boiler is currently non-operational and requires immediate system replacement. The cast iron sections have been compromised by rust and degradation and can no longer maintain a seal to contain the water/media within the sections and internal piping assemblies. NSE reviewed the existing system installation and discussed replacement approach during the site tour. It was noted that the existing cast iron boiler assembly was not piped properly during the original install, as the installer did not provide 90 degree swing joint connections to allow for expansion. The Power Flame Burner assembly is equipped with low-high-low capability and is provided with an Outdoor Air sensor system controls for warm weather shutdown (WWSD) to prevent operation during warmer periods. The burner assembly dates to the 2018/2019 gas system replacement effort.

The two-pipe steam system serves areas throughout the original Sanctuary and Fellowship Hall areas, as well as the 1956 rear addition. The existing steam and condensate piping varies in condition throughout the facility, however NSE has been informed that all of the existing steam traps have been replaced over the past three years. Condensate feed tank appeared functional and maintained. Various sections of the steam piping appeared to be insulated with materials that may contain Asbestos. Materials or finishes that are suspected of being Asbestos Containing Materials (ACM's) should be independently tested by a certified testing agency to confirm if ACM's are present and to form an abatement plan if required. If ACM's are confirmed to be present on site, either abatement and removal, or encapsulating the pipes and abandoning them in place may both options.

Existing steam piping runs within various concealed ceiling and wall assemblies – some section of condensate return piping appear to be routed through inaccessible cavity spaces and possibly

concealed within slab/wall assemblies on the lower level. Even though the steam and condensate piping system has been periodically maintained, the piping installed within the 1956 Addition is now 65 Years old. Depending on the local water quality and system maintenance, black steel piping can have a lifespan of approx. 50-100 years.

The Steam system provides Six (6) Zones of Heating:

1. Sanctuary
2. Narthex & Lower Offices
3. Fellowship Hall
4. Sexton & Common Spaces
5. 1st Floor Classrooms
6. 2nd Floor Classroom

Each steam zone of heating is controlled by pneumatic control valve that opens and closes via local space sensor. The pneumatic control valves and associated system piping are served by a dedicated air compressor located within the lower level mechanical boiler room. The existing air compressor appears in relatively new condition, the pneumatic valves appear to be maintained and functional. It is unclear if the existing pneumatic system is intact or if system leaks require the compressor to run more frequently. The pneumatic controls operate on air pressure devices which sometimes can have minor leaks, leaky systems will consume more energy throughout the year to operate the system compressors.

Steam cast-iron radiators are still operational and are found throughout the Original 1861 and adjacent areas of the Facility. The lower level spaces within the Original 1861 building construction have concealed two-pipe steam convectors that are mounted within existing framed cavities below window assemblies at the exterior wall assemblies. The South Church facilities team has maintaining the steam system by replacing failed steam traps and insulating exposed piping where accessible.

The 1956 addition consists of various steam cabinet convectors and steam baseboard sections that have each been equipped with a non-electric zone control valve to provide local temperature control. The non-electric zone valves (NEZV's) act as a means for manual temperature adjustment and can become faulty/compromised over extended periods of use as they operate using very small capillary tubes to adjust the steam valve actuator. When these tubes are damaged the valves no-longer work as intended and can create comfort control issues within the space.

Sanctuary Systems

The Sanctuary is provided with both perimeter cast-iron radiators, as well as (2) Air Handling Units (AHU's) that are concealed within cavities at left and right areas adjacent to the Sanctuary Alter. Each AHU uses a large cast-iron pin radiator to heat the air, supply and return ductwork plenums as well as original internal blower assembly. The original Motor starters and switches are located in the rear corridor at the second seating level, original controls appear to have high/low blower settings. AHU supply ductwork distributes tempered air via ceiling diffusers, and the each AHU has a dedicated return plenum at the first floor level, adjacent the Sanctuary Platform. NSE has been told that the systems are no longer operational, further review would be required in order to determine what repairs are required.

Fellowship Hall Systems

The Fellowship Hall is directly below the Sanctuary and consists of a large gathering space which is used more frequently for community meetings. The Fellowship Hall is served by a large AHU system that is located within the lower level Mechanical room. The AHU is equipped with an outdoor air intake louver/plenum assembly and a fixed damper. When operational, the AHU provides heating as well as ventilation air to the Fellowship Hall space. Supply ductwork is concealed within the ceiling assembly and distributes tempered air via ceiling diffusers. There is a large common return grille that is located centrally at the rear of the space.

Parish Hall / RTU Systems

The 2005 Parish Hall additional of the Facility is served by (2) 10-Ton Packaged DX / Gas-Fired RTU systems which serve various zones. RTU's are equipped with Economizers and provide ventilation as well as heating/cooling during normal occupied periods of operation. These systems date to the 2018 system replacement and are equipped with all new gas piping connections. The RTU systems serve indoor zones via Variable Air Volume box/damper assemblies that can provide heating and cooling. The RTU systems are currently functional, although it was noted that some of the balancing and system control programming was ongoing. NSE would not recommend immediate replacement of these systems and as the Owner has stated the intention is to retain the RTU's this report will not outline any system replacements that are specific to the Parish Hall 2005 HVAC Systems.

Air Conditioning Systems

A/C is currently provided to only the Parish Hall spaces as described above via (2) roof top units (RTU's). More complete and permanently installed A/C systems are being considered for various areas.

The approximate cooling load for the church is estimated approximately at between 60 and 75 tons (1 ton of cooling capacity = 12,000 BTU/Hr). For many Church Sanctuaries it is logical to consider installing less than full calculated capacity for the Sanctuary. Many days will not include a full house and cooling for the heat given off by people is therefore reduced. Additionally, by running an undersized A/C system in advance of occupancy and 'deep' cooling (eg; T'stat set at 68°-70°) the space and thereby storing 'coolth' in the pews and plaster the space temperature once occupied will drift up slowly and provide adequate comfort through the duration of a service and likely for a wedding ceremony as well. Note that the heat given off by 200 parishioners is roughly 6.5 tons. As with heating system design, a room by room cooling load calculation set should be prepared as the first step in designing any A/C systems.

HVAC System Controls

The Church installed a modern digital Schneider based Building Management System (BMS) roughly within the past 2-3 years. The BMS system allows the Owner to control schedules, set points and receive system notifications remotely through a central 'dashboard' or on site at a dedicated BMS 'work station'. NSE has been told that the existing BMS system has the following HVAC system elements within the BMS platform;

- Boiler Plant Control (Enable/Disable, Monitoring, Schedules)
- (6) Zone Control Valves (Occ/Unocc Set Points, Schedules)
- RTU-1 System serving Parish Hall

- RTU-2 System Serving Parish Hall

The Kitchen Equipment has been provided with stand-alone system controls per the manufacturer. The Type-1 Kitchen Hood, and associated exhaust fan and makeup air system all date to the 2019 gas appliance replacements. The Kitchen equipment and system controls have been assumed to be functional and stand-alone for the purposes of this report.

Domestic Hot Water (DHW)

The existing DHW heater is a 2018 RUUD 50 Gallon, Gas-Fired water heater with a 36MBH Input. The system is equipped with a power venter and is DHW consumption on site is fairly low serving; (10) bathroom groups, lower level kitchen fixtures, as well as various hand and custodial sinks on site. Site DHW consumption is relatively infrequent and likely sees large consumption periods before and after Sunday Service and regular weekly meeting times. The existing system has new piping connections at the water heater, but is not equipped with a recirc pump. A recirculation pump is now required by energy code standards based on the plumbing fixture and DHW tank site configuration (IECC has verify stringent requirements that are now based on volume of water within the piping, we will exceed this requirement based on the system piping and fixture locations). A recirculation pump circulates the DHW hot water loop so that when you open the fixture tap hot water is readily available. The pump allows the Owner to limit the water wasted as Occupants wait for hot water at the tap. These pumps and piping could be incorporated within future system designs if requested.

Mechanical Ventilation

The building currently has limited exhaust systems, mainly dedicated systems for bathrooms and the kitchen commercial equipment. The Fellowship Hall AHU system has a dedicated intake louver and plenum assembly to provide Outdoor Air (OA), however the exact airflow quantity is unknown. The Fellowship AHU OA intake plenum is equipped with a pneumatic motorized damper. It is unclear if the pneumatic actuator serving the damper assembly is still functional, or if the system has been balanced based on the required airflow rates for ventilation. Based on the age and equipment assemblies, the system should be inspected to verify function and damper position. The majority of the Office spaces and Classroom spaces do not have active mechanical ventilation systems, but are provided with operable window assemblies for natural ventilation when outdoor conditions allow.

If this Building was designed as a new system, current codes would require a mechanical ventilation system that supplies fresh air and provides balanced exhaust to all Classroom and Assembly spaces. It is still acceptable for Office spaces to be code compliant with operable windows for natural ventilation, so long as the space in question has an operable window to the exterior that is greater than 4% of the floor area served.

Thermal Envelope

The sanctuary has recently undergone significant improvements to its thermal envelope. In 2021 loose-fill cellulose insulation was added to the Sanctuary ceiling cavity to increase the ceiling R-Value, the Sanctuary attic ceiling now has approximately 18”-22” of insulation (approximately R-60+ in total). Fiberglass insulation was also installed at the rear wall assembly at the Sanctuary Alter to further reduce space losses. Additionally, some air sealing was performed in the attic. This report does not attempt to enumerate the remaining opportunities to further insulate and

tighten up the building shell. Window assemblies vary in age and condition, most of the 1860 Window assemblies appear to be original window glazing assemblies with interior shutter assemblies for light.

Solar PV

The Sanctuary roof currently has a 52kW Solar PV Array which is installed for a net-metering utility configuration. This allows any energy produced by the PV array to offset the Building's electrical consumption at the meter assembly. The system equipment is located within the Sanctuary Attic space and is currently operational. The Church Team monitors the Solar production and on-site historical electrical Utility consumption.

SYSTEM REPLACEMENT OPTIONS

Option-1: Existing Steam Boiler System Replacement

As replacement will be required prior to the next heating season, this option consists of replacing the boiler to maintain the existing Steam system for space heat production. The proposed scope includes a new steam boiler equivalent to the existing HB Smith 28A cast-iron sectional boiler with an approximate capacity of 1,733 MBH steam heat production. The new steam boiler system would be served by the existing 2019 PowerFlame natural-gas burner assembly. The existing boiler header was piped incorrectly, which does not allow for proper pipe expansion between the piping sections at the common steam header. Typically, steam piping connections at the boiler discharge are required to be provided with a 90 degree elbow to allow the multiple steam connections to slightly expand as the boiler/piping assemblies expand and contract.

This option will allow the facility to retain the existing steam and condensate piping, radiators, valve assemblies, system controls and system appurtenances without requiring a complete system replacement. As a result of maintaining the existing piping systems, you also run the risk of older piping system failures and ongoing maintenance. As the piping system degrades over time, future repairs and emergency failures are likely to occur with more frequency. It is recommended that the new boiler is provided with a dedicated water meter on the boiler cold water feed. This will allow the Owner's team to monitor water consumption in the system in order to understand if there are any existing leaks within the steam distribution piping system.

Please see *Appendix F – Boiler Replacement Quote* for detailed information regarding a replacement proposal by Industrial Boiler and Mechanical Services, LLC.

Option-1: Existing Steam Boiler System Replacement

This option allows the building to retain natural gas as the main source of fuel on site for heating. This options provides heating only, no cooling.

Estimated Cost of Construction ..……..$49,000 – $59,900
Estimated Annual Cost Savings ..……...$0/Year
Estimated Reduction in Emissions ……..…….…… 0 lbs CO2e
Estimated Payback Time……..…… N/A

Option-2: Gas-Fired High-Efficiency Hydronic System and Boilers

The proposed heating system includes two new, high efficiency gas fired condensing mode boilers, each with a rated efficiency of at least 95%. 'Condensing mode' refers to the type of combustion technology used. Condensing mode boilers are constructed so that the combustion exhaust gases are routed through an additional heat exchanger that transfers enough of the heat from the high temperature combustion gasses that they drop below the dew point and water (H_2O) is condensed out of the now cooler flue gases. The phase change from water vapor (gaseous state) to liquid water extracts 1,000 BTU/lb-vapor of useful heating energy to heat the hot water and improve efficiency. This slightly acidic flue gas condensate is drained away from the boiler, buffered by lime chips in a small piped container and then piped to a regular waste drain connection. This technology is well proven and in fact is essentially required for new hot water boiler installations based on the requirements of the current International Energy Conservation Code (IECC).

Our design recommendation is to use two small boilers that together provide approximately 120% of the required 'design load' heating output capacity on the coldest night of winter and thereby should one boiler fail, the capacity provided by the remaining boiler will be able to keep the building from freezing on this worst case day and fully comfortable on an average winter day. This partial redundancy is important for a building of this type. The firing rate of this type of boiler will automatically modulate between 100% & 20% output (5 to 1 turndown ratio) to match the heating load as it changes with warmer or cooler weather. By code, boiler controls must now include outdoor reset of circulating water temperature where the hot water supply (HWS) temperature out of the boiler system to the heating terminal units is reduced as outdoor temperatures increase and less heat is needed to achieve thermostat set points. A typical new hydronic system installation of this type would normally be sized using a maximum hot water supply (HWS) temperature of 160° F or lower when outdoor temp's (To) are lowest (eg: 0° F) and vary down to approximately 110° F when outdoor temps are in the high 50's. Your existing steam heating terminal units are operating at a temperature of approximately 210° F.

Venting & Combustion Air

The existing boiler system draws outdoor combustion air into the space via sidewall intake louvers at the mechanical room exterior wall. When the boiler's gas burner is enabled, the burner combusts gas with the combustion air and the exhaust flues are vented through the masonry chimney to the outdoors. Once the existing boiler is removed the existing masonry chimney will no longer be in service and can be used as a chase to the roof to run the new boiler venting and combustion air piping (made of plastic) for the new boilers. In this way, the vents will be concealed within the masonry chimney to preserve exterior appearance and avoid new roof penetrations. All combustion air for the boilers will be piped directly to each boiler, thereby eliminating the drafts and uncontrolled heat loss created by permanently open combustion air intake louvers to the exterior as is currently installed.

System Piping

The existing Steam piping is not suitable for a hydronic boiler system application. The piping is likely corroded based on the past 60+ years of service and would not lend itself to reuse based on size and conditions. If a new Hydronic Boiler System was provided on site, all supply and distribution piping would be new. The boiler systems would be provided with local piping connections to the common piping loop in a primary/secondary piping arrangement. Any new system installation would need to be carefully reviewed during the design phase to minimize the

impact on existing finishes and limit cost for ceiling repair and cutting and patching.

Zoning and Variable Speed Pumping

There are currently (6) temperature zones served by the existing Steam Boiler system. Some of these zones, such as the Sanctuary space, could be modified to better serve the needs of the church and allow perimeter heating systems to be separately controlled from the larger AHU systems. Any future system replacement would include multiple zones of control and variable speed pumping. Motorized two-way valves would be provided at AHU's / radiators and open on call for heat from the local thermostat. When the heating demand is satisfied, the two-way valve will close, stopping water flow. Variable speed pumps will automatically detect the change in flow requirements and reduce speed and flow to provide electrical power savings, when compared to conventional pumps. For reliability we recommend using a duplex pumping arrangement where two pumps are installed each capable of serving the whole building. Automatic controls will bring on the second pump if the other fails and can also provide automatic switching between pumps to allow equal number of hours over time.

Heating Terminal Units (Radiators, Fan Coils, Base Board, etc.)

In a conversion to high efficiency condensing mode gas boilers, maximum hot water supply temperature would need to be reduced to maximize system efficiency. This reduction in water temperature reduces the heat output of hydronic terminal units compared against a Steam Radiator supply temperature. With this in mind, additional terminal units may be required in some spaces to meet the heating load. This cannot be fully quantified until heating load calculations are performed on a room by room basis and the existing terminal units in each room are examined for their performance at lower water temperatures than exist today.

The following outlines the several other hydronic heating radiation/convection devices that we believe are applicable to your building's various spaces. The following options all have differing aesthetics and material costs.

Steel Panel Radiators: Steel panel radiators are the modern equivalent of cast iron products and are available in many geometries and colors. We believe they are appropriate for use in most of your spaces. Please note that there is a broad range of steel panel radiators that vary in cost. Radiators manufactured by Runtal, are a premium product that we often use in areas where aesthetics are more critical. Compared to a commercial baseboard product, the Runtal Steel panel radiators are approximately four times more in initial cost for a comparable BTU/Hr output. Comparing the Runtal panel radiator, to a lower initial cost Hydronic Alternatives panel radiator, the Runtals are approximately 30% higher in initial cost. Please refer to the product cuts in the Appendix-E of this report. During design radiator style, color, and geometry need to be worked out.

Finned Tube Element: Currently installed in the sanctuary, Commercial finned tube baseboard convector products offer a cost-effective alternative compared to steel panel radiators, but are less attractive and do not come in as many geometric options. The least costly finned tube convector is a sheet metal baseboard style. Please refer to the product cuts in the Appendix-E of this report.

Fan Coils: Like in the Sanctuary that uses 'cabinet' fan coils, are a mechanical unit that houses a fan with a heating and/or cooling fin-tube coil(s). A fan coil takes return air from the space and passes it through the coil assembly to transfer the energy from the hot water in

the coil to the air, which is then supplied back into the conditioned space. Fan coils come in a variety of mounting types, can be connected to a concealed ducted systems or ductless exposed systems. The heating/cooling source in of the coil, can be in the form of hydronic (hot water), electric resistance, chilled water, or a refrigerant media (see mini-split fan coils below).

Non-electric Zone Valves: These valves are not heating elements, but they are a type of controlling valve that allows individual heating elements to have their own adjustable means of flow control. The non-electric zone valves (NEZVs) are thermostatic valves that have adjustable dials that control the flow of water through the heating element. The NEZV does not require electrical connections or any form of low voltage wiring, is self-regulating and can sense ambient temperatures to control flow in response to the user's desired setting. This valve can be beneficial for areas such as bathroom or hallway spaces that may not need a thermostat with a 2-way valve (avoiding additional installation costs). They are single set point controllers and are not programmable.

Zone Temperature Controls

Zone temperature control options vary in cost and complexity. At a minimum, the new zone controls should include independent thermostats for each Classroom, Office or dedicated area of heating zone control. New thermostats should be capable of integration within the existing Schneider based BMS system as well as allow occupant temporary override. This will allow local adjustment by the space occupants as well as scheduling and set back control via the BMS.

Option-2: Gas-Fired High-Efficiency Hydronic Boilers

This Option retains natural gas as the main source of fuel on site for heating and would provide lower heating operating costs compared to Options 3, 4A & 4B. However, unlike Options 3, 4A & 4B this system option would not provide cooling.

Estimated Cost of Construction ..... $ 760,000 - $1,000,050
Estimated Annual Cost Savings .....$ 1,638 /Year
Estimated Reduction in Emissions ..... 20,006 lbs CO2e
Estimated Payback Time..... 460+ Years

There are prescriptive utility rebates for the new High-Efficiency Boiler systems as well as potentially Variable Frequency Drive rebates depending on the final equipment selections. The project would be considered commercial and to maximize rebates, we recommend that the church also considers a 'custom rebate' approach which would involve an application and analysis by the utility.

Option-3: Air Source Heat Pumps (ASHPs)

ASHP System Overview:

New Air Source Heat Pump (ASHP) systems shall include new cold climate, Variable Refrigerant Flow (VRF) outdoor heat pump units, refrigerant piping, indoor air handling units, and associated system controls and appurtenances. These new cold climate VRF units provide 100% of the listed heating capacity at 5°F outdoor temperature and 78% heating capacity at -13°F. The output will meet the building heating load at these cold

outdoor temperatures using only heat pump operation without the need for auxiliary electric heat. Therefore, auxiliary electric heat is an option to be considered for use when/if the outdoor heat pump has a failure and/or needs service. It is far more efficient and cost effective to use the heat pump operation for heating rather than the auxiliary electric coil.

Heat Pump Systems can be designed in various indoor fan coil unit (FCU) zoning configurations, based on the required quantities and unit capacities. Each FCU system is essentially a zone of space conditioning and each FCU is capable of providing both heating and cooling. The systems range in complexity based on the site requirements and Owner desires. A more conventional Heat Pump system would allow all of the zones to be in either heating mode or cooling mode – however not simultaneous heating/cooling spaces. More modern Heat Pump systems allow simultaneous heating and cooling on the same system through the use of devices call Brachbox Controllers (BC's). In this approach, if one FCU is getting a call for heating and another for cooling, both FCU's can operate simultaneously to satisfy their local thermostatic set point.

Indoor FCU's are available as ductless and ducted systems, based on the space they are serving and system capacity requirements. Product cuts have been provided for reference within the following Appendix-C.

ASHPs are a good solution to provide heating and cooling while minimizing space requirements, installation cost, annual operating cost, and emissions. The ASHP option has a nearly 30% reduction in CO2e emissions when compared to the existing steam system.

It should be noted that the installation of an electrically operated ASHP system may require an electrical service to increase. The final project design scope will include any additional requirements for electrical service increases and coordination with the utility.

Option-3: Air Source Heat Pumps (ASHPs)

This option consists of new VRF Heat Pump systems to provide heating and cooling throughout the 1860 Original Section of the Building as well as the 1956 Section of the Building – essentially all areas outside of the Parish Hall, that are currently served by the Steam boiler. This Option allows both heating and air conditioning at each FCU and would allow the Owner greater flexibility with regard to zone control. However, this option will have higher heating operating costs and will likely require a new electrical service.

