Solar Cal Poly Active HVAC Project

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Executive Summary

For this project, the goal was to conceptualize, design, test, and implement an active HVAC system to be used in the Solar Cal Poly house competing in the Department of Energy's 2015 Solar Decathlon. With many house iterations, it was decided to use a split system with an outdoor heat pump and indoor air handler, paired with a HRV for ventilation. Through system modeling using Design Builder and Energy Pro 6.5, the cooling load of the house was determined along with the cooling schedule. The foreseen safety precautions and limited construction time guided the entire project, along with the active HVAC system, to use a contractor for the majority of the house assembly. The HVAC system will compete in Irvine, CA in October of 2015.

Chapter 1: Introduction

Solar Cal Poly is a collaborative effort that requires the contribution of various engineering, architectural, and marketing disciplines. As Cal Poly seniors in pursuit of a Bachelor's degree in mechanical engineering, we are responsible for the active HVAC and hot water systems for Solar Cal Poly. Specifically, we will be designing and implementing the aforementioned systems in order to fulfill the requirements set forth by the Solar Decathlon competition guidelines, as well as the rest of the Solar Cal Poly team. Thus, we must consider multiple audiences in producing solutions that meet the needs of each group. These audiences include the US Department of Energy, as they will be judging and scoring the contest based on predefined rules and targets, the rest of the Solar Cal Poly team, as our systems must be compatible with the other systems of the house, and any potential occupants of the house, as they will be living in the house that we collaboratively build. In consideration of our audiences and the available resources at Cal Poly, we will perform the design, analysis and implementation of active HVAC and hot water systems that are both optimized and innovative.

Chapter 2: Background

Contest

Given the nature of our assignment, a contest based project, we first looked at the competition rules and guidelines that applied to our focus. There are 4 out of the 10 decathlon contests which we will be targeting: these include the engineering, comfort zone, home life, and energy balance contests. The engineering contest is our only target which will be subjectively judged; the engineering design, analysis and implementation will all be judged based upon innovation, functionality, efficiency, reliability and the level of documentation. These do not provide us with concrete specifications for our systems, but will significantly help us in creating our requirements and critiquing our ideas. The comfort zone contest applies strictly to the functionality of the house's HVAC system, and thus has become one of our main focal points. The contest is based upon temperature and humidity performance, of which 75 points will be awarded for keeping the house between 71°F and 76°F, and 25 points awarded for maintaining humidity levels under 60%. The home life contest involves the functionality of the plumbing and appliances within the house. Half of the total 100 points possible in this contest are awarded for completing 16 water draws in which the temperature of the water sampled is at an average of 110°F. The draws can be taken at any point throughout the competition and will provide us with another focal point to ensure our hot water system meets the demand of the contest. The final contest of concern is the energy balance contest. This involves keeping the electrical energy consumed during the contest week to less than 175 kWh, and thus is an overarching requirement to keep in mind when analyzing the electrical demands of any systems we consider. The entire contest criteria can be found in Appendix A.

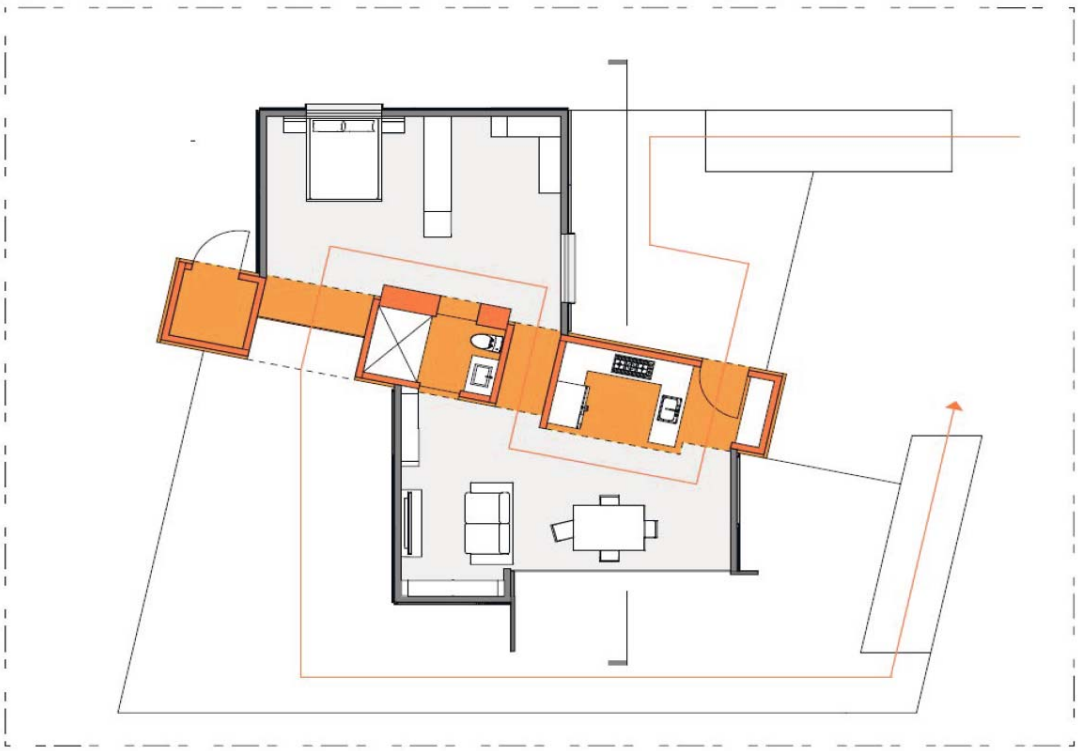


Figure 1. Initial Proposed Layout of the House

To also aid in our understanding of the competition, we looked over the proposed architectural designs of the house. Since the Solar Cal Poly effort had been going on for 9 months before we joined, much progress was made in determining the overall layout of the house. This review of the proposed layouts proved instrumental in our research. We discovered that the house would consist of two zones, a living room/kitchen area and a bedroom/bathroom area, which would all be contained in a 1000 ft^2 plot. This gave us an idea of the types of heating, cooling and hot water demands that will arise, and directed us in the right direction when looking at system characteristics.

HVAC System

After gaining an understanding of our responsibilities in the competition, we next researched the various HVAC and hot water systems and practices that are currently used in residential and commercial building. The DOE website offered many basic overviews of the types of cooling and heating systems available, and this served as a starting point for more exploration. We also found that the websites of equipment manufacturers provide a good deal of valuable information; we used their websites to familiarize ourselves with the different componentry used.

From our research into the HVAC industry, we organized our options for heating and cooling based upon the means of air distribution: through a ducted or ductless system. We chose

this distinction as we felt that the air distribution component would be the part of our system that would require the greatest care in assuring it is compatible with the other house systems. We were initially informed that the architecture teams greatly opposed drop ceilings in the house; this placed a hindrance on our possibilities with a ducted system but guided our research in a direction that sought to avoid needing drop ceilings.

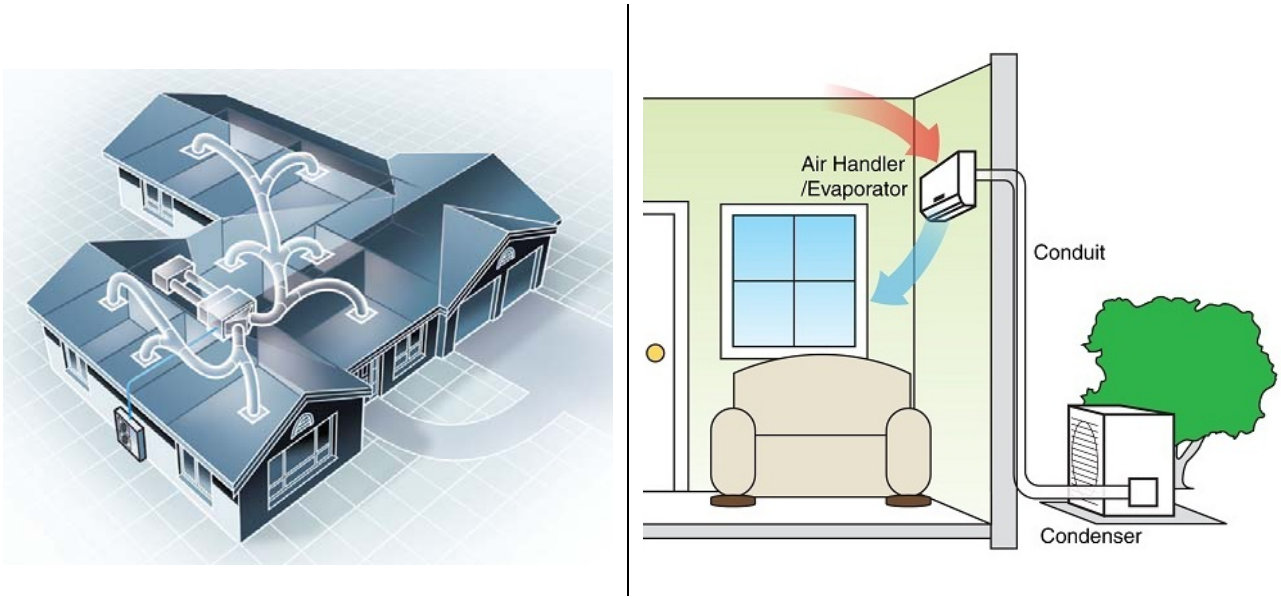


Figure 2. General layout for ducted System (left) and ductless system (right)

In a ducted system, air is heated or cooled by a separate unit before being distributed throughout the house by air ducts. Ducted systems have been conventionally used in commercial applications and are also used in many residential buildings as well. There are various types of systems that interface with air ducts, but we further classified ducted systems into 2 groups. The first includes packaged units, which are typically centrally located in the building and contain all necessary components for heating and cooling in one unit. Packaged units are generally used in commercial applications where heating and cooling loads are large, and where there is adequate space, such as in a large mechanical room or on top of a roof. The second group includes split system units. While there are some variations among the components in a split system, there is always one component responsible for heating or cooling the air and one component responsible for dispersing the air. A review of many of the 2013 Solar Decathlon submissions showed that a heat pump and air handler were commonly used as the two components. For example, in 2013 Team Ontario, who came in first in the engineering competition, used a 1.5 ton heat pump and air handling unit with an energy recovery ventilator as their HVAC system. Alternatively, another split system option is the condenser and furnace/cooling coil combination, which was found to be used in many large, residential houses.

In contrast to ducted systems, a ductless system utilizes individual heating/cooling elements located in various locations throughout the house. The most popular type of ductless system is referred to as a ductless mini-split system. In this setup, the individual heating/cooling elements, called cassettes, are responsible for heating, cooling and circulating air in each location they are placed. Each cassette is supplied with a coolant line, which comes from a condenser responsible for heating or cooling the working fluid. There are two main types of ductless mini-split systems: variable refrigerant flow and fixed flow systems. Like the name suggests, a variable refrigerant flow, of VRF, system has multiple cassettes controlled by one condenser, as it allows the necessary amount of refrigerant to be supplied to each cassette. VRF systems are relatively new and thus more expensive, and typically are used in large, multi-zone buildings where temperature differences are significant among different zones. Fixed flow systems, on the other hand, require a dedicated condenser for each unit, as the refrigerant is supplied at a fixed flow rate. Another type of ductless equipment is the evaporative cooler, also known as swamp cooler, which cools outdoor air using evaporated water and circulates it through an area.

With both a ducted and ductless system defined, we next began research on specific systems in each category. For ductless systems, we primarily investigated two common unit categories utilized in most residential applications: wall mounted cassettes, and ceiling mounted cassettes. For further reference it is important to mention that these systems are commonly referred to as ductless mini-split air conditioning systems. Alternatively, for ducted systems we investigated ceiling concealed cassette units, and split systems with a heat pump and air handler. Ducted systems are commonly referred to as central systems. Each of these systems could be implemented within the house, but further research was necessary in order to optimize the efficiency of the system and integration within the house itself.

To begin, we researched wall-mounted cassettes. As mentioned above, the wall-mounted cassette system is a modernized form of air conditioning in which one, or multiple, standalone units are fastened to a wall within a specific zone of a house or building. As inferred by the ductless designation, these units are solely connected via input and output refrigerant lines that are very small (~1/2 in diameter) compared to ducts. These coolant lines navigate relatively easily through the building due to their small size, and connect to an outdoor unit, the compressor/condenser. This unit circulates refrigerant to and from the indoor cassettes and provides the necessary heat transfer fluid. As mentioned above, these systems can either be VRF systems, or fixed flow systems, depending on how many units you need for your specified application. The main advantage of using mini splits is their small size and flexibility for zoning. Zoning refers to the ability to heat and cool individual rooms independently. With this capability, each unit incorporates a very intuitive and simple control system where the user is given a wireless remote to control the temperature in each zone. Compared with conventional ducted systems, mini split systems avoid energy losses associated with ducting (which can be up to 30% of energy consumption in worst case), thus they operate with significantly higher

efficiencies. Wall mounted cassettes are sold based on a large range of heating/cooling loads and styles. Adversely, mini split systems have a few clear disadvantages. Perhaps the primary disadvantage is their lack of ventilation. The system operates without return air, and does not pull fresh outdoor air in, thus it simply circulates indoor air repeatedly. This is an issue for ventilation, and also humidity. Next, the DOE estimates that such systems cost roughly $2,000 per ton of cooling capacity (about 30% more than central systems). Along with high cost, wall mounted cassettes are inherently more obtrusive than central systems as the cassettes must be placed within manufacturer specified clearances of indoor components such as televisions and accompanying walls, thus they are always in clear view. Below, we have attached a few different examples of possible wall-mounted cassettes.

Figure 3. Comparison of common wall mounted cassette vs. slim design.

Next, we researched another form of mini split system; ceiling mounted units. The only difference physically between these units and wall-mounted units is their position within the room. As the name implies, these units are mounted directly to the ceiling of each zone that needs conditioning. The cassettes are still connected solely by refrigerant lines that run to an outdoor compressor/condenser unit, thus all of the advantages discussed above translate to these units. The main difference with these units is that they are much less obtrusive as they are simply mounted in the ceiling and operate fairly unnoticed. Unfortunately, a clear disadvantage of incorporating this feature is that the building requires a drop ceiling, as the ceiling cassettes are an average of 10” in height. Wall mounted thermostats, instead of remotes, control each unit. Similar to wall mounted cassettes, these units are sold based on heating/cooling capacity and style. Below are a few examples of ceiling mounted cassettes from a few manufacturers.

Figure 4. Ceiling mounted cassettes for ductless mini split system

Switching gears, we next investigated a ducted system with ceiling concealed cassettes. This proved to be a viable system as the architects provided increased space in the mechanical chase for the current iteration of the house. Dr. Maddren recommended this system as it provided necessary ventilation, as well as a very visually appealing design. Ceiling concealed cassettes are commonly utilized in designs when systems are in need of an inconspicuous design. The cassettes are mounted within the duct space, blowing air horizontally through a grill to circulate through the room. Similar to mini split systems, a compressor/condenser unit circulates refrigerant to and from the cassette to provide the necessary heat transfer fluid. The cassettes are then ducted to the outside to provide fresh air intake, and thus drastically improve ventilation. This creates a relatively complicated system as both ducts and refrigerant lines must navigate through the mechanical chase. The primary advantage to these systems is their visual appeal. Additionally, as the units are ducted, they provide the capability for heat exchange with incoming and outgoing air. Again, an example has been provided below.

Figure 5. Ceiling concealed ducted cassette example.

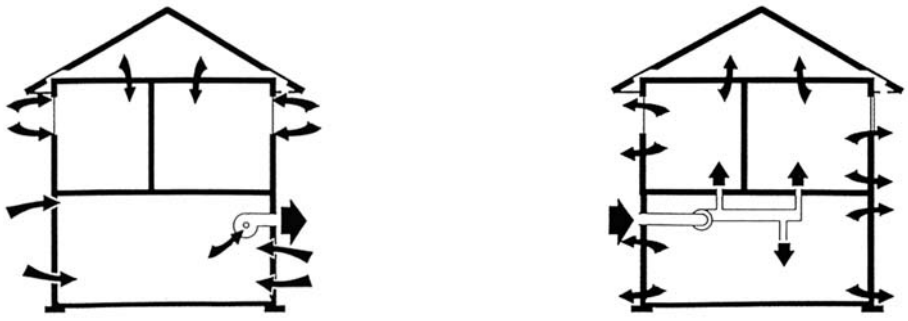
Lastly, we researched a conventional ducted system using an outdoor air-to-air heat pump coupled with an indoor air handler unit. For clarity, this is still referred to as a split system as it

incorporates both an indoor and outdoor unit. As outlined above in the general description of ducted systems, the outdoor heat pump is responsible for heating and cooling the air, and the air handler is responsible for dispersing the air within the space. The primary advantage of these ducted systems is their inherent ventilation integration. A common system is comprised of a centralized duct run, with stemming supply and return vents. Fresh outdoor air is drawn in through the air handler, and is dispersed through the house, only to then exit through the return lines. This creates very efficient air circulation within the space and can also help to maintain humidity levels. Furthermore, with net zero houses, it is very common that some sort of heat recovery ventilation system is used in conjunction with this system to increase efficiency. Similar to ceiling concealed ducted systems, the entire system is concealed within the mechanical chase, thus making the system almost completely hidden. A few disadvantages to this conventional system include: lower efficiency compared to mini split systems, more space required for ducting, and lack of originality. As mentioned above, ducted systems can lose up to 30% of energy consumption as the heat transfer to and from the air occurs further from the conditioned spaces. The system also requires much more space than a mini split system, as ducts are over 10 times as large as refrigerant piping. Lastly, the system lacks originality and innovation as these types of systems have been used for many years. A few images are provided below to further explain each component described in this section.

Figure 6. Air handler (left) and heat pump (right).

An important aspect of the HVAC system is the ventilation of the house. While a lot of research went into how we were going to heat and cool the solar house, we also had to put in a significant amount of research into how we were going to keep the air in the house fresh. We first found that a dedicated exhaust fan is needed in both the bathroom and kitchen, as these areas contain odors that could contaminate the rest of the house if not vented separately (ASHRAE 62.1). With us getting involved with the project later than other team members, there had already been discussions of how to ventilate the house; we were told that a Heat Recovery Ventilator was the suggested method. Keeping the suggestion in the back of our heads, we wanted to research other ventilation strategies in order to design a system that would best be incorporated into our overall HVAC system. There are a few options to consider when deciding upon a mechanical technique to freshen air in a house: an exhaust-only system, a supply-only system, a balanced system, and a balanced system with heat recovery by the use of a Heat Recovery Ventilator, HRV or Energy Recovery Ventilator, ERV.

Exhaust-only and supply-only systems are effective working on the same principal of causing a pressure difference between the inside of the house and the surrounding environment of the house. By the use of an exhaust fan, polluted, stale air is removed from the inside of the house and transferred outside. This is usually accomplished with the use of ducts as a method to move the air. As a result, fresh outside air enters the house via small unintentional leaks within the building envelope, and it takes the place of stale air. A system with a supply-only method works in a similar way except fresh air travels in the ducts from outside to the inside. The added pressure causes the current stale air in the room to leak out of the house through the various openings of the building envelope. Both of these systems are the least expensive and only require minimal maintenance, but also have a few downfalls. They both have heat losses, as air at the desired temperature is removed from the house, while air at an unwanted temperature is added, and the exhaust only system, specifically, does not provide filtration. These are common ventilation strategies for older homes that not as tightly sealed off to the outside compared to houses that are being built today.



(a) (b)

Figure 7. The image on the right (a) is an example of how an exhaust-only ventilation system works, and (b) demonstrates how a supply-only ventilation system works.

A balanced system is one that does what an exhaust only and supply only system do simultaneously. A fan transfers air from within a building to the outside at the same rate that a supply fan provides fresh air to the living areas. This is a more complex system, but it can provide a better air distribution if properly installed. Figure 8 shows the basic operation for how a balanced system works.

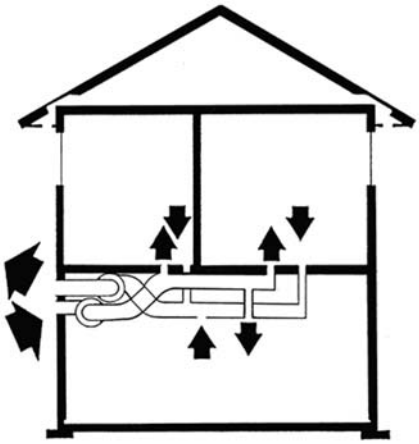


Figure 8. Demonstration for how a balanced ventilation system performs within a house.

Commonly, some sort of recovery method is incorporated within a balanced ventilation system. The most popular devices used today to achieve some sort of recovery are either a Heat Recovery Ventilator (HRV) or an Energy Recovery Ventilator (ERV). A HRV works like a balanced system, but the exiting indoor air and incoming outside air pass through the HRV and exchange heat. Figure 9 shows how air enters and exits a HRV.

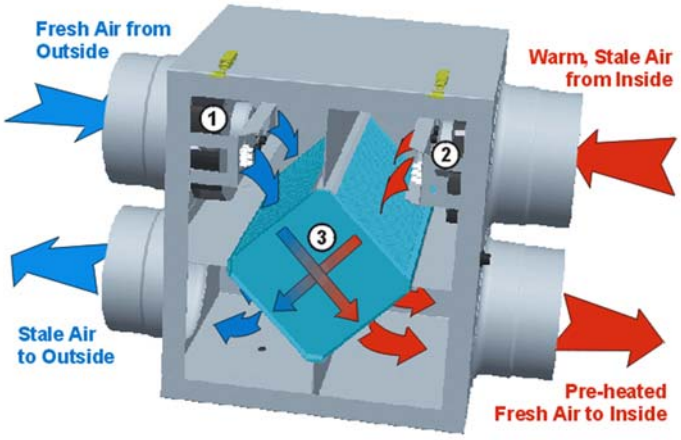


Figure 9. Schematic for how a HRV utilizes a heat exchange between the inside and outside air.

We again looked through various construction documents from the 2013 competition and found that almost every house used an energy recovery ventilator, or ERV. An ERV exchanges heat and moisture from stale, indoor air to fresh, outdoor air, which can then be supplied to an air handling unit or dispersed throughout the house. Similar to the ERV is the heat recovery ventilator, or HRV, which also can exchange heat, but cannot exchange moisture. While these two pieces of equipment are similar, there are certain climates where one is preferred over the other. Because a HRV can only perform a heat exchange, it will transfer any moisture from the outside air into the house. Thus, it is recommended that an ERV be used where a HRV will have a negative effect on the building environment, such as in a hot, humid climate or a cold, dry climate (buildinggreen.com). On average, the required energy to run a HRV is 150 watts and they can recover anywhere from 60 to 75% of heat. An ERV also recovers heat, but it is different in the fact that it is also capable of retaining a difference in humidity between inside and outside of the house. Although an ERV will provide the humidity difference, it is incapable of providing enough humidity exchange to be the only means of dehumidification of a house for a humid climate.

If our decision came down to a balanced ventilation system with heat recovery, it would be important for us to know the local environment of Irvine, CA. To achieve this we used the resource *Surface Meteorology and Solar Energy* by NASA. This resource gives various meteorological characteristics of given latitude and longitude. The user can input a specific coordinate in the database, and they have access to various historical averages for anywhere within a 0.5 latitude and longitudinal coordinate.

Solar Thermal System

When researching solar thermal systems, we found that the interaction with solar power was much more complex. Unlike the HVAC systems, which utilize the sun's energy after it has been converted to electrical power, solar thermal systems generally use the direct heat of the sun to gain thermal energy. For this reason, the opportunity for creative design is much greater, as we will be doing much more than choosing an appropriate system for the house. Still, we focused our initial research on the current systems that are used today. We found that many of the past Solar Decathlon houses used some type of solar collector to transfer thermal energy to a fluid that was circulating through it. This fluid was then used, either directly or indirectly, to provide hot water to the house. While these water heating systems all operate on the same principles, there is a large variation in componentry available.

A main distinction in solar thermal systems is the type of solar collector used. According to the US DOE, there are 3 types of solar collectors used for residential applications (Solar Water Heaters). The first is a flat plate collector, which is simply an insulated, weatherproof box. Inside the box is a dark absorber plate with fluid conduit lines welded beneath which circulate the heat transfer through. The absorber plate and fluid conduit are often shielded by multiple sheets of a

polymer cover which contribute to the thermal absorptivity of the box while providing protection. A cross-sectional view of a flat plate collector can be seen below in figure 10. Similar to the flat plate collector is the evacuated tube collector, which instead has fluid conduit lines that are exposed to the ambient conditions. Each line has an inner tube through with the heat transfer fluid flows, and an outer tube that creates a vacuum between the two tubes. This helps to significantly reduce radiative heat loss from the fluid lines, and thus makes the evacuated tube collector more effective, but as a result nearly doubles the cost per square foot compared to flat plate collectors. A final solar collector is the integral collector-storage (ICS) system. Also known as batch systems, these have one or more black tanks or tubes inside an insulated box. The main difference in an ICS system is that the heat transfer fluid is stored in the box for a period of time, compared to being circulated through. ICS systems are often used to preheat water for a conventional backup heating system and do not require any forced circulation to transport fluid.

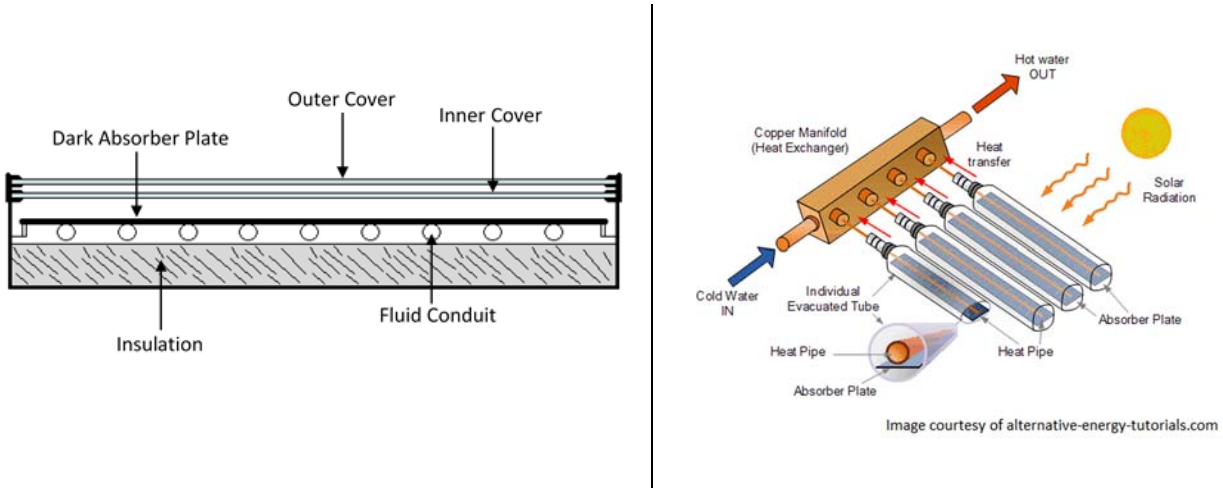


Figure 10. Flat plate collector vs. evacuated tube collector for solar thermal system loop.

Another distinction in residential solar thermal systems is whether they are an open or closed loop system. In an open loop system, the heat transfer fluid is the water that is eventually used throughout the house. As the name suggests, cold water circulates through the solar thermal loop, gaining thermal energy from the solar collector(s). It then returns to the hot water tank and is distributed to the rest of the house via the plumbing system. Because the domestic water supply is circulating throughout this entire loop, there is an added complexity to ensure that the water remains sanitary. In contrast, a closed loop system utilizes a heat transfer fluid that is continually run through the same loop and is never distributed to the house. A closed loop system requires a heat exchanger to transfer the thermal energy from the heat transfer fluid to the domestic water, and thus introduces thermal losses in the process. While closed loop systems are less efficient for this reason, they also have many benefits. For example, the nature of a closed loop system allows different heat transfer fluids with better physical properties to be used. Many

antifreeze solutions are common heat transfer fluids, as they have lower freezing points and higher boiling points than just water. For this reason, closed loop systems are often implemented in areas where freezing is common, as the piping of an open loop system would freeze much faster with just water flowing through. The elevated boiling points of antifreeze solutions are also desired, as the heat transfer fluid can experience rooftop temperatures over 300° F that may cause a portion of the fluid to boil off. This not only requires that addition of more heat transfer fluid over time, but can also damage the integrity of the solar collectors as steam becomes trapped inside them.

Dynalene, a manufacturer of heat transfer fluids and coolants, lists the criteria for selecting an appropriate heat transfer fluid for a solar thermal application: high thermal stability at temperatures of up to 350° F; non-toxic; good corrosion protection; and high reserve alkalinity or good pH buffering (Selecting a Glycol for Solar Thermal Applications). High reserve alkalinity is a chemical property which defines the ability of a fluid keep the pH stable and slows the increase in acid production as the glycol degrades. Dynalene also compares three common glycols used in heat transfer applications. The first is ethylene glycol, which is considered toxic and thus is not typically used in domestic water applications. Propylene glycol, on the other hand, is non-toxic and therefore safer in domestic water applications. Compared to ethylene glycol, it degrade more slowly, but also exhibits lower performance as the viscosity is higher and thermal conductivity is lower. The third is called trimethylene glycol, and unlike the previous glycols, is bio-derived from corn sugar. It exhibits slower thermal degradation and has better thermal and physical properties than the other two glycols, but as a result of its natural refining process it is more expensive.

From our review of previous houses' solar thermal systems, such as the 2005 Cal Poly and 2013 UNLV submission, we found other common characteristics that are necessary for a functional system. The systems we researched all relied on forced circulation to transport the heat transfer fluid. Inline pumps were used to circulate the fluid through the system, operating on a temperature differential between the top of the system loop and the bottom of the hot water tank. To aid in decreasing the amount of fluid boiled off, the systems were often pressurized to a few atmospheres, thus raising the boiling point of the fluid. Also utilized to help avoid boiling and freezing was a drain-back system. In this system, a drain-back tank is incorporated in the loop to be used as a storage tank for the fluid when the pump is not in operation. To account for when boiling occurs, an automatic air valve is often placed in connection with the solar collector(s), as steam from the boiled off fluid can damage the solar collectors if not allowed to vent out. We found that each loop had an expansion tank, which is used to regulate the pressure in the system by providing for an excess space for fluid to expand into when pressure increases. Expansion tanks have a maximum pressure rating, which, when exceeding, function as a pressure relief valve, preventing the system from any overpressurization risks. Also integral to the system loop are strategically placed check valves, which only allow flow in one direction. All systems

we researched appeared to have one placed on the outlet side of the pump but before the compressor, and after the solar collectors but before the hot water tank. Locations of these check valves and other componentry discussed can be found below in the idea selection section, Figure 12, which depicts UNLV's solar thermal loop from 2013.

Additional Resources

We next turned to the graduate students working on the project to understand how we will be working in conjunction with them. We first met with Bryce Willis, a graduate student who has been working on the design of the HVAC system for the past two quarters. She shared with us her various energy models of the house using the software program DesignBuilder. This software provides the ability to model a building and run energy analysis based upon an exhaustive list of parameters. The analysis includes many useful calculations, such as the required heating and cooling loads for each specific zone of a building. Based upon Bryce's initial model of the house, she suggested that a mini-split system be implemented in order to effectively cool the house. While initially we were not aiming to begin any decision making processes, we gave Bryce's recommendation due consideration as she had been on the project much longer than us.

We also met with graduate student Jared Tower, who is beginning his thesis on the design of the solar thermal system. Jared shared with us his plans for implementing a parabolic concentrated collector, called a Sheffler collector, as he would like to create a system that is backed by academic research. He provided us with some names and topics to follow up with, and we will be working closely with him to design a system that is both unique and effective.

Figure 11. Sheffler parabolic collector example.

Finally, we met with Dr. Jesse Maddren, who was the lead mechanical engineer on the 2005 Cal Poly house. He provided us with the design report of their submission, which was extremely helpful in explaining all of the design decisions and analysis that went into the engineering of the previous house. Their design included an air-source heat pump with electric resistance backup heating and an ERV. In designing their solar thermal system, they performed design studies which compared collector tilt angle, collector area and orientation, hot water space heating, and flat plate vs. evacuated tube collectors. Also worth mentioning from the house was the added thermal mass that they incorporated in the form of a trombe wall. A trombe wall is simply a water storage tank that allows the water inside to continually gain thermal energy. The benefit to this type of added thermal mass is that there is essentially no additional weight or componentry that needs to be transported to the competition site; water is simply added to the trombe wall at the competition.

From the current architecture team, we learned that the house they are designing is similar to the 2013 UNLV submission. Their design, which took 2nd, used a mini-split system along with an ERV as the HVAC system, and a closed loop solar thermal system with evacuated tube solar collectors.

Chapter 3: Design Development

Objectives

In order to provide functioning and optimized hot water and active HVAC systems, we must make sure that we are spending appropriate time on given project requirements. By the use of a Quality Function Deployment (QFD), we were able to assign engineering specifications to given customer requirements. Considering the needs of multiple groups - the Solar Decathlon competition, the buyer of the house, the guests of the house, and the rest of the Solar Cal Poly team – we were able to compile a list of various requirements to help shape our engineering specifications.

To begin, we will discuss the requirements associated with the active HVAC system. We first compiled a list of requirements based on the competition guidelines and our engineering judgment. This list included categories pertaining to cost, energy usage, house integration, reliability, etc. (this can be referenced in Appendix E within the QFD). Each of these requirements was given a relative weight for how they applied to our four customer groups (judges, house guests, house occupants, Solar Cal Poly team). By applying a weight (1-5) to each of our customer requirements, we are able to determine the relative importance of the entire list. For example, the requirement to remain within contest parameters was given a 5 for judges, house occupants, and the Solar Cal Poly team, as this defines how we do in the competition, while it was given a 2 for houseguests, who will not be observing these parameters. Similar

decisions were made for the remaining requirements. This system then provides the basis for a general design direction and the requirements that need to be considered heavily.

By further analyzing the requirements list, we generated a list of formal engineering specifications for both our active HVAC and hot water systems. Each requirement was examined individually to create quantifiable categories. For instance, to create our first HVAC specification, cooling/heating capacity, we considered the requirement of remaining within the contest parameters. The DOE defines that the house must remain within 71°F to 76°F, and thus a specific cooling/heating capacity is required to provide the necessary conditioning. This method was utilized to compile a full list of engineering specifications. The entire list of engineering specifications is shown in Tables 1 & 2 below, followed by justification.

Table 1. Solar Cal Poly active HVAC system formal specifications.

Spec #	Parameter Description	Requirement of Target	Tolerance	Risk	Compliance
H1	Cooling/Heating Capacity	12 kBtu/h	± 2 kBtu/h	H	A,T,S
H2	Number of Settings	2-3	Max	L	S,I
H3	Life	10-15 yr.	Min	M	A,S
H4	Efficiency	SEER > 13	Min	M	A,T,S
H5	Total Cost	< $5,000	Max	M	A,S,I
H6	Size	Compatible with 1000 ft^2 house	–	L	A,I
H7	Potential Losses	< 30%	Max	M	A,T

The next step in the process was assigning each specification something quantifiable to design around. To obtain these values, we utilized many resources, and conducted intense research. Each specification required different pools of resources, thus we will discuss how we generated each value individually.

First, we determined the cooling/heating capacity by obtaining recent energy models from Bryce Willis, the Masters student that has been working on Solar Decathlon for two quarters. Using DesignBuilder and Energy Pro 5, Bryce modeled the most recent floor plan for the house and ran numerous energy models. With these models, she varied window and shading configurations to see how the cooling and heating loads were affected. Over the numerous models, the cooling and heating loads ranged from 9-13 kBtu/hr (2.64 - 3.81 kW/hr). As the

final floor plan for the house is not yet complete, these are preliminary load requirements, but they provide us a valid estimate.

We next incorporated a specification for number of settings. This is a very broad specification as it considers potential equipment, as well as system controls. These are two very important categories as they contribute to both ease of use and system efficiency. First, as we are striving to design a user friendly, yet innovative system, we believe it is necessary to limit the overall system complexity. Thus, we believe a control system that is intuitive to use is essential. Next, to benefit system efficiency, we will use this specification as a guideline in choosing possible equipment. For example, in both solar hot water systems and HVAC systems, pumps are often multi-speed to increase system efficiency. For the 2005 Cal Poly Solar Decathlon, the team selected a two-speed high efficiency heat pump with 2-ton capacity. This decision was made as the pump could be running on the low speed setting 75-80% of the time, thus increasing system efficiency. Using this piece of information, we find it necessary to incorporate multi-speed equipment to increase system efficiency and versatility.

With all HVAC systems, it is necessary to provide an estimated life span. Each type of system has a different life span, thus we decided on a conservative life span of 10-15 years. According to the department of energy (DOE) guide to home cooling, the systems that we are considering range from 10-20 years. For a ductless, mini-split system the estimated life span is 12-15 years; for a ducted packaged system the estimated life span is 10-15 years. We have thus chosen to maintain a conservative approach, as much more analysis is required to determine which system will be utilized.

Next, when designing any HVAC system, overall system efficiency is of the utmost importance. To quantify a system's efficiency, the Seasonal Energy Efficiency Ratio (SEER) is universally used. According to ASHRAE standard 90.1-2004, a 13.0 SEER rating is required for all systems under consideration. This will be a very simple requirement to implement as for each system the manufacturer always specifies a SEER rating.

We next chose to limit overall system cost to $5,000. As published in the 2005 Cal Poly Solar Decathlon energy analysis report, a total of just under $4,000 was spent on a ducted HVAC system. As technologies have improved, and almost ten years have passed, we have estimated a 25% increase in total expenditures.

The next specification considered was the complete system size. We have left this specification very general and stated that the system must be compatible within a 1000 ft^2 house as this is the size of our current model. At this point in the design, we must also design around a total of 62 ft^2 in the mechanical room and an unspecified duct space through the core of the house. With a house model still not set in stone, this specification will be revised as necessary.

Lastly, we have decided on potential system energy losses being less than 30%. According to an article posted on energy.gov, 25-40% of heating or cooling energy output by the central unit is lost due to leaks, holes, poorly connected ducts, or windows. As we have not specified our system, ducted or ductless, this value serves as a conservative estimate.

Table 2. Solar Cal Poly hot water system formal specifications.

Spec #	Parameter Description	Requirement of Target	Tolerance	Risk	Compliance
W1	Output Temperature	110°F	± 10°F	M	A, T, I
W2	Input Temperature	40°F	Min	M	A,T,I
W3	Collector Tilt Angle	34°	− 10°	L	A,S,I
W4	Life	10 yr.	Min	M	A, S
W5	Efficiency	TBD	Min	L	A, T, S
W6	Total Cost	< $5,000	Max	M	A, S
W7	Collector Area	< 1000 ft^2	Max	L	A, I

Our specifications above assume that we will be using some type of solar thermal collector in our hot water system. At this point we did not make the decision whether an open loop or closed loop will be utilized, and thus our target efficiency will be determined once we choose a system type.

We established that our main specifications for the hot water systems are the input and output temperatures. Ideally, we would like the output temperature of the system to be as close to the competition target (110°F) as possible. If we are able to produce a system that has an output temperature close to the target temperature, then no intermediate heating or cooling device would be necessary to maintain the correct water temperature from tank to faucet. The input temperature is also of concern, as we must ensure that the system is protected from freezing.

From the previous 2005 Cal Poly submission, it was noted that the ideal solar collector tilt angle was at 40° from horizontal. Due to architectural constraints, they finalized on using a 30° collector tilt angle and sacrificed the additional efficiency. Similar to how the 40° was agreed upon for ideal collector angle of the previous house, our ideal collector angle is found to be 34°. This is based on the latitude of Orange County Great Park (location of competition). Since the 40° tilt angle was originally declined due to the obtrusive appearance, we will assume that there would be no desire to set the tilt angle greater than our target.

As an arbitrary target, we will aim to design a hot water system that lasts at least 10 years. From our background research, we found that solar thermal systems can be undermined by

freezing or fouling within the system loop, and thus will require attention to avoid. We also found that steam escaping within the solar collectors can reduce their life and effectiveness.

Again we chose to limit our total cost to less than $5,000. The 2005 submission spent slightly over $4,000 on their solar thermal system; considering that their submission occurred 10 years ago, we assumed a budget increase of roughly 25% was feasible.

Finally, our collector area is limited to 1000 ft^2, as that is the extent to which any part of the house may extend. The collector area we will utilize will be nowhere close to this large, but because we may install collectors on the roof, ground, or both, we decided not to limit our possibilities in any way.

Method of Approach

Before beginning our senior project, we took prerequisite courses that introduced us to the engineering design process. These classes, such as Philosophy of Design and the Design series, gave us the chance to deliver a specified product in an organized manner over the span of one quarter. For the Solar Decathlon, it is crucial for us to follow a similar method, this time over the span of three quarters, in order to complete our objectives by the time of the competition. The Solar Decathlon has set forward submission dates for CAD files and construction documents of the house; these will serve as deadlines for our system designs and require an accelerated schedule in comparison to tradition senior projects. A simple quarterly breakdown is shown below in Table 3 that describes an overview of what will be accomplished over the next 9 months.

Table 3. Quarterly breakdown of main objectives.

Quarter	Objectives
Fall 2014	Design and analyze systems, submit documentation to DOE
Winter 2015	Order equipment, ensure compatibility with rest of house
Spring 2015	Build house, prepare contest documentation

Much of the design of our systems will include collaborating with the architecture teams to produce a solution that is valid from both an architectural and engineering standpoint. Thus, our submission procedure will be an iterative process where we will submit our plans to the other teams, receive their feedback and input, and make changes to our plans as necessary. We will be working in conjunction with Bryce and Jared to design our systems, and will be seeking the advice of industry experts such as Dr. Maddren and Larry Myrick of Brummel, Myrick & Associates. Through the review of other Solar Decathlon submissions, we have compiled a list of component suppliers who we can contact for quotes. We have also collected a list of software programs that will be useful in analyzing our proposed designs, such as DesignBuilder and

F-Chart Solar System Analysis. As mentioned above, DesignBuilder will allow us to analyze the heating and cooling loads of the house while adjusting an exhaustive list of system parameters. F-Chart Solar System Analysis will help us to model the water heating in the solar thermal loop, which can be used with MATLAB and Simulink to perform hourly energy simulations. When a final design is agreed on for each system, we will be creating 2D and 3D models in Revit to be submitted to the DOE for review.

Concept Generation

Both the HVAC and domestic hot water disciplines have been around for a long time. While industries are always evolving and becoming more advanced, our goal in this project is to implement appropriate HVAC and hot water systems, rather than design completely new ones. Therefore, our background research will serve as our concept generation, as we are making the assumption that the current market-available equipment and consumer-available knowledge is technologically relevant. While we will not be creating any new intellectual property, our academic contribution will be in demonstrating how to implement effective HVAC and solar thermal systems through proper analysis and sound engineering judgment.

Aside from reviewing past houses, we also performed brainstorming activities to ensure that we were thorough in exploring concepts for each system. Table 4 shows the result of a technique called brainwriting, where we took turns separately writing down concepts, specifically for how to maintain the house temperature with the comfort zone, in a timed period.

Table 4. Generated concepts for maintaining house temperature with comfort zone.

- Heated/cooled air
- Radiant liquid system
- Ice/steam
- Keep oven on/refrigerator open
- Shading/sun exposure
- Insulative/ventilative materials
- Large fans for cooling/open toaster oven for heating
- Phase change materials
- Thermal masses
- Adding a gym and using the latent heat
- Removable/mobile insulation boards

Many of the functions above are performed by off-the-shelf equipment that we researched. Heated or cooled air is obviously the function that is most easily achievable with standard equipment, but other concepts, such as ice cooling, led us to find some interesting options. One company, called Ice Energy, produces a cooling device that uses blocks of ice as the air coolant rather than conventional refrigeration fluid. This piece is equipment was not something that was suited for our needs, but it was stimulating to see how different technologies are utilized in the HVAC industry. While some of the other concepts above were far-fetched, it was important that we did not limit ourselves at that point in the design process. Ultimately we

ended up matching equipment with the functions above, and found that some are more versatile than others.

In exploring potential solutions, we further looked at how teams from the 2013 competition implemented their HVAC and hot water systems. In fact, many of the teams used a large number of components in their HVAC system. Although it seemed as if the heating and cooling capacity of these systems was far greater than what was needed in the small houses, it was valuable to see how different equipment was used in combination. We noticed that a popular combination was using an ERV with various heating/cooling systems. For example, Team Ontario used an ERV in conjunction with a heat pump and air handler, the Czech Republic used an ERV with a heat pump connected to cassettes, and Team Austria used an ERV with a radiant floor system. These three teams took first through third, respectively, in the engineering contest, and thus we paid close attention to their designs.

As mentioned above, our concept generation phase was not as integral to our design process as in classic design problems. We performed a few activities to spur creativity and thoroughly explore our options. While our concept generation phase was brief, our idea selection phase was much more in-depth.

Idea Selection

HVAC System Idea Selection

When beginning the idea selection for how to heat and cool the house, we first consulted the mechanical engineers who had been working on the project over the summer. Based on the size and layout of the house, they were in favor of using ductless mini splits. Keeping this in mind, we researched other HVAC systems that could be implemented into the house and compared the benefits and drawbacks of each. Our resulting conclusion was that we still felt the use of ductless mini splits would be the best solution with our given parameters.

When we compared mini splits with a conventional ducted system, we found that their efficiency and lack of ductwork made them the better choice for the house. A conventional system would take up much more space, as ductwork would be approximately one foot in diameter and have to be run all extents of the house. In contrast, a ductless mini split system would only have refrigerant lines, roughly 3” in diameter, which would need to be connected to each mini-split cassette. If wall mounted cassettes were used, we would also eliminate the need for drop ceilings in the living room and bedroom; a conventional ducted system would require it. It was also found that houses that had used a ductless mini split system in past solar decathlons had some of the best scores for the comfort zone portion of the competition. While they seem to

be favored in the competition, the main drawbacks of the mini split system include their cost, the need for a separate ventilation system, and the negative aesthetic aspect of many cassette types.

We favored the idea of wall-mounted cassettes, but were limited by how we could run the refrigerant lines to the desired cassette locations. Since the house will be tightly insulated with SIPs, the possibility of running refrigerant lines through the walls was eliminated. That left us needing to run the refrigerant lines through the core, and then branch out to the ceilings of the bedroom and living room. While trying to figure out how to achieve this, the architects proposed another iteration to the design of the house that included an elevated space above the core, called a mechanical chase. After consulting with Dr. Maddren, we came up with a design using cassettes and refrigerant lines all concealed in the mechanical chase. The design included two cassettes which could be controlled separately to condition the bedroom and living areas. Although we had a practical design for the current house, a separate ventilation system still needed to be incorporated. After another brainstorming session with Dr. Maddren, we explored running incoming air from the HRV to the cassettes. This dual-benefit HVAC system would deliver both fresh, outdoor air and conditioned air to the living room and bedroom.

After we solidified this concept, we took a step back to consider the complexity of the design. A couple of red flags were evident. Although the refrigerant lines would take up less space than ductwork, we still introduced a significant amount of ductwork with the ventilation system. The limitations of the cassette placement due to the mechanical chase also took away from the benefits of a mini-split system; simple supply air diffusers and return air grilles could be placed in the same location and achieve the same amount of air distribution. With this in mind, the only real advantage that a mini split system had over a conventional system was efficiency. As it was stated before, mini split systems are advertised to be up to 30% more efficient than a conventional ducted system. This increased efficiency is based upon implementation in an application where there are long, complex duct runs and less insulation than what SIPs provide. Therefore in our situation, where we would have short, straight duct runs and well insulated spaces, the additional efficiency of a mini-split system is likely negligible. Now, the main factor that separated the mini split from a conventional system for cooling a house was that a mini split system was more expensive. Ultimately, because the size and efficiency turned out to differ only slightly from the two systems, we designed a conventional HVAC system with a heat pump and air handler with an integrated ventilation system. The initial layout for this system is shown below and can be found in Appendix B as well.

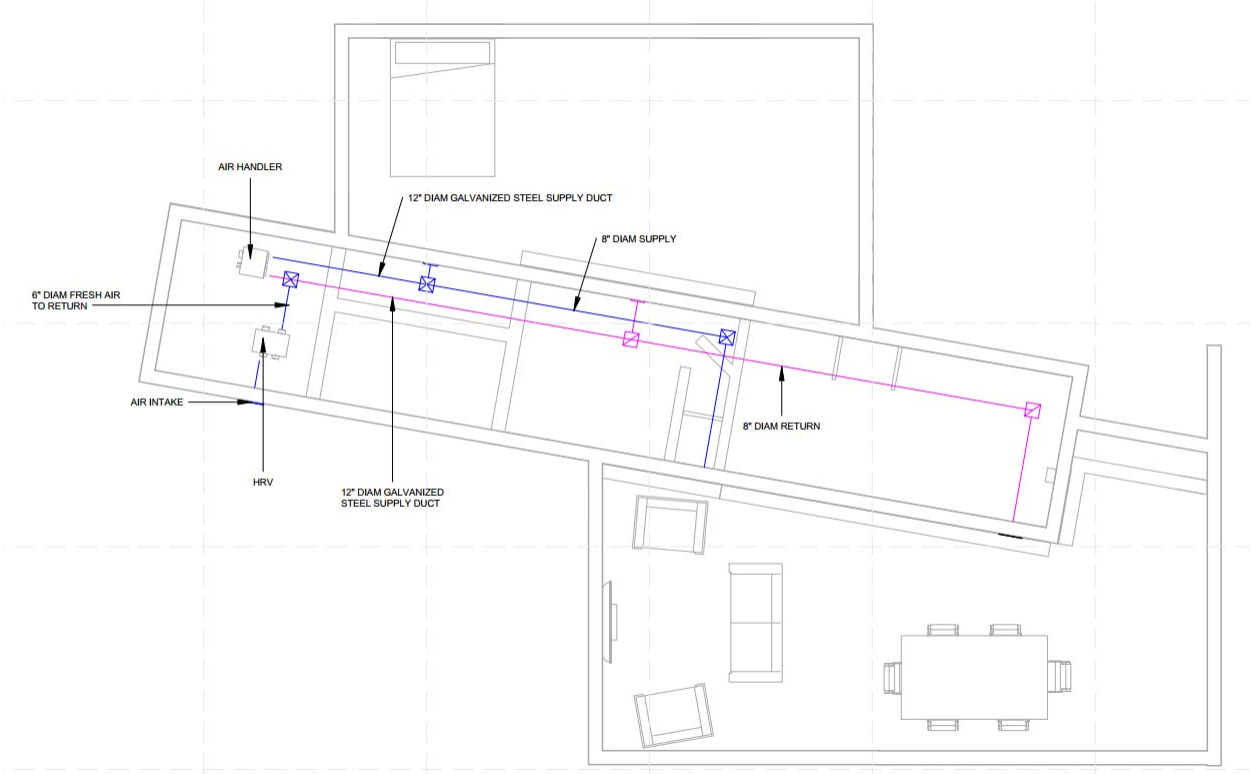


Figure 12. Top view of initial layout of ducted system, with air handler and HRV. Supply lines are shown in blue, while return lines are shown in pink.

The above design shows how the HRV is integrated within the system. The HRV draws in air from the outside, performs the heat exchange with stale exhaust air from the house, and supplies fresh air into the return line of the air handler. Not picture is the exhaust line of the HRV, which draws in the exhaust air of the house and expels it to the outside.

As outlined by the preliminary design loads, with a worst-case scenario at roughly 14 kBtu/hr, we designed a conventional system with a 2-ton capacity. This value is derived from a safety factor of 1.5. The heating/cooling capacity is the primary driving factor in selecting a component set, and thus gave us all the necessary information to choose our products. Also from the design builder model, we were able to get an estimate of the supply flowrate required in each room. After applying a safety factor, this came out to be roughly 300 cfm for both the living room/kitchen area and bedroom area. Using the equivalent friction method of duct sizing, we designed the supply air and return air ducts using a basis of 0.08 and 0.05 in. of static pressure loss per 100 ft. of duct, respectively. This provided us with the largest dimensions that will be needed in our system, and thus we were able to figure out the minimum clearance for the mechanical chase section. A section view of the initial mechanical chase can be found in Appendix B, as it was used to justify the dimensions for the architectural engineering team. After

determining the sizes of the ducting, we chose the configuration for the supply diffusers and return grilles. A good HVAC design principle is to place the supply diffusers in the most south-western location of the house as possible, as this is the face of the house that receives the most solar radiation throughout the day. Therefore we decided on one supply diffuser per zone which was located as far south-west as possible. In choosing a location for the supply grilles, we chose locations that would promote full-house air circulation by placing the grilles as far north-east as possible. While the locations of the supply diffusers and return grilles are limited by the extents of the mechanical chase, our proposed layout is optimized to provide heated or cooled air in the appropriate locations. A 3D Revit layout can be found in Appendix B.

We next made the decision to include independent kitchen and bathroom exhaust fans. Contest rule 7-4 states that bathroom must be provided with ventilation systems capable of providing 50 cfm for intermittent ventilation or 20 cfm for continuous. For the bathroom fan, we specified a Broan fan with 100 cfm capability. As a common rule of thumb, ventilation rates are based on eight full air changes per hour. Using this value, along with the volume of the bathroom (defined in the Revit model), a conservative flow rate was determined to be 61.6 cfm. To ensure proper ventilation during extreme conditions (long showers), a 100 cfm unit was selected. Next, for the exhaust fan in the kitchen, we specified a Broan kitchen range hood with 370 cfm capability. Similar to the ventilation standard for a bathroom, kitchens require 15 full air changes per hour. Again, using the current Revit file, an approximate volume for the kitchen was determined. Using this volume, and the air changes per hour, a minimum flow rate of 260 cfm was calculated. As a conservative selection, a 370 cfm unit was chosen to account for possible extreme conditions (excess smoke when cooking). For a comprehensive specification sheet on each of these products, refer to Appendix D.

Ventilation Idea Selection

When making the decision between the various ventilation systems, we thought of some requirements to compare each system. Each one has pros and cons, and it was our goal to decide what would best be incorporated with the solar house. The different requirements that were considered include: installation cost, required power, heat recovery, and effective ventilation given the design of the solar house. There are more requirements we could have taken into account, but we feel that the ones stated above provide the most useful information on why one system would work better than others. For example we considered making the size of the ventilation system a requirement, and it would be seen that exhaust and supply-only systems take up less room, but a balanced system would be able to fit within the space provided to us in the upper core area, so this requirement would have less of an effect on our final design.

Minimizing cost is one of our main considerations in the competition. Given the budget we have for our house, everything that we plan on implementing will have a strong reliance on

cost. This is why installation cost is a requirement taken into consideration for comparisons. For our house, we are always trying as hard as we can to reduce required energy. Factors that influence this are types of insulation used, and the direction the house is facing. With this in mind, we thought that implementing a heat recovery system to reduce the required cooling for the hot climate of Irvine would be a strongly considered option. This is also true for the required power. We want something that has as low energy consumption as possible so we can use the energy we save for different parts of the house. Lastly, an important thing to consider is the effective ventilation. It is stated in *NZS 4303 Ventilation For Acceptable Indoor Air Quality* that there needs to be 0.35 air changes every hour within a house. There are systems that will achieve this circulation more easily than others given the tight design of the solar house. For this solar house, this will turn out to be the most important factor to keep in mind when deciding upon a ventilation system. Once these parameters were determined, we went through and saw how each of the designs compared to one another.

Installation cost is something we see a large variance in when it comes to the different considered ventilation systems. It was found that a system with a HRV or ERV is more expensive than an exhaust or supply-only system. They are can almost be $2,000 more to install compared to the one-way systems. The cost for installation presents itself to be the main downfall of a heat recovery system. The price of a balanced system without heat recovery is more expensive than the one-way systems, but it is still a better decision than a HRV or ERV from a financial standpoint.

When comparing all the systems to one another on the idea of energy consumption, they all fall within the same general required energy. The reason for this is because the only required energy from all of these systems is the energy to operate the fans that are transferring the air. An exhaust or supply-only system requires less power than the balanced systems because they only need the fan power to move the air in one direction. A balanced system with or without heat recovery is virtually the same price because both have fans that move inside air out and outside air in. Although this may make the one-way systems more of a desired solution, it is important to remember that if a HRV or ERV is implemented, the recovered energy through the use of heat exchange with the outside can result into a savings of almost 70%. An exhaust-only system would remove the cool air from the inside and bring in warm air from the outside through the leaks, thus making it so we would be working against ourselves when trying to cool the house. The same problem would be apparent for a supply-only system with the cool air leaking through the walls while the fan would be drawing in warm air from outside. Although there might be a little more energy consumption by the HRV or ERV, the difference could be saved with heat recovery.

Finally, we compared the various systems to, what we believe is the most important requirement: the effective ventilation capabilities in accordance with the solar house. As

mentioned earlier, older homes allow air to easily move through leaks within the building envelope to consistently be exchanged from within the house and the surrounding environment; this is the main reason why an exhaust or supply-only system is effective at ventilation. Newer homes that are being built, especially the house that will be used for the competition, try and reduce this because this allows for heat loss and reduced energy savings. The house used for the competition will be tightly sealed from the outside with structurally insulated panels (SIPs), making it designed more for the use of a HRV or ERV rather than a one-way system. In the end the big differences in the systems, for the solar house parameters, are the installation cost and the effective ventilation based on the tightly sealed envelope of the house. Due to the fact that this house is going to be so tightly sealed and there will be savings through heat recovery, we agreed with the original proposal of using a balanced system with heat recovery despite the installation cost. It will provide the best ventilation and it will help us reduce the energy needed to cool the home during extreme heat.

The next decision that needed to be made was whether or not we were going to use a HRV or an ERV. With help from the *Surface Meteorology and Solar Energy Database*, we were able to get an idea of what the average relative humidity is during the month of October at Orange County Great Park. Over the past 22 years the average relative humidity at that location is 39.4% during the month of October. As a note, this value is roughly 20% less than the amount permissible by the contest rules. This is a low relative humidity and it was the main reason why we decided to use a HRV rather than an ERV. As mentioned earlier, if the climate is going to be hot and dry, there is no real need to add the recovery of humidity in with our house. If we did use an ERV, the humidity exchange would be very small compared to what it is designed for in hot humid climates that you would find in a place like Florida. Since we were just interested in the heat exchange of our system, the HRV seemed to be the best solution.

Solar Thermal System Idea Selection

As previously mentioned, the concept of our house was modeled to be similar to the UNLV house from the 2013 competition. They used a closed loop solar thermal system with 2 evacuated tube collectors, and thus for our October 9th submittal, we created a similar system layout. Because this was right at the start of joining the project, we had little knowledge on solar thermal heating and therefore had to assume the system UNLV used was an adequate design. Nevertheless, this proved to be useful in the design of our system, as it gave us a basis for beginning research and allowed us to analyze each part of the solar thermal loop. A comparison of the UNLV solar thermal loop and our first-pass design can be seen below in Figure 13.

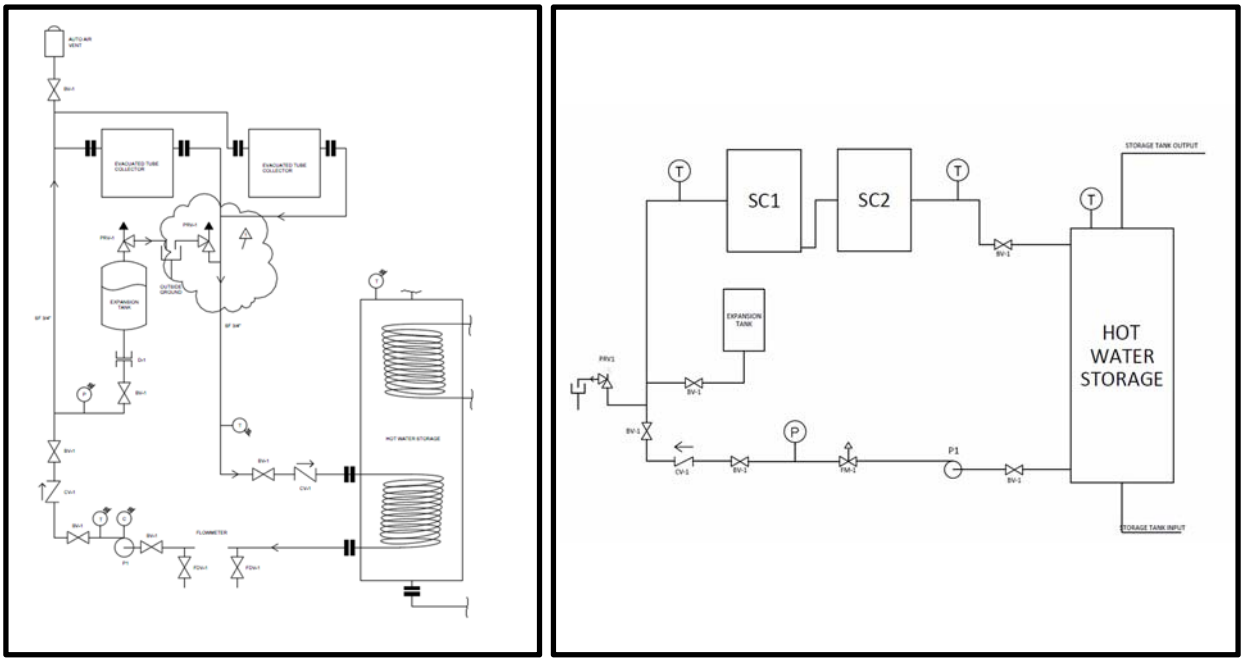


Figure 13. Comparison of UNLV solar thermal loop (left) and our first-pass solar thermal design (right).

After learning more about Jared's intentions, we discovered that he was trying to incorporate a Scheffler collector as a way to harvest concentrated sunlight. While it was unclear at first what the collector would be used for, we assumed that there would still be a need for a solar thermal loop. There were also some initial barriers to overcome from an architectural standpoint, as the aesthetic aspects of the Scheffler collector were negatively viewed. Jared and the architecture teams eventually came to a compromise, and the result was a setup where the Scheffler collector would primarily be focusing concentrated sunlight onto a phase change material (PCM) apparatus, and secondarily would be powering an outdoor cooking grill. We met with Jared once this was finalized, and he shared with us the capabilities of his proposed system. From the meeting, we came away with the idea to have a solar thermal loop that included both the Scheffler collector and PCM apparatus, and an intermediate solar collector to be used for pre-heating.

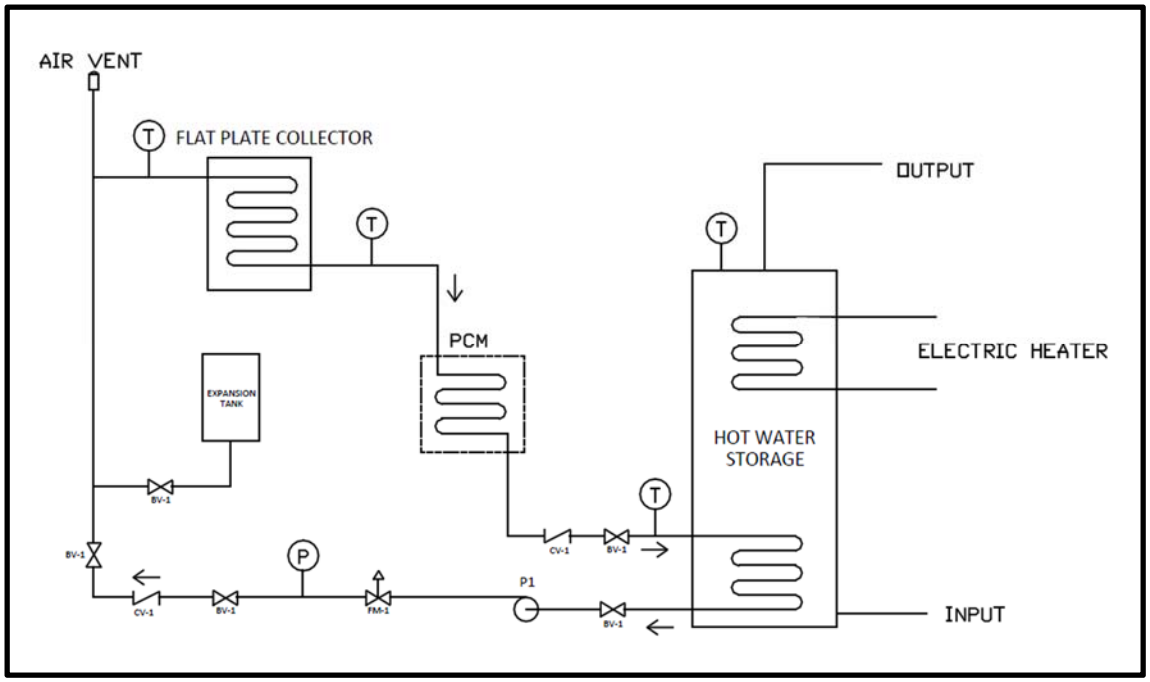


Figure 14. Current design of solar thermal system with flat plate collector and phase change material (PCM).

The above design is a closed loop system where a flat plate collector is used to first preheat the heat transfer fluid, and the PCM apparatus then brings the fluid up to the desired set point temperature. Similar to the initial design, we will still be utilizing an inline centrifugal pump, expansion tank and heat exchanger within the hot water tank. Because of the complexity of the system, having two solar collectors, we decided that a closed loop system would help to simplify the process of designing a system that provides potable water. While the location of the competition does not introduce much risk of pipe freezing, using a closed loop eliminates the possibility of fouling and is more compatible with the high temperatures that the phase change material may reach. If a direct loop was used with the PCM, there is a possibility that a significant amount of water would boil off within the loop, increasing the pressure of the system and decreasing the efficiency of the system. The decision to incorporate a flat plate collector before the PCM was driven by the fact that the Sheffler collector is ineffective on cloudy and overcast days; thus the flat plate collector can be thought of as a safety net for the system. The above design has only been considered from a 2-D, component standpoint; once the architectural design of the house is finalized we will be determining exact how the system interfaces with the house.

In designing the above system, we created an equipment spec. sheet as well. This can be found in Appendix D. Notable decisions on the spec. sheet include our choice of 1,3 propanediol, a type of propylene glycol, as our heat transfer fluid. While trimethylene glycol is attractive from an organic, energy efficient standpoint, we felt that a propylene glycol was a much more readily-

available, cost-efficient option. We chose to use a flat plate collector over an evacuated tube collector, as again valued its lower cost. From the solar collector manufacturer Heliodyne, we found an objective comparison that actually showed flat plate collectors to have a higher year-round collector production at almost half the price of two other evacuated tube collectors (Solar Flat Plate vs. Evacuated Tube Collectors). Figure 15 below shows the monthly production of 4 solar collectors, with the GOBI 410 flat plate collector, similar to the GOBI 406 we chose, and three other evacuated tube collectors. The GOBI 406 has a design flowrate of 0.8 gpm; we used this, along with the assumption that we would need to pump the fluid a maximum of 15 to 20 ft., to pick a centrifugal pump. Once more of the design is finalized with the PCM, we will have to go back and ensure that our selected equipment is appropriate. The high temperatures that the PCM apparatus produces may exceed the maximum working temperatures of the piping components and thus needs to be considered.