Estimated Cost of Construction ..... $860,000 - $960,000
Estimated Annual Cost Savings ..... ($15,661)*
Estimated Reduction in Emissions ..... 59,650 lbs CO2e
Estimated Payback Time..... N/A
*Value Represents an increase in Annual Costs

Option-4A & 4B: Ground Source Heat Pumps (GSHPs)

Ground source heat pump systems will result in the lowest emissions of the system types examined within this Study. Option-4A: Water-to-Air heat pump system will reduce CO2e emissions by 120,444 lbs/Yr or 61% less than Option-1 (gas-fired steam boiler system). However, the annual operating cost is estimate at $4,890/Year more than Option-1 (gas-fired steam boiler system). Option-4B: Water-to-Water heat pump system will reduce CO2e emissions by 98,748 lbs/Yr or 50% less than Option-1. However, the annual operating cost is estimated at $10,880/Year more than Option-1 (gas-fired steam boiler system).

Ground source heat pumps (GSHP's), also called Geothermal heat pumps use the relatively moderate and constant temperature of the earth as a thermal source for heating and as a thermal sink when used to help provide cooling as opposed to air source heat pumps (ASHP) that use outside air. Keep in mind that all GSHP or ASHP use electricity to power the compressors that do most of the work transferring thermal energy from one coil to another using a refrigerant cycle just as does a refrigerator or typical air conditioner. GSHPs electrical power is also used to pump circulating fluid for the geothermal coupling portion of the system.

One of the critically important realities about GSHP systems is that if they are used solely or dominantly for either heating or cooling this will typically result in 'thermally polluting' the well system. As an example: If the church uses the system only to heat the building the heat exchange to the ground is only an extraction of heat that will continue to lower the ground temperature around the wells. GSHPs suffer reduced efficiency or COP (coefficient of performance) as the temperature of the geo loop drops. Without operating in the cooling mode where heat is delivered from the building to the ground, geo loop temps will continue to drop and ultimately the drop in COP will result in both a reduction in heating capacity which mean the system can no longer provide the required heating and commensurately there is an extreme increase in operating cost. This then implies that with a GSHP the Church would have to provide cooling through the new system which is an amenity we understand is desired by the parish. Note that providing cooling from any system type that adds capacity as compared to the small A/C now provided will add to the operating cost of the building.

To build the geothermal coupling part of the system we recommend drilling ***vertical wells*** on site. Each well bore would be 6" in diameter, roughly 450 feet deep, include a pair of 1-1/4" HDPE pipes with a return bend at the bottom of the well, and then receive thermally conductive grout injected into the bore to help make proper thermal contact between the ground and the recirculating loop. Ultimately, site testing will need to be performed to verify the ground characteristics and confirm how many vertical wells are required. Each pair of well pipes would then be routed into the building mechanical room where they join (manifold) together to make the overall pumped circulating geothermal loop. The pump system for this loop would be variable speed and be piped through a water-to-water heat exchanger that then exchanges heat with the hydronic loop that serves the various heat pumps in the building that ultimately transfer heat obtained from the ground into the spaces. During the cooling season the process is reversed and heat from the spaces is moved by the heat pumps into the hydronic loop where it passes through the water-to-water heat exchanger, thereby into the geothermal loop and finally through the wells and into the ground.

To provide the heating (and cooling) requirement for the Church initial space heat gain/loss calculations need to be performed and the ground thermal conductivity needs to be evaluated. Wells should be 20 feet apart minimum and the exact location and design configuration would

need to be evaluated by a geothermal technician who specializes in GSHP system installations. Part of the challenge is the cost of creating the well system, related pumping and the heat exchanger which would can vary in cost from site to site.

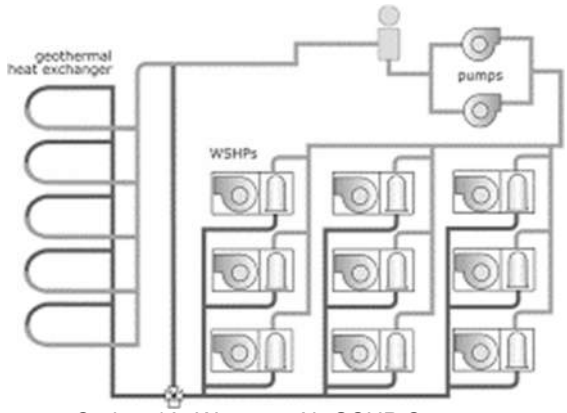
For the Church there are many site challenges that would need to be addressed during the system design process, such as

- Location of wells on site
- Pipe routing at exterior from wells to building penetration
- Location of system well water pumps and heat exchanger

GSHPs Applicable to Our Site are as Follows:

A) 'Water-to-Air' & 'Water-to-Water' GSHP's

The water-to-air type is predominantly used in new building construction projects or buildings that already have air distribution ductwork that is insulated so it can properly convey cooled air (55 Deg F). A two pipe system from the well system heat exchanger circulates water to heat pump units, both small and large. Each heat pump unit includes the refrigerant based heat pump and compressor system and either warms or cools the air and a fan and motor that move the air through ducts to the spaces. Cabinet fan coils are also available that provide the same function but without the requirement for ducts; they are located within the conditioned space and you can hear the fan and compressor noise which is likely not ideal for the sanctuary. Each of the heat pumps provides a zone of temperature control.



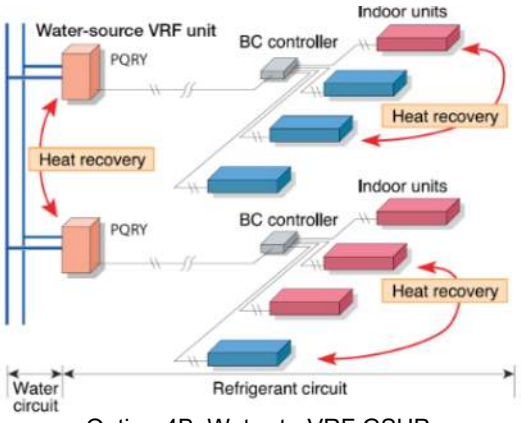
Option-4A: Water-to-Air GSHP System

'Water-to-Water' GSHP's utilize a hydronic closed loop of piping and a series of heating radiators and convectors to distribute heat into the space, in lieu of a ducted air distribution system. This will allow the use of perimeter panel radiators, baseboard and hydronic convector terminal heating systems as described within the Hydronic Boiler system approach in Option-2. Hydronic perimeter heating is more ideal for spaces such as the Sanctuary, where interior acoustics may be impacted by larger air distribution systems. This option would consist of a mixture of both 'Water-to-Water' and 'Water-to-Air' GSHP's as there are different design strategies that may be more ideal based on the various space usage. It is important to note that a water-to-air system has a 28.6% higher COP rating than the water-to-water system, resulting in lower operating costs and a greater reduction in CO2e.

B) Water-to-VRF GSHPs

Water-to-VRF GSHPs are similar to the water-to-water system operation, but transfer the thermal energy between the well system and central VRF heat pumps. Similar to what is described for the Air-to-Air approach (Option-3), instead of the VRF system using the ambient air for heat rejection/extraction, the geothermal loop is used as a heat source and heat sink. It is similar technology, however now the Owner has the flexibility to zone indoor FCU's in different ducted or ductless FCU configurations (compared to all ducted terminal units required in Option-4A). These larger VRF units would live in the mechanical room housing the well pumps and heat exchanger systems. Refrigerant pipes would then route through the building to the various FCU's that include all of the styles described in the air-to-air ASHP Option-3. Efficiencies are slightly better in this approach, compared against an ASHP air-to-air system in Option-3.

This system approach will have a higher initial cost due to the infrastructure of vertical wells, system piping, pumps, as well as landscaping/sitework that will be required once the mechanical systems are in place. Due to these increased system costs, this option does not present itself as a cost-effective solution. However, it does offer the great benefit of least emissions and when the grid becomes 100% emissions free (as would any of the all electric heating system options stated in Option).



Option-4B: Water-to-VRF GSHP

Option 4A: Ground Source Heat Pump System Water-to-Air

Estimated Cost of Construction Option-4A (Water-to-Air)……..…$975,000 - $1,250,000
Estimated Annual Cost Savings Option-4A (Water-to-Air)……($3,536)
Estimated Reduction in Emissions Option-4A (Water-to-Air)..……120,444 lbs CO2e
Estimated Payback Time……..…N/A
*Value Represents an increase in Annual Costs

We do not know of any incentives through your utilities that will help fund this approach. Working the relationships you have with both your gas and electric utilities towards the end of obtaining all the available rebates & help will be important.

Option-4B: Ground Source Heat Pump System B) Water-to VRF

Estimated Cost of Construction Option-4B (Water-to-VRF)……...$ 975,000 - $1,250,000
Estimated Annual Cost Savings Option-4B (Water-to- VRF)…… ($7,886)
Estimated Reduction in Emissions Option-4B (Water-to- VRF)..……..98,748 lbs CO2e
Estimated Payback Time……..…N/A
*Value Represents an increase in Annual Costs

OTHER THINGS TO CONSIDER

Increase Electrical Load Panels

The existing Electrical Service is 400A/208V/1ph. As a result of an replacing a gas-fired heating system with an electrically operated Heat Pump system, it is likely that the new electrical connected load will exceed what the current service is designed for. This will be further analyzed during the design phase as we define the site requirements.

ACM (Asbestos) Testing

The Owner should contact and independent testing agency if they would like to confirm whether or not the existing steam pipe insulation contains Asbestos. NSE can provide the contact information for testing companies if requested.

UTILITY REBATES

Utility rebates are available that will help reduce the cost of the heating system installation. Rebates/Incentives are paid for by the 'sponsors' of Mass Save, namely the utility companies that participate in the program. It's all done through the Mass Save program, but the money comes from the utilities. We anticipate that MassSave would provide rebates and incentives based on Business/Commercial Rebate Programs. Full rebate potential will not be known until the replacement system has been determined and system designs are underway. However, it is best practice to contact MassSave prior to any work being performed so that they may assist with the project scope and rebate potential.

Helpful Rebate Likes and Information:

https://www.masssave.com/en/saving/business-rebates/

https://www.masssaveapplicationportal.com/resource/1551816311000/BusinessIncentives

https://www.masssaveapplicationportal.com/resource/1550805328000/MAPApplicationDocumentation

We recommend that you or the consulting engineer before design, speak with a representative, describe the project(s) that will be implemented and they can help the process and requirements. MassSave typically recommends getting a Facility Assessment from their energy audit providers where they analyze what qualifies for updating or retrofitting, recommend controls, and other energy saving solutions. These typically should include new lighting systems, low flow plumbing aerators and fixtures, High-Efficiency Heating & Water Heater equipment, variable speed pumping, pipe insulation, HVAC system controls, and thermal envelope air sealing & weatherization.

APPENDIX A:

Photographs

DHW Gas-Fired Heater System 36MBH

Power-Flame Gas Low-High-Low Boiler Burner

Smith Boiler Assembly – Cast Iron Sectional Boiler

Condensate Feed Pump & SPR Piping

Fellowship Hall Air Handling Unit

Boiler Combustion Intake & AHU OA Intake Louver

Air Compressor Serving Pneumatic Control

Electrical Service Panel and Solar PV Equipment

Sanctuary Space
(Currently Undergoing Ceiling Plaster Repairs)

Sanctuary Typical Cast Iron Steam Radiator

Entry Area Cast Iron Steam Radiator

Main Sanctuary Entry Area

Sanctuary AHU in Dedicated Closet

Sanctuary AHU Controls

Sanctuary Attic Space

Lower Level Bathroom

Lower Level Steam Convector

Fellowship Hall

1860 Parish Room – Recessed Convectors

1956 Addition – 2nd FL Classroom

New 2019 Kitchen Equipment; Range/Griddle, Oven and Hood Assemblies

New Kitchen Exhaust Fan and MAU

Gas Meter and Regulator Valve Assembly

South Church – 2003 Parish Hall Addition and South Elevation of 1860 Sanctuary

North Elevation of 1860 Sanctuary and Fellowship Hall

1956 & 2003 Addition West Elevation (Rear of Building)

NORIAN / SIANI ENGINEERING, INC.
43 Bradford Street, Concord, MA 01742 • Tel: 781-398-2250

APPENDIX B:

Energy Consumption Analyses

NORIAN / SIANI ENGINEERING, INC.

43 Bradford Street, 3rd Floor, Concord, MA, 01742-2972 Tel: (781) 398-2250

Project: South Church Andover
Date: 1/12/2022

EXISTING SPACE HEAT CONSUMPTION ANALYSIS

ANNUAL HEATING SEASON	TOTAL CONSUMPTION (Therms/Year)	TOTAL CONSUMPTION (BTU/Year)	AVERAGE SEASONAL COMUSTION EFFICIENCY (%)	BUILDING HEATING REQUIREMENT (BTU/YR)	HEATING DEGREE DAYS (HDD/YEAR) (BASE 65F)	BUILDING HEATING REQUIREMENT (BTU/HDD-YR)
2019-2020 Summary	11,901	1,190,129,520	75.60%	899,737,917	5,709	157,600

HDD Historic Norm = (1991-2010)	5759

ANNUAL HEATING SEASON	TOTAL CONSUMPTION (Therms/Year)	TOTAL CONSUMPTION (BTU/Year)	AVERAGE SEASONAL COMUSTION EFFICIENCY (%)	BUILDING HEATING REQUIREMENT (BTU/YR)	HEATING DEGREE DAYS (HDD/YEAR) (BASE 65F)	BUILDING HEATING REQUIREMENT (BTU/HDD-YR)
ANNUAL NORMAL = (Corrected for Weather)	12,006	1,200,573,641	75.6%	907,633,673	5,759	157,600

2021 Natural Gas Cost =	$0.968	$/Therm

Total Cost =	$11,621.55	$/Year

Existing System Average Annual Cost (VALUES DO NOT INCLUDE ESTIMATED PARISH CENTER OR DHW GAS CONSUMPTION WHICH ARE EXISTING TO REMAIN)

NORIAN / SIANI ENGINEERING, INC.
43 Bradford Street, 3rd Floor, Concord, MA, 01742-2972 Tel: (781) 398-2250

Project: South Church Andover
Date: 1/12/2022

SYSTEM OPERATING COSTS & EMISSIONS COMPARISON

Natural Gas Cost: $ 0.968 / Therm
Heating Electricity Cost: $ 0.256 / KWH

Notes: For this comparative analysis we have used two years of Gas consumption records and the historical climate record to derive a normal consmption for an average winter. Using this value, current utility costs and annual system efficiency we are then able to calculate heating season energy consuption and costs for different system options. We have included a few system options that are not under consideration but we believe they are useful for comparative and informational purposes. The cooling load we have shown is not intended to predict the historical consumption which has not been analyzed.

Operating Costs & Emissions Comparison

	System Type	Fuel Cost									Emissions [1]					
		Fuel	BTU / Unit	$/UNIT	System Efficiency [7]	Total BTU/Yr Required (load)	Fuel units Required (input)	Cost $/yr	Difference from Existing Condition [13]	Multiple Vs. Reference [8]	CO_2 [2] lbs	CH_4 [3] lbs	SO_2 [4] lbs	NO_x [5] lbs	CO_2e [6] lbs	Multiple Vs. Reference [9][10]
HEATING	**OPTION-1:** Gas Fired Steam Boiler System Replacement	Natural Gas	100,000 / gal	$0.9680	75.6%	907,633,673	12,006	$11,621.55	$0	1.00	141,187	28	1	118	141,982	1.00
HEATING	**OPTION-2:** Condensing Boilers w/ HWS=180F max at To=0 Deg F	Natural Gas	100,000 / therm	$0.968	88.0%	907,633,673	10,314	$9,984	-$1,638	0.86	121,293	24	1	101	121,975	0.86
HEATING	**OPTION-3:** Air Source Heat Pump (ASHP)	Electricity	3,413 / kWh	$0.256	250.0% [11] [12]	907,633,673	106,374	$27,283	$15,661	2.35	79,461	691	18	37	98,821	0.70
HEATING	**OPTION-4A:** Ground Water Source Heat Pump - Water to Air	Electricity	3,413 / kWh	$0.256	450.0% [11]	907,633,673	59,097	$15,157	$3,536	1.30	44,145	384	10	21	54,901	0.39
HEATING	**OPTIONS 4B:** Ground Water Source Heat Pump - Water to VRF	Electricity	3,413 / kWh	$0.256	350.0% [11]	907,633,673	75,981	$19,488	$7,866	1.68	56,758	494	13	27	70,587	0.50
HEATING	Electric Resistance Heat	Electricity	3,413 / kWh	$0.256	100.0%	907,633,673	265,934	$68,207	$56,585	5.87	198,653	1,729	45	93	247,053	1.74
COOLING	Window Air Conditioners & Older RTU (SEER 11)	Electricity	3,413 / kWh	$0.256	290%	175,000,000	17,681	$4,534.79	$1,484	48.6%	13,208	115	3	6	16,426	1.49
COOLING	Chiller with Fan Coils & Newer RTU (SEER 13)	Electricity	3,413 / kWh	$0.256	328%	175,000,000	15,632	$4,009.42	$958	31.4%	11,677	102	3	5	14,523	1.31
COOLING	DX Cooling with Fan Coil (14 SEER)	Electricity	3,413 / kWh	$0.256	345%	175,000,000	14,862	$3,811.85	$761	24.9%	11,102	97	3	5	13,807	1.25
COOLING	DX Cooling with Fan Coil or Mini-split (16 SEER)	Electricity	3,413 / kWh	$0.256	375%	175,000,000	13,673	$3,506.90	$456	14.9%	10,214	89	2	5	12,702	1.15
COOLING	Mini-Split Air Source Heat Pump in Cooling Mode (21 SEER)	Electricity	3,413 / kWh	$0.256	431% [11] [12]	175,000,000	11,897	$3,051.25	$0	0.0%	8,887	77	2	4	11,052	1.00
COOLING	Ground Water Source Heat Pump in Cooling Mode (SEER 18.5)	Electricity	3,413 / kWh	$0.256	488% [11]	175,000,000	10,507	$2,694.86	-$356	-11.7%	7,849	68	2	4	9,761	0.88

Notes

[1] **Emissions** for electricity are based on ISO NE 2015 annual emissions rates. Emissions for other fuels are estimated using *Emissions Factors and Energy Prices* , April 2004 by Leonardo Academy, Inc.
[2] **Carbon Dioxide (CO2)** is released when fossil fuels (e.g., Coal, Oil, and Natural Gas) are burned. Carbon Dioxide, a greenhouse gas, is a major contributor to global warming.
[3] **Methane (CH4)** is the primary component of natural gas and is a potent greenhouse gas. Methane is released due to leakage in the distribution infrastructure. Based on the 2014 study, Methance Emissions from Natural Gas Infrastructure and Use in the Urban Region of Boston, Massachusetts, published in the Proceedings of the National Academy of Science, the approximate leakage rate for infrastructutre in the Boston Metro Area is 2.7%. Since methane in its unburned state has a significant impact on global warming, this emission has been added in for both electricity and natural gas options.
[4] **Sulfur Dioxide (SO2)** is formed when fuels containing sulfur are burned, primarily coal and oil. Major health effects associated with SO2 include asthma, respiratory illness and aggravation of existing cardiovascular disease. SO2 combines with water and oxygen in the atmosphere to form acid rain, which raises the acid level of lakes and streams and accelerates the decay of buildings and monuments.
[5] **Nitrogen Oxides (NOx)** form when fossil fuels are burned at high temperatures. They contribute to acid rain and ground-level ozone (smog), and may cause respiratory illness in children with frequent high level exposure. NOx also contribute to oxygen deprivation of lakes and coastal waters which is destructive to fish and other animal life.
[6] **Carbon Dioxide Equivalent (CO_2e)** is a measure of the varying global warming potential (GWP) of different greenhouse gases. This scale is based on CO_2 which has a GWP of 1.0. CH_4 has a GWP of 28, meaning that 1 lb of CH_4 contributes as much to global warming as 28 lbs of CO_2. GWP values are for
[7] **System efficiency** is a critical factor in comparing fuel costs. Efficiencies shown above are seasonal not steady state.
[8] **Multiple Vs. Reference** This value = how many times more or less an alternative system will cost to operate.
[9] **Multiple Vs. Reference** For heating this value = how many times more or less an alternative system will omit of CO_2e compared to the existing system.
[10] **Multiple Vs. Reference** For cooling this value = how many times more or less an alternative system will omit of CO2e compared to the suggested option.
[11] **Heat pump efficiency** is often expressed as a Coefficient of Performance, COP. A Seasonal Energy Efficiency Ratio for cooling, SEER of 19 = a COP of 5.00 or a listed System Efficiency of 500% .
[12] **Air Source Heat Pumps** in our area achieve lower COPs than manufacturer's ratings.
[13] **Difference From Existing Condtion** For cooling this value = how much more or less an alternative system would cost compared to the recommended option.