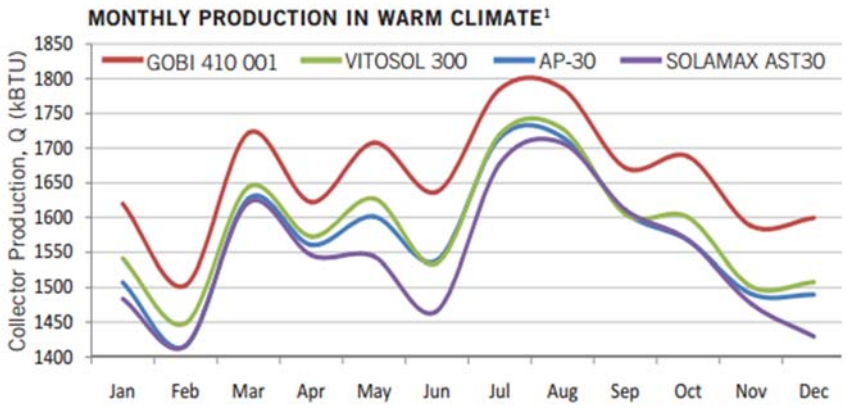


Figure 15. Monthly production of Heliodyne solar collectors. (Figure courtesy of heliodyne.com)

Chapter 4: Description of the Final Design

Decisions

The first decision we finalized was the type of HVAC system we would use. This clearly guided all future decisions, and thus was given priority. With the possibility of a mini-split system ruled out and the fact that a complete packed system would be too large, it was concluded that a split system with an outdoor and heat pump and indoor air handler was the best option. It allows for the cooling and heating demands to be effectively met while also allowing us to incorporate a HRV, which we favored. Figure 16 below shows a schematic of the entire system, with internal components and ductwork connectivity. The HRV is the sole provider of the fresh air to the air handler, connecting to the return line just before entering into the bottom of the air handler. The HRV also provides an exhaust line from the kitchen to the outside environment, transferring any heat from the stale indoor air to the incoming fresh air. The heat pump provides

refrigerant to the evaporator coil in the air handler, which transfers heat to or from the air used for conditioning the house. The heat pump also contains a reversing valve, which determines whether the air is being heated or cooled through the direction of refrigerant flow. The diagram below shows the system in cooling mode.

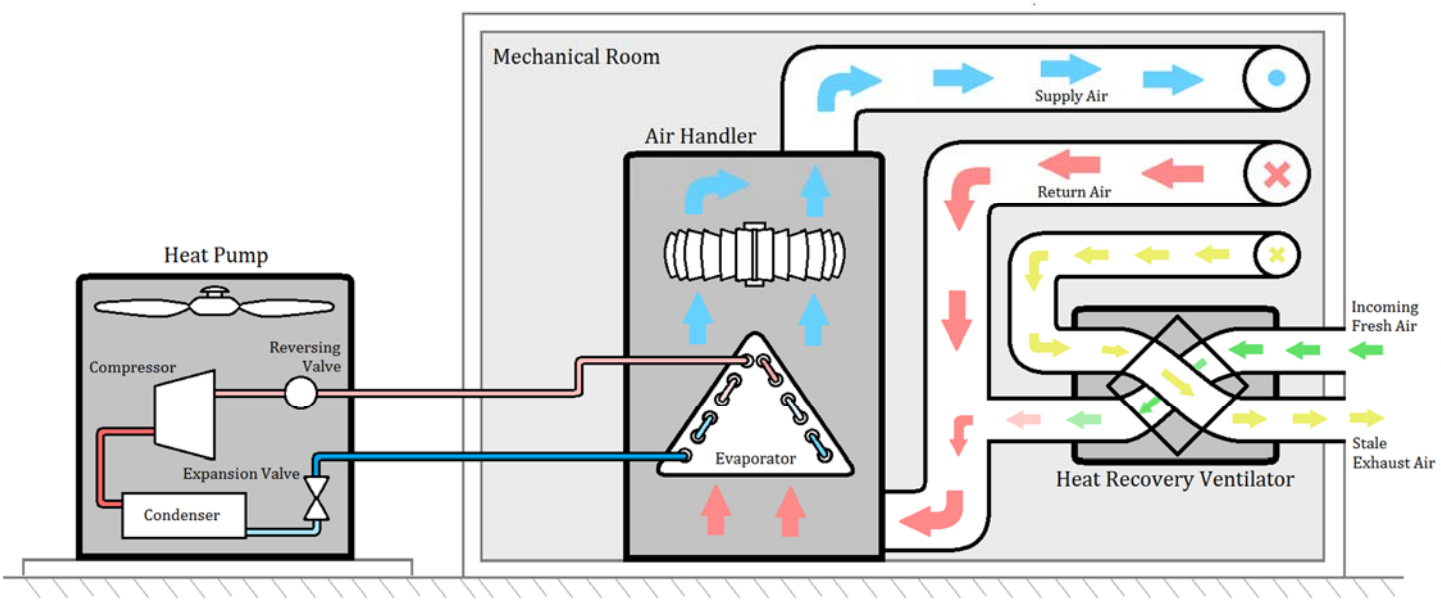


Figure 16. HVAC system interface.

When we originally selected an air handler and heat pump, we based our decision solely on the capacity of the system we needed. We knew that Trane was a well-known supplier of HVAC equipment, and thus referred to their website for equipment selection. While there were many options available, there were no descriptions of the benefits, features or applications for the various models. We therefore contacted Alex Doyle, an account manager from Trane, through which Dr. Maddren had connections. We provided Alex with our situation and what we wanted to implement, and he sent us his recommendation. He provided us with information and a selection for a 1.5 ton air handler/heat pump combination, but warned us about using a HRV. As he advised, HRVs are generally used for large commercial applications; implementing one on such a small scale would be expensive and have a small return on investment. While this was true, we decided to still implement one, given the nature of the competition. For us, the draw of having a more efficient system with modern technology far outweighed any economic impacts of adding a HRV.

To explore ventilation options outside of a HRV, we worked with the passive HVAC team to implement a separate ventilation system with a phase change material. The basis of this design includes separate ductwork containing phase change material with a melting point around

roughly 70° F. At night and other times of low temperature, air would be blown over the material to solidify it and store cooling potential. Then, at times of peak cooling demand, air could be blown back over the material to lower its temperature and reduce the work of the air handler. While the two systems will not directly interact, the phase change ventilator will help to reduce the heating or cooling load of the split system by up to 10%.

Upon submittal of the 100% detailed design drawings of the house to the Solar Decathlon officials, many architectural changes were made which further limited our distribution system. The most significant was the addition of a clerestory window placed over most of the kitchen and bathroom. While the basis of the window was to increase natural light without adding much solar radiation, its addition severely limited our space in the mechanical chase above the kitchen and bathroom. Also vying for space above the kitchen was the phase change material ventilator, which was designed to be placed along the southern facing wall of the chase. Thus, to adapt to these changes, we devised the ducting layout below, which has many similar aspects from our previous design but also has some noteworthy changes.

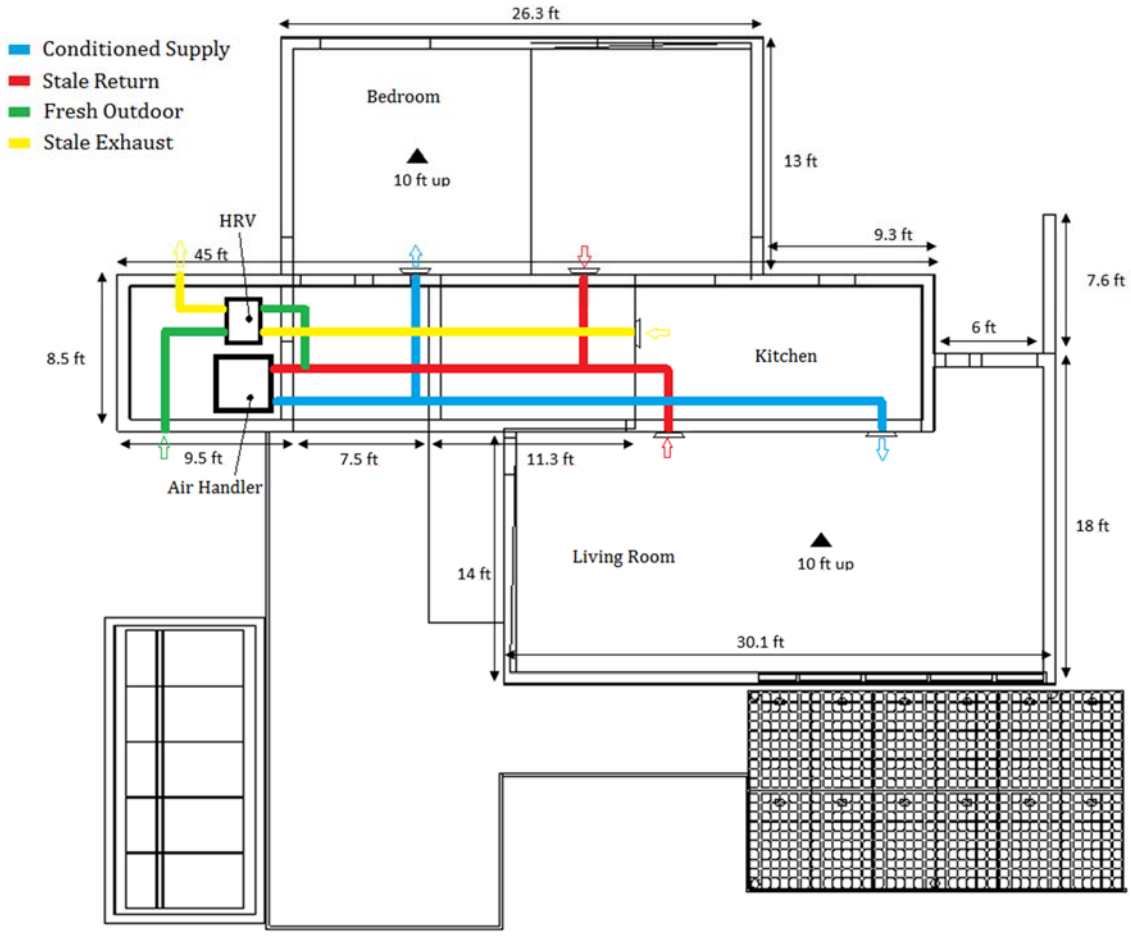


Figure 17. Final design layout of house and HVAC system.

As can be seen in Figure 17, the final house layout was chosen to have an orthogonal core compared to an angled core. This did not affect our system layout, but helped to eliminate awkward corners where air distribution could not be achieved. The area between the kitchen and bathroom has a space which is not occupied by the clerestory window and thus allowed us to branch off from the main return line and draw air from both of the main zones. We also decided to place the HRV exhaust grille in this space, as it will pull stale air from the kitchen and rest of the house. Included in the contest rules is that return air shall not be taken from a kitchen (rule 7-2). Our system therefor allows for a separate exhaust line from the kitchen and eliminates the need for a dedicated exhaust fan. In determining the locations of the inlet and exhaust lines to the HRV from outside, we considered rule 7-3a, which states that outside air shall not be taken closer than 10' from an appliance or plumbing vent, or discharge outlet of an exhaust fan. To comply with this, we have the inlet to the HRV coming from the south side of the mechanical room and the exhaust discharge coming out of the north side.

Figure 18 below shows a section view of the mechanical chase if looking westward from the kitchen. The section view shows the supply line that provides air to the living room of the house. This is a critical zone, as it will be receiving the most solar radiation and will be inhabited throughout most of the day. Therefore, we need to ensure that this duct line and supply diffuser will be able to provide the heating and cooling needs of this area. To protect the system from large pressure losses and allow for high face velocities, we recommended that we have at least 2 feet of space from the southern wall of the mechanical chase. This will allow us to have at least 6" of straight duct leading into the diffuser and to implement a direct route to the diffuser. While the drawing shows two 90° elbows leading into the diffuser, flex ducting will be used instead to further reduce pressure losses. Finalized system layouts can be found in Appendix B.

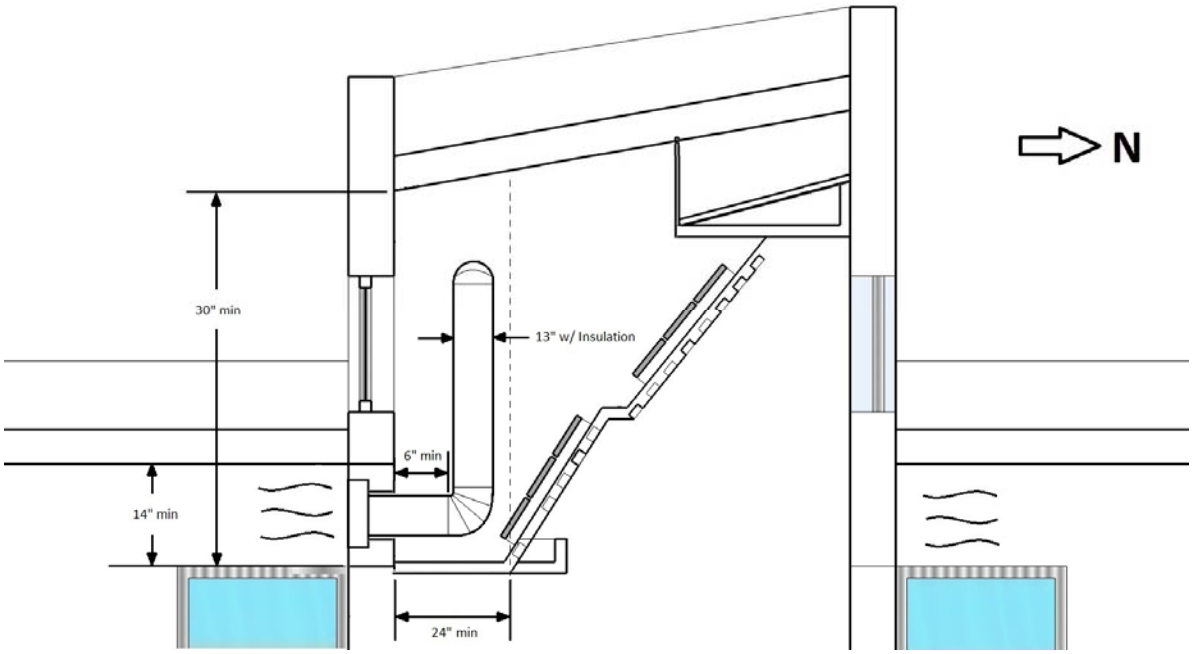


Figure 18. Section view of the kitchen with clerestory window.

While both the air handler and HRV will run normally when heating or cooling is desired, we also faced the instance where we would only want to provide ventilation for the house. Since the HRV in our system supplies fresh outside air to the return line of the air handler, it would not be able to be run unless the air handler is running as well. To combat this, we devised a by-pass system which uses actuated dampers to create a different air path through the ductwork. Shown below in Figure 18, the dotted green line represents a duct which will be closed during normal operation, but when only ventilation is desired, it opens up to allow air to flow into the blue supply line to the bedroom. The other dampers, which are shown as small grey rectangles, close to prevent airflow into the return line of the air handler and into the other supply ducting. The decision to vent air only to the bedroom was based upon the assumption that the by-pass system would likely be used at a time when the windows of the house are open. With the configuration of the windows, we felt that air would freely circulate throughout all areas of the house except for the bedroom, as there are no windows on the west facing wall. Therefore by providing mechanical ventilation in this area, we would achieve whole house ventilation. Contributing to the rationale to only have mechanical ventilation in the bedroom, we assumed that this system would be utilized mostly at night time when the outside air is cool enough to bring into the house. At this time, the inhabitants would be likely in the bedroom, and thus would not suffer if the eastern part of the living room did not receive circulation, for example.

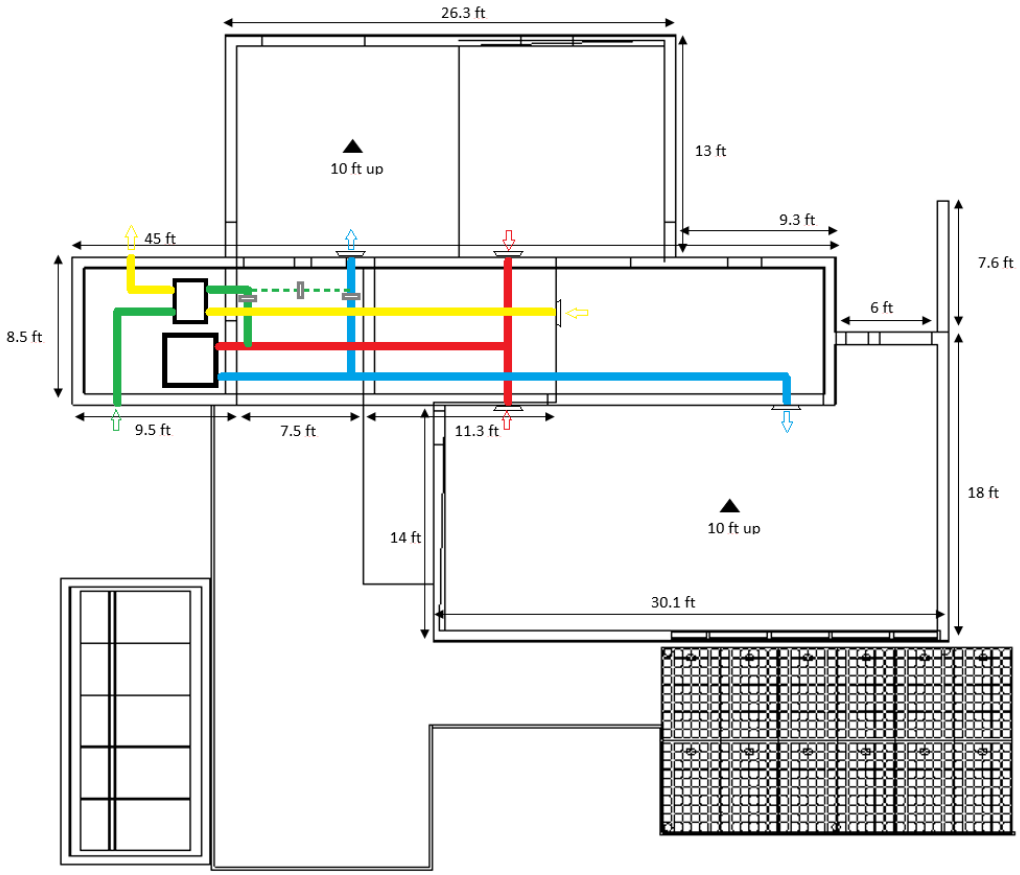
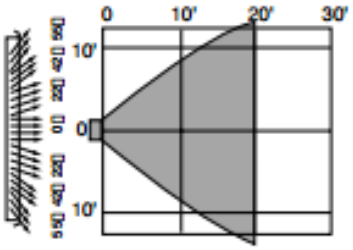


Figure 19. Air handler by-pass mechanism for ventilation only. Air handler lines are show in blue (supply) and red (return), and HRV lines are shown in green (supply) and yellow (return).

We later learned from Dr. Maddren that the air handler can be run without utilizing the heating or cooling coils. This is done but having a shut-off valve for the refrigerant supply to the air handler. Thus, we could run the entire system without conditioning the air, and it would act as a mechanical ventilation system. This would allow us to evenly distribute fresh air to the entire house, rather than ventilation just in the bedroom, and we would be able to use the existing ductwork. In research control systems to achieve this, we came across the Honeywell Prestige IAQ8000 thermostat. An all-inclusive device, this thermostat will configure both the split system and HRV to run during different scenarios, while maintaining the appropriate residential standards such as ASHRAE 62.2.

Obviously there are concerns that arise from having only one supply diffuser for each main zone. In an ideal scenario, the diffusers would be placed in a central location or other position that addresses the areas of concentrated solar gain. With our limitations by the mechanical chase, we want to ensure that our registers have an air throw that reaches the extents of the house. In researching different diffusers, we found a product which allows for adjustable air deflection to provide for distributed cooling and heating. Figure 20 below shows the coverage of the Hart & Cooley A618 supply diffuser. If we consider the 14 x 8 register at 600 fpm, we see that we achieve 275 cfm with an area of coverage that is roughly 20' by 25'. The living room and bedroom can be approximated by 20' x 30' and 10' x 25' areas, respectively. Thus, we can assume that these diffusers will allow air to be distributed to nearly every part of the zone.



Face Velocity		300	400	500	600	700	800	900	1000	1100	1200
Pressure Loss		.006	.010	.016	.022	.031	.040	.050	.062	.075	.090
8 x 4	CFM	35	45	60	70	85	95	105	120	130	140
Ak .118	Throw	2.0	2.5	3.5	4.0	5.0	5.5	6.0	6.5	7.5	8.0
10 x 4	CFM	45	60	75	90	105	120	135	150	165	180
Ak .149	Throw	2.0	3.0	3.5	4.5	5.0	6.0	6.5	7.5	8.0	9.0
12 x 4	CFM	55	70	90	110	125	145	165	180	200	215
Ak .181	Throw	2.5	3.0	4.0	5.0	5.5	6.5	7.5	8.0	9.0	10.0
10 x 6	CFM	70	95	120	140	165	190	210	235	260	285
Ak .236	Throw	3.0	4.0	5.0	5.5	6.5	7.5	8.5	9.5	10.0	11.0
12 x 6	CFM	85	115	145	170	200	230	255	285	315	345
Ak .286	Throw	3.0	4.0	5.0	6.0	7.0	8.5	9.0	10.0	11.0	12.0
10 x 8	CFM	95	130	160	190	225	255	290	320	350	385
Ak .320	Throw	3.0	4.5	5.5	6.5	7.5	8.5	10.0	11.0	12.0	13.0
14 x 6	CFM	100	135	170	200	235	270	300	335	370	405
Ak .336	Throw	3.5	4.5	5.5	6.5	8.0	9.0	10.0	11.0	12.0	13.0
12 x 8	CFM	120	160	200	235	275	315	355	395	435	475
Ak .395	Throw	3.5	5.0	6.0	7.0	8.0	10.0	11.0	12.0	13.0	15.0
14 x 8	CFM	140	185	230	275	320	370	415	460	505	550
Ak .460	Throw	4.0	5.5	6.5	8.0	9.0	10.5	11.5	13.0	14.5	15.5

Figure 20. Hart & Cooley A618 Supply Diffuser Deflection G engineering data (See Appendix D for complete data sheet).

After defining the main components, we focused on smaller aspects required for a complete HVAC system. A bathroom exhaust fan was needed to meet contest regulations; we chose to have this fan run continuously to meet proper standards and selected its location to be above the sink in the bathroom. As is discussed in the foregoing section, the bedroom and living room require different amounts of air flow. To change the volumetric flowrate coming out of each supply diffuser, as the air handler outputs a constant value, we had the option of implementing manual or automatic air dampers. Since the use of automatic dampers would require an additional control system, the manual dampers were chosen for their simplicity. Once installed, they can be adjusted to allow different amounts of airflow to the living room and bedroom. Finally, the location of the thermostat needed to be determined. Since its position in the house will determine the output of the air handler, we decided to place it along the west wall of the kitchen. In this spot, it will be shaded from an incident sunlight and is as centrally-located as possible.

Complete site plans were developed using Revit and can be found in Appendix B. These show exact locations of the components as well as the specifics of the ductwork and distribution system. A section view of the complete system is shown below in Figure 21.

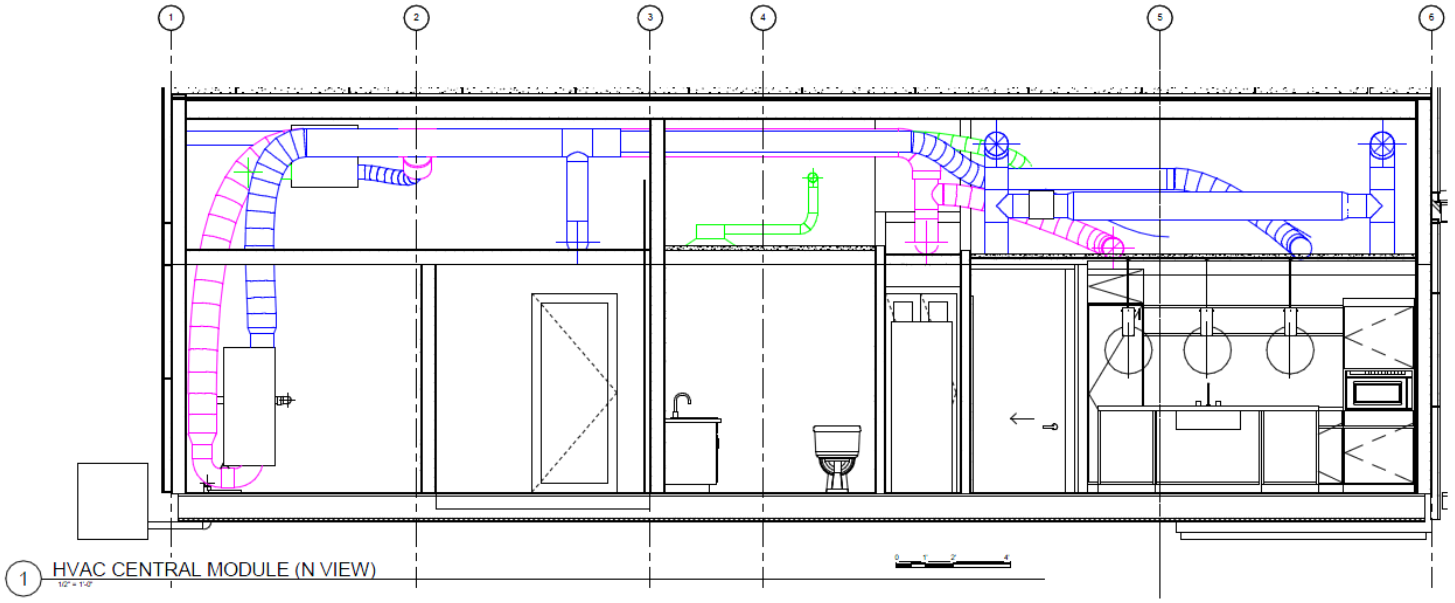


Figure 21. North-facing section view of core.

While we had completed the background research, concept generation and idea selection for the solar thermal system, we were not responsible for the final design, analysis or equipment procurement of this system. We made our recommendation, and then passed the design onto other teams.

Analysis

With all of our equipment selected and layout defined, we needed to run a performance analysis of our system within the house. Due to the constraints of the competition, we needed performance results dealing with the following parameters: energy consumption, solar gains, steady state temperatures, cooling and heating loads, system effectiveness, etc. We relied on DesignBuilder to achieve these results. In order to get acquainted with the software, our team completed many of the online tutorials including: creating a model, HVAC data, heating and cooling design calculations, and simulations.

Although we had gained the experience to create our own model, the SIP (structurally insulated panel) engineering team already had a working DesignBuilder model to track changes in heating and cooling loads with varying SIP configurations. Now with a model, we needed to make a decision on which analysis method to use: simple, compact, or detailed HVAC (three choices within DesignBuilder). After completing a few more online tutorials, we decided to run analysis using both simple and detailed HVAC to compare results. In order to acquire the most detailed results, the house was subdivided into three distinct zones: the bedroom, living room, and kitchen (not the mechanical room as it does not need to be conditioned). This was done as each zone contributes distinct portions of the overall heating and cooling load due to differing solar gains, occupancy, glazing, etc.

Unfortunately, at this stage we ran into a big problem with our model. It was discovered when we were attempting to run a simulation using the detailed analysis type, and only one of the zones could be selected for conditioning. The problem directly stemmed from the construction of the house, as each zone was created using the merge feature in DesignBuilder. This created solid partitions that didn't allow for air movement through the zones. To combat the issue, these solid partitions were removed from the model, creating a single zone that encompassed the living room, bedroom and kitchen. Although this allowed for whole house conditioning, the model assumed a uniform temperature throughout the house, which was very inaccurate. We then came across the capability to create virtual partitions, which allowed for zoning and continuous air movement through the house. This was exactly what our model needed, but again due to the construction of the house, the virtual partitions did not generate the zones we required. With little success, we then decided to reach out for help with someone that was proficient with the software, Dr. Steffen Peuker (Cal Poly Mechanical Engineering professor).

Before meeting Dr. Peuker, we made the decision to rebuild the model, as the merged construction of the current model was the root of our problems. To ensure we did not have to merge components together, we built the entire model from a solid block. We made necessary alterations to the block to match the dimensions of the house, and then placed partitions where needed to create the bedroom, living room, and kitchen zones. The mechanical room on the far

west side was divided using a solid partition as it will not be conditioned and therefore should not be included in the load analysis. The figure on the next page shows the newly constructed house within DesignBuilder.

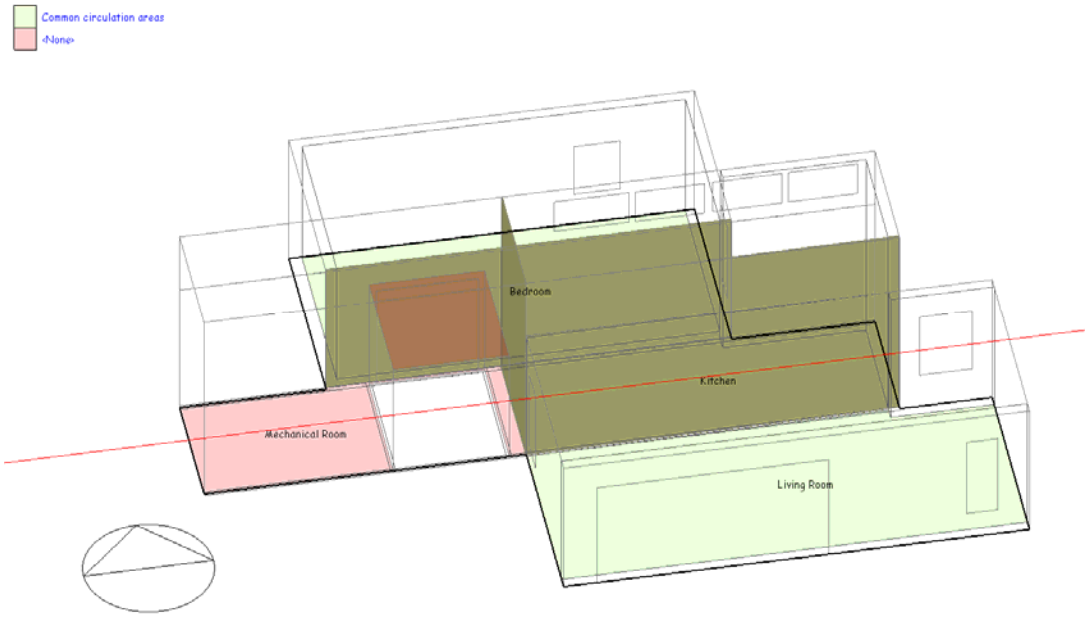


Figure 22. DesignBuilder model of house.

We then finally met with Dr. Peuker to get a better idea of the capability of DesignBuilder and what results we could expect. From this meeting, we were instructed to primarily continue with the 'simple' HVAC analysis type. Dr. Peuker specifically mentioned that the 'detailed' analysis type is very difficult to use and can restrict the understanding of system parameters. Dr. Peuker also mentioned that even though we may not get completely accurate results (after all it's only a model), the general trends would be a sufficient resource to analyze. For instance, if heat recovery is included, how much does it reduce the heating and cooling loads and energy consumption?

As we now had a completely functional DesignBuilder model, we proceeded by running a series of parametric studies using the 'simple' HVAC analysis. Holding all else constant, we varied the following parameters: use of heat recovery, use of an economizer, percent glazing, airtightness (air changes per hour), set-point temperatures, weather data (average day or summer design day), etc. As we have selected appropriate equipment to condition the space, parameters were altered accordingly to model actual behavior.

Before the parametric studies could begin, it was important to verify our model was producing intuitive results. This is a very important step in modeling as if a simple model doesn't produce an intuitive result then any additional complexity will produce inaccurate results. To achieve these baseline calculations, a cooling design was run on design builder. After multiple iterations, and many changes to our model, we felt very confident that we had a working model. A few of the iterations that we conducted are outlined below:

> *A basic model was simulated, and the corresponding cooling load was recorded. The model was then altered so that conditioned zones of the house were to be unconditioned. By making these changes, we expected a decreased cooling load, and that is exactly what we found. The magnitudes of the cooling loads that resulted (<1 ton – 1.3 ton) were very reasonable for the size of the model. We then altered thermal resistance values in the walls and windows and saw recorded very similar results. Additional iterations included altering weather data, occupancy, etc.*

Following the verification of our model, all parameters were changed to final design values. Again to reiterate, as Figure 22 shows, four distinct zones were created, three conditioned zones and one unconditioned zone. The kitchen, bedroom, and living room were conditioned (green zones), while the mechanical room and part of the mechanical chase were to be unconditioned (red zones). From this model, a final cooling design was run during the competition time in October. In Appendix E, you can find the resulting design loads and temperature distribution. Also included is an example window screenshot of the settings that were utilized when running the model.

After running a simple cooling design of the model, we next broadened our analysis and wanted to obtain results using our selected equipment. Luckily, within the simple HVAC module of DesignBuilder, we were able to select a simulation method in which each zone utilized its own cooling capacity. This essentially meant that each zone could be supplied with a cooling load capacity, and the simulation would supply the resulting flow rate needed to maintain the temperature within the specified set points. Using the previous cooling design, we set each zones cooling capacity accordingly, and included about 50% more capacity to ensure each zone was cooled efficiently. A summer design week simulation was then run in order to provide the worst-case design scenario experienced in Irvine. As seen in Appendix E, the simulation provided the design flow rates for cooling and heating along the design week, system peak times, house temperature distribution, heat gains, etc. From this data, the most important take away lies within the flow rate distributed to the living room and bedroom. As seen in the data, the design flow rate of the living room is roughly 200 cfm, while the bedroom is roughly 90 cfm. Across multiple simulations, the same trend emerged, that the bedroom required about half of the flow rate to the living room. This result is very intuitive as the living room is open to increased solar gains due to the large southern facing window, thus the flow rate would need to be larger to offset the heat

gained. From this result, we decided to restrict the flow rate delivered to the bedroom by roughly one half of the living room. This will ensure that the bedroom is not overly cooled/heated if the living room needs continuous conditioning. To restrict the flow, a fixed damper will be implemented within the supply to the bedroom.

The next issue we faced with our energy analysis was based on the controller of the system, the thermostat. We needed to decide the thermostat location, as well as provide data to ensure our system would operate effectively with only one thermostat. At first glance, it seemed simple, as the house is so small and wouldn't have significant temperature fluctuations. Unfortunately, with large thermal gains through windows, high occupancy variation, and appliance heating, this constant temperature assumption was one that we couldn't make. To provide analysis for this issue, we again turned to the DesignBuilder model. To achieve these results, we utilized a constant volume HVAC template with a specifiable thermostatic control zone. This designation made it possible to select one conditioned zone as the thermostatic control zone that would effectively dictate the system operation (on/off). Each of the other zones could simply fluctuate in temperature while the thermostatic control zone was kept constant. This was beneficial as it simulated the actual use of a thermostat. While running preliminary simulations, we soon discovered that the default cooling and occupancy schedules utilized in DesignBuilder were limiting the system operation as they accounted for a humans normal work schedule (8am-5pm). To combat this, we developed our own schedules in which the system would run whenever the thermostatic control zone required heating/cooling. Finally, we developed the correct schedules and ran summer design week simulations. Unfortunately, when we ran the following simulation, a discrepancy was recognized that invalidated the results. During this simulation we had selected the living room as our thermostatic control zone. This was strategic as if the system was operated according to the zone that required the largest load, it should show that the other rooms were cooled too much. To our surprise, the other rooms did the exact opposite and became too warm, while the living room remained constant. Each subsequent simulation displayed similar results, invalidating the model. Thus, to conclude, this model provided inconclusive results, so we followed our intuition and knew that something within the model was incorrect. To define the thermostat location, we utilized results from previous models.

To continue the energy analysis, the house required California Title 24 compliance. Jennifer Rennick, a Certified Energy Analyst (CEA) from In Balance Green Consulting was contacted and agreed to conduct the analysis. The house passed Title 24 in Irvine as well as in San Luis Obispo. The Title 24 compliance report from Irvine can be found in Appendix E. After achieving this compliance, our team stayed in contact with Jennifer, as we wanted to compare values between our two models to ensure we were producing accurate results. Jennifer supplied us with her model, which was designed in a different energy-modeling program, EnergyPro. This took some time to gain experience in, as the graphical interface is very different. To help, we set up a meeting with Jennifer to get acquainted with the software. After this meeting, we

investigated her model and ensured that all design parameters were the same as our model. As EnergyPro is primarily an energy use program, when the model was run, we discovered that many of the results we had obtained from DesignBuilder could not be generated. We also ran into a problem that the majority of the energy use terms were in the unit, kTDV/ft^2-yr. TDV refers to the Time Dependent Valuation for energy use. This unit is used frequently with compliance as it incorporates the variation of the value for energy. To explain further, a TDV multiplier is applied at each hour of the day to account for the need for energy. This means that during peak times, perhaps when it is very hot and energy use is high, the TDV multiplier would be relatively large to account for expensive energy. For this reason alone, it makes it impossible to compare our energy use numbers from DesignBuilder with Jennifer's EnergyPro numbers.

Although we were unable to compare values between the two programs, we continued analysis with Jennifer's model as it provided data that DesignBuilder couldn't. Specifically, it was capable of generating an energy use simulation over the course of a full year. A chart of the energy used strictly for space heating and cooling is shown below in Figure 23. This was beneficial as energy use is one of the main competition categories we need to satisfy. The full house performance report from EnergyPro can be found in Appendix E.

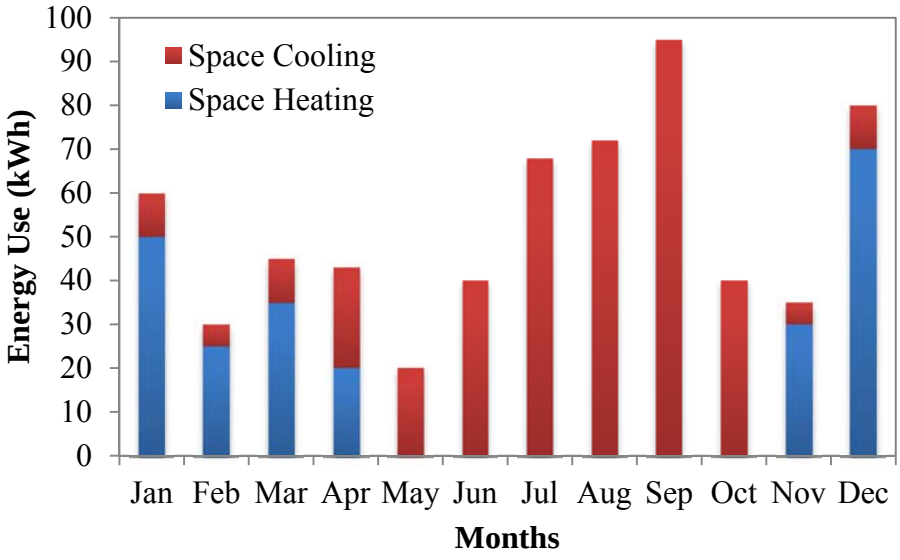


Figure 23. Energy use for space cooling and heating supplied by EnergyPro model.

Chapter 5: Product Realization

After selecting a final design and performing the proper analysis, our main task consisted of contacting equipment suppliers for quotes and possible sponsorship. For us, our product realization was accomplished through equipment procurement, as we are relying on an outside construction company for construction of the house. Solar Cal Poly as a whole has hired Maino

Construction Company to perform all pre-contest construction of the house, which is being built over the summer before the competition. Thus, we were responsible for making sure Maino has all the right equipment and understanding to properly install our system.

We turned to our original equipment selections as a starting place for procuring equipment. We quickly found that many of the large companies were difficult to communicate with. After a frustrating process of unsuccessful communication with manufacturers, we eventually decided to consult with a local HVAC contracting company for all of our equipment needs. This made the process much easier, as we teamed up with Ron Mathis of Wighton's Inc. in San Luis Obispo. After meeting with Ron, he provided us with a quote that included a heat pump – air handler package, HRV, control system, bathroom exhaust fan, and much of the ductwork. While Ron was able to provide a majority of the exact equipment we specified, he recommended that we utilized Airtemp components for our split-system. According to him, Airtemp products are just as effective as well-known brands such as Trane or Carrier, but he was able to provide them at a much lower cost. He also helped to provide us with a cost comparison between models of different efficiency ratings, after which we were able to conclude that the additional cost of choosing a heat pump with a higher SEER rating was not actually beneficial in terms of performance. Once receiving this quote, found in Appendix C, we met with Kevin Dong and Mariam Emyan of the College of Architecture and Environmental Design department, who took over the process of ordering through Wighton's. The information provided to them can be found in Appendix C as well, which lists the equipment covered by the quote, as well as the equipment that Maino will be providing through their own suppliers.

The last step in the product realization process was providing Maino with the necessary documents to be able to understand and implement our system. This consisted of collecting all data sheets, installation guides, owner's manuals and material safety data sheets from our procured equipment, and compiling a list of short form specifications. The short form specifications acted as a guide for communicating the purpose, details, standards and necessary instructions for all equipment being provided by us. A compilation of these documents can be found in Appendix D, although the extent of the documents included is not exhaustive. While we compiled as many of the above-mentioned documents as possible, some of the information will not be provided until delivery of the equipment, and thus is not provided in this report.

Chapter 6: Design Verification

Given the construction schedule of the project, the HVAC system is not expected to be installed until the middle of the summer before the competition. Thus, we will not be performing any tests on the system, but our recommendation for how we would perform such duties can be found in the DVPR in Appendix H. The majority of this includes taking quantitative

measurements, such as temperature, pressure and exit velocity when the system is running under normal conditions.

Therefore to ensure proper design verification, we have specified how to properly install the system components in the short form specifications and installation guides. The foregoing discussion summarizes the process of installing our main components.

To install the bathroom fan one must first mount the housing using the provided hanging bars. This is followed by snapping on the damper/duct connector and installing the 4-in. duct work, which exhausts outside. The fan is then hooked up to the house's electrical wiring, and the provided grille is attached to the housing for completion.

The detailed installation guide of the thermostat discusses the proper wiring guides for the conventional systems; heat pump systems; geothermal radiant heat; humidification, dehumidification, and ventilation controls; and the Economizer Module. There are also detailed descriptions on how to install the thermostat and the equipment interface module, and the initial setup of the device.

We are suspending the HRV in the mechanical room so the proper steps will need to be taken in order to hang it with the provided tie wraps. Once the main core is secured, a systematic approach is taken in order to route the duct work in accordance to the proposed design, install the condensation drain line, connect the power cord, and install the outside hoods for the fresh air and exhaust. Lastly, there are detailed instructions on how to properly wire the HRV in the installation guide.

Another big equipment item located in the mechanical room that is provided with an installation guide is the air handler. For the house, our air handler will have an Upflow configuration within the mechanical room, which includes the return air coming through the bottom and the supply air leaving the top. With the return air entering the bottom, it will be necessary to elevate the air handler enough to provide a clearance for the ductwork. Once mounted, there are a series of steps taken to connect the refrigerant lines, ductwork, and electrical work. These can be seen in greater detail in the installation guide. As for the heat pump, the installation guide was not provided by the equipment supplier, but its installation will be dependent on the air handler installation, and will go hand-in-hand. Upon procurement of the equipment, the installation guide will be provided.

For the rest of the smaller equipment with no installation guides, we will rely on the professional advice and experience of Maino Construction Company to properly and safely complete the installation. We will be available for consultation regarding the execution of our designs, yet we may need to implement quick redesigns if a construction procedure calls for

such. Although Maino will be performing the majority of the construction in San Luis Obispo, it will be inexperienced students who reassemble the house in Irvine, and thus the system needs to be installed in an orderly and safe fashion.

Chapter 7: Conclusions and Recommendations

As we conclude our project, it is unfortunate that we will not get to see its completion or functionality as a working HVAC system. While that is the case, we have provided all the necessary information from our end to ensure that Maino and the remainder of the Solar Cal Poly team can understand our efforts and intentions. While we designed and specified what we thought was thorough and complete, we recommend that any changes be made as necessary for the welfare of our system. As is expected with any construction project, there may be unforeseen developments that call for the modification of our system.

At the beginning of this project, we set out to design and verify an active HVAC system that would both succeed in the Solar Decathlon competition and seamlessly interconnect with the other systems involved. Through many iterations, we were able to reach a design that was well integrated with the architectural, structural and other mechanical aspects of the house. We performed the proper industry research, equipment selection and energy analysis in order to conclude that we have chosen the optimum system components and parameters with our given limitations. The entire project was a learning experience from the standpoint of mechanical engineering, residential construction, communication with other disciplines and many other facets.

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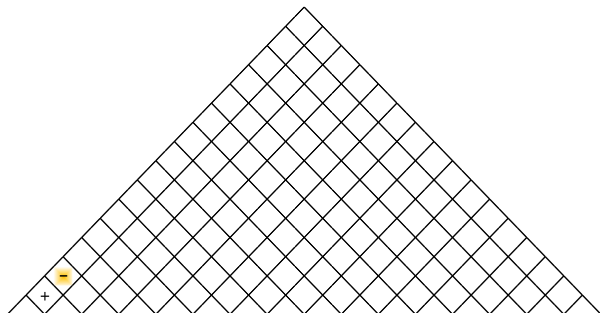
Appendix A

QFD: House of Quality
Project:
Revision:
Date:

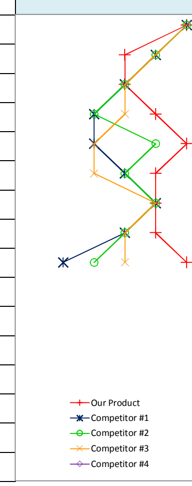
Correlations	
Positive	+
Negative	−
No Correlation	

Relationships	
Strong	●
Moderate	○
Weak	▽

Direction of Improvement	
Maximize	▲
Target	◇
Minimize	▼

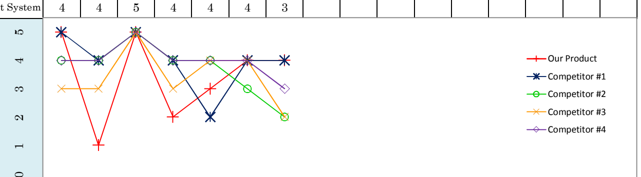


Row #	Weight Chart	Relative Weight	Judges	House Guests	House Occupants	Cal Poly Solar Team	Maximum Relationship	WHAT: Customer Requirements (explicit & implicit) / HOW: Engineering Specifications	Cooling/Heating Capacity	Number of Settings	Efficiency	Life	Cost	Size	Potential Losses										Mini-split System	Ducted Heat Pump System	Ducted Packaged Unit	Ducted Hybrid Heat Split System		Row #
								Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	NOW: Current Product Assesment - Customer Requirements					
								Direction of Improvement	▲	▼	◇																			
1		15%	5	2	5	5	9	Within Contest Parameters	●	▽		▽	○		○										5	5	5	5		1
2		12%	3	2	4	4	3	Discreet & Aesthetically Appealing	○					○											3	4	4	4		2
3		9%	3	1	4	3	9	Cost Efficient	▽	○	●	○	●	▽	▽										3	3	3	3		3
4		14%	4	2	4	5	9	Energy Efficient	●	●	●		○		●										4	2	2	3		4
5		10%	2	1	3	5	9	Compatiblility	▽		▽			●	▽										5	2	4	2		5
6		9%	3	1	4	2	9	Reliablilty	▽			●	○												4	3	3	2		6
7		9%	3	1	5	1	9	Ease Of Use		●															4	4	4	4		7
8		8%	2	1	4	2	3	Ease Of Maintenance				○		▽											4	3	3	3		8
9		15%	5	3	2	5	3	Innovativion	▽	▽	▽	▽	▽	▽	○										5	1	2	3		9
10		0%																												10
11		0%																												11
12		0%																												12
13		0%																												13
14		0%																												14
15		0%																												15
16		0%																												16



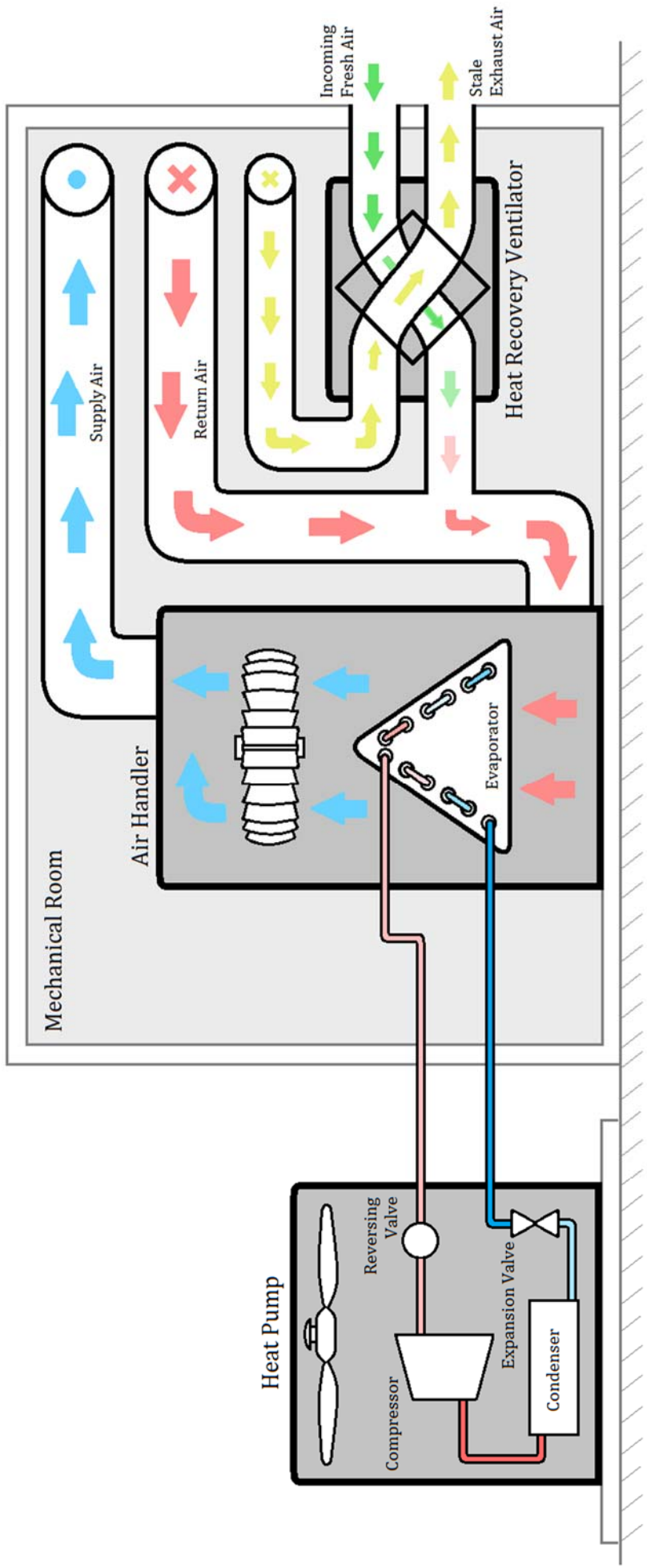
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
HOW MUCH: Target	9-13 kBTU/hr	2-3 settings	Seer rating > 13	10-15 years	less than $5000	compat. With 1000 sq. ft. house	less than 30% losses									
Max Relationship	9	9	9	9	9	9	9									
Technical Importance Rating	338.67	259.29	232.75	160.5	213.01	153.89	232.22									
Relative Weight	21%	16%	15%	10%	13%	10%	15%									
Weight Chart																
Our Product	5	1	5	2	3	4	4									
mini-split system	5	4	5	4	2	4	4									
Ducted Heat Pump System	4	4	5	4	4	3	2									
Ducted Packaged Unit	3	3	5	3	4	4	2									
Ducted Hybrid Heat Split System	4	4	5	4	4	4	3									
Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Current Product Assesment - Engineering Specifications

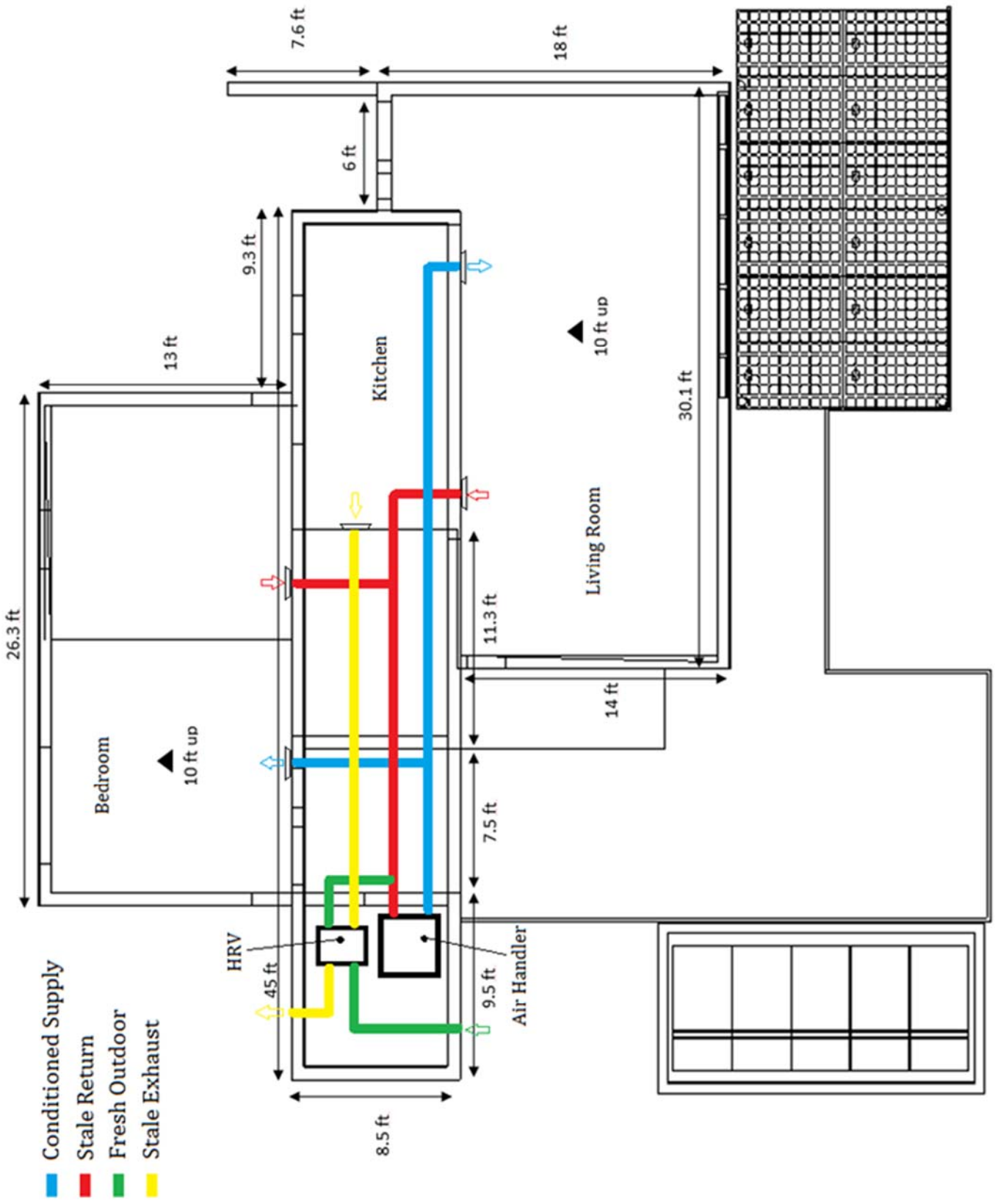


Template Revision: 0.9 Date: 4/23/2010
Christopher Battles

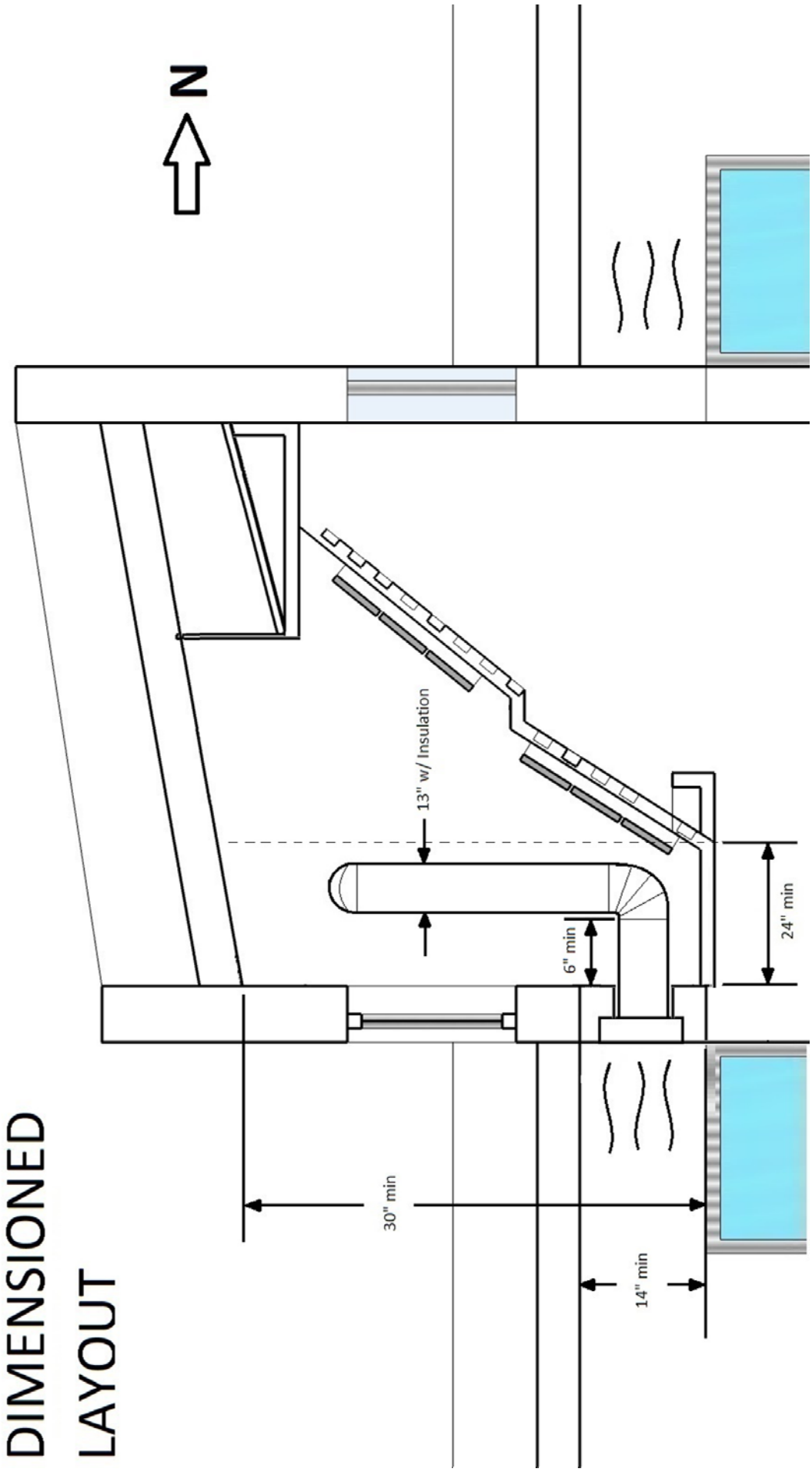
Appendix B


Incoming
Fresh Air
Stale
Exhaust Air
Heat Recovery Ventilator
Supply Air
Return Air
Mechanical Room
Air Handler
Evaporator
Heat Pump
Reversing
Valve
Expansion Valve
Compressor
Condenser

Appendix B

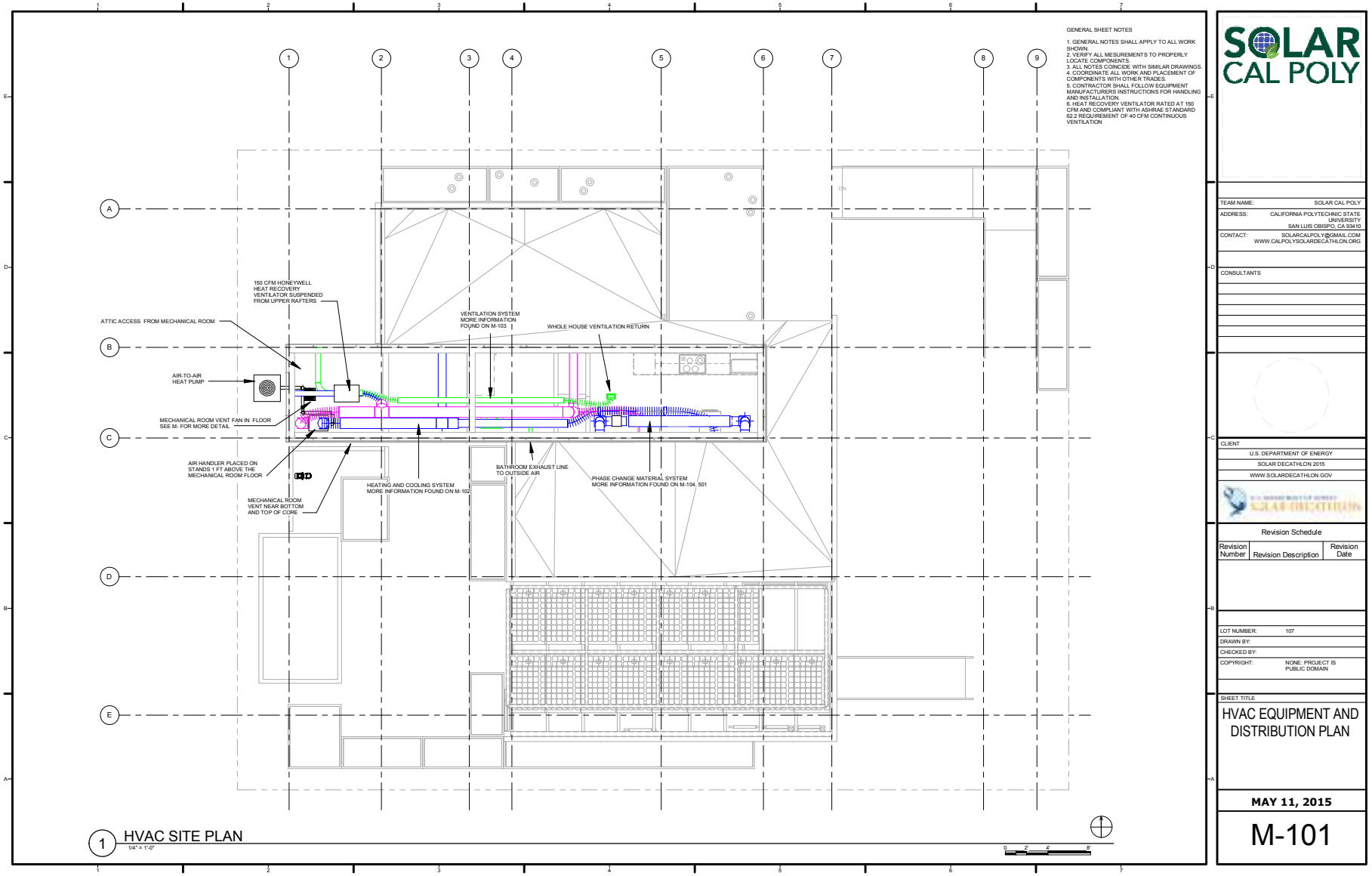

7.6 ft
18 ft
6 ft
9.3 ft
13 ft
Kitchen
10 ft up
30.1 ft
Living Room
11.3 ft
14 ft
26.3 ft
Bedroom
10 ft up
7.5 ft
HRV
45 ft
9.5 ft
Air Handler
8.5 ft
Conditioned Supply
Stale Return
Fresh Outdoor
Stale Exhaust

Appendix B



DIMENSIONED LAYOUT

Appendix B



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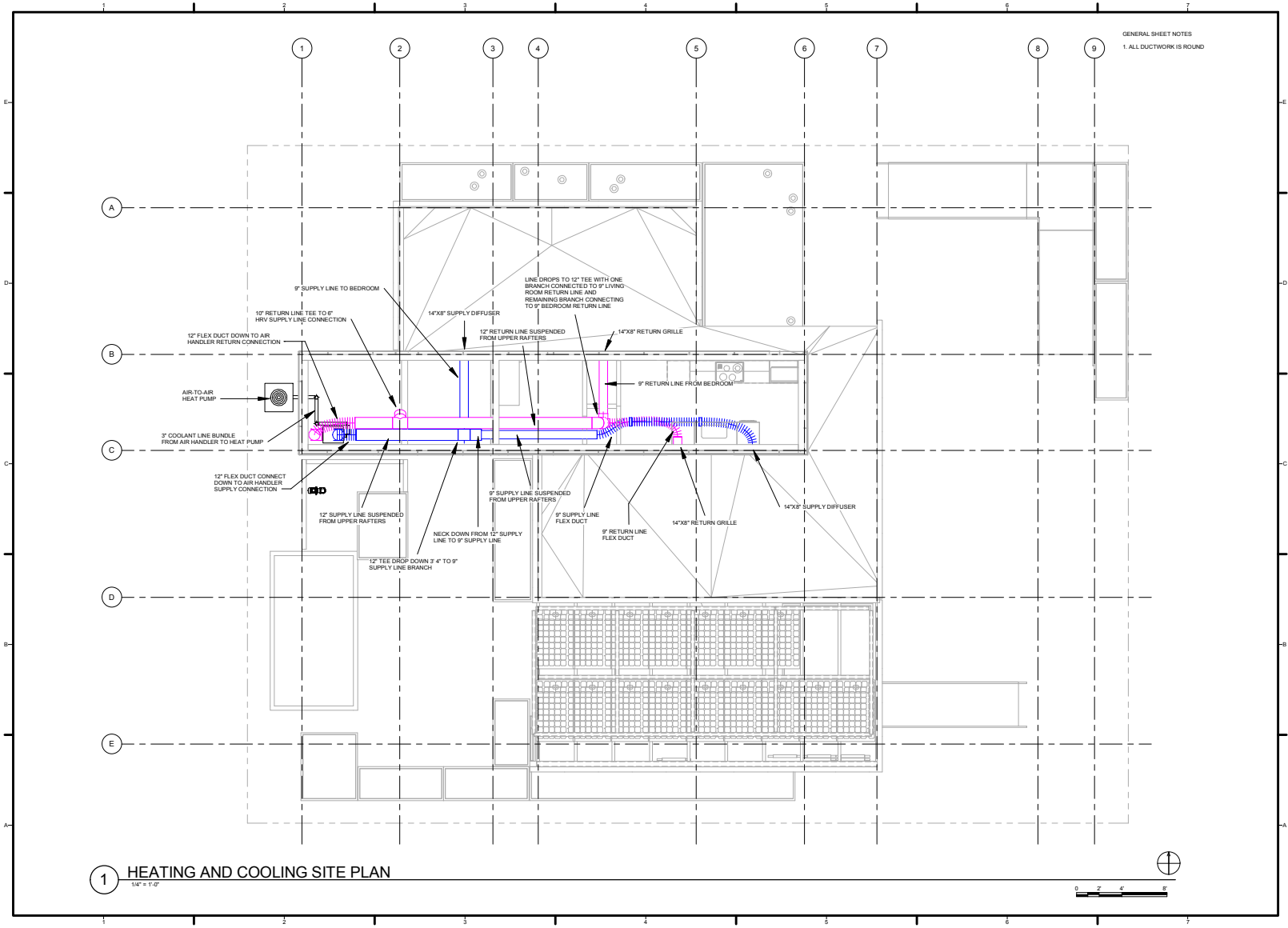
SHEET TITLE

HVAC EQUIPMENT AND DISTRIBUTION PLAN

MAY 11, 2015

M-101

Appendix B



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HEATING AND COOLING SITE PLAN

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M-102

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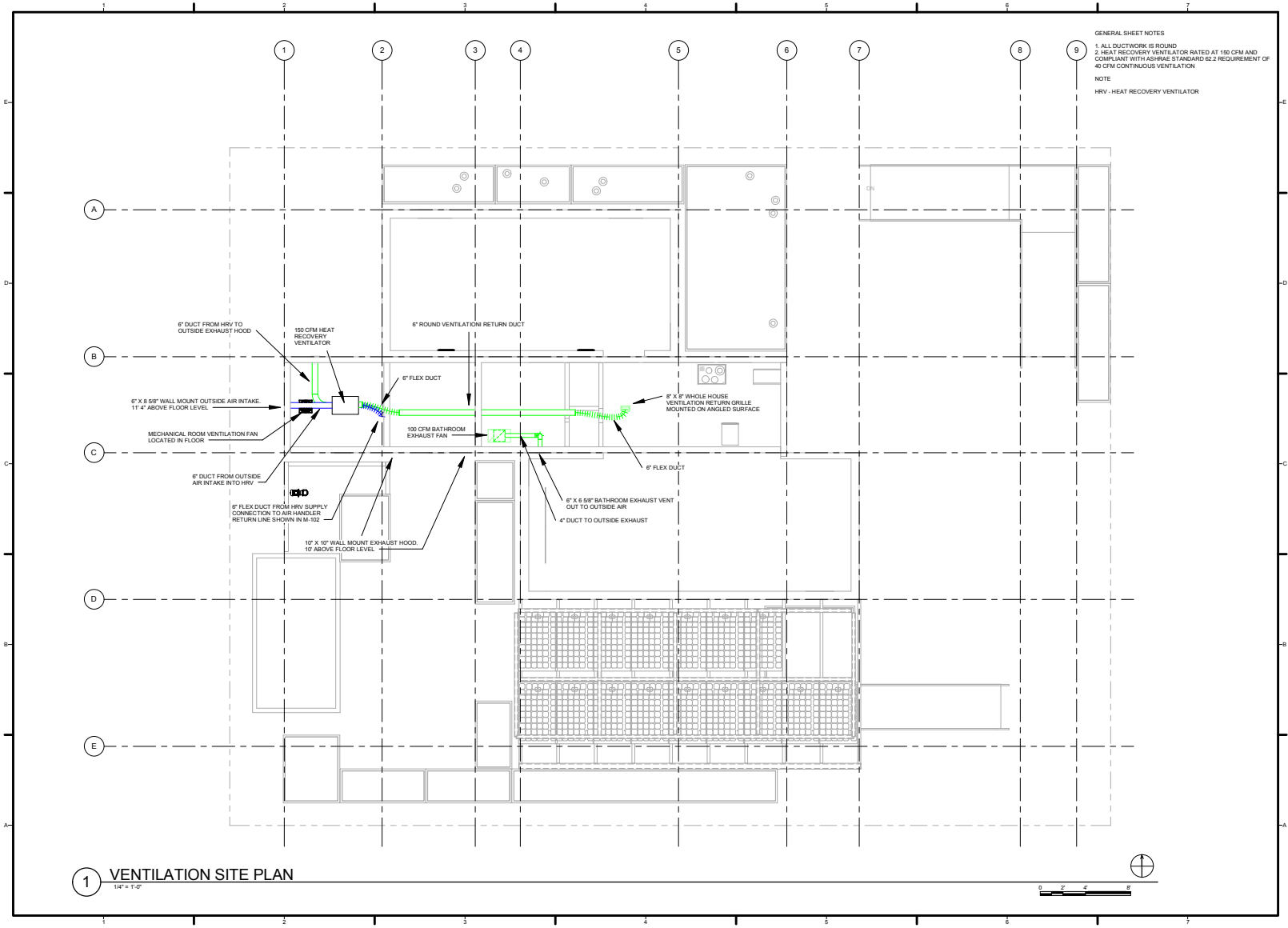

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SHEET TITLE
VENTILATION SITE PLAN

MAY 11, 2015

M-103

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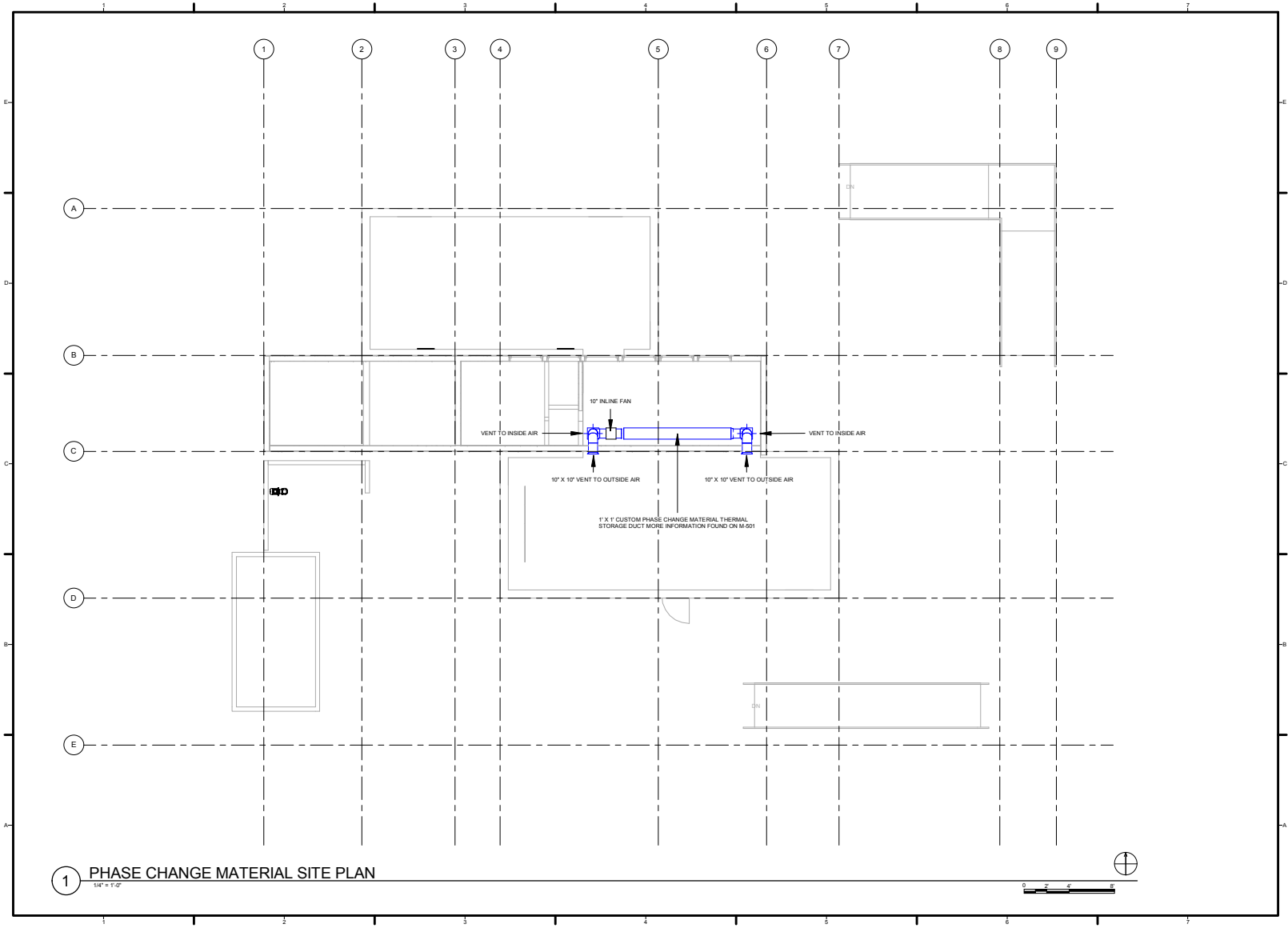

1 PHASE CHANGE MATERIAL SITE PLAN
1/4" = 1'-0"

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PHASE CHANGE MATERIAL SITE PLAN

MAY 11, 2015

M-104

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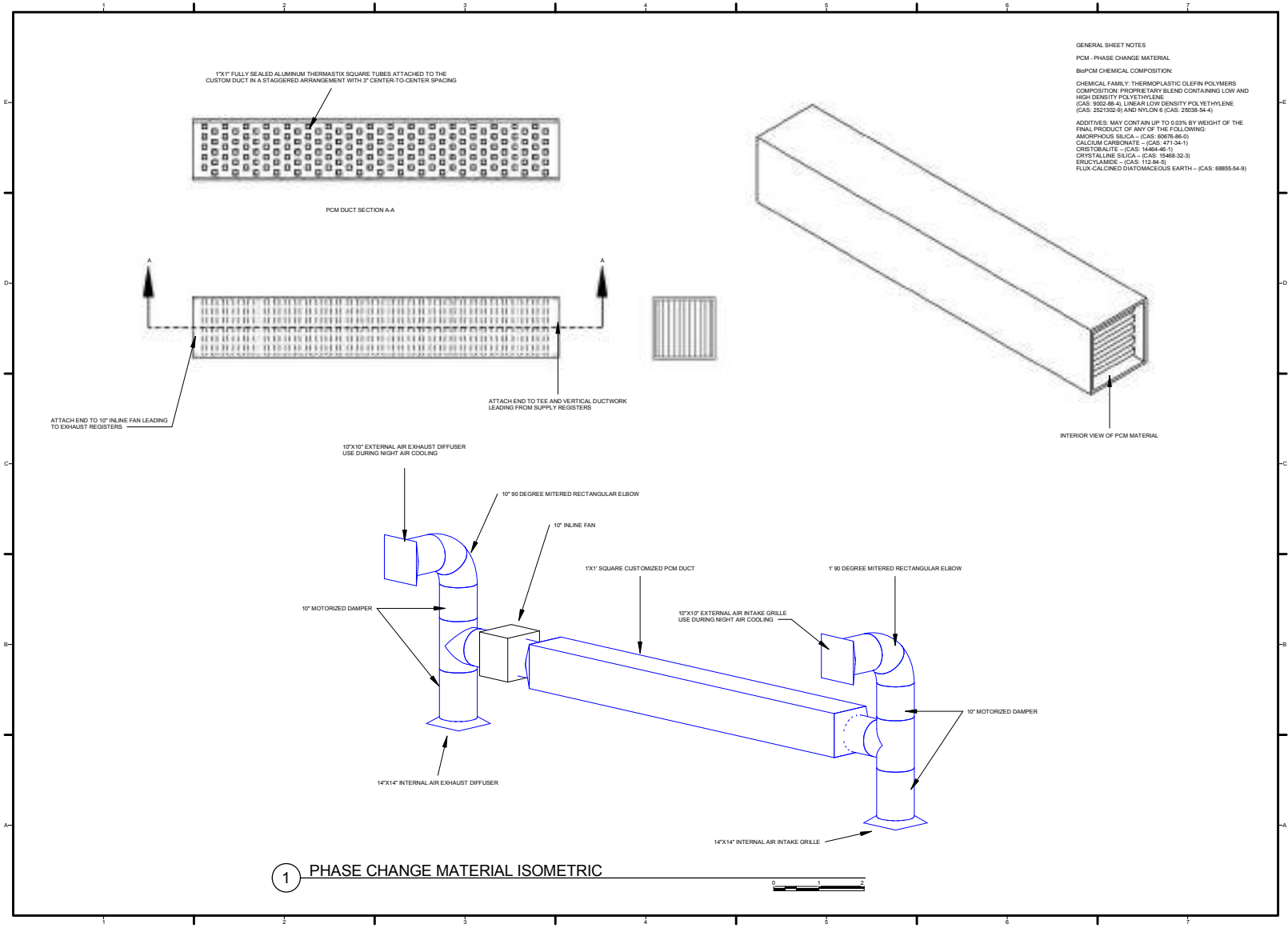

GENERAL SHEET NOTES

PCM - PHASE CHANGE MATERIAL

BioPCM CHEMICAL COMPOSITION:

CHEMICAL FAMILY: THERMOPLASTIC OLEFIN POLYMERS
COMPOSITION: PROPRIETARY BLEND CONTAINING LOW AND HIGH DENSITY POLYETHYLENE
(CAS: 9002-88-4), LINEAR LOW DENSITY POLYETHYLENE
(CAS: 2521302-9) AND NYLON 6 (CAS: 25038-54-4)

ADDITIVES: MAY CONTAIN UP TO 0.03% BY WEIGHT OF THE FINAL PRODUCT OF ANY OF THE FOLLOWING:
AMORPHOUS SILICA – (CAS: 60676-86-0)
CALCIUM CARBONATE – (CAS: 471-34-1)
CRISTOBALITE – (CAS: 14464-46-1)
CRYSTALLINE SILICA – (CAS: 15468-32-3)
ERUCYLAMIDE – (CAS: 112-84-5)
FLUX-CALCINED DIATOMACEOUS EARTH – (CAS: 68855-54-9)

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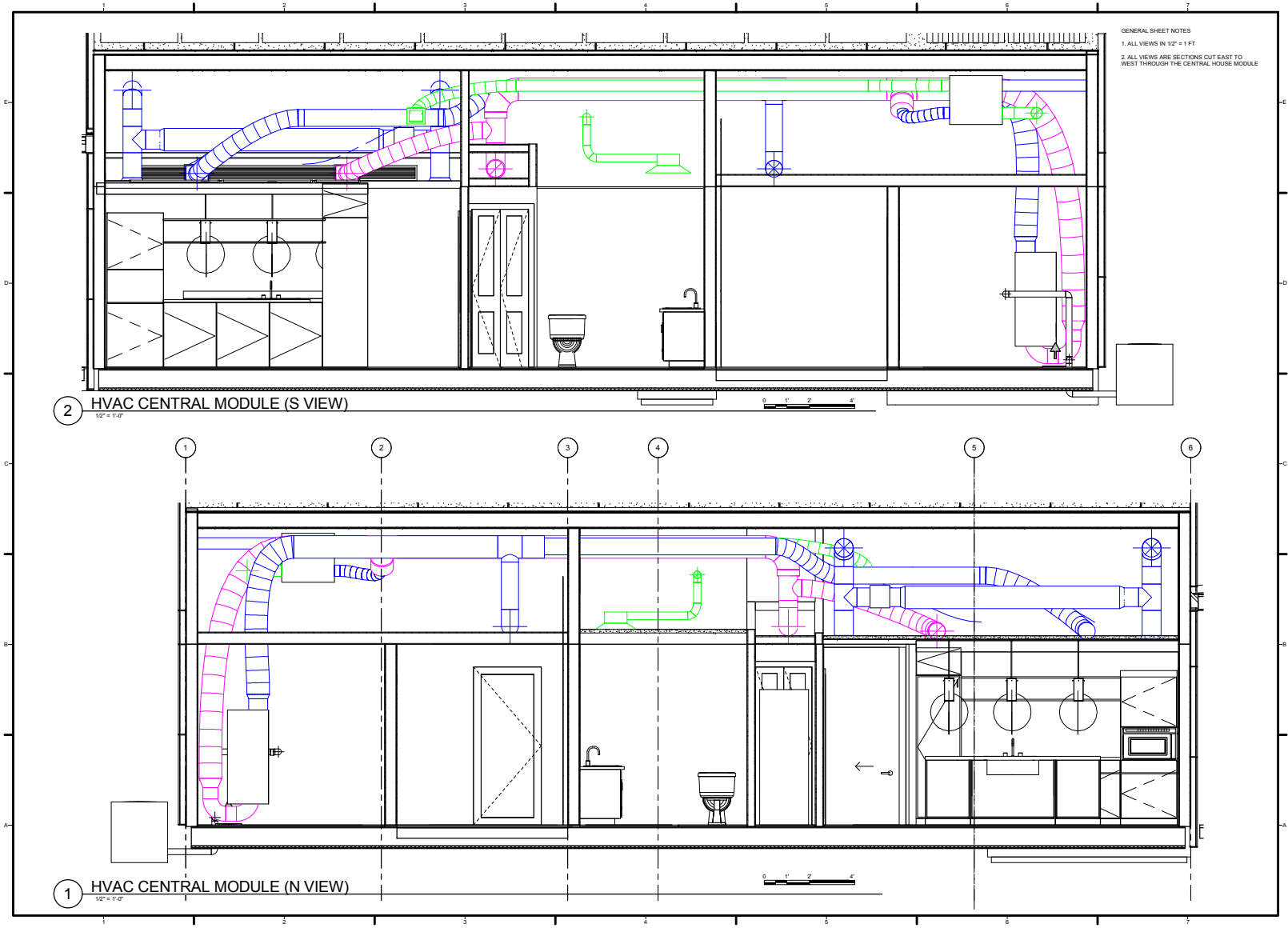
MECHANICAL DETAILS

MAY 11, 2015

M-501

Appendix B


GENERAL SHEET NOTES
1. ALL VIEWS IN 1/2" = 1 FT
2. ALL VIEWS ARE SECTIONS CUT EAST TO WEST THROUGH THE CENTRAL HOUSE MODULE
2 HVAC CENTRAL MODULE (S VIEW)
1/2" = 1'-0"
1 HVAC CENTRAL MODULE (N VIEW)
1/2" = 1'-0"
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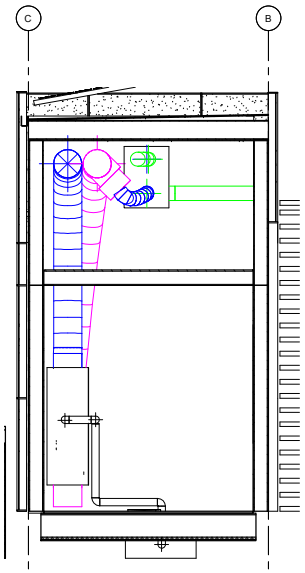
SHEET TITLE
HVAC SECTIONS
MAY 11, 2015
M-502

Appendix B

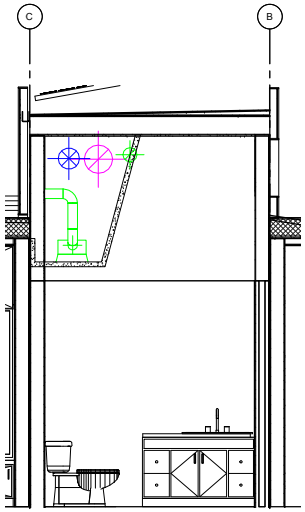
GENERAL SHEET NOTES

1. ALL VIEWS IN 1/2" = 1 FT

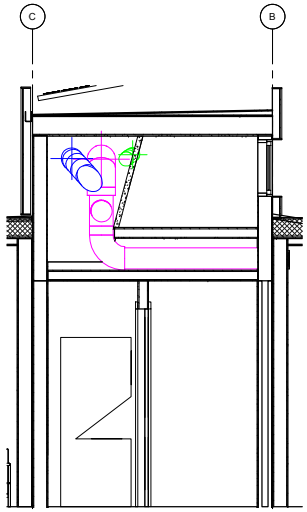
2. ALL VIEWS ARE SECTIONS CUT NORTH TO SOUTH THROUGH THE CENTRAL HOUSE MODULE



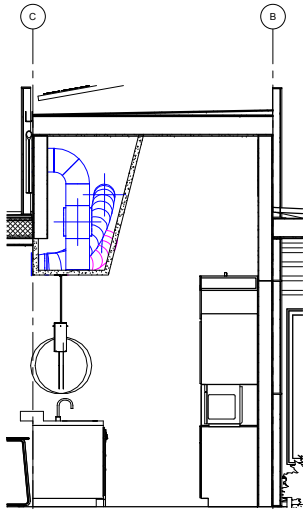
4 HVAC MECHANICAL ROOM (W VIEW)
1/2" = 1'-0"



1 HVAC BATHROOM (W VIEW)
1/2" = 1'-0"



3 HVAC LAUNDRY ROOM (W VIEW)
1/2" = 1'-0"



2 HVAC KITCHEN (W VIEW)
1/2" = 1'-0"

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MORE HVAC SECTIONS

MAY 11, 2015

M-503

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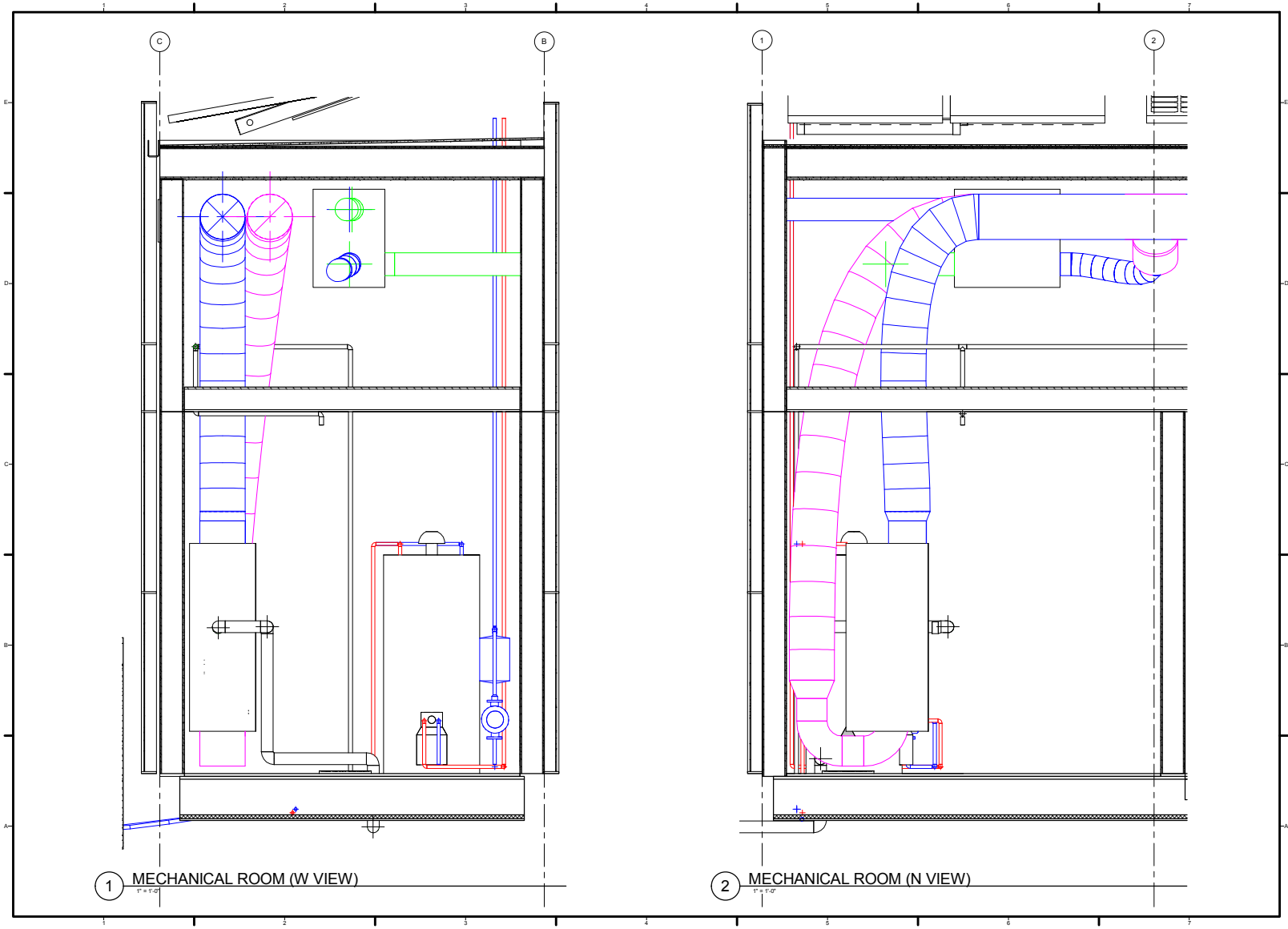

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MECHANICAL ROOM

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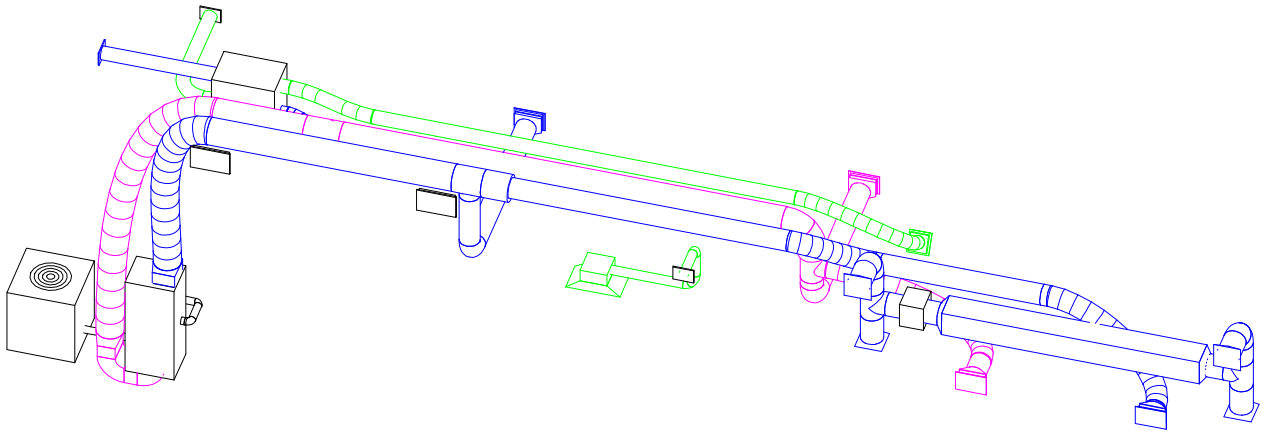

1 HVAC AND PCM ISOMETRIC

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SHEET TITLE

HVAC ISOMETRICS

MAY 11, 2015

M-901

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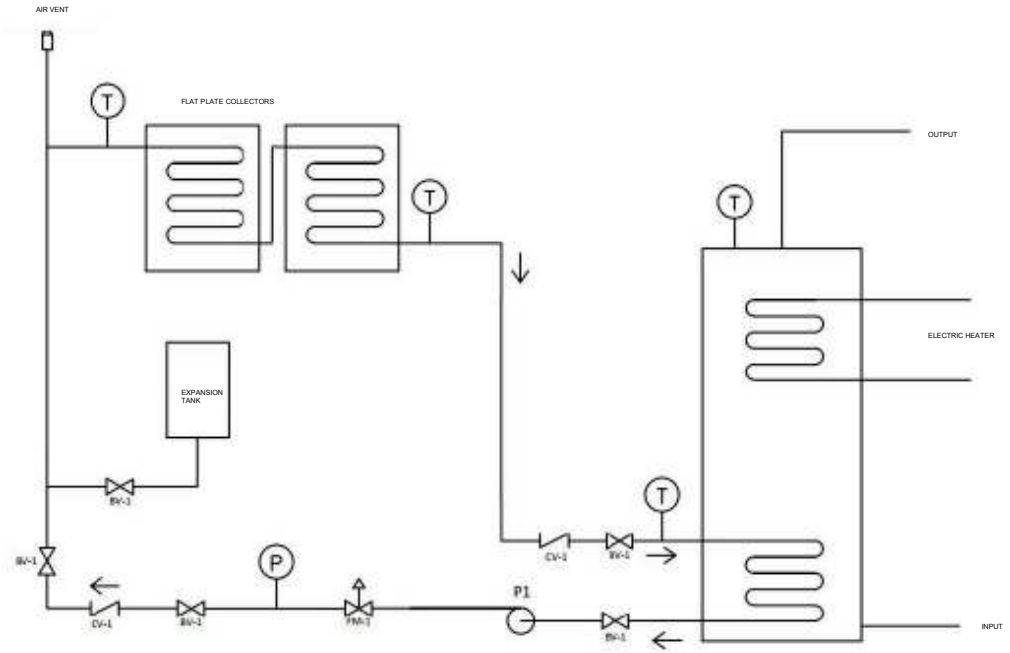

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SHEET TITLE

SOLAR WATER DIAGRAMS

MAY 11, 2015

M-603

Appendix C

RUN DATE: 5/23/15 CUST PH # 805-781-2574 5/23/15
CUST FAX # 805-543-2370 8:13:32 AM PT
R.E. MICHEL COMPANY LLC CHARGE
SANTA MARIA CA ** QUOTE **
SANTA MARIA CA 93455 1 OF 2
499366 N

46-2354418
805-621-7070

CHG PRC

261215

WIGHTON'S INC
183 PRADO RD
SAN LUIS OBISPO, CA 93401

WIGHTON'S INC
183 PRADO RD
SAN LUIS OBISPO, CA 93401

49936600 CAL POLY 032155 TBD

O/QTY	S/QTY	BKO	ITEM #	DESCRIPTION		UNIT $	EXTEND $
				THIS PRICING GOOD FOR 30 DAYS (COPPER PRICES VALID FOR 7 DAYS, FREON VALID SAME DAY ONLY) TAX AND FREIGHT NOT INCLUDED.			
1	0	1	1AT310	VT4BE-018K	AIRTEMP HP, 14 SEER, R410A	877.81	877.81
1	0	1	22B425C	B6EMMX24K-A	AIRTEMP AIR HANDLER, MULTI-SEER	421.12	421.12
1	0	1	2C5150H	VNT5150H1000	HONEYWELL 150CFM HEAT RECOVERY VENTILATOR	698.43	698.43
1	0	1	4CS1132	ULTRA SILENT FAN 110CFM 1.3-SO QTRE110		109.69	109.69
2	0	2	7CC1452	210VM 14X8 BAR-TYPE SW REG.		11.54	23.08
2	0	2	4SW3120	14X8 BASEBOARD RETURN WHITE 3 173W14X8		5.48	10.96
1	0	1	8CC4284	12X9 SURE-FIT REDUCER 26GA SEALED		6.69	6.69
1	0	1	8CC4273	10X6 SURE-FIT REDUCER 26GA		4.64	4.64

** CONTINUED **

RUN DATE: 5/23/15 CUST PH # 805-781-2574 5/23/15
CUST FAX # 805-543-2370 8:13:32 AM PT
R.E. MICHEL COMPANY LLC CHARGE
SANTA MARIA CA ** QUOTE **
SANTA MARIA CA 93455 2 OF 2
499366 N

46-2354418
805-621-7070

CHG PRC

261215

WIGHTON'S INC
183 PRADO RD
SAN LUIS OBISPO, CA 93401

WIGHTON'S INC
183 PRADO RD
SAN LUIS OBISPO, CA 93401

49936600 CAL POLY 032155 TBD

O/QTY	S/QTY	BKO	ITEM #	DESCRIPTION	UNIT $	EXTEND $
				SEALED		
1	0	1	8H616	ELBOW 9" ADJ 26GA	4.01	4.01
1	0	1	8H613	06 90 ELBOW 26GAA	2.94	2.94
1	0	1	8H998B	#036 12"X25' R6.0 FLEX DUCT	46.83	46.83
				FOIL JACKET		
1	0	1	8H999B	#036 9"X25' R6 FLEX DUCT	38.09	38.09
				FOIL JACKET		
1	0	1	8H996B	#036 6"X25' R6.0 FLEX DUCT	24.65	24.65
				FOIL JACKET		
14	0	14	8CC1622	PIPE GALV KD 12" X 3' 26 GA	8.03	112.42
				DLSKD1226		
22	0	22	8CC1614	PIPE GALV KD 9" X 3' 26 GA	6.64	146.08
				DLSKD0926		
1	0	1	8CC1602	PIPE GALV KD 6" X 3' 26 GA	4.53	4.53
				DLSKD0626		

1	0	1	8CC2306	9" VOLUME DAMPER DLSSCD09	7.10	7.10	
1	0	1	1C0184A	YTHX9421R5085WW PRESTIGE IAQ KITS EIM,2 DUCT SENSORS WW	260.42	260.42	

MCARPENT 2799.49
CAS009B083 223.96

3023.45

** This is NOT an invoice **
** DO NOT sign this document as a receipt **
1.5 18.0

Appendix C

Quoted Equipment:

Item	Brand	Qty	Item #	Model	Cost	Additional Specifications	Application
Heat Pump	Airtemp	1	1AT310	VT4BE-018K	$ 877.81	14 SEER, R410a	Heating and Cooling Equipment
Air Handler	Airtemp	1	22B425C	B6EMMX24K-A	$ 421.12	Mulit-SEER	Heating and Cooling Equipment
Heat Recovery Ventilator	Honeywell	1	2C5150H	VNT5150H1000	$ 698.43	150 cfm	Ventilation Equipment
Bathroom Exhaust Fan	Broan	1	4CS1132	QTRE110	$ 109.69	110 cfm, 1.3-SO	Ventilation Equipment
Supply Diffusers	-	2	7CC1452	210VM	$ 23.08	14"x8", bar-type, sidewall	Air Distribution System
Return Grilles	-	2	4SW3120	173W14X8	$ 10.96	14"x8", baseboard	Air Distribution System
12" to 9" Reducer	Sure-fit	1	8CC4284	-	$ 6.69	26GA sealed	Air Distribution System
10" to 6" Reducer	Sure-fit	1	8CC4273	-	$ 4.64	26GA sealed	Air Distribution System
9" Elbow - 90°	-	1	8H616	-	$ 4.01	ADJ, 26GA	Air Distribution System
6" Elbow - 90°	-	1	8H613	-	$ 2.94	26GAA	Air Distribution System
12" Flex Duct	-	1	8H998B	-	$ 46.83	#036, 25' section, R6.0	Air Distribution System
9" Flex Duct	-	1	8H999B	-	$ 38.09	#036, 25' section, R6.1	Air Distribution System
6" Flex Duct	-	1	8H996B	-	$ 24.65	#036, 25' section, R6.2	Air Distribution System
12" Round Duct	-	14	8CC1622	DLSKD1226	$ 112.42	Galv, 3' section, 26GA	Air Distribution System
9" Round Duct	-	22	8CC1614	DLSKD0926	$ 146.08	Galv, 3' section, 26GA	Air Distribution System
6" Round Duct	-	1	8CC1602	DLSKD0626	$ 4.53	Galv, 3' section, 26GA	Air Distribution System
9" Volume Damper	-	1	8CC2306	DLSSCD09	$ 7.10		Air Distribution System
Prestige IAQ Thermostat Kit	Honeywell	1	1C0184A	YTHX9421R5085WW	$ 260.42	2 duct sensors	Control System
					$ 2,799.49		

Not provided by Cal Poly:

Item	Qty
3" Refrigerant Piping	10'
12" Round Tee	2
12" to 6" Reducer	1
12" to 9" Reducer	1 addt'l
4" Round Duct	10'
4" Elbow - 90°	1
6" x 6 5/8" Exhuast Vent to Outside	1
6" x 8 5/8" Exhuast Vent to Outside	2
8" x 8" Return Grille	1

Note: See M-102 & M-103 for equipment callouts

Appendix D

SECTION 23 00 00
HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 GENERAL

1.1 SUMMARY

A. Provide vapor-compression cycle for refrigerant piping system.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

1.3 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers, which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 MATERIALS

A. HVAC Heat Pump
   1. Manufacturers: Airtemp Heat Pump VT4BE-018K.
   2. Sustainable Design: Energy efficient equipment and fixtures.
   3. Sustainable Design: Energy modeling.
   4. Sustainable Design: Commissioning.
   5. Type: Central HVAC equipment.
      a. Packaged outdoor HVAC equipment.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to VT4BE-018K installation guide for complete instructions for proper outdoor installation.

B. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials in proper relation with adjacent construction and with uniform appearance for exposed work. Coordinate with work of other sections. Comply with applicable regulations and building code requirements.

C. Support piping properly. Pitch to drain points. Install with pipe expansion loops, mechanical expansion joints, and anchors.

D. Install shutoff valves on each piece of equipment on both hot and cold water supply.

E. Install ductwork in accordance with SMACNA recommendations. Seal duct seams with sealer. Provide splitters and balancing dampers. Provide fire dampers and automatic smoke and fire dampers where required. Provide flexible connectors and inlet and discharge connections. Clean before testing and balancing.

F. Clearly label and tag all components.

G. Test and balance all systems for proper operation.

H. Restore damaged finishes. Clean and protect work from damage.

I. Instruct Owner's personnel in proper operation of systems.

END OF SECTION

TECHNICAL SPECIFICATIONS

VT4BE Series

R-410A High Efficiency Heat Pump 14 SEER Residential System 1.5 – 5 Ton Capacity

The VT4BE Series now offers the choice of a heat pump that uses a more efficient and environmentally friendly refrigerant designated R-410A. The VT4BE Series of heat pumps offers exceptional performance. The unit, when combined with our engineered coils or air handlers, offers a full line of quality, split system cooling and heating equipment. The VT4BE is rated at 14 SEER and 8.5 HSPF when matched with our air handlers. When matched with our variable speed air handler, or our variable speed blower kits, the VT4BE is rated up to 15 SEER and 8.5+ HSPF. Units are ideally sized for slab or rooftop mounting in single, multifamily, and light commercial applications.

WARRANTY

– This product offers a 10-year all-parts warranty.
– This product offers a 1 Year Replacement Pledge to replace the unit if the compressor fails in the first year of operation, to the original owner. All split system products must be installed with a matched indoor air handler or indoor coil.
– Consumer product registration required for 10 year All Parts Warranty and Replacement Pledge within a limited period of time after the installation. See current warranty document or visit our consumer web site listed on the back of this document for warranty details.

FEATURES and BENEFITS

- **R-410A Refrigerant**: Earth friendly non-ozone depleting refrigerant.
- **Composite Base Pan:** Absorbs sound and corrosion resistant. Composite is also stronger and lighter than steel.
- **Copper Tube / Aluminum Fin Coils:** Both indoor and outdoor coils are designed to optimize heat transfer, minimize size and cost, and increase durability and reliability.
- **Permanently Lubricated Motor:** A heavy duty PSC motor for long lasting reliability and quiet operation. Requires no maintenance and is completely protected from rain and snow.
- **Durable, Attractive Cabinet:** Designed using galvanized steel with a polyester urethane finish. The 950 hour salt spray finish is 1.5 mil thick and resists corrosion 50% better than comparable units.
- **Removable Top Grille Assembly:** Allows ease of service from the top without disconnecting fan motor leads.
- **High Pressure Switch:** Protects against abnormally high system pressures. Auto-reset feature prevents nuisance service visits.
- **Liquid Line Filter Drier:** Included with unit, field installed.
- **One Piece Top/Orifice:** Designed for maximum airflow and quiet operation.
- **Five Minute Restart Time Delay:** When the unit shuts down, a five minute delay keeps the unit from restarting, eliminating the highest cause for compressor failure.
- **Suction Accumulator:** Protection from liquid flood back and future compressor failures.
- **Hot Gas Muffler:** Reduces compressor noise and vibration.
- **Easy Compressor and Control Access:** Designed to make servicing easier for the contractor, access panels are provided to all controls and the compressor from the side of the unit.
- **Complete Metal Wrapper:** Protects the units coil from being damaged.
- **Fixed Orifice:** Integrated in liquid line service valve for easy change-out.

MODEL IDENTIFICATION CODES

EX: VT4BE-036K

VT 4 B E - 036 K

VS - Air Conditioner
VT - Heat Pump

Design Series

Product Identifier

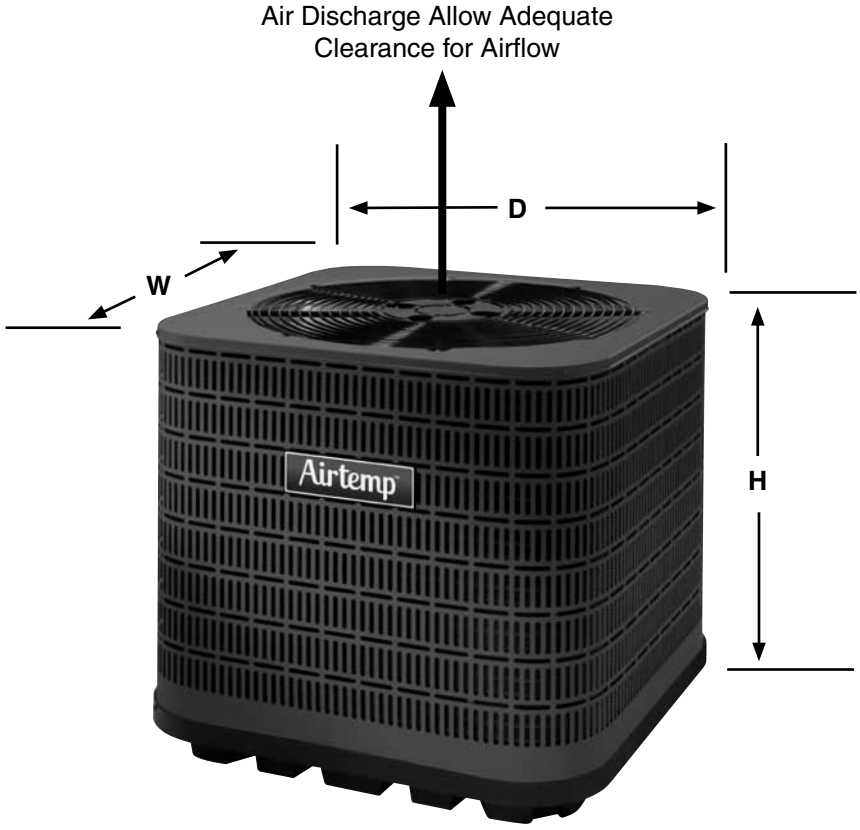
BE = Braze 14 SEER

Nominal Capacity
(000) BTU

Electrical Code
K = 208/230-60-1

DIMENSIONS
OUTDOOR SECTION

VT4BE	018K	024K	030K	036K	042K	048K	060K
H	43	43	43	43	43	43	43
W	30 3/4	30 3/4	30 3/4	30 3/4	30 3/4	30 3/4	30 3/4
D	30 3/4	30 3/4	30 3/4	30 3/4	30 3/4	30 3/4	30 3/4



PHYSICAL AND ELECTRICAL SPECIFICATIONS / OUTDOOR UNITS

14 SEER — High Efficiency — Single Phase

Model Number VT4BE			018K	024K	030K	036K	042K	048K	060K
Electrical Data	Volts-Cycles-Phase (1)		208/230-60-1	208/230-60-1	208/230-60-1	208/230-60-1	208/230-60-1	208/230-60-1	208/230-60-1
	Total Amps		11.86	16.34	15.7	16.98	20.82	21.24	27.64
	Delay Fuse Max. (2)		20	30	30	30	40	45	60
	Min. Circuit Ampacity		14.1	19.7	18.9	20.5	25.3	26.2	34.2
Condenser Data	Coil	Area ft^2	25.4	25.4	25.4	25.4	25.4	25.4	25.4
		Rows-FPI	1-20	1-20	1-20	1-20	2-16	2-16	2-16
		Tube Dia	3/8” O.D.	3/8” O.D.	3/8” O.D.	3/8” O.D.	3/8” O.D.	3/8” O.D.	3/8” O.D.
	Fan Motor	Type	BLDC	BLDC	BLDC	BLDC	BLDC	PSC	PSC
		Amps	2.9	2.9	2.9	2.9	2.9	1.4	1.4
		Watts-HP	1/3	1/3	1/3	1/3	1/3	1/4	1/4
	Fan Blade	Dia-# Blades	24”-2	24”-2	24”-2	24”-2	24”-2	24”-2	24”-2
		SCFM	2800	2800	2800	3400	4000	4000	4000
	Compressor Data	RLA	8.96	13.44	12.8	14.08	17.92	19.84	26.24
		LRA	48	58.3	64	77	112	109	134
Refrigerant suction line O.D.(all length of liquid line are 3/8” O.D.)		0-24 ft.	3/4”	3/4”	3/4”	7/8”	7/8”	7/8”	7/8”
		25-39 ft.	3/4”	3/4”	3/4”	7/8”	7/8”	1 1/8” (3)	1 1/8” (3)
		40-75 ft.	3/4”	3/4”	3/4”	7/8”	7/8”	1 1/8” (3)	1 1/8” (3)
Weight Approximate (lbs.)		Net	179	180	180	182	279	280	290
		Ship	188	189	189	191	294	295	305
Sound Ratings db (5)			78	78	78	79	79	79	79

(1) Operating Voltage Range: 187V min.- 253V max.
(2) HACR Type Circuit Breaker may be used.
(3) Requires 7/8" to 1-1/8" reducer from line to unit.

ACCESSORIES - Condensing Unit

Start Assist Kit - 912933
Provides additional starting torque for the compressor motor when operating with low line voltage or high operating temperatures.

Snow Stand
Plastic-coated, molded wire stand which elevates units 7-1/4" above ground level.
913145 - (024 through 048) Shipped six (6) per box.

Outdoor Thermostat - 913235
Two-stage logic provides ability to lock out electric strips down to balance point and bring on in stages.

Time Delay Relay Kit (TDR) - 911758

SYSTEM HEATING AND COOLING CAPACITIES

Appendix D

14+ SEER — High Efficiency — Single Phase

Outdoor Unit	Indoor Unit	BTUH	SEER	EER	Heating Capacity BTUH @ 47 F	HSPF	CFM
VT4BE-018K	C7B(A,H)M01824(C,U)-A + TXV	18,000	14.00	12.20	19,000	8.2	665
VT4BE-018K	C7B(A,H)M01824(C,U)-B + TXV	18,000	14.00	12.20	19,000	8.2	655
VT4BE-024K	C7B(A,H)M01824(C,U)-A + TXV	22,800	14.00	12.20	25,000	8.2	755
VT4BE-024K	C7B(A,H)M01824(C,U)-B + TXV	22,800	14.00	12.20	25,000	8.2	830
VT4BE-030K	C7B(A,H)M03036(C,U)-A + TXV	28,200	14.00	12.20	29,200	8.2	990
VT4BE-030K	C7B(A,H)M03036(C,U)-B+TXV	28,200	14.00	12.20	29,200	8.2	990
VT4BE-030K	C7B(A,H)M030(C,U)-C + TXV	28,200	14.00	12.20	29,200	8.2	990
VT4BE-036K	C7B(A,H)M03642(C,U)-B + TXV	34,400	14.00	12.20	35,800	8.2	1215
VT4BE-036K	C7B(A,H)M03648(C,U)-C + TXV	34,400	14.00	12.20	35,800	8.2	1215
VT4BE-042K	C7B(A,H)M03642(C,U)-B + TXV	40,000	14.00	12.00	41,500	8.2	1360
VT4BE-042K	C7B(A,H)M03648(C,U)-C + TXV	40,000	14.00	12.00	41,500	8.2	1360
VT4BE-042K	C7B(A,H)M042(C,U)-D + TXV	40,000	14.00	12.00	41,500	8.2	1360

Outdoor Unit	Indoor Unit	BTUH	SEER	EER	Heating Capacity BTUH @ 47 F	HSPF	SCFM
VT4BE-018K	B6BM-X24K-A	18,000	14.0	12.2	19,000	8.2	675
VT4BE-018K	B6BM-X24K-B	18,000	14.0	12.2	19,000	8.2	675
VT4BE-024K	B6BM-X24K-A	23,200	14.0	12.2	25,000	8.2	700
VT4BE-024K	B6BM-X24K-B	23,200	14.0	12.2	25,000	8.2	700
VT4BE-030K	B6BM-X30K-A	27,600	14.0	12.2	28,200	8.2	905
VT4BE-030K	B6BM-X30K-B	27,600	14.0	12.2	28,200	8.2	905
VT4BE-036K	B6EMMX36K-B	34,200	15.0	12.5	34,200	8.5	1270
VT4BE-042K	B6BM-X42K-B	39,000	14.0	11.0	39,000	8.2	1340
VT4BE-048K	B6BM-X60K-C	45,500	14.0	12.2	44,000	8.2	1575
VT4BE-060K	B6EMMX60K-C	58,000	14.1	11.5	60,000	8.5	1710

Outdoor Unit	Indoor Unit	BTUH	SEER	EER	Heating Capacity BTUH @ 47° F	HSPF	SCFM
VT4BE-018K	B6EMMX24K-A	17400	15.00	12.50	18900	8.50	560
VT4BE-018K	B6EMMX24K-B	18900	15.00	12.50	19900	8.50	670
VT4BE-024K	B6EMMX24K-A	22800	15.00	12.50	25400	8.50	740
VT4BE-024K	B6EMMX24K-B	23000	15.00	12.50	24800	8.50	690
VT4BE-030K	B6EMMX30K-A	28600	15.00	12.50	29400	8.50	1070
VT4BE-030K	B6EMMX30K-B	28000	15.00	12.50	28400	8.50	1030
VT4BE-036K	B6EMMX36K-B	34200	15.00	12.50	34200	8.50	1270
VT4BE-042K	B6EMMX42K-B	40000	15.00	12.50	42000	8.50	1500
VT4BE-042K	B6EMMX48K-C	40000	15.00	12.50	41000	8.50	1405
VT4BE-048K	B6EMMX48K-C	45500	15.00	12.50	46500	8.50	1660
VT4BE-060K	B6EMMX60K-C	58000	14.10	11.50	60000	8.50	1710

Outdoor Unit	Indoor Unit	BTUH	SEER	EER	Heating Capacity BTUH @ 47ºF	HSPF	SCFM
VT4BE-018K	B6VMAX24K-(A,B)	19200	15.0	12.5	18800	8.5	675
VT4BE-024K	B6VMAX24K-(A,B)	23400	15.0	12.5	24600	8.5	720
VT4BE-030K	B6VMAX30K-B	28400	15.0	12.5	29400	8.5	960
VT4BE-036K	B6VMAX36K-B	34800	15.0	12.5	33600	8.5	1125
VT4BE-042K	B6VMAX48K-C	40000	15.0	12.5	38500	8.5	1300
VT4BE-048K	B6VMAX48K-C	45500	14.0	11.7	44000	8.2	1665
VT4BE-060K	B6VMAX60K-C	59000	14.0	11.7	52500	8.2	1665

All ratings are with time delay relay.

See current AHRI Directory for certified combinations and ratings.
www.ahridirectory.org

14 SEER COOLING EXPANDED RATINGS - LOOSE COIL

VT4BE-018K C7B(A,H)M01824(C,U)-A + TXV Kit

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
525	80	62	18.7	14.8	0.99	18.0	14.6	1.13	17.2	14.7	1.26	16.4	14.4	1.41	15.52	15.18	1.56	14.58	14.26	1.74
	80	67	20.5	12.0	0.98	19.6	11.9	1.12	18.8	12.0	1.26	17.9	11.7	1.41	16.87	11.53	1.57	15.81	10.73	1.75
	80	72	22.8	9.3	0.97	21.9	9.3	1.11	20.9	9.5	1.26	19.8	9.3	1.41	18.69	9.11	1.57	17.44	9.32	1.75
	75	63	18.9	11.6	0.99	18.1	11.5	1.12	17.3	11.6	1.26	16.5	11.3	1.41	15.58	10.35	1.56	14.57	11.12	1.74
600	80	62	19.3	15.9	1.02	18.5	16.2	1.15	17.7	15.8	1.29	16.8	15.7	1.43	16.05	15.50	1.59	15.18	15.05	1.77
	80	67	21.0	12.8	1.01	20.1	13.1	1.15	19.2	12.7	1.29	18.2	12.6	1.43	17.17	12.54	1.60	16.08	12.49	1.77
	80	72	23.3	9.9	1.00	22.3	10.3	1.14	21.2	10.0	1.29	20.1	9.9	1.44	18.66	9.91	1.60	17.44	9.88	1.78
	75	63	19.4	12.3	1.02	18.6	12.6	1.15	17.7	12.2	1.29	16.8	12.1	1.43	15.86	12.00	1.59	14.83	11.91	1.77
675	80	62	19.7	17.2	1.04	18.9	17.3	1.17	18.2	16.9	1.31	17.4	16.5	1.46	16.56	16.00	1.62	15.64	15.57	1.80
	80	67	21.4	13.7	1.03	20.5	13.8	1.17	19.5	13.5	1.31	18.5	13.4	1.46	17.44	13.24	1.62	16.29	13.24	1.80
	80	72	23.7	10.6	1.02	22.6	10.8	1.17	21.2	10.5	1.31	20.1	10.4	1.47	18.90	10.29	1.63	17.65	10.33	1.81
	75	63	19.8	13.2	1.04	18.9	13.3	1.17	18.0	12.9	1.31	17.1	12.8	1.46	16.10	12.65	1.62	15.02	12.61	1.80

VT4BE-024K C7B(A,H)M01824(C,U)-B + TXV KIT

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
700	80	62	23.7	19.0	1.31	22.8	18.8	1.47	21.8	18.9	1.63	20.7	18.6	1.81	19.63	19.27	2.01	18.58	18.24	2.23
	80	67	25.7	15.3	1.31	24.7	15.1	1.47	23.6	15.3	1.64	22.4	15.0	1.82	21.19	14.69	2.02	19.87	13.86	2.24
	80	72	28.6	11.9	1.30	27.3	11.8	1.47	26.1	12.0	1.64	24.7	11.8	1.83	23.25	11.58	2.03	21.50	11.81	2.25
	75	63	23.8	14.8	1.31	22.9	14.6	1.47	21.9	14.7	1.63	20.8	14.4	1.81	19.62	13.22	2.01	18.38	14.19	2.23
800	80	62	24.3	20.4	1.35	23.3	20.8	1.50	22.3	20.4	1.67	21.3	20.0	1.85	20.34	19.66	2.05	19.24	19.07	2.27
	80	67	26.3	16.2	1.34	25.2	16.7	1.50	24.1	16.2	1.67	22.8	16.0	1.86	21.54	15.97	2.05	20.17	15.90	2.28
	80	72	29.1	12.5	1.34	27.8	13.1	1.51	26.3	12.7	1.69	24.7	12.5	1.87	23.33	12.52	2.07	21.82	12.50	2.29
	75	63	24.3	15.7	1.35	23.3	16.0	1.50	22.3	15.6	1.67	21.1	15.4	1.85	19.93	15.29	2.05	18.65	15.18	2.27
900	80	62	24.8	22.1	1.38	23.9	22.2	1.54	23.0	21.5	1.71	22.0	20.9	1.89	20.93	20.23	2.09	19.76	19.68	2.31
	80	67	26.8	17.4	1.38	25.6	17.6	1.54	24.4	17.1	1.71	23.2	17.0	1.89	21.81	16.85	2.09	20.44	16.87	2.31
	80	72	29.1	13.4	1.38	27.8	13.6	1.55	26.5	13.2	1.72	25.1	13.1	1.90	23.61	13.00	2.10	22.05	13.06	2.33
	75	63	24.8	16.8	1.38	23.7	16.9	1.54	22.6	16.4	1.71	21.4	16.3	1.89	20.22	16.12	2.08	18.92	16.44	2.31

VT4BE-030K C7B(A,H)M03036(C,U)-A + TXV Kit

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
875	80	62	28.9	22.2	1.71	27.9	22.8	1.87	26.7	22.9	2.06	25.5	22.6	2.27	24.20	23.69	2.51	22.90	22.42	2.78
	80	67	31.7	18.4	1.72	30.4	18.2	1.88	29.1	18.4	2.07	27.8	18.1	2.27	26.33	17.83	2.51	24.77	16.71	2.79
	80	72	34.9	14.2	1.72	33.5	14.2	1.89	32.1	14.5	2.07	30.6	14.2	2.28	29.01	14.00	2.52	27.29	14.38	2.80
	75	63	29.3	17.8	1.71	28.2	17.7	1.88	27.0	17.8	2.06	25.7	17.5	2.27	24.37	16.08	2.51	22.84	17.29	2.78
1000	80	62	29.7	24.7	1.76	28.6	25.2	1.92	27.4	24.7	2.11	26.1	24.5	2.32	25.15	24.30	2.56	23.86	23.66	2.83
	80	67	32.4	19.5	1.76	31.0	20.1	1.93	29.7	19.6	2.12	28.3	19.4	2.32	26.79	19.40	2.56	25.15	19.39	2.84
	80	72	35.6	15.0	1.77	34.2	15.7	1.93	32.7	15.2	2.12	31.1	15.1	2.33	29.45	15.24	2.57	27.65	15.37	2.84
	75	63	30.0	18.9	1.76	28.8	19.4	1.92	27.5	18.9	2.11	26.2	18.6	2.32	24.78	18.59	2.56	23.23	18.52	2.83
1125	80	62	30.4	26.8	1.81	29.2	27.0	1.97	28.3	26.3	2.16	27.2	25.8	2.37	25.92	25.04	2.61	24.55	24.45	2.88
	80	67	32.9	20.9	1.81	31.6	21.2	1.98	30.2	20.7	2.16	28.7	20.6	2.37	27.15	20.47	2.61	25.47	20.57	2.89
	80	72	36.2	16.0	1.82	34.7	16.4	1.98	33.1	15.9	2.16	31.5	16.0	2.37	29.71	15.97	2.61	27.82	16.17	2.89
	75	63	30.5	20.2	1.81	29.3	20.4	1.97	28.0	19.9	2.15	26.6	19.8	2.36	25.12	19.59	2.61	23.53	19.60	2.88

VT4BE-036K C7B(A,H)M03648(C,U)-C + TXV Kit

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
1050	80	62	35.6	28.2	2.02	34.2	28.0	2.24	32.8	28.1	2.47	31.2	27.5	2.73	29.55	28.69	3.03	27.86	27.05	3.36
	80	67	38.7	23.2	2.03	37.2	23.1	2.25	35.6	23.3	2.49	33.9	22.8	2.75	32.05	22.43	3.04	30.12	20.95	3.38
	80	72	42.6	18.0	2.05	40.8	17.9	2.27	38.9	18.3	2.51	36.8	17.9	2.77	34.58	17.59	3.06	32.51	17.93	3.39
	75	63	36.0	22.5	2.02	34.5	22.3	2.24	33.0	22.4	2.48	31.5	22.0	2.73	29.77	20.24	3.03	27.95	21.70	3.36
1200	80	62	36.4	30.2	2.08	35.0	30.7	2.30	33.4	29.9	2.53	31.8	29.5	2.79	30.22	29.06	3.09	28.60	28.36	3.42
	80	67	39.5	24.7	2.09	37.9	25.4	2.31	36.2	24.7	2.55	34.4	24.4	2.81	32.55	24.37	3.10	30.58	24.29	3.44
	80	72	42.8	19.0	2.11	40.9	19.8	2.33	39.1	19.2	2.57	37.2	18.9	2.83	35.14	18.97	3.12	32.97	18.99	3.45
	75	63	36.7	23.9	2.08	35.2	24.4	2.30	33.6	23.8	2.54	32.0	23.5	2.79	30.20	23.35	3.09	28.36	23.21	3.42
1350	80	62	37.0	32.3	2.14	35.6	32.4	2.36	34.0	31.5	2.59	32.5	30.9	2.85	30.98	29.93	3.15	29.33	29.20	3.49
	80	67	40.1	26.5	2.15	38.5	26.7	2.37	36.7	26.1	2.61	34.9	25.9	2.87	32.91	25.71	3.16	30.89	25.64	3.50
	80	72	43.3	20.2	2.17	41.5	20.6	2.39	39.6	19.9	2.64	37.6	19.9	2.89	35.52	19.72	3.18	33.28	19.86	3.51
	75	63	37.3	25.5	2.14	35.7	25.7	2.36	34.1	25.0	2.59	32.4	24.9	2.85	30.54	24.57	3.14	28.61	24.43	3.48

14 SEER COOLING EXPANDED RATINGS - LOOSE COIL (CONTINUED)

VT4BE-042K C7B(A,H)M03642(C,U)-B + TXV Kit

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
1225	80	62	41.6	32.4	2.40	40.1	32.1	2.63	38.4	32.3	2.90	36.6	31.6	3.21	34.66	33.05	3.55	32.68	31.16	3.94
	80	67	45.1	26.7	2.41	43.4	26.5	2.65	41.5	26.8	2.92	39.6	26.2	3.23	37.49	25.78	3.58	35.31	24.12	3.97
	80	72	49.6	20.9	2.44	47.5	20.8	2.68	45.2	21.2	2.95	42.6	20.7	3.26	40.36	20.33	3.61	37.98	20.73	4.01
	75	63	42.0	26.0	2.40	40.4	25.7	2.63	38.7	25.9	2.90	36.8	25.3	3.21	34.84	23.36	3.56	32.80	25.01	3.94
1400	80	62	42.5	34.6	2.47	40.8	35.2	2.70	39.2	34.4	2.97	37.3	33.8	3.28	35.34	33.55	3.63	33.33	33.05	4.01
	80	67	46.0	28.3	2.48	44.2	29.1	2.72	42.3	28.3	2.99	40.3	28.0	3.30	38.11	27.94	3.65	35.84	27.87	4.04
	80	72	49.6	21.9	2.50	47.6	22.8	2.75	45.5	22.1	3.02	43.3	21.8	3.33	40.95	21.86	3.69	38.48	21.88	4.08
	75	63	42.8	27.4	2.47	41.2	28.1	2.70	39.4	27.3	2.97	37.5	26.9	3.28	35.45	26.81	3.63	33.31	26.66	4.01
1575	80	62	43.2	37.0	2.53	41.5	37.1	2.77	39.8	36.2	3.04	37.9	35.7	3.35	36.03	34.81	3.70	34.17	34.02	4.09
	80	67	46.8	30.3	2.55	44.9	30.6	2.79	42.9	29.8	3.06	40.7	29.7	3.38	38.57	29.39	3.72	36.25	29.42	4.11
	80	72	50.3	23.3	2.57	48.3	23.7	2.82	46.1	22.9	3.09	43.8	22.8	3.41	41.38	22.64	3.76	38.83	22.78	4.14
	75	63	43.5	29.2	2.54	41.8	29.5	2.77	39.9	28.7	3.04	37.9	28.5	3.35	35.85	28.12	3.70	33.63	28.10	4.08

VT4BE-048K C7B(A,H)M048(C,U)-C + TXV Kit + VSB

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
1400	80	62	47.2	37.4	2.59	45.4	37.1	2.84	43.5	37.3	3.14	41.4	36.6	3.48	39.16	38.15	3.87	36.92	35.97	4.29
	80	67	51.6	30.8	2.61	49.5	30.6	2.88	47.4	30.9	3.17	45.1	30.3	3.51	42.62	29.89	3.89	40.07	27.91	4.32
	80	72	56.5	23.6	2.65	54.2	23.5	2.90	51.8	24.0	3.20	49.3	23.5	3.54	46.61	23.22	3.92	43.79	23.82	4.35
	75	63	47.9	29.9	2.59	46.1	29.6	2.85	44.0	29.9	3.15	41.9	29.3	3.49	39.65	27.05	3.87	37.25	29.08	4.29
1600	80	62	48.3	40.0	2.64	46.4	40.8	2.90	44.4	39.8	3.20	42.3	39.2	3.54	40.08	38.72	3.92	38.05	37.73	4.35
	80	67	52.6	32.8	2.67	50.5	33.7	2.93	48.2	32.9	3.22	45.9	32.6	3.56	43.32	32.62	3.94	40.68	32.63	4.37
	80	72	57.6	24.9	2.70	55.2	26.1	2.95	52.7	25.3	3.25	50.0	25.1	3.59	47.18	25.30	3.97	44.32	25.46	4.40
	75	63	48.9	31.7	2.64	47.0	32.5	2.90	44.9	31.7	3.20	42.6	31.4	3.54	40.27	31.30	3.92	37.79	31.23	4.34
1800	80	62	49.2	42.9	2.69	47.3	43.1	2.95	45.3	41.8	3.25	43.2	41.1	3.59	41.23	39.84	3.97	39.10	38.93	4.41
	80	67	53.5	35.2	2.72	51.3	35.7	2.98	48.9	34.8	3.27	46.5	34.7	3.61	43.87	34.53	3.99	41.15	34.53	4.42
	80	72	58.4	26.7	2.75	55.9	27.3	3.00	53.3	26.5	3.30	50.6	26.6	3.64	47.77	26.48	4.02	44.82	26.82	4.45
	75	63	49.7	34.0	2.69	47.7	34.4	2.95	45.5	33.5	3.25	43.2	33.4	3.59	40.79	33.07	3.97	38.23	32.96	4.39

VT4BE-060K with C6BH-X60C-C + VSB

ODT			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
1460	80	62	58.4	46.7	3.93	55.8	45.8	4.35	53.2	45.0	4.82	50.3	44.4	5.36	47.0	42.7	5.97
	80	67	63.4	40.5	3.98	60.6	39.4	4.41	57.8	38.2	4.89	54.6	36.8	5.42	51.0	35.4	6.03
	80	72	69.5	33.1	4.06	66.4	32.0	4.50	63.1	30.8	4.97	59.6	29.6	5.50	55.5	28.2	6.11
	75	63	58.1	40.5	3.94	55.6	39.3	4.36	53.0	38.1	4.82	50.1	36.5	5.36	46.8	35.0	5.96
1660	80	62	60.1	50.0	3.96	57.4	49.0	4.37	54.7	48.2	4.84	51.7	48.2	5.38	48.3	46.4	5.99
	80	67	65.2	43.1	4.02	62.2	41.9	4.43	59.0	40.7	4.91	55.9	39.0	5.44	52.2	37.5	6.05
	80	72	71.0	34.8	4.10	67.7	33.6	4.52	64.3	32.5	4.98	60.4	31.2	5.52	56.3	29.7	6.12
	75	63	59.8	42.7	3.96	57.1	41.5	4.37	54.4	40.3	4.84	51.3	38.9	5.38	47.9	37.4	5.98
1860	80	62	61.4	53.9	4.01	58.8	52.6	4.39	56.0	52.0	4.86	52.9	51.0	5.40	49.5	48.7	6.00
	80	67	66.7	45.1	4.05	63.6	43.9	4.45	60.5	42.7	4.93	57.0	41.2	5.46	53.1	39.7	6.06
	80	72	72.0	36.4	4.13	68.6	35.2	4.54	65.2	34.0	5.01	61.4	32.6	5.54	57.2	31.1	6.14
	75	63	61.3	45.1	3.99	58.5	43.9	4.39	55.5	42.6	4.86	52.3	41.2	5.40	48.8	39.6	6.00