NORIAN / SIANI ENGINEERING, INC.
43 Bradford Street, Concord, MA 01742 • Tel: 781-398-2250

APPENDIX C:

Product Information

CITYMULTI®

20-TON PURY-HP240TSNU-A

MITSUBISHI ELECTRIC

Job Name:

System Reference: Date:

208/230V OUTDOOR VRF HEAT RECOVERY SYSTEM

ACCESSORIES

- ☑ Twinning Kit (Required) CMY-R200NCBK
- ☑ BC Controller (Required) ..... for details see BC Controller Submittals
- ☐ Joint Kit ..... for details see Pipe Accessories Submittal
- ☐ Panel Heater Kit ..... for details see Panel Heater Kit Submittal
- ☐ Snow/Hail Guards Kit ..... for details see Snow/Hail Guards Kit Submittal

Specifications			System
Unit Type			PURY-HP240TSNU-A
Cooling Capacity (Nominal)		BTU/H	240,000
Heating Capacity (Nominal)		BTU/H	270,000
Net Weight		Lbs. [kg]	1324 [600]
Refrigerant Piping Diameter	Liquid (High Pressure)	In. [mm]	7/8 [22.2] Brazed
	Gas (Low Pressure)	In. [mm]	1-3/8 [34.93] Brazed
Max. Total Refrigerant Line Length		Ft.	2624
Max. Refrigerant Line Length (Between ODU & IDU)		Ft.	541
Max. Control Wiring Length		Ft.	1640
Indoor Unit Connectable	Total Capacity		50.0~150.0% of outdoor unit capacity
	Model/Quantity		P05~P96/2.0~50.0
Sound Pressure Levels		dB(A)	67.0–68.0
Sound Power Levels		dB(A)	87.0/88.0
Compressor Operating Range			7.5% to 100.0%
AHRI Ratings (Ducted/Non-ducted)	EER		11.2/11.7
	IEER		18.8/22.2
	COP		3.36/3.56
	SCHE		22.9/26.8

Specifications			Module 1	Module 2
Unit Type			PURY-HP120TNU-A	PURY-HP120TNU-A
Cooling Capacity (Nominal)		BTU/H	120,000	120,000
Heating Capacity (Nominal)		BTU/H	135,000	135,000
Guaranteed Operating Range[1]	Cooling[2]	°F [°C]	23.0~126.0 [-5.0~52.0]	23.0~126.0 [-5.0~52.0]
	Heating[3]	°F [°C]	-22~60 [-30.0~15.5]	-22~60 [-30.0~15.5]
Extended Operating Range	Heating	°F [°C]	-31.0~60.0 [-35.0~15.5]	-31.0~60.0 [-35.0~15.5]
External Dimensions (H x W x D)		In. [mm]	71-5/8 x 48-7/8 x 29-3/16 [1818 x 2401 x 740]	71-5/8 x 48-7/8 x 29-3/16 [1818 x 2401 x 740]
Net Weight		Lbs. [kg]	662 [300]	662 [300]
External Finish			Pre-coated galvanized steel sheet <MUNSELL 5Y 8/1>	Pre-coated galvanized steel sheet <MUNSELL 5Y 8/1>
Electrical Power Requirements	Voltage, Phase, Hertz, Power Tolerance		208/230V, 3-phase, 60 Hz, ±10%	208/230V, 3-phase, 60 Hz, ±10%
Minimum Circuit Ampacity		A	47.0/44.0	47.0/44.0
Maximum Overcurrent Protection		A	70/60	70/60
Recommended Fuse Size		A	70/60	70/60
Recommended Minimum Wire Size		AWG [mm]	4/4 [21.2/21.2]	4/4 [21.2/21.2]
SCCR		kA	5	5
FAN[4]	Type x Quantity		Propeller fan x 2 x 2	Propeller fan x 2 x 2
	Airflow Rate	CFM	9550	9550
	External Static Pressure	In. WG	Selectable; 0.00, 0.12, 0.24, 0.32 In. WG; factory set to 0 In. WG	Selectable; 0.00, 0.12, 0.24, 0.32 In. WG; factory set to 0 In. WG
Compressor	Type x Quantity		Inverter scroll hermetic x 1	Inverter scroll hermetic x 1
Refrigerant	Type x Original Charge		R410A x 23 lbs + 12 oz [10.8 kg]	R410A x 23 lbs + 12 oz [10.8 kg]
Protection Devices	High Pressure Protection		High pressure sensor, High pressure switch at 4.15 MPa (601 psi)	High pressure sensor, High pressure switch at 4.15 MPa (601 psi)
	Inverter Circuit (Comp./Fan)		Over-heat protection	Over-heat protection
	Fan Motor		Over-current protection	Over-current protection

NOTES:
Nominal cooling conditions (Test conditions are based on AHRI 1230)
Indoor: 80°FD.B./67°FW.B. (26.7°CD.B./19.4°CW.B.), Outdoor: 95°FD.B. (35°CD.B.)
Nominal heating conditions (Test conditions are based on AHRI 1230)
Indoor: 70°FD.B. (21.1°CD.B.), Outdoor: 47°FD.B./43°FW.B. (8.3°CD.B./6.1°CW.B.)

[1]Harsh weather environments may demand performance enhancing equipment. Ask your Mitsubishi Electric representative for more details about your region
[2]For details on extended cooling operation range down to -10° F DB, see Low Ambient Kit Submittal
[3]When applying product below -4°F, consult your design engineer for cold climate application best practices, including the use of a backup source for heating
[4]Unit will continue to operate in extended operating range, but capacity is not guaranteed

Each individual module requires a separate electrical connection. Refer to electrical data for each individual module.

Specifications are subject to change without notice.

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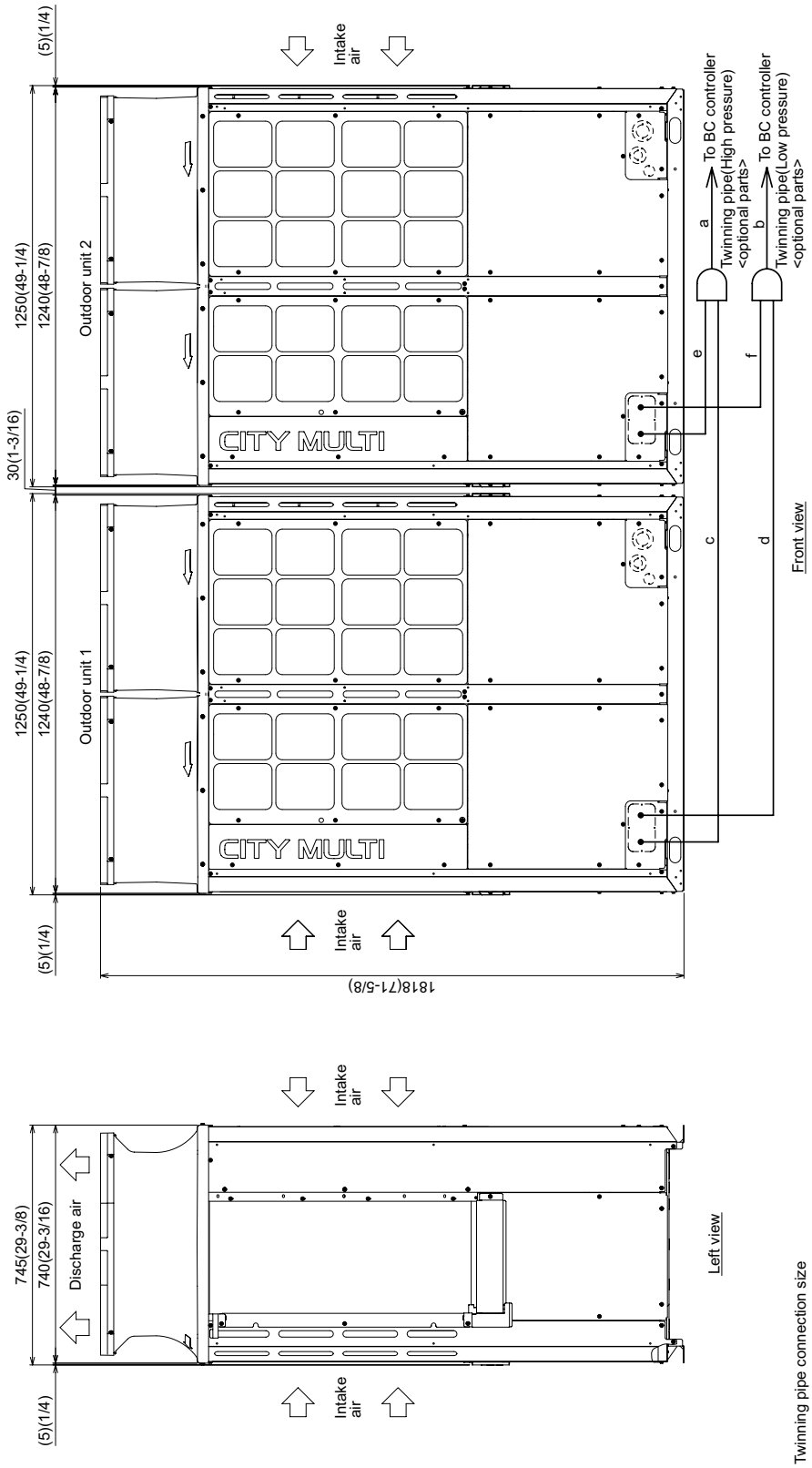
OUTDOOR UNIT: PURY-HP240TSNU-A – DIMENSIONS

PURY-HP144, 192, 240TSNU-A

Unit: mm (in.)



		High pressure	Low pressure
	Unit model	c or e	d or f
Twinning pipe–Outdoor unit	HP72	ø15.88(5/8)	ø19.05(3/4)
	HP96	ø19.05(3/4)	ø22.2(7/8)
	HP120	ø19.05(3/4)	ø28.58(1-1/8)

Twinning pipe connection size

Package unit name			PURY-HP144TSNU-A	PURY-HP192TSNU-A	PURY-HP240TSNU-A
Component unit name	Outdoor unit 1		PURY-HP72TNU-A	PURY-HP96TNU-A	PURY-HP120TNU-A
	Outdoor unit 2		PURY-HP72TNU-A	PURY-HP96TNU-A	PURY-HP120TNU-A
Outdoor Twinning Kit(optional parts)			CMY-R100NCBK		CMY-R200NCBK
BC controller ~Twinning pipe	High pressure	a	ø22.2(7/8)		ø22.2(7/8) ø28.58(1-1/8)*
	Low pressure	b	ø28.58(1-1/8)		ø34.93(1-3/8)

* When the piping length is 65m(213ft) or longer, use the ø28.58(1-1/8) pipe for the part that exceeds 65m(213ft).

Note 1. Connect the pipes as shown in the figure above. Refer to the table above for the pipe size.
2. Twinning pipes should not be tilted more than 15 degrees from the horizontal plane.
Be sure to see the Installation Manual for details of Twinning pipe installation.
3. The pipe section before the Twinning pipe (section "a"and "b"in the figure) must have at least 500mm(19-11/16) of straight section ("including the straight pipe that is supplied with the Twinning pipe).
4. Only use the Twinning pipe by Mitsubishi (optional parts).

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MODULE 1: PURY-HP120TNU-A – DIMENSIONS

PURY-HP72, 96, 120TNU-A

Unit: mm (in.)

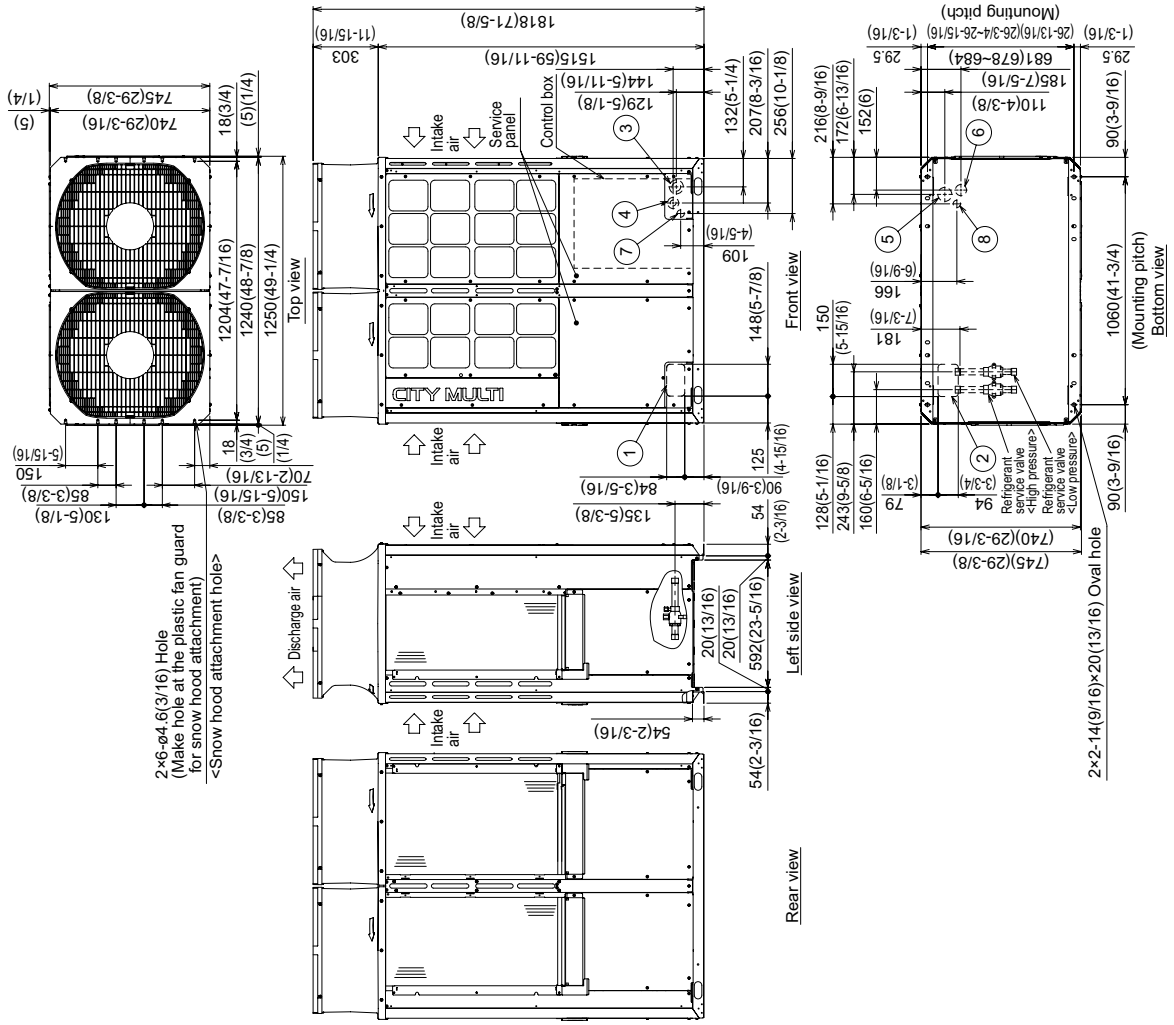
Note 1. At brazing of pipes, wrap the refrigerant service valve with wet cloth and keep the temperature of refrigerant service valve under 120°C(248°F).

Connecting pipe specifications

Model	Diameter			
	Refrigerant pipe		Service valve	
	High pressure	Low pressure	High pressure	Low pressure
HP72	ø15.88(5/8) Brazed *1	ø19.05(3/4) Brazed *1	ø28.58(1-1/8)	ø28.58(1-1/8)
HP96	ø19.05(3/4) Brazed *1	ø22.2(7/8) Brazed *1		
HP120		ø28.58(1-1/8) Brazed		

*1 Connect the refrigerant pipe to the service valve according to the Installation Manual.

NO.	Usage		Specifications
①	For pipes	Front through hole	148(5-7/8) × 84(3-5/16) Knockout hole
②		Bottom through hole	150(5-15/16) × 94(3-3/4) Knockout hole
③	For wires	Front through hole	ø62.7(2-1/2) or ø34.5(1-3/8) Knockout hole
④		Front through hole	ø43.7(1-3/4) or ø22.2(7/8) Knockout hole
⑤		Bottom through hole	ø65(2-9/16) Knockout hole
⑥		Bottom through hole	ø52(2-1/16) Knockout hole
⑦	For transmission cables	Front through hole	ø34(1-3/8) Knockout hole
⑧		Bottom through hole	ø34(1-3/8) Knockout hole



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CITYMULTI®

MODEL: PLFY-P18NFMU-E

MITSUBISHI ELECTRIC

Job Name:	
System Reference:	Date:

GENERAL FEATURES

- Square edge, sleek design
- 3D i-see Sensor™ available as an option
- Improved installation features[1]
- Occupancy detection[1]
- Energy saving features[1]
- Improved occupant comfort
- Four fan speed settings including auto-fan
- Individual vane settings
- 2' x 2' size matches size of many ceiling tiles
- Corner-pocket design for simplified installation
- Built-in condensate lift mechanism designed to provide up to 33" of lift
- Ventilation air intake supported

[1]Requires a PAR-32MAA-J controller

Specifications are subject to change without notice.

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CITY**MULTI**® **Model: PKFY-P24NKMU-E2** MITSUBISHI ELECTRIC

Job Name:	
Schedule Reference:	Date:

GENERAL FEATURES

- Dual set point functionality
- Compact, lightweight, shiny-white, flat-panel design
- Quiet operation
- Multiple fan-speed settings
- Intake grille filter is easily removed for cleaning
- Wireless receiver on board

OPTIONS

□ Condensate Pump……SI3100-230
□ CN24 Relay Kit……CN24RELAY-KIT-CM3

SPECIFICATIONS

Capacity*
Cooling……24,000 Btu/h
Heating……27,000 Btu/h

Power
Power Source……208 / 230V, 1-phase, 60Hz
Power Consumption
Cooling……0.07 kW
Heating……0.07 kW
Current
Cooling……0.50 A
Heating……0.50 A
Minimum Circuit Ampacity (MCA)……0.63 A
Maximum Overcurrent Protection (MOCP) Fuse……15 A

ExternalFinish……MunsellNo.1.0Y9.2/0.2

External Dimensions
Inches……14-3/8 H x 46-1/16 W x 11-5/8 D
mm……365 H x 1,170 W x 295 D

Net Weight
Unit……46 lbs. / 21 kg

Coil Type……Cross Fin
(Aluminum Plate Fin and Copper Tube)

Fan
Type x Quantity……Line Flow Fan x 1
Airflow Rate (Low-High)……570 - 920 CFM
Motor Type……Direct-drive DC Motor

Air Filter……Polypropylene Honeycomb

Refrigerant Piping Dimensions
Liquid (High Pressure)……3/8" / 9.52 mm (Flare)
Gas (Low Pressure)……5/8" / 15.88 mm (Flare)

Drainpipe Dimension……I.D. 5/8" / 16 mm

Sound Pressure Levels
Low-High……39 - 49 dB(A)

* Cooling / Heating capacity indicated at the maximum value at operation under the following conditions:
Cooling | Indoor: 80° F (27° C) DB / 67° F (19° C) WB, Outdoor 95° F (35° C) DB
Heating | Indoor: 70° F (21° C) DB, Outdoor 47° F (8° C) DB / 43° F (6° C) WB

Notes:

R410A

Specifications are subject to change without notice.
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Model: PFFY-P24NRMU-E

Job Name:	
System Reference:	Date:

GENERAL FEATURES:

- Dual set point functionality
- Compact floor-mount
- Two-speed settings
- Controls can be wall-mounted or unit-mounted in a hidden case

ACCESSORIES:

CN24 Relay Kit (CN24RELAY-KIT-CM3)

SPECIFICATIONS:

Capacity*		
Cooling	Btu/h	24,000
Heating	Btu/h	27,000

* Cooling / Heating capacity indicated at the maximum value at operation under the following conditions:
Cooling | Indoor : 80° F (27° C) DB / 67° F (19° C) WB
Cooling | Outdoor : 95° F (35° C) DB
Heating | Indoor : 70° F (21° C) DB
Heating | Outdoor : 47° F (8° C) DB / 43° F (6°C) WB

Electrical		
Electrical Power Requirements	208 / 230V, 1-phase, 60Hz	
Minimum Circuit Ampacity (MCA)	A	0.59 / 0.64 (60Hz)

External Dimensions	
Unit (H x W x D) In. (mm)	25-3/16 x 49-1/16 x 8-11/16 (639 x 1,246 x 220)

Net Weight		
Unit	Lbs.(kg)	71 (32)

External Finish	Galvanized

Coil Type	Cross fin (Aluminium fin and copper tube)

Fan		
Type x Quanity	Sirocco fan x 2	
Airflow rate (Low-High)	CFM	353 - 494
Motor Type	1-phase induction motor	

Air Filter	Standard filter

Refrigerant Piping Diameter		
Liquid (High Pressure)	In.(mm)	3/8 (9.52) Flare
Gas (Low Pressure)	In.(mm)	5/8 (15.88) Flare

Field Drain Pipe Size	In.(mm)	I.D. 1 (26)

Sound Level			
Low-High	dB(A)	208/230V	40 - 46

Notes:

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PVFY-P12NAMU-E1

Job Name:	
System Reference:	Date:

PVFY-P12NAMU-E1

GENERAL FEATURES

- Multi-position design is suitable for any application requires no additional kits, even for downflow configuration
- Dual set point functionality
- Designed specifically for use with CITY MULTI® outdoor units
- Choice of three fan speeds for optimum comfort
- Highly efficient DC motor and a forward curved blower ensures quiet, consistent fan operation
- Optional relay kit provides functionality for two stage auxiliary heat (1 kit per stage), humidifier integration, or other custom applications
- Control board includes a condensate overflow switch connection
- Heavy-gauge steel cabinets with 1" fiberglass-free foam insulation with an R-4.2 insulation value
- Suitable for use in air handling spaces in accordance with Section 18.2 of UL 1995 4th Edition
- Tested in accordance with ANSI/ASHRAE Standard 193; less than 1% air leakage at maximum airflow

ACCESSORIES:

- □ Relay Kit…….....…….....……CN24RELAY-KIT-CM3
- □ Fan Speed Indication Adapter…….....……PAC-735
- □ Electric Heat Kit…….....……for details see Electric Heat Kit Submittal

SPECIFICATIONS:

Capacity*		
Cooling	Btu/h	12,000
Heating	Btu/h	13,500

* Cooling / Heating capacity indicated at the maximum value at operation under the following conditions:
Cooling | Indoor : 80° F (27° C) DB / 67° F (19° C) WB
Cooling | Outdoor : 95° F (35° C) DB
Heating | Indoor : 70° F (21° C) DB
Heating | Outdoor : 47° F (8° C) DB / 43° F (6°C) WB

Electrical		
Electrical Power Requirements	1-phase, 208 / 230V, 60Hz	
Minimum Circuit Ampacity (MCA)	A	3.00 / 3.00
Maximum Fuse Size	A	15

External Dimensions		
Height	In.(mm)	50-1/4 (1,275)
Width	In.(mm)	17 (432)
Depth	In.(mm)	21-5/8 (548)

Net Weight	Lbs.(kg)	113 (51)
External Finish	High-gloss polyester powder coated	
Coil Type	Cross Fin (Aluminum Plate Fin and Copper Tube)	

Fan		
Type x Quanity	Sirocco fan x 1	
Airflow rate (Low - Mid - High)	CFM	280 - 340 - 400
External Static Pressure	In. WG	0.30 / 0.50 / 0.80 (Selectable)
Motor Type	DC motor	

Air Filter	Polypropylene Honeycomb

Refrigerant Piping Diameter		
Liquid (High Pressure)	In.(mm)	1/4 (6.35) Brazed
Gas (Low Pressure)	In.(mm)	1/2 (12.7) Brazed

Field Drain Pipe Size	In.(mm)	FPT 3/4 (19.05)

Sound Data (Low - Mid - High) (measured in anechoic room)		
Sound Pressure Level	dB(A)	27 - 31 - 35

Specifications are subject to change without notice.