14 SEER HEATING EXPANDED RATINGS - LOOSE COIL

VT4BE-018K / C7B(A,H)M01824(C,U)-A + TXV Kit

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
565	60	10.6	2.35	1.32	12.6	2.69	1.38	13.5	2.83	1.40	16.4	3.27	1.47	19.3	3.66	1.55	21.4	3.91	1.60	22.3	4.01	1.63	25.2	4.34	1.70
	70	10.0	2.37	1.24	11.9	2.66	1.32	12.7	2.77	1.35	15.4	3.11	1.45	18.1	3.40	1.56	19.9	3.58	1.63	20.7	3.65	1.67	23.4	3.88	1.77
	80	9.5	2.35	1.18	11.2	2.58	1.27	11.9	2.68	1.30	14.3	2.95	1.42	16.7	3.17	1.55	18.4	3.31	1.63	19.2	3.37	1.67	21.6	3.54	1.79
665	60	10.6	2.28	1.37	12.7	2.63	1.42	13.6	2.77	1.44	16.6	3.22	1.51	19.6	3.62	1.59	21.7	3.88	1.64	22.6	3.98	1.66	25.5	4.32	1.74
	70	10.2	2.30	1.29	12.1	2.59	1.37	12.9	2.71	1.40	15.6	3.05	1.50	18.3	3.36	1.60	20.2	3.55	1.67	21.1	3.62	1.70	23.8	3.86	1.81
	80	9.6	2.30	1.22	11.3	2.54	1.31	12.1	2.63	1.35	14.6	2.90	1.47	17.1	3.13	1.60	18.8	3.28	1.68	19.6	3.33	1.72	22.0	3.50	1.85
765	60	10.8	2.24	1.41	12.9	2.59	1.46	13.8	2.73	1.48	16.8	3.18	1.55	19.8	3.59	1.62	21.9	3.85	1.67	22.8	3.96	1.69	25.8	4.31	1.76
	70	10.3	2.26	1.33	12.2	2.55	1.40	13.0	2.67	1.43	15.8	3.02	1.53	18.6	3.33	1.64	20.5	3.53	1.71	21.4	3.61	1.74	24.1	3.85	1.84
	80	9.7	2.25	1.26	11.5	2.49	1.35	12.2	2.58	1.39	14.7	2.85	1.51	17.2	3.08	1.64	19.0	3.22	1.73	19.7	3.28	1.77	22.3	3.45	1.89

VT4BE-024K / C7B(A,H)M01824(C,U)-B + TXV Kit

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
730	60	13.0	2.43	1.58	15.7	2.79	1.65	16.9	2.94	1.69	20.7	3.38	1.80	24.6	3.78	1.91	27.3	4.03	1.99	28.4	4.13	2.02	32.3	4.45	2.13
	70	12.5	2.38	1.53	15.0	2.69	1.63	16.1	2.82	1.67	19.7	3.18	1.81	23.3	3.50	1.95	25.8	3.69	2.05	26.9	3.77	2.09	30.5	4.01	2.23
	80	11.9	2.30	1.51	14.2	2.57	1.62	15.2	2.68	1.67	18.6	2.99	1.83	22.0	3.25	1.99	24.4	3.41	2.10	25.4	3.48	2.14	28.8	3.67	2.30
830	60	13.1	2.38	1.62	15.8	2.74	1.69	17.0	2.89	1.72	20.9	3.35	1.83	24.8	3.75	1.94	27.6	4.01	2.02	28.8	4.12	2.05	32.7	4.44	2.16
	70	12.6	2.33	1.58	15.1	2.65	1.68	16.2	2.77	1.72	19.9	3.15	1.85	23.6	3.48	1.99	26.1	3.68	2.08	27.2	3.76	2.12	30.9	4.01	2.26
	80	12.0	2.26	1.55	14.4	2.54	1.66	15.4	2.65	1.71	18.9	2.96	1.87	22.3	3.23	2.03	24.7	3.40	2.14	25.8	3.46	2.18	29.2	3.66	2.34
930	60	13.2	2.33	1.66	16.0	2.70	1.73	17.2	2.85	1.76	21.1	3.32	1.87	25.1	3.73	1.97	27.8	4.00	2.04	29.0	4.10	2.07	33.0	4.44	2.18
	70	12.7	2.30	1.62	15.3	2.62	1.71	16.4	2.74	1.75	20.1	3.13	1.89	23.8	3.46	2.02	26.4	3.67	2.11	27.6	3.75	2.15	31.3	4.01	2.29
	80	12.1	2.23	1.59	14.5	2.50	1.70	15.6	2.61	1.75	19.0	2.93	1.91	22.5	3.20	2.06	24.9	3.37	2.17	26.0	3.43	2.22	29.4	3.63	2.37

VT4BE-030K / C7B(A,H)M03036(C,U)-A + TXV Kit

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
890	60	16.1	2.59	1.82	18.9	2.90	1.91	20.0	3.02	1.95	24.0	3.40	2.07	27.9	3.73	2.20	30.7	3.94	2.28	31.9	4.03	2.32	35.8	4.30	2.44
	70	15.5	2.49	1.82	18.1	2.75	1.93	19.2	2.85	1.97	22.9	3.17	2.12	26.6	3.44	2.27	29.2	3.61	2.38	30.4	3.68	2.42	34.1	3.89	2.57
	80	14.9	2.38	1.84	17.3	2.60	1.96	18.4	2.69	2.01	21.9	2.95	2.17	25.4	3.18	2.34	27.8	3.32	2.46	28.8	3.38	2.51	32.3	3.55	2.67
990	60	16.2	2.54	1.86	19.0	2.86	1.95	20.2	2.98	1.98	24.2	3.37	2.10	28.2	3.72	2.22	31.0	3.94	2.31	32.2	4.03	2.34	36.2	4.31	2.47
	70	15.6	2.45	1.87	18.2	2.72	1.97	19.4	2.82	2.01	23.1	3.15	2.16	26.9	3.43	2.30	29.5	3.61	2.40	30.7	3.68	2.45	34.5	3.90	2.59
	80	15.0	2.34	1.88	17.5	2.57	1.99	18.5	2.66	2.04	22.1	2.94	2.21	25.7	3.17	2.37	28.2	3.32	2.49	29.2	3.38	2.54	32.8	3.56	2.70
1090	60	16.2	2.50	1.90	19.1	2.82	1.99	20.3	2.95	2.02	24.4	3.34	2.14	28.4	3.70	2.25	31.3	3.93	2.33	32.5	4.02	2.37	36.5	4.31	2.48
	70	15.7	2.42	1.90	18.4	2.70	2.00	19.5	2.80	2.04	23.4	3.13	2.19	27.2	3.42	2.33	29.8	3.61	2.43	31.0	3.68	2.47	34.8	3.91	2.61
	80	15.1	2.32	1.91	17.6	2.55	2.03	18.7	2.64	2.08	22.3	2.92	2.24	25.9	3.16	2.40	28.4	3.30	2.52	29.4	3.36	2.57	33.0	3.55	2.73

VT4BE-036K / C7B(A,H)M03648(C,U)-C + TXV Kit

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
1065	60	19.6	2.62	2.19	22.9	2.95	2.28	24.3	3.08	2.31	29.1	3.50	2.44	33.8	3.87	2.56	37.1	4.12	2.64	38.5	4.21	2.68	43.2	4.53	2.80
	70	18.9	2.47	2.25	22.1	2.76	2.35	23.4	2.88	2.39	28.0	3.24	2.53	32.5	3.57	2.67	35.6	3.78	2.77	37.0	3.86	2.81	41.5	4.13	2.95
	80	18.3	2.32	2.32	21.4	2.58	2.43	22.6	2.68	2.47	26.9	3.00	2.63	31.2	3.29	2.78	34.2	3.47	2.89	35.5	3.55	2.94	39.8	3.78	3.09
1215	60	19.8	2.58	2.24	23.1	2.92	2.33	24.6	3.05	2.36	29.4	3.48	2.48	34.2	3.87	2.59	37.6	4.12	2.67	39.0	4.23	2.71	43.8	4.55	2.82
	70	19.1	2.43	2.30	22.3	2.73	2.40	23.7	2.85	2.44	28.3	3.23	2.57	32.9	3.57	2.70	36.1	3.78	2.80	37.5	3.87	2.84	42.1	4.15	2.97
	80	18.5	2.29	2.37	21.6	2.55	2.48	22.9	2.66	2.52	27.3	2.99	2.67	31.7	3.29	2.82	34.7	3.48	2.93	36.1	3.56	2.97	40.4	3.80	3.12
1365	60	19.8	2.54	2.29	23.3	2.88	2.37	24.7	3.02	2.40	29.7	3.46	2.52	34.6	3.86	2.63	38.0	4.12	2.71	39.5	4.22	2.74	44.4	4.56	2.85
	70	19.3	2.41	2.35	22.6	2.71	2.44	24.0	2.84	2.48	28.6	3.22	2.61	33.3	3.56	2.74	36.6	3.79	2.83	38.0	3.88	2.87	42.6	4.17	3.00
	80	18.7	2.26	2.42	21.8	2.53	2.53	23.1	2.64	2.57	27.6	2.98	2.71	32.0	3.28	2.86	35.1	3.48	2.96	36.4	3.56	3.00	40.9	3.81	3.15

14 SEER HEATING EXPANDED RATINGS - LOOSE COIL (CONTINUED)

VT4BE-042K / C7B(A,H)M03642(C,U)-B + TXV Kit

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
1215	60	23.3	2.83	2.42	27.0	3.05	2.60	28.6	3.14	2.67	33.9	3.38	2.93	39.1	3.59	3.19	42.8	3.72	3.37	44.4	3.77	3.45	49.6	3.92	3.71
	70	22.6	2.64	2.51	26.1	2.83	2.71	27.6	2.90	2.80	32.7	3.11	3.08	37.8	3.29	3.37	41.4	3.40	3.57	42.9	3.44	3.65	48.0	3.57	3.94
	80	22.0	2.47	2.62	25.4	2.63	2.84	26.9	2.69	2.93	31.7	2.87	3.25	36.6	3.01	3.56	40.0	3.10	3.78	41.4	3.14	3.87	46.3	3.24	4.18
1365	60	23.5	2.80	2.46	27.3	3.03	2.64	28.9	3.12	2.71	34.2	3.38	2.96	39.6	3.61	3.21	43.3	3.75	3.39	44.9	3.80	3.46	50.2	3.97	3.71
	70	22.8	2.61	2.56	26.4	2.81	2.75	27.9	2.89	2.83	33.1	3.12	3.11	38.2	3.31	3.38	41.8	3.43	3.58	43.4	3.47	3.66	48.5	3.62	3.93
	80	22.2	2.43	2.67	25.6	2.61	2.88	27.1	2.68	2.97	32.1	2.87	3.27	37.0	3.04	3.57	40.5	3.14	3.78	41.9	3.18	3.87	46.9	3.29	4.17
1515	60	23.5	2.75	2.51	27.4	2.99	2.68	29.0	3.09	2.75	34.5	3.37	3.00	39.9	3.61	3.24	43.7	3.76	3.41	45.4	3.81	3.49	50.8	3.99	3.73
	70	23.0	2.59	2.61	26.7	2.80	2.79	28.2	2.88	2.87	33.4	3.12	3.14	38.6	3.32	3.41	42.3	3.45	3.59	43.8	3.50	3.68	49.0	3.65	3.94
	80	22.4	2.41	2.72	25.9	2.60	2.92	27.4	2.67	3.01	32.4	2.87	3.30	37.3	3.05	3.59	40.8	3.16	3.80	42.3	3.20	3.88	47.3	3.32	4.17

VT4BE-048K / C7B(A,H)M048(C,U)-C + TXV Kit + VSB

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
1430	60	24.5	2.75	2.62	28.8	3.06	2.76	30.6	3.19	2.82	36.7	3.57	3.02	42.8	3.90	3.22	47.1	4.11	3.36	48.9	4.20	3.42	55.1	4.46	3.62
	70	23.7	2.54	2.74	27.9	2.82	2.89	29.6	2.94	2.96	35.6	3.28	3.18	41.5	3.58	3.40	45.7	3.77	3.55	47.4	3.85	3.62	53.4	4.08	3.84
	80	23.2	2.36	2.88	27.2	2.62	3.05	28.9	2.72	3.12	34.6	3.02	3.36	40.3	3.29	3.59	44.3	3.46	3.76	46.0	3.52	3.83	51.7	3.73	4.07
1630	60	24.8	2.72	2.67	29.1	3.04	2.81	31.0	3.17	2.86	37.2	3.57	3.05	43.4	3.93	3.24	47.8	4.15	3.38	49.6	4.24	3.43	55.9	4.52	3.62
	70	24.0	2.52	2.80	28.2	2.81	2.94	30.0	2.93	3.01	36.1	3.29	3.21	42.1	3.61	3.42	46.3	3.81	3.57	48.1	3.89	3.63	54.1	4.14	3.84
	80	23.4	2.33	2.94	27.5	2.60	3.10	29.2	2.71	3.17	35.1	3.03	3.39	40.9	3.32	3.61	45.0	3.50	3.77	46.7	3.57	3.84	52.5	3.79	4.06
1830	60	24.9	2.67	2.73	29.3	3.01	2.86	31.2	3.14	2.91	37.6	3.56	3.10	43.9	3.93	3.28	48.4	4.16	3.41	50.3	4.26	3.46	56.6	4.55	3.65
	70	24.3	2.50	2.86	28.6	2.80	2.99	30.4	2.92	3.05	36.5	3.29	3.25	42.6	3.62	3.45	46.9	3.83	3.59	48.7	3.92	3.65	54.8	4.18	3.85
	80	23.7	2.31	3.00	27.8	2.59	3.15	29.6	2.70	3.21	35.5	3.03	3.43	41.4	3.33	3.64	45.5	3.52	3.79	47.3	3.60	3.85	53.2	3.83	4.07

VT4BE-060K with C6BH-X60C-C + VSB

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
1450	60	32.8	2.65	3.62	36.8	2.87	3.76	38.6	2.96	3.82	44.4	3.24	4.02	50.2	3.49	4.21	54.3	3.66	4.35	56.1	3.73	4.41	61.9	3.94	4.61
	70	31.8	2.39	3.89	35.8	2.60	4.04	37.5	2.68	4.10	43.2	2.95	4.30	48.9	3.19	4.50	52.9	3.34	4.64	54.6	3.41	4.70	60.3	3.61	4.90
	80	31.3	2.19	4.19	35.2	2.38	4.34	36.8	2.45	4.40	42.3	2.69	4.61	47.7	2.90	4.82	51.5	3.05	4.96	53.2	3.10	5.03	58.6	3.29	5.23
1650	60	33.1	2.65	3.65	37.2	2.88	3.78	39.0	2.98	3.84	44.9	3.27	4.02	50.8	3.54	4.21	55.0	3.72	4.34	56.8	3.79	4.40	62.7	4.01	4.58
	70	32.2	2.41	3.92	36.2	2.62	4.05	37.9	2.71	4.11	43.7	2.98	4.30	49.5	3.24	4.48	53.5	3.40	4.61	55.2	3.47	4.67	61.0	3.68	4.86
	80	31.5	2.19	4.22	35.5	2.39	4.36	37.1	2.47	4.41	42.7	2.72	4.61	48.3	2.95	4.80	52.2	3.11	4.93	53.9	3.17	4.99	59.4	3.37	5.18
1850	60	33.1	2.63	3.69	37.3	2.87	3.81	39.1	2.97	3.87	45.2	3.28	4.05	51.3	3.56	4.23	55.6	3.74	4.36	57.4	3.82	4.41	63.5	4.06	4.59
	70	32.5	2.41	3.96	36.6	2.63	4.09	38.4	2.72	4.14	44.2	3.00	4.32	50.0	3.27	4.49	54.1	3.44	4.61	55.8	3.51	4.67	61.7	3.73	4.84
	80	31.9	2.19	4.26	35.8	2.40	4.38	37.5	2.48	4.44	43.1	2.74	4.61	48.8	2.99	4.79	52.7	3.15	4.91	54.4	3.21	4.97	60.1	3.43	5.14

14 SEER COOLING EXPANDED RATINGS

VT4BE-018K with B6BM-X24K-(A,B)

O.D.T			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
600	80	62	19.3	17.3	1.24	18.4	16.9	1.37	17.5	16.6	1.53	16.6	16.3	1.71	15.6	15.4	1.91
	80	67	20.9	14.4	1.24	20.0	14.0	1.37	19.0	13.6	1.53	17.8	13.2	1.71	16.6	12.7	1.91
	80	72	22.7	11.4	1.24	21.7	11.1	1.37	20.6	10.7	1.53	19.3	10.2	1.71	18.1	9.8	1.91
	75	63	19.0	14.6	1.24	18.2	14.1	1.37	17.3	13.7	1.53	16.3	13.3	1.71	15.2	12.8	1.91
700	80	62	20.0	18.7	1.24	19.1	18.4	1.37	18.1	17.7	1.53	17.3	17.3	1.71	16.3	16.3	1.91
	80	67	21.5	15.6	1.24	20.5	15.2	1.37	18.7	14.8	1.53	18.3	14.3	1.71	17.0	13.8	1.91
	80	72	23.3	12.2	1.24	22.2	11.8	1.37	21.0	11.4	1.53	19.8	11.0	1.72	18.4	10.5	1.92
	75	63	19.6	15.8	1.25	18.8	15.4	1.37	17.8	14.9	1.53	16.7	14.4	1.71	15.5	13.9	1.91
800	80	62	20.7	19.7	1.25	19.9	19.3	1.37	19.0	18.7	1.53	18.0	18.0	1.71	16.9	16.9	1.91
	80	67	21.9	16.8	1.25	20.9	16.4	1.37	19.8	15.9	1.53	18.6	15.5	1.71	17.3	14.9	1.91
	80	72	23.7	13.0	1.24	22.6	12.5	1.37	21.4	12.1	1.54	20.1	11.7	1.72	18.7	11.2	1.92
	75	63	20.1	17.0	1.25	19.2	16.5	1.37	18.2	16.1	1.53	17.1	15.5	1.71	15.9	14.9	1.91

VT4BE-024K with B6BM-X24K-(A,B)

O.D.T			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
600	80	62	22.9	18.8	1.48	21.9	18.4	1.63	20.9	18.1	1.83	19.7	17.9	2.04	18.5	17.2	2.29
	80	67	24.9	15.7	1.48	23.7	15.3	1.63	22.6	14.8	1.83	21.4	14.3	2.05	20.0	13.8	2.29
	80	72	27.3	12.7	1.48	26.1	12.2	1.64	24.8	11.8	1.84	23.3	11.3	2.06	21.7	10.8	2.30
	75	63	22.8	16.1	1.48	21.8	15.7	1.64	20.7	15.1	1.83	19.6	14.6	2.04	18.3	14.0	2.29
700	80	62	23.7	20.5	1.48	22.6	20.0	1.63	21.6	19.7	1.83	20.4	19.7	2.04	19.1	18.9	2.29
	80	67	25.7	16.9	1.48	24.5	16.5	1.63	23.2	16.0	1.83	22.0	15.4	2.05	20.6	14.9	2.29
	80	72	27.8	13.5	1.48	26.5	13.0	1.64	25.2	12.6	1.83	23.8	12.1	2.06	22.2	11.5	2.30
	75	63	23.5	17.3	1.48	22.4	16.8	1.64	21.4	16.3	1.83	20.2	15.8	2.04	18.8	15.2	2.29
800	80	62	24.3	22.3	1.49	23.3	21.8	1.63	22.2	21.5	1.83	21.0	21.0	2.05	19.8	19.8	2.29
	80	67	26.3	18.1	1.49	25.1	17.6	1.64	23.8	17.1	1.83	22.5	16.6	2.05	21.0	16.0	2.29
	80	72	28.4	14.2	1.49	27.0	13.7	1.64	25.7	13.3	1.84	24.3	12.8	2.06	22.6	12.2	2.31
	75	63	24.1	18.5	1.49	23.0	18.0	1.64	21.9	17.5	1.83	20.6	16.9	2.05	19.3	16.3	2.29

VT4BE-030K with B6BM-X30K-(A,B)

O.D.T			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
830	80	62	27.8	24.3	1.81	26.6	23.9	2.00	25.4	23.5	2.22	24.0	23.2	2.47	22.5	22.2	2.76
	80	67	30.1	20.7	1.80	28.8	20.1	2.00	27.5	19.6	2.22	26.0	19.0	2.47	24.3	18.3	2.75
	80	72	30.1	20.8	1.80	28.8	20.1	2.00	27.5	19.6	2.22	26.0	19.0	2.47	24.3	18.3	2.75
	75	63	27.6	20.7	1.81	26.4	20.1	2.01	25.1	19.5	2.23	23.7	18.9	2.47	22.1	18.2	2.76
930	80	62	28.6	25.9	1.81	27.3	25.4	2.00	26.1	24.9	2.22	24.7	24.7	2.47	23.3	23.3	2.76
	80	67	30.8	22.0	1.81	29.4	21.4	2.00	28.0	20.8	2.22	26.4	20.2	2.47	24.7	19.5	2.75
	80	72	30.8	22.1	1.81	29.4	21.4	2.00	28.0	20.8	2.22	26.4	20.2	2.47	24.7	19.5	2.75
	75	63	28.2	21.9	1.82	27.0	21.3	2.00	25.7	20.7	2.22	24.2	20.1	2.47	22.6	19.4	2.76
1030	80	62	29.1	27.7	1.83	27.9	27.0	2.00	26.7	26.3	2.22	25.4	25.4	2.47	24.0	24.0	2.75
	80	67	31.3	23.2	1.82	29.9	22.6	2.00	28.4	22.0	2.22	26.9	21.4	2.47	25.1	20.7	2.75
	80	72	31.4	23.3	1.82	29.9	22.6	2.00	28.4	22.0	2.22	26.9	21.4	2.47	25.1	20.7	2.75
	75	63	28.8	23.1	1.82	27.4	22.5	2.00	26.1	21.9	2.22	24.6	21.3	2.47	22.9	20.5	2.76

VT4BE-036K B6EMMX36K-C

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
1050	80	62	35.2	28.5	1.89	33.9	28.3	2.12	32.5	28.4	2.37	31.0	27.9	2.65	29.42	28.89	2.97	27.79	27.29	3.33
	80	67	38.3	23.4	1.90	36.7	23.3	2.15	35.1	23.5	2.39	33.5	23.1	2.67	31.74	22.71	2.99	29.87	21.38	3.35
	80	72	42.0	18.0	1.93	40.2	18.0	2.17	38.3	18.3	2.42	36.2	18.0	2.70	34.29	17.65	3.01	32.24	18.02	3.37
	75	63	35.5	22.7	1.89	34.1	22.5	2.12	32.7	22.7	2.37	31.1	22.2	2.65	29.52	20.52	2.97	27.73	22.04	3.33
1200	80	62	36.1	30.6	1.91	34.7	31.1	2.15	33.3	30.3	2.40	31.8	29.8	2.68	30.29	29.26	3.00	28.75	28.50	3.36
	80	67	39.0	25.0	1.92	37.5	25.7	2.17	35.8	25.0	2.42	34.1	24.8	2.70	32.30	24.72	3.01	30.36	24.69	3.38
	80	72	42.3	19.1	1.95	40.6	19.9	2.19	38.8	19.3	2.44	36.9	19.1	2.72	34.88	19.13	3.04	32.77	19.18	3.40
	75	63	36.3	24.2	1.91	34.8	24.7	2.15	33.3	24.1	2.40	31.7	23.8	2.68	30.02	23.70	3.00	28.23	23.60	3.35
1350	80	62	36.9	32.8	1.94	35.5	32.8	2.17	34.1	31.8	2.43	32.7	31.0	2.71	31.17	30.11	3.03	29.55	29.42	3.38
	80	67	39.7	26.9	1.95	38.1	27.2	2.19	36.4	26.6	2.44	34.6	26.4	2.72	32.76	26.18	3.04	30.76	26.25	3.40
	80	72	43.0	20.4	1.98	41.2	20.7	2.22	39.3	20.1	2.47	37.4	20.1	2.75	35.32	19.97	3.06	33.14	20.15	3.42
	75	63	36.9	25.9	1.94	35.4	26.2	2.17	33.9	25.4	2.42	32.2	25.3	2.70	30.47	25.04	3.02	28.58	25.03	3.38

14 SEER COOLING EXPANDED RATINGS (CONTINUED)

VT4BE-042K with B6BM-X42K-B

O.D.T			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
1140	80	62	38.7	33.0	2.57	37.0	32.3	2.85	35.3	31.8	3.15	33.4	31.4	3.49	31.4	30.2	3.88
	80	67	42.0	28.7	2.59	40.1	27.9	2.86	38.3	27.0	3.17	36.2	26.1	3.51	33.9	25.1	3.90
	80	72	45.8	23.2	2.60	43.7	22.4	2.88	41.6	21.7	3.19	39.2	20.8	3.54	36.7	19.9	3.93
	75	63	38.4	28.1	2.58	36.8	27.3	2.85	35.1	26.5	3.15	33.1	25.6	3.50	31.0	24.7	3.88
1340	80	62	40.1	35.9	2.59	38.3	35.2	2.85	36.5	34.5	3.16	34.7	34.3	3.50	32.6	32.6	3.89
	80	67	43.3	30.9	2.60	41.3	30.1	2.87	39.0	29.3	3.18	37.1	28.3	3.52	34.7	27.3	3.91
	80	72	46.8	24.7	2.62	44.7	23.9	2.89	42.5	23.1	3.20	40.2	22.3	3.55	37.5	21.3	3.94
	75	63	39.7	30.4	2.59	37.9	29.6	2.86	36.1	28.8	3.16	34.0	27.9	3.50	31.8	26.9	3.89
1540	80	62	41.4	38.7	2.61	39.6	37.7	2.86	37.7	37.1	3.16	35.9	35.8	3.51	33.8	33.8	3.90
	80	67	44.3	33.2	2.62	42.3	32.3	2.87	40.2	31.4	3.18	37.9	30.5	3.53	35.4	29.4	3.91
	80	72	47.8	26.2	2.63	45.5	25.4	2.89	43.3	24.6	3.21	40.8	23.7	3.55	38.1	22.7	3.94
	75	63	40.7	32.7	2.60	38.8	31.8	2.86	36.9	30.9	3.16	34.8	29.9	3.51	32.5	28.9	3.90

VT4BE-048K B6BM-X60K-C

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
1400	80	62	49.2	40.7	2.65	47.3	40.4	2.91	45.2	40.6	3.22	43.0	39.9	3.57	40.98	40.29	3.97	38.91	38.25	4.42
	80	67	53.5	33.1	2.66	51.2	32.9	2.93	48.9	33.2	3.24	46.4	32.6	3.59	43.87	32.17	3.99	41.24	30.74	4.43
	80	72	58.4	25.0	2.69	55.9	24.9	2.96	53.3	25.4	3.26	50.7	24.9	3.61	47.84	24.53	4.01	44.96	25.15	4.45
	75	63	49.8	32.1	2.65	47.7	31.8	2.91	45.5	32.1	3.22	43.2	31.4	3.57	40.86	29.05	3.97	38.38	31.22	4.42
1600	80	62	50.5	44.1	2.70	48.5	44.8	2.97	46.6	43.5	3.28	44.6	42.1	3.63	42.51	41.08	4.03	40.32	39.98	4.48
	80	67	54.5	35.6	2.72	52.2	36.6	2.99	49.8	35.7	3.29	47.3	35.4	3.65	44.64	35.40	4.04	41.92	35.41	4.49
	80	72	59.5	26.6	2.75	56.9	27.8	3.00	54.3	27.0	3.32	51.5	26.7	3.68	48.59	26.93	4.06	45.60	27.14	4.50
	75	63	50.8	34.4	2.70	48.7	35.3	2.97	46.4	34.4	3.28	44.0	34.0	3.63	41.57	33.92	4.03	39.02	33.84	4.47
1800	80	62	51.9	47.3	2.76	50.1	46.7	3.03	48.1	44.8	3.33	46.0	43.7	3.69	43.78	42.30	4.08	41.46	41.28	4.53
	80	67	55.4	38.6	2.77	53.0	39.0	3.04	50.5	38.2	3.35	47.9	38.0	3.70	45.22	37.81	4.09	42.44	37.99	4.54
	80	72	60.3	28.7	2.80	57.6	29.3	3.06	54.9	28.5	3.37	52.0	28.6	3.72	49.05	28.50	4.11	45.95	28.88	4.55
	75	63	51.6	37.2	2.75	49.4	37.5	3.02	47.1	36.6	3.34	44.7	36.4	3.68	42.14	36.14	4.08	39.51	36.20	4.52

VT4BE-060K B6EMMX60K-C

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
1550	80	62	60.8	43.5	3.60	58.6	43.2	3.96	56.2	43.4	4.38	53.7	42.7	4.84	51.06	44.88	5.38	48.18	42.35	5.99
	80	67	66.2	36.4	3.67	63.7	36.1	4.04	61.2	36.6	4.46	58.5	35.8	4.93	55.55	35.27	5.46	52.48	32.86	6.08
	80	72	72.8	28.8	3.76	70.1	28.7	4.14	67.2	29.3	4.56	64.2	28.7	5.03	60.89	28.25	5.58	57.39	29.04	6.18
	75	63	61.6	35.6	3.61	59.4	35.2	3.97	57.0	35.5	4.39	54.4	34.8	4.86	51.68	32.26	5.39	48.80	34.55	6.00
1700	80	62	61.9	45.4	3.65	59.6	46.4	4.02	57.2	45.4	4.43	54.7	44.9	4.90	51.93	44.82	5.43	48.95	44.37	6.05
	80	67	67.4	37.8	3.72	64.9	39.0	4.10	62.2	37.9	4.51	59.4	37.5	4.98	56.39	37.58	5.52	53.18	37.60	6.13
	80	72	74.0	29.7	3.82	71.1	31.2	4.20	68.2	30.2	4.62	65.0	29.9	5.09	61.59	30.20	5.63	57.93	30.46	6.23
	75	63	62.8	36.9	3.66	60.4	37.9	4.03	58.0	36.8	4.44	55.3	36.4	4.91	52.53	36.34	5.45	49.51	36.24	6.06
1850	80	62	62.9	47.9	3.70	60.6	48.3	4.07	58.1	47.3	4.48	55.5	46.7	4.96	52.61	46.29	5.49	49.56	46.27	6.10
	80	67	68.4	39.8	3.78	65.9	40.3	4.15	63.2	39.3	4.57	60.3	39.2	5.04	57.09	38.89	5.57	53.87	39.16	6.18
	80	72	75.0	31.3	3.88	72.0	32.1	4.25	68.8	31.1	4.67	65.5	31.2	5.14	62.07	31.10	5.68	58.24	31.58	6.28
	75	63	63.8	38.8	3.71	61.4	39.2	4.08	58.8	38.1	4.49	56.1	37.9	4.97	53.21	37.57	5.50	50.11	37.68	6.11

14 SEER HEATING EXPANDED RATINGS

VT4BE-018K with B6BM-X24K-(A,B)

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
510	60	10.0	2.13	1.38	12.0	2.50	1.40	12.8	2.66	1.41	15.5	3.17	1.43	18.2	3.66	1.46	20.2	4.00	1.48	21.0	4.14	1.49	23.7	4.59	1.51
	70	9.5	2.14	1.31	11.3	2.46	1.34	12.0	2.59	1.36	14.5	3.01	1.41	17.0	3.40	1.46	18.7	3.66	1.50	19.5	3.77	1.51	21.9	4.11	1.56
	80	8.9	2.09	1.25	10.5	2.37	1.30	11.2	2.49	1.32	13.4	2.85	1.38	15.6	3.19	1.44	17.2	3.40	1.48	17.9	3.49	1.50	20.1	3.78	1.56
610	60	10.1	2.08	1.42	12.0	2.45	1.44	12.9	2.61	1.45	15.7	3.12	1.47	18.5	3.61	1.50	20.4	3.95	1.52	21.3	4.09	1.52	24.1	4.56	1.55
	70	9.6	2.08	1.36	11.4	2.40	1.39	12.2	2.53	1.41	14.7	2.96	1.46	17.2	3.36	1.51	19.0	3.62	1.54	19.8	3.73	1.55	22.3	4.08	1.60
	80	9.0	2.05	1.29	10.7	2.33	1.34	11.3	2.45	1.36	13.6	2.81	1.42	16.0	3.14	1.49	17.6	3.35	1.54	18.3	3.44	1.56	20.6	3.72	1.62
710	60	10.3	2.05	1.47	12.2	2.42	1.49	13.1	2.57	1.49	15.9	3.08	1.51	18.7	3.58	1.53	20.7	3.92	1.55	21.5	4.07	1.55	24.3	4.54	1.57
	70	9.7	2.04	1.40	11.5	2.37	1.43	12.3	2.50	1.44	14.9	2.93	1.49	17.5	3.33	1.54	19.3	3.59	1.57	20.1	3.70	1.59	22.7	4.06	1.64
	80	9.2	2.01	1.34	10.8	2.29	1.38	11.5	2.40	1.40	13.8	2.76	1.47	16.1	3.08	1.54	17.7	3.29	1.58	18.4	3.38	1.60	20.8	3.65	1.67

VT4BE-024K with B6BM-X24K-(A,B)

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
600	60	13.1	2.42	1.59	15.4	2.74	1.65	16.4	2.87	1.67	19.6	3.28	1.75	22.9	3.65	1.84	25.2	3.89	1.90	26.1	3.99	1.92	29.4	4.29	2.01
	70	12.5	2.38	1.55	14.7	2.65	1.62	15.6	2.75	1.66	18.6	3.08	1.77	21.6	3.37	1.88	23.7	3.56	1.95	24.6	3.63	1.99	27.6	3.86	2.10
	80	12.0	2.30	1.53	13.9	2.53	1.61	14.7	2.62	1.65	17.5	2.89	1.78	20.3	3.13	1.90	22.2	3.28	1.99	23.1	3.34	2.03	25.8	3.52	2.15
700	60	13.2	2.37	1.63	15.5	2.70	1.69	16.5	2.83	1.71	19.8	3.24	1.79	23.1	3.62	1.87	25.4	3.87	1.93	26.4	3.97	1.95	29.8	4.29	2.03
	70	12.7	2.33	1.59	14.8	2.60	1.67	15.7	2.71	1.70	18.8	3.05	1.81	21.9	3.35	1.91	24.0	3.54	1.99	24.9	3.62	2.02	28.0	3.86	2.13
	80	12.1	2.26	1.57	14.1	2.49	1.65	14.9	2.58	1.69	17.7	2.86	1.82	20.6	3.11	1.94	22.6	3.26	2.03	23.4	3.32	2.07	26.3	3.51	2.19
800	60	13.3	2.33	1.67	15.6	2.66	1.73	16.7	2.79	1.75	20.0	3.21	1.83	23.3	3.60	1.90	25.7	3.85	1.96	26.7	3.96	1.98	30.0	4.29	2.05
	70	12.8	2.29	1.63	14.9	2.57	1.70	15.9	2.68	1.74	19.0	3.03	1.84	22.1	3.33	1.95	24.3	3.53	2.02	25.2	3.61	2.05	28.4	3.86	2.15
	80	12.2	2.23	1.61	14.2	2.46	1.69	15.1	2.55	1.73	17.9	2.83	1.86	20.8	3.07	1.98	22.8	3.23	2.07	23.6	3.29	2.11	26.5	3.48	2.23

VT4BE-030K with B6BM-X30K-(A,B)

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
785	60	15.8	2.62	1.76	18.5	2.91	1.87	19.7	3.03	1.91	23.7	3.38	2.05	27.6	3.68	2.20	30.3	3.87	2.30	31.5	3.95	2.34	35.5	4.18	2.49
	70	15.1	2.53	1.75	17.7	2.78	1.87	18.9	2.87	1.93	22.6	3.15	2.10	26.3	3.39	2.27	28.9	3.54	2.39	30.0	3.60	2.44	33.7	3.78	2.62
	80	14.6	2.43	1.76	17.0	2.63	1.90	18.1	2.71	1.95	21.5	2.94	2.15	25.0	3.14	2.34	27.5	3.25	2.47	28.5	3.30	2.53	32.0	3.44	2.72
885	60	15.8	2.57	1.80	18.6	2.87	1.90	19.8	2.99	1.94	23.8	3.35	2.09	27.8	3.67	2.23	30.7	3.87	2.32	31.9	3.95	2.37	35.9	4.19	2.51
	70	15.3	2.49	1.80	17.9	2.74	1.92	19.0	2.84	1.97	22.8	3.13	2.13	26.6	3.38	2.30	29.2	3.54	2.42	30.3	3.60	2.47	34.1	3.79	2.64
	80	14.7	2.39	1.80	17.2	2.60	1.93	18.2	2.68	1.99	21.8	2.93	2.18	25.3	3.13	2.37	27.8	3.25	2.51	28.9	3.30	2.56	32.4	3.45	2.75
985	60	15.9	2.53	1.85	18.8	2.83	1.94	20.0	2.96	1.98	24.0	3.33	2.12	28.1	3.65	2.25	30.9	3.86	2.35	32.1	3.94	2.39	36.2	4.20	2.53
	70	15.4	2.46	1.83	18.1	2.72	1.95	19.2	2.82	2.00	23.0	3.12	2.16	26.8	3.38	2.33	29.5	3.54	2.44	30.6	3.60	2.49	34.5	3.80	2.66
	80	14.8	2.36	1.84	17.3	2.58	1.97	18.4	2.66	2.03	21.9	2.90	2.21	25.5	3.11	2.40	28.0	3.24	2.54	29.1	3.29	2.59	32.6	3.44	2.78

VT4BE-036K with B6EMMX36K-C

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
1120	60	17.9	2.64	1.99	21.2	2.96	2.10	22.6	3.09	2.15	27.3	3.49	2.30	32.0	3.83	2.45	35.3	4.05	2.56	36.7	4.14	2.60	41.4	4.41	2.76
	70	17.3	2.51	2.02	20.4	2.79	2.14	21.7	2.90	2.20	26.2	3.24	2.37	30.7	3.53	2.55	33.9	3.71	2.67	35.2	3.79	2.73	39.7	4.01	2.91
	80	16.7	2.37	2.06	19.7	2.62	2.20	21.0	2.72	2.26	25.2	3.01	2.45	29.5	3.26	2.65	32.5	3.41	2.79	33.7	3.48	2.85	38.0	3.66	3.04
1270	60	18.1	2.59	2.05	21.4	2.92	2.15	22.9	3.05	2.19	27.7	3.46	2.34	32.4	3.83	2.49	35.8	4.05	2.59	37.2	4.15	2.63	42.0	4.44	2.78
	70	17.5	2.46	2.08	20.6	2.75	2.20	22.0	2.87	2.25	26.6	3.22	2.42	31.1	3.53	2.59	34.3	3.72	2.71	35.7	3.80	2.76	40.3	4.03	2.93
	80	16.8	2.33	2.12	19.9	2.59	2.25	21.2	2.69	2.31	25.6	3.00	2.50	29.9	3.26	2.69	33.0	3.42	2.82	34.3	3.49	2.88	38.6	3.69	3.07
1420	60	18.2	2.54	2.10	21.6	2.88	2.20	23.1	3.02	2.24	27.9	3.44	2.38	32.8	3.81	2.52	36.2	4.05	2.62	37.7	4.15	2.66	42.5	4.45	2.81
	70	17.7	2.43	2.13	20.9	2.73	2.25	22.3	2.85	2.29	26.9	3.21	2.46	31.5	3.52	2.62	34.8	3.72	2.74	36.2	3.80	2.79	40.8	4.05	2.95
	80	17.1	2.30	2.17	20.1	2.56	2.30	21.4	2.67	2.36	25.8	2.98	2.54	30.2	3.25	2.73	33.3	3.42	2.86	34.6	3.48	2.91	39.0	3.69	3.10

14 SEER HEATING EXPANDED RATINGS (CONTINUED)

VT4BE-042K with B6BM-X42K-B

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
1175	60	22.9	2.72	2.47	26.4	3.04	2.55	27.9	3.17	2.59	33.0	3.58	2.70	38.0	3.96	2.81	41.5	4.21	2.89	43.0	4.31	2.92	48.0	4.64	3.04
	70	22.1	2.53	2.57	25.5	2.82	2.66	27.0	2.93	2.70	31.8	3.31	2.82	36.6	3.64	2.95	40.0	3.86	3.04	41.5	3.96	3.08	46.3	4.24	3.20
	80	21.6	2.36	2.69	24.8	2.62	2.78	26.2	2.72	2.82	30.8	3.06	2.96	35.4	3.36	3.09	38.6	3.55	3.19	40.0	3.63	3.23	44.6	3.89	3.37
1325	60	23.1	2.69	2.52	26.7	3.01	2.59	28.2	3.15	2.63	33.3	3.57	2.73	38.4	3.97	2.84	42.0	4.22	2.91	43.5	4.33	2.95	48.6	4.67	3.05
	70	22.4	2.51	2.62	25.8	2.80	2.70	27.3	2.92	2.74	32.2	3.30	2.86	37.1	3.65	2.98	40.5	3.88	3.06	42.0	3.97	3.10	46.9	4.27	3.22
	80	21.8	2.33	2.73	25.1	2.60	2.83	26.5	2.71	2.86	31.2	3.05	2.99	35.9	3.37	3.12	39.1	3.57	3.21	40.6	3.66	3.25	45.2	3.92	3.38
1475	60	23.1	2.64	2.56	26.8	2.98	2.64	28.3	3.12	2.67	33.5	3.55	2.77	38.7	3.96	2.87	42.4	4.22	2.94	44.0	4.33	2.98	49.2	4.68	3.08
	70	22.6	2.49	2.66	26.1	2.79	2.74	27.6	2.91	2.78	32.5	3.30	2.89	37.5	3.65	3.01	41.0	3.89	3.09	42.4	3.99	3.12	47.4	4.29	3.24
	80	22.0	2.32	2.78	25.3	2.59	2.87	26.7	2.70	2.90	31.5	3.05	3.03	36.2	3.37	3.15	39.5	3.58	3.24	40.9	3.66	3.28	45.7	3.94	3.40

VT4BE-048K / B6BM-X60K-C

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
1375	60	23.5	2.54	2.71	28.0	2.91	2.82	30.0	3.06	2.87	36.5	3.53	3.03	43.0	3.95	3.19	47.5	4.22	3.30	49.5	4.33	3.35	56.0	4.68	3.51
	70	22.7	2.33	2.85	27.1	2.68	2.97	29.0	2.81	3.02	35.3	3.24	3.19	41.7	3.63	3.37	46.1	3.87	3.49	48.0	3.97	3.54	54.3	4.29	3.72
	80	22.1	2.16	3.00	26.4	2.47	3.13	28.2	2.60	3.19	34.4	2.99	3.37	40.5	3.33	3.56	44.7	3.55	3.69	46.6	3.64	3.75	52.7	3.93	3.93
1575	60	23.7	2.51	2.77	28.3	2.89	2.87	30.3	3.05	2.92	37.0	3.53	3.07	43.6	3.97	3.22	48.2	4.26	3.32	50.2	4.37	3.37	56.8	4.74	3.52
	70	23.0	2.32	2.90	27.5	2.67	3.02	29.4	2.81	3.07	35.8	3.25	3.23	42.2	3.65	3.39	46.7	3.91	3.51	48.7	4.01	3.55	55.1	4.34	3.72
	80	22.4	2.14	3.06	26.7	2.46	3.18	28.6	2.59	3.24	34.8	2.99	3.41	41.0	3.36	3.58	45.4	3.59	3.71	47.3	3.69	3.76	53.5	3.99	3.93
1775	60	23.8	2.48	2.82	28.5	2.87	2.92	30.6	3.02	2.96	37.3	3.52	3.11	44.1	3.97	3.25	48.8	4.27	3.35	50.8	4.39	3.40	57.6	4.77	3.54
	70	23.3	2.31	2.96	27.8	2.66	3.07	29.8	2.80	3.11	36.3	3.26	3.27	42.8	3.66	3.42	47.3	3.93	3.53	49.3	4.04	3.58	55.8	4.38	3.73
	80	22.6	2.13	3.12	27.0	2.45	3.23	28.9	2.58	3.28	35.2	3.00	3.45	41.5	3.37	3.61	45.9	3.61	3.73	47.8	3.71	3.78	54.1	4.03	3.94

VT4BE-060K / B6EMMX60K-C

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
1510	60	31.5	2.66	3.48	37.4	2.99	3.68	40.0	3.12	3.76	48.4	3.51	4.04	56.8	3.86	4.32	62.7	4.07	4.52	65.3	4.16	4.60	73.7	4.43	4.88
	70	30.6	2.40	3.74	36.4	2.71	3.94	38.9	2.83	4.03	47.2	3.20	4.32	55.5	3.53	4.61	61.3	3.73	4.82	63.8	3.81	4.90	72.1	4.07	5.20
	80	30.1	2.20	4.01	35.7	2.48	4.23	38.2	2.59	4.32	46.3	2.93	4.63	54.3	3.22	4.95	60.0	3.41	5.16	62.4	3.48	5.26	70.5	3.71	5.57
1710	60	31.8	2.65	3.52	37.8	2.99	3.70	40.4	3.13	3.78	48.9	3.54	4.05	57.5	3.91	4.31	63.4	4.13	4.50	66.0	4.23	4.58	74.6	4.51	4.85
	70	30.9	2.41	3.77	36.8	2.72	3.96	39.3	2.85	4.04	47.7	3.24	4.32	56.1	3.58	4.60	61.9	3.79	4.79	64.5	3.88	4.87	72.8	4.15	5.15
	80	30.3	2.19	4.05	36.0	2.48	4.25	38.5	2.60	4.34	46.7	2.96	4.63	54.9	3.27	4.92	60.7	3.47	5.12	63.1	3.55	5.21	71.3	3.80	5.50
1910	60	31.8	2.63	3.55	37.9	2.98	3.73	40.5	3.12	3.81	49.2	3.55	4.07	58.0	3.92	4.33	64.1	4.16	4.51	66.7	4.26	4.59	75.4	4.56	4.85
	70	31.3	2.41	3.81	37.2	2.73	4.00	39.7	2.86	4.08	48.2	3.26	4.34	56.6	3.61	4.60	62.5	3.83	4.78	65.1	3.92	4.86	73.5	4.20	5.13
	80	30.6	2.19	4.09	36.4	2.49	4.28	38.9	2.61	4.36	47.2	2.98	4.64	55.4	3.31	4.91	61.2	3.52	5.10	63.7	3.60	5.18	72.0	3.87	5.45

14 SEER COOLING EXPANDED RATINGS

VT4BE-018K B6EMMX24K-A

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
525	80	62	18.0	14.4	0.92	17.4	14.3	1.06	16.7	14.4	1.20	16.0	14.2	1.35	15.2	14.9	1.52	14.4	14.1	1.71
	80	67	19.6	11.6	0.91	18.9	11.5	1.05	18.1	11.7	1.20	17.3	11.4	1.35	16.4	11.3	1.52	15.4	10.6	1.71
	80	72	21.8	9.0	0.91	20.9	9.0	1.05	20.0	9.2	1.20	19.0	9.0	1.36	17.9	8.9	1.53	16.6	9.1	1.72
	75	63	18.1	11.2	0.92	17.5	11.2	1.06	16.7	11.2	1.20	16.0	11.0	1.35	15.1	10.2	1.52	14.2	10.9	1.71
600	80	62	18.6	15.6	0.93	17.9	15.9	1.06	17.2	15.5	1.21	16.4	15.4	1.36	15.8	15.2	1.53	15.0	14.8	1.72
	80	67	20.1	12.4	0.92	19.3	12.7	1.06	18.5	12.4	1.21	17.7	12.3	1.36	16.7	12.3	1.53	15.7	12.2	1.72
	80	72	22.2	9.6	0.91	21.3	10.0	1.06	20.0	9.7	1.21	19.1	9.6	1.36	18.1	9.6	1.54	17.0	9.7	1.73
	75	63	18.6	11.9	0.93	17.9	12.3	1.06	17.1	11.9	1.21	16.3	11.8	1.36	15.5	11.8	1.53	14.6	12.0	1.72
675	80	62	19.1	16.9	0.93	18.4	17.0	1.07	17.8	16.5	1.22	17.1	16.2	1.37	16.3	15.7	1.54	15.4	15.4	1.73
	80	67	20.5	13.3	0.93	19.7	13.4	1.07	18.9	13.1	1.22	18.0	13.1	1.37	17.0	13.0	1.54	16.0	13.3	1.73
	80	72	22.3	10.3	0.92	21.3	10.5	1.07	20.4	10.1	1.22	19.4	10.1	1.37	18.4	10.0	1.55	17.2	10.1	1.74
	75	63	19.0	12.8	0.93	18.3	12.9	1.07	17.5	12.6	1.22	16.7	12.5	1.37	15.8	12.7	1.54	14.8	12.7	1.73

VT4BE-024K B6EMMX24K-A

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
700	80	62	23.8	18.9	1.26	23.0	18.8	1.42	22.1	18.9	1.60	21.1	18.6	1.78	20.0	19.4	1.99	19.0	18.4	2.23
	80	67	25.7	15.2	1.26	24.7	15.1	1.43	23.7	15.2	1.60	22.6	14.9	1.79	21.5	14.7	2.00	20.3	13.9	2.24
	80	72	28.5	11.9	1.28	27.3	11.9	1.44	25.9	12.1	1.62	24.3	11.8	1.81	23.0	11.6	2.02	21.7	11.8	2.26
	75	63	23.9	14.7	1.27	23.0	14.6	1.42	22.0	14.7	1.60	21.0	14.4	1.78	19.9	13.3	1.99	18.8	14.2	2.23
800	80	62	24.5	20.4	1.28	23.6	20.8	1.44	22.6	20.3	1.62	21.6	20.1	1.80	20.7	19.9	2.02	19.7	19.5	2.26
	80	67	26.3	16.1	1.29	25.3	16.6	1.45	24.2	16.1	1.63	23.1	15.9	1.82	21.9	15.9	2.02	20.7	15.9	2.26
	80	72	28.3	12.5	1.29	27.2	13.0	1.46	26.0	12.6	1.64	24.8	12.4	1.83	23.4	12.4	2.04	22.0	12.4	2.28
	75	63	24.4	15.6	1.28	23.5	16.0	1.44	22.5	15.6	1.61	21.5	15.3	1.80	20.3	15.3	2.01	19.1	15.2	2.25
900	80	62	25.0	22.0	1.30	24.1	22.1	1.46	23.2	21.6	1.64	22.4	21.2	1.83	21.3	20.6	2.04	20.2	20.1	2.28
	80	67	26.8	17.3	1.30	25.8	17.5	1.47	24.7	17.0	1.65	23.5	16.9	1.84	22.2	16.8	2.05	21.0	16.8	2.29
	80	72	28.8	13.3	1.32	27.7	13.5	1.48	26.4	13.1	1.66	25.1	13.0	1.85	23.7	12.9	2.06	22.3	12.9	2.30
	75	63	24.9	16.7	1.30	23.9	16.8	1.46	22.9	16.4	1.63	21.8	16.2	1.82	20.7	16.1	2.03	19.5	16.4	2.27

VT4BE-030K B6EMMX30K-A

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
875	80	62	28.9	23.4	1.60	27.8	23.2	1.76	26.6	23.3	1.94	25.4	22.9	2.15	24.2	23.4	2.39	23.7	22.9	2.70
	80	67	31.4	19.3	1.60	30.1	19.1	1.76	28.9	19.3	1.95	27.5	19.0	2.15	26.2	18.7	2.39	24.6	18.2	2.66
	80	72	34.5	14.9	1.61	32.9	14.8	1.77	31.4	15.1	1.95	29.8	14.8	2.16	28.2	14.5	2.39	26.6	14.9	2.66
	75	63	29.1	18.6	1.60	28.0	18.5	1.76	26.8	18.6	1.94	25.6	18.2	2.15	24.2	16.9	2.39	22.8	18.0	2.66
1000	80	62	29.6	25.1	1.63	28.4	25.5	1.79	27.3	24.9	1.98	26.1	24.4	2.18	24.8	24.0	2.42	23.6	23.4	2.69
	80	67	32.0	20.5	1.63	30.7	21.1	1.80	29.4	20.6	1.98	28.0	20.4	2.19	26.6	20.3	2.42	25.0	20.3	2.70
	80	72	34.7	15.7	1.64	33.2	16.3	1.80	31.8	15.8	1.98	30.3	15.7	2.19	28.7	15.7	2.43	27.0	15.8	2.70
	75	63	29.7	19.8	1.63	28.5	20.3	1.79	27.3	19.8	1.98	26.0	19.5	2.18	24.6	19.4	2.42	23.1	19.3	2.69
1125	80	62	30.2	26.8	1.67	29.0	26.8	1.83	27.9	26.0	2.01	26.7	25.4	2.22	25.5	24.7	2.45	24.2	24.1	2.72
	80	67	32.5	22.1	1.67	31.2	22.3	1.83	29.8	21.7	2.01	28.4	21.6	2.22	26.9	21.4	2.46	25.3	21.5	2.73
	80	72	35.2	16.7	1.67	33.7	17.0	1.83	32.2	16.5	2.01	30.7	16.5	2.22	29.0	16.4	2.46	27.2	16.5	2.73
	75	63	30.2	21.2	1.67	29.0	21.3	1.83	27.7	20.8	2.01	26.4	20.7	2.22	25.0	20.5	2.45	23.4	20.4	2.72

VT4BE-036K B6EMMX36K-C

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
1050	80	62	35.2	28.5	1.89	33.9	28.3	2.12	32.5	28.4	2.37	31.0	27.9	2.65	29.4	28.9	2.97	27.8	27.3	3.33
	80	67	38.3	23.4	1.90	36.7	23.3	2.15	35.1	23.5	2.39	33.5	23.1	2.67	31.7	22.7	2.99	29.9	21.4	3.35
	80	72	42.0	18.0	1.93	40.2	18.0	2.17	38.3	18.3	2.42	36.2	18.0	2.70	34.3	17.7	3.01	32.2	18.0	3.37
	75	63	35.5	22.7	1.89	34.1	22.5	2.12	32.7	22.7	2.37	31.1	22.2	2.65	29.5	20.5	2.97	27.7	22.0	3.33
1200	80	62	36.1	30.6	1.91	34.7	31.1	2.15	33.3	30.3	2.40	31.8	29.8	2.68	30.3	29.3	3.00	28.7	28.5	3.36
	80	67	39.0	25.0	1.92	37.5	25.7	2.17	35.8	25.0	2.42	34.1	24.8	2.70	32.3	24.7	3.01	30.4	24.7	3.38
	80	72	42.3	19.1	1.95	40.6	19.9	2.19	38.8	19.3	2.44	36.9	19.1	2.72	34.9	19.1	3.04	32.8	19.2	3.40
	75	63	36.3	24.2	1.91	34.8	24.7	2.15	33.3	24.1	2.40	31.7	23.8	2.68	30.0	23.7	3.00	28.2	23.6	3.35
1350	80	62	36.9	32.8	1.94	35.5	32.8	2.17	34.1	31.8	2.43	32.7	31.0	2.71	31.2	30.1	3.03	29.5	29.4	3.38
	80	67	39.7	26.9	1.95	38.1	27.2	2.19	36.4	26.6	2.44	34.6	26.4	2.72	32.8	26.2	3.04	30.8	26.2	3.40
	80	72	43.0	20.4	1.98	41.2	20.7	2.22	39.3	20.1	2.47	37.4	20.1	2.75	35.3	20.0	3.06	33.1	20.1	3.42
	75	63	36.9	25.9	1.94	35.4	26.2	2.17	33.9	25.4	2.42	32.2	25.3	2.70	30.5	25.0	3.02	28.6	25.0	3.38

14 SEER COOLING EXPANDED RATINGS (CONTINUED)

VT4BE-042K B6EMMX42K-B

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
1225	80	62	41.0	32.4	2.28	39.5	32.2	2.51	37.8	32.3	2.78	35.9	31.7	3.09	33.9	33.0	3.44	31.9	31.0	3.82
	80	67	44.9	26.7	2.30	43.0	26.5	2.54	41.1	26.8	2.81	39.0	26.3	3.12	36.8	25.9	3.47	34.5	24.2	3.85
	80	72	49.0	20.5	2.32	47.1	20.4	2.56	44.9	20.8	2.84	42.6	20.4	3.16	40.1	20.0	3.50	37.5	20.5	3.89
	75	63	41.7	25.9	2.28	40.0	25.7	2.52	38.2	25.9	2.78	36.3	25.4	3.09	34.2	23.3	3.44	32.0	25.1	3.82
1400	80	62	42.0	34.7	2.33	40.4	35.3	2.57	38.6	34.5	2.84	36.6	33.9	3.14	34.7	33.4	3.49	32.8	32.5	3.88
	80	67	45.8	28.4	2.34	43.9	29.3	2.59	41.8	28.5	2.86	39.7	28.2	3.17	37.4	28.2	3.52	34.9	28.1	3.91
	80	72	50.0	21.6	2.37	47.9	22.6	2.62	45.6	21.9	2.90	43.1	21.7	3.21	40.6	21.8	3.56	38.0	21.9	3.95
	75	63	42.5	27.5	2.33	40.8	28.2	2.57	38.9	27.5	2.84	37.0	27.2	3.15	34.8	27.1	3.49	32.5	26.9	3.87
1575	80	62	42.8	37.2	2.38	41.1	37.3	2.62	39.3	36.2	2.89	37.4	35.5	3.20	35.6	34.4	3.55	33.6	33.5	3.94
	80	67	46.5	30.6	2.40	44.5	30.9	2.64	42.4	30.2	2.91	40.2	30.0	3.23	37.8	29.8	3.57	35.3	29.7	3.96
	80	72	50.6	23.2	2.42	48.4	23.7	2.66	46.0	23.0	2.95	43.6	22.9	3.26	41.0	22.8	3.61	38.3	23.0	4.00
	75	63	43.2	29.5	2.38	41.4	29.8	2.62	39.5	29.0	2.89	37.4	28.8	3.20	35.2	28.4	3.54	32.9	28.4	3.93

VT4BE-048K B6EMMX48K-C

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
1400	80	62	46.5	36.2	2.65	44.8	35.9	2.91	42.9	36.1	3.21	40.9	35.5	3.55	38.7	37.1	3.93	36.4	34.9	4.35
	80	67	50.9	29.9	2.67	48.9	29.7	2.94	46.8	30.0	3.23	44.5	29.5	3.57	42.1	29.0	3.95	39.6	27.0	4.38
	80	72	55.8	23.1	2.71	53.6	23.0	2.97	51.2	23.5	3.26	48.7	23.0	3.60	46.1	22.7	3.98	43.2	23.3	4.40
	75	63	47.2	29.0	2.66	45.4	28.8	2.91	43.5	29.0	3.21	41.4	28.5	3.55	39.2	26.3	3.93	36.8	28.2	4.35
1600	80	62	47.6	38.7	2.72	45.8	39.4	2.97	43.8	38.5	3.27	41.7	37.9	3.60	39.5	37.6	3.99	37.3	36.9	4.41
	80	67	51.9	31.7	2.74	49.9	32.7	2.99	47.7	31.9	3.29	45.3	31.5	3.63	42.9	31.6	4.01	40.2	31.6	4.44
	80	72	56.9	24.3	2.77	54.5	25.5	3.02	52.0	24.7	3.32	49.3	24.5	3.66	46.7	24.7	4.04	43.8	24.8	4.46
	75	63	48.2	30.7	2.72	46.4	31.6	2.97	44.3	30.8	3.27	42.1	30.4	3.61	39.8	30.3	3.99	37.4	30.2	4.41
1800	80	62	48.5	41.4	2.76	46.6	41.6	3.03	44.6	40.5	3.32	42.5	40.0	3.66	40.4	39.0	4.05	38.3	38.1	4.47
	80	67	52.8	34.0	2.80	50.7	34.5	3.06	48.4	33.6	3.35	46.0	33.5	3.69	43.4	33.3	4.07	40.7	33.5	4.50
	80	72	57.5	26.1	2.83	55.2	26.6	3.08	52.7	25.8	3.38	50.0	25.8	3.72	47.2	25.7	4.10	44.3	26.0	4.52
	75	63	49.0	32.9	2.77	47.1	33.2	3.03	45.0	32.4	3.33	42.8	32.2	3.67	40.3	31.9	4.05	37.8	32.0	4.47

VT4BE-060K B6EMMX60K-C

O.D.T			65°F			75°F			85°F			95°F			105°F			115°F		
CFM	E.D.B.	E.W.B.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.	T.C.	S.C.	K.W.
1550	80	62	60.8	43.5	3.60	58.6	43.2	3.96	56.2	43.4	4.38	53.7	42.7	4.84	51.1	44.9	5.38	48.2	42.3	5.99
	80	67	66.2	36.4	3.67	63.7	36.1	4.04	61.2	36.6	4.46	58.5	35.8	4.93	55.6	35.3	5.46	52.5	32.9	6.08
	80	72	72.8	28.8	3.76	70.1	28.7	4.14	67.2	29.3	4.56	64.2	28.7	5.03	60.9	28.2	5.58	57.4	29.0	6.18
	75	63	61.6	35.6	3.61	59.4	35.2	3.97	57.0	35.5	4.39	54.4	34.8	4.86	51.7	32.3	5.39	48.8	34.6	6.00
1700	80	62	61.9	45.4	3.65	59.6	46.4	4.02	57.2	45.4	4.43	54.7	44.9	4.90	51.9	44.8	5.43	49.0	44.4	6.05
	80	67	67.4	37.8	3.72	64.9	39.0	4.10	62.2	37.9	4.51	59.4	37.5	4.98	56.4	37.6	5.52	53.2	37.6	6.13
	80	72	74.0	29.7	3.82	71.1	31.2	4.20	68.2	30.2	4.62	65.0	29.9	5.09	61.6	30.2	5.63	57.9	30.5	6.23
	75	63	62.8	36.9	3.66	60.4	37.9	4.03	58.0	36.8	4.44	55.3	36.4	4.91	52.5	36.3	5.45	49.5	36.2	6.06
1850	80	62	62.9	47.9	3.70	60.6	48.3	4.07	58.1	47.3	4.48	55.5	46.7	4.96	52.6	46.3	5.49	49.6	46.3	6.10
	80	67	68.4	39.8	3.78	65.9	40.3	4.15	63.2	39.3	4.57	60.3	39.2	5.04	57.1	38.9	5.57	53.9	39.2	6.18
	80	72	75.0	31.3	3.88	72.0	32.1	4.25	68.8	31.1	4.67	65.5	31.2	5.14	62.1	31.1	5.68	58.2	31.6	6.28
	75	63	63.8	38.8	3.71	61.4	39.2	4.08	58.8	38.1	4.49	56.1	37.9	4.97	53.2	37.6	5.50	50.1	37.7	6.11

14 SEER HEATING EXPANDED RATINGS

VT4BE-018K / B6EMMX24K-A

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
460	60	9.4	2.25	1.22	11.4	2.61	1.28	12.3	2.76	1.31	15.2	3.21	1.39	18.1	3.60	1.47	20.1	3.86	1.53	20.9	3.96	1.55	23.8	4.28	1.63
	70	8.9	2.31	1.13	10.7	2.61	1.21	11.5	2.72	1.24	14.2	3.06	1.36	16.8	3.35	1.47	18.6	3.53	1.55	19.4	3.60	1.58	22.0	3.81	1.70
	80	8.3	2.31	1.05	10.0	2.55	1.14	10.7	2.64	1.18	13.1	2.91	1.32	15.4	3.13	1.45	17.1	3.26	1.54	17.8	3.31	1.58	20.2	3.47	1.71
560	60	9.5	2.18	1.27	11.5	2.55	1.32	12.4	2.70	1.35	15.3	3.15	1.43	18.3	3.56	1.51	20.3	3.82	1.56	21.2	3.92	1.59	24.2	4.26	1.67
	70	9.0	2.23	1.18	10.9	2.53	1.26	11.7	2.65	1.29	14.4	3.00	1.40	17.0	3.30	1.51	18.9	3.49	1.59	19.7	3.56	1.62	22.4	3.79	1.73
	80	8.4	2.25	1.09	10.1	2.50	1.19	10.9	2.59	1.23	13.3	2.86	1.36	15.8	3.09	1.50	17.5	3.22	1.59	18.2	3.27	1.63	20.7	3.43	1.76
660	60	9.6	2.14	1.32	11.7	2.51	1.37	12.6	2.65	1.39	15.6	3.11	1.47	18.5	3.53	1.54	20.6	3.79	1.59	21.5	3.90	1.61	24.4	4.25	1.69
	70	9.1	2.18	1.22	11.0	2.49	1.30	11.8	2.61	1.33	14.6	2.97	1.44	17.3	3.28	1.55	19.2	3.47	1.62	20.0	3.55	1.66	22.8	3.78	1.76
	80	8.6	2.20	1.14	10.3	2.44	1.23	11.0	2.53	1.27	13.5	2.80	1.41	15.9	3.03	1.54	17.7	3.16	1.64	18.4	3.22	1.68	20.9	3.38	1.81

VT4BE-024K / B6EMMX24K-A

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
640	60	12.2	2.34	1.53	14.9	2.73	1.60	16.1	2.89	1.63	20.0	3.38	1.73	23.9	3.81	1.83	26.6	4.09	1.90	27.7	4.20	1.93	31.6	4.55	2.04
	70	11.7	2.30	1.49	14.2	2.64	1.58	15.3	2.78	1.61	18.9	3.18	1.74	22.6	3.54	1.87	25.1	3.75	1.96	26.2	3.84	2.00	29.9	4.11	2.13
	80	11.1	2.23	1.46	13.4	2.53	1.56	14.5	2.65	1.60	17.9	3.00	1.75	21.3	3.29	1.90	23.7	3.47	2.00	24.7	3.55	2.04	28.1	3.76	2.19
740	60	12.3	2.29	1.58	15.0	2.68	1.64	16.2	2.84	1.67	20.2	3.34	1.77	24.1	3.78	1.87	26.9	4.07	1.94	28.0	4.18	1.97	32.0	4.55	2.06
	70	11.8	2.25	1.53	14.4	2.59	1.62	15.5	2.73	1.66	19.1	3.15	1.78	22.8	3.51	1.91	25.4	3.73	2.00	26.5	3.83	2.03	30.2	4.11	2.16
	80	11.2	2.19	1.50	13.6	2.49	1.60	14.6	2.61	1.64	18.1	2.97	1.79	21.6	3.27	1.94	24.0	3.45	2.04	25.0	3.52	2.08	28.5	3.75	2.23
840	60	12.4	2.25	1.62	15.2	2.64	1.69	16.4	2.81	1.71	20.4	3.31	1.81	24.3	3.76	1.90	27.1	4.05	1.96	28.3	4.17	1.99	32.3	4.54	2.08
	70	11.9	2.22	1.57	14.5	2.56	1.66	15.6	2.70	1.69	19.4	3.12	1.82	23.1	3.49	1.94	25.7	3.72	2.03	26.8	3.82	2.06	30.6	4.10	2.19
	80	11.3	2.16	1.54	13.8	2.46	1.64	14.8	2.58	1.68	18.3	2.93	1.83	21.8	3.23	1.98	24.2	3.42	2.08	25.2	3.49	2.12	28.7	3.72	2.27

VT4BE-030K / B6EMMX30K-A

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
970	60	16.2	2.75	1.73	19.0	3.07	1.81	20.1	3.20	1.85	24.0	3.59	1.96	27.9	3.94	2.08	30.7	4.16	2.16	31.8	4.25	2.20	35.7	4.53	2.31
	70	15.6	2.67	1.71	18.2	2.94	1.81	19.3	3.05	1.85	23.0	3.37	2.00	26.6	3.65	2.14	29.2	3.82	2.24	30.3	3.89	2.29	34.0	4.11	2.43
	80	15.0	2.57	1.71	17.4	2.80	1.83	18.5	2.89	1.87	21.9	3.16	2.03	25.4	3.39	2.20	27.8	3.53	2.31	28.8	3.59	2.36	32.2	3.76	2.52
1070	60	16.3	2.70	1.77	19.1	3.03	1.85	20.3	3.16	1.88	24.2	3.56	2.00	28.2	3.92	2.11	31.0	4.15	2.19	32.2	4.24	2.22	36.1	4.53	2.34
	70	15.7	2.62	1.76	18.3	2.90	1.85	19.4	3.01	1.90	23.2	3.34	2.03	26.9	3.63	2.17	29.5	3.81	2.27	30.6	3.88	2.31	34.4	4.11	2.45
	80	15.1	2.53	1.75	17.6	2.77	1.86	18.6	2.86	1.91	22.1	3.14	2.07	25.7	3.37	2.23	28.1	3.52	2.34	29.2	3.58	2.39	32.7	3.76	2.55
1170	60	16.4	2.65	1.81	19.2	2.98	1.89	20.4	3.12	1.92	24.4	3.53	2.03	28.4	3.90	2.14	31.2	4.14	2.21	32.4	4.23	2.25	36.4	4.54	2.36
	70	15.8	2.59	1.79	18.5	2.87	1.89	19.6	2.98	1.93	23.4	3.32	2.07	27.2	3.62	2.20	29.8	3.81	2.30	31.0	3.88	2.34	34.7	4.11	2.48
	80	15.3	2.50	1.79	17.7	2.74	1.90	18.8	2.83	1.95	22.3	3.11	2.11	25.9	3.35	2.26	28.3	3.50	2.38	29.4	3.56	2.42	32.9	3.74	2.58