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GEOTHERMAL

THE LOGICAL CHOICE
FOR ENERGY EFFICIENT
RESIDENTIAL HEATING
AND COOLING

Comfort-Aire®

NOTHING COMPARES

...TO THE EFFICIENCY OF A GEOTHERMAL HEAT PUMP

Glossary of Terms

GEOTHERMAL—Refers to a geothermal heat pump which uses the thermal energy of the ground or ground water to provide heating and cooling; primarily residential

WATER SOURCE—Refers to water source heat pumps used in commercial installations; generally involves boiler/cooling tower and/or water loop installation

BTUH—British thermal units per hour, used to indicate heat output

CLOSED LOOP—Another name for ground loop geothermal systems

COP—Coefficient of Performance, a measurement of efficiency in heating; the higher the number, the more efficient the equipment

DESUPERHEATER—A partial heat recovery system that captures heat from hot refrigerant as it leaves the heat pump compressor and transfers the heat to domestic hot water

EER—Energy Efficiency Ratio, a measurement of efficiency in cooling; the higher the number, the more efficient the equipment

ENERGY STAR®—Signifies an energy efficient product, designation first developed by United States government and now recognized by Canada and a number of other countries

EWT—Entering water temperature which is the temperature of the water or water/antifreeze solution when it enters the coaxial coil of the unit where the heat exchange process with the refrigerant cycle begins

HVAC—Refers to heating, ventilation and air conditioning equipment and systems

GROUND LOOP—Geothermal system with heat transfer liquid permanently contained in piping buried in the ground or submerged in a pond or lake

GROUND WATER—Geothermal system in which water is pulled from an aquifer and used for heat transfer, then released to another well, a ditch or other approved water source

OPEN LOOP—Another name for ground water geothermal installations

R-410A—The environmentally friendly refrigerant now used in all HVAC equipment; all Comfort-Aire geothermal units shown in this brochure are charged with R-410A

SINGLE STAGE—Heat pump that operates at one stage and one capacity

TAX CREDITS—U.S. Federal law allows a tax credit of 30% for installations of new qualifying geothermal equipment, with no dollar cap, through 2016

TWO STAGE—Heat pump that operates at two stages, depending on demand, and at different speeds through the use of multi-stage compressors and multi-speed blower motors; exceptionally efficient at low speeds but capable of supplying more heat or cooling when required

WATER LOOP—Installation used in many commercial applications, includes boiler/cooling tower

TODAY'S GEOTHERMAL:
Energy Efficient *and* Earth Friendly

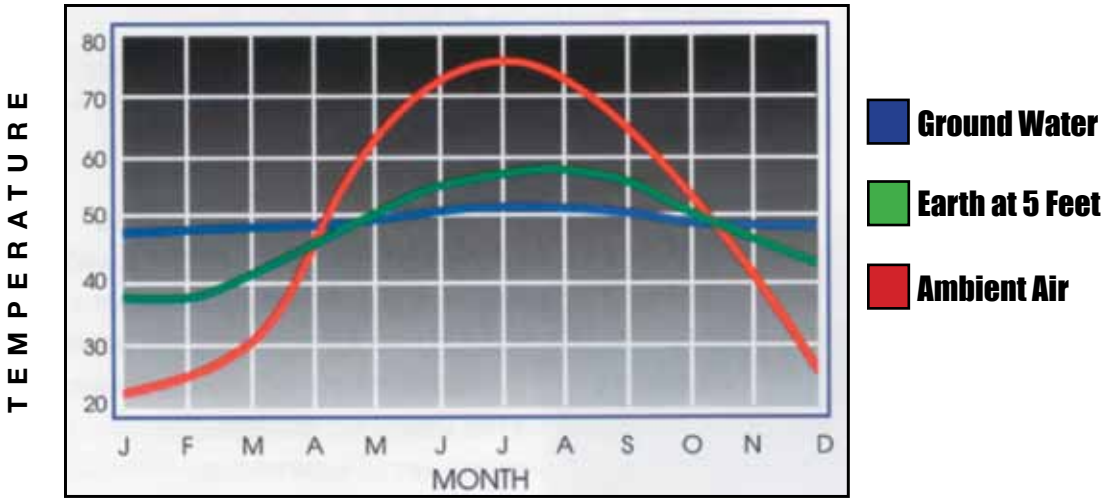
Rising energy costs have made us all aware of the need for energy efficiency. At the same time, we are becoming conscious of the cost to the earth's environment for the ever-expanding use of fossil fuels. While there are many approaches to saving energy, lowering utility costs, and conserving natural resources, geothermal systems offer a proven solution that's not only practical, but readily available today. Nothing compares to the efficiency of geothermal systems.

A geothermal heat pump can save half the cost of heating and cooling the average home. In fact, for every unit of energy used to run a geothermal pump and blower, three to five units of heat energy are produced.

Because geothermal systems rely on the relatively stable temperatures of the earth for heat transfer, they aren't burning fossil fuels to create energy for heat or cooling. The systems are extraordinarily efficient because in most geographical areas, the temperature of the earth at five feet below the surface remains fairly consistent, no matter what the season. Similarly, ground water temperatures are constant over the course of the year.

The basic concept is simple: piping or tubing is buried in the ground or submerged in a pond or lake. In the winter, heat is absorbed from the water or ground (depending on the type of system) and transferred to the heat pump where it is distributed through the home's ductwork. In the summer, hot air in the home is extracted and

USING THE EARTH ITSELF FOR HEAT TRANSFER



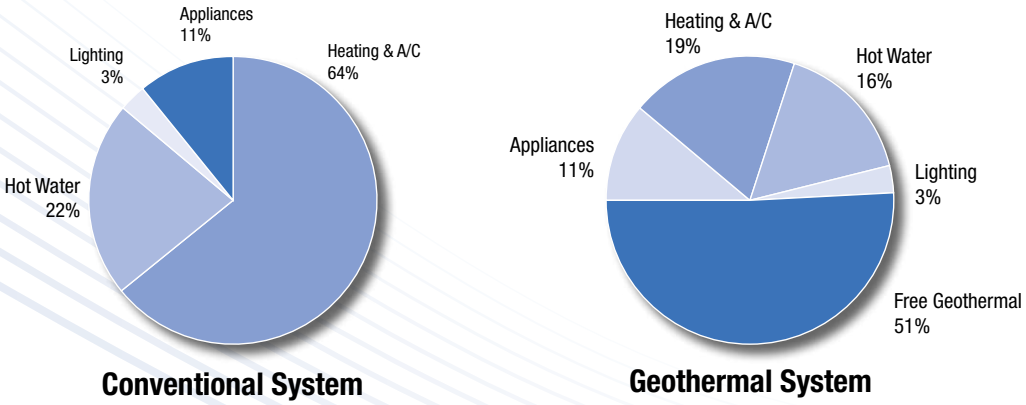
The year 'round stable temperatures of ground water and the earth itself make it possible for the energy exchange to occur in geothermal systems.

transferred to the cooler ground or water. It is this consistency of earth or water temperature that allows heat transfer to occur—keeping you cool in summer and warm in winter.

Energy efficiency is the primary advantage of a geothermal system. Energy is needed only to run the compressor and to pump a water solution through the buried piping and then to run the system's blower to distribute the conditioned air. Not only is it possible to heat and cool your home with a geothermal heat pumps, but several of our systems come with a hot water generator that supplements heating of domestic hot water (in both the heating and cooling modes) for further savings.

With a geothermal system, over half your home's energy is free!

RESIDENTIAL ENERGY USE



Conventional System | **Geothermal System**

Our geothermal systems can work in virtually every climate. With an extended operating range of 20° to 120° F for entering water temperature, they provide a comfortable indoor environment all year long, although some northern locations may require a supplemental heat source.

Other advantages include exceptionally quiet operation. Multiple sound attenuation features are built into the design, including a special compressor mounting system that reduces vibration and interior cabinet insulation. Also, there are fewer moving parts to wear out than with a conventional heating/cooling system.

Many people appreciate the safety that is inherent in a geothermal system. No gas or oil is used, there's no standing pilot light, no fumes and no odors to worry about.

Finally, there's the confidence that comes from having technology that's been proven over many years and recognized by the EPA and the U.S. Department of Energy.

Exceptional efficiency means fast payback...

Although the initial cost of a geothermal system is higher than a conventional heat pump or furnace/condenser combination, you can quickly recoup these costs through energy savings and potential Federal tax credits.

On average, geothermal heat pumps provide:

- 40% greater efficiency than air-to-air heat pumps
- 48% greater efficiency than gas furnaces
- 75% greater efficiency than oil furnaces

(Source: Geothermal Heat Pump Consortium)

Ask your dealer to prepare a cost savings analysis for you to determine just how much you can save over the life of the system. Our LoopLogix® software makes it easy to compare operating costs of various systems based on your home's requirements and historical weather data.

Geothermal... the logical choice

Installation Flexibility

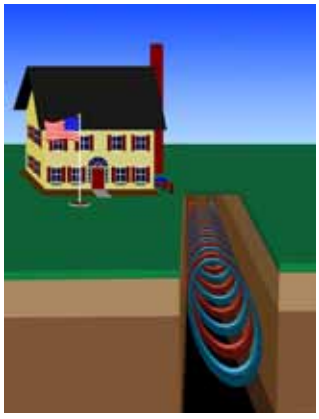
Which type of system and which type of installation you choose is determined by your preference, your geographic area, and the availability of ground water or adequate land for burying loop pipes. Designed properly, all systems work equally well.

GROUND LOOP

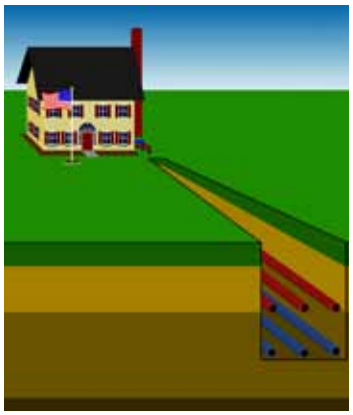
In this heat exchange method, the heat transfer fluid is permanently contained in a closed piping system. This piping, typically made of polyethylene tubing, is buried in the earth or submerged in a pond or lake. The heat transfer fluid—a solution of antifreeze and water—is pumped through the piping. In the winter, it absorbs heat from the earth or water. This relatively warm solution is then pulled back to the heat pump which extracts heat and circulates warm air throughout the house.

During hot weather, heat in the home is extracted by the heat pump and transferred to the liquid circulating through the closed loop piping. The cooler earth or water then absorbs this heat, and the cooled water is circulated back to the heat pump and used to cool the house.

Ground loop systems can have piping buried in horizontal trenches or in vertical bores—some types of installations are shown below. The number, length and diameter of the pipes are determined by the heating/cooling load of the house, as well as the amount of land or the availability of a pond or lake.

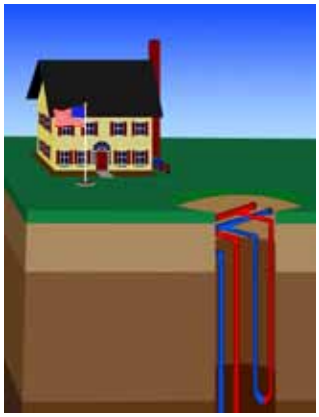


Slinky-type piping can be buried in a horizontal trench.



This backhoe trench shows six pipes—three outgoing, three incoming.

Coils of piping can be submerged in a pond, as can slinky piping.



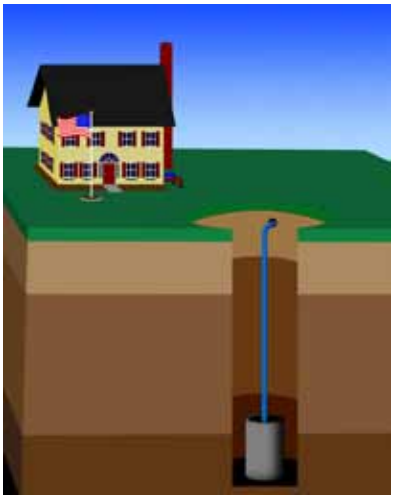
For a limited space, a vertcal hole is used; this one shows two u-tubes.

GROUND WATER

In this type of system, there is no heat exchange fluid enclosed in piping. Water is removed from an aquifer and is circulated through the heat pump. This water is then discharged to a pond or lake, or into another well—unchanged except for temperature.

The heat exchange process works the same as in a Ground Loop system: in the heating mode, heat is extracted from the water and transferred to the air being circulated in the home. In the cooling mode, the process is reversed and heat from the home is extracted by the heat pump and transferred to the cooler ground water.

The illustration shows how water is pulled from a well into the heat pump inside the house, before being discharged into another well, pond or approved location.



A typical ground water well installation.

advanced DESIGN

All Comfort-Aire geothermal heat pumps are designed for reliable, quiet operation and long life to keep you comfortable for years to come

DEPENDABLE

- State-of-the-art, solid state microprocessor controls feature easy to understand diagnostics
- Scroll compressor is rated for heat pump use, and designed for quiet operation and efficiency
- Performance monitoring system signals a potential problem, much like a car's "check engine" light, so service can be scheduled
- Insulated, stainless steel drain pan has condensate overflow protection
- Limited number of moving parts means less wear and long life expectancy
- Tin-plated air coil prolongs equipment life in most environments and improves efficiency

INSTALLATION FLEXIBILITY

- Condensate line is internally trapped
- Swivel connectors make water hook-up quick and easy
- Compact models are ideal for tight spaces or retrofit applications

QUIET OPERATION

- Double spring and grommet isolation mounting system for the compressor reduces vibration
- Flexible torsion motor mounting further reduces vibration and related sound
- Compressor compartment is insulated; it's also separated from the air handler by an insulated divider (package models)
- Discharge muffler reduces inherent compressor pulse noise

EASY SERVICING

- Components can be accessed from multiple sides to simplify service and maintenance
- Removable blower inlet ring allows easy access to the fan and motor for maintenance
- Safety features protect the unit:
  High pressure and loss of refrigerant charge to protect compressor; condensate overflow; freeze protection for coaxial heat exchanger and air coil; hot water generator limiter; fault lock-out enables emergency heat and prevents compressor operation

What do we mean by 'Energy Efficiency'?

In recent years, the HVAC industry has made significant advances in the energy efficiency of heating and cooling systems. You can judge efficiencies yourself by comparing some industry standards.

Cooling efficiency is measured by an Energy Efficiency Ratio (EER). This is a ratio of total cooling capacity to electrical energy output. The higher the number, the more efficient the equipment. Our geothermal units have EER ratings as high as 31.5 at ground water conditions, while conventional air-to-air heat pumps have ratings generally in the teens—13 to 18 SEER, for instance, which translates to an actual EER of 10 to 15.

On the heating side, efficiency is shown by a Coefficient of Performance (COP), which shows the ratio of total heating capacity to electrical energy output. As with EERs, the higher the number, the more efficient the equipment. Again, geothermal systems—especially our two-stage models—rate significantly higher than traditional heat pumps.

ENERGY STAR

Comfort-Aire models in this brochure are Energy Star® compliant and most qualify for Federal Tax Credits.

Look for the Energy Star logo throughout this brochure.

Advanced design and quality construction make our two-stage models exceptionally quiet and efficient

Heavy duty blower with multiple features for noise dampening

ECM blower motor automatically adapts to system requirements for even temperatures

Removable panels on three sides allow easy access for installation, maintenance

Air handler and compressor compartments are separated by an insulated divider

Insulated, stainless steel drain pan has condensate overflow protection

Microprocessor controls with monitoring system

G90 galvanized steel cabinet with epoxy powder coat paint for durability and attractive appearance

Large filter captures pollutants for enhanced indoor air quality, can be easily changed

Tin plated air coil for corrosion protection

Two-stage compressor delivers comfort more efficiently than single stage models, has discharge muffler for sound reduction

Double isolated compressor mounting reduces vibration and related operational sound

Brass swivel connectors are standard and are conveniently located for fast installation

All Comfort-Aire geothermal heat pumps meet or exceed all applicable industry standards.

HT SERIES HEAT PUMP CONFIGURATIONS

HTV VERTICAL:
As shown above

HTH HORIZONTAL: Includes same components as shown above, with upper and lower compartments placed side by side.

HTD DOWNFLOW: Includes the same components as shown above, but with upper and lower compartments reversed.

HTS SPLIT SYSTEM:
Contains components in the bottom half of the unit shown above. A separate air handler or furnace fan is required.

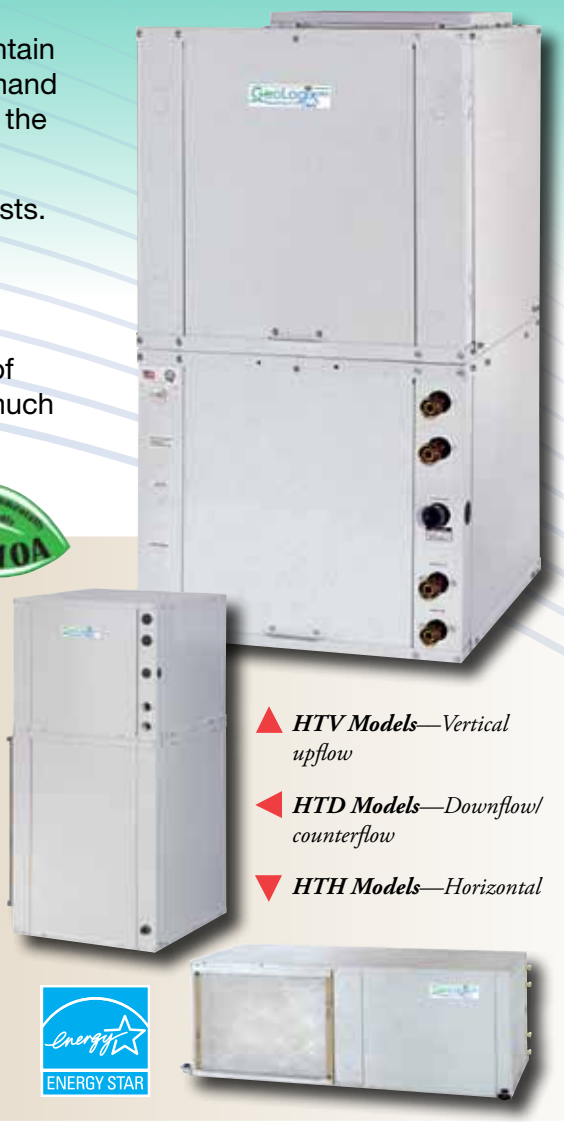
Two-Stage Package Heat Pump

GeoLogix Plus™

Our two-stage design far exceeds ASHRAE 90.1 efficiencies, allowing the unit to run at 67% capacity most of the time to maintain a consistent temperature and humidity level. When there's a demand for greater heating or cooling, such as during weather extremes, the unit instantly shifts to 100% capacity.

This full load/part load capacity significantly lowers operating costs. At the same time, it increases comfort because there's no on/off cycling of the system.

The high tech design of the high efficiency ECM blower motor adapts automatically to system demand, delivering a multitude of benefits including silent ramp-up, a speed for every mode and much more—all designed to overcome ductwork static pressure (even poor duct design) to maximize the flow of conditioned air.



▲ ***HTV Models***—*Vertical upflow*

◀ ***HTD Models***—*Downflow/ counterflow*

▼ ***HTH Models***—*Horizontal*

R-410A

ENERGY STAR

FEATURES

- ***Quiet Operation***—*Double isolation compressor mounting and vibration isolation springs combined with insulated compressor and air handler compartments dampen operating sound*
- ***Variable Speed Blower Motor***—*Automatically adapts to all applications; provides a multitude of operational modes that maximize comfort and efficiency*
- ***Two Stage Compressor***—*Copeland multi-stage scroll compressor delivers comfort at higher efficiencies than single stage models*
- ***Microprocessor Controls***—*Includes performance monitoring system to signal a potential problem before a lockout can occur*
- ***Standard Features***—*Comes with domestic hot water generator with built-in pump for value and extra efficiency*
- ***Extended Operating Range***—*20º to 120º F entering water temperature makes the HT Series suitable for virtually all applications and climates*

Power 208/230-1-60

AHRI/ISO/ASHRAE/ANSI 13256-1 Performance

2 to 6 Tons

Model	Capacity Modulation	Ground Water				Ground Loop				Shipping Wt. (lbs)
		Cooling Water 59ºF		Heating Water 50ºF		Cooling Ful Load 77 ºF Part Load 68ºF		Heating Full Load 32 ºF Part Load 41ºF		
		BTUH	EER	BTUH	COP	BTUH	EER	BTUH	COP	
HTV/HTD/	Full	28,500	27.1	24,600	4.9	26,100	19.7	18,700	3.9	308
HTH024	Part	21,800	35.1	17,500	5.2	20,700	27.8	15,100	4.5	
HTV/HTD/	Full	43,100	26.9	37,000	5.1	39,700	20.1	29,000	4.3	345
HTH036	Part	31,100	34.2	25,900	5.3	30,200	29.4	23,000	4.7	
HTV/HTD/	Full	55,600	25.9	48,200	4.7	50,600	19.1	37,000	3.9	458
HTH048	Part	41,800	34.1	34,800	5.0	40,100	27.7	29,900	4.3	
HTV/HTD/	Full	71,300	24.2	63,000	4.7	66,000	18.6	48,500	3.8	485
HTH060	Part	52,900	32.3	43,800	4.9	51,000	26.5	37,900	4.3	
HTV/HTD/	Full	77,500	22.3	71,200	4.3	71,500	16.7	55,600	3.6	485
HTH070	Part	60,600	28.4	53,000	4.4	57,900	23.0	45,800	3.8	

Cooling capacities based on 80.6º F DB, 66.2º F WB entering air temp.
Heating capacities based on 68º F DB, 59º F WB entering air temp.
All ratings based on 208V operation.

Outstanding Limited Warranty—12 years on compressor and parts
(Some limitations apply; see printed warranty for details.)

GEOTHERMAL

2 to 5 Tons

Two Stage Package Heat Pump

Self-contained, package HE Series units combine a small footprint with two stage operation and integrated digital communication controls at a competitive price. Exceeding industry standards for energy efficiency including Energy Star® Tier 3 requirements, the units are eligible for tax credits.

A digital electronic controller links the thermostat, fan motor and compressor staging to provide set-up and diagnostic data, saving time during installation and service calls. Also saving installation time is a four wire connection between the controller and the communicating thermostat. If the communicating thermostat is not used, the installer can use an optional separate diagnostic tool to access the data, and a port for the tool is built into the unit.

The two stage compressor runs at 67% capacity most of the time to maintain a consistent temperature/humidity level. When there's demand, the unit instantly shifts to 100% capacity. The ECM blower motor automatically adapts to system requirements for increased efficiency.

The HE Series is designed for open loop, closed loop and boiler/cooling tower applications, and the compact size makes it ideal for tight spaces. (Vertical unit pictured, horizontal unit also available.)

ENERGY STAR

With Electronic Digital Controller

FEATURES

- ***Extended Range Refrigerant Circuit***—*HE unit is capable of geothermal ground loop and ground water applications, as well as boiler/cooling tower water loop installations*
- ***Scroll Compressor***—*Dependable two stage design is efficient, reliable and quiet*
- ***Large Filter***—*Captures pollutants for enhanced indoor air quality, can be quickly changed as needed*
- ***System Performance Monitoring***—*Signals when the system is not running at peak performance so maintenance can be scheduled*
- ***Quiet Operation***—*Double isolation compressor mounting and air handler compartment insulation make the HE one of the quietest units on the market*
- ***Easy Service Access***—*All components can be accessed through the conveniently located control box and large access panels for fast installation, easy maintenance*

R-410A

All models 208/230V-1-60

AHRI/ISO/ASHRAE/ANSI 13256-1 Performance

Model	Capacity Modulation	Ground Water				Ground Loop				Shipping Weight (lbs.)
		Cooling Water 59° F		Heating Water 50° F		Cooling Full Load 77° F Part Load 68° F		Heating Full Load 32° F Part Load 41° F		
		BTUH	EER	BTUH	COP	BTUH	EER	BTUH	COP	
HEV/HEH 024	Full	24,900	20.2	22,900	4.2	22,700	15.0	18,200	3.5	213
	Part	18,600	24.0	16,200	4.3	17,800	20.0	14,100	3.7	
HEV/HEH 030	Full	32,100	20.5	29,800	4.1	29,700	15.5	23,600	3.5	213
	Part	24,700	24.6	21,800	4.2	24,000	20.7	19,200	3.8	
HEV/HEH 036	Full	37,200	19.6	34,700	4.1	34,500	14.6	27,700	3.5	239
	Part	27,700	25.0	24,500	4.4	26,900	20.4	22,100	3.9	
HEV/HEH 042	Full	46,100	21.1	42,100	4.0	42,900	15.9	33,100	3.4	250
	Part	35,000	26.2	30,300	4.2	33,800	21.8	26,700	3.8	
HEV/HEH 048	Full	51,600	20.7	44,800	4.3	47,900	15.3	35,400	3.6	306
	Part	39,000	26.6	32,400	4.5	37,400	21.0	29,000	4.0	
HEV/HEH 060	Full	63,800	20.4	58,000	4.0	59,600	15.9	45,700	3.4	321
	Part	48,900	25.9	42,100	4.2	47,000	21.8	37,000	3.8	

Outstanding Limited Warranty—10 years on compressor and parts
(Some limitations apply; see printed warranty for details.)

Two-Stage Split System

GeoLogix Plus™

The HTS Series combines the advantages of split system design with two stage efficiency. Far exceeding ASHRAE 90.1 effiicencies, the unit runs at 67% capacity most of the time to maintain a constant temperature and humidity level. When there's a demand for greater heating or cooling, such as during weather extremes, the unit instantly shifts to 100% capacity. Comfort is increased and operating costs lowered through this shifting of part load and full load capacity.

The HTS split system is ideal for locations where a packaged geothermal unit won't fit the existing space, such as an attic or crawl space. Not only is the cabinet compact in size, it can be stacked for multi-unit installation and, when matched with an air handler, delivers high levels of efficiency similar to our two-stage package heat pumps. All models are pre-charged with environmentally friendly R-410A.

FEATURES

- ***Quiet Operation***—*Double isolation compressor mounting system and vibration isolation springs for sound attenuation; insulated compressor compartment also reduces operational sound*
- ***Easy Installation/Service***—*Back-seating service valves included; panels on three sides are easily removed for access to components*
- ***Extended Operating Range***—*20° to 120° F EWT range makes units suitable for virtually all applications and climates*
- ***Two-Stage Compressor***—*Copeland multi-stage scroll compressor provides steady comfort at higher efficiencies than single stage models*
- ***DMX Controls***—*Two-way communication capability with optional communicating digital thermostat speeds set-up and configuration, helps diagnose operation problems*
- ***Durable Cabinet***—*G90 galvanized steel has a tough epoxy powder coat paint finish; drain pan is stainless steel; air coils are tin plated for corrosion protection*

WDG Air Handler

- Multi-position—can be installed for vertical upflow or downflow, or horizontal right or left airflow
- ECM blower motor matches speed to changing requirements for efficiency
- Factory installed A-coil
- Insulation reduces blower sound

Cabinet Sizes: A = 18.5 W x 44 H x 22 D; B = 22 W x 55 H x 22 D; C = 25.5 W x 59 H x 22 D

MWG Cased Coil

- Multi-position for upflow, horizontal and downflow applications, and horizontal left or right airflow
- Built with R-410A TXV thermal expansion valve
- Corrosion-proof drain pan
- Lined with foil faced insulation for quiet operation
- Dual condensate connections simplify hook-ups

Fits Furnace Width: B = 17.5"; C = 21" to 21.5"; D = 24.5"

Model	Nom. Cap. BTUH	Fan Motor HP	Cabinet Sizes	Shipping Wt. (lbs)
WDG24VS	24,000	1/2	A & B	96 & 179
WDG36VS	36,000	1/2	B & C	198 & 206
WDG48VS	48,000	1	B & C	218 & 226
WDG60VS	60,000	1	C	236

Model	Nom. Cap. BTUH	Fan Motor HP	Furnace Width	Shipping Wt. (lbs)
MWG24	24,000	1/2	B & C	57 & 60
MWG36	36,000	1/2	C & D	60 & 118
MWG48	48,000	1	C & D	83 & 118
MWG60	60,000	1	D	118

Coil and air handlers are AHRI certified when matched with HTS split units for water source applications.

HWW Series Water-to-Water Systems

3 to 10 Tons

These flexible systems, available in 3, 5, and 10 ton capacities, have a wide range of HVAC and industrial applications. Units are used for such applications as radiant floors, snow/ice melting, chilled water for fan coils, potable hot water, and other types of residential or industrial applications that require cost-effective heated or chilled water. They can be installed using a ground loop, ground water or water loop (boiler/cooling tower) installation. As with all geothermal models, they offer the benefits of super high efficiency with low operating costs.

Flexibility is a hallmark of geothermal units. As reverse cycle heat pumps, 208/230V models can provide both hot and chilled water, as well as domestic hot water. All HWW units can be installed side by side for large capacity applications, thanks to compact size, single side service access, and water connections at the top of the unit.

With no outdoor fan, special mounting systems and 1/2" dual density acoustic type fiberglass cabinet insulation, operation is exceptionally quiet. A system performance monitor signals when the system is not running at peak performance so maintenance can be scheduled. Units come pre-charged with R-410A.

Exceeds ASHRAE 90.1 efficiencies

FEATURES

- ***Microprocessor Controls***—*State-of-the-art controls include on-board diagnostics and seven standard "Safeties" including anti-short cycle, over- and under-voltage, loss of charge, high refrigerant pressure and more, to protect the unit and the compressor*
- ***Quiet Operation***—*Double compressor mounting system and compressor compartment insulation minimize operating noise*
- ***Scroll Compressor***—*Dependable design is proven efficient and quiet, with internally sprung and externally isolated vibration isolation system, including rubber grommet mounts*
- ***System Performance Monitoring***—*Signals when the system is not running at peak performance so maintenance can be scheduled*
- ***Easy Service Access***—*All components can be accessed through a front panel for maintenance and service; side panel can also be opened*

PERFORMANCE DATA

AHRI/ISO/ASHRAE/ANSI 13256-2 Performance

	Water loop—BTUH				Ground Loop—BTUH				
	Cooling		Heating		Cooling		Heating		
	Indoor 53.6°F Outdoor 86°F		Indoor 104°F Outdoor 68°F		Indoor 53.6°F Outdoor 77°F		Indoor 104°F Outdoor 32°F		Shipping
Model	Cap. BTUH	EER	Cap. BTUH	COP	Cap. BTUH	EER	Cap. BTUH	COP	Wt. (lbs.)
HWW036A	33,000	14.6	44,000	5.0	34,000	16.8	28,000	3.1	373
HWW060B	52,800	14.3	72,700	4.7	55,600	16.2	48,500	3.0	385
HWW120B	105,600	14.1	145,400	4.6	111,200	16.0	97,000	3.0	770

	Ground Water—BTUH			
	Cooling		Heating	
	Indoor 53.6°F Outdoor 59°F		Indoor 104°F Outdoor 50°F	
Model	Cap. BTUH	EER	Cap. BTUH	COP
HWW036A	37,000	23.1	36,000	4.0
HWW060B	60,200	22.0	60,300	4.0
HWW120B	120,400	21.6	120,600	3.9

Limited Warranty—5 years on compressor, 1 year on parts
(Some limitations apply; see printed warranty for details.)

NOTES:

Units available in 208/230-1-60, 208/230-3-60, 460-3-60, and 575-3-60 (no HWW036).

208/230-1-60 models available with hot water generator with internal pump.

Lochinvar®

FTXL FIRE TUBE CONDENSING BOILER

Submittal Sheet **FTX-Sub-03**

FTXL FIRE TUBE COMMERCIAL BOILERS

Job Name: _____ Model No. _____

Location: _____ Type Gas: _____

Engineer: _____ Equipment Tag(s):

Agent/Wholesaler: _____ _____

Contractor: _____ _____

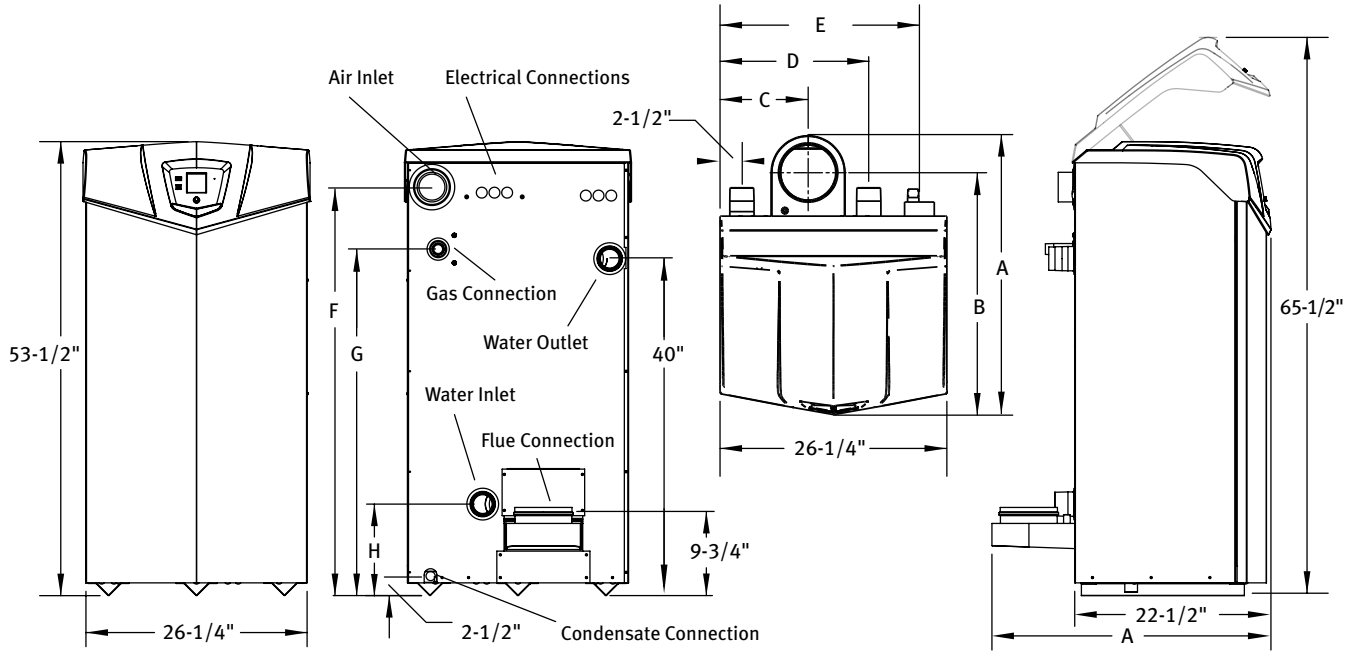
NOTES:

FOR EASE IN ORDERING BY MODEL NUMBER

FTX	850	N	M13
FTXL Boiler	850,000 Btu/Hr Input	Natural Gas	Firing Control

This model is:

- FTXL Fire Tube boiler
- 850,000 Btu/hr
- Natural gas
- M13 Firing Controls



FTXL Boiler

Dimensions and Specifications

	Model No.	Input Min MBH	Input Max MBH	Thermal Eff.	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.	Ship 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"	10-3/4"	2"	4"	4"	1"	435
○	FTX500(N,L)	50.0	500.0	97.7%	489	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"	10-3/4"	2"	4"	4"	1"	460
○	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"	10-3/4"	2"	4"	4"	1"	470
○	FTX725(N,L)	103.5	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.

FTXL™ FIRE TUBE BOILER

CON·X·US® REMOTE CONNECT CAPABLE
CASCADING SEQUENCER
LOCH-N-LINK™ USB DRIVE SETUP
5 INPUTS FROM 399,999 TO 850,000 BTU/HR
UP TO 10:1 TURNDOWN RATIO
COMMON VENT AND PVC DIRECT-VENTING
FLOW RATES FROM 10 TO 150 GPM
SMALL 6.2 SQ. FT. FOOTPRINT
4 PUMP CONTROL
WIRELESS OUTDOOR SENSOR CAPABLE

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**
  0-10 VDC Input to Control Modulation or Setpoint
  0-10 VDC Input from Variable-Speed System Pump
  0-10 VDC Modulation Rate Output Signal
  0-10 VDC 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
  Building Recirculation Return Temp Sensor Contacts
  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
  Low Water Cutoff
  Custom Maintenance Reminder with Contact Info
  Password Security
  Customizable Freeze Protection Parameters

Optional Equipment

- ☐ Alarm Bell
- ☐ BACnet MSTP Communications Kit
- ☐ BMS Gateway to BACnet or LonMark
- ☐ Common Vent Kit
- ☐ Concentric Vent Kit (FTX400-FTX600)
- ☐ Condensate Neutralization Kit
- ☐ Constant-Speed Boiler Circulator
- ☐ CON·X·US Remote Connectivity
- ☐ Flow Switch
- ☐ High and Low Gas Pressure Switches w/Manual Reset (FTX500-FTX850)
- ☐ ModBus Communication
- ☐ Motorized Isolation Valve
- ☐ Multi-Temperature Loop Control
- ☐ SMART SYSTEM PC Software
- ☐ Variable-Speed Boiler Circulator
- ☐ Wireless Outdoor Temperature Sensor
- ☐ 30 psi ASME Relief Valve
- ☐ 75 psi ASME Relief Valve
- ☐ 100 psi ASME Relief Valve
- ☐ 125 psi ASME Relief Valve
- ☐ 150 psi ASME Relief Valve

› Firing Controls

- ☐ M9 - Standard Construction
- ☐ M13 - CSD-1/FM/GE Gap (FTX500-FTX850)

Lochinvar®

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

4/19—Printed in U.S.A.

runtal

Baseboard Radiators

Runtal's Baseboard style *is ideal for those desiring a low profile. As a retrofit, Runtal baseboard is a natural replacement for fin-tube or cast iron. In these cases, it is often easiest to use the existing piping and simply order the appropriate lengths. Depending upon the heat output, or the desired design "look", Runtal will supply baseboard styles ranging from 1 to 4 tubes high.*

With Fins*

Model No.	VLX 7/7	VLX 14/14	VLX 21/21	VLX 28/28
Height	2.8″	5.8″	8.6″	11.5″
Depth	2″	2″	2″	2″
BTUH/ft. Output @ 180°F:	380	610	790	950

No Fins*

Model No.	VX 7	VX 14	VX 21	VX 28
Height	2.8″	5.8″	8.6″	11.15″
Depth	2″	2″	2″	2″
BTUH/ft. Output @ 180°F:	160	290	430	570

Available in lengths from 20 to 354 inches (in 2″ increments).
*Runtal baseboards are offered with and without fins. When hung, visually they look similar. Finned units offer a higher convective component and as a result nearly double the output of comparable non-finned units.

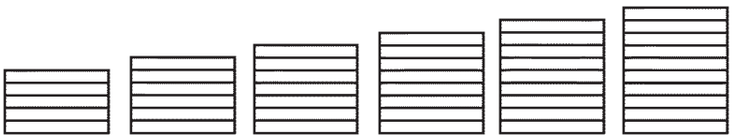
In Stock Baseboard UF Series

Runtal offers 2, 3 and 4 panels high baseboards in white for immediate delivery in 2′, 2.5′, 3′, 3.5′, and from 4′–14′ in even foot increments. All stock baseboards have multiple tappings (AB) that allow for all types of bottom and side piping connections (See piping configuration AB on page 13, Table 3). Stock baseboards may be special ordered in any of the other nine standard colors with a two-week delivery.

runtal

Wall Panels

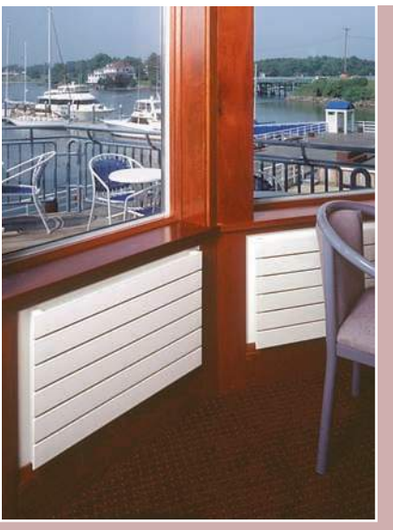
Runtal's Wall Panel style *radiators are ideal for placement under windows or on walls where floor space is at a premium. When placed under windows, wall panels help eliminate cold spots and drafts while allowing curtains to hang to the floor. Wall panel radiators are available in a variety of heights and widths to suit most any need.*



With Fins* Model No.	VLX 35/35	VLX 42/42	VLX49/49	VLX 56/56	VLX 63/56	VLX 70/56
Height	14.4"	17.2"	20.2"	23.1"	26.1"	29.0"
Depth	2"	2"	2"	2"	2"	2"
BTUH/ft. Output @ 180°F:	1260	1460	1650	1840	1950	2050

No Fins* Model No.	VX 35	VX 42	VX 49	VX 56	VX 63	VX 70
Height	14.4"	17.2"	20.2"	23.1"	26.1"	29.0"
Depth	2"	2"	2"	2"	2"	2"
BTUH/ft. Output @ 180°F:	710	860	1010	1150	1300	1450

Available in lengths from 20 to 354 inches (in 2" increments).
Additional heights (up to 24 tubes high or 69-3/4") available upon request.
*Runtal wall panels are offered with and without fins. When hung, visually they look similar. Finned units offer a higher convective component and as a result nearly double the output of comparable non-finned units.



In Stock Wall Panels UF Series

Runtal offers 2 wall panels (6 and 8 panels) in 2', 3', and 4' lengths in white for immediate delivery. All stock wall panels have multiple tappings (AB) that allow for all types of bottom and side piping connections (See piping configuration AB on page 13, Table 3). Stock wall panels may be special ordered in any of the other nine standard colors with a two-week delivery.