VT4BE-036K / B6EMMX36K-C

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
1120	60	17.9	2.64	1.99	21.2	2.96	2.10	22.6	3.09	2.15	27.3	3.49	2.30	32.0	3.83	2.45	35.3	4.05	2.56	36.7	4.14	2.60	41.4	4.41	2.76
	70	17.3	2.51	2.02	20.4	2.79	2.14	21.7	2.90	2.20	26.2	3.24	2.37	30.7	3.53	2.55	33.9	3.71	2.67	35.2	3.79	2.73	39.7	4.01	2.91
	80	16.7	2.37	2.06	19.7	2.62	2.20	21.0	2.72	2.26	25.2	3.01	2.45	29.5	3.26	2.65	32.5	3.41	2.79	33.7	3.48	2.85	38.0	3.66	3.04
1270	60	18.1	2.59	2.05	21.4	2.92	2.15	22.9	3.05	2.19	27.7	3.46	2.34	32.4	3.83	2.49	35.8	4.05	2.59	37.2	4.15	2.63	42.0	4.44	2.78
	70	17.5	2.46	2.08	20.6	2.75	2.20	22.0	2.87	2.25	26.6	3.22	2.42	31.1	3.53	2.59	34.3	3.72	2.71	35.7	3.80	2.76	40.3	4.03	2.93
	80	16.8	2.33	2.12	19.9	2.59	2.25	21.2	2.69	2.31	25.6	3.00	2.50	29.9	3.26	2.69	33.0	3.42	2.82	34.3	3.49	2.88	38.6	3.69	3.07
1420	60	18.2	2.54	2.10	21.6	2.88	2.20	23.1	3.02	2.24	27.9	3.44	2.38	32.8	3.81	2.52	36.2	4.05	2.62	37.7	4.15	2.66	42.5	4.45	2.81
	70	17.7	2.43	2.13	20.9	2.73	2.25	22.3	2.85	2.29	26.9	3.21	2.46	31.5	3.52	2.62	34.8	3.72	2.74	36.2	3.80	2.79	40.8	4.05	2.95
	80	17.1	2.30	2.17	20.1	2.56	2.30	21.4	2.67	2.36	25.8	2.98	2.54	30.2	3.25	2.73	33.3	3.42	2.86	34.6	3.48	2.91	39.0	3.69	3.10

14 SEER HEATING EXPANDED RATINGS (CONTINUED)

VT4BE-042K / B6EMMX42K-B

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
1370	60	23.8	3.02	2.31	27.5	3.22	2.50	29.0	3.30	2.58	34.3	3.53	2.85	39.6	3.72	3.12	43.3	3.83	3.31	44.9	3.88	3.39	50.2	4.01	3.66
	70	23.0	2.82	2.39	26.5	2.99	2.60	28.1	3.06	2.69	33.2	3.25	2.99	38.3	3.41	3.29	41.8	3.51	3.50	43.4	3.54	3.59	48.5	3.65	3.89
	80	22.4	2.65	2.48	25.9	2.79	2.71	27.3	2.85	2.81	32.2	3.00	3.14	37.1	3.13	3.47	40.5	3.21	3.70	41.9	3.23	3.80	46.8	3.32	4.13
1520	60	23.9	2.97	2.36	27.7	3.19	2.54	29.3	3.28	2.62	34.7	3.53	2.88	40.0	3.73	3.14	43.8	3.86	3.33	45.4	3.91	3.41	50.8	4.06	3.67
	70	23.2	2.79	2.44	26.8	2.97	2.64	28.4	3.05	2.73	33.5	3.26	3.02	38.7	3.43	3.31	42.3	3.53	3.51	43.9	3.58	3.60	49.0	3.70	3.89
	80	22.6	2.61	2.54	26.1	2.77	2.76	27.6	2.83	2.85	32.5	3.01	3.17	37.5	3.15	3.49	41.0	3.24	3.71	42.4	3.27	3.81	47.4	3.37	4.12
1670	60	24.0	2.92	2.41	27.8	3.15	2.59	29.4	3.24	2.66	34.9	3.51	2.92	40.4	3.73	3.17	44.2	3.87	3.35	45.9	3.92	3.43	51.3	4.08	3.69
	70	23.4	2.76	2.49	27.1	2.96	2.69	28.7	3.03	2.77	33.9	3.26	3.05	39.1	3.44	3.33	42.8	3.55	3.53	44.3	3.60	3.61	49.6	3.73	3.90
	80	22.8	2.58	2.59	26.3	2.75	2.80	27.8	2.82	2.89	32.8	3.01	3.20	37.8	3.16	3.51	41.3	3.25	3.72	42.8	3.29	3.82	47.8	3.40	4.12

VT4BE-048K / B6EMMX48K-C

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
1460	60	24.3	2.65	2.69	28.6	2.96	2.84	30.5	3.08	2.90	36.8	3.46	3.11	43.0	3.79	3.33	47.4	4.00	3.48	49.3	4.08	3.54	55.5	4.34	3.75
	70	23.5	2.44	2.82	27.7	2.72	2.98	29.5	2.84	3.05	35.6	3.18	3.29	41.7	3.48	3.52	45.9	3.66	3.68	47.8	3.74	3.75	53.8	3.97	3.98
	80	22.9	2.26	2.97	27.0	2.52	3.15	28.8	2.62	3.22	34.6	2.92	3.48	40.5	3.19	3.73	44.6	3.35	3.90	46.3	3.42	3.98	52.2	3.62	4.23
1660	60	24.5	2.62	2.74	29.0	2.94	2.89	30.9	3.07	2.95	37.2	3.47	3.15	43.6	3.82	3.35	48.0	4.04	3.49	50.0	4.13	3.55	56.3	4.40	3.75
	70	23.8	2.42	2.88	28.1	2.72	3.03	29.9	2.83	3.10	36.1	3.19	3.32	42.3	3.50	3.54	46.6	3.70	3.69	48.4	3.78	3.75	54.6	4.03	3.97
	80	23.2	2.24	3.04	27.3	2.50	3.20	29.1	2.61	3.27	35.1	2.93	3.51	41.1	3.22	3.74	45.2	3.39	3.91	47.0	3.47	3.98	53.0	3.69	4.21
1860	60	24.6	2.58	2.80	29.2	2.92	2.93	31.1	3.05	2.99	37.6	3.46	3.19	44.1	3.82	3.38	48.6	4.05	3.52	50.6	4.14	3.58	57.1	4.43	3.77
	70	24.1	2.41	2.94	28.5	2.71	3.08	30.3	2.83	3.15	36.6	3.20	3.35	42.8	3.52	3.56	47.2	3.73	3.71	49.0	3.81	3.77	55.3	4.07	3.98
	80	23.4	2.22	3.09	27.7	2.50	3.25	29.5	2.61	3.32	35.5	2.94	3.54	41.5	3.23	3.77	45.8	3.42	3.92	47.6	3.50	3.99	53.6	3.73	4.21

VT4BE-060K / B6EMMX60K-C

		OUTDOOR TEMPERATURE (Deg. F)																							
	Indoor T.	10			17			20			30			40			47			50			60		
CFM	Deg.F	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW	MBH	COP	kW
1510	60	31.5	2.66	3.48	37.4	2.99	3.68	40.0	3.12	3.76	48.4	3.51	4.04	56.8	3.86	4.32	62.7	4.07	4.52	65.3	4.16	4.60	73.7	4.43	4.88
	70	30.6	2.40	3.74	36.4	2.71	3.94	38.9	2.83	4.03	47.2	3.20	4.32	55.5	3.53	4.61	61.3	3.73	4.82	63.8	3.81	4.90	72.1	4.07	5.20
	80	30.1	2.20	4.01	35.7	2.48	4.23	38.2	2.59	4.32	46.3	2.93	4.63	54.3	3.22	4.95	60.0	3.41	5.16	62.4	3.48	5.26	70.5	3.71	5.57
1710	60	31.8	2.65	3.52	37.8	2.99	3.70	40.4	3.13	3.78	48.9	3.54	4.05	57.5	3.91	4.31	63.4	4.13	4.50	66.0	4.23	4.58	74.6	4.51	4.85
	70	30.9	2.41	3.77	36.8	2.72	3.96	39.3	2.85	4.04	47.7	3.24	4.32	56.1	3.58	4.60	61.9	3.79	4.79	64.5	3.88	4.87	72.8	4.15	5.15
	80	30.3	2.19	4.05	36.0	2.48	4.25	38.5	2.60	4.34	46.7	2.96	4.63	54.9	3.27	4.92	60.7	3.47	5.12	63.1	3.55	5.21	71.3	3.80	5.50
1910	60	31.8	2.63	3.55	37.9	2.98	3.73	40.5	3.12	3.81	49.2	3.55	4.07	58.0	3.92	4.33	64.1	4.16	4.51	66.7	4.26	4.59	75.4	4.56	4.85
	70	31.3	2.41	3.81	37.2	2.73	4.00	39.7	2.86	4.08	48.2	3.26	4.34	56.6	3.61	4.60	62.5	3.83	4.78	65.1	3.92	4.86	73.5	4.20	5.13
	80	30.6	2.19	4.09	36.4	2.49	4.28	38.9	2.61	4.36	47.2	2.98	4.64	55.4	3.31	4.91	61.2	3.52	5.10	63.7	3.60	5.18	72.0	3.87	5.45

ENERGY STAR

USA DESIGNED & ASSEMBLED

C ETL LISTED US Intertek

We Encourage Professionalism. Through Technician Certification by NATE

AHRI CERTIFIED www.ahridirectory.org Unitary Small HP AHRI Standard 210/240

HRAI MEMBER COMPANY

GENERAL TERMS OF LIMITED WARRANTY

NORDYNE will furnish a replacement for any part of this product which fails in normal use and service within the first ten years of installation, in accordance with the terms of the warranty.

For complete details of the Limited Warranty, including applicable terms and conditions, see your local installer or contact the NORDYNE warranty department for a copy.

NORDYNE
COMPLETE COMFORT. GENUINE VALUE. 8000 Phoenix Parkway | O'Fallon, MO 63368-3827

Specifications and illustrations subject to change without notice and without incurring obligations. Printed in U.S.A (07/2012)

889D-0712 (Replaces 889D-0512)

Appendix D

SECTION 23 30 00
HVAC AIR DISTRIBUTION

PART 1 GENERAL

1.1 SUMMARY

A. Provide HVAC air distribution systems and ductwork.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, including operating instructions, list of spare parts and maintenance schedule.

1.3 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers, which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 MATERIALS

A. HVAC Air Distribution:
   1. Manufacturers: Airtemp Air Handler B6EMMX24K-A.
   2. Application: Distribute conditioned air to duct system.
   3. Sustainable Design: Utility efficient equipment and fixtures.
   4. Sustainable Design: Commissioning.
   5. Central Station Air-Handling Units:
      a. Indoor Constant-Volume, Central-Station-Air Handling: ARI 430, NFPA 90A.
      b. Components: Motors, coils, dampers, filters.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to B6EMMX24K-A installation guide for complete instructions for proper installation in upflow configuration.

B. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials in proper relation with adjacent construction and with uniform appearance for exposed work. Coordinate with work of other sections. Comply with applicable regulations and building code requirements.

C. Support piping properly. Pitch to drain points. Install with pipe expansion loops, mechanical expansion joints, and anchors.

D. Install shutoff valves on each piece of equipment on both hot and cold water supply.

E. Install ductwork in accordance with SMACNA recommendations. Seal duct seams with sealer. Provide splitters and balancing dampers. Provide fire dampers and automatic smoke and fire dampers where required. Provide flexible connectors and inlet and

discharge connections. Clean before testing and balancing.

F. Clearly label and tag all components.

G. Test and balance all systems for proper operation.

H. Restore damaged finishes. Clean and protect work from damage.

I. Instruct Owner's personnel in proper operation of systems.

3.2 MAINTENANCE

A. B6 Series Air Handlers are not supplied with a single air filter when shipped from the factory. It is recommended that the filter be cleaned or replaced monthly. Newly built or recently renovated homes may require more frequent changing until the construction dust has minimized. Filter sizes shown in Table 2 are available at most local retailers

B. Dirt and lint can create excessive loads on the motor resulting in higher than normal operating temperatures and shortened service life. It is recommended that the blower compartment be cleaned of dirt or lint that may have accumulated in the compartment or on the blower and motor as part of the annual inspection.

C. Inspect the blower wheel blades for accumulations of dirt and clean if necessary. Inspect mounting nut for tightness when done.

D. Inspect the blower assembly and motor mounting brackets for tightness and corrosion. Correct deficiencies if necessary. The blower motor contains sealed bearings and under normal operating conditions, no maintenance is necessary for the life of the equipment.

END OF SECTION

B6EMMX Series

Air Handler with TXV
14-15 SEER Residential System
18,000 - 60,000 Btuh (Heat Pump & Air Conditioner)
R-410A Refrigerant

The B6EMMX Series of air handlers, when combined with our heat pump or air conditioner, offers a full line of quality, split system heating and cooling equipment.

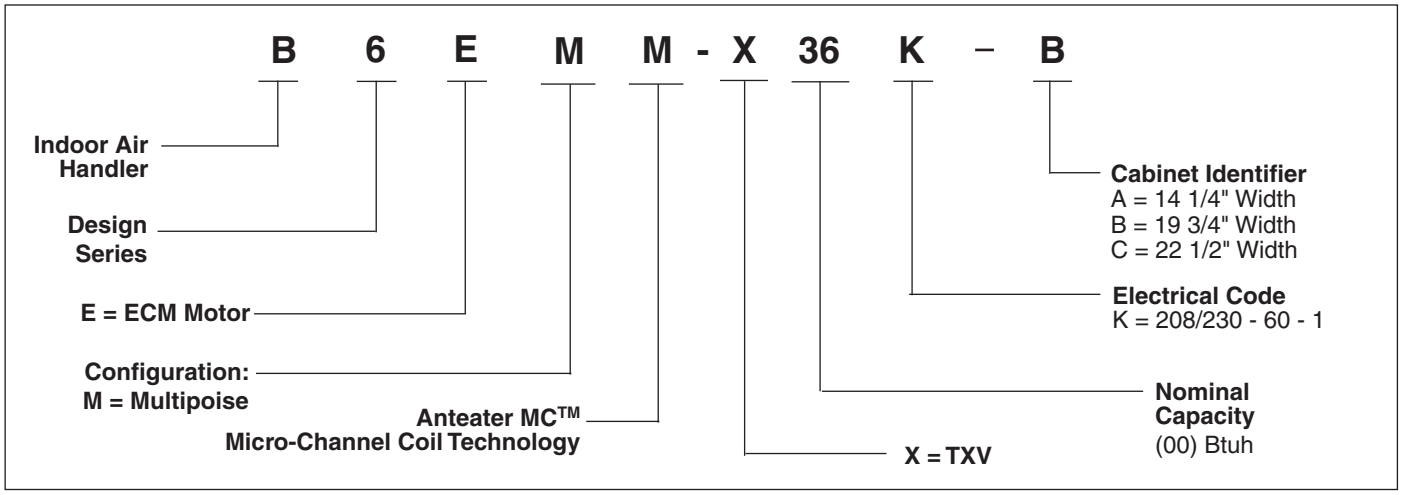
WARRANTY

– This product carries a 5-year all parts warranty. When installed with a matched outdoor unit, the air handler will carry the outdoor system warranty. See current warranty document or visit our consumer web site for warranty details.

FEATURES and BENEFITS

- **Energy Efficient Fixed Speed ECM Motor:** Provides 16 field-selectable cooling airflows and 16 field-selectable heating airflows to match any application.
- **Quiet Blower Operation:** Extra quiet and smooth blower on and off cycles.
- **Reduced air stratification:** This results in improved air quality by optimizing humidity removal and filtration capabilities.
- **Multi-poised:** Can be used in horizontal, upflow, downflow and vertical applications.
- **Built in Filter Rack:** makes the air handler easy to service.
- **Plug-in Heater Kit:** Available in 5 kw through 30 kw (Not for use in 115 Volt units)
- **Circuit Board:** Incorporating blower time delay relay, low voltage terminal strip, and heat-strip sequencing.
- **Breaker Accessibility:** Breaker accessible from the front of the unit when heater is applied.
- **Plastic Drain Pan:** Provides corrosion resistance.
- **Durable Cabinet:** Galvanized steel with a polyurethane finish. The finish will endure 950 hours of salt spray and resist corrosion 50% better than comparable units.
- **Designed to meet the requirements 610.2.A.2:** Meets Florida building code requirements for air leakage.
- **Thermal Expansion Valve:** Factory installed externally equalized thermal expansion valve provides precise refrigerant control under varying load conditions.
- **Cabinet Insulation:** 1" insulation with an R-value of 4.2 contributes to quiet operation and prevents cabinet sweating in difficult applications.
- **Anteater MC™ Micro-Channel Coil Technology:** All aluminum coil provides high corrosion resistance.

MODEL IDENTIFICATION CODE



SPECIFICATIONS

Model B6EMMX	24K-A	24K-B	30K-A	30K-B	36K-B	42K-B	48K-C	60K-C
Refrigerant Flow Control	TXV	TXV	TXV	TXV	TXV	TXV	TXV	TXV
Maximum Available Auxiliary Heat (kw)	15	20	15	20	20	20	30	30
Nominal Blower Size (D X W)	10 x 6	11 x 8	10 x 6	11 x 8	11 x 8	11 x 8	11 x 10	11 x 10
Variable Speed Motor HP	1/2	1/2	1/2	1/2	1/2	1/2	3/4	3/4
Filter Size	12 x 20 x 1	18 x 20 x 1	12 x 20 x 1	18 x 20 x 1	18 x 20 x 1	18 x 20 x 1	20 x 20 x 1	20 x 20 x 1
Approximate Shipping Weight (lbs.)	93	105	95	107	110	117	140	140

NOTES: See current AHRI Directory for certified combinations and ratings. **www.ahridirectory.org**

MINIMUM HEATING AIRFLOW SETTINGS (in CFM)

Cabinet	Nominal Electic Heat KW						
	5	8	10	15	20	25	30
A	800	900	1000	1300	N/A	N/A	N/A
B	900	1000	1100	1300	1500	N/A	N/A
C	1000	1100	1200	1400	1600	1800	2000

ACCESSORIES

Accessory Kit Description	Cabinet Size			Part Number
	A	B	C	
Downflow Adaptor Kit	X			917342
		X		919321
			X	919322
Single Circuit Adaptor for 2 Circuit Breakers	X	X	X	913874
Single Circuit Adaptor for 3 Circuit Breakers	n/a	n/a	X	913556

240v Single-Phase Electric Heater Kits

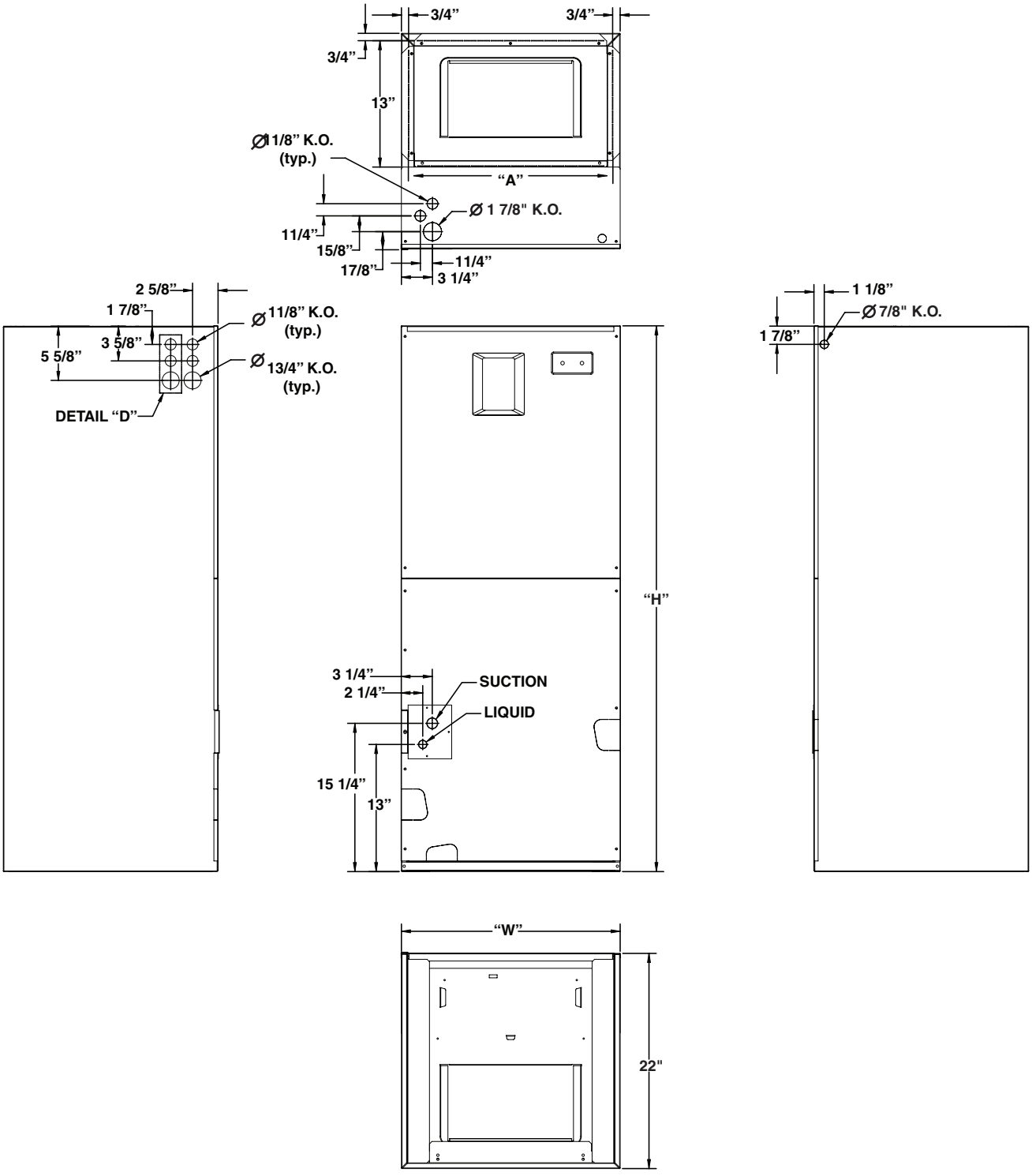
Nominal KW	Matched Units								Part Number	
	24K-A	24K-B	30K-A	30K-B	36K-B	42K-B	48K-C	60K-C	With Circuit Breakers	Without Circuit Breakers
5	X	X	X	X	X	X	X	X	904407	904406
8	X	X	X	X	X	X	X	X	904409	904408
10	X	X	X	X	X	X	X	X	904412	904411
15	X	X	X	X	X	X	X	X	904414	n/a
20	n/a	X	n/a	X	X	X	X	X	904416	n/a
25	n/a	n/a	n/a	n/a	n/a	n/a	X	X	921609	n/a
30	n/a	n/a	n/a	n/a	n/a	n/a	X	X	921610	n/a

240v Three-Phase Electric Heater Kits

Nominal KW	Matched Units								Part Number	
	24K-A	24K-B	30K-A	30K-B	36K-B	42K-B	48K-C	60K-C	With Circuit Breakers	Without Circuit Breakers
9	X	X	X	X	X	X	X	X	904410	n/a
15	X	X	X	X	X	X	X	X	904415	n/a

DIMENSIONS

Models B6EMMX	Height	Width	Refrigerant Connections		Filter Size	Supply Air Duct Dimensions
			Suction Dia.	Liquid Dia.		
24K-A	43 1/2	14 1/4	3/4	3/8	12 x 20 x 1	12 7/8 x 12 3/4
24K-B	43 1/2	19 3/4	3/4	3/8	18 x 20 x 1	12 7/8 x 18 1/4
30K-A	43 1/2	14 1/4	3/4	3/8	12 x 20 x 1	12 7/8 x 12 3/4
30K-B	43 1/2	19 3/4	3/4	3/8	18 x 20 x 1	12 7/8 x 18 1/4
36K-B	49 1/2	19 3/4	7/8	3/8	18 x 20 x 1	12 7/8 x 18 1/4
42K-B	49 1/2	19 3/4	7/8	3/8	18 x 20 x 1	12 7/8 x 18 1/4
48K-C	56	22 1/2	7/8	3/8	20 x 20 x 1	12 7/8 x 21
60K-C	56	22 1/2	7/8	3/8	20 x 20 x 1	12 7/8 x 21



ELECTRICAL DATA

Appendix D

			Voltage 240								Voltage 208							
			Minimum Circuit Ampacity				Maximum Over-current Rating				Minimum Circuit Ampacity				Maximum Over-current Rating			
Cabinet	Capacity	Model Number H6HK-	Circuit A	Circuit B	Circuit C	Single Circuit	Circuit A	Circuit B	Circuit C	Single Circuit	Circuit A	Circuit B	Circuit C	Single Circuit	Circuit A	Circuit B	Circuit C	Single Circuit
A	24/30	None	4.5	-	-	4.5	15.0	-	-	15.0	4.8	-	-	4.8	15.0	-	-	15.0
		005H-XX	29.5	-	-	29.5	30.0	-	-	30.0	26.4	-	-	26.4	30.0	-	-	30.0
		008H-XX	44.1	-	-	44.1	45.0	-	-	45.0	39.1	-	-	39.1	40.0	-	-	40.0
		010H-XX	54.5	-	-	54.5	60.0	-	-	60.0	48.1	-	-	48.1	50.0	-	-	50.0
		015H-XX	54.5	25.0	-	68.1	60.0	30.0	-	80.0	48.1	21.7	-	69.8	50.0	25.0	-	70.0
		009Q-XX	-	-	-	31.6	-	-	-	35.0	-	-	-	28.2	-	-	-	30.0
		015Q-XX	-	-	-	47.8	-	-	-	50.0	-	-	-	42.3	-	-	-	45.0
B	24/30/ 36/42	None	4.5	-	-	4.5	15.0	-	-	15.0	4.8	-	-	4.8	15.0	-	-	15.0
		005H-XX	29.5	-	-	29.5	30.0	-	-	30.0	26.4	-	-	26.4	30.0	-	-	30.0
		008H-XX	44.1	-	-	44.1	45.0	-	-	45.0	39.1	-	-	39.1	40.0	-	-	40.0
		010H-XX	54.5	-	-	54.5	60.0	-	-	60.0	48.1	-	-	48.1	50.0	-	-	50.0
		015H-XX	54.5	25.0	-	68.1	60.0	30.0	-	80.0	48.1	21.7	-	69.8	50.0	25.0	-	70.0
		020H-XX	54.5	50.0	-	104.5	60.0	60.0	-	110.0	48.1	43.3	-	91.4	50.0	45.0	-	100.0
		009Q-XX	-	-	-	31.6	-	-	-	35.0	-	-	-	28.2	-	-	-	30.0
		015Q-XX	-	-	-	47.8	-	-	-	50.0	-	-	-	42.3	-	-	-	45.0
C	48/60	None	6.3	-	-	6.3	15.0	-	-	15.0	6.8	-	-	6.8	15.0	-	-	15.0
		005H-XX	31.3	-	-	31.3	35.0	-	-	35.0	28.4	-	-	28.4	30.0	-	-	30.0
		008H-XX	45.8	-	-	45.8	50.0	-	-	50.0	41.1	-	-	41.1	45.0	-	-	45.0
		010H-XX	56.3	-	-	56.3	60.0	-	-	60.0	50.1	-	-	50.1	60.0	-	-	60.0
		015H-XX	56.3	25.0	-	81.3	60.0	30.0	-	90.0	50.1	21.7	-	71.8	60.0	25.0	-	80.0
		020H-XX	56.3	50.0	-	106.3	60.0	60.0	-	110.0	50.1	43.3	-	93.4	60.0	45.0	-	100.0
		025H-XX	56.3	50.0	25.0	131.3	60.0	60.0	60.0	150.0	50.1	43.3	21.7	115.1	60.0	45.0	45.0	125.0
		030H-XX	56.3	50.0	50.0	156.3	60.0	60.0	60.0	175.0	50.1	43.3	43.3	136.8	60.0	45.0	45.0	150.0
		009Q-XX	-	-	-	33.3	-	-	-	35.0	-	-	-	30.2	-	-	-	35.0
		015Q-XX	-	-	-	49.6	-	-	-	50.0	-	-	-	44.3	-	-	-	45.0

AIRFLOW DATA

Appendix D

	Switch Settings				Cooling or Heating Airflow (CFM)							
					Dry Coil ESP							
	1/5	2/6	3/7	4/8	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
B6EMMX A-cabinet	0	0	0	0	585	550	520	460	420	405		
	1	0	0	0	710	670	650	610	560	530	475	440
	0	1	0	0	845	790	765	715	680	655	625	580
	1	1	0	0	890	865	840	785	760	710	680	655
	0	0	1	0	955	925	900	850	825	790	770	720
	1	0	1	0	1030	995	975	940	910	870	840	815
	0	1	1	0	1115	1085	1060	1020	995	965	925	905
	1	1	1	0	1155	1130	1095	1070	1040	1010	985	950
	0	0	0	1	1200	1175	1145	1110	1085	1060	1025	1000
	1	0	0	1	1240	1215	1195	1170	1140	1110	1080	1060
	0	1	0	1	1320	1290	1265	1240	1215	1185	1160	1130
	1	1	0	1	1355	1330	1305	1280	1255	1220	1200	1175
	0	0	1	1	1405	1375	1345	1325	1295	1275	1250	1210
	1	0	1	1	1440	1415	1385	1355	1325	1290	1255	1215
	0	1	1	1	1465	1425	1390	1355	1320	1290	1260	1215
	1	1	1	1	1465	1425	1390	1355	1320	1290	1260	1215

	Switch Setting				Cooling or Heating Airflow (CFM)							
					Dry Coil ESP							
	1/5	2/6	3/7	4/8	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
B6EMMX B-cabinet	0	0	0	0	600	550	430	390				
	1	0	0	0	660	610	540	460	425			
	0	1	0	0	830	750	695	640	580	520		
	1	1	0	0	860	825	765	690	630	600	525	485
	0	0	1	0	935	895	835	790	710	655	620	585
	1	0	1	0	1045	975	920	875	830	795	720	685
	0	1	1	0	1095	1040	995	950	900	850	805	750
	1	1	1	0	1155	1105	1060	1010	965	920	870	825
	0	0	0	1	1230	1185	1140	1090	1045	1010	965	920
	1	0	0	1	1285	1260	1210	1165	1125	1080	1040	1010
	0	1	0	1	1330	1290	1245	1205	1170	1125	1085	1045
	1	1	0	1	1395	1365	1315	1275	1235	1205	1160	1130
	0	0	1	1	1450	1405	1375	1335	1295	1260	1220	1180
	1	0	1	1	1490	1450	1410	1385	1340	1300	1270	1230
	0	1	1	1	1530	1485	1460	1425	1380	1350	1310	1280
	1	1	1	1	1530	1490	1465	1425	1390	1350	1310	1285

NOTE: 0 = OFF, 1 = ON

AIRFLOW DATA continued

Appendix D

	Switch Setting				Cooling or Heating Airflow (CFM)							
					Dry Coil ESP							
	1/5	2/6	3/7	4/8	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
B6EMMX C-cabinet	0	0	0	0	710	580	395					
	1	0	0	0	830	690	675	530	505			
	0	1	0	0	930	875	710	665	560	530		
	1	1	0	0	1065	1015	900	840	800	705	665	635
	0	0	1	0	1185	1115	1010	960	925	875	830	745
	1	0	1	0	1275	1220	1175	1120	1060	970	930	890
	0	1	1	0	1365	1350	1255	1200	1150	1105	1060	1025
	1	1	1	0	1480	1430	1370	1325	1265	1225	1185	1140
	0	0	0	1	1560	1535	1485	1430	1375	1335	1285	1240
	1	0	0	1	1650	1600	1545	1500	1450	1405	1360	1305
	0	1	0	1	1730	1685	1660	1610	1570	1520	1470	1420
	1	1	0	1	1785	1740	1695	1645	1615	1545	1510	1470
	0	0	1	1	1865	1820	1785	1750	1695	1655	1605	1560
	1	0	1	1	1920	1890	1850	1805	1765	1715	1675	1640
	0	1	1	1	2010	1965	1960	1900	1850	1810	1775	1730
	1	1	1	1	2065	2020	1985	1955	1915	1880	1840	1810

NOTE: 0 = OFF, 1 = ON

Appendix D

GENERAL TERMS OF LIMITED WARRANTY

NORDYNE will furnish a replacement for any part of this product which fails in normal use and service within the first five years of installation, in accordance with the terms of the warranty.

For complete details of the Limited Warranty, including applicable terms and conditions, see your local installer or contact the NORDYNE warranty department for a copy.

Appendix D

SECTION 23 00 00
HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 GENERAL

1.1 SUMMARY

A. Provide heating, ventilating, and air conditioning systems.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, including operating instructions, list of spare parts and maintenance schedule.

PART 2 PRODUCTS

2.1 MATERIALS

A. Heat Recovery Ventilator
   1. Manufacturer: Honeywell VNT5150H1000
   2. Application: Provide whole house ventilation
   3. Sustainable Design: Energy efficient equipment and fixtures.
   4. Sustainable Design: Energy modeling.
   5. Sustainable Design: Commissioning.
   6. Type: Central HVAC equipment.
      a. Air-to-air energy recovery equipment.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to Honeywell VNT5150H1000 installation guide for more details.

B. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials in proper relation with adjacent construction and with uniform appearance for exposed work. Coordinate with work of other sections. Comply with applicable regulations and building code requirements.

C. Support piping properly. Pitch to drain points. Install with pipe expansion loops, mechanical expansion joints, and anchors.

D. Install shutoff valves on each piece of equipment on both hot and cold water supply.

E. Install ductwork in accordance with SMACNA recommendations. Seal duct seams with sealer. Provide splitters and balancing dampers. Provide fire dampers and automatic smoke and fire dampers where required. Provide flexible connectors and inlet and discharge connections. Clean before testing and balancing.

F. Clearly label and tag all components.

G. Test and balance all systems for proper operation.

H. Restore damaged finishes. Clean and protect work from damage.

I. Instruct Owner's personnel in proper operation of systems.

3.2 MAINTENANCE

A. Clean filters four times per year or as needed, vacuum the filters. Replace filters as needed.

B. Once a year or as needed, clean the interior of the unit (walls and drain pan) with a mild and nonabrasive soap. It is recommended to use products that are environmentally-friendly.

C. Once a year or as needed, vacuum the four surfaces, let soak in warm water and mild soap for 15 minutes, then spray rinse and let dry

D. See additional cleaning steps as needed in installation guide provided.

3.3 OPERATION

A. Refer to installation manual for balancing steps, and control panel use.

END OF SECTION

Appendix D

SECTION 23 00 00
HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 GENERAL

1.1 SUMMARY

A. Provide heating, ventilating, and air conditioning systems.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, including operating instructions, list of spare parts and maintenance schedule.

PART 2 PRODUCTS

2.1 MATERIALS

A. Bathroom Exhaust Fan
   1. Manufacturer: Broan QTRE110 Ultra Silent Fan
   2. Application: Provide continuous or intermittent bathroom ventilation.
   3. Sustainable Design: Energy efficient equipment and fixtures.
   4. Sustainable Design: Energy modeling.
   5. Sustainable Design: Commissioning.
   6. Type: Convection heating and cooling units.
      a. Unit ventilators.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to Broan QTRE110 Ultra Silent Fan installation guide for more details.

B. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials in proper relation with adjacent construction and with uniform appearance for exposed work. Coordinate with work of other sections. Comply with applicable regulations and building code requirements.

C. Support piping properly. Pitch to drain points. Install with pipe expansion loops, mechanical expansion joints, and anchors.

D. Install shutoff valves on each piece of equipment on both hot and cold water supply.

E. Install ductwork in accordance with SMACNA recommendations. Seal duct seams with sealer. Provide splitters and balancing dampers. Provide fire dampers and automatic smoke and fire dampers where required. Provide flexible connectors and inlet and discharge connections. Clean before testing and balancing.

F. Clearly label and tag all components.

G. Test and balance all systems for proper operation.

H. Restore damaged finishes. Clean and protect work from damage.

I. Instruct Owner's personnel in proper operation of systems.

3.2 MAINTENANCE

A. For quiet and efficient operation, long life, and attractive appearance - lower or remove grille and vacuum interior of unit with the dusting brush attachment.

B. The motor is permanently lubricated and never needs oiling. If the motor bearings are making excessive or unusual noises, replace the blower assembly (includes motor and impeller).

3.3 OPERATION

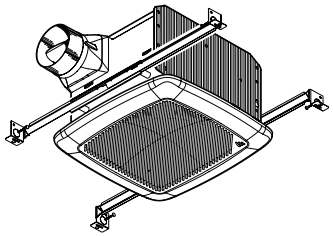
A. Use an on/off switch or speed control to operate this ventilator. See “Connect Wiring” for details. Use of speed controls other than the Broan Models 78V and 78W may cause a motor humming noise.

END OF SECTION

BROAN®

SPECIFICATION SHEET

MODEL QTRE100S HUMIDITY SENSING FAN



A modern-styled, high performance fan, with sensing circuitry, that "knows" when to ventilate the room.

FEATURES

BLOWER:
- Plug-in, permanently lubricated motor - engineered for continuous operation
- Dynamically balanced centrifugal blower wheel for quiet, efficient performance
- Maintains a high percentage of rated CFM in less than ideal installations
- Low RPM for quiet operation

HOUSING:
- Rugged, 26 gauge, galvanized steel construction
- 4" round ducting for superior performance
- Polymeric duct connector with tapered sleeve and no metallic clatter
- 7-5/8" height allows for 2" x 8" (nominal) joist installations
- Sturdy, easy, four-point mounting directly to joist
- Includes unique spacer (patent pending) for mounting to engineered "I" joists
- Includes hanger bars to position housing anywhere between 16" to 24"-on-center joists
- Two sets of mounting holes for hanger bars allow flush installation with bottom or top of drywall

GRILLE:
- Polymeric construction
- Innovative design - the result of extensive research with designers and consumers

AUTOMATIC CONTROL:
- Humidity control automatically turns fan ON when either of these conditions is detected:
  - a rapid to moderate increase of humidity
  - humidity above factory set-point
- Two wire manual operation for odor control - Turns fan ON when power line through wall switch is cycled ON, OFF and back ON
- Remains ON for 20 minutes after humidity has stabilized and is below factory set-point or after manually initiated through power line cycling
- Saves energy because unit runs only for the time required. A unit controlled with a wall timer may keep fan ON longer than required or turn it OFF before room is sufficiently ventilated

CONTROLS (Purchase separately):
- Refer to Broan's catalog for a complete line of accessories to effectively adapt these fans to your construction requirements

U.L. Listed for use over bathtubs and showers when connected to a GFCI protected branch circuit (ceiling mount only).

3-Year Warranty

HVI® 2100 CERTIFIED

UL®

ENERGY STAR

Broan-NuTone LLC Hartford, Wisconsin www.broan.com 800-558-1711

REFERENCE	QTY.	REMARKS	Project
			Location
			Architect
			Engineer
			Contractor
			Submitted by Date

TYPICAL SPECIFICATION

Ceiling Ventilator shall be Broan Model QTRE100S.

The unit will have a control that will automatically turn fan ON when humidity increase is rapid to moderate, or when humidity is higher than factory set-point, or when supply power is cycled from ON (for more than a second) to OFF (for less than a second) and back ON. It shall turn OFF 20 minutes after humidity has stabilized and is below factory set-point, or after manually initiated by supply power cycling.

Ceiling Ventilator shall have corrosion resistant galvanized steel housing with four-point mounting capability. It shall be ducted to a roof or wall cap using 4" round ductwork.

Blower assembly shall be removable, have a centrifugal-type blower wheel and a permanently lubricated motor designed for continuous operation.

Non-metallic damper/duct connector shall be included.

Air delivery shall be no less than 100 CFM and sound level no greater than 1.5 Sones. All air and sound ratings shall be certified by HVI.

Ceiling Ventilator shall be Energy Star® qualified and have an energy efficient permanent split capacitor motor.

Ceiling Ventilator shall be U.L. Listed for use over bathtubs and showers when connected to a GFCI protected branch circuit.

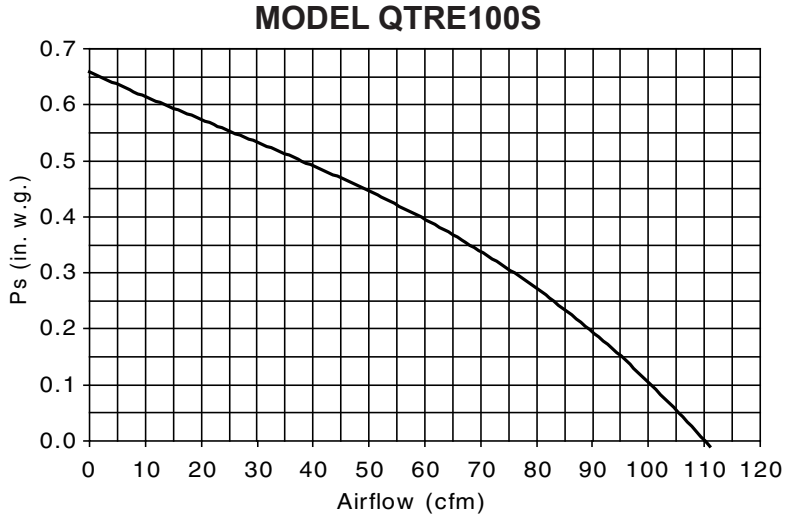
PERFORMANCE RATINGS
MODEL QTRE100S VENTILATOR

HVI PERFORMANCE

Model	Sones @0.1" Ps	CFM @0.1" Ps
QTRE100S	1.5	100

HVI-2100 CERTIFIED RATINGS comply with new testing technologies and procedures prescribed by the Home Ventilating Institute, for off-the-shelf products, as they are available to consumers. Product performance is rated at 0.1 in. static pressure, based on tests conducted in a state-of-the-art test laboratory. Sones are a measure of humanly-perceived loudness, based on laboratory measurements.

AIR FLOW PERFORMANCE



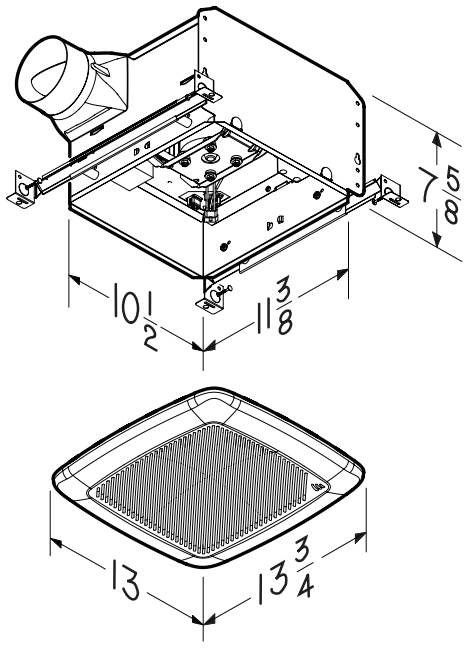
AMPS

Model	Amps*
QTRE100S	0.3

* Total connected load

WEIGHT

Model	Shipping Weight
QTRE100S	12.2 lbs.



Appendix D

SECTION 23 30 00
HVAC AIR DISTRIBUTION - REGISTERS

PART 1 GENERAL

1.1 SUMMARY

A. Provide diffusers and registers for HVAC air distribution system.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, including operating instructions, list of spare parts and maintenance schedule.

1.3 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers, which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 MATERIALS

A. HVAC Air Distribution:
   1. Manufacturers: TruAire.
      a. 14” x 8” bar-type side wall registers.
      b. 14” x 8” baseboard return grilles.
   2. Application: Locations indicated.
   3. Sustainable Design: Utility efficient equipment and fixtures.
   4. Sustainable Design: Commissioning.
   5. Air Outlets and Inlets:
      a. Ceiling Air Diffusers: Patterns, dampers, accessories suitable for use.
      b. Wall Registers and Grilles: Patterns, dampers, accessories suitable for use.

END OF SECTION

Appendix D

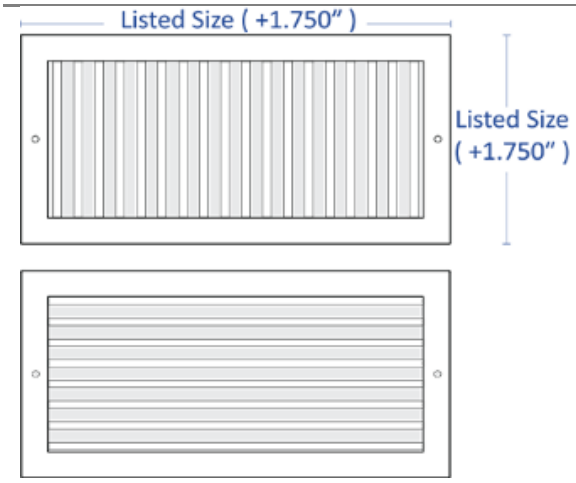
TRUaire REGISTERS & GRILLES™

Submittal and Drawing: Model 210

Submitted by: _____

Date: _____

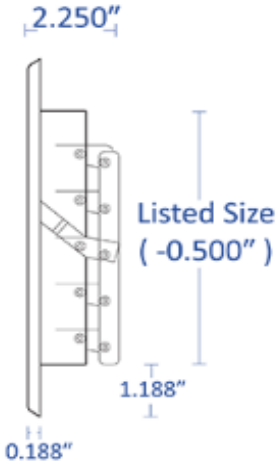
Bar Type Supply | Side wall / Ceiling | **Model:**



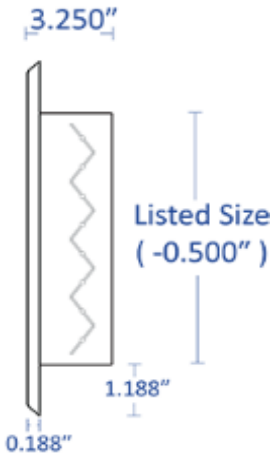
Available Options

- ☐ Aluminum
- ☐ Steel
- ☐ Multi-Shutter Damper
- ☐ Opposed Blade Damper
- ☐ Horizontal blades
- ☐ Vertical blades

Multi-Shutter Damper



Opposed Blade Damper



Model Features

Single deflection adjustable bars
One piece frame (up to 14" x 10")
Durable white powder coat finish

Material: Steel or Aluminum

Face: Adjustable Bar Type

Model Size: ☐

Project Name: _____ Architect: _____

Project Location: _____ Engineer: _____

Contractor: _____

T.A. Industries, Inc. 11335 Greenstone Ave
Santa Fe Springs, CA 90670
Tel. 562-466-1000
Fax. 562-466-1010
truaire.com
mytruairehome.com

Appendix D

SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Provide instrumentation and control for HVAC.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Operation Data: Submit manufacturer's operation data, including operating instructions.

1.3 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 MATERIALS

A. Instrumentation and Control for HVAC:
   1. Manufacturers: Honeywell YTHX9421R5085WW Prestige Thermostat
   2. Application: Provide control for split system with coupled HRV.
   3. Sustainable Design: Utility efficient equipment and fixtures.
   4. Sustainable Design: Commissioning.
   5. Electric Control System Components:
      a. Valves: Control valves, service valves, terminal unit control valves.
      b. Dampers: Automatic control dampers, frames, and damper and valve motors.
      c. Thermostats: Room remote-bulb fire protection low-temperature thermostats.
      d. Clocks: 7 day, 24 hour type with power backup.
      e. Sensors: Electronic temperature and relative humidity sensors.
      f. Controllers: Step, electronic, fan speed, and electric heat current controllers.
      g. Control Panels: Local control panels, central control panels.
   6. Pneumatic Control System Components:
      a. Air Piping: ASTM B 88 seamless copper tubing.
      b. Air Piping: ASTM D 2737 polyethylene non- metallic tubing.
      c. Valves: Pneumatic control valves and service valves.
      d. Dampers: Automatic control dampers and frames, and pneumatic operators.
      e. Thermostats: Room and return air thermostats; fire protection thermostats.
      f. Humidistats: Fully proportional type.
      g. Controllers: Temperature, humidity, static pressure and dewpoint controllers.
      h. Sensors: Temperature sensors; humidity sensors; pressure sensors.
      i. Clocks: 7 day, 24 hour type with power backup.
      j. Air Supply Systems: Duplex air compressor.
      k. Air Supply Systems: Single air compressor dryer system.
      l. Air Supply Systems: Single air compressor refrigerator drier system.
      m. Control Panels: Local control panels, central control panels.

PART 3 EXECUTION

Appendix D

3.1 INSTALLATION

A. Refer to Honeywell YTHX9421R5085WW Prestige thermostat installation guide for proper wiring and incorporation with other system modules.

B. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials in proper relation with adjacent construction and with uniform appearance for exposed work. Coordinate with work of other sections. Comply with applicable regulations and code requirements. Provide proper clearances for servicing.

C. Maintain indicated fire ratings of walls, partitions, ceilings and floors at penetrations. Seal with firestopping to maintain fire rating.

D. Clearly label and tag all components.

E. Test and balance all systems for proper operation.

F. Restore damaged finishes. Clean and protect work from damage.

G. Instruct Owner's personnel in proper operation of systems.

3.2 OPERATION

A. Refer to Honeywell YTHX9421R5085WW Prestige Thermostat Owner’s Manual for proper operation.

END OF SECTION

Appendix D

SECTION 23 30 00
HVAC AIR DISTRIBUTION – METAL DUCTWORK

PART 1 GENERAL

1.1 SUMMARY

A. Provide HVAC air distribution systems and ductwork.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

1.3 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers, which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

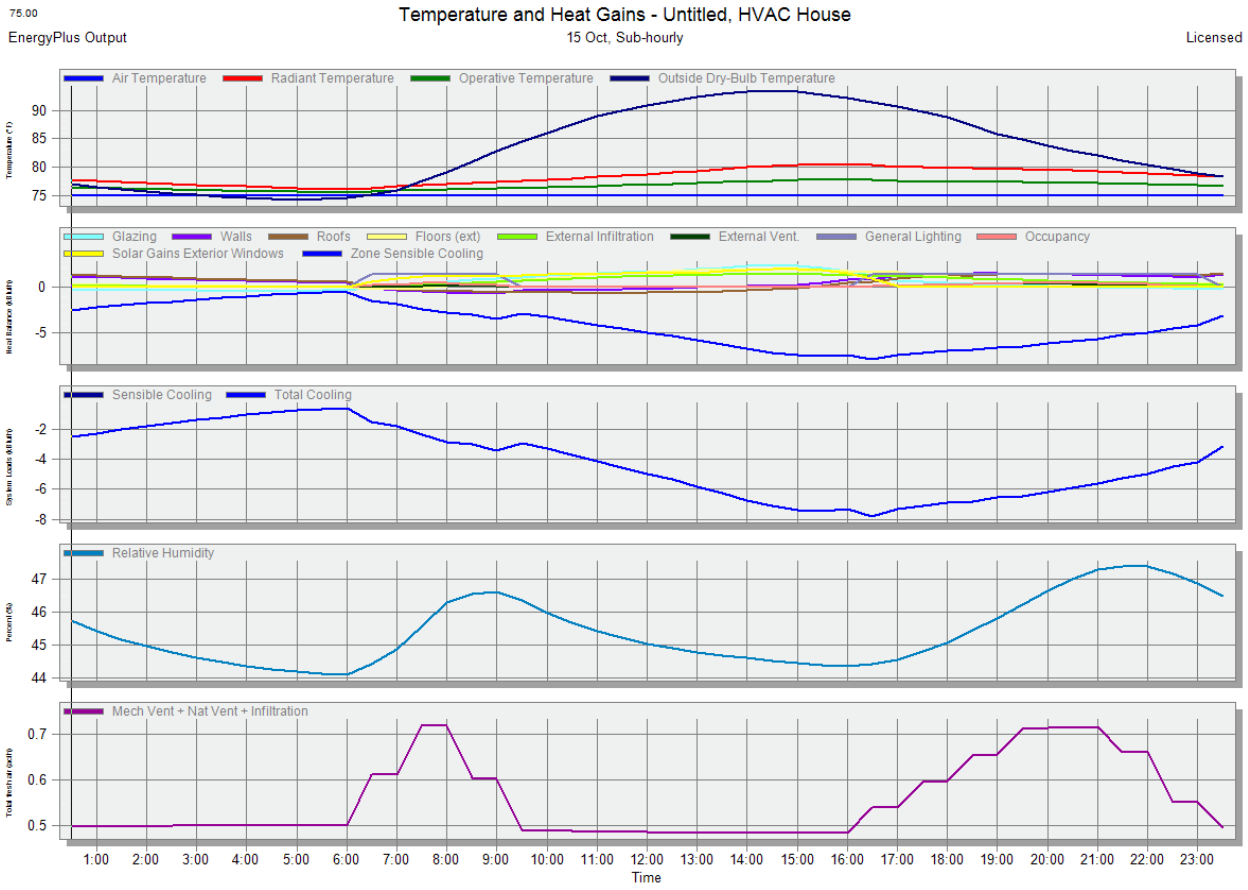
PART 2 PRODUCTS

2.1 MATERIALS

A. HVAC Air Distribution:
   1. Size:
      a. 12” round
      b. 9” round
      c. 6” round
      d. 12” round flex
      e. 9” round flex
      f. 6” round flex
   2. Application: Locations indicated.
   3. Sustainable Design: Utility efficient equipment and fixtures.
   4. Sustainable Design: Commissioning.
   5. Metal Ductwork:
      a. Types: Rectangular, round, and flat-oval metal ducts and plenums.
      b. Galvanized Sheet Steel: Lock-forming quality, ASTM A 653 G90.
      c. PVC-Coated Galvanized Steel: UL 181 Class 1, ASTM A 653 G90.
      d. Carbon Steel Sheets: ASTM A 366, cold-rolled sheets.
      e. Stainless Steel: ASTM A 480, Type 316, with No. 4 finish if exposed.
      f. Aluminum Sheets: ASTM B 209, Alloy 3003-H14, sheet form, bright finish.
      g. Duct Liner: NFPA 90A, TIMA AHC-101, ASTM C 1071, Type II.
      h. Sealing Materials: Joint and seam sealants, tapes and mastics.
      i. Firestopping: Fire-resistant sealant.
      j. Hangers and Supports: Concrete inserts, powder actuated fasteners.
      k. Fabrication: SMACNA HVAC Duct construction Standards.

END OF SECTION

1). Final Cooling Design with Split HVAC System Template

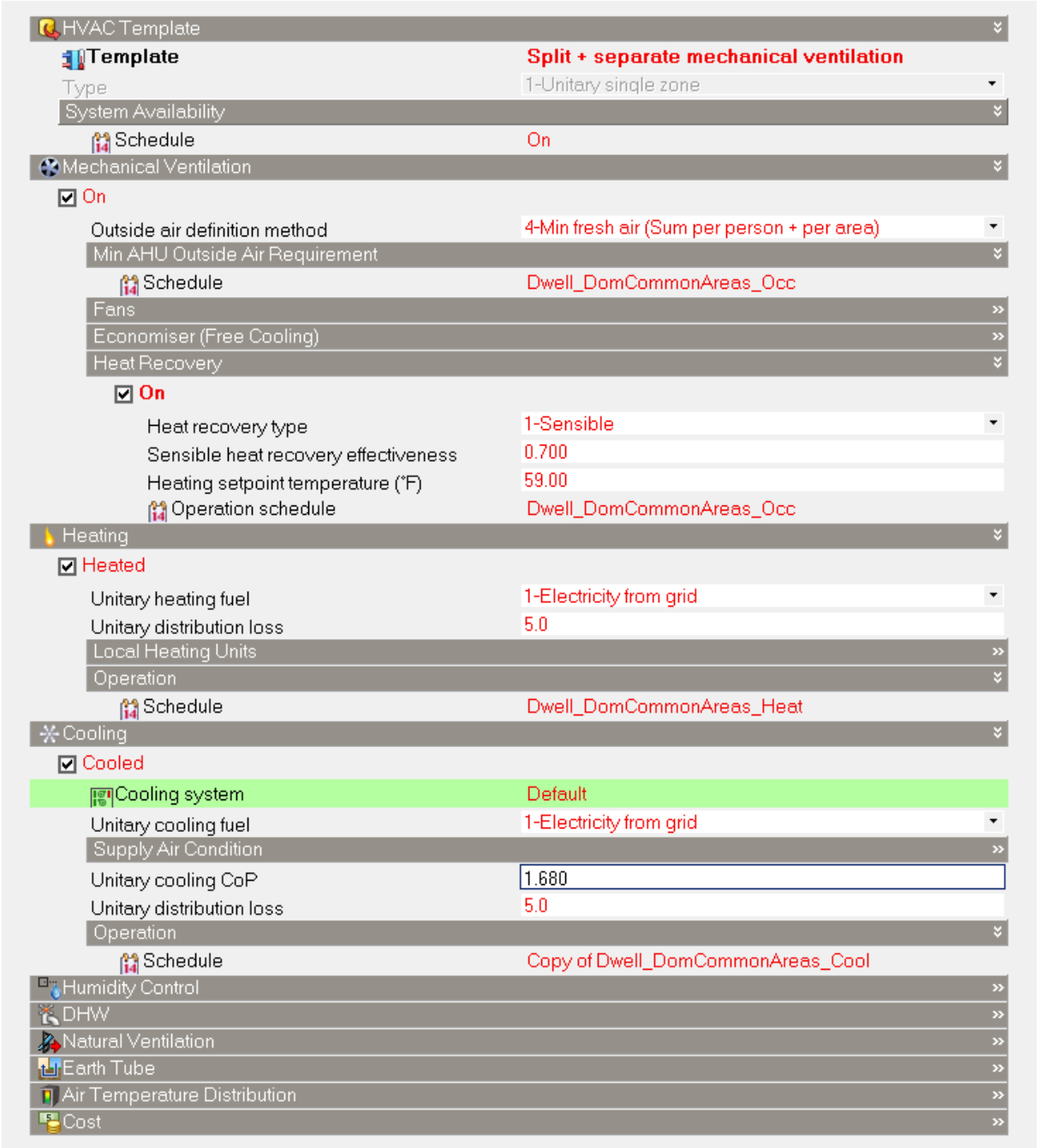


Temperature and Heat Gains - Untitled, HVAC House

EnergyPlus Output — 15 Oct, Sub-hourly — Licensed

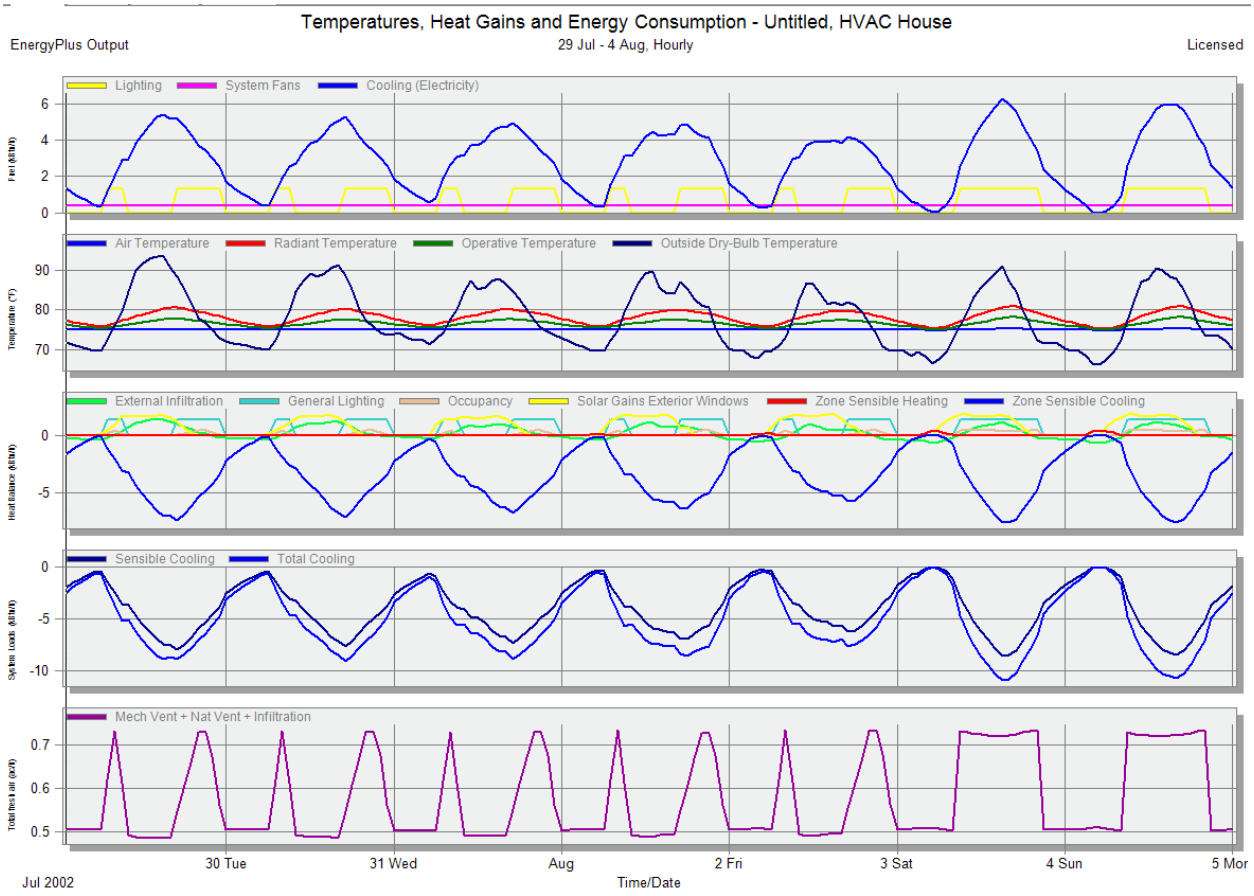
Time	2:00	4:00	6:00	8:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00
Air Temperature (°F)	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
Radiant Temperature (°F)	77.23	76.56	76.00	76.99	77.72	78.76	79.92	80.39	79.84	79.47	78.92
Operative Temperature (°F)	76.12	75.78	75.50	76.00	76.36	76.88	77.46	77.70	77.42	77.23	76.96
Outside Dry-Bulb Temperature (°F)	75.66	74.51	74.51	79.13	86.06	90.88	93.38	92.22	88.76	83.75	80.28
Glazing (kBtu/h)	-0.39	-0.44	-0.40	0.61	1.24	1.63	2.23	1.69	0.45	0.09	-0.14
Walls (kBtu/h)	0.89	0.64	0.44	-0.62	-0.40	-0.20	0.05	0.75	1.41	1.39	1.18
Roofs (kBtu/h)	1.06	0.77	0.52	-0.44	-0.55	-0.65	-0.41	0.40	1.18	1.36	1.33
Floors (ext) (kBtu/h)	0.12	0.04	-0.01	0.04	0.91	1.63	1.81	1.72	1.08	0.65	0.39
External Infiltration (kBtu/h)	0.05	-0.04	-0.04	0.31	0.83	1.19	1.37	1.28	1.03	0.66	0.40
External Vent. (kBtu/h)	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.23	0.30	0.14
General Lighting (kBtu/h)	0.00	0.00	0.00	1.34	0.00	0.00	0.00	0.00	1.34	1.34	1.34
Occupancy (kBtu/h)	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.20	0.40	0.30
Solar Gains Exterior Windows (kBtu/h)	0.00	0.00	0.00	1.14	1.31	1.43	1.80	1.50	0.00	0.00	0.00
Zone Sensible Cooling (kBtu/h)	-1.79	-1.03	-0.55	-2.81	-3.28	-4.95	-6.73	-7.33	-6.90	-6.17	-4.95
Sensible Cooling (kBtu/h)	-1.79	-1.03	-0.55	-2.81	-3.28	-4.95	-6.73	-7.33	-6.90	-6.17	-4.95
Total Cooling (kBtu/h)	-1.79	-1.03	-0.55	-2.81	-3.28	-4.95	-6.73	-7.33	-6.90	-6.17	-4.99
Relative Humidity (%)	44.95	44.36	44.08	46.29	45.99	45.04	44.60	44.35	45.08	46.65	47.41
Mech Vent + Nat Vent + Infiltration (ac/h)	0.50	0.50	0.50	0.72	0.49	0.49	0.48	0.48	0.60	0.71	0.66

Appendix E



Zone	Design Capacity (kBtu/h)	Design Flow Rate (ft3/min)	Total Cooling Load (kBtu...	Sensible (kBtu/h)	Latent (kBtu/h)	Air Temperature (°F)	Humidity (%)	Time of Max Cooli...	Max Op Temp in D
HVAC House									
Block1:LivingRoom	**5.1**	**221.608**	4.5	4.5	0.0	75.0	44.6	Oct 15:30	78.8
Block1:Mechanical...	0.0	0.000	0.0	0.0	0.0	-	-	Oct 18:30	91.7
Block1:Kitchen	**1.8**	**77.102**	1.5	1.5	0.0	75.0	44.2	Oct 16:30	77.3
Block1:Bedroom	**2.2**	**97.323**	2.0	2.0	0.0	75.0	44.8	Oct 17:30	77.0
Totals	**9.2**	**396.033**	**8.0**	**8.0**	**0.0**	**68.0**	**37.3**	**N/A**	**91.7**

2). Split Capacity Summer Design Week Simulation



Temperatures, Heat Gains and Energy Consumption - Untitled, HVAC House

EnergyPlus Output — 29 Jul - 4 Aug, Hourly — Licensed

Time/Date										
Lighting (kBtu/h)	0.00	0.00	1.34	0.00	0.00	1.34	1.34	0.00	1.34	0.00
System Fans (kBtu/h)	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Cooling (Electricity) (kBtu/h)	5.45	0.38	3.46	3.74	0.86	4.83	2.98	1.31	6.32	0.10
Air Temperature (°F)	75.10	75.01	75.00	75.00	75.00	75.04	75.00	75.00	75.42	74.70
Radiant Temperature (°F)	80.34	75.88	79.00	78.87	76.56	79.90	77.60	77.29	80.67	75.36
Operative Temperature (°F)	77.72	75.45	77.00	76.94	75.78	77.47	76.30	76.15	78.04	75.03
Outside Dry-Bulb Temperature (°F)	93.29	69.89	75.79	85.10	70.70	85.10	77.45	69.80	90.95	67.55
External Infiltration (kBtu/h)	1.35	-0.40	0.06	0.76	-0.33	0.76	0.19	-0.40	1.15	-0.56
General Lighting (kBtu/h)	0.00	0.00	1.34	0.00	0.00	1.34	1.34	0.00	1.34	0.00
Occupancy (kBtu/h)	0.00	0.00	0.40	0.00	0.00	0.20	0.20	0.00	0.39	0.00
Solar Gains Exterior Windows (kBtu/h)	1.76	0.17	0.00	1.49	0.00	0.72	1.78	0.00	1.77	0.70
Zone Sensible Heating (kBtu/h)	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Zone Sensible Cooling (kBtu/h)	-7.05	-0.11	-4.59	-4.54	-0.72	-6.31	-3.08	-1.37	-7.62	-0.05
Sensible Cooling (kBtu/h)	-7.43	-0.49	-5.01	-4.93	-1.11	-6.88	-3.51	-1.77	-8.53	-0.11
Total Cooling (kBtu/h)	-8.84	-0.69	-6.52	-6.46	-1.58	-8.56	-5.53	-2.46	-10.88	-0.19
Mech Vent + Nat Vent + Infiltration (ac/h)	0.48	0.51	0.73	0.49	0.50	0.61	0.61	0.51	0.72	0.51

Appendix E

Report: **HVAC Sizing Summary**

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For: **Entire Facility**

Timestamp: **2015-05-22 16:38:44**

Zone Cooling

	Calculated Design Load [Btu/h]	User Design Load [Btu/h]	User Design Load per Area [Btu/h-ft2]	Calculated Design Air Flow [ft3/min]	User Design Air Flow [ft3/min]	Design Day Name	Date/Time Of Peak	Thermostat Setpoint Temperature at Peak Load [F]	Indoor Temperature at Peak Load [F]	Indoor Humidity Ratio at Peak Load [lbWater/lbAir]	Outdoor Temperature at Peak Load [F]	Outdoor Humidity Ratio at Peak Load [lbWater/lbAir]
BLOCK1:LIVINGROOM	4410.26	5071.80	14.56	201.773	232.039	SUMMER DESIGN DAY IN UNTITLED OCT	10/15 15:30:00	32.00	75.00	0.00801	92.80	0.00812
BLOCK1:KITCHEN	1499.38	1724.29	8.77	68.598	78.888	SUMMER DESIGN DAY IN UNTITLED OCT	10/15 17:00:00	32.00	75.00	0.00805	90.68	0.00812
BLOCK1:BEDROOM	1862.31	2141.65	7.17	85.203	97.983	SUMMER DESIGN DAY IN UNTITLED OCT	10/15 17:30:00	32.00	75.00	0.00808	89.72	0.00812

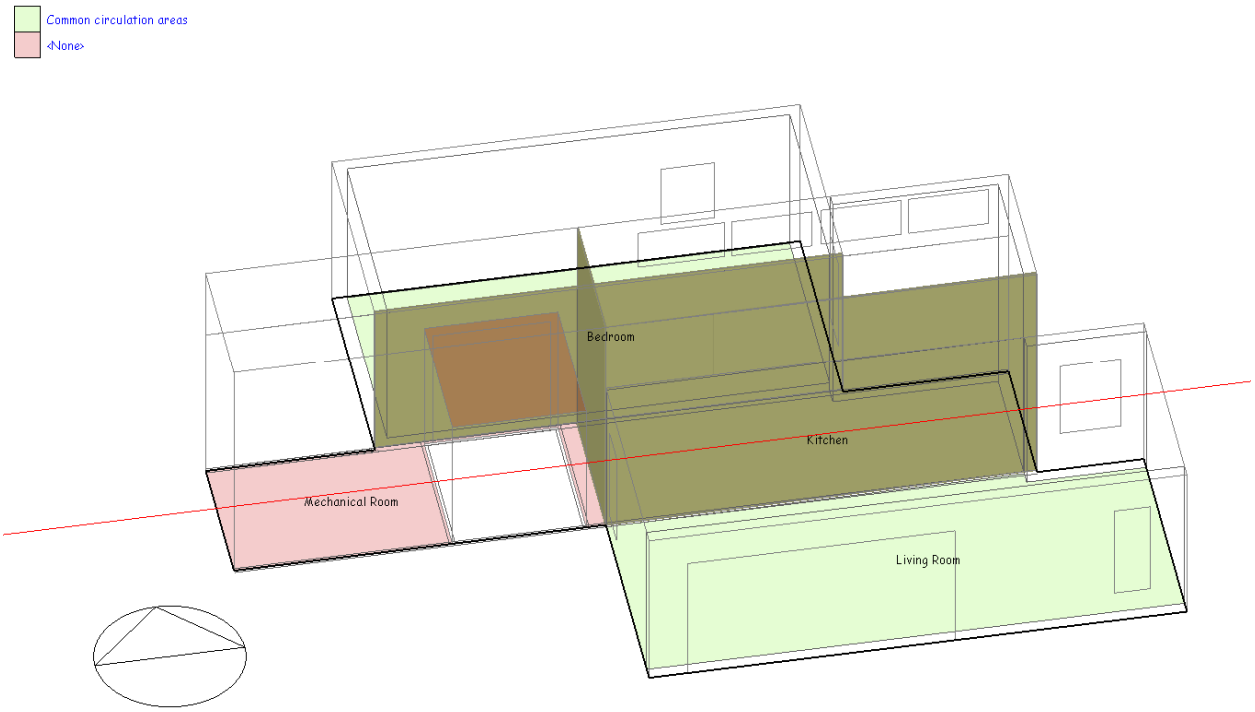
Zone Heating

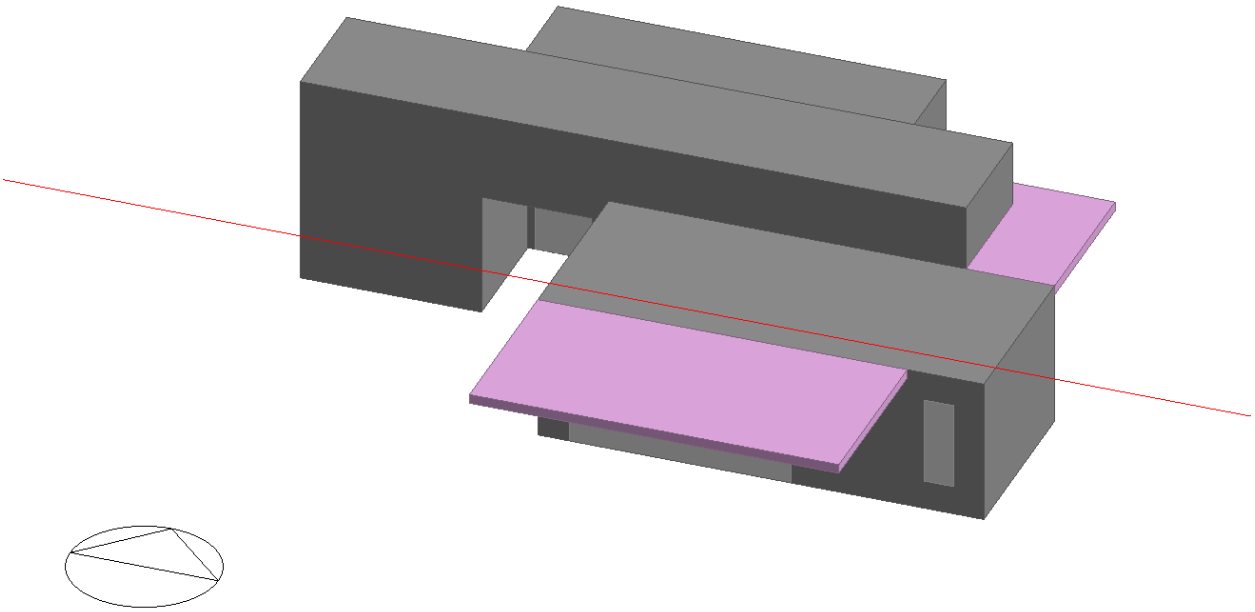
	Calculated Design Load [Btu/h]	User Design Load [Btu/h]	User Design Load per Area [Btu/h-ft2]	Calculated Design Air Flow [ft3/min]	User Design Air Flow [ft3/min]	Design Day Name	Date/Time Of Peak	Thermostat Setpoint Temperature at Peak Load [F]	Indoor Temperature at Peak Load [F]	Indoor Humidity Ratio at Peak Load [lbWater/lbAir]	Outdoor Temperature at Peak Load [F]	Outdoor Humidity Ratio at Peak Load [lbWater/lbAir]
BLOCK1:LIVINGROOM	7479.47	9349.34	26.84	126.072	157.590	WINTER DESIGN DAY IN UNTITLED	1/15 06:00:00	32.00	71.00	0.00703	39.20	0.00505
BLOCK1:KITCHEN	4110.64	5138.30	26.14	67.239	84.048	WINTER DESIGN DAY IN UNTITLED	1/15 16:00:00	32.00	71.00	0.00686	39.20	0.00505
BLOCK1:BEDROOM	5502.35	6877.94	23.02	92.379	115.474	WINTER DESIGN DAY IN UNTITLED	1/15 16:00:00	32.00	71.00	0.00692	39.20	0.00505

System Design Air Flow Rates

	Calculated cooling [ft3/min]	User cooling [ft3/min]	Calculated heating [ft3/min]	User heating [ft3/min]
BLOCK1:LIVINGROOM AHU	232.04	232.04	157.59	157.59
BLOCK1:KITCHEN AHU	78.89	78.89	84.05	84.05
BLOCK1:BEDROOM AHU	97.98	97.98	115.47	115.47

3). DesignBuilder models





BUILDING ENERGY ANALYSIS REPORT

PROJECT:

Solar Cal Poly
Cal Poly
Irvine, CA

Project Designer:

Cal Poly Solar Decathlon Team
Cal Poly, San Luis Obispo
San Luis Obispo, CA

Report Prepared by:

California Polytechnic State University

,

Job Number:

Date:

5/22/2015

The EnergyPro computer program has been used to perform the calculations summarized in this compliance report. This program has approval and is authorized by the California Energy Commission for use with both the Residential and Nonresidential 2013 Building Energy Efficiency Standards.

This program developed by EnergySoft, LLC – www.energysoft.com.

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GENERAL INFORMATION					
01	**Project Name**	Residential Building			
02	**Calculation Description**	Title 24 Analysis			
03	**Project Location**	Cal Poly			
04	**City**	Irvine	05	**Standards Version**	Compliance 2015
06	**Zip Code**		07	**Compliance Manager Version**	BEMCmpMgr 2013-3c (710)
08	**Climate Zone**	CZ8	09	**Software Version**	EnergyPro 6.5
10	**Building Type**	Single Family	11	**Front Orientation (deg/Cardinal)**	0
12	**Project Scope**	Newly Constructed	13	**Number of Dwelling Units**	1
14	**Total Cond. Floor Area (FT^2)**	966	15	**Number of Zones**	1
16	**Slab Area (FT^2)**	0	17	**Number of Stories**	1
18	**Addition Cond. Floor Area**	N/A	19	**Natural Gas Available**	No
20	**Addition Slab Area (FT^2)**	N/A	21	**Glazing Percentage (%)**	28.5%

COMPLIANCE RESULTS	
01	**Building Complies with Computer Performance**
02	**This building incorporates features that require field testing and/or verification by a certified HERS rater under the supervision of a CEC-approved HERS provider.**
03	**This building incorporates one or more Special Features shown below**

ENERGY USE SUMMARY

04	05	06	07	08
Energy Use (kTDV/ft2-yr)	**Standard Design**	**Proposed Design**	**Compliance Margin**	**Percent Improvement**
Space Heating	4.50	2.79	1.71	38.0%
Space Cooling	29.49	17.78	11.71	39.7%
IAQ Ventilation	1.15	1.15	0.00	0.0%
Water Heating	26.38	27.51	-1.13	-4.3%
Photovoltaic Offset	----	0.00	0.00	----
Compliance Energy Total	**61.52**	**49.23**	**12.29**	**20.0%**

REQUIRED SPECIAL FEATURES

The following are features that must be installed as condition for meeting the modeled energy performance for this computer analysis.

- **Cathedral Ceiling**
- **Floor has high level of insulation**
- **Window overhangs and/or fins**

HERS FEATURE SUMMARY

The following is a summary of the features that must be field-verified by a certified HERS Rater as a condition for meeting the modeled energy performance for this computer analysis. Additional detail is provided in the building components tables below.

Building-level Verifications:
- **Building Envelope Air Leakage**
- **IAQ mechanical ventilation**

Cooling System Verifications:
- **Minimum Airflow**
- **Fan Efficacy Watts/CFM**

HVAC Distribution System Verifications:
- **Duct Sealing**
- **Verified low-leakage ducts located entirely in conditioned space**

Domestic Hot Water System Verifications:
- **-- None --**

ENERGY DESIGN RATING

This is the sum of the annual TDV energy consumption for energy use components included in the performance compliance approach for the Standard Design Building (Energy Budget) and the annual TDV energy consumption for lighting and components not regulated by Title 24, Part 6 (such as domestic appliances and consumer electronics) and accounting for the annual TDV energy offset by an on-site renewable energy system.

	Reference Energy Use	Energy Design Rating	Margin	Percent Improvement
Total Energy (kTDV/f2-yr)*	**145.93**	**133.64**	**12.29**	**8.4%**

* includes calculated Appliances and Miscellaneous Energy Use (AMEU)

BUILDING - FEATURES INFORMATION

01	02	03	04	05	06	07
Project Name	**Conditioned Floor Area (ft2)**	**Number of Dwelling Units**	**Number of Bedrooms**	**Number of Zones**	**Number of Ventilation Cooling Systems**	**Number of Water Heating Systems**
Residential Building	966	1	1	1	0	1

ZONE INFORMATION

01	02	03	04	05	06	07
Zone Name	Zone Type	HVAC System Name	Zone Floor Area (ft^2)	Avg. Ceiling Height	Water Heating System 1	Water Heating System 2
Zone 1	Conditioned	HVAC System1	966	10.4	DHW Sys 1	

OPAQUE SURFACES

01	02	03	04	05	06	07	08
Name	Zone	Construction	Azimuth	Orientation	Gross Area (ft^2)	Window & Door Area (ft^2)	Tilt (deg)
Front Wall SIPS (North)	Zone 1	8.25 SIP Wall	0	Front	250	24	90
Front Wall Stud (North)	Zone 1	2x6 + R-10	0	Front	187	57	90
Left Wall SIPS (East)	Zone 1	8.25 SIP Wall	90	Left	247	15	90
Left Wall Stud (East)	Zone 1	8.25 SIP Wall	90	Left	112	12	90
Rear Wall SIPS (South)	Zone 1	8.25 SIP Wall	180	Back	285	131.478	90
Rear Wall Stud (South)	Zone 1	2x6 + R-10	180	Back	131	21	90
Right Wall SIPS (West)	Zone 1	8.25 SIP Wall	270	Right	247	15	90
Right Wall Stud (West)	Zone 1	2x6 + R-10	270	Right	112		90
Raised Floor	Zone 1	R-24 + R-5 Floor			966		

OPAQUE SURFACES – Cathedral Ceilings

01	02	03	04	05		06	07	08	09	10	11
Name	Zone	Type	Orientation	Area (ft^2)	Skylight Area (ft2)	Roof Rise (x in 12)	Roof Pitch	Roof Tilt (deg)	Roof Reflectance	Roof Emittance	Framing Factor
Roof Framed	Zone 1	2x8 + R-10	Front	234	0	1	0.08	4.76	0.1	0.85	0.07
Roof SIPS	Zone 1	8.25 EPS SIP Panel + R10	Front	732	0	1	0.08	4.76	0.1	0.85	0

WINDOWS

01	02	03	04	05	06	07	08	09	10
Name	Type	Surface (Orientation-Azimuth)	Width (ft)	Height (ft)	Multiplier	Area (ft^2)	U-factor	SHGC	Exterior Shading
Window 2- 3x4	Window	Front Wall SIPS (North) (Front-0)	----	----	1	24.0	0.34	0.29	Insect Screen (default)
Window 6- 3x2	Window	Front Wall Stud (North) (Front-0)	----	----	1	36.0	0.34	0.29	Insect Screen (default)
French Dr	Window	Front Wall Stud (North) (Front-0)	----	----	1	21.0	0.34	0.29	Insect Screen (default)
Window 2.5x6	Window	Left Wall SIPS (East) (Left-90)	2.5	6.0	1	15.0	0.34	0.29	Insect Screen (default)
Window 3x4	Window	Left Wall Stud (East) (Left-90)	3.0	4.0	1	12.0	0.34	0.29	Insect Screen (default)
Nana Wall System	Window	Rear Wall SIPS (South) (Back-180)	14.7	7.9	1.003	116.5	0.30	0.23	Insect Screen (default)
Window 2.5x6 2	Window	Rear Wall SIPS (South) (Back-180)	2.5	6.0	1	15.0	0.34	0.29	Insect Screen (default)
French Dr 2	Window	Rear Wall Stud (South) (Back-180)	3.0	7.0	1	21.0	0.34	0.29	Insect Screen (default)
Window 2.5x6 3	Window	Right Wall SIPS (West) (Right-270)	2.5	6.0	1	15.0	0.34	0.29	Insect Screen (default)

OVERHANGS AND FINS

01	02	03	04	05	06	07	08	09	10	11	12	13	14
	Overhang					Left Fin				Right Fin			
Window	Depth	Dist Up	Left Extent	Right Extent	Flap Ht.	Depth	Top Up	DistL	Bot Up	Depth	Top Up	Dist R	Bot Up
Window 2.5x6	0	0	0	0	0	9.5	0	0.1	0	0	0	0	0
Window 3x4	0	0	0	0	0	6.5	0	2	0	0	0	0	0
Nana Wall System	12	0.3	2	12	2	0	0	0	0	0	0	0	0
Window 2.5x6 2	12	0.3	24	2	2	0	0	0	0	0	0	0	0
French Dr 2	8.5	0.3	3	1	0	8.5	0	3.5	0	8.5	0	1	0
Window 2.5x6 3	0	0	0	0	0	21	0	0.1	0	0	0	0	0

OPAQUE SURFACE CONSTRUCTIONS

01	02	03	04	05	06	07
Construction Name	**Surface Type**	**Construction Type**	**Framing**	**Total Cavity R-value**	**Winter Design U-value**	**Assembly Layers**
R-24 + R-5 Floor	Exterior Floors	Wood Framed Floor	2x8 @ 24 in. O.C.	R 22	0.034	• *Floor Surface: Carpeted* • *Floor Deck: Wood Siding/sheathing/decking* • *Cavity / Frame: R-22 / 2x8* • *Sheathing / Insulation: R5 Sheathing*
8.25 SIP Wall	Exterior Walls	SIPS Wall	8.25 in. Panel, OSB Spline	R 28	0.038	• *Inside Finish: Gypsum Board* • *Panel Rated R (@ 75 F): R-28 / 8.25in. OSB* • *Exterior Finish: Wood Siding/sheathing/decking*
2x6 + R-10	Exterior Walls	Wood Framed Wall	2x6 @ 24 in. O.C.	R 21	0.036	• *Inside Finish: Gypsum Board* • *Cavity / Frame: R-21 / 2x6* • *Sheathing / Insulation: R10 Sheathing* • *Exterior Finish: Wood Siding/sheathing/decking*
2x8 + R-10	Cathedral Ceilings	Wood Framed Ceiling	2x8 @ 24 in. O.C.	R 21	0.032	• *Inside Finish: Gypsum Board* • *Cavity / Frame: R-21 / 2x8* • *Roof Deck: Wood Siding/sheathing/decking* • *Above Deck Insulation: R10 Sheathing* • *Roofing: Light Roof (Asphalt Shingle)*
8.25 EPS SIP Panel + R10	Cathedral Ceilings	SIPS Ceiling	2x4 Top Chord of Roof Truss @ 24 in. O.C.	R 28	0.025	• *Inside Finish: Gypsum Board* • *Cavity / Frame: R-28 / 2x4 Top Chrd* • *Roof Deck: Wood Siding/sheathing/decking* • *Above Deck Insulation: R10 Sheathing* • *Roofing: Light Roof (Asphalt Shingle)*

BUILDING ENVELOPE - HERS VERIFICATION

01	02	03	04
Quality Insulation Installation (QII)	**Quality Installation of Spray Foam Insulation**	**Building Envelope Air Leakage**	**ACH @ 50 Pa**
Not Required	Not Required	Required	736.7

WATER HEATING SYSTEMS

01	02	03	04	05	06
Name	**System Type**	**Distribution Type**	**Water Heater**	**Number of Heaters**	**Solar Fraction (%)**
DHW Sys 1 - 1/1	DHW	Pipe Insulation, All Lines	DHW Heater 1	1	60.0%

WATER HEATERS

01	02	03	04	05	06	07	08
Name	Heater Element Type	Tank Type	Tank Volume (gal)	Energy Factor or Efficiency	Input Rating	Tank Exterior Insulation R-value	Standby Loss (Fraction)
DHW Heater 1	none	Small Storage	80	0.88	4500-watts	0	0

WATER HEATING - HERS VERIFICATION

01	02	03	04	05	06	07
Name	Pipe Insulation	Parallel Piping	Compact Distribution	Point-of Use	Recirculation Control	Central DHW Distribution
DHW Sys 1 - 1/1	---	---	---	---	---	---

SPACE CONDITIONING SYSTEMS

01	02	03	04	05	06
SC Sys Name	System Type	Heating Unit Name	Cooling Unit Name	Fan Name	Distribution Name
:Heat Pump System 1:Air Distribution System 1:HVAC Fan 1:2	Heat Pump Heating and Cooling System	Heat Pump System 1	Heat Pump System 1	HVAC Fan 1	Air Distribution System 1

HVAC - HEAT PUMPS

01	02	03	04	05	06	07	08	09	10
		Heating			Cooling		Zonally	Multispeed	HERS
Name	Type	HSPF/COP	Cap 47	Cap 17	SEER	EER	Controlled	Compressor	Verification
Heat Pump System 1	SplitHeatPump	8.2	17200	10000	14	11.7	No	No	Heat Pump System 1-hers-cool

HVAC - COOLING UNIT TYPES

01	02	03	04	05	06	07
		Efficiency				
Name	System Type	EER	SEER	Zonally Controlled	Multi-speed Compressor	HERS Verification
	SplitHeatPump	11.7	14	Not Zonal	Single Speed	

HVAC COOLING - HERS VERIFICATION

01	02	03	04	05	06
Name	Verified Airflow	Airflow Target	Verified EER	Verified SEER	Verified Refrigerant Charge
Heat Pump System 1-hers-cool	Required	350	Not Required	Not Required	Not Required

HVAC - DISTRIBUTION SYSTEMS

01	02	03	04	05	06	07
Name	Type	Duct Leakage	Insulation R-value	Duct Location	Bypass Duct	HERS Verification
Air Distribution System 1	LowLICod	Sealed and tested	6	n/a	None	Air Distribution System 1-hers-dist

HVAC DISTRIBUTION - HERS VERIFICATION

01	02	03	04	05	06	07	08
Name	Duct Leakage Verification	Duct Leakage Target (%)	Verified Duct Location	Verified Duct Design	Buried Ducts	Deeply Buried Ducts	Low-leakage Air Handler
Air Distribution System 1-hers-dist	Required	6.0	Required	Not Required	Not Required	Not Required	---

HVAC - FAN SYSTEMS

01	02	03	04
Name	Type	Fan Power (Watts/CFM)	HERS Verification
HVAC Fan 1	Single Speed PSC Furnace Fan	0.58	HVAC Fan 1-hers-fan

HVAC FAN SYSTEMS - HERS VERIFICATION

01	02	03
Name	Verified Fan Watt Draw	Required Fan Efficiency (Watts/CFM)
HVAC Fan 1-hers-fan	Required	0.58

IAQ (Indoor Air Quality) FANS

01	02	03	04	05	06
Dwelling Unit	IAQ CFM	IAQ Watts/CFM	IAQ Fan Type	IAQ Recovery Effectiveness(%)	HERS Verification
SFam IAQVentRpt	24.66	0.25	Default	0	Required

DOCUMENTATION AUTHOR'S DECLARATION STATEMENT	
1. I certify that this Certificate of Compliance documentation is accurate and complete.	
Documentation Author Name:	Documentation Author Signature:
Company: California Polytechnic State University	Signature Date: 5/22/2015
Address:	CEA/HERS Certification Identification (If applicable):
City/State/Zip: ,	Phone:

RESPONSIBLE PERSON'S DECLARATION STATEMENT	
I certify the following under penalty of perjury, under the laws of the State of California: 1. I am eligible under Division 3 of the Business and Professions Code to accept responsibility for the building design identified on this Certificate of Compliance. 2. I certify that the energy features and performance specifications identified on this Certificate of Compliance conform to the requirements of Title 24, Part 1 and Part 6 of the California Code of Regulations. 3. The building design features or system design features identified on this Certificate of Compliance are consistent with the information provided on other applicable compliance documents, worksheets, calculations, plans and specifications submitted to the enforcement agency for approval with this building permit application.	
Responsible Designer Name: Cal Poly Solar Decathlon Team	Responsible Designer Signature:
Company: Cal Poly Solar Decathlon Team	Date Signed:
Address: Cal Poly, San Luis Obispo	License:
City/State/Zip: San Luis Obispo, CA	Phone:

2013 Low-Rise Residential Mandatory Measures Summary

Appendix E

NOTE: Low-rise residential buildings subject to the Standards must comply with all applicable mandatory measures listed, regardless of the compliance approach used. Exceptions may apply. Review the respective code section for more information.

Building Envelope Measures:	
§110.6(a)1:	Doors and windows between conditioned and unconditioned spaces are manufactured to limit air leakage.
§110.6(a)5:	Fenestration products (except field-fabricated windows) have a label listing the certified U-Factor, certified Solar Heat Gain Coefficient (SHGC), and infiltration that meets the requirements of §10-111(a).
§110.7:	Exterior doors and windows are weatherstripped; all joints and penetrations are caulked and sealed.
§110.8(a):	Insulation specified or installed meets Standards for Insulating Material. Indicate type and include on the CF2R.
§110.8(i):	The thermal emittance and aged solar reflectance values of the cool roofing material meets the requirements of §110.8(i) when the installation of a cool roof is specified on the CF1R.
§110.8(j):	A radiant barrier shall have an emittance of 0.05 or less when the installation of a radiant barrier is specified on the CF1R.
§150.0(a):	Minimum R-30 insulation in wood-frame ceiling; or the weighted average U-factor shall not exceed 0.031. Minimum R-19 in a rafter roof alteration. Attic access doors shall have permanently attached insulation using adhesive or mechanical fasteners. The attic access shall be gasketed to prevent air leakage.
§150.0(b):	Loose fill insulation shall conform with manufacturer's installed design labeled R-value.
§150.0(c):	Minimum R-13 insulation in 2x4 inch wood framing wall or have a U-factor of 0.102 or less (R-19 in 2x6 or 0.074 maximum U-factor).
§150.0(d):	Minimum R-19 insulation in raised wood-frame floor or 0.037 maximum U-factor.
§150.0(g)1:	In Climate Zones 14 and 16 a Class II vapor retarder shall be installed on the conditioned space side of all insulation in all exterior walls, vented attics and unvented attics with air-permeable insulation.
§150.0(g)2:	In Climate Zones 1-16 with unvented crawl spaces the earth floor of the crawl space shall be covered with a Class I or Class II vapor retarder.
§150.0(g)3:	In a building having a controlled ventilation crawl space, a Class I or Class II vapor retarder shall be placed over the earth floor of the crawl space to reduce moisture entry and protect insulation from condensation, as specified in the exception to Section 150.0(d).
§150.0(l):	Slab edge insulation shall: have a water absorption rate, for the insulation material alone without facings, no greater than 0.3%; have water vapor permeance rate is no greater than 2.0 perm/inch, be protected from physical damage and UV light deterioration; and when installed as part of a heated slab floor meets the requirements of §110.8(g).
§150.0(q):	Fenestration, including skylights, separating conditioned space from unconditioned space or outdoors shall have a maximum U-factor of 0.58; or the weighted average U-factor of all fenestration shall not exceed 0.58.
Fireplaces, Decorative Gas Appliances and Gas Log Measures:	
§150.0(e)1A:	Masonry or factory-built fireplaces have a closable metal or glass door covering the entire opening of the firebox.
§150.0(e)1B:	Masonry or factory-built fireplaces have a combustion outside air intake, which is at least six square inches in area and is equipped with a readily accessible, operable, and tight-fitting damper or a combustion-air control device.
§150.0(e)1C:	Masonry or factory-built fireplaces have a flue damper with a readily accessible control.
§150.0(e)2:	Continuous burning pilot lights and the use of indoor air for cooling a firebox jacket, when that indoor air is vented to the outside of the building, are prohibited.
Space Conditioning, Water Heating and Plumbing System Measures:	
§110.0-§110.3:	HVAC equipment, water heaters, showerheads, faucets and all other regulated appliances are certified to the Energy Commission.
§110.3(c)5:	Water heating recirculation loops serving multiple dwelling units meet the air release valve, backflow prevention, pump isolation valve, and recirculation loop connection requirements of §110.3(c)5.
§110.5:	Continuously burning pilot lights are prohibited for natural gas: fan-type central furnaces, household cooking appliances (appliances without an electrical supply voltage connection with pilot lights that consume less than 150 Btu/hr are exempt), and pool and spa heaters.
§150.0(h)1:	Heating and/or cooling loads are calculated in accordance with ASHRAE, SMACNA or ACCA using design conditions specified in §150.0(h)2.
§150.0(h)3A:	Installed air conditioner and heat pump outdoor condensing units shall have a clearance of at least five feet from the outlet of any dryer vent.
§150.0(i):	Heating systems are equipped with thermostats that meet the setback requirements of §110.2(c).
§150.0(j)1A:	Storage gas water heaters with an energy factor equal to or less than the federal minimum standards shall be externally wrapped with insulation having an installed thermal resistance of R-12 or greater.
§150.0(j)1B:	Unfired hot water tanks, such as storage tanks and backup storage tanks for solar water-heating systems, have R-12 external insulation or R-16 internal insulation where the internal insulation R-value is indicated on the exterior of the tank.
§150.0(j)2A:	For domestic hot water system piping, whether buried or unburied: the first 5 feet of hot and cold water pipes from the storage tank, all piping with a nominal diameter of 3/4 inch or larger, all piping associated with a domestic hot water recirculation system regardless of the pipe diameter, piping from the heating source to storage tank or between tanks, piping buried below grade, and all hot water pipes from the heating source to kitchen fixtures must be insulated according to the requirements of TABLE 120.3-A.
§150.0(j)2B:	All domestic hot water pipes that are buried below grade must be installed in a water proof and non-crushable casing or sleeve that allows for installation, removal, and replacement of the enclosed pipe and insulation.

2013 Low-Rise Residential Mandatory Measures Summary

§150.0(j)2C:	Pipe for cooling system lines shall be insulated as specified in §150.0(j)2A. Piping insulation for steam and hydronic heating systems or hot water systems with pressure > 15 psig shall meet the requirements in TABLE 120.3-A.
§150.0(j)3:	Insulation is protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind.
§150.0(j)3A:	Insulation exposed to weather shall either be rated for outdoor use or installed with a cover suitable for outdoor service. For example, protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation protected as specified or painted with coating that is water retardant and provides shielding from solar radiation that degrades the material.
§150.0(j)3B:	Insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall have a Class I or Class II vapor retarding facing, or the insulation shall be installed at the thickness that qualifies as a Class I or Class II vapor retarder.
§150.0(n)1:	Systems using gas or propane water heaters to serve individual dwelling units shall include: a 120V electrical receptacle within 3 feet of the water heater; a Category III or IV vent, or a Type B vent with straight pipe between the outside termination and the space where the water heater is installed; a condensate drain that is no more than 2 inches higher than the base of the installed water heater, and allows natural draining without pump assistance; and a gas supply line with a capacity of at least 200,000 Btu/hr.
§150.0(n)2:	Recirculating loops serving multiple dwelling units shall meet the requirements of §110.3(c)5.
§150.0(n)3:	Solar water-heating systems and collectors shall be certified and rated by the Solar Rating and Certification Corporation (SRCC) or by a testing agency approved by the Executive Director.
Ducts and Fans Measures:	
§150.0(m)1:	All air-distribution system ducts and plenums installed are sealed and insulated to meet the requirements of CMC §601.0, §602.0, §603.0, §604.0, §605.0 and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible 3rd Edition. Supply-air and return-air ducts and plenums are insulated to a minimum installed level of R-6.0 (or higher if required by CMC §605.0) or enclosed entirely in directly conditioned space as confirmed through field verification and diagnostic testing (RA3.1.4.3.8). Connections of metal ducts and inner core of flexible ducts are mechanically fastened. Openings shall be sealed with mastic, tape, or other duct-closure system that meets the applicable requirements of UL 181, UL 181A, or UL 181B or aerosol sealant that meets the requirements of UL 723. If mastic or tape is used to seal openings greater than ¼ inch, the combination of mastic and either mesh or tape shall be used. Building cavities, support platforms for air handlers, and plenums defined or constructed with materials other than sealed sheet metal, duct board or flexible duct shall not be used for conveying conditioned air. Building cavities and support platforms may contain ducts. Ducts installed in cavities and support platforms shall not be compressed to cause reductions in the cross-sectional area of the ducts**.**
§150.0(m)2:	Factory-Fabricated Duct Systems shall comply with specified requirements for duct construction, connections, and closures; joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and draw bands.
§150.0(m)3-6:	Field-Fabricated Duct Systems shall comply with requirements for: pressure-sensitive tapes, mastics, sealants, and other requirements specified for duct construction; duct insulation R-value ratings; duct insulation thickness; and duct labeling.
§150.0(m)7:	All fan systems that exchange air between the conditioned space and the outside of the building must have backdraft or automatic dampers.
§150.0(m)8:	Gravity ventilating systems serving conditioned space have either automatic or readily accessible, manually operated dampers except combustion inlet and outlet air openings and elevator shaft vents.
§150.0(m)9:	Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind but not limited to the following: insulation exposed to weather shall be suitable for outdoor service. For example, protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation.
§150.0(m)10:	Flexible ducts cannot have porous inner cores.
§150.0(m)11:	When space conditioning systems use forced air duct systems to supply conditioned air to an occupiable space, the ducts shall be sealed and duct leakage tested, as confirmed through field verification and diagnostic testing, in accordance with Reference Residential Appendix RA3.
§150.0(m)12:	Mechanical systems that supply air to an occupiable space through ductwork exceeding 10 feet in length and through a thermal conditioning component, except evaporative coolers, shall be provided with air filter devices that meet the requirements of §150.0(m)12.
§150.0(m)13:	Space conditioning systems that utilize forced air ducts to supply cooling to an occupiable space shall have a hole for the placement of a static pressure probe (HSPP), or a permanently installed static pressure probe (PSPP) in the supply plenum. The space conditioning system must also demonstrate airflow ≥ 350 CFM per ton of nominal cooling capacity through the return grilles, and an air-handling unit fan efficacy ≤ 0.58 W/CFM as confirmed by field verification and diagnostic testing, in accordance with Reference Residential Appendix RA3.
§150.0(m)15:	Zonally controlled central forced air cooling systems shall be capable of simultaneously delivering, in every zonal control mode, an airflow from the dwelling, through the air handler fan and delivered to the dwelling, of ≥ 350 CFM per ton of nominal cooling capacity, and operating at an air-handling unit fan efficacy of ≤ 0.58 W/CFM as confirmed by field verification and diagnostic testing, in accordance with Reference Residential Appendix RA3.
§150.0(o):	All dwelling units shall meet the requirements of ASHRAE Standard 62.2. Neither window operation nor continuous operation of central forced air system air handlers used in central fan integrated ventilation systems are permissible methods of providing the Whole Building Ventilation.
§150.0(o)1A:	Whole Building Ventilation airflow shall be confirmed through field verification and diagnostic testing, in accordance with Reference Residential Appendix RA3.
Pool and Spa Heating Systems and Equipment Measures:	
§110.4(a):	Any pool or spa heating system shall be certified to have: a thermal efficiency that complies with the Appliance Efficiency Regulations; an on-off switch mounted outside of the heater that allows shutting off the heater without adjusting the thermostat setting; a permanent weatherproof plate or card with operating instructions; and shall not use electric resistance heating.

2013 Low-Rise Residential Mandatory Measures Summary

§110.4(b)1:	Any pool or spa heating equipment shall be installed with at least 36 inches of pipe between filter and heater or dedicated suction and return lines, or built-up connections for future solar heating.
§110.4(b)2:	Outdoor pools or spas that have a heat pump or gas heater shall have a cover.
§110.4(b)3:	Pools shall have directional inlets that adequately mix the pool water, and a time switch that will allow all pumps to be set or programmed to run only during off-peak electric demand periods.
§110.5:	Natural gas pool and spa heaters shall not have a continuous burning pilot light.
§150.0(p):	Residential pool systems or equipment shall meet specified pump sizing, flow rate, piping, filters, and valve requirements.
Lighting Measures:	
§110.9:	All lighting control devices and systems, ballasts, and luminaires shall meet the applicable requirements of §110.9.
§150.0(k)1A:	Installed luminaires shall be classified as high-efficacy or low-efficacy for compliance with §150.0(k) in accordance with TABLE 150.0-A or TABLE 150.0-B, as applicable.
§150.0(k)1B:	When a high efficacy and low efficacy lighting system are combined in a single luminaire, each system shall separately comply with the applicable provisions of §150.0(k).
§150.0(k)1C:	The wattage and classification of permanently installed luminaires in residential kitchens shall be determined in accordance with §130.0(c). In residential kitchens, the wattage of electrical boxes finished with a blank cover or where no electrical equipment has been installed, and where the electrical box can be used for a luminaire or a surface mounted ceiling fan, shall be calculated as 180 watts of low efficacy lighting per electrical box.
§150.0(k)1D:	Ballasts for fluorescent lamps rated 13 watts or greater shall be electronic and shall have an output frequency no less than 20 kHz.
§150.0(k)1E:	Permanently installed night lights and night lights integral to installed luminaires or exhaust fans shall be rated to consume no more than 5 watts of power per luminaire or exhaust fan as determined in accordance with §130.0(c). Night lights do not need to be controlled by vacancy sensors.
§150.0(k)1F:	Lighting integral to exhaust fans (except when installed by the manufacturer in kitchen exhaust hoods) shall meet the applicable requirements of §150.0(k).
§150.0(k)2A:	High efficacy luminaires must be switched separately from low efficacy luminaires.
§150.0(k)2B:	Exhaust fans shall be switched separately from lighting systems.
§150.0(k)2C:	Luminaires shall be switched with readily accessible controls that permit the luminaires to be manually switched ON and OFF.
§150.0(k)2D:	Controls and equipment are installed in accordance with manufacturer's instructions.
§150.0(k)2E:	No control shall bypass a dimmer or vacancy sensor function if the control is installed to comply with §150.0(k).
§150.0(k)2F:	Lighting controls comply with applicable requirements of §110.9.
§150.0(k)2G:	An Energy Management Control System (EMCS) may be used to comply with dimmer requirements if: it functions as a dimmer according to §110.9; meets Installation Certificate requirements of §130.4; the EMCS requirements of §130.5; and all other requirements in §150.0(k)2.
§150.0(k)2H:	An Energy Management Control System (EMCS) may be used to comply with vacancy sensor requirements of §150.0(k) if: it functions as a vacancy sensor according to §110.9; meets Installation Certificate requirements of §130.4; the EMCS requirements of §130.5; and all other requirements in §150.0(k)2.
§150.0(k)2I:	A multiscene programmable controller may be used to comply with dimmer requirements of this section if it provides the functionality of a dimmer according to §110.9, and complies with all other applicable requirements in §150.0(k)2.
§150.0(k)3A:	A minimum of 50 percent of the total rated wattage of permanently installed lighting in kitchens shall be high efficacy.
§150.0(k)3B:	Kitchen lighting includes all permanently installed lighting in the kitchen except internal lighting in cabinets that illuminate only the inside of the cabinets. Lighting in areas adjacent to the kitchen, including but not limited to dining and nook areas, are considered kitchen lighting if they are not separately switched from kitchen lighting.
§150.0(k)4:	Permanently installed lighting that is internal to cabinets shall use no more than 20 watts of power per linear foot of illuminated cabinet.
§150.0(k)5:	A minimum of one high efficacy luminaire shall be installed in each bathroom; and all other lighting installed in each bathroom shall be high efficacy or controlled by vacancy sensors.
§150.0(k)6:	Lighting installed in attached and detached garages, laundry rooms, and utility rooms shall be high efficacy luminaires and controlled by vacancy sensors.
§150.0(k)7:	Lighting installed in rooms or areas other than in kitchens, bathrooms, garages, laundry rooms, and utility rooms shall be high efficacy, or shall be controlled by either dimmers or vacancy sensors.
§150.0(k)8:	Luminaires recessed into ceilings shall: be listed for zero clearance insulation contact (IC) by Underwriters Laboratories or other nationally recognized testing/rating laboratory; have a label that certifies that the luminaire is airtight with air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283; be sealed with a gasket or caulk between the luminaire housing and ceiling, and shall have all air leak paths between conditioned and unconditioned spaces sealed with a gasket or caulk; and allow ballast maintenance and replacement without requiring cutting holes in the ceiling. For recessed compact fluorescent luminaries with ballasts to qualify as high efficacy for compliance with §150.0(k), the ballasts shall be certified to the Energy Commission to comply with the applicable requirements in §110.9.
§150.0(k)9A:	For single-family residential buildings, outdoor lighting permanently mounted to a residential building or other buildings on the same lot shall be high efficacy, or may be low efficacy if it meets all of the following requirements: i. Controlled by a manual ON and OFF switch that does not override to ON the automatic actions of Items ii or iii below; and ii. Controlled by a motion sensor not having an override or bypass switch that disables the motion sensor, or controlled by a motion sensor having a temporary override switch which temporarily bypasses the motion sensing function and automatically reactivates the motion sensor within 6 hours; and iii. Controlled by one of the following methods:

2013 Low-Rise Residential Mandatory Measures Summary

	a. Photocontrol not having an override or bypass switch that disables the photocontrol; or b. Astronomical time clock not having an override or bypass switch that disables the astronomical time clock, and which is programmed to automatically turn the outdoor lighting OFF during daylight hours; or c. Energy management control system which meets all of the following requirements: At a minimum provides the functionality of an astronomical time clock in accordance with §110.9; meets the Installation Certification requirements in §130.4; meets the requirements for an EMCS in §130.5; does not have an override or bypass switch that allows the luminaire to be always ON; and, is programmed to automatically turn the outdoor lighting OFF during daylight hours.
§150.0(k)9B:	For low-rise multifamily residential buildings, outdoor lighting for private patios, entrances, balconies, and porches; and outdoor lighting for residential parking lots and residential carports with less than eight vehicles per site shall comply with one of the following requirements: i. Shall comply with §150.0(k)9A; or ii. Shall comply with the applicable requirements in §110.9, §130.0, §130.2, §130.4, §140.7 and §141.0.
§150.0(k)9C:	For low-rise residential buildings with four or more dwelling units, outdoor lighting not regulated by §150.0(k)9B or 150.0(k)9D shall comply with the applicable requirements in §110.9, §130.0, §130.2, §130.4, §140.7 and §141.0.
§150.0(k)9D:	Outdoor lighting for residential parking lots and residential carports with a total of eight or more vehicles per site shall comply with the applicable requirements in §110.9, §130.0, §130.2, §130.4, §140.7 and §141.0.
§150.0(k)10:	Internally illuminated address signs shall comply with §140.8; or shall consume no more than 5 watts of power as determined according to §130.0(c).
§150.0(k)11:	Lighting for residential parking garages for eight or more vehicles shall comply with the applicable requirements for nonresidential garages in §110.9, §130.0, §130.1, §130.4, §140.6, and §141.0.
§150.0(k)12A:	In a low-rise multifamily residential building where the total interior common area in a single building equals 20 percent or less of the floor area, permanently installed lighting for the interior common areas in that building shall be high efficacy luminaires or controlled by an occupant sensor.
§150.0(k)12B:	In a low-rise multifamily residential building where the total interior common area in a single building equals more than 20 percent of the floor area, permanently installed lighting in that building shall: i. Comply with the applicable requirements in §110.9, §130.0, §130.1, §140.6 and §141.0; and ii. Lighting installed in corridors and stairwells shall be controlled by occupant sensors that reduce the lighting power in each space by at least 50 percent. The occupant sensors shall be capable of turning the light fully On and Off from all designed paths of ingress and egress.
Solar Ready Buildings:	
§110.10(a)1:	Single family residences located in subdivisions with ten or more single family residences and where the application for a tentative subdivision map for the residences has been deemed complete, by the enforcement agency, on or after January 1, 2014, shall comply with the requirements of §110.10(b) through §110.10(e).
§110.10(a)2:	Low-rise multi-family buildings shall comply with the requirements of §110.10(b) through §110.10(d).
§110.10(b)1:	The solar zone shall have a minimum total area as described below. The solar zone shall comply with access, pathway, smoke ventilation, and spacing requirements as specified in Title 24, Part 9 or other Parts of Title 24 or in any requirements adopted by a local jurisdiction. The solar zone total area shall be comprised of areas that have no dimension less than 5 feet and are no less than 80 square feet each for buildings with roof areas less than or equal to 10,000 square feet or no less than 160 square feet each for buildings with roof areas greater than 10,000 square feet. For single family residences the solar zone shall be located on the roof or overhang of the building and have a total area no less than 250 square feet. For low-rise multi-family buildings the solar zone shall be located on the roof or overhang of the building or on the roof or overhang of another structure located within 250 feet of the building or on covered parking installed with the building project and have a total area no less than 15 percent of the total roof area of the building excluding any skylight area.
§110.10(b)2:	All sections of the solar zone located on steep-sloped roofs shall be oriented between 110 degrees and 270 degrees of true north.
§110.10(b)3A:	No obstructions, including but not limited to, vents, chimneys, architectural features, and roof mounted equipment, shall be located in the solar zone.
§110.10(b)3B:	Any obstruction, located on the roof or any other part of the building that projects above a solar zone shall be located at least twice the distance, measured in the horizontal plane, of the height difference between the highest point of the obstruction and the horizontal projection of the nearest point of the solar zone, measured in the vertical plane.
§110.10(b)4:	For areas of the roof designated as solar zone, the structural design loads for roof dead load and roof live load shall be clearly indicated on the construction documents.
§110.10(c):	The construction documents shall indicate: a location for inverters and metering equipment and a pathway for routing of conduit from the solar zone to the point of interconnection with the electrical service (for single family residences the point of interconnection will be the main service panel); a pathway for routing of plumbing from the solar zone to the water-heating system.
§110.10(d):	A copy of the construction documents or a comparable document indicating the information from §110.10(b) through §110.10(c) shall be provided to the occupant.
§110.10(e)1:	The main electrical service panel shall have a minimum busbar rating of 200 amps.
§110.10(e)2:	The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future solar electric installation. The reserved space shall be: positioned at the opposite (load) end from the input feeder location or main circuit location, and permanently marked as "For Future Solar Electric".

HVAC SYSTEM HEATING AND COOLING LOADS SUMMARY

Project Name	Date
Educational Version for Class Assignments Only	5/22/2015
System Name	**Floor Area**
HVAC System	966

ENGINEERING CHECKS

Number of Systems	1
Heating System	
Output per System	17,200
Total Output (Btuh)	17,200
Output (Btuh/sqft)	17.8
Cooling System	
Output per System	19,400
Total Output (Btuh)	19,400
Total Output (Tons)	1.6
Total Output (Btuh/sqft)	20.1
Total Output (sqft/Ton)	597.5
Air System	
CFM per System	610
Airflow (cfm)	610
Airflow (cfm/sqft)	0.63
Airflow (cfm/Ton)	377.3
Outside Air (%)	0.0 %
Outside Air (cfm/sqft)	0.00
Note: values above given at ARI conditions	

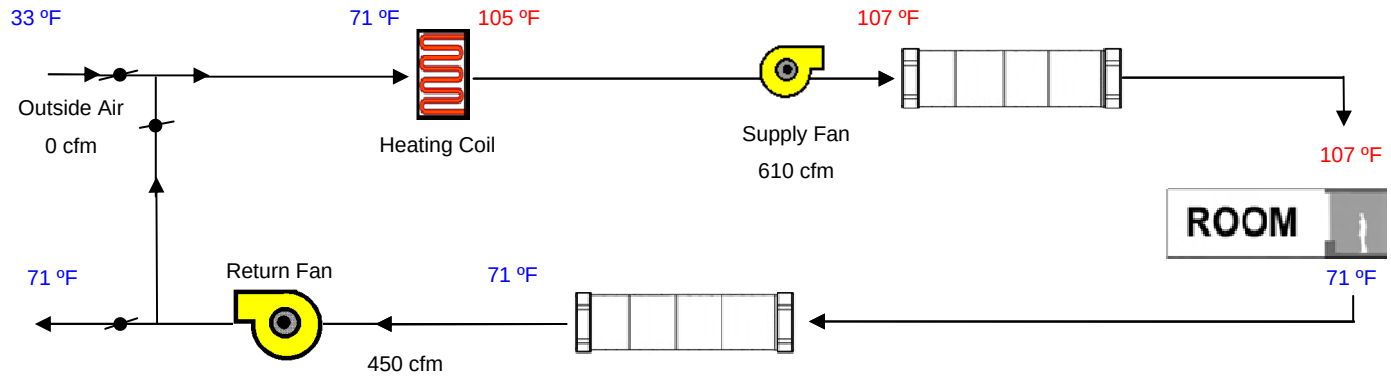
SYSTEM LOAD

	COIL COOLING PEAK			COIL HTG. PEAK	
	CFM	**Sensible**	**Latent**	**CFM**	**Sensible**
Total Room Loads	401	8,071	888	230	9,006
Return Vented Lighting		0			
Return Air Ducts		0			0
Return Fan		0			0
Ventilation	0	0	0	0	0
Supply Fan		1,535			-1,535
Supply Air Ducts		0			0
TOTAL SYSTEM LOAD		9,606	888		7,471

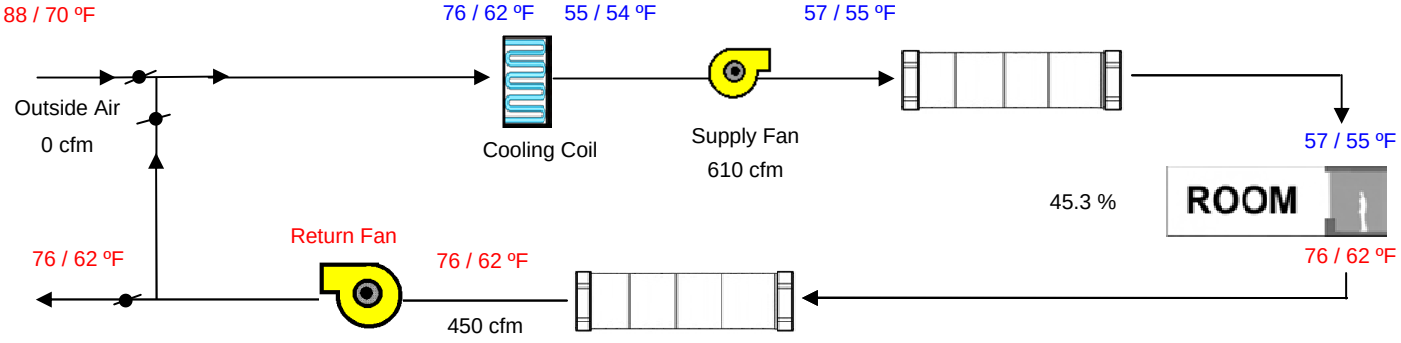
HVAC EQUIPMENT SELECTION

Airtemp VT4BE-018K	18,510	0		12,850
Total Adjusted System Output (Adjusted for Peak Design conditions)	18,510	0		12,850
TIME OF SYSTEM PEAK		Aug 3 PM		Jan 1 AM

HEATING SYSTEM PSYCHROMETRICS (Airstream Temperatures at Time of Heating Peak)



COOLING SYSTEM PSYCHROMETICS (Airstream Temperatures at Time of Cooling Peak)



ROOM LOAD SUMMARY

Project Name	Date
Educational Version for Class Assignments Only	*5/22/2015*
System Name	**Floor Area**
HVAC System	*966*

ROOM LOAD SUMMARY

			ROOM COOLING PEAK			COIL COOLING PEAK			COIL HTG. PEAK	
Zone Name	Room Name	Mult.	CFM	Sensible	Latent	CFM	Sensible	Latent	CFM	Sensible
Zone 1	*Single Zoned House*	*1*	*401*	*8,071*	*888*	*401*	*8,071*	*888*	*230*	*9,006*

PAGE TOTAL	*401*	*8,071*	*888*	*230*	*9,006*
TOTAL *	*401*	*8,071*	*888*	*230*	*9,006*

* Total includes ventilation load for zonal systems.

ROOM HEATING PEAK LOADS

Project Name	Date
Educational Version for Class Assignments Only	*5/22/2015*

ROOM INFORMATION		DESIGN CONDITIONS	
Room Name	*Single Zoned House*	**Time of Peak**	*Jan 1 AM*
Floor Area	*966.0 ft²*	**Outdoor Dry Bulb Temperature**	*33 ºF*
Indoor Dry Bulb Temperature	*71 ºF*		

Conduction	Area		U-Value		ΔT °F		Btu/hr
R-24 + R-5 Floor	966.0	X	0.0347	X	38	=	1,274
8.25" SIP Wall	943.5	X	0.0320	X	38	=	1,147
Ultrex Low-E2 Fiberglass/Air	159.0	X	0.3400	X	38	=	2,054
2x6 + R-10	352.0	X	0.0398	X	38	=	532
Nana Low-E2 TripleAir	116.5	X	0.3000	X	38	=	1,328
2x8 + R-10	234.0	X	0.0315	X	38	=	280
8.25" EPS SIP Panel + R10	732.0	X	0.0248	X	38	=	690
		X		X		=	
		X		X		=	
		X		X		=	
		X		X		=	
		X		X		=	
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		X		X		=	
		X		X		=	

Items shown with an asterisk (*) denote conduction through an interior surface to another room — **Page Total** 7,306

Infiltration: [1.00 (Schedule Fraction) X 1.078 (Air Sensible) X 966 (Area) X 10.40 (Ceiling Height) X 0.248 (ACH) / 60] X 38 (ΔT) = 1,700

TOTAL HOURLY HEAT LOSS FOR ROOM *9,006*

RESIDENTIAL ROOM COOLING LOAD SUMMARY

Project Name	Date
Educational Version for Class Assignments Only	*5/22/2015*

ROOM INFORMATION		DESIGN CONDITIONS	
Room Name	*Single Zoned House*	**Outdoor Dry Bulb Temperature**	*88 ºF*
Floor Area	*966.0 ft²*	**Outdoor Wet Bulb Temperature**	*70 ºF*
Indoor Dry Bulb Temperature	*76 ºF*	**Outdoor Daily Range:**	*27 ºF*

Opaque Surfaces	Orientation	Area		U-Factor		CLTD[1]		Btu/hr
R-24 + R-5 Floor		*966.0*	X	*0.0347*	X	*4.0*	=	*134*
8.25" SIP Wall	*(N)*	*226.0*	X	*0.0320*	X	*3.0*	=	*22*
2x6 + R-10	*(N)*	*130.0*	X	*0.0398*	X	*3.0*	=	*16*
8.25" SIP Wall	*(E)*	*332.0*	X	*0.0320*	X	*13.0*	=	*138*
8.25" SIP Wall	*(S)*	*153.5*	X	*0.0320*	X	*6.0*	=	*29*
2x6 + R-10	*(S)*	*110.0*	X	*0.0398*	X	*6.0*	=	*26*
8.25" SIP Wall	*(W)*	*232.0*	X	*0.0320*	X	*13.0*	=	*97*
2x6 + R-10	*(W)*	*112.0*	X	*0.0398*	X	*13.0*	=	*58*
2x8 + R-10	*(N)*	*234.0*	X	*0.0315*	X	*37.0*	=	*273*
						Page Total		*792*

Items shown with an asterisk (*) denote conduction through an interior surface to another room.
1. Cooling Load Temperature Difference (CLTD)

		Shaded				Unshaded				
Fenestration	**Orientation**	**Area**		**GLF**		**Area**		**GLF**		**Btu/hr**
Window 2- 3x4	*(N)*	*0.0*	X	*11.5*	+	*24.0*	X	*11.5*	=	*276*
Window 6- 3x2	*(N)*	*0.0*	X	*11.5*	+	*36.0*	X	*11.5*	=	*414*
French Dr	*(N)*	*0.0*	X	*11.5*	+	*21.0*	X	*11.5*	=	*242*
Window 2.5x6	*(E)*	*0.0*	X	*11.5*	+	*15.0*	X	*29.2*	=	*437*
Window 3x4	*(E)*	*0.0*	X	*11.5*	+	*12.0*	X	*29.2*	=	*350*
Nana Wall System	*(S)*	*116.5*	X	*9.1*	+	*0.0*	X	*10.7*	=	*1,061*
Window 2.5x6	*(S)*	*15.0*	X	*11.5*	+	*0.0*	X	*13.5*	=	*173*
French Dr	*(S)*	*21.0*	X	*11.5*	+	*0.0*	X	*13.5*	=	*242*
Window 2.5x6	*(W)*	*0.0*	X	*11.5*	+	*15.0*	X	*29.2*	=	*437*
							Page Total			*3,632*

Internal Gain							Btu/hr
Occupants	*3.9*	Occupants	X	*245*	Btuh/occ.	=	*947*
Equipment	*966*	Floor Area	X	*0.50*	w/sqft	=	*1,648*

Infiltration: *1.078* (Air Sensible) X *0.64* (CFM) X *46.04* (ELA) X *12* (ΔT) = *380*

TOTAL HOURLY SENSIBLE HEAT GAIN FOR ROOM *8,071*

Latent Gain							Btu/hr
Occupants	*3.9*	Occupants	X	*155*	Btuh/occ.	=	*599*

Infiltration: *4,833* (Air Sensible) X *0.64* (CFM) X *46.04* (ELA) X *0.00204* (ΔW) = *289*

TOTAL HOURLY LATENT HEAT GAIN FOR ROOM *1,117*

RESIDENTIAL ROOM COOLING LOAD SUMMARY

Project Name	Date
Educational Version for Class Assignments Only	*5/22/2015*

ROOM INFORMATION		DESIGN CONDITIONS	
Room Name	*Single Zoned House*	**Outdoor Dry Bulb Temperature**	*88 ºF*
Floor Area	*966.0 ft²*	**Outdoor Wet Bulb Temperature**	*70 ºF*
Indoor Dry Bulb Temperature	*76 ºF*	**Outdoor Daily Range:**	*27 ºF*

Opaque Surfaces	Orientation	Area		U-Factor		CLTD[1]		Btu/hr
8.25" EPS SIP Panel + R10	*(N)*	*732.0*	X	*0.0248*	X	*37.0*	=	*672*
			X		X		=	
			X		X		=	
			X		X		=	
			X		X		=	
			X		X		=	
			X		X		=	
			X		X		=	
			X		X		=	
			X		X		=	
						Page Total		*672*

Items shown with an asterisk (*) denote conduction through an interior surface to another room.
1. Cooling Load Temperature Difference (CLTD)

		Shaded			Unshaded			
Fenestration	**Orientation**	**Area**	**GLF**		**Area**	**GLF**		**Btu/hr**
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
						Page Total		*0*

Internal Gain							Btu/hr
Occupants	*3.9*	Occupants	X	*245*	Btuh/occ.	=	*947*
Equipment	*966*	Floor Area	X	*0.50*	w/sqft	=	*1,648*

Infiltration:	*1.078*	X	*0.64*	X	*46.04*	X	*12*	=	*380*
	Air Sensible		CFM		ELA		ΔT		

TOTAL HOURLY SENSIBLE HEAT GAIN FOR ROOM *8,071*

Latent Gain						Btu/hr
Occupants	*3.9*	Occupants	X	*155*	Btuh/occ.	=	*599*

Infiltration:	*4,833*	X	*0.64*	X	*46.04*	X	*0.00204*	=	*289*
	Air Sensible		CFM		ELA		ΔW		

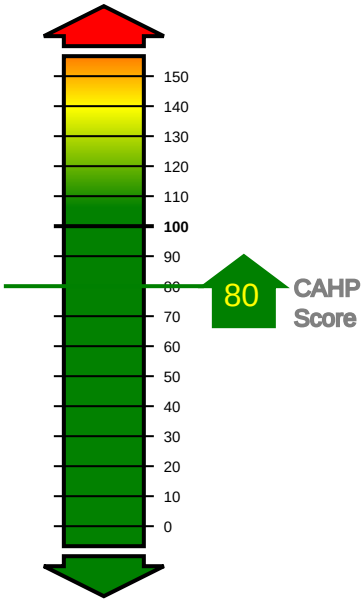
TOTAL HOURLY LATENT HEAT GAIN FOR ROOM *1,117*

Appendix E

CAHP Incentive Report (CIR)

Home Incentive: $ 700

Project Size and Location		Orientation and Type	
Conditioned Floor Area	966 sq. ft.	Project Type	Single Family
Climate Zone	CZ8 (Fullerton)	Front Orientation (in degrees)	0



Kicker and Incentive Summary	
CAHP Score Initial	80
DOE Zero Energy Ready Home (3 possible)	- 0
Future Code Preparation (5 possible)	- 0
High Efficacy Lighting Credit (3 possible)	- 0
Low Energy Use Home (5 possible)	- 0
Ultra Low Use Home (5 possible)	- 0
CAHP Score Final	80
Total Project kTDV Energy	129,096
Incentive Amount	$ 0,700

Project Savings Margins	
Project Savings (kW)	0.3
Project Savings (kWh/yr)	289
Project Savings (therms)	0

Energy Use Summary

End Use	Savings (kWh/yr)	Savings (therms)	CAHP Std (kTDV/ft2)	Proposed (kTDV/ft2)
Space Heating	97.00	0.00	5.92	2.79
Space Cooling	245.00	0.00	49.62	17.78
IAQ Ventilation	0.00	0.00	1.15	1.15
Other HVAC	0.00	0.00	0.00	0.00
Water Heating	-52.00	0.00	26.38	27.51
Inside Lighting	0.00	0.00	12.49	12.49
Appl. & Cooking	0.00	0.00	40.89	40.89
Plug Loads	0.00	0.00	30.36	30.36
Exterior	0.00	0.00	0.67	0.67
PV Credit				**0.00**
Compliance Total			83.07	49.23
TOTAL	289.00	0.00	167.48	133.64

Name of Model File:	Residential Building
Date and Time of Analysis:	16:21, Fri, May 22, 2015

Pacific Gas and Electric Company®

SOUTHERN CALIFORNIA EDISON®
An EDISON INTERNATIONAL® Company

SDGE
A Sempra Energy utility®

Southern California Gas Company
A Sempra Energy utility®

Home Energy Performance Report

Project: ***Solar Cal Poly***

Address: ***Cal Poly***
Irvine, CA

Prepared By: ***California Polytechnic State University***

,

Phone:

Fax:

E-mail:

Date: ***5/22/2015***

This report includes the results of an on-site assessment of this project for the purposes of the evaluation of the energy consumption and upgrade potential of the building. Results reported are based upon information determined at the site, and discussions with the project occupants as well as incorporating published typical weather year information. If you have any questions about this report or would like to discuss the details or findings, please call or e-mail us

TABLE OF CONTENTS

Project Summary

Cal Poly

Irvine, CA

Date of Audit:	*1/1/0001*
Conditioned Floor Area:	*966*
Number of Stories:	*1*
Number of Bedrooms:	*1*

House Type:	*Single Family*
Foundation Type:	*Raised Floor*
California Climate Zone:	*8*
Weather Data:	*CZ08_wy3.bin*

WHERE THE ENERGY IS USED

No Data

This pie chart estimates the energy cost for the various types of end uses in the home. Data has been calculated using software that uses typical profiles of usage to estimate end use cost. Your costs may vary from these numbers depending upon how the home is operated.

Energy Use Summary

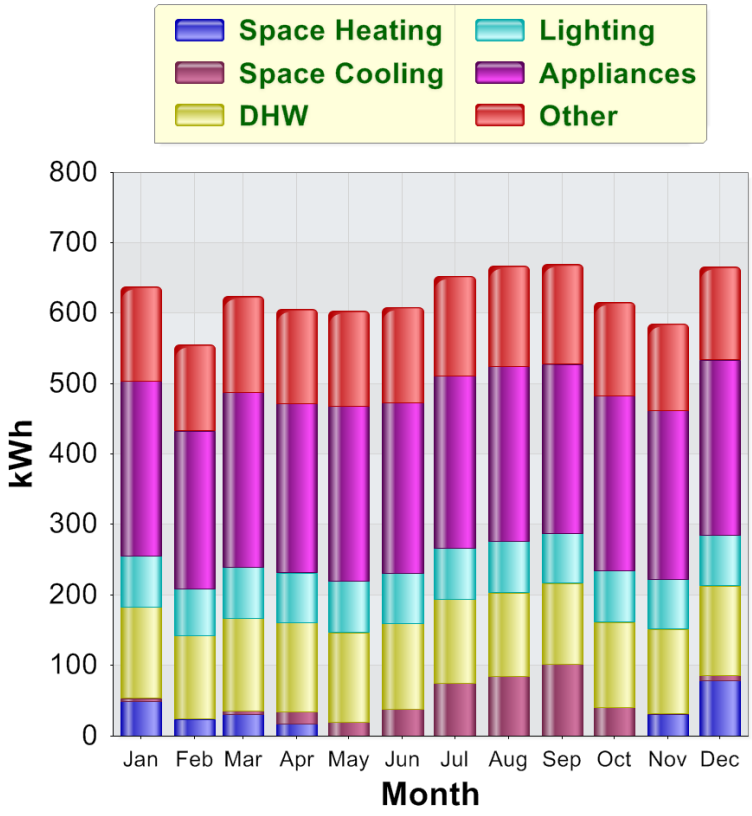
Cal Poly

Irvine, CA

The tables and graphs below summarize the major energy uses in the home for both electricity and fossil fuels. Ancillary uses include swimming pools and spas.