Hydronic Alternatives™

RADIATORS

288 Verge Street Springfield, MA 01129 phone 413.543.8733 fax 413.543.8737
www.HydronicAlternatives.com E-mail : info@hydronicalternatives.com

Integral

Hydronic Alternatives™

Plainor

Choose from either sleek design. The Integral with a profiled front, or the flat front Plainor.

European style radiator with an integrated valve suited to receive a non-electric thermostat. The surface temperature of the unit changes to match the room's set point requirements. An oversized radiator can be used to accommodate low temperature hydronics and will never get hot to the touch. Many say this is the next best thing to radiant floor heat. A heating device that has a small foot print and easy to clean around. These radiators can be recessed for a flush clean look. The name says it all, a complete radiator with an invisible pipe system and an integrated thermostatic radiator valve.

Types:	11 - 21 - 22 - 33	
Dimensions:	Height: (Integral & Plainor) 11 ¾" to 35 ⅜"	Width: (Integral) 15 ¾" to 118 ⅛"
Heating capacity:	1,000 to 47,000 BTU/hr	(Plainor) 15 ¾" to 78 ¾"
Standard Color:	RAL9016 white, custom colors are available at additional cost.	

288 Verge Street Springfield, MA 01129 phone 413.543.8733 fax 413.543.8737
www.HydronicAlternatives.com E-mail : info@hydronicalternatives.com

Grundfos MAGNA
Amazingly adaptable

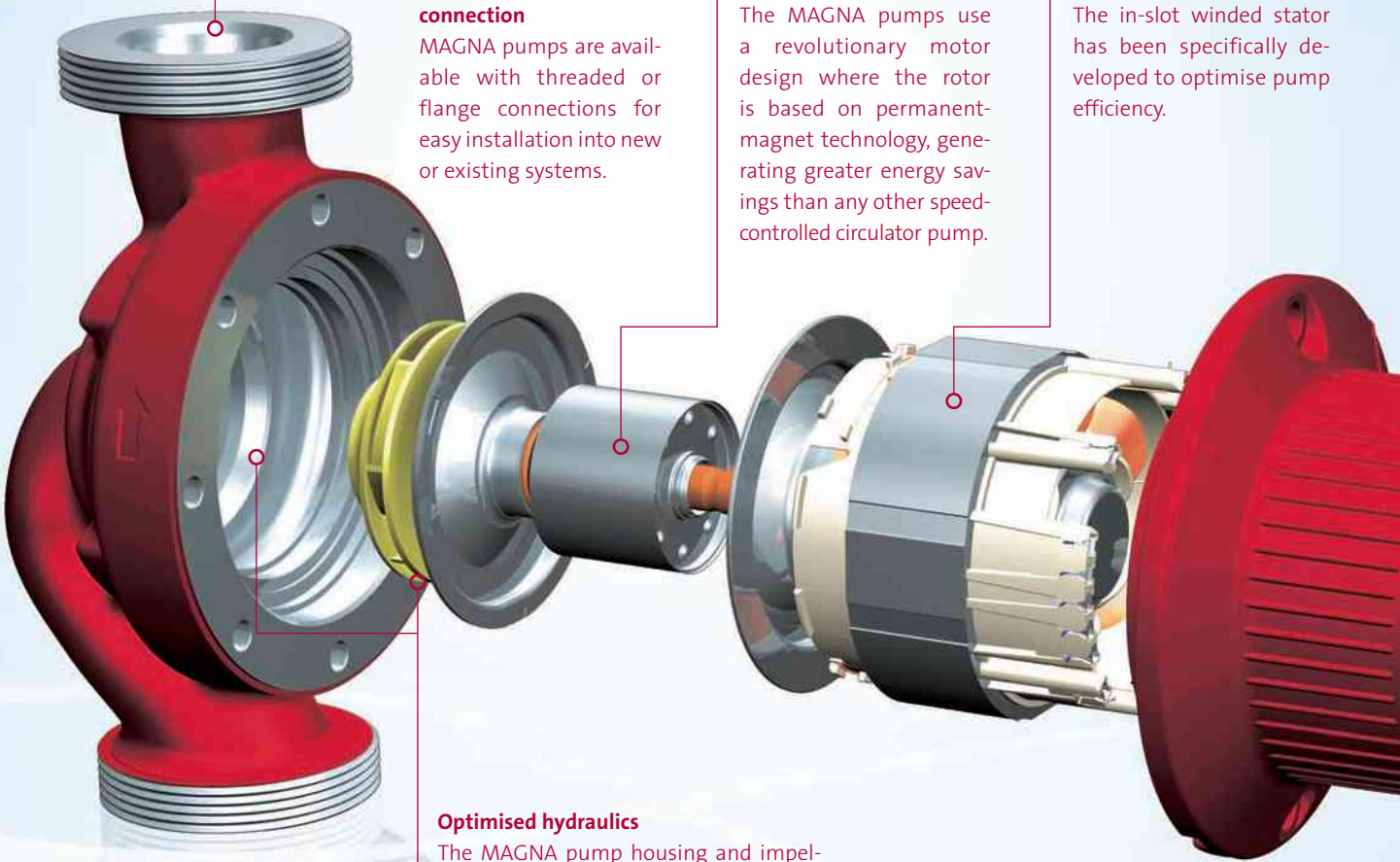
Intelligent, speed-controlled circulators
for heating and air conditioning systems

AUTOADAPT unique technology unique technology unique technology

BE > THINK > INNOVATE >

GRUNDFOS

Amazing technology



Threaded or flange connection
MAGNA pumps are available with threaded or flange connections for easy installation into new or existing systems.

Permanent-magnet rotor
The MAGNA pumps use a revolutionary motor design where the rotor is based on permanent-magnet technology, generating greater energy savings than any other speed-controlled circulator pump.

In-slot winded stator
The in-slot winded stator has been specifically developed to optimise pump efficiency.

Optimised hydraulics
The MAGNA pump housing and impeller are designed to be a perfect match. Extensive 3D testing and simulations ensure that the hydraulics in the MAGNA pumps are as efficient as possible – thereby reducing energy consumption.

Plug-and-pump installation
On all smaller MAGNA models, main connection is established simply by putting in the plug. And installation is so simple that the MAGNA can quite accurately be called “plug-and-pump” technology.

An inside look at the MAGNA range

The MAGNA pumps are the result of a development process dedicated to creating a truly efficient circulator pump. The design has been optimised with a view to reducing energy consumption and making the product as smart as possible. Nothing was left to chance: for example, sophisticated 3D design software and efficient flow simulation equipment helped our engineers bring you the exceptional performance that is the MAGNA hallmark. For the Grundfos MAGNA, only one quality is good enough: the best.

Some of the features of the Grundfos MAGNA are briefly described here. For more information, contact us.

NORIAN / SIANI ENGINEERING, INC.
43 Bradford Street, Concord, MA 01742 • Tel: 781-398-2250

APPENDIX D:

Utility Rebate Information

Massachusetts Commercial Upstream HVAC and Heat Pump Initiative

Qualifying Minimum Efficiency and Incentive Levels

Effective April 1, 2021

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

WE ARE MASS SAVE®:

Cape Light Compact · EVERSOURCE · nationalgrid · Unitil

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

Dual Enthalpy Economizer Controls (when installed with new qualifying equipment)	
Equipment	**Customer Incentive/Unit**
Outside Air Economizer Utilizing 2 Enthalpy Sensors	$125.00

Electronically Commutated Motor (ECM) Circulator Pumps for Hydronic Heating or Service Hot Water Installations	
Commercial Pump Size	**Customer Incentive/Unit**
≤ 1/6 HP	$100.00
> 1/6 HP and ≤ 3/4 HP	$100.00
> 3/4 HP and ≤ 3 HP	$200.00

High-Efficiency Condensing Units (HECU) for Refrigeration	
Equipment Size	**Customer Incentive/HP**
≥ 1 and ≤ 3 HP	$400.00
> 3 and ≤ 6 HP	$200.00

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

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

[2] Heating efficiency applies only to heat pumps.

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

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

mass save®
Savings through energy efficiency

Massachusetts Commercial Upstream HVAC and Heat Pump Initiative

Qualifying Minimum Efficiency and Incentive Levels

Effective April 1, 2021

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

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

[1] Equipment capacity is AHRI rated capacity or capacity at AHRI rating conditions for units without an AHRI rating.
[2] Heating efficiency applies only to heat pumps.
Instant discount is expected to be passed down to the end-use customer. Onsite verifications may be required.

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

mass save®
Savings through energy efficiency

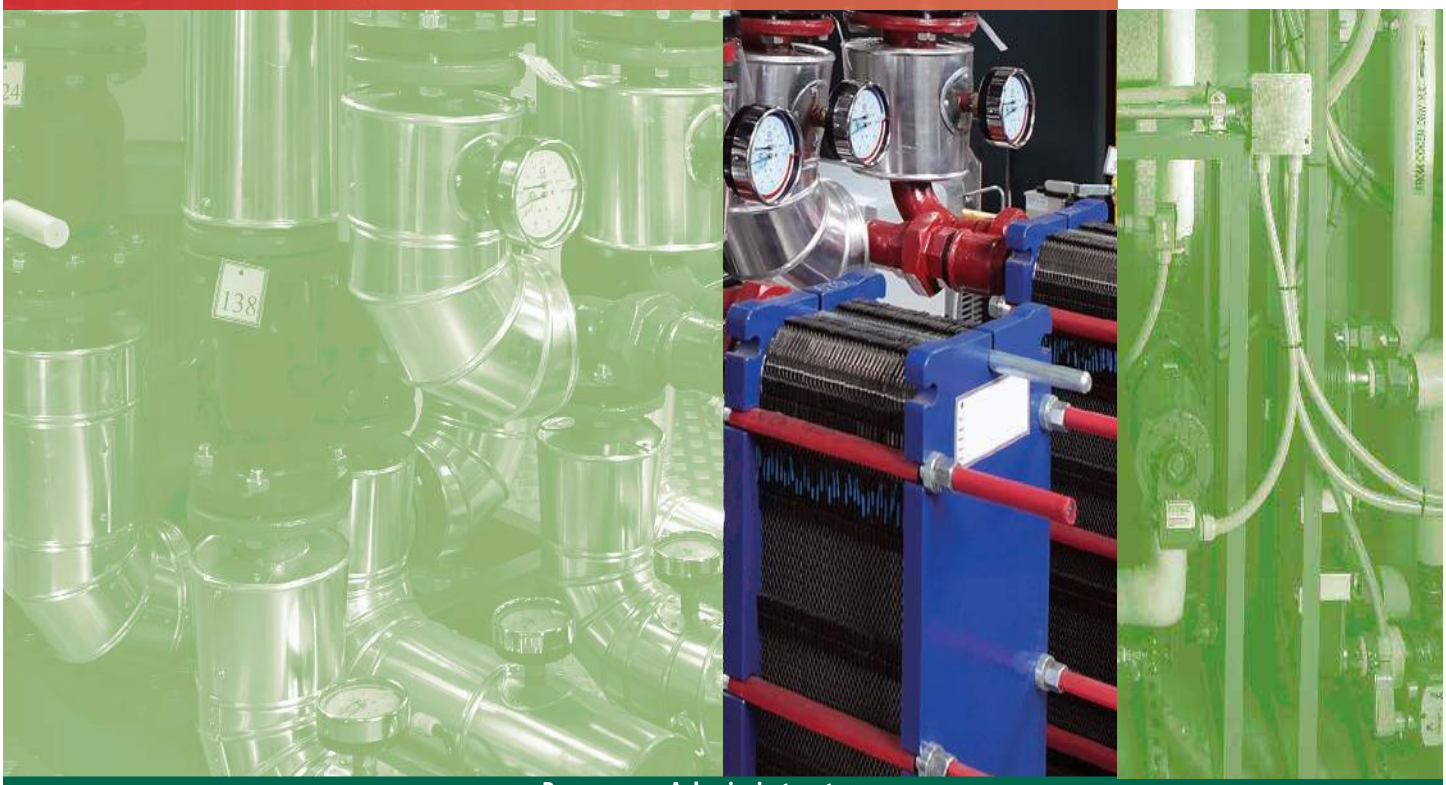
2021

New Buildings, New Equipment, and Major Renovations

Commercial & Industrial Natural Gas Equipment

mass save
Savings through energy efficiency

Apply online at www.MassSaveApplicationPortal.com



Program Administrators

WE ARE MASS SAVE®:

BERKSHIRE GAS
An AVANGRID Company

Berkshire Gas
Tel: 1-800-944-3212
www.berkshiregas.com
efficiency@berkshiregas.com

Cape Light Compact

Cape Light Compact
Tel: 1-800-797-6699
www.capelightcompact.org
efficiency@capelightcompact.org

EVERSOURCE

Eversource Energy
Tel: 1-844-887-1400
www.eversource.com
efficiencyma@eversource.com

Liberty

Liberty Utilities
Tel: 1-508-324-7811
www.libertyutilities.com
efficiency@libertyutilities.com

nationalgrid

National Grid
Tel: 1-800-787-1706
www.nationalgridus.com
efficiency@nationalgrid.com

Unitil

Unitil
Tel: 1-888-301-7700
www.unitil.com
efficiency@unitil.com

Rebates are provided to reduce the cost difference between standard efficiency and high-efficiency equipment

- High-Efficiency Heating Equipment
- After Market Boiler Reset Controls
- Programmable & Wireless Thermostats
- Steam Traps
- Shower Heads
- Faucet Aerators

A list of qualifying equipment is available at www.ahridirectory.org or call 800-232-0672

Application Instructions

1. Have a licensed heating contractor or plumber install eligible equipment. Must be installed between 1/1/2021 - 12/31/2021.
2. Apply online at www.MassSaveApplicationPortal.com or complete this application.
   If you have questions, call 800-232-0672.
3. If not submitting online, mail the signed rebate form with attached documentation to:

   Mass Save Rebates
   40 Washington Street, Suite 2000
   Westborough, MA 01581
4. If you are interested in financing your project, please contact your energy efficiency program administrator to discuss terms and eligibility prior to purchasing your qualifying equipment. Further information can be found on www.masssave.com/en/learn/business/the-mass-save-financing-for-business-program/.

Program Details: This rebate program applies to equipment purchased and installed between January 1, 2021 and December 31, 2021.
Reminder: Retain a copy of the completed rebate form for your records.

REQUIRED DOCUMENTS

All are required to process application. Failure to provide all required information and/or supporting documents will result in processing delays.

- ☐ Completed and signed Application
- ☐ Copy of the pre-approval rebate letter (if applicable)
- ☐ Manufacturer's technical specification sheets ("cut sheets") for each type of eligible equipment purchased
- ☐ W-9 Form with Tax ID number (National Grid customers only)
- ☐ Copy of a dated work order, invoice, or receipt within 60 days from installation.

Invoice must include the following:

- ☐ Manufacturer
- ☐ Equipment or measure installed
- ☐ Contractor
- ☐ Installation Costs
- ☐ Model/Serial Number
- ☐ Efficiency Rating
- ☐ Contractor Address
- ☐ Installation Address

High-Efficiency Natural Gas Equipment Rebates Rebates

Heating Equipment

Condensing Boilers	Rating	Rebate
1701 to 2000 MBH	90% Thermal Efficiency or greater	$10,000
1000 to 1700 MBH	90% Thermal Efficiency or greater	$7,500
500 to 999 MBH	90% Thermal Efficiency or greater	$4,000
301 to 499 MBH	90% Thermal Efficiency or greater	$2,000
Up to 300 MBH	95% AFUE* or greater	$1,500
Up to 300 MBH	90% AFUE* or greater	$1,000

Furnace	Rating	Rebate
Natural Gas Furnace w/On Demand DHW	97% AFUE* or greater & ECM motor	$950
Up to 150 MBH	97% AFUE* or greater & ECM motor	$600
Up to 150 MBH	95% AFUE* or greater & ECM motor	$300

Infrared Heaters	Rating	Rebate
All Sizes	Low Intensity	$750

Intergrated Condensing Boiler / Water Heater with On-Demand Hot Water	Rating	Rebate
	Minimum AFUE Rating of 95%	$1,600
	Must be considered one unit by manufacturer.	

Condensing Unit Heater	Rating	Rebate
Up to 300 MBH	90% Thermal Efficiency or greater	$750

* AFUE = Annual Fuel Utilization Efficiency, MBH levels are based on the unit's input. Equipment must meet program guidelines, rebates are given on a per-unit basis not to exceed purchase price.

Other Measure Equipment

	Rebate		Rebate
After Market Boiler Reset Controls	$225	**Steam Traps (Mechanical Traps Only)**	$50
Wireless Enabled Thermostats	up to $100	**Shower Heads: 1.5 GPM or less**	up to $20
Programmable Thermostats	up to $25	**Faucet Aerators: 1.5 GPM or less**	up to $8

ALL FIELDS ON THIS PAGE ARE REQUIRED TO COMPLETE YOUR APPLICATION

COMMERCIAL GAS UTILITY

☐ BERKSHIRE GAS ☐ EVERSOURCE ENERGY (MA ONLY) ☐ LIBERTY UTILITIES (MA ONLY) ☐ NATIONAL GRID (MA ONLY) ☐ UNITIL (MA ONLY)

COMMERCIAL ELECTRIC UTILITY (Required for Wireless Thermostat Rebates Only)

☐ EVERSOURCE ENERGY (MA ONLY) ☐ NATIONAL GRID (MA ONLY) ☐ UNITIL (MA ONLY) ELECTRIC ACCOUNT NUMBER (Must match installation address)

CUSTOMER/ACCOUNT HOLDER INFORMATION (Account Number must match Installation Address)

COMPANY NAME	CONTACT PERSON	APPLICATION DATE
INSTALL SITE	PHONE	FAX NUMBER
EMAIL ADDRESS		UTILITY REPRESENTATIVE NAME
STREET ADDRESS	CITY	STATE / ZIP
MAILING ADDRESS (IF DIFFERENT)	CITY	STATE / ZIP
GAS COMPANY NAME		GAS ACCOUNT NUMBER

BUILDING TYPE (PLEASE PLACE "X" IN APPROPRIATE BALLOT BOX)

☐ ASSEMBLY	☐ FAST FOOD	☐ HOTEL	☐ MULTI STORY RETAIL	☐ RELIGIOUS	☐ SMALL RETAIL
☐ AUTOMOTIVE	☐ FULL SERVICE RESTAURANT	☐ LARGE REFRIGERATED SPACE	☐ MULTIFAMILY HIGH-RISE	☐ K-12 SCHOOL	☐ UNIVERSITY
☐ BIG BOX	☐ GROCERY	☐ LARGE OFFICE	☐ MULTIFAMILY LOW-RISE	☐ SMALL OFFICE	☐ WAREHOUSE
☐ COMMUNITY COLLEGE	☐ HEAVY INDUSTRIAL	☐ LIGHT INDUSTRIAL	☐ OTHER:		
☐ DORMITORY	☐ HOSPITAL	☐ MOTEL			

PROJECT TYPE (select one)

☐ NEW BUILDING ☐ EXPANSION OF AN EXISTING BUILDING ☐ RENOVATION OF AN EXISTING BUILDING ☐ CHANGE IN THE USE OF FUNCTION OF THE BUILDING SPACE ☐ FUEL CONVERSION
☐ NEW CONTROLS FOR IMPROVED PERFORMANCE ☐ NEW EQUIPMENT FOR NEW PROCESS OR EXPANDED OPERATION ☐ PLANNED REPLACEMENT OF EQUIPMENT ☐ REPLACEMENT OF FAILED EQUIPMENT

PAYMENT METHOD (PAYEE MUST SUBMIT A W-9 FORM)

PAYMENT TO: ☐ CUSTOMER ☐ VENDOR/INSTALLER	CUSTOMER — TAX ID# (REQUIRED)	VENDOR/INSTALLER — TAX ID# (REQUIRED IF RECEIVING INCENTIVE)
CHECK PAYABLE TO:	CUSTOMER COMPANY TYPE: ☐ INC. ☐ NOT INCORP. ☐ EXEMPT	VENDOR COMPANY TYPE: ☐ INC. ☐ NOT INCORP. ☐ EXEMPT

VENDOR INFORMATION

VENDOR/INSTALLER	CONTACT NAME	
STREET ADDRESS	CITY	STATE / ZIP
PHONE	EMAIL ADDRESS	
DATE	VENDOR/INSTALLER AUTHORIZED SIGNATURE (NOT APPLICABLE IF CUSTOMER IS PAYEE.) X	

CUSTOMER ACCEPTANCE OF TERMS

☐ I CERTIFY THAT ALL STATEMENTS MADE IN THIS APPLICATION ARE CORRECT TO THE BEST OF MY KNOWLEDGE AND THAT I HAVE READ AND AGREE TO THE TERMS AND CONDITIONS ON THE BACK OF THIS FORM.

ANTICIPATED COMPLETION DATE

DATE	PRINT NAME	AUTHORIZED SIGNATURE X

FOR PROGRAM ADMINISTRATORS ONLY

REQUIRED INSPECTIONS	DATE	INSPECTOR	PROJECT COSTS:	
PRE-INSPECTION:				
POST INSPECTION:			LABOR $:	
APPROVAL	DATE	PROGRAM MANAGER		
PRE-APPROVED INCENTIVE:			MATERIAL $:	
FINAL INCENTIVE:				

Commercial Natural Gas Heating Equipment

Measure Information—the same information must also be included on your invoice.

Measure Information - Heating Equipment								
Type of Equipment	**Date Installed**	**Manufacturer**	**Model Number**	**Rating** (Thermal Efficiency, AFUE or Energy Factor)	**MBH Input Size**	**Installed Cost**	***Qty Installed**	***Rebate Amount**
Condensing Boiler 1701 to 2000 MBH, 90% Thermal Efficiency or greater **$10,000**								$ 0.00
Condensing Boiler 1000 to 1700 MBH, 90% Thermal Efficiency or greater **$7,500**								$ 0.00
Condensing Boiler 500 to 999 MBH 90% Thermal Efficiency or greater **$4,000**								$ 0.00
Condensing Boiler 301 to 499 MBH 90% Thermal Efficiency or greater **$2,000**								$ 0.00
Condensing Boiler up to 300 MBH 95% AFUE* or greater $**1,500**								$ 0.00
Condensing Boiler up to 300 MBH 90% AFUE* or greater **$1,000**								$ 0.00
Natural Gas Furnace w/On-Demand DHW ≥ 97% AFUE and with Electronically Commutated Motor $**950**								$ 0.00
Natural Gas Furnace up to 150 MBH 97% AFUE* or greater & ECM Motor **$600**								$ 0.00
Natural Gas Furnace up to 150 MBH 95% AFUE* or greater & ECM Motor **$300**								$ 0.00
Condensing Unit Heater up to 300 MBH 90% Thermal Efficiency or greater **$750**								$ 0.00
Infrared Heater (Low Intensity) **$750**	0							$ 0.00
Integrated Condensing Boiler/ Water Heater with On-Demand Hot Water Minimum AFUE Rating of 95% **$1,600**								$ 0.00

* Projects that are expected to exceed 10 of the same units and / or $25,000 in rebates will require pre-approval from your gas company. Contact MassSaveRebates@efi.org

Measure Information - Other Equipment							
Type of Equipment	**Date Installed**	**Manufacturer**	**Model Number**	**Size of Unit Controlled (BTU)**	**Installed Cost**	***Qty Installed**	**Rebate Amount**
After Market Boiler Reset Controls **$225**							$ 0.00
Steam Traps **$50**							$ 0.00
Shower Heads **up to $20**							$ 0.00
Faucet Aerators **up to $8**							$ 0.00

* Projects that are expected to exceed 50 steam traps will require pre-approval from your gas company. Contact MassSaveRebates@efi.org

Measure Information - Thermostat Rebates							
Type of Equipment	**Date Installed**	**Manufacturer**	**Model Number**	**Does the Thermostat Control Air Conditioning?**	**Installed Cost**	**Qty Installed**	**Rebate Amount**
Programmable Thermostat **up to $25**				☐ Yes ☐ No			$ 0.00
Wireless Enabled Thermostat **up to $100**				☐ Yes ☐ No			$ 0.00

Customers with central AC must provide Serial Number and MAC Address to be eligible for additional offerings.

Serial No._____ MAC Address_____

Anticipated Total Rebate: $ 0.00

Terms and Conditions

1. Incentives

Subject to these Terms & Conditions, the PA will pay Incentives to Customer for the installation of EEMs.

2. Definitions

(a) "Approval Letter" means the letter issued by PA stating PA's approval of Customer's application, the maximum approved Incentives, required date of EEM completion, any changes to Customer's application and any other requirements of the PA related to the Incentives.
(b) "Customer" means the commercial and industrial ("C&I") customer maintaining an active account for service with either a gas or electric distribution company.
(c) "EEMs" are those energy efficiency measures described in the Program Materials or other Custom Measures that may be approved by the PA.
(d) "Facility" means the Customer location in Massachusetts served by the PA where EEMs are to be installed.
(e) "Incentives" means those payments made by the PA to Customer pursuant to the Program and these Terms and Conditions. Incentives may also be referred to as "Rebates".
(f) "Minimum Requirements Document" means the minimum requirements document that may be required by the PA, which, if so required, will be submitted with Customer's application and approved by PA.
(g) "Program" means any of the energy efficiency programs offered to a C&I Customer by PA.
(h) "PA" or "Program Administrator" means The Berkshire Gas Company, or Cape Light Compact JPE, or Eversource Energy, or Liberty Utilities, or National Grid, or Unitil, as applicable.
(i) "Program Materials" means the documents and information provided or made available by the PA specifying the qualifying EEMs, technology requirements, costs and other Program requirements.

3. Application Process and Requirement for PA Approval

(a) The Customer shall submit a completed application to the PA. The Customer may be required to provide the PA with additional information upon request by the PA. Customer will, upon request by the PA, provide a copy of the as-built drawings and equipment submittals for the Facility after EEMs are installed. To the extent required by the PA or by applicable law, regulation or code, this analysis shall be prepared by a Professional Engineer licensed in the state where the Facility is located.
(b) To be eligible for gas funded EEM's Customer must have an active natural gas account. To be eligible for electric funded EEM's a Customer must have an active electric account. Customers must meet any additional eligibility requirements set forth in the Program Materials.
(c) The PA reserves the right to reject or modify Customer's application. The PA may also require the Customer to execute additional agreements, or provide other documentation prior to PA approval. If PA approves Customer's application, PA will provide Customer with the Approval Letter.
(d) The PA reserves the right to approve or disapprove of any application or proposed EEMs.
(e) Sections 3(a)-(c) do not apply in the event that the Program Materials explicitly state that no Approval Letter is required for the Program. In such an event, Customer must submit to PA the following: (i) completed and signed Program rebate form, (ii) original date receipts for purchase and installation of EEMs, and (iii) any other required information or documentation within such time as Program Materials indicate.

4. Pre- and Post-Installation Verification; Monitoring and Inspection

(a) Customer shall cooperate and provide access to Facility and EEM for PA's pre-installation and post-installation verifications. Such verifications must be completed to PA's satisfaction.
(b) Customer agrees that PA may perform monitoring and inspection of the EEMs for a three year period following completion of the installation in order to determine the actual demand reduction and energy savings.

5. Installation Schedule Requirements

If the Customer does not complete installation of the approved EEMs within the earlier of the completion date specified in the Approval Letter or twelve (12) months from the date the PA issues written pre-approval of the EEM project, the PA may terminate any obligation to make Incentive payments.

6. Incentive Amounts, Requirements for Incentives and Incentive Payment Conditions

(a) The PA reserves the right to adjust and/or negotiate the Incentive amount. PA will pay no more than the cost to Customer of purchasing and installing the EEM, the calculated incremental cost, the prescriptive rebate on the form, or the amount in the Approval Letter (unless such Approval Letter is not required), whichever is less.
(b) PA shall not be obligated to pay the Incentive amount until all the following conditions are met: (1) PA approves Customer's application and provides the Approval Letter (unless an Approval Letter is not required by the terms of the Rebate), (2) satisfactory completion of pre-installation and post-installation verifications by PA, (3) purchase and installation of EEMs in accordance with Approval Letter, Program Materials, Minimum Requirements Document, Customer's application and these Terms and Conditions, (4) all applicable permits, licenses and inspections have been obtained by Customer, (5) PA's receipt of final drawings, operation and maintenance manuals, operator training, permit documents, and other reasonable documentation, and (6) PA's receipt of all invoices for the purchase and installation of the EEMs.
(c) All EEM invoices will include, at the minimum, the model, quantity, labor, materials, and cost of each EEM and/or service, and will identify any applicable discounts or other incentives.
(d) PA reserves the right, in its sole discretion, to modify, withhold or eliminate the Incentive if the conditions set forth in Section 6(b) are not met.
(e) Upon PA's written request, Customer will be required to refund any Incentives paid in the event that Customer does not comply with these Terms and Conditions and
Program requirements.
(f) PA shall use commercially reasonable efforts to pay the Incentive amount within forty-five (45) days after the date all conditions in Section 6(b) are met.

7. Contractor Shared Savings Arrangements

If EEMs are being installed by a contractor under a shared savings arrangement, in which the contractor's compensation is based on the savings achieved, the PA maintains the right to determine the cost of purchasing and installing the EEMs.

8. Maintenance of EEMs

Customer shall properly operate and maintain the EEMs in accordance with the manufacturer's recommendations and the terms thereof for the life of the equipment.

9. Program/Terms and Conditions Changes

Program terms and materials (including these Terms & Conditions) may be changed by the PA at any time without notice. The PA reserves the right, for any reason, to withhold approval of projects and any EEMs, and to cancel or alter the Program, at any time without notice. Approved applications will be processed under the Terms and Conditions and Program Materials in effect at the time of the Approval Letter.

10. Publicity of Customer Participation

The Customer grants to the PA the absolute and irrevocable right to use and disclose for promotional and regulatory purposes (a) any information relating to the Customer's participation in the Program, including, without limitation, Customer's name, project energy savings, EEMs installed, and incentive amounts, and (b) any photographs taken of Customer, EEMs, or Facility in connection with the Program, in any medium now here or hereafter known.

11. Indemnification and Limitation of the PA's Liability

To the fullest extent allowed by law, Customer shall indemnify, defend and hold harmless PA, its affiliates and their respective contractors, officers, directors, members, employees, agents, representatives from and against any and all claims, damages, losses and expenses, including reasonable attorneys' fees and costs incurred to enforce this indemnity, arising out of, resulting from, or related to the Program or the performance of any services or other work in connection with the Program, caused or alleged to be caused in whole or in part by any actual or alleged act or omission of the Customer, or any contractor, subcontractor, agent, or third party hired by or directly or indirectly under the control of the Customer, including any party directly or indirectly employed by or under the control of any such contractor, subcontractor, agent, or third party or any other party for whose acts any of them may be liable.

To the fullest extent allowed by law, the PA's aggregate liability, regardless of the number or size of the claims, shall be limited to paying approved Incentives in accordance with these Terms and Conditions and the Program Materials, and the PA and its affiliates and their respective contractors, officers, directors, members, employees, agents, representatives shall not be liable to the Customer or any third party for any other obligation. To the fullest extent allowed by law and as part of the consideration for participation in the Program, the Customer waives and releases the PA and its affiliates from all obligations (other than payment of an Incentive), and for any liability or claim associated with the EEMs, the performance of the EEMs, the Program, or these Terms and Conditions.

12. No Warranties or Representations by the PA

(a) THE PA DOES NOT ENDORSE, GUARANTEE, OR WARRANT ANY CONTRACTOR, MANUFACTURER OR PRODUCT, AND THE PA MAKES NO WARRANTIES OR GUARANTEES IN CONNECTION WITH ANY PROJECT, OR ANY SERVICES PERFORMED IN CONNECTION HEREWITH OR THEREWITH, WHETHER STATUTORY, ORAL, WRITTEN, EXPRESS, OR IMPLIED, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THIS DISCLAIMER SHALL SURVIVE ANY CANCELLATION, COMPLETION, TERMINATION OR EXPIRATION OF THE CUSTOMER'S PARTICIPATION IN THE PROGRAM. CUSTOMER ACKNOWLEDGES AND AGREES THAT ANY WARRANTIES PROVIDED BY ORIGINAL MANUFACTURERS', LICENSORS', OR PROVIDERS' OF MATERIAL, EQUIPMENT, OR OTHER ITEMS PROVIDED OR USED IN CONNECTION WITH THE PROGRAM UNDER THESE TERMS AND CONDITIONS, INCLUDING ITEMS INCORPORATED IN THE PROGRAM, ("THIRD PARTY WARRANTIES") ARE NOT TO BE CONSIDERED WARRANTIES OF THE PA AND THE PA MAKES NO REPRESENTATIONS, GUARANTEES, OR WARRANTIES AS TO THE APPLICABILITY OR ENFORCEABILITY OF ANY SUCH THIRD PARTY WARRANTIES. THE TERMS OF THIS SECTION SHALL GOVERN OVER ANY CONTRARY VERBAL STATEMENTS OR LANGUAGE APPEARING IN ANY PA's OTHER DOCUMENTS.

(b) Review of the design and installation of EEMs by PA is limited solely to determine whether Program requirements have been met and shall not constitute an assumption by PA of liability with respect to the EEMs. Neither the PA nor any of its employees or contractors is responsible for determining that the design, engineering or installation of the EEMs is proper or complies with any particular laws, codes, or industry standards. The PA does not make any representations of any kind regarding the benefits or energy savings to be achieved by the EEMs or the adequacy or safety of the EEMs.

(c) PA is not a manufacturer of, or regularly engaged in the sale or distribution of, or an expert with regard to, any equipment or work.

(d) No activity by the PA includes any kind of safety, code or other compliance review.

13. Customer Responsibilities

Customer is responsible for all aspects of the EEMs and related work including without limitation, (a) selecting and purchasing the EEMs, (b) selecting and contracting with the contractor(s), (c) ensuring contractor(s) are properly qualified, licensed and insured, (d) ensuring EEMs and installation of EEMs meet industry standards, Program requirements and applicable laws, regulations and codes, and (e) obtaining required permits and inspections. PA reserves the right to (a) deny a vendor or contractor providing equipment or services, and (b) exclude certain equipment from the Program.

14. Removal of Equipment

The Customer shall properly remove and dispose of or recycle the equipment, lamps and components in accordance with all applicable laws, and regulations and codes. Customer will not re-install any of removed equipment in the Commonwealth of Massachusetts or the service territory of any affiliate of the PA, and assumes all risk and liability associated with the reuse and disposal thereof.

15. Energy Benefits

Other than the (i) the energy cost savings realized by Customer, (ii) energy or ancillary service market revenue achieved through market sensitive dispatch, (iii) alternative energy credits, and (iv) renewable energy credits, the PA has the unilateral rights to apply for any credits or payments resulting from the Program or EEMs. Such credits and payments include but are not limited to: (a) ISO-NE capacity, (b) forward capacity credits, (c) other electric or natural gas capacity and avoided cost payments or credits, (d) demand response program payments. Except for the credits and payments set forth in (i)-(iv) of this Section, Customer agrees not to, directly or indirectly, file payments or credits associated with the Program or EEMs, and further will not consent to any other third party's right to such payments or credits without prior written consent from the PA. PA's rights under this Section are irrevocable for the life of the EEMs unless the PA provides prior written consent.

16. Customer Must Declare and Pay All Taxes

The benefits conferred upon the Customer through participation in this Program may be taxable by the federal, state, and local government. The Customer is responsible for declaring and paying all such taxes. The PA is not responsible for the payment of any such taxes.

17. Counterpart Execution; Scanned Copy.

Any and all Program related agreements and documents may be executed in several counterparts. A scanned or electronically reproduced copy or image of such agreements and documents bearing the signatures of the parties shall be deemed an original.

18. Miscellaneous

(a) Paragraph headings are for the convenience of the parties only and are not to be construed as part of these Terms and Conditions.

(b) If any provision of these Terms and Conditions is deemed invalid by any court or administrative body having jurisdiction, such ruling shall not invalidate any other provision, and the remaining provisions shall remain in full force and effect in accordance with their terms.

(c) These Terms and Conditions shall be interpreted and enforced according to the laws of the Commonwealth of Massachusetts. Any claim or action arising under or related to the Program or arising between the parties shall be brought and heard only in a court of competent jurisdiction located in the Commonwealth of Massachusetts.

(d) In the event of any conflict or inconsistency between these Terms and Conditions and any Program Materials, these Terms and Conditions shall be controlling.

(e) Except as expressly provided herein, there shall be no modification or amendment to these Terms and Conditions or the Program Materials unless such modification or amendment is in writing and signed by a duly authorized officer of the PA.

(f) Sections 4(b), 10, 11, 12, 14, 15 & 18 shall survive the termination or expiration of the Customer's participation in the Program.

NORIAN / SIANI ENGINEERING, INC.
43 Bradford Street, Concord, MA 01742 • Tel: 781-398-2250 • Fax: 781-398-2280

APPENDIX E:

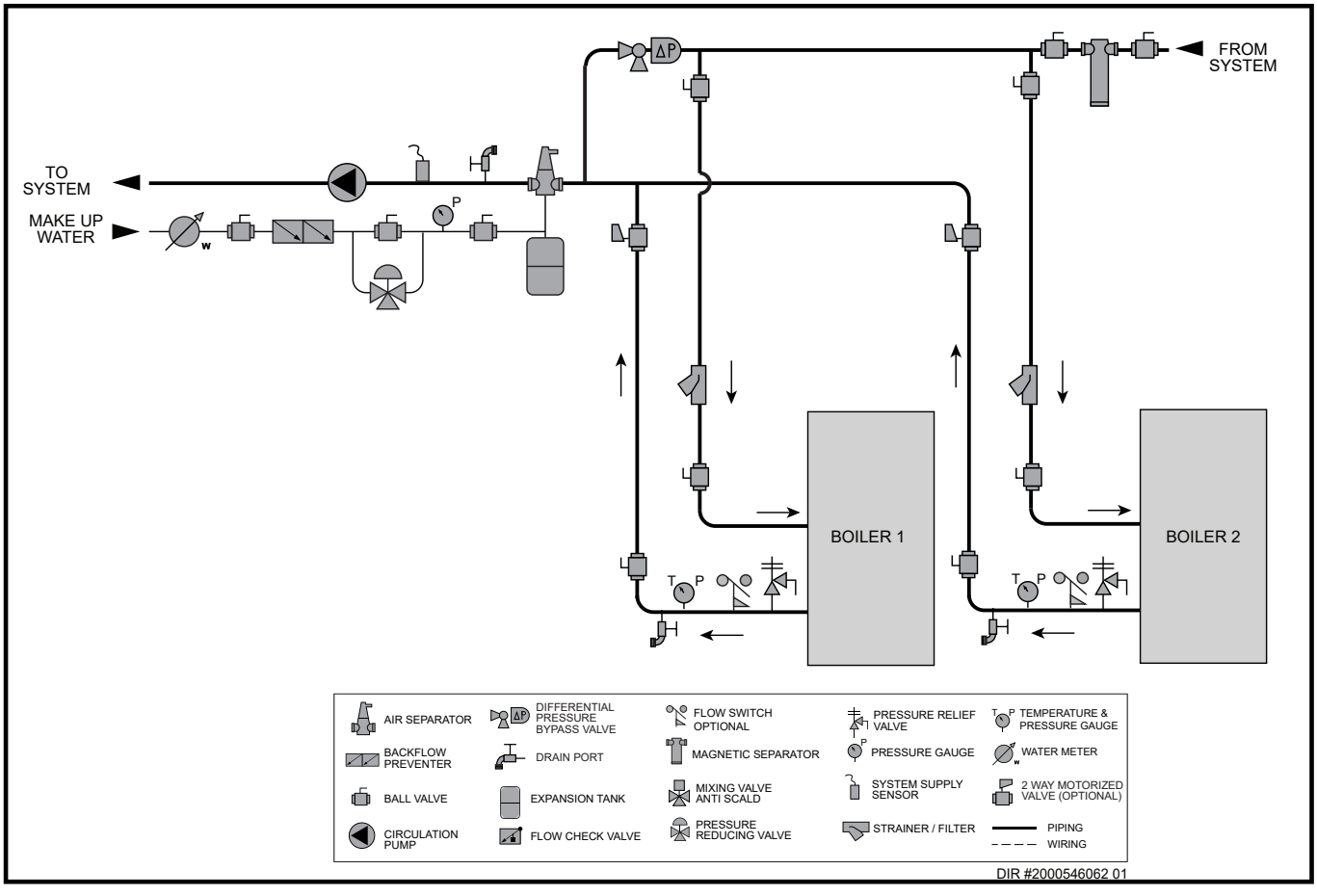
System Diagrams & Graphics

NORIAN / SIANI ENGINEERING, INC.
43 Bradford Street, Concord, MA 01742 • Tel: 781-398-2250 • Fax: 781-398-2280

OPTION-2: HYDRONIC SYSTEM DIAGRAMS

RADIANT "STAPLE-UP" SYSTEM

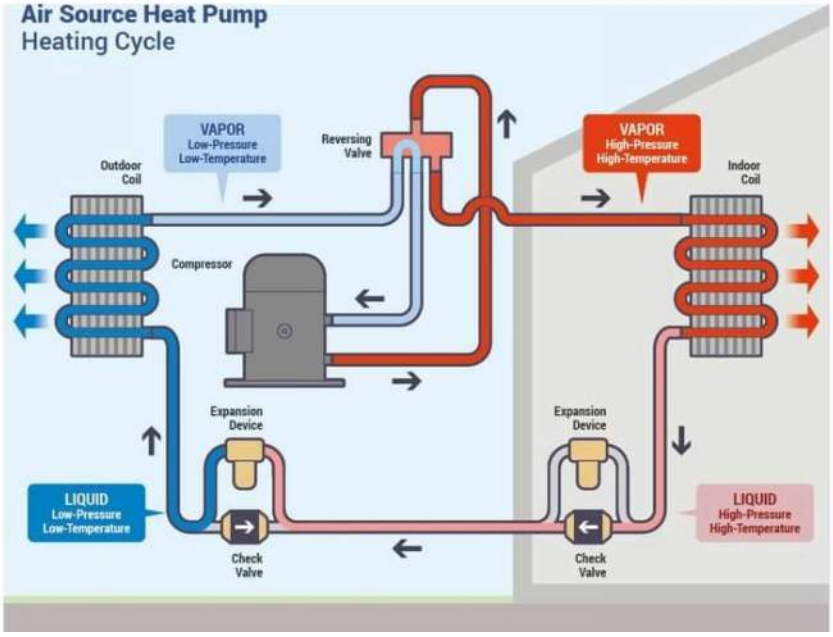
WALL-MOUNTED BOILERS



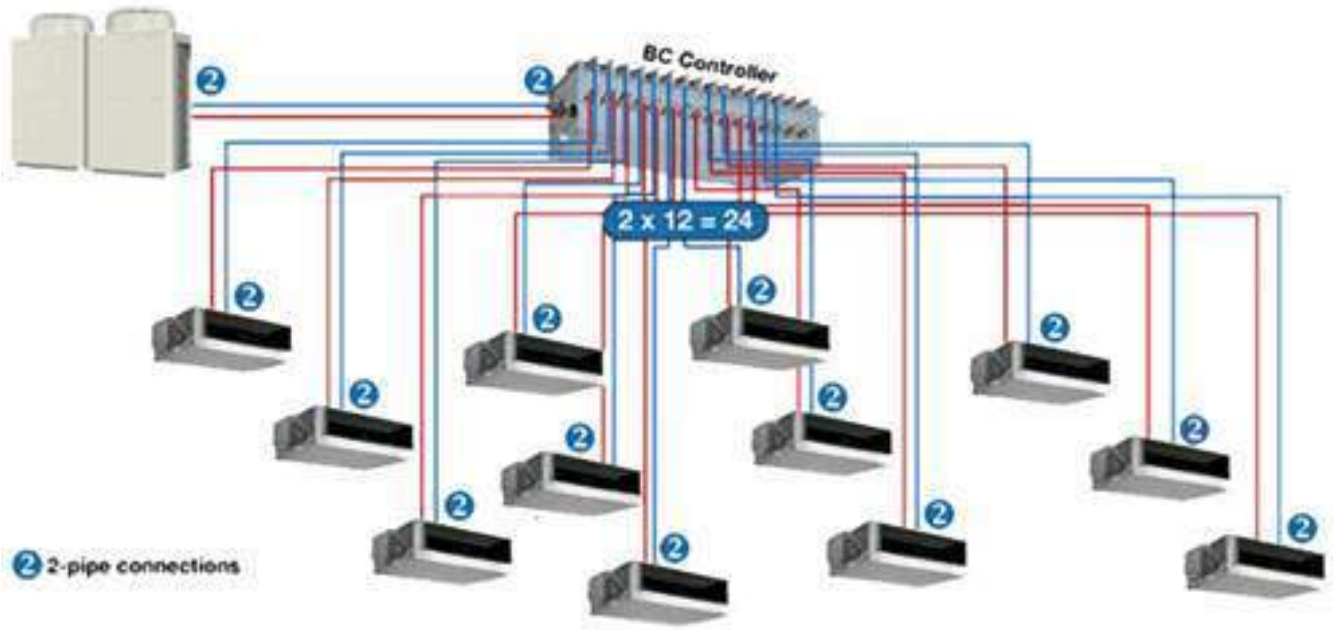
HYDRONIC BOILER SYSTEM PIPING DIAGRAM

NORIAN / SIANI ENGINEERING, INC.
43 Bradford Street, Concord, MA 01742 • Tel: 781-398-2250 • Fax: 781-398-2280