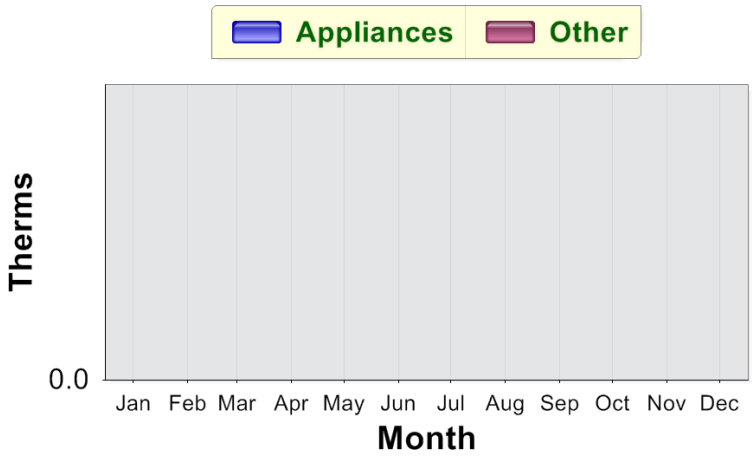
ELECTRICITY

End Use	kWh/yr
Space Heating	*230*
Space Cooling	*398*
Fans	*138*
Pumps	*0*
Domestic Hot Water	*1,472*
Indoor Lighting	*794*
Outdoor Lighting	*66*
Appliances	*2,919*
Ancillary	*0*
Renewables	*0*
TOTAL	***6,016***



FOSSIL FUEL

End Use	Therms/yr
Space Heating	*0*
Domestic Hot Water	*0*
Appliances	*0*
Ancillary	*0*
TOTAL	***0***



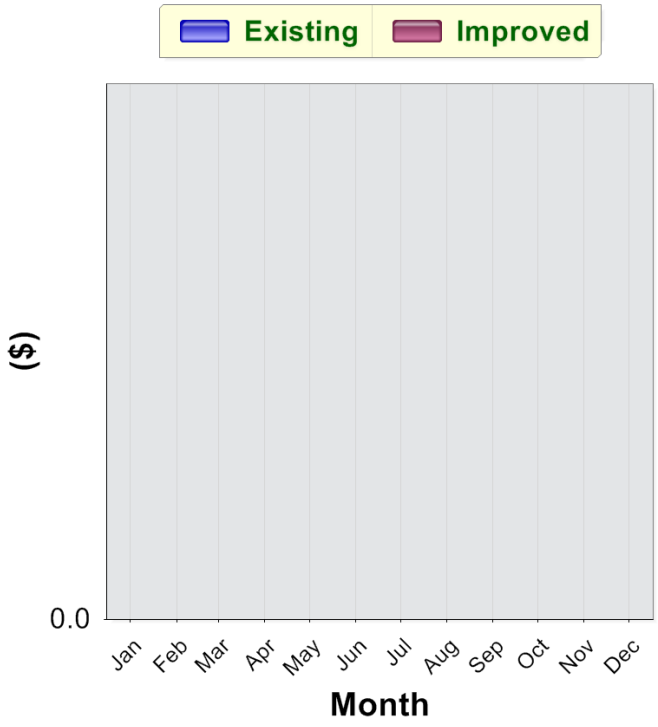
Recommendations

Cal Poly

Irvine, CA

The summary below compares the annual home energy cost before and after the measures shown in the recommendations table. Some savings may occur in features that have not been upgraded simply because the reduced energy usage from other recommendations moves the home into a lower utility rate tier. The existing data shown is based upon the calculated amount the home would use under normal weather and operating conditions.

Annual Results	Energy Cost		
End Use	**Existing**	**Improved**	**Savings**
Space Heating	*$0*	*$0*	*$0*
Space Cooling	*$0*	*$0*	*$0*
Fans	*$0*	*$0*	*$0*
Pumps	*$0*	*$0*	*$0*
Domestic Hot Water	*$0*	*$0*	*$0*
Indoor Lighting	*$0*	*$0*	*$0*
Outdoor Lighting	*$0*	*$0*	*$0*
Appliances	*$0*	*$0*	*$0*
Ancillary	*$0*	*$0*	*$0*
Renewables	*$0*	*$0*	*$0*
TOTAL	***$0***	***$0***	***$0***



Misc	Existing	Improved	Savings
Average Demand (kW)	*1.60*	*1.60*	*0.00*
TDV Energy (kBtu/ft^2-yr)	*143.18*	*143.18*	*0.00*

Demand usage is important to the utility as it impacts how much power plant capacity they must have at a given hour. Time Dependent Valuation (TDV) energy is a metric used by the California Energy Commission to value energy at different hours of the year.

CO_2 (tons/year)	Existing	Improved	Savings
Electricity	*0.00*	*0.00*	*0.00*
Fossil Fuel	*0.00*	*0.00*	*0.00*
TOTAL	***0.00***	***0.00***	***0.00***

This table compares calculated Carbon Dioxide (CO_2) emissions before and after the home improvements. By reducing the energy usage of the home, the amount of CO_2 emissions resulting from electricity production and fossil fuel combustion will be reduced.

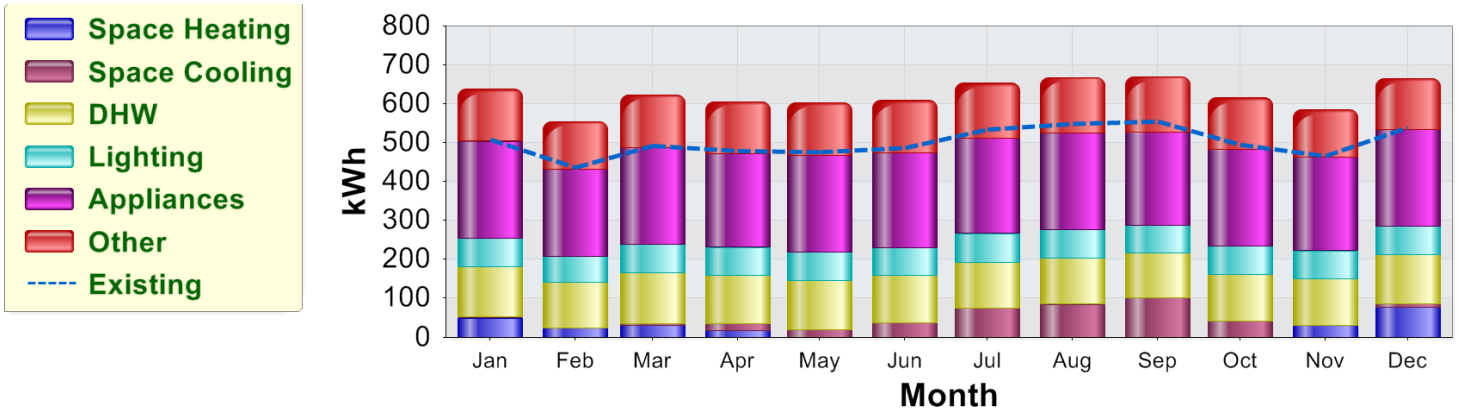
Recommendations

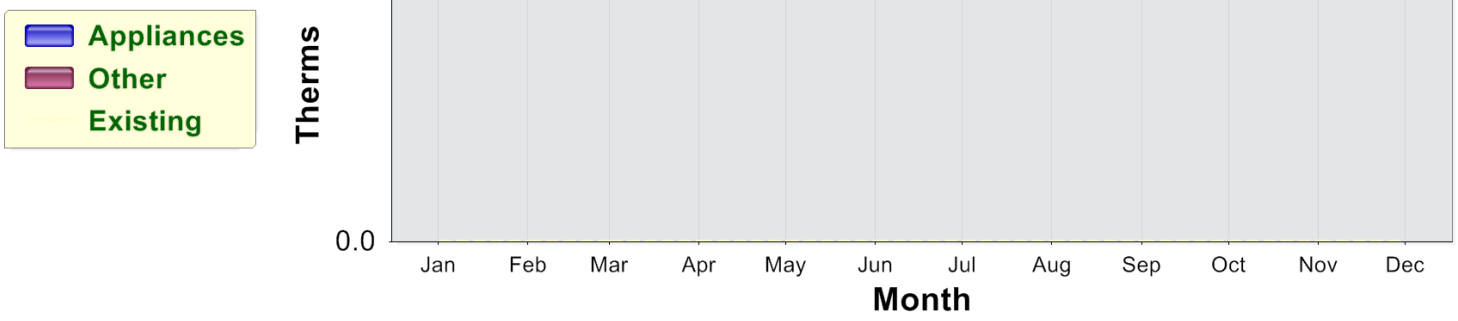
Cal Poly

Irvine, CA

Annual Results	Electricity (kWh)			Fossil Fuel (therms)		
End Use	Existing	Improved	Savings	Existing	Improved	Savings
Space Heating	*230*	*230*	*0*	*0*	*0*	*0*
Space Cooling	*398*	*398*	*0*	*0*	*0*	*0*
Fans	*138*	*138*	*0*	*0*	*0*	*0*
Pumps	*0*	*0*	*0*	*0*	*0*	*0*
Domestic Hot Water	*1,472*	*1,472*	*0*	*0*	*0*	*0*
Indoor Lighting	*794*	*794*	*0*	*0*	*0*	*0*
Outdoor Lighting	*66*	*66*	*0*	*0*	*0*	*0*
Appliances	*2,919*	*2,919*	*0*	*0*	*0*	*0*
Ancillary	*0*	*0*	*0*	*0*	*0*	*0*
Renewables	*0*	*0*	*0*	*0*	*0*	*0*
TOTAL	***6,016***	***6,016***	***0***	***0***	***0***	***0***

This summary compares the calculated annual home energy usage before and after the measures shown in the recommendations table. The existing data shown is based upon the calculated amount the home would use under normal weather and operating conditions.





HVAC SYSTEM HEATING AND COOLING LOADS SUMMARY

Project Name	Date
Educational Version for Class Assignments Only	5/22/2015
System Name	**Floor Area**
HVAC System	966

ENGINEERING CHECKS

Number of Systems	1
Heating System	
Output per System	17,200
Total Output (Btuh)	17,200
Output (Btuh/sqft)	17.8
Cooling System	
Output per System	19,400
Total Output (Btuh)	19,400
Total Output (Tons)	1.6
Total Output (Btuh/sqft)	20.1
Total Output (sqft/Ton)	597.5
Air System	
CFM per System	610
Airflow (cfm)	610
Airflow (cfm/sqft)	0.63
Airflow (cfm/Ton)	377.3
Outside Air (%)	0.0 %
Outside Air (cfm/sqft)	0.00
Note: values above given at ARI conditions	

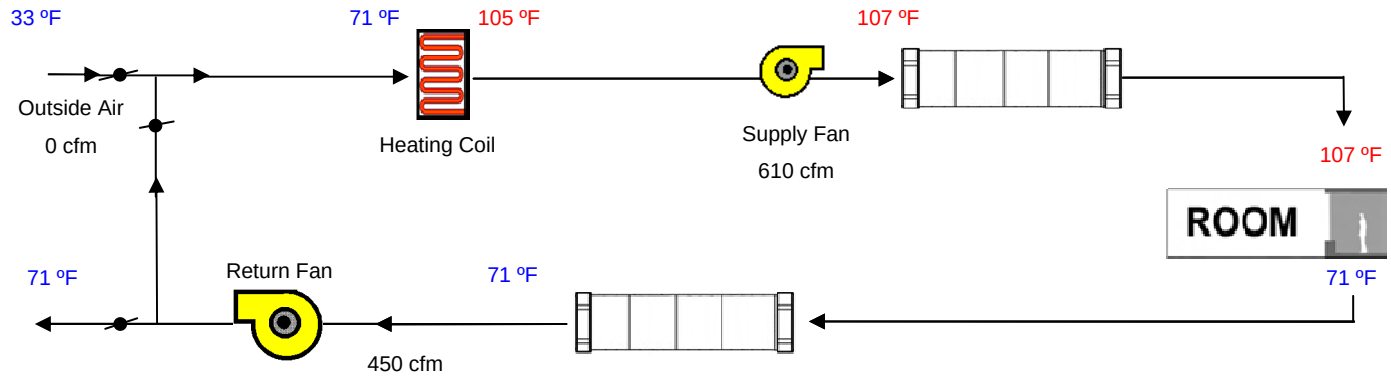
SYSTEM LOAD

	COIL COOLING PEAK			COIL HTG. PEAK	
	CFM	**Sensible**	**Latent**	**CFM**	**Sensible**
Total Room Loads	401	8,071	888	230	9,006
Return Vented Lighting		0			
Return Air Ducts		0			0
Return Fan		0			0
Ventilation	0	0	0	0	0
Supply Fan		1,535			-1,535
Supply Air Ducts		0			0
TOTAL SYSTEM LOAD		9,606	888		7,471

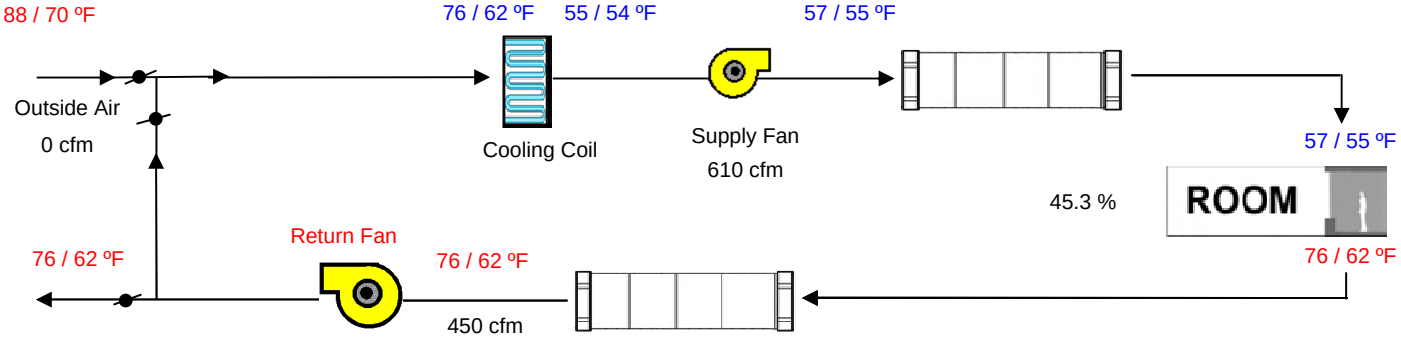
HVAC EQUIPMENT SELECTION

Airtemp VT4BE-018K	18,510	0		12,850
Total Adjusted System Output (Adjusted for Peak Design conditions)	18,510	0		12,850
TIME OF SYSTEM PEAK		Aug 3 PM		Jan 1 AM

HEATING SYSTEM PSYCHROMETRICS (Airstream Temperatures at Time of Heating Peak)



COOLING SYSTEM PSYCHROMETICS (Airstream Temperatures at Time of Cooling Peak)



ROOM LOAD SUMMARY

Project Name	Date
Educational Version for Class Assignments Only	*5/22/2015*
System Name	**Floor Area**
HVAC System	*966*

ROOM LOAD SUMMARY

			ROOM COOLING PEAK			COIL COOLING PEAK			COIL HTG. PEAK	
Zone Name	Room Name	Mult.	CFM	Sensible	Latent	CFM	Sensible	Latent	CFM	Sensible
Zone 1	*Single Zoned House*	*1*	*401*	*8,071*	*888*	*401*	*8,071*	*888*	*230*	*9,006*

PAGE TOTAL	*401*	*8,071*	*888*	*230*	*9,006*
TOTAL *	*401*	*8,071*	*888*	*230*	*9,006*

* Total includes ventilation load for zonal systems.

ROOM HEATING PEAK LOADS

Project Name	Date
Educational Version for Class Assignments Only	*5/22/2015*

ROOM INFORMATION		DESIGN CONDITIONS	
Room Name	*Single Zoned House*	**Time of Peak**	*Jan 1 AM*
Floor Area	*966.0 ft²*	**Outdoor Dry Bulb Temperature**	*33 ºF*
Indoor Dry Bulb Temperature	*71 ºF*		

Conduction	Area		U-Value		ΔT ºF		Btu/hr
R-24 + R-5 Floor	966.0	X	0.0347	X	38	=	1,274
8.25" SIP Wall	943.5	X	0.0320	X	38	=	1,147
Ultrex Low-E2 Fiberglass/Air	159.0	X	0.3400	X	38	=	2,054
2x6 + R-10	352.0	X	0.0398	X	38	=	532
Nana Low-E2 TripleAir	116.5	X	0.3000	X	38	=	1,328
2x8 + R-10	234.0	X	0.0315	X	38	=	280
8.25" EPS SIP Panel + R10	732.0	X	0.0248	X	38	=	690

Items shown with an asterisk (*) denote conduction through an interior surface to another room **Page Total** 7,306

Infiltration:[1.00 (Schedule Fraction) X 1.078 (Air Sensible) X 966 (Area) X 10.40 (Ceiling Height) X 0.248 (ACH) / 60] X 38 (ΔT) = 1,700

TOTAL HOURLY HEAT LOSS FOR ROOM *9,006*

RESIDENTIAL ROOM COOLING LOAD SUMMARY

Project Name	Date
Educational Version for Class Assignments Only	*5/22/2015*

ROOM INFORMATION		DESIGN CONDITIONS	
Room Name	*Single Zoned House*	**Outdoor Dry Bulb Temperature**	*88 ºF*
Floor Area	*966.0 ft²*	**Outdoor Wet Bulb Temperature**	*70 ºF*
Indoor Dry Bulb Temperature	*76 ºF*	**Outdoor Daily Range:**	*27 ºF*

Opaque Surfaces	Orientation	Area		U-Factor		CLTD[1]		Btu/hr
R-24 + R-5 Floor		*966.0*	X	*0.0347*	X	*4.0*	=	*134*
8.25" SIP Wall	*(N)*	*226.0*	X	*0.0320*	X	*3.0*	=	*22*
2x6 + R-10	*(N)*	*130.0*	X	*0.0398*	X	*3.0*	=	*16*
8.25" SIP Wall	*(E)*	*332.0*	X	*0.0320*	X	*13.0*	=	*138*
8.25" SIP Wall	*(S)*	*153.5*	X	*0.0320*	X	*6.0*	=	*29*
2x6 + R-10	*(S)*	*110.0*	X	*0.0398*	X	*6.0*	=	*26*
8.25" SIP Wall	*(W)*	*232.0*	X	*0.0320*	X	*13.0*	=	*97*
2x6 + R-10	*(W)*	*112.0*	X	*0.0398*	X	*13.0*	=	*58*
2x8 + R-10	*(N)*	*234.0*	X	*0.0315*	X	*37.0*	=	*273*
						Page Total		*792*

Items shown with an asterisk (*) denote conduction through an interior surface to another room.
1. Cooling Load Temperature Difference (CLTD)

		Shaded				Unshaded				
Fenestration	**Orientation**	**Area**		**GLF**		**Area**		**GLF**		**Btu/hr**
Window 2- 3x4	*(N)*	*0.0*	X	*11.5*	+	*24.0*	X	*11.5*	=	*276*
Window 6- 3x2	*(N)*	*0.0*	X	*11.5*	+	*36.0*	X	*11.5*	=	*414*
French Dr	*(N)*	*0.0*	X	*11.5*	+	*21.0*	X	*11.5*	=	*242*
Window 2.5x6	*(E)*	*0.0*	X	*11.5*	+	*15.0*	X	*29.2*	=	*437*
Window 3x4	*(E)*	*0.0*	X	*11.5*	+	*12.0*	X	*29.2*	=	*350*
Nana Wall System	*(S)*	*116.5*	X	*9.1*	+	*0.0*	X	*10.7*	=	*1,061*
Window 2.5x6	*(S)*	*15.0*	X	*11.5*	+	*0.0*	X	*13.5*	=	*173*
French Dr	*(S)*	*21.0*	X	*11.5*	+	*0.0*	X	*13.5*	=	*242*
Window 2.5x6	*(W)*	*0.0*	X	*11.5*	+	*15.0*	X	*29.2*	=	*437*
						Page Total				*3,632*

Internal Gain							Btu/hr
Occupants	*3.9*	Occupants	X	*245*	Btuh/occ.	=	*947*
Equipment	*966*	Floor Area	X	*0.50*	w/sqft	=	*1,648*

Infiltration:									
1.078	X	*0.64*	X	*46.04*	X	*12*	=		*380*
Air Sensible		CFM		ELA		ΔT			

TOTAL HOURLY SENSIBLE HEAT GAIN FOR ROOM *8,071*

Latent Gain							Btu/hr
Occupants	*3.9*	Occupants	X	*155*	Btuh/occ.	=	*599*

Infiltration:									
4,833	X	*0.64*	X	*46.04*	X	*0.00204*	=		*289*
Air Sensible		CFM		ELA		ΔW			

TOTAL HOURLY LATENT HEAT GAIN FOR ROOM *1,117*

RESIDENTIAL ROOM COOLING LOAD SUMMARY

Project Name	Date
Educational Version for Class Assignments Only	*5/22/2015*

ROOM INFORMATION		DESIGN CONDITIONS	
Room Name	*Single Zoned House*	**Outdoor Dry Bulb Temperature**	*88 ºF*
Floor Area	*966.0 ft²*	**Outdoor Wet Bulb Temperature**	*70 ºF*
Indoor Dry Bulb Temperature	*76 ºF*	**Outdoor Daily Range:**	*27 ºF*

Opaque Surfaces	Orientation	Area		U-Factor		CLTD[1]		Btu/hr
8.25" EPS SIP Panel + R10	*(N)*	*732.0*	X	*0.0248*	X	*37.0*	=	*672*
			X		X		=	
			X		X		=	
			X		X		=	
			X		X		=	
			X		X		=	
			X		X		=	
			X		X		=	
			X		X		=	
			X		X		=	
						Page Total		*672*

Items shown with an asterisk (*) denote conduction through an interior surface to another room.
1. Cooling Load Temperature Difference (CLTD)

		Shaded			Unshaded			
Fenestration	**Orientation**	**Area**	**GLF**		**Area**	**GLF**		**Btu/hr**
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
			X	+		X	=	
						Page Total		*0*

Internal Gain							Btu/hr
Occupants	*3.9*	Occupants	X	*245*	Btuh/occ.	=	*947*
Equipment	*966*	Floor Area	X	*0.50*	w/sqft	=	*1,648*

Infiltration:										
1.078	X	*0.64*	X	*46.04*	X	*12*	=			*380*
Air Sensible		CFM		ELA		ΔT				

TOTAL HOURLY SENSIBLE HEAT GAIN FOR ROOM *8,071*

Latent Gain						Btu/hr
Occupants	*3.9*	Occupants	X	*155*	Btuh/occ.	= *599*

Infiltration:										
4,833	X	*0.64*	X	*46.04*	X	*0.00204*	=			*289*
Air Sensible		CFM		ELA		ΔW				

TOTAL HOURLY LATENT HEAT GAIN FOR ROOM *1,117*

ENERGY USE AND COST SUMMARY — ECON-1

Project Name: *Educational Version for Class Assignments Only*

Date: *5/22/2015*

Rate: **Fuel Type:** *Electricity*

	STANDARD			PROPOSED			MARGIN		
	Energy Use (kWh)	Peak Demand (kW)	Cost ($)	Energy Use (kWh)	Peak Demand (kW)	Cost ($)	Energy Use (kWh)	Peak Demand (kW)	Cost ($)
Jan				508	3.8				
Feb				436	3.4				
Mar				492	3.3				
Apr				479	2.2				
May				476	2.2				
Jun				481	2.0				
Jul				540	1.8				
Aug				549	1.9				
Sep				555	2.9				
Oct				495	2.5				
Nov				466	3.4				
Dec				539	3.8				
Year				6,016	3.8				
CO_2		lbs/yr			lbs/yr			lbs/yr	

Rate: **Fuel Type:** *Propane*

	STANDARD			PROPOSED			MARGIN		
	Energy Use (therms)	Peak Demand (kBtu/hr)	Cost ($)	Energy Use (therms)	Peak Demand (kBtu/hr)	Cost ($)	Energy Use (therms)	Peak Demand (kBtu/hr)	Cost ($)
Jan				0	0.0				
Feb				0	0.0				
Mar				0	0.0				
Apr				0	0.0				
May				0	0.0				
Jun				0	0.0				
Jul				0	0.0				
Aug				0	0.0				
Sep				0	0.0				
Oct				0	0.0				
Nov				0	0.0				
Dec				0	0.0				
Year				0	0.0				
CO_2		lbs/yr			lbs/yr			lbs/yr	

Annual Totals	Energy	Demand	Cost	Cost/sqft	Virtual Rate
Electricity	*6,016* kWh	*4* kW	$ *0*	$ *0.00* /sqft	$ *0.00* /kWh
Propane	*0* therms	*0* kBtu/hr	$ *0*	$ *0.00* /sqft	$ *0.00* /therm
		Total	$ *0*	$ *0.00* /sqft	

Avoided CO_2 Emissions: lbs/yr

Energy Upgrade Recommendations — ECON-2

Project Name *Solar Cal Poly*	Documentation Author *California Polytechnic State University*
Project Address *Cal Poly Irvine, CA*	Author Address ,

Recommended Improvements	Description	Annual Savings	Est. Cost to Install	Savings Site	Savings TDV

Annual Results	Energy Cost			Electricity (kWh)			Fossil Fuel (therms)		
End Use	Existing	Improved	Savings	Existing	Improved	Savings	Existing	Improved	Savings
Space Heating	*$0*	*$0*	*$0*	*230*	*230*	*0*	*0*	*0*	*0*
Space Cooling	*$0*	*$0*	*$0*	*398*	*398*	*0*	*0*	*0*	*0*
Fans	*$0*	*$0*	*$0*	*138*	*138*	*0*	*0*	*0*	*0*
Pumps	*$0*	*$0*	*$0*	*0*	*0*	*0*	*0*	*0*	*0*
Domestic Hot Water	*$0*	*$0*	*$0*	*1,472*	*1,472*	*0*	*0*	*0*	*0*
Indoor Lighting	*$0*	*$0*	*$0*	*794*	*794*	*0*	*0*	*0*	*0*
Outdoor Lighting	*$0*	*$0*	*$0*	*66*	*66*	*0*	*0*	*0*	*0*
Appliances/Plug Loads	*$0*	*$0*	*$0*	*2,919*	*2,919*	*0*	*0*	*0*	*0*
Ancillary	*$0*	*$0*	*$0*	*0*	*0*	*0*	*0*	*0*	*0*
Renewables	*$0*	*$0*	*$0*	*0*	*0*	*0*	*0*	*0*	*0*
TOTAL	***$0***	***$0***	***$0***	***6,016***	***6,016***	***0***	***0***	***0***	***0***

CO_2 (lbs/year)	Existing	Improved	Savings
Electricity	*0*	*0*	*0*
Fossil Fuel	*0*	*0*	*0*
TOTAL	***0***	***0***	***0***
Average Demand (kW)	*1.60*	*1.60*	*0.00*
TDV Energy (kBtu/ft^2-yr)	*143.18*	*143.18*	*0.00*

Climate Zone:	*8*
Electric Rate:	
Gas Rate:	
Floor Area:	*966*
Type:	*Single Family*

Improvements above shown with cumulative savings benefit for combined measures

The estimated operating costs shown in this report are dependent upon many factors. The construction and conservation features of the project clearly are important. Equally important is the thermostat setting. How the thermostat is used, appliance use, and occupant interaction all influence the annual operating cost. The estimates provided in this report are based on typical conditions; your actual usage will vary.

Appendix F

HVAC & Hot Water Systems

Solar Cal Poly

Today's Date: 6/5/2015 Friday

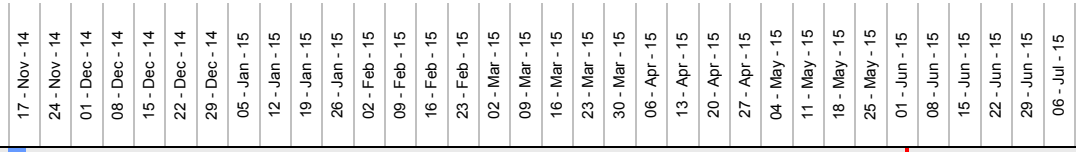
(vertical red line)

Project Lead: Jake, Patrick, James

Start Date: 11/16/2014 Sunday

First Day of Week (Mon=2): 2

WBS	Tasks	Task Lead	Start	End	Duration (Days)	% Complete	Working Days	Days Complete	Days Remaining
1	**Detailed Design/Analysis**		11/16/14	11/20/14	5	100%	4	5	0
1.1	Preliminary Design Report	All	11/16/14	11/17/14	2	100%	1	2	0
1.2	Preliminary Design Review	All	11/18/14	11/20/14	3	100%	3	3	0
1.3	FMEA, DVPR, Analysis Plan	All	11/20/14	12/2/14	13	100%	9	13	0
1.4	Break	All	12/13/14	1/5/15	24	100%	16	24	0
1.5	Verify design against code/standards	All	12/2/14	1/6/15	36	100%	26	36	0
1.6	Determine design conditions	All	1/6/15	1/12/15	7	100%	5	7	0
1.7	Verify equipment meets HVAC reqrmts	Jm, P	1/12/15	2/8/15	28	100%	20	28	0
1.8	Verify equipment meets ST reqrmts	Jk	1/12/15	2/8/15	28	100%	20	28	0
1.9	Determine system losses/consump./produc.	All	2/8/15	2/21/15	14	100%	10	14	0
1.10	Analyze life of systems	All	2/21/15	2/27/15	7	100%	5	7	0
2	**Construction**		5/15/15	7/31/15	78	27%	56	20	58
2.1	Develop construction plan	All	2/27/15	4/2/15	35	100%	25	35	0
2.2	Order Equipment	All	5/15/15	6/5/15	21	75%	16	15	6
2.3	Build & Test	All	6/1/15	7/31/15	60	10%	45	6	54
3	**Documentation**		5/22/15	6/5/15	15	100%	11	15	0
3.1	Final Project Report	All	5/28/15	6/5/15	7	100%	7	7	0
3.2	Design Expo	All	5/22/15	5/28/15	7	100%	5	7	0



Potential
Failure Mode and Effect Analysis
(Design FMEA)

___ System
___ Subsystem
___ Component

Design Responsibility:

FMEA Number:

Page 1 of 1

Model Year(s)/Vehicle(s):

Key Date:

Prepared By:

Core Team:

FMEA Date (Orig.) **(Rev.)**

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Potential Cause(s) / Mechanism(s) of Failure	Occur	Crit	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occur	Crit
HVAC System (Heating and Cooling): Keep space within 71-76 degrees	Equipment Failure 'Duct Leak 'Heat Pump Failure 'Air Handler Failure 'Refrigerant line leak	House not within comfort zone House is uncomfortable Poor score Air stratified	7	Improper Installation Improper Equipment Selection Extended Use	3	21	Proper Equipment Selection Proper Analysis Proper Installation Maintenance Checks	James 1/5/15				
	Sensor Failure		6	Power Outage Improper Installation	4	24	Proper Equipment Selection Proper Analysis Proper Installation Maintenance Checks	James 1/5/15				
	Extreme ambient conditions		4	Global Warming Mother Nature	6	24	Necessary insulation	James 1/5/15				
	Too many people in house		3	Party/Event Tours	6	18	Account for in equipment selection and controls	James 1/5/15				
	Corrosion		6	Water Leaks Extended Use Stagnant Water	4	24	Maintenance Checks	James date (na)				
HVAC System (Humidity): Keep relative humidity below 60%	Equipment Failure 'Duct Leak 'Heat Pump Failure 'Air Handler Failure 'Refrigerant line leak	House not within comfort zone House is uncomfortable Poor score High Condensation Biological Growth	7	Improper Installation Improper Equipment Selection Extended Use	3	21	Proper Equipment Selection Proper Analysis Proper Installation Maintenance Checks	All date (na)				
	Sensor Failure		6	Power Outage Improper Installation	4	24	Proper Equipment Selection Proper Analysis Proper Installation Maintenance Checks	All date (na)				
	Extreme ambient conditions		4	Global Warming Mother Nature	6	24	Necessary insulation	All date (na)	Active HVAC has not currently been implemented, so no actions have been taken yet.			
	Too many people in house		3	Party/Event Tours	6	18	Account for in equipment selection and controls	All date (na)				
	Corrosion		6	Water Leaks Extended Use Stagnant Water	4	24	Maintenance Checks	All date (na)				
HVAC System (Ventilation): Help to change air 0.35 times every hour	Equipment Failure 'Duct Leaks 'HRV Failure	House not within comfort zone Poor air quality High levels of Carbon Dioxide	7	Improper Installation Improper Equipment Selection Extended Use	3	21	Proper Equipment Selection Proper Analysis Proper Installation Maintenance Checks	Patrick date (na)				
	Sensor Failure	Lack in control of humidty	6	Power Outage Improper Installation	4	24	Proper Equipment Selection Proper Analysis Proper Installation Maintenance Checks	Patrick date (na)				
	Hazerdous Intake Air		8	Surrounding Condition	1	8	Knowledge of air quality and exhaust of other systems	Patrick date (na)				
Solar Thermal System: Preheat water-glycol mix in solar thermal loop	Equipment Failure 'Pump Failure 'Pipe leaks 'Valve Failure 'Solar Collector	Does not heat water Water loss Flooding	7	Improper Installation Improper Equipment Selection Extended Use	5	35	Proper Equipment Selection Proper Analysis Proper Installation Maintenance Checks	Cosmo date (na)				
	Overheating water mix within loop	Pipe Leaks Breaking Flat Plate	7	Extreme Ambient Conditions Heat transfer fluid	1	7	Proper Analysis Maintenance Checks	Cosmo date (na)				

ME428/429/430 Senior Design Project 2014-2015

SENIOR PROJECT CRITICAL DESIGN HAZARD IDENTIFICATION CHECKLIST

Team: Solar Decathlon HVAC & Solar Thermal Team Advisor: Dr. Shollenberger

Y	N	
☒	☐	Do any parts of the design create hazardous revolving, reciprocating, running, shearing, punching, pressing, squeezing, drawing, cutting, rolling, mixing or similar action, including pinch points and sheer points adequately guarded?
☐	☒	Does any part of the design undergo high accelerations/decelerations that are exposed to the user?
☐	☒	Does the system have any large moving masses or large forces that can contact the user?
☐	☒	Does the system produce a projectile?
☒	☐	Can the system to fall under gravity creating injury?
☐	☒	Is the user exposed to overhanging weights as part of the design?
☐	☒	Does the system have any sharp edges exposed?
☐	☒	Are there any ungrounded electrical systems in the design?
☒	☐	Are there any large capacity batteries or is there electrical voltage in the system above 40 V either AC or DC?
☐	☒	Is there be any stored energy in the system such as batteries, flywheels, hanging weights or pressurized fluids when the system is either on or off?
☒	☐	Are there any explosive or flammable liquids, gases, dust, or fuel in the system?
☐	☒	Is the user of the design required to exert any abnormal effort and/or assume a an abnormal physical posture during the use of the design?
☒	☐	Are there any materials known to be hazardous to humans involved in either the design or the manufacturing of the design?
☒	☐	Will the system generate high levels of noise?
☒	☐	Will the product be subjected to extreme environmental conditions such as fog, humidity, cold, high temperatures ,etc. that could create an unsafe condition?
☐	☒	Is it easy to use the system unsafely?
☐	☒	Are there any other potential hazards not listed above? If yes, please explain on the back of this checklist.

For any “Y” responses, add a complete description on the reverse side. DO NOT fill in the corrective actions or dates until you meet with the mechanical and electrical technicians.

Description of Hazard	Corrective Actions to be Taken	Planned Completion Date	Actual Completion Date

B6BM, B6EM, & B6VM Series

INSTALLATION INSTRUCTIONS

AIR HANDLER

IMPORTANT

Please read all information in this manual thoroughly and become familiar with the capabilities and use of your appliance before attempting to operate or maintain this unit. These instructions are primarily intended to assist qualified individuals experienced in the proper installation of this appliance. Some local codes require licensed installation/service personnel for this type of equipment. Improper installation, service, adjustment, or maintenance may cause explosion, fire, electrical shock or other hazardous conditions which may result in personal injury or property damage.

Unless otherwise noted in these instructions, only factory authorized kits or accessories may be used with this product. Keep this manual where you have easy access to it in the future. If a problem occurs, check the instructions and follow recommendations given. If these suggestions don't eliminate your problem, call your servicing contractor.

DO NOT DESTROY. PLEASE READ CAREFULLY AND KEEP IN A SAFE PLACE FOR FUTURE REFERENCE.

TABLE OF CONTENTS

IMPORTANT SAFETY INFORMATION

INSTALLER: Please read all instructions before servicing this equipment. Pay attention to all safety warnings and any other special notes highlighted in the manual. Safety markings are used frequently throughout this manual to designate a degree or level of seriousness and should not be ignored. **WARNING** indicates a potentially hazardous situation that if not avoided, could result in personal injury or death. **CAUTION** indicates a potentially hazardous situation that if not avoided, may result in minor or moderate injury or property damage.

⚠ WARNING:

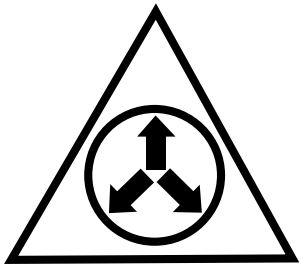
ELECTRICAL SHOCK, FIRE OR EXPLOSION HAZARD

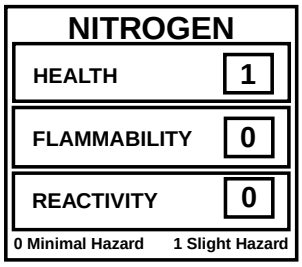
Failure to follow safety warnings exactly could result in serious injury or property damage.

Improper servicing could result in dangerous operation, serious injury, death or property damage.

- **Before servicing, disconnect all electrical power to air handler.**
- **When servicing controls, label all wires prior to disconnecting. Reconnect wires correctly.**
- **Verify proper operation after servicing.**

⚠ WARNING:





B6 series air handlers leave the factory with a nitrogen holding charge. Use caution when preparing coils for field connections. If repairs make it necessary for evacuation and charging, it should only be attempted by qualified, trained personnel thoroughly familiar with this equipment. Some local codes require licensed installation service personnel to service this type of equipment. Under no circumstances should the equipment owner attempt to install and/or service this equipment. Failure to comply with this warning could result in equipment damage, personal injury, or death.

⚠ WARNING:

PROPOSITION 65 WARNING: This product contains chemicals known to the state of California to cause cancer, birth defects or other reproductive harm.

REQUIREMENTS & CODES

⚠ WARNING:

This unit must be installed in accordance with instructions outlined in this manual during the installation, service, and operation of this unit. Unqualified individuals should not attempt to interpret these instructions or install this equipment. Failure to follow safety recommendations could result in possible damage to the equipment, serious personal injury or death.

- The installer must comply with all local codes and regulations which govern the installation of this type of equipment. Local codes and regulations take precedence over any recommendations contained in these instructions. Consult local building codes for special installation requirements.
- This equipment contains nitrogen gas. Installation or servicing should only be performed by qualified trained personnel thoroughly familiar with this type equipment.
- All electrical wiring must be completed in accordance with local, state and national codes and regulations and with the National Electric Code (ANSI/NFPA 70) or in Canada the Canadian Electric Code Part 1 CSA C.22.1.
- Installation of equipment may require brazing operations. Installer must comply with safety codes and wear appropriate safety equipment (safety glasses, work gloves, fire extinguisher, etc.) when performing brazing operations.
- Install this unit only in a location and position as specified on pages 4 & 5. This unit is designed only for Indoor installations and should be located with consideration of minimizing the length of the supply and return ducts. See Tables 5 - 9 (pages 19 - 22) and the rating plate for proper circulating airflow data.
- Follow all precautions in the literature, on tags, and on labels provided with the equipment. Read and thoroughly understand the instructions provided with the equipment prior to performing the installation and operational checkout of the equipment.
- This air handler may be used for temporary heating of buildings or structures under construction. See the guidelines listed on page 4.
- Air handler installations in a residential garage must be installed as specified on page 5.

GENERAL INFORMATION

This appliance has been tested for capacity and efficiency in accordance with AHRI Standards and will provide many years of safe and dependable comfort, providing it is properly installed and maintained. Abuse, improper use, and/or improper maintenance can shorten the life of the appliance and create unsafe hazards. Please read all instructions before installing the unit.

Before You Install this Unit

√ This equipment is securely packaged at the time of shipment and upon arrival should be carefully inspected for damage prior to installing the equipment at the job site. Claims for damage (apparent or concealed) should be filed immediately with the carrier.

√ it is recommended that the cooling load of the area to be conditioned should be calculated and a system of the proper capacity selected.

√ Check the electrical supply and verify the power supply is adequate for unit operation. The system must be wired and provided with circuit protection in accordance with local building codes. If there is any question concerning the power supply, contact the local power company.

√ Verify the duct system is appropriate for the air handler being installed. Please note that when replacing an existing system with lower air-flow, the duct system may require modification.

Locating the Air Handler

- Survey the job site to determine the best location for mounting the unit. Consideration should be given to availability of electric power, service access, and noise.
- The dimensions of the room or alcove must be able to accommodate the overall size of the unit and the installation clearances listed in Table 1. Physical dimensions for this air handler are also shown in Figure 11 (page 17).
- The air handler should be set into position before routing the refrigerant tubing.

Minimum Clearances

- This appliance must be installed in accordance with clearances listed in Table 1. The air handler must be installed with ample clearance for easy access to the air filter, blower assembly, heater assembly, controls, and vent connections. Applicable building codes may require additional clearance to equipment. Refer to applicable building codes for details.
- Static pressure drop through louvered openings and through return air plenums should be considered in the overall duct design in the determination of the total external static pressure.

Operation of Air Handler During Construction

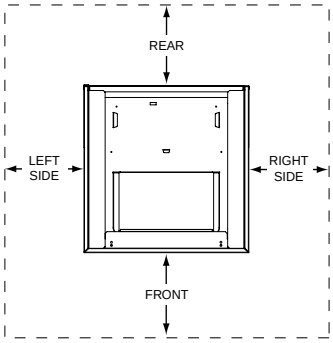
⚠ CAUTION:

Failure to follow these instructions will void the factory warranty and may significantly reduce the life or the performance of the air handler, and/or result in other unsafe conditions. It is the responsibility of the installing contractor to insure these provisions are met.

Operating an air handler in a construction environment can cause the appliance a variety of problems. Proper use of commercial portable space heating equipment during construction is recommended. This air handler may be used during construction if it is not in violation of any applicable codes and the following criteria are met:

- The installation must meet all applicable codes and be permanently installed according to the instructions supplied with the air handler including electrical supply and duct work.
- The air handler must be controlled by a properly installed thermostat that complies with the current provisions of the NEC (ANSI/NFPA 70) and all applicable codes having jurisdiction. Thermostat connections must be made in accordance with instructions supplied with the air handler and thermostat. See pages 11 - 12.
- The installation must include a properly installed filter in the return air system with no by-pass air. The filter must be inspected frequently and replaced when necessary.
- Return air must be supplied unrestricted and located such that dust and gases from construction activity are not introduced into the circulating air system.
- Before occupying the structure: The filter must be replaced or cleaned, the duct work must be inspected

INSTALLATION CLEARANCES	
Left Side..... 0 Inches	Right Side ..... 0 Inches
Back..... 0 Inches	Front..... †See Notes



†**NOTES:**

Alcove Installations - Allow 24 in. minimum clearance from front of unit to nearest wall or partition for servicing. Recommended clearance is 36 in.

Table 1. Minimum Unit Clearances

and cleaned of any construction debris, and the air handler must be cleaned and/or repaired if found to be dirty, damaged, or malfunctioning in any way by a qualified HVAC technician. The air handler shall be inspected and approved by applicable local authority even if this requires redundant inspections.

- The serial number for the air handler used during construction must be submitted in writing (fax and email also acceptable). This information will be used to track the long-term affects of air handler usage during construction. Proof of this submittal shall be available for the final inspection of the air handler prior to occupancy.

Installation in a Garage

⚠ WARNING:

Do not place combustible materials on or against the cabinet. Do not place flammable materials, (gasoline, paint thinners, etc.) or any other flammable vapors and liquids, in the vicinity of the air handler.

The B6 Series air handler may be installed in a residential garage with the provision that the unit must be located or protected to prevent physical damage by vehicles**.**

Plenums & Air Ducts

- Plenums and air ducts should be installed in accordance with the standards of the National Fire Protection Association Standard for Installation of Air Conditioning Systems (NFPA 90A), Standard for Installation of Residence Type Warm Air Heating and Air Conditioning Systems (NFPA 90B), and all applicable local codes. NFPA publications are available by writing to: National Fire Protection Association, Batterymarch Park, Quincy, ME 02269 or visit www.NFPA.org online.

⚠ WARNING:

All return ducts must be secured to the air handler using appropriate methods. All return ducts must be adequately sealed. When return air is provided through the bottom of the unit, the joint between the air handler and the return air plenum must be air tight.

Return air and circulating air ducts must not be connected to any other heat producing device such as a fireplace insert, stove, etc. This may result in fire, explosion, carbon monoxide poisoning, personal injury, or property damage.

- Design the duct work according to methods described by the Air Conditioning Contractors of America (ACCA).
- This unit is designed only for use with a return and supply duct. The return air duct must have the same free area as the opening provided on the air handler. The ducts should be appropriately sized to the capacity of the air handler to ensure its proper airflow rating.
- Use transition fittings if the supply and/or return air openings of the unit do not match the duct openings. These transitions should be dimensioned in accordance with standard practice as specified in the ASHRAE recommendations for duct transitions.
- Flexible connectors may be used between the unit and the ductwork to prevent transmission of vibration from the unit to the structure. If electric heater kits are installed, heat resistant material must be used for the flexible connector at the supply air end of the unit.
- It is good practice to seal all connections and joints with industrial grade sealing tape or liquid sealant. Requirements for sealing ducts vary from region to region. Consult with local codes for requirements specific to your area.

Unconditioned Spaces

All duct work passing through unconditioned space must be properly insulated to minimize duct losses and prevent condensation. Use insulation with an outer vapor barrier. Refer to local codes for insulation material requirements.

Air Filters

B6 Series Air Handlers are not supplied with an air filter when shipped from the factory. The installer must provide a high velocity filter that is appropriately sized to the return air duct opening or filter rack located in the bottom of the unit. Accessing the filter does not require tools and can be removed from the front of the unit by removing the filter door. See Unit Maintenance (page 16) for filter sizes and installation information.

⚠ WARNING:

Never operate the air handler without a filter or with doors removed. Dust and lint can build up on internal components, resulting in loss of efficiency, equipment damage, and possible fire.

Acoustical Duct Work

- Certain installations may require the use of acoustical lining inside the supply duct work. Acoustical insulation must be in accordance with the current revision of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) application standard for duct liners. Duct lining must be UL classified batts or blankets with a fire hazard classification of FHC-25/50 or less.
- Fiber duct work may be used in place of internal duct liners if the fiber duct work is in accordance with the current revision of the SMACNA construction standard on fibrous glass ducts. Fibrous duct work and internal acoustical lining must be NFPA Class 1 air ducts when tested per UL Standard 181 for Class 1 ducts.
- Damping ducts, flexible vibration isolators, or pleated media-style filters on the return air inlet of the air

handler may be used to reduce the transmission of equipment noise eminating from the air handler. These treatments can produce a quieter installation, particularly in the heated space. However, they can increase the pressure drop in the duct system. Care must be taken to maintain the proper maximum pressure rise across the air handler, temperature rise and flow rate. This may mean increasing the duct size and/or reducing the blower speed. These treatments must be constructed and installed in accordance with NFPA and SMACNA construction standards. Consult with local codes for special requirements. For best sound performance, be sure to install all the needed gaskets and grommets around penetrations into the air handler, such as for electrical wiring.

AIR HANDLER INSTALLATION

The B6 Series Air Handler is shipped ready for vertical upflow installation and is approved for attic, basement, alcove/closet or crawlspace installation with zero clearance to combustibles. See Table 1 (page 4) for required installation clearances. **This appliance is approved only for indoor use.**

- The unit must be leveled at installation and attached to a properly installed duct system.
- The surface that the air handler is mounted on must provide sound physical support of the unit.
- The air handler must be installed so that all electrical components are protected from water.
- If a louvered door is installed across the front of this unit, the appliance must be mounted flush or behind front edge of finished wall.
- Always reinstall the doors on the air handler after servicing or cleaning/changing the filters. **Do not operate the air handler without all doors and covers in place.**

Packaging Removal

Remove the shipping crate and User's Manual from the equipment. When removing the crate, use extra care so tubing connectios are not damaged. Do not pull on the coils upper tubes.

Mounting Applications

Vertical only air handlers are factory ready for upflow applications. These units may be applied in downflow applications when applied with the appropriate field kit.

Factory ready horizontal air handlers may be applied in upflow or horizontal-left and -right discharge applications. These units may also be applied in downflow discharge when applied with the appropriate field kit as specified in the units Technical Specifications.

Through-the-floor installations require a 1/4" thick noncombustible resilient gasket to be used whenever the supply or return air ducts pass through the floor. The gasket should be positioned between the duct, unit, and floor.

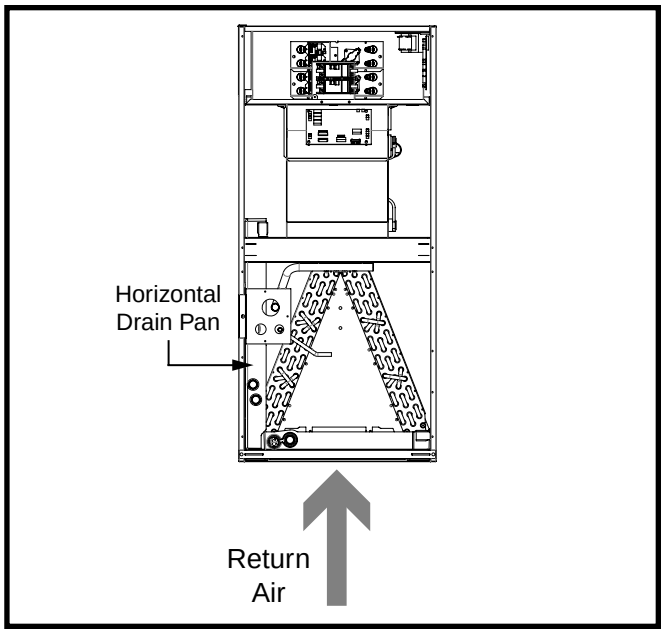


Figure 1. Upflow Installation

Upflow Installations

All air handlers are factory shipped, ready for upflow installation. The horizontal drain pan may be removed from the air handler when installing the unit in an upflow configuration. All return air must enter from the bottom of the unit. A typical upflow unit is shown in Figure 1.

Downflow Installations

The downflow accessory kit (See Technical Specifications) is required for downflow applications. Instructions for installing the downflow accessory kit are included with the kit. It is recommended that the accessory be installed prior to installing the unit. All return air in downflow applications must enter through the top of the unit. A typical installation of the unit in a downflow application is shown in Figure 2.

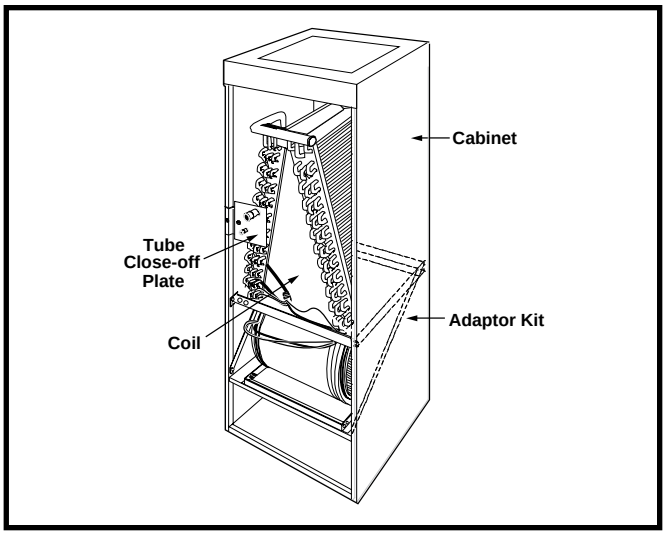


Figure 2. Downflow Installation

Horizontal Installations

The B6 Series air handler can be installed horizontally in an attic, basement, crawl space or alcove. It can also be suspended from a ceiling in a basement or utility room in either a right to left airflow or left to right airflow as shown in Figure 3. Air handlers may or may not be shipped from the factory with all the parts required for horizontal left applications and horizontal right applications. If your unit does not have parts for a horizontal application, a kit may be available.

NOTE: In all horizontal applications in which the unit is installed above a finished ceiling and/or living space, a secondary drain pan must be installed under the entire unit to avoid damage to the ceiling in the event of condensate overflow. Additionally, it is recommended that an approved water level indicator or float switch device be used to shut down the unit in the event water is detected in the auxiliary drain pan.

If suspending the air handler from the ceiling, assemble a support frame (Figure 4) using slotted iron channel and full threaded rod. Fasten the frame together with nuts, washers, and lockwashers. Secure the support frame to the rafters with lag bolts. The air handler can also be suspended using steel straps around each end of the unit. The straps should be attached to the air handler with sheet metal screws and to the rafters with bolts.

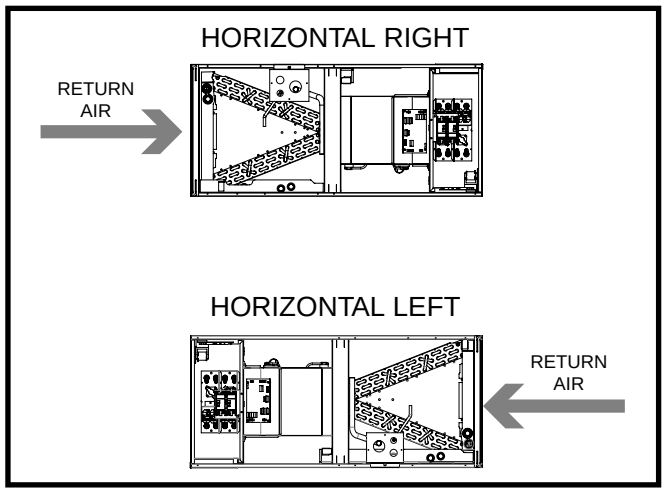


Figure 3. Horizontal Configurations

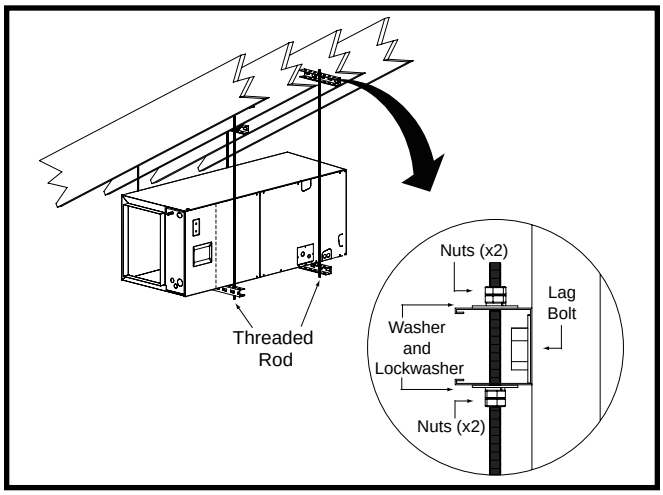


Figure 4. Unit Horizontally Suspended

Horizontal Left Installations:

1. Remove the coil access door.
2. Remove the plug from one of the threaded holes in the horizontal drain pan. Completely remove the webbing located in the threaded holes of the horizontal drain pan. **IMPORTANT:** If the webbing is not removed, the condensate will not drain properly and ceiling damage may occur.
3. Insert the plug (from horizontal drain pan) into the open and unused drain hole in the drain pan at the bottom of the unit to block bypass air.
4. Remove the corresponding drain line knockout from the coil access door to allow access to the horizontal drain.
5. Replace the door and attach the drain line.

Horizontal Right Installations:

1. Remove the coil access door. Unscrew the line-set tube close-off plate from the front left cabinet rail.
2. Slide the coil and drain pan assembly out of the unit.
3. Remove the sheet metal hairpin covers (if supplied) from the back of the coil and discard.
4. Place the horizontal drain pan on the opposite side of the coil. On units with 2 sets of knockouts, remove the other set of knockouts in the coil spacing plates and insert support rod.
5. Slide the coil and the horizontal drain pan assembly back into the unit. Re-attach the tube close off plate.

   NOTE: For A-size cabinet applications, it may be preferrable to remove the blower assembly prior to installing the coil & drainpan. In this case follow instructions 1-4 as listed above but also remove the blower access door and blower assembly. The blower assembly is secured with two screws on either side near the front. With these removed the blower assembly can slide out of the front of the unit. Install the coil and drain pan as described in step 5 and then replace the blower assembly. Take care to ensure that the flanges on the sides of the blower assembly are captured by the pockets in the blower deck. It may be necessary to lift the blower assembly during insertion to allow the lower blower leg to clear the side of the drain pan. The blower will stop against the back of the blower deck. Replace the two screws and the blower access door and procede with steps 6-9.

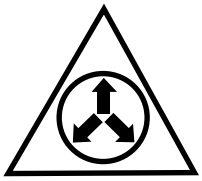
6. Remove the plug from one of the threaded holes in the horizontal drain pan. Completely remove the webbing located in the threaded holes of the drain pan. **IMPORTANT: If the webbing is not removed, the condensate will not drain properly and ceiling damage may occur.**

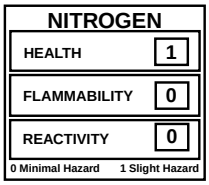
NOTE: It is recommended that the suction line be insulated up to the coil inside of the cabinet.

7. Insert the plug (from horizontal drain pan) into the open and unused drain hole in the drain pan at the bottom of the unit to block bypass air.
8. Remove the corresponding drain line knockout from the coil access door to allow access to the horizontal drain.
9. Replace the door and attach the drain line

Refrigerant Line Connections

⚠ WARNING:





The coil in the air handler is factory shipped with a nitrogen charge. Avoid direct face exposure or contact with valve when gas is escaping. Always ensure adequate ventilation is present during the depressurization process. Address any uncertainties before proceeding. Failure to comply with this warning could result in equipment damage, personal injury, or death.

- The installer should make every effort to ensure the field installed refrigerant containing components of the system have been installed in accordance with these instructions and sound installation practices for reliable system operation and longevity.
- The air handler coil does not contain a refrigerant charge. Refer to the installation instructions supplied with the outdoor unit for refrigerant charge information.
- Always refer to the installation instructions supplied with the outdoor unit for piping requirements. The suction and liquid lines must be sized in accordance with the condensing unit specifications. See Figure 11 (page 17) for liquid and suction line locations.
- When connecting refrigerant linesets together, it is recommended that dry nitrogen be flowing through the joints during brazing. This will prevent internal oxidation and scaling from occurring.
- Refrigerant tubing should be routed in a manner that minimizes the length of tubing and the number of bends in the tubing. It should be supported in a manner that prevents it from vibrating or abrading during system operation. Tubing should be kept clean of foreign debris during installation.
- If precise forming of refrigerant lines is required, a copper tubing bender is recommended. Avoid sharp bends and contact of the refrigerant lines with metal surfaces.
- Refrigerant lines should be wrapped with pressure sensitive neoprene or other suitable material where they pass against sharp sheet metal edges.
- B6 Series air handlers are charged through service valves on the end of the liquid tube for each circuit. These must be removed before brazing the line sets.

Orifice Removal & Installation

The orifice installed in the air handler has been sized for use with the most popularly matched outdoor units. The orifice size as shipped from the factory is listed on the air handler rating plate. Perform steps 1 - 9 to confirm that the orifice size meets the requirements outlined in the outdoor unit installation manual.

1. Remove the cap from the end of the liquid line.
2. Verify pressurization by depressing the Schrader valve on the end of the liquid line. Listen for any escaping gas. If there is no pressure, test the coil for leakage.
- If leakage is found, clearly mark the location of the leak and return the coil to the distributor for processing.
- If no leaks are found, the coil may be installed.

3. Depress the valve to relieve all pressure from the coil.
4. Remove and discard the valve core.

⚠ CAUTION:

To prevent damage to the unit or internal components, it is recommended that two wrenches be used when loosening or tightening nuts. Do not over tighten!

5. Using two wrenches, loosen the nut and distributor body as shown in Figure 5. Turn the assembly nut counter-clock-wise until the orifice body halves are seperated.

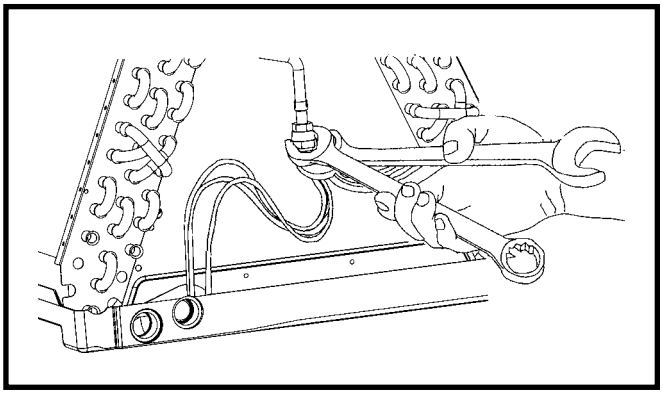


Figure 5. Loosening of Nut & Distributor Body

6. Insert a light-gauge wire hook between the distributor body and the restrictor orifice while being careful not to scratch either part. Carefully remove the restrictor orifice from the distributor body. See Figure 6 (page 9).
7. Check the actual size of the new orifice. **NOTE:** The size is stamped on its side. Do not use pin gauges to measure the orifice diameter.
8. Insert the new orifice into the distributor body, rounded end down. See Figure 7 (page 9).

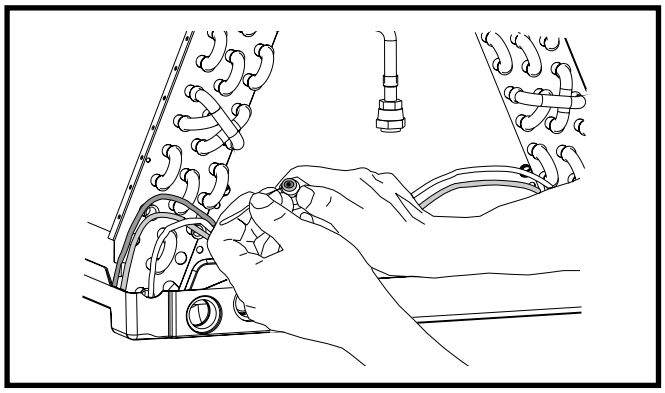


Figure 6. Removal of Orifice

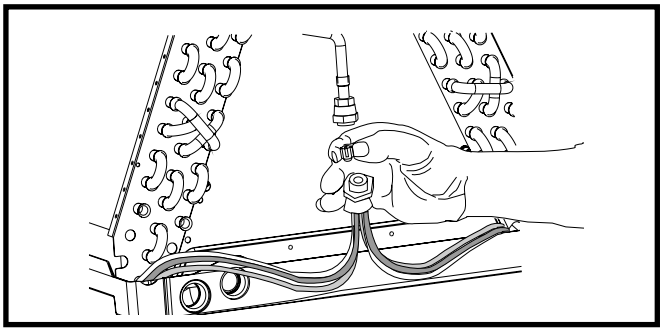


Figure 7. Restrictor Insertion into Distributor Body

⚠ CAUTION:

To prevent damage to the unit or internal components, it is recommended that two wrenches be used when loosening or tightening nuts. Do not over tighten!

9. Realign the assembly nut on the distributor body and hand tighten both components. Mark a line on both bodies and then tighten an additional 1/4 turn using two wrenches. The movement of the two lines will show how much the nut is tightened. If a torque wrench is used, tighten to 10-12 ft. lbs. or 14-16 Nm.

Connecting the Linesets

IMPORTANT NOTES FOR HORIZONTAL OR DOWNFLOW INSTALLATIONS WITH TXV VALVE:

- **The sensing bulb must be located flush against the suction line for optimum heat transfer.**
- **Avoid attaching the sensing bulb to the lowest part of the suction line where condensate may accumulate.**
- **Do not locate the sensing bulb on vertical sections of the lineset.**
- **For horizontal lines, the bulb should not be located at 12 or 6 o'clock position of the suction line. The best location is at 4 or 8 o'clock.**
- **For additional information on proper sensing bulb locations, please refer to the valve manufacturer's instructions.**

IMPORTANT: The steps in the Orifice Removal & Installation section (page 8) must be performed before the linesets are connected.

1. Remove grommets from line set holes.

⚠ CAUTION:

It is recommended that a wet rag be wrapped around the suction line in front of the close off plate or the sensing bulb (if TXV is installed) before applying heat. Failure to keep components cool during brazing may result in structural damage, premature equipment failure, or possible personal injury.

2. Unbraze and remove the cap on the suction line.
3. Route and cut both lineset tubes to proper length in accordance with the outdoor unit specifications. Verify the ends are round, clean, and free of any burrs.
4. Position grommet on line set with sufficient distance away from brazing area. Brazing processes can permanently damage grommets.
5. Connect the suction and liquid lineset tubes.

⚠ CAUTION:

It is recommended that a wet rag be wrapped around the suction line in front of the close off plate or the sensing bulb (if TXV is installed) before applying heat. Failure to keep components cool during brazing may result in structural damage, premature equipment failure, or possible personal injury.

6. Braze the individual connections with dry nitrogen flowing through the joints. **NOTE:** This will prevent internal oxidation and scaling from occurring.

7. Wrap the refrigerant lines with pressure sensitive neoprene or other suitable material especially where the lines enter the opening in the sheet metal.
8. Evacuate the system of moisture and non-condensables to prevent low efficiency operation or damage to the unit. The suggested range of evacuation is 350 - 500 microns.
9. Charge the system with refrigerant. Refer to the outdoor unit installation manual for additional charging instructions.
10. Check the system for leaks, including the lineset and the brazed joints.
11. Replace all grommets and properly dispose of all removed parts.

Condensate Drainage

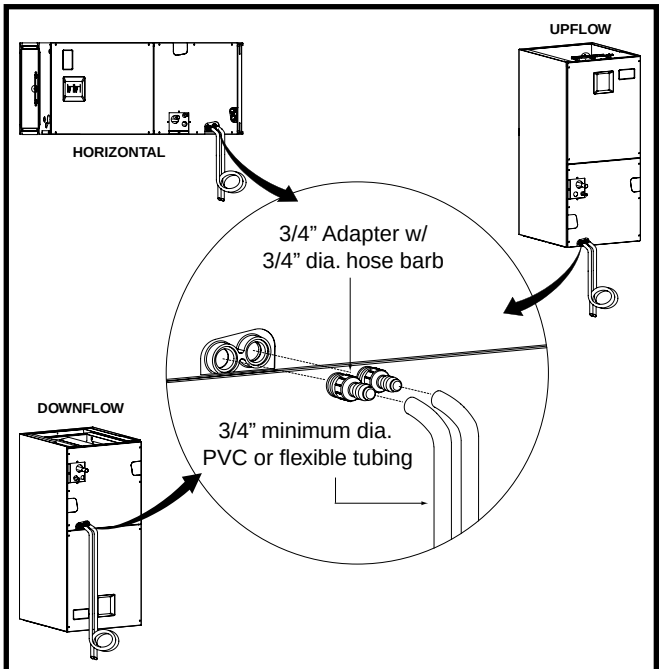
⚠ CAUTION:

The air handler must be level to ensure proper condensate drainage. An unlevel installation may result in structural damage, premature equipment failure, or possible personal injury.

- Methods for disposing of condensate vary according to local codes. Refer to local codes or authority having jurisidiction for restrictions and proper condensate disposal requirements.
- The drain pan that is supplied with this air handler contains a primary and secondary drain fitting. The condensate is drained from the unit through two 3/4" female pipe fittings located on the front side of the unit as shown in Figure 8.
- The drain pan must be drained with field supplied tubing or pvc pipe and adequately trapped. Both drain tubes must have a minimum diameter of 3/4" and be trapped separately.

  IMPORTANT: Failure to install a trap may result in condensation overflowing the drain pan, resulting in substantial water damage to surrounding area.