OPTION-3: AIR SOURCE HEAT PUMP DIAGRAMS



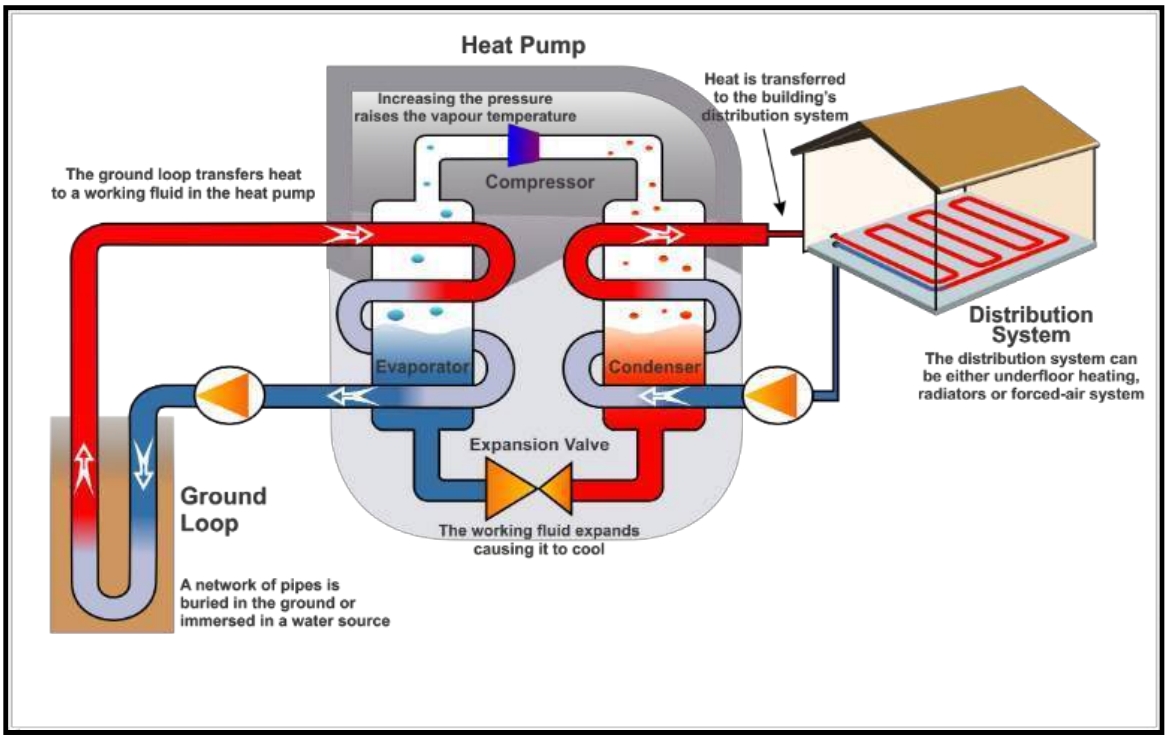
BASIC ASHP SYSTEM DIAGRAM



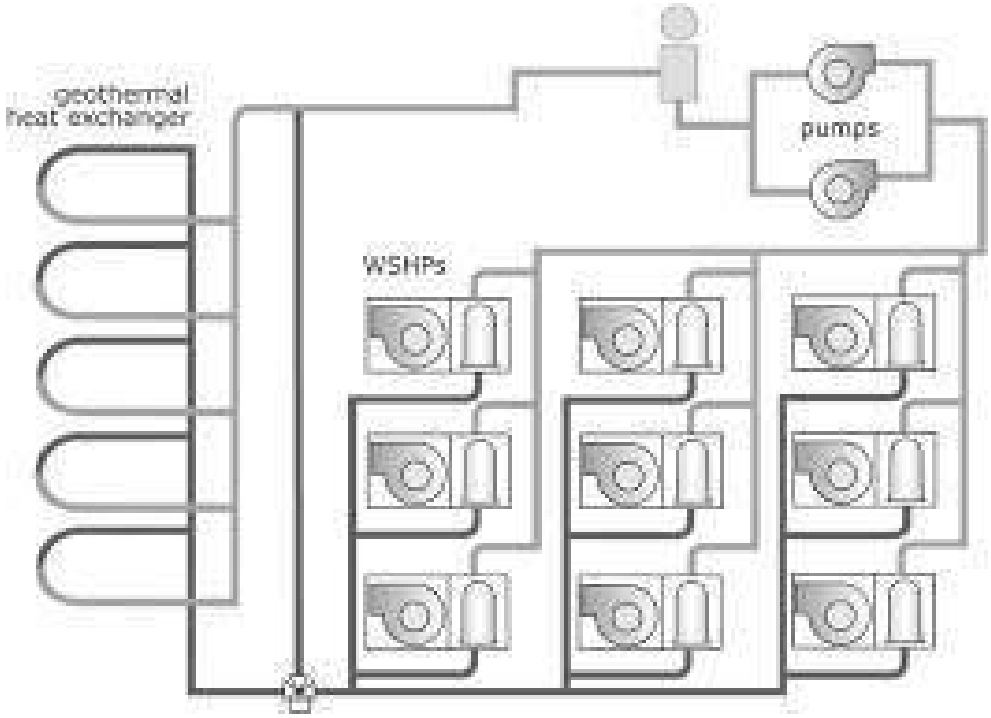
ASHP VRF SYSTEM PIPING DIAGRAM

NORIAN / SIANI ENGINEERING, INC.
43 Bradford Street, Concord, MA 01742 • Tel: 781-398-2250 • Fax: 781-398-2280

OPTION-4A: GROUND SOURCE HEAT PUMP DIAGRAMS



GSHP BASIC SYSTEM DIAGRAM



GSHP WATER-TO-AIR SYSTEM PIPING DIAGRAM

NORIAN / SIANI ENGINEERING, INC.
43 Bradford Street, Concord, MA 01742 • Tel: 781-398-2250 • Fax: 781-398-2280

OPTION-4B: GROUND SOURCE HEAT PUMP DIAGRAMS

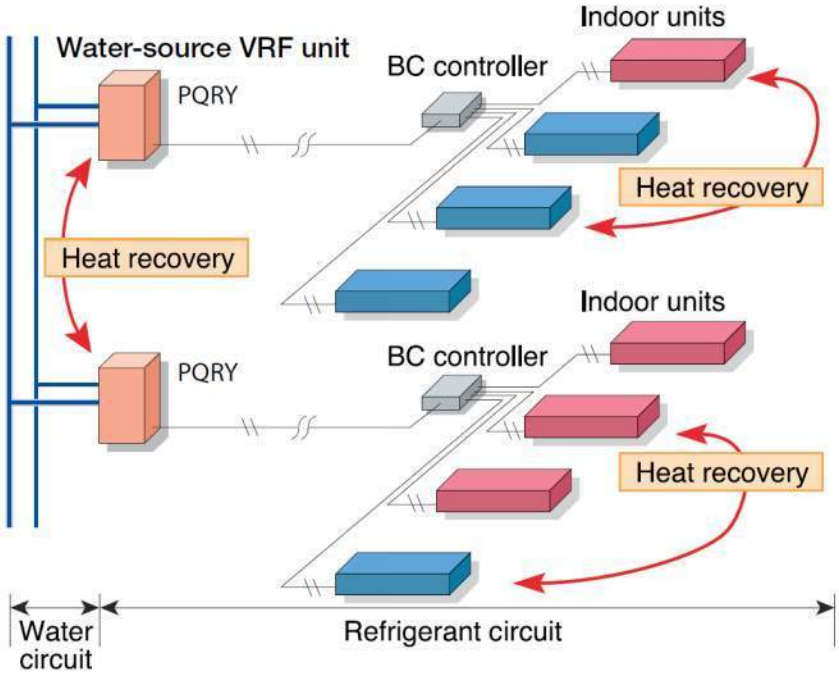


Figure 1. Water-Source VRF General Schematic. WR2-Series Shown. The WY-series requires that all the fan coil units attached to a system be in the same mode, either heating or cooling (**Figure 2**).

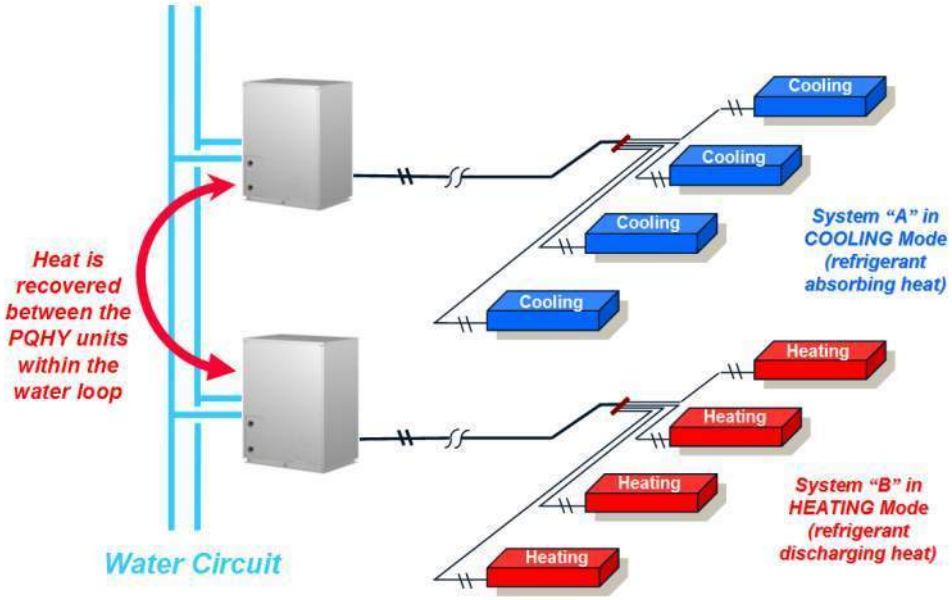


Figure 2. Water-Source VRF General Schematic. WY-Series Shown

NORIAN / SIANI ENGINEERING, INC.
43 Bradford Street, Concord, MA 01742 • Tel: 781-398-2250 • Fax: 781-398-2280

APPENDIX F:

Boiler Replacement Quote

Industrial Boiler & Mechanical Services, LLC.
156 Maple Street
Danvers, Ma 01923
Phone (877) 532-6632

APRIL 21, 2021

SOUTH CHURCH
41 CENTRAL STREET
ANDOVER, MASS 01810

PROJECT: REPLACE LEAKING BOILER

Dear Andy.

Thank you for inviting Industrial Boiler to quote on the replacement of the leaking boiler.

The existing H.B. Smith boilers steam header is not piped as per the manufacturer's instructions.

Not being piped as per there instructions creates an issue for any future warranty claims.

We have included an add/alternate to our quote to repipe the steam header of the new boiler.

Please accept the following as our proposal and quote to perform the following.

REPLACE EXISTING BOILER:

The contractor Industrial Boiler & Mechanical Services, LLC. Shall:

- Disconnect the existing boiler, dismantle and remove boiler from building and legally dispose of same.
- Provide one new H.B. Smith model 28A-9S steam boiler, rig same into boiler room and assemble on the existing concrete housekeeping pad.
- Reconnect all existing steam supply and return piping and weld same as necessary.
- Reuse the existing McDonnell and Miller 51-2 Auto feeder/low water cut off.
- Provide and install on the new boiler one new McDonnell & Miller model 751P manual reset low water cut off control.
- Reuse the existing Honeywell steam Pressurtrols and piping.
- Reuse the existing Power Flame burner.

- Reconnect smoke pipe to boiler as necessary.
- Reconnect gas piping to burner.
- Provide all necessary electrical wiring.
- Fire off Power Flame burner and commission new boiler test all safeties.

THE COST FOR THE ABOVE WORK IS:.....$41,500.00

ADD/ALTERNATE NEW STEAM HEADER AS PER MANUFACTURERS INSTRUCTIONS:

- Remove existing steam header and dispose of same.
- Provide and install a new welded steam header as per manufactures instruction. **(see attached piping diagram.)**
- Obtain the necessary Town of Andover cutting and welding permit.
- Hire Fire detail during welding operations.

THE COST FOR THE NEW STEAM HEADER IS:.....$7,500.00

Thank you in advance.

Dean Presutti
Owner

Figure 16 - Relief & Safely Valve Piping

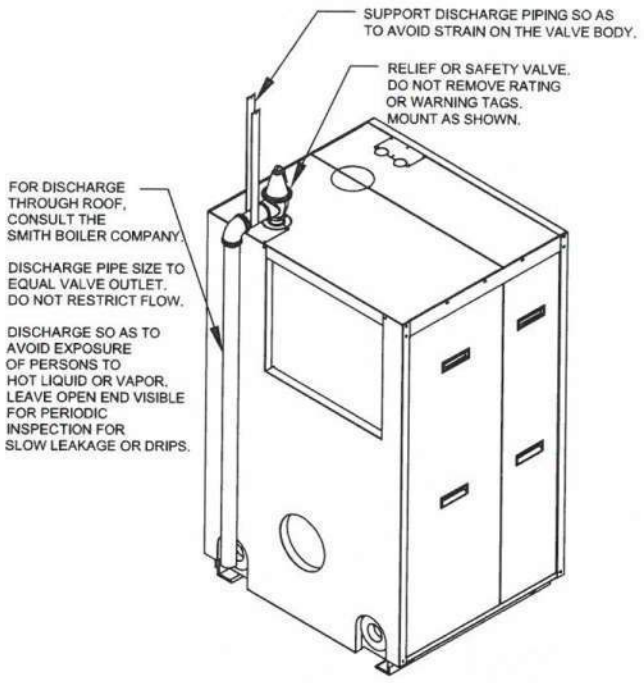


Table 7- Boiler Water Content

Boiler Model	Steam Boilers	
	Gallons	*Liters*
28HE-4	**104**	*394*
28HE-5	**126**	*477*
28HE-6	**148**	*560*
28HE-7	**170**	*644*
28HE-8	**192**	*727*
28HE-9	**214**	*810*
28HE-10	**236**	*893*
28HE-11	**258**	*977*
28HE-12	**280**	*1060*
28HE-13	**302**	*1143*
28HE-14	**324**	*1227*
28HE-15	**346**	*1310*
28HE-16	**368**	*1393*
28HE-17	**399**	*1511*
28HE-18	**412**	*1560*

Control Installation

Locate the temperature & pressure gage, low water cutoff, high limit and operating controls per Figures 14 & 18. Optional controls must be installed in accordance with the control manufacturers instructions and Figures 14 & 18.

Note: The front jacket panel MUST be installed before any controls are attached to the front boiler section!

CAUTION: The controls must be mounted in the correct location and according to the control manufacturer's instructions or the boiler may not function properly!

Water Column Piping

A variety of water level controls are available for the 28HE. The water column piping needed to properly mount each control is available from Smith. Figure 18 shows a typical water column piping arrangement. The 1" NPT x 7 1/2" nipple is always installed in the lower water column tapping, Figures 14 & 18 and Table 5.

STEAM BOILER PIPING

Steam Boiler Piping Connections

Table 3 contains the steam riser location schedule. Riser, equalizer and header pipe sizes are located in Table 8. A typical single boiler piping arrangement is shown in Figure 22. Figures 23 & 24 contain typical piping diagrams for steam boilers in a battery.

NOTE: See CLEANING OF STEAM BOILERS before connecting the return piping.

CAUTION: Improper placement of steam risers will result in poor steam quality!

Table 8 - Steam Boiler Piping Sizes

Boiler Model	Number of 5" NPT Risers	Header Size, NPT	Equalizer Size, NPT
4 & 5	1	5"	2 1/2"
6 & 7	2	5"	2 1/2"
8 Through 10	2	6"	4"
11 Through 18	3	8"	4"

The steam piping should be pitched so the condensate flows in the direction of steam travel. The return tappings should be yoked to equalize the return flow, Figure 17. Swing joints should be used.

Figure 18 - Boiler Control Locations

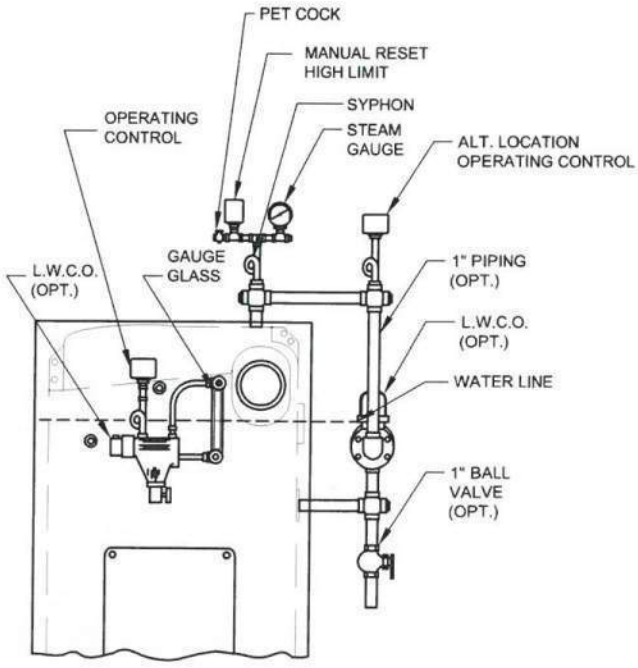


Table 9 - Steam Boiler Capacities

Boiler Model	I=B=R Gross Output		Evaporation Rate		Minimum Feed Water Pumping Rate		Condensate Receiver Capacity	
	MBH	*kW*	**GPM**	*L/hr*	**GPM**	*L/hr*	**Gallons**	*Liters*
28A/HE-S-4	**900**	*264*	**1.9**	*7.3*	**3.9**	*14.8*	**37**	*140*
28A/HE-S-5	**1166**	*342*	**2.5**	*9.5*	**5.0**	*18.9*	**48**	*182*
28A/HE-S-6	**1433**	*420*	**3.1**	*11.7*	**6.2**	*23.5*	**59**	*223*
28A/HE-S-7	**1699**	*498*	**3.7**	*13.8*	**7.3**	*27.6*	**69**	*261*
28A/HE-S-8	**1965**	*576*	**4.2**	*16.0*	**8.4**	*31.8*	**80**	*303*
28A/HE-S-9	**2232**	654	**4.8**	*18.1*	**9.6**	*36.3*	**91**	*345*
28A/HE-S-10	**2498**	*732*	**5.4**	*20.3*	**10.7**	*40.5*	**102**	*386*
28A/HE-S-11	**2764**	*810*	**5.9**	*22.5*	**11.9**	*45.1*	**113**	*428*
28A/HE-S-12	**3031**	*888*	**6.5**	*24.7*	**13.0**	*49.2*	**124**	469
28A/HE-S-13	**3297**	*966*	**7.1**	*26.8*	**14.2**	*53.8*	**135**	*511*
28A/HE-S-14	**3563**	*1044*	**7.7**	*29.0*	**15.3**	*57.9*	**145**	*549*
28A/HE-S-15	**3830**	*1122*	**8.2**	*31.2*	**16.5**	*62.5*	**156**	*591*
28A/HE-S-16	**4096**	*1200*	**8.8**	*33.3*	**17.6**	*66.6*	**167**	*632*
28A/HE-S-17	**4362**	*1278*	**9.4**	*35.5*	**18.7**	*70.8*	**178**	*674*
28A/HE-S-18	**4629**	*1356*	**9.9**	*37.6*	**19.9**	*75.3*	**189**	*716*

Note: These recommendations are considered normal for compact buildings. Where buildings are spread out, additional receiver capacity may be necessary because of the extended time required for condensate to return to the receiver.

Figure 22 - Typical Single Boiler Steam Piping