- Route both lines to a suitable drain, avoiding sharp bends and pinching of the lines. The drain should maintain a minimum horizontal slope in the direction of discharge of not less than 1" vertical for every 10 ft of horizontal run.
- If the air handler is located in or above a living space where damage may result from condensate overflow, an auxiliary drain pan shall be installed under the unit. A separate drain line should extend from the pan to a conspicuous point and serve as an alarm indicating that the primary drain is restricted. As an alternative to a separate drain line, an approved water level indicator or float switch device may be used to shut down the unit in the event water is detected in the auxiliary pan.
- Install a single 5 inch trap in the condensate drain line as close to the coil as possible. Make sure that the top of the trap is below the bottom of the drain pan to prevent the condensate from overflowing the drain pan. **NOTE:** There must be only one trap in the drain line. Using more than one trap may prevent drainage.
- Prime the trap with water. Insulate the drain if it is located in an unconditioned space, and test the condensate line for leaks. Consult local codes for additional restrictions or precautions.
- During system checkout, inspect the drain line and connections to verify proper condensate drainage.



NOTES:
1. The drain lines must maintain a downward slope to ensure proper condensate drainage.
2. Each condensate drain must be trapped separately using a J-Trap or field supplied loop.

Figure 8. Condensate Drainage Example

ELECTRICAL CONNECTIONS

⚠ WARNING:

ELECTRICAL SHOCK, FIRE OR EXPLOSION HAZARD

Failure to follow safety warnings exactly could result in serious injury or property damage.

Improper servicing could result in dangerous operation, serious injury, death or property damage.

- **Before servicing, disconnect all electrical power to the air handler.**
- **When servicing controls, label all wires prior to disconnecting. Reconnect wires correctly**.
- **Verify proper operation after servicing.**

- Electrical connections must be in compliance with all applicable local codes and ordinances, and with the current revision of the National Electric Code (ANSI/NFPA 70).
- For Canadian installations, the electrical connections and grounding shall comply with the current Canadian Electrical Code (CSA C22.1 and/or local codes).

Pre-Electrical Checklist:

√ Verify the voltage, frequency, and phase of the supply source match the specifications on the unit rating plate.

√ Verify that the service provided by the utility is sufficient to handle the additional load imposed by this equipment. See the unit wiring label or Tables 9 - 10 (pages 28 - 29) for proper high and low voltage wiring.

√ Verify factory wiring is in accordance with the unit wiring diagram (Figures 17 - 19, pages 24 - 26). Make sure the connections didn't loosen during shipping or installation.

Line Voltage

- **An electrical disconnect must be located within sight of and readily accessible to the unit**. This switch shall be capable of electrically de-energizing the outdoor unit. See unit data label for proper incoming field wiring. Any other wiring methods must be acceptable to authority having jurisdiction.
- It is recommended that the line voltage to the unit be supplied from a dedicated branch circuit containing the correct fuse or circuit breaker for the unit.
- Overcurrent protection must be provided at the branch circuit distribution panel and sized as shown on the unit rating label and according to applicable local codes. See the unit rating plate and Tables 7 - 8 (pages 27 - 28) for maximum circuit ampacity and maximum overcurrent protection limits.
- The installer should become familiar with the wiring diagram/schematic before making any electrical connections to the unit. See the unit wiring label or Figures 9 & 17 - 19 (pages 12 & 24 - 26).
- Use only copper wire for the line voltage power supply to this unit. Use proper code agency listed conduit and a conduit connector for connecting the supply wires to the unit. Aluminum supply wire may be used if a heater kit is installed.
- If replacing any of the original wires supplied with the unit, the replacement wire must be copper wire consisting of the same gauge and temperature rating.
- Provide power supply for the unit in accordance with the unit wiring diagram, and the unit rating plate. Use UL listed conduit and conduit connectors for connecting the supply wires to the unit and for proper grounding. Field supplied bushings for the power supply cables must be added to support and protect the power supply cables.
- All 208/230 Volt units are shipped from the factory wired for 240 volt operation. For 208V operation, remove the lead from the transformer terminal marked 240V and connect it to the terminal marked 208V.

Grounding

⚠ WARNING:

The unit cabinet must have an uninterrupted or unbroken electrical ground to minimize personal injury if an electrical fault should occur. Do not use gas piping as an electrical ground!

This unit must be electrically grounded in accordance with local codes or, in the absence of local codes, with the National Electrical Code (ANSI/NFPA 70) or the CSA C22.1 Electrical Code. Use the grounding lug provided in the control box for grounding the unit.

Thermostat Connections

- Thermostat connections shall be in accordance with the instructions supplied with the thermostat. The thermostat used with this equipment must operate in conjunction with any installed accessories. Typical AC and air handler hookups are shown in Figure 9 (page 12).

⚠ CAUTION:

Isolation must be maintained from the external Class 2 output of any transformer in a cooling circuit. Use a thermostat with isolating contacts to prevent inter-connection of Class 2 outputs.

- Where local codes require that the thermostat wiring must be routed through a conduit or raceway, splices can be made inside the unit; however, all wiring must be NEC Class 1 and separated from incoming power leads.
- The thermostat should be mounted about 5 feet above the floor on an inside wall. DO NOT install the thermostat on an outside wall or any other location where its operation may be adversely affected by radiant heat from

fireplaces, sunlight, or lighting fixtures, and convective heat from warm air registers or electrical appliances. Refer to the thermostat manufacturer's instruction sheet for detailed mounting and installation information.

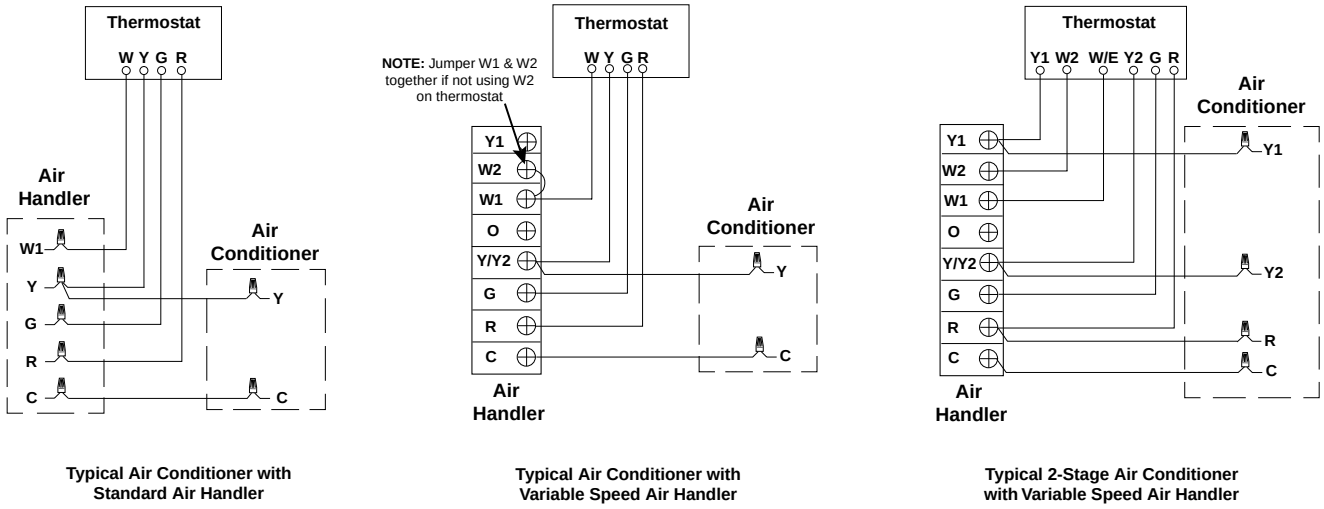
- Install the grommet, which is packed with the unit, in the hole for low-voltage wires. Properly connect the low-voltage wiring between the thermostat, outdoor unit, and control board. **NOTE:** When the low voltage wires are positioned in this grommet, the grommet will prevent chafing and/or shorting of the low voltage leads.

Control Board

The control board in the air handler controls the timing sequence of the elements. The board is equipped with a 3 second blower on delay and a 15 second blower off delay in heating and a 40 second blower off delay in cooling. See Figures 13 or 14 (page23) and Table 12 (pages 29-30) for control board modes and actions.

Twinning

B6BM air handlers are not supplied with a built in twinning capability. To connect two air handlers to a common single stage AC condensing unit or heat pump, a twinning kit is available for field installation. **Please follow the instructions supplied with the kit.**



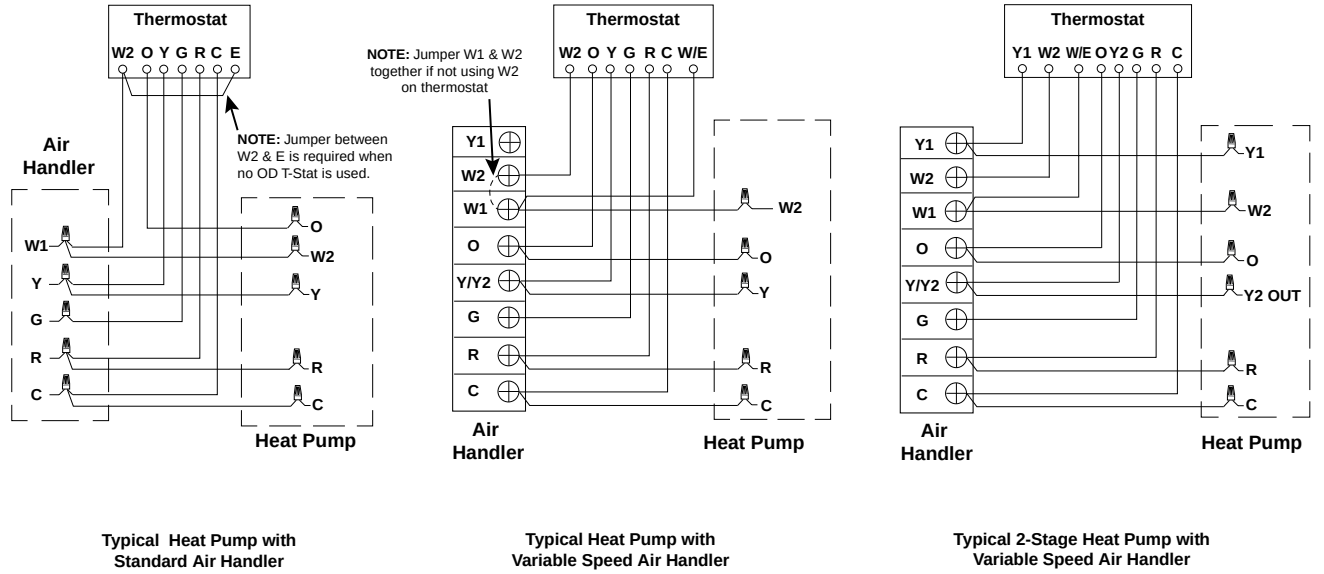


Figure 9. Typical Thermostat Connections

NOTE: Variable speed air handlers cannot be twinned.

Heater Kits

When electric heat packages with circuit breakers are field-installed, the circuit breaker may be used as a disconnecting means in most applications. Reference the NEC and local codes for disconnect requirements.

If a heater kit is installed:

The B6BM air handler is shipped from the factory without an electric heater kit installed. If Electric heat is desired, the H6HK heater kit may be purchased separately and field installed. Determine the correct size heater kit for your unit by referring to the list below or the units rating label.

A Cabinet..... 15Kw max
B Cabinet..... 20Kw max
C Cabinet..... 30Kw max

1. Connect the 2 wire plug of the air handler to the mating 2 wire plug of the heater kit.
2. Connect the line voltage leads to the circuit breaker or terminal block provided.
3. Connect the heater kit plug with the mating receptacle on the air handler control board.

If a heater kit is not installed:

1. Remove the 2 wire plug of the air handler by cutting the wires and discarding the plug.
2. Strip the ends of the 2 air handler wires and connect to the line-voltage leads with the 2 wire nuts provided.

Electronic Air Cleaner (EAC)

The unit has an output to power an electronic air cleaner when the blower is running. This output is rated to 1.0 amp at 208/240V.

Humidifier

The unit has an output to power a humidifier when the blower is running. This output is rated to 1.0 amp at 208/240V.

Optional Humidistat

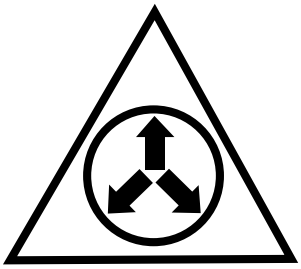
(B6EM or B6VM Models Only)

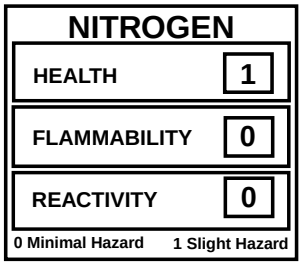
The optional humidistat may be installed in the return air duct to provide excellent humidity control when needed and maximum system capacity and energy efficiency when humidity levels are normal. The humidistat senses when humidity in the return air stream is above a preset level (field adjustable) and sends a signal to the motor to reduce the airflow so that more moisture may be removed until the humidity level drops. The air handler is pre-programmed for humidistat operation.

Install the humidistat in the return air duct as directed in the installation instructions included with the kit. Wire the humidistat through the low-voltage wire entrance in the air handler to the control board terminal marked **DEHUM**. Wire the humidistat to open on rise in humidity. See Figures 15 & 16 (page 23).

STARTUP & ADJUSTMENTS

⚠ WARNING:





The evaporator coil is shipped from the factory with a nitrogen charge. Use caution when preparing coils for field connections. If repairs make it necessary for evacuation and charging, it should only be attempted by qualified, trained personnel thoroughly familiar with this equipment. Some local codes require licensed installation service personnel to service this type of equipment. Under no circumstances should the equipment owner attempt to install and/or service this equipment. Failure to comply with this warning could result in equipment damage, personal injury, or death.

Before You Start the Unit

Prior to start-up, complete the following inspections:

√ Verify the unit is level and properly located with adequate clearances for servicing the unit. See Table 1 (page 4).
√ Check condensate drain line(s) for proper drainage.
√ Verify the surrounding area and top of the unit is free from obstructions and debris.
√ Check all duct connections. Make sure the duct work is adequately sealed to prevent air leakage.
√ Check all coil connections for leaks.
√ Verify that the line voltage power leads are securely connected and the unit is properly grounded. Make sure all doors are installed before restoring power to the unit
√ Verify the thermostat is wired correctly. Make sure all low voltage wires are securely connected.
√ Verify the power supply branch circuit overcurrent protection is sized properly.
√ Verify filter is properly and securely installed.

IMPORTANT: Before starting the unit, install the initial charge on units that are factory shipped with a nitrogen holding charge:

1. Read all installation instructions first.
2. Purge the nitrogen holding charge.
3. Evacuate the unit to 350 - 500 microns.
4. Allow the unit to remain under vacuum for at least 30 minutes.

5. Weigh in the proper amount of new (or reclaimed) refrigerant. Refer to the air conditioner or heat pump installation manual for the proper type and quantity of refrigerant.

Refrigerant Charging

The system refrigerant charge can be checked and adjusted through the service ports provided at the front panel of the outdoor unit. Use only gauge lines which have a Schrader depression device present to actuate the valve.

Air Circulation

Running the Blower Continuously

Set the thermostat's system mode to **OFF** and the thermostat's fan mode to **ON**. The blower motor should run continuously. Check for air delivery at the register(s). Ensure that there are no obstructions at the registers or in the ducts.

Selecting continuous low speed fan operation
(Standard Blower)

The air handler is equipped with an option of continuous low speed fan operation. When **G** is energized without **Y/Y2**, the air handler will operate using the cooling speed. With **G** & **Y/Y2** or **Y/Y2** energized, the air handler will operate in the selected cooling speed (including 40 sec blower-off delay).

Turning the Blower Off

Set thermostat's fan mode to **AUTO**, the blower will shut down immediately.

System Cooling

1. Set the thermostat's system mode to **COOL** and fan mode to **AUTO**. Lower the thermostat's temperature mode below room temperature and observe that the blower energizes. Check the air being discharged at the register is cooler than room temperature. Verify unit refrigerant pressures are in order. Blower should be turning in direction indicated by arrow.

   NOTE: DO NOT alter unit wiring. Listen for any unusual noises. Locate the source and correct as needed.

2. Allow the unit to run for several minutes and then set the thermostat's temperature above room temperature. Verify the blower cycles off with the thermostat.

System Heating

1. Set the thermostat's system mode to **HEAT** and the fan mode to **AUTO**. Increase the thermostat's temperature above room temperature and observe that the blower energizes. Check the air being discharged at the register is warmer than room temperature.
2. Allow the unit to run for several minutes and then set the thermostat's temperature below room temperature. Verify the blower cycles off with the thermostat.

Selecting Minimum Electric Heat Airflow

The minimum electric heat airflow setting controls the minimum air flow that will be produced whenever electric heater kits are used. When the electric heater kit is energized along with a heat pump, the airflow may be higher depending on the basic cooling/heat-pump airflow setting. The minimum electric heat airflow is selected by the red blower wire on 3-speed models or setting switches 1,2,3 & 4 on B6EM models. B6VM models automatically set the heating speed based on the amount of installed heat. The A/B switch must be set appropriately for the unit cabinet size. For C-sized cabinets, the A/B switch can be set in either position. The remaining 3 HEAT switches have no function. Switch settings are listed in Tables 6 or 9 (pages 20 & 22). **NOTE:** For B6EM Models, the minimum electric heat airflow setting may be set higher, but must never be set lower than the setting shown in Table 7 (page 21).

Blower Configurations

Determining Nominal System Capacity

To select the appropriate airflows for the air handler, the nominal system capacity must be known. The nominal system capacity is always the nominal capacity of the outdoor unit. However, in some situations the nominal system capacity may not be the same as the nominal capacity of the air handler. Always refer to the nominal capacity of the outdoor unit to determine the nominal system capacity.

NOTE: The CFM values listed in Table 9 (page 22) are not dependent on duct static pressure. The VSHE motor automatically compensates for changes in duct static pressure (within the limits of the motor).

3-Speed Units

The blower speed is preset at the factory for operation at the same speed for heating and cooling, by using the jumping terminal on the blower motor and connecting it to the desired speed with both the red and black wires connected to the jumping terminal. **NOTE:** The control board is programmed with a 40 second off delay in the cooling mode for optimum system performance and efficiency.

⚠ CAUTION:

To avoid personal injury or property damage, make sure the motor leads do not come into contact with any uninsulated metal components of the unit.

For optimum system performance and comfort, it may be necessary to change the factory set speed. See Table 5 (page 19) for airflow data. To change the blower speed:

1. Disconnect all electrical power to the unit and remove the upper door.
2. Remove the black and red wires from the blower motor jumping terminal. Discard the blower motor jumping terminal.
3. Connect the heating speed wire (red) and the cooling speed wire (black) to the desired blower speed marked on the terminal block of the blower motor.

- Terminal 4 = Hi speed
- Terminal 5 = Med speed
- Terminal 6 = Low speed

4. Replace the upper door and secure it to the unit.
5. Restore power to the unit.

High Efficiency Units (Variable & Fixed Speed)
IMPORTANT! This air handler has been designed to give the installer maximum flexibility to optimize system performance, efficiency, and comfort. Because there are so many different ways to set up the air handler it is important to read and follow these directions carefully.

B6EM & B6VM air handlers use high efficiency circulating air motors that come in two variations and both are controlled differently. The fixed speed motor control board (Figure 15, page 23) controls the torque and the variable speed motor control board (Figure 16) controls the airflow at a constant CFM. Both boards use the same control board.

Before operation, the air handler must be configured to match the unit with the system, system options, and climatic conditions. When configured, the air handler responds directly to the thermostat inputs, as well as the optional humidistat (see page 13). During normal operation, the motor will gradually change speeds during start-up, shut down, when thermostat inputs change, and when the duct static pressure changes (vents closed or opened, filter clogging, etc.). The air handler is configured by setting the selector switches and removing jumper connectors.

Selecting Basic Heating Airflow
Fixed & variable speed motor control boards (Figures 15 & 16) contain a set of dip switches for setting the blower speed. For B6EM models, pins 1-4 set the speed for heating. For B6VM models, the A/B switch must be set for the appropriate cabinet size (either setting can be used for C-size cabinets). The airflow is set automatically based on the amount of installed heat. For both B6EM & B6VM models, the cooling speed is selected via switches 5,6,7,& 8. To determine the appropriate switch settings for your installation, see Tables 6, 7, 8, or 9 (pages 20 - 22).

Selecting Basic Cooling / Heat Pump Airflow
The basic cooling/heat-pump airflow is controlled by setting switches 5 - 8 on the motor control board (mounted on the blower). All airflows for other modes of operation (except electric heat) are determined by this basic setting. FAN ONLY would deliver 50% of the selected cooling airflow. Table 8 (page 20) lists the basic airflow values versus the airflow selector switch settings and ranges of basic air flow settings recommended for each nominal system capacity.

- When operating in the heat pump mode, a higher basic airflow setting will increase the energy efficiency and capacity but will also decrease the supply air temperature.
- For maximum capacity and energy efficiency, select an airflow at or near the top of the range for that nominal capacity. See Table 8 (page 21).
- For maximum dehumidification, select an airflow near the middle or bottom of the range for that nominal capacity. Additional information on humidity control can be found in the Humidistat and Delay Setting sections.
- For thermostats with a dehumidifier output, use a field supplied wire to connect the thermostat's dehumidifier output to the terminal marked **DHUM**. The thermostat should be set so that the **DHUM** output should be high (energized) when dehumidification is needed. See also Dehumidification Options section.

IMPORTANT! If coil icing is observed, the basic cooling/ heat-pump airflow selected may be too low. Verify the setting selected is within the range shown in Table 8 and that the the system is properly charged. Please refer to the instructions supplied with the outdoor unit. If icing continues to occur, raise the selected airflow one or two steps.

NOTE: Variable speed air handlers with SEER ratings higher than 15 are matched with a 2-stage cooling outdoor unit. They are programmed to operate at 75% of the selected airflow while the system is in the lo-cool mode and 100% of the selected airflow while in hi-cool mode.

Dehumidification Options

(B6EM or B6VM Models Only)
Both motor control boards (Figures 15 & 16, page 23) have a **DHUM** connection that allows the system to increase the amount of humidity that is removed from the circulating air. This is accomplished by reducing the CFM and allowing the cooling coil to become colder. This will only occur when there is a call for cooling. There are many ways that this can be electrically wired.

1. If the room thermostat incorporates a humidity sensor and **DHUM** output, connect the **DHUM** on the thermostat to the **DHUM** terminal on the motor control board.
2. If using a separate humidistat, connect the **DHUM** & **R** terminals on the humidistat to the **DHUM** & **R** terminals on the motor control board of the air handler. In this option, the **DHUM** output of the humidistat must be set to be normally open and closed when there is a call for humidification. See Figure 10.
3. If a humidistat is not available, it is an acceptable option to connect the **R** & **DHUM** terminals on the motor control board together with a field supplied wire. This option causes the blower to run at a reduced CFM for 10 minutes after a call for cooling. **NOTE:** If outdoor unit is a heat pump, connect the **O** terminal to **DHUM**.

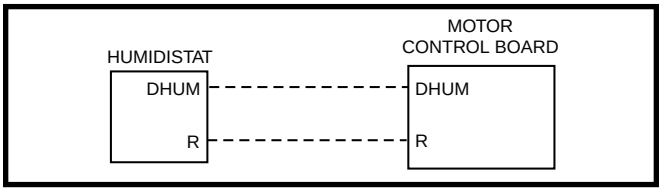


Figure 10. DHUM Wiring Configuration

UNIT MAINTENANCE

Proper maintenance is most important to achieve the best performance from a air handler. Some of the components and their locations are shown in Figure 12 (page 18). If any component of the air handler must be replaced, use only factory authorized replacement parts specified in the Replacement Parts List provided online.

⚠ WARNING:

ELECTRICAL SHOCK, FIRE OR EXPLOSION HAZARD

Failure to follow safety warnings exactly could result in serious injury or property damage.

Improper servicing could result in dangerous operation, serious injury, death or property damage.

- **Before servicing, disconnect all electrical power to air handler.**
- **When servicing controls, label all wires prior to disconnecting. Reconnect wires correctly**.
- **Verify proper operation after servicing.**

- These maintenance instructions are primarily intended to assist qualified technicians experienced in the proper maintenance and operation of this appliance.
- Always reinstall the doors on the air handler after servicing or cleaning/changing the filters. **Do not operate the air handler without all doors and covers in place.**
- Verify that the thermostat is properly installed and is not being affected by drafts or heat from lamps or other appliances.
- To achieve the best performance and minimize equipment failure, it is recommended that a yearly maintenance checkup be performed. At a minimum, this check should include the following items:

Air Filter(s)

B6 Series Air Handlers are not supplied with a single air filter when shipped from the factory. It is recommended that the filter be cleaned or replaced monthly. Newly built or recently renovated homes may require more frequent changing until the construction dust has minimized. Filter sizes shown in Table 2 are available at most local retailers.

⚠ WARNING:

Never operate the air handler without a filter in place. Dust and lint in the return air can build up on internal components, resulting in loss of efficiency, equipment damage, and possible fire.

Filters designed to remove smaller particles such as pollen, may require additional maintenance.

CABINET SIZE	FILTER SIZE
A	12 x 20 x 1
B	18 x 20 x 1
C	20 x 20 x 1

Table 2. Filter Sizes

Blower Compartment

Dirt and lint can create excessive loads on the motor resulting in higher than normal operating temperatures and shortened service life. It is recommended that the blower compartment be cleaned of dirt or lint that may have accumulated in the compartment or on the blower and motor as part of the annual inspection.

Blower Fan Wheel

Inspect the blower wheel blades for accumulations of dirt and clean if necessary. Inspect mounting nut for tightness when done.

Blower Motor & Assembly

Inspect the blower assembly and motor mounting brackets for tightness and corrosion. Correct deficiencies if necessary. The blower motor contains sealed bearings and under normal operating conditions, no maintenance is necessary for the life of the equipment.

TROUBLESHOOTING

If the air handler fails to operate, check the following:

- Is the electric turned on?
- Is the thermostat operating properly?
- Are the blower compartment door(s) in place?
- Is the air handler disconnect closed?
- Has the circuit breaker tripped or the control board fuse burned open?
- Are any manual reset switches open?
- Is the filter dirty or plugged?
- Is the LED on both control boards constantly ON? If not, refer to Tables 3 or 4 to determine fault condition.

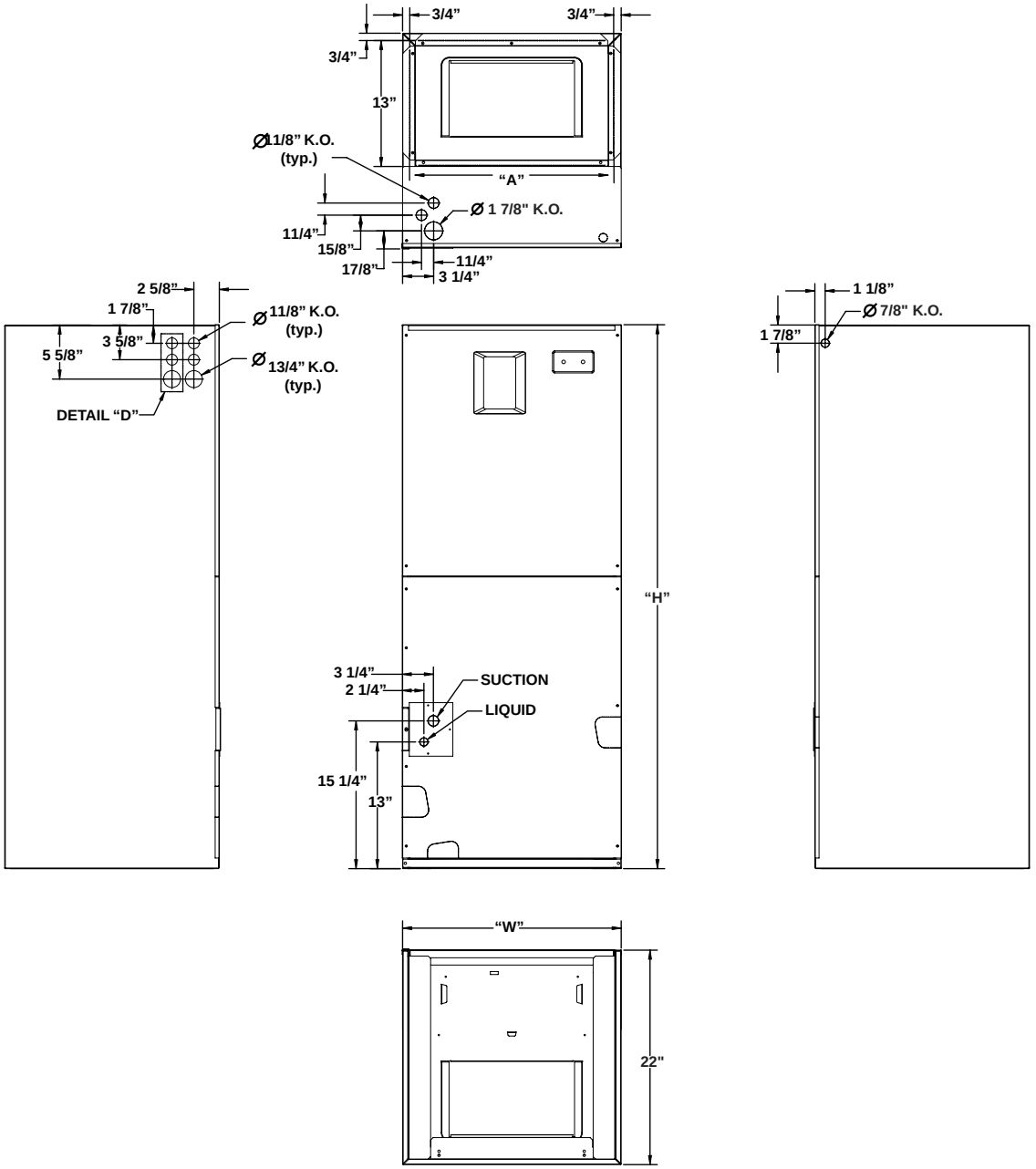
RED LED (AN2)	DIAGNOSTIC
OFF	Control Fault (No Power)
Flash	Blower Fault
ON	Normal Operation

Table 3. Air handler Control Board Fault Conditions

	DIAGNOSTIC	GREEN LED	RED LED
Fixed Speed Furnaces	Control Fault (No Power)	Off	Off
	Normal Operation	On	On
	Motor Fault	On	Flash
	Twin Fault (no motor fault)	Flash	On
	Communications Fault	Flash	Flash
Variable Speed Furnaces	Control Fault (No Power)	Off	Off
	Normal Operation	On	On
	Motor Fault	On	Flash
	Communications Fault	Flash	Flash

Table 4. Motor Control Board Fault Conditions

FIGURES & TABLES



Cabinet Size	H	W	A	Detail D
A	43-5/16	14-3/16	12-3/4	No
B	43-5/16	19-11/16	18-1/4	No
Tall B	49-5/16	19-11/16	18-1/4	No
C	55-15/16	22-7/16	21	Yes

Figure 11. B6 Series Physical Dimensions

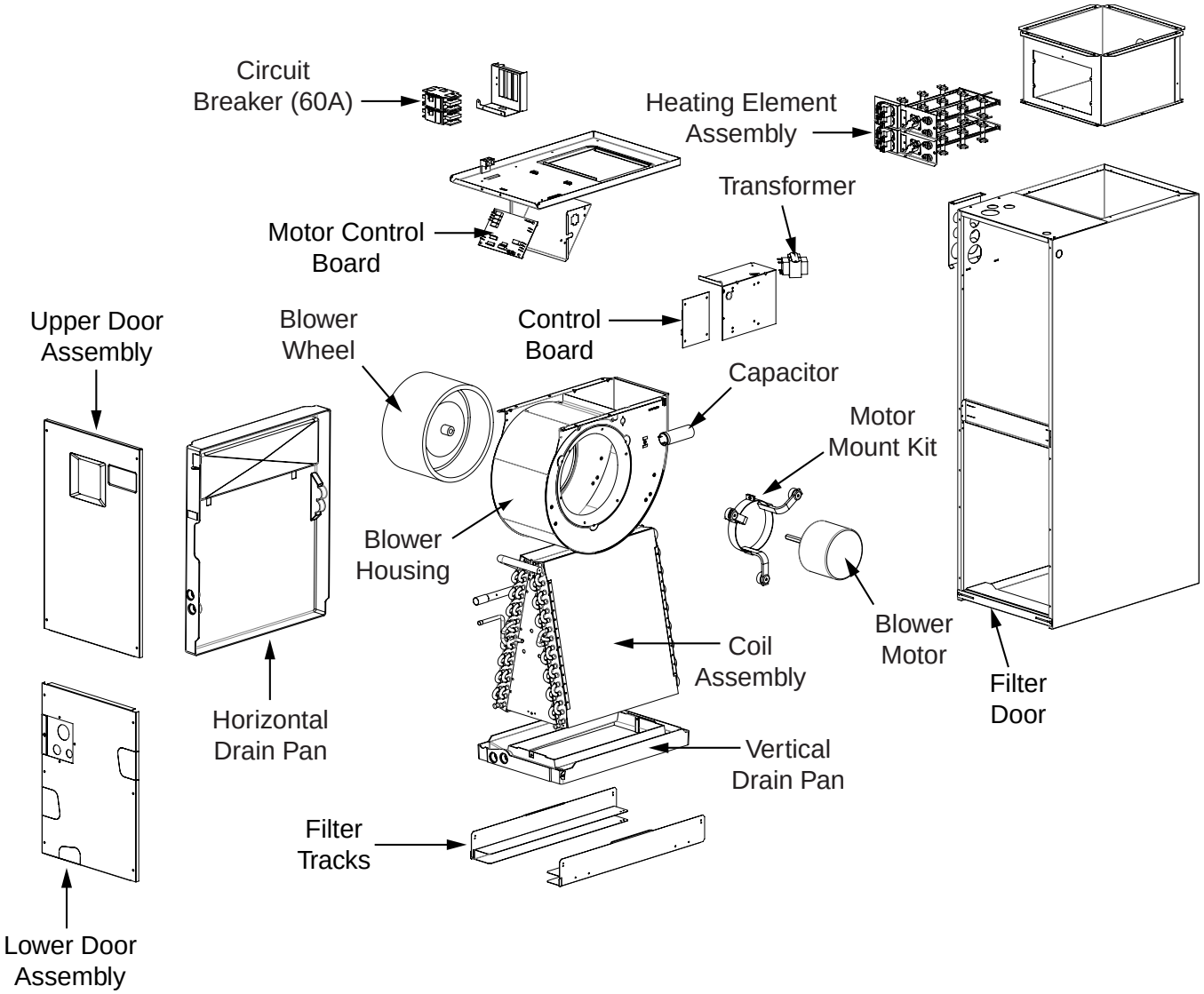


Figure 12. Air Handler Components

AIRFLOW DATA

Dry Coil ESP		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80
***24K A-Cabinet**	Low	683	647	607	563	515	463	406	345
	Corrected ESP[1]	0.00	0.07	0.19	0.30	0.42	0.53	0.65	0.76
	Medium	861	823	781	734	682	625	564	498
	Corrected ESP[1]	0.00	0.00	0.11	0.23	0.36	0.48	0.60	0.72
	High	1072	1026	975	920	860	797	730	659
	Corrected ESP[1]	0.00	0.00	0.00	0.14	0.27	0.40	0.53	0.67
***30K A-Cabinet**	Low	849	825	793	753	704	647	581	508
	Corrected ESP[1]	0.00	0.04	0.15	0.27	0.38	0.50	0.62	0.74
	Medium	1118	1087	1046	997	940	874	799	717
	Corrected ESP[1]	0.00	0.00	0.04	0.17	0.29	0.42	0.55	0.68
	High	1277	1233	1184	1130	1070	1005	935	860
	Corrected ESP[1]	0.00	0.00	0.00	0.10	0.23	0.36	0.49	0.63
***24K B-Cabinet**	Low	708	690	664	628	584	532	471	401
	Corrected ESP[1]		0.08	0.19	0.30	0.41	0.53	0.64	0.76
	Medium	909	904	886	854	810	753	683	600
	Corrected ESP[1]			0.10	0.22	0.33	0.46	0.58	0.71
	High	1118	1132	1126	1101	1056	992	908	805
	Corrected ESP[1]				0.09	0.22	0.35	0.49	0.64
***30/*36K B-Cabinet**	Low	953	915	871	821	764	701	631	555
	Corrected ESP[1]	0.00	0.04	0.16	0.27	0.39	0.51	0.62	0.74
	Medium	1265	1232	1188	1133	1067	991	903	805
	Corrected ESP[1]	0.00	0.00	0.03	0.15	0.28	0.41	0.54	0.68
	High	1427	1385	1333	1270	1196	1113	1018	913
	Corrected ESP[1]	0.00	0.00	0.00	0.09	0.23	0.36	0.50	0.64
***42/48K B-Cabinet**	Low	1324	1302	1271	1233	1187	1134	1072	1003
	Corrected ESP[1]	0.00	0.06	0.17	0.27	0.38	0.49	0.61	0.72
	Medium	1485	1455	1418	1373	1320	1260	1193	1118
	Corrected ESP[1]	0.00	0.00	0.13	0.24	0.36	0.47	0.58	0.70
	High	1637	1601	1558	1506	1447	1380	1305	1223
	Corrected ESP[1]	0.00	0.00	0.00	0.21	0.33	0.44	0.56	0.68
***48K C-Cabinet**	Low	1605	1606	1592	1565	1524	1468	1399	1316
	Corrected ESP[1]	0	0.11	0.21	0.31	0.42	0.52	0.63	0.74
	Medium	1977	1939	1890	1830	1758	1675	1580	1474
	Corrected ESP[1]	0	0	0.18	0.28	0.39	0.50	0.61	0.72
	High	2264	2182	2095	2003	1906	1805	1698	1586
	Corrected ESP[1]	0	0	0	0.26	0.37	0.49	0.60	0.71
***60K C-Cabinet**	Use B6EM C-Cabinet airflow data. See Table 5 (page 20).								

Notes:

1) Airflow is shown in cfm, +/- 5%.
2) External static pressure (ESP) is shown in inches w.c.
3) See unit nameplate or installation instructions for maximum recommended external static pressure.

Table 5. Airflow Data for B6BM Air Handlers

	Switch Settings 0 = OFF, 1 = ON				Cooling or Heating Airflow (CFM) Dry Coil ESP							
	1/5	2/6	3/7	4/8	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
B6EM A-cabinet	0	0	0	0	585	550	520	460	420	405		
	1	0	0	0	710	670	650	610	560	530	475	440
	0	1	0	0	845	790	765	715	680	655	625	580
	1	1	0	0	890	865	840	785	760	710	680	655
	0	0	1	0	955	925	900	850	825	790	770	720
	1	0	1	0	1030	995	975	940	910	870	840	815
	0	1	1	0	1115	1085	1060	1020	995	965	925	905
	1	1	1	0	1155	1130	1095	1070	1040	1010	985	950
	0	0	0	1	1200	1175	1145	1110	1085	1060	1025	1000
	1	0	0	1	1240	1215	1195	1170	1140	1110	1080	1060
	0	1	0	1	1320	1290	1265	1240	1215	1185	1160	1130
	1	1	0	1	1355	1330	1305	1280	1255	1220	1200	1175
	0	0	1	1	1405	1375	1345	1325	1295	1275	1250	1210
	1	0	1	1	1440	1415	1385	1355	1325	1290	1255	1215
	0	1	1	1	1465	1425	1390	1355	1320	1290	1260	1215
	1	1	1	1	1465	1425	1390	1355	1320	1290	1260	1215

	Switch Settings 0 = OFF, 1 = ON				Cooling or Heating Airflow (CFM) Dry Coil ESP							
	1/5	2/6	3/7	4/8	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
B6EM B-cabinet	0	0	0	0	600	550	430	390				
	1	0	0	0	660	610	540	460	425			
	0	1	0	0	830	750	695	640	580	520		
	1	1	0	0	860	825	765	690	630	600	525	485
	0	0	1	0	935	895	835	790	710	655	620	585
	1	0	1	0	1045	975	920	875	830	795	720	685
	0	1	1	0	1095	1040	995	950	900	850	805	750
	1	1	1	0	1155	1105	1060	1010	965	920	870	825
	0	0	0	1	1230	1185	1140	1090	1045	1010	965	920
	1	0	0	1	1285	1260	1210	1165	1125	1080	1040	1010
	0	1	0	1	1330	1290	1245	1205	1170	1125	1085	1045
	1	1	0	1	1395	1365	1315	1275	1235	1205	1160	1130
	0	0	1	1	1450	1405	1375	1335	1295	1260	1220	1180
	1	0	1	1	1490	1450	1410	1385	1340	1300	1270	1230
	0	1	1	1	1530	1485	1460	1425	1380	1350	1310	1280
	1	1	1	1	1530	1490	1465	1425	1390	1350	1310	1285

	Switch Settings 0 = OFF, 1 = ON				Cooling or Heating Airflow (CFM) Dry Coil ESP							
	1/5	2/6	3/7	4/8	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
B6EM C-cabinet	0	0	0	0	710	580	395					
	1	0	0	0	830	690	675	530	505			
	0	1	0	0	930	875	710	665	560	530		
	1	1	0	0	1065	1015	900	840	800	705	665	635
	0	0	1	0	1185	1115	1010	960	925	875	830	745
	1	0	1	0	1275	1220	1175	1120	1060	970	930	890
	0	1	1	0	1365	1350	1255	1200	1150	1105	1060	1025
	1	1	1	0	1480	1430	1370	1325	1265	1225	1185	1140
	0	0	0	1	1560	1535	1485	1430	1375	1335	1285	1240
	1	0	0	1	1650	1600	1545	1500	1450	1405	1360	1305
	0	1	0	1	1730	1685	1660	1610	1570	1520	1470	1420
	1	1	0	1	1785	1740	1695	1645	1615	1545	1510	1470
	0	0	1	1	1865	1820	1785	1750	1695	1655	1605	1560
	1	0	1	1	1920	1890	1850	1805	1765	1715	1675	1640
	0	1	1	1	2010	1965	1960	1900	1850	1810	1775	1730
	1	1	1	1	2065	2020	1985	1955	1915	1880	1840	1810

NOTE: When matched with two-stage outdoor units, the airflow on low (Y1 or W1) input will be 70% of the values shown in this table.

Table 6. Airflow Data for B6EM (FSHE) Air Handlers

Cabinet	Nominal Electic Heat KW						
	5	8	10	15	20	25	30
A	800	900	1000	1300	N/A	N/A	N/A
B	900	1000	1100	1300	1500	N/A	N/A
C	1000	1100	1200	1400	1600	1800	2000

NOTE: See Table 6 for appropriate switch settings for these airflows.

Table 7. Minimum Heating Airflow Settings (in CFM) for B6EM (FSHE) Air Handlers

A-CABINET					
CFM	SWITCH SETTINGS (1 = ON, 0 = OFF)				NOMINAL CAPACITY
	5	6	7	8	
525	0	0	0	0	1.5 TON
560	0	0	0	1	
600	0	0	1	0	
625	0	0	1	1	
700	0	1	0	0	2 TON
750	0	1	0	1	
800	0	1	1	0	
850	0	1	1	1	
875	1	0	0	0	2.5 TON
890	1	0	0	1	
930	1	0	1	0	
950	1	0	1	1	
1000	1	1	0	0	
1050	1	1	0	1	
1125	1	1	1	0	
1200	1	1	1	1	3 TON

B-CABINET					
CFM	SWITCH SETTINGS (1 = ON, 0 = OFF)				NOMINAL CAPACITY
	5	6	7	8	
525	0	0	0	0	1.5 TON
560	0	0	0	1	
600	0	0	1	0	
650	0	0	1	1	
700	0	1	0	0	2 TON
750	0	1	0	1	
800	0	1	1	0	
850	0	1	1	1	2.5 TON
875	1	0	0	0	
950	1	0	0	1	
1050	1	0	1	0	3 TON
1150	1	0	1	1	
1250	1	1	0	0	3.5 TON
1350	1	1	0	1	
1400	1	1	1	0	
1600	1	1	1	1	4 TON

C-CABINET					
CFM	SWITCH SETTINGS (1 = ON, 0 = OFF)				NOMICAL CAPACITY
	5	6	7	8	
1100	0	0	0	0	3 TON
1200	0	0	0	1	
1250	0	0	1	0	3.5 TON
1300	0	0	1	1	
1350	0	1	0	0	
1400	0	1	0	1	4 TON
1450	0	1	1	0	
1500	0	1	1	1	
1550	1	0	0	0	
1600	1	0	0	1	
1650	1	0	1	0	
1700	1	0	1	1	
1750	1	1	0	0	
1800	1	1	0	1	
1900	1	1	1	0	
2000	1	1	1	1	5 TON

Table 8. Recommended Cooling Airflow Settings for B6VM Air Handlers

B6VM A-cabinet

Cooling Airflow					
A/B Switch Setting 0 = OFF, 1 = ON	COOL Switch Setting 0 = OFF, 1 = ON				Airflow (CFM)
	5	6	7	8	
0	0	0	0	0	525
0	0	0	0	1	560
0	0	0	1	0	600
0	0	0	1	1	625
0	0	1	0	0	700
0	0	1	0	1	750
0	0	1	1	0	800
0	0	1	1	1	850
0	1	0	0	0	875
0	1	0	0	1	890
0	1	0	1	0	930
0	1	0	1	1	950
0	1	1	0	0	1000
0	1	1	0	1	1050
0	1	1	1	0	1125
0	1	1	1	1	1200

Heating Airflow		
A/B Switch Setting 0 = OFF, 1 = ON	Heater Kit Installed (KW)	Airflow (CFM)
0	0	600
0	5	800
0	8	1000
0	10	1000
0	15	1300
0	20	n/a
0	25	n/a
0	30	n/a

B6VM B-cabinet

Cooling Airflow					
A/B Switch Setting 0 = OFF, 1 = ON	COOL Switch Setting 0 = OFF, 1 = ON				Airflow (CFM)
	5	6	7	8	
1	0	0	0	0	525
1	0	0	0	1	560
1	0	0	1	0	600
1	0	0	1	1	650
1	0	1	0	0	700
1	0	1	0	1	750
1	0	1	1	0	800
1	0	1	1	1	850
1	1	0	0	0	875
1	1	0	0	1	950
1	1	0	1	0	1050
1	1	0	1	1	1150
1	1	1	0	0	1250
1	1	1	0	1	1350
1	1	1	1	0	1400
1	1	1	1	1	1600

Heating Airflow		
A/B Switch Setting 0 = OFF, 1 = ON	Heater Kit Installed (KW)	Airflow (CFM)
1	0	700
1	5	900
1	8	1100
1	10	1100
1	15	1300
1	20	1500
1	25	n/a
1	30	n/a

B6VM C-cabinet

Cooling Airflow					
A/B Switch Setting (* = either 0 or 1)	COOL Switch Setting 0 = OFF, 1 = ON				Airflow (CFM)
	5	6	7	8	
*	0	0	0	0	1100
*	0	0	0	1	1200
*	0	0	1	0	1250
*	0	0	1	1	1300
*	0	1	0	0	1350
*	0	1	0	1	1400
*	0	1	1	0	1450
*	0	1	1	1	1500
*	1	0	0	0	1550
*	1	0	0	1	1600
*	1	0	1	0	1650
*	1	0	1	1	1700
*	1	1	0	0	1750
*	1	1	0	1	1800
*	1	1	1	0	1900
*	1	1	1	1	2000

Heating Airflow		
A/B Switch Setting (* = either 0 or 1)	Heater Kit Installed (KW)	Airflow (CFM)
*	0	800
*	5	1000
*	8	1200
*	10	1200
*	15	1400
*	20	1600
*	25	1800
*	30	2000

NOTES:

- Airflow values listed are for 240V operation. For 208V operation, multiply A & B cabinet values by .95; for C-cabinet values mulitply by .90
- When matched with two-stage outdoor units the airflow on low (Y1 or W1) input only will be 70% of the values shown in this table.

Table 9. Airflow Data for B6VM (VSHE) Air Handlers

ELECTRICAL DIAGRAMS & DATA

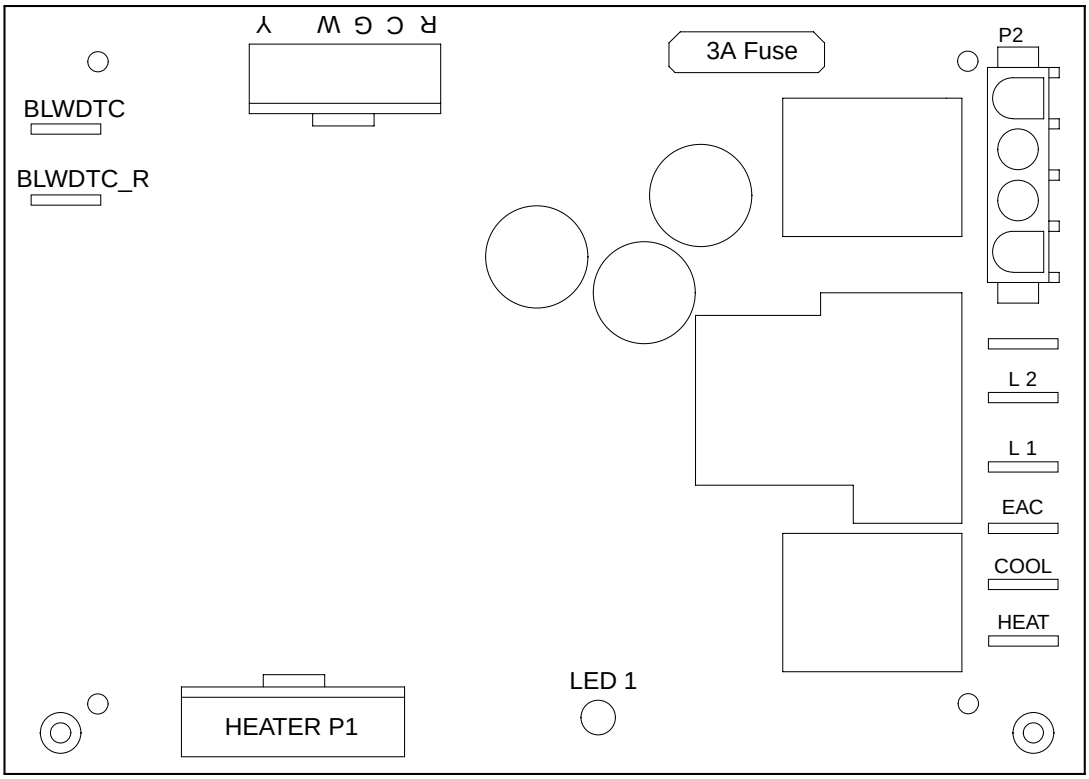


Figure 13. Single Stage Control Board

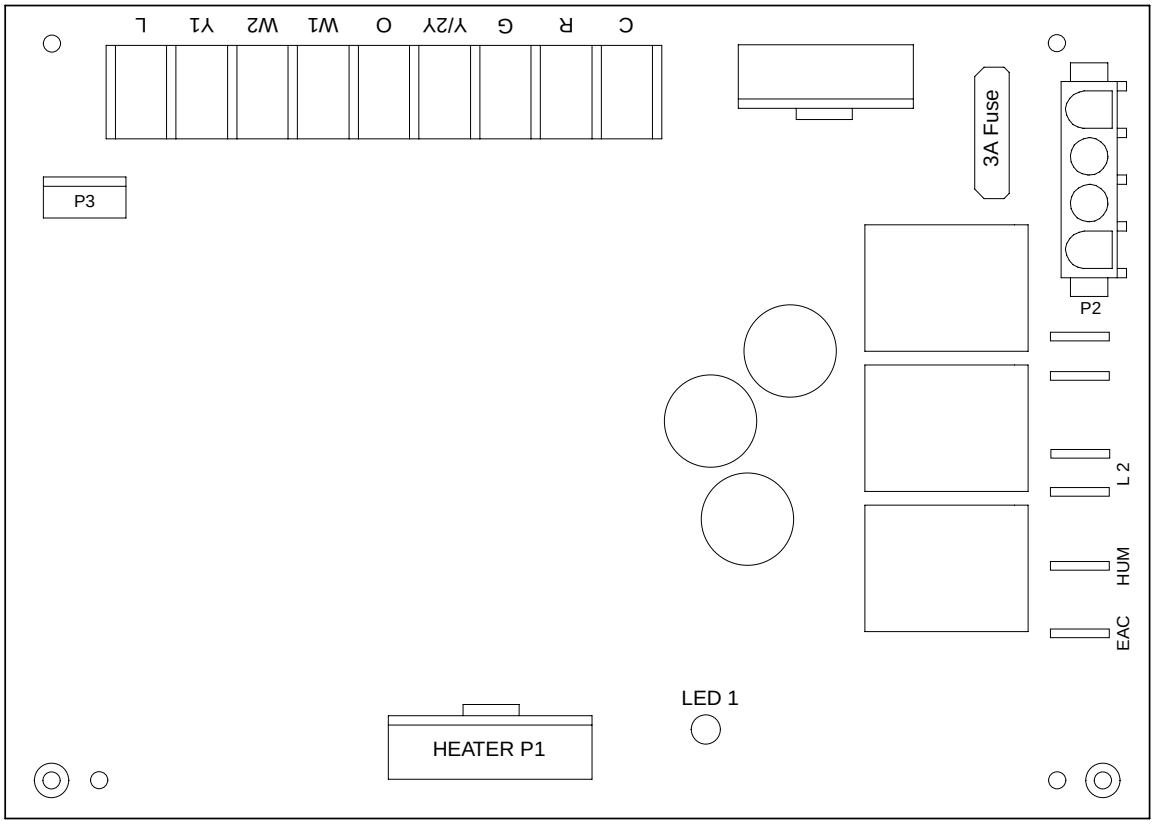


Figure 14. Two - Stage Control Board

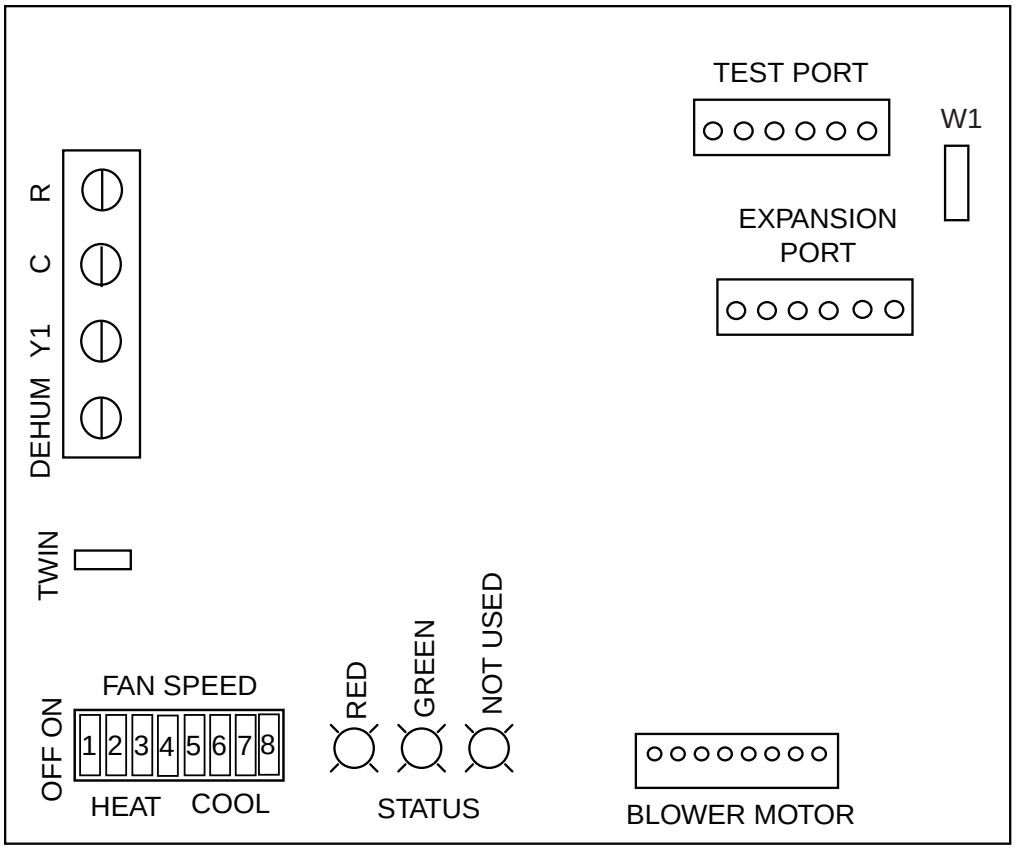


Figure 15. Fixed Speed Motor Control Board

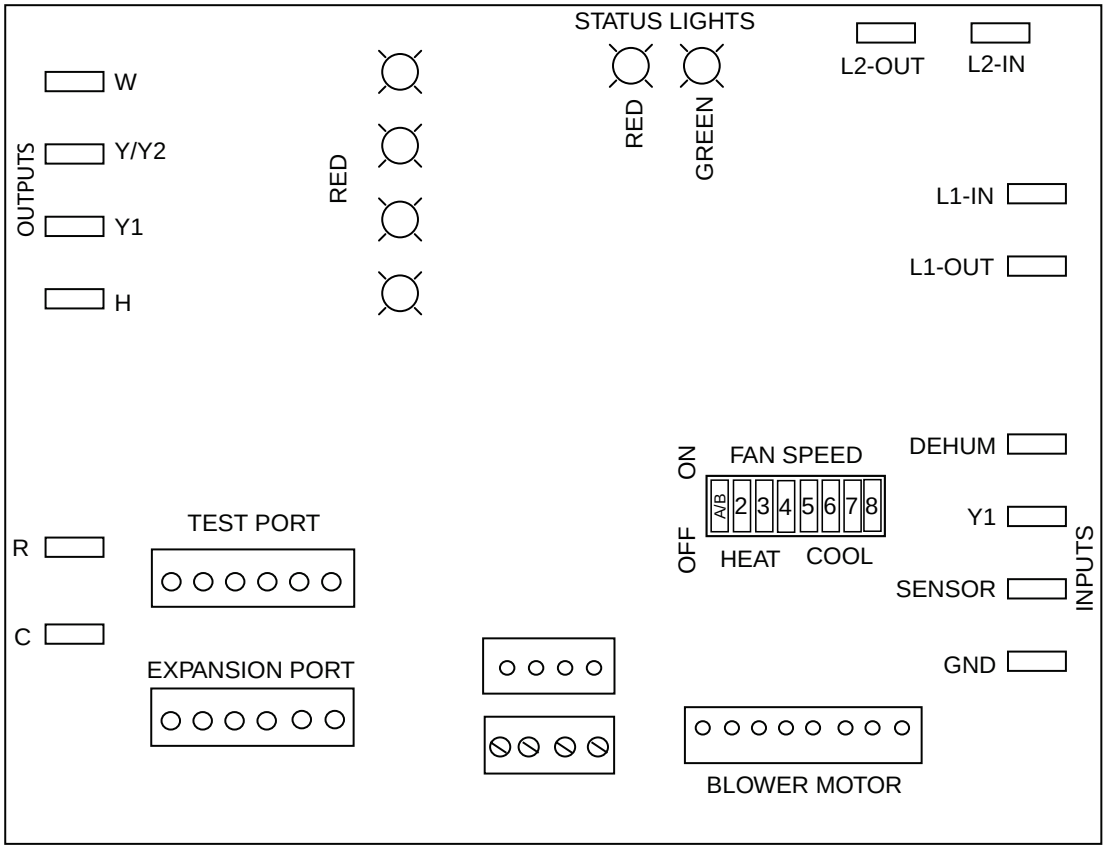


Figure 16. Variable Speed Motor Control Board

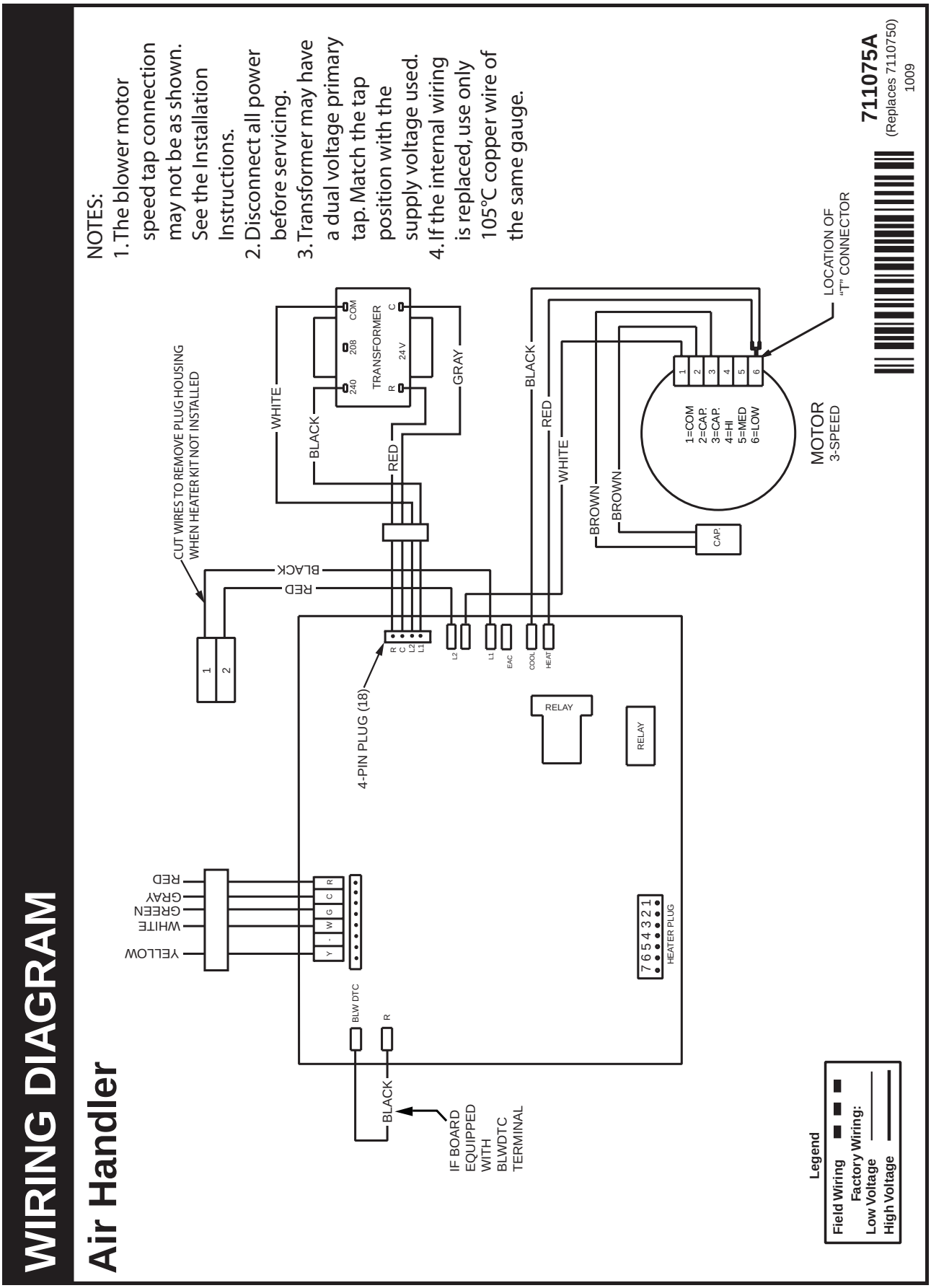


Figure 17. Wiring Diagram for B6BM Series Air Handler

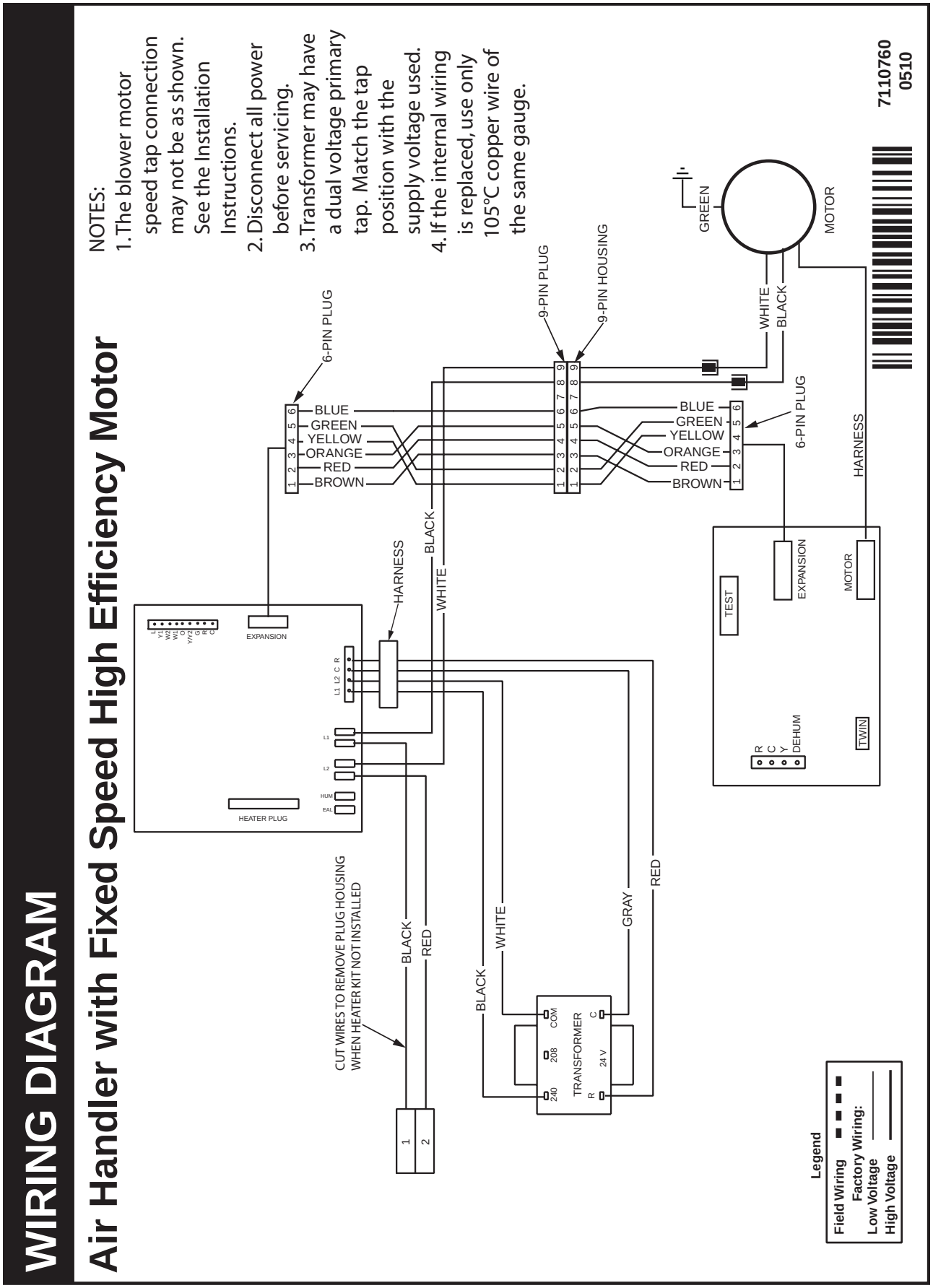


Figure 18. Wiring Diagram for B6EM Series Air Handler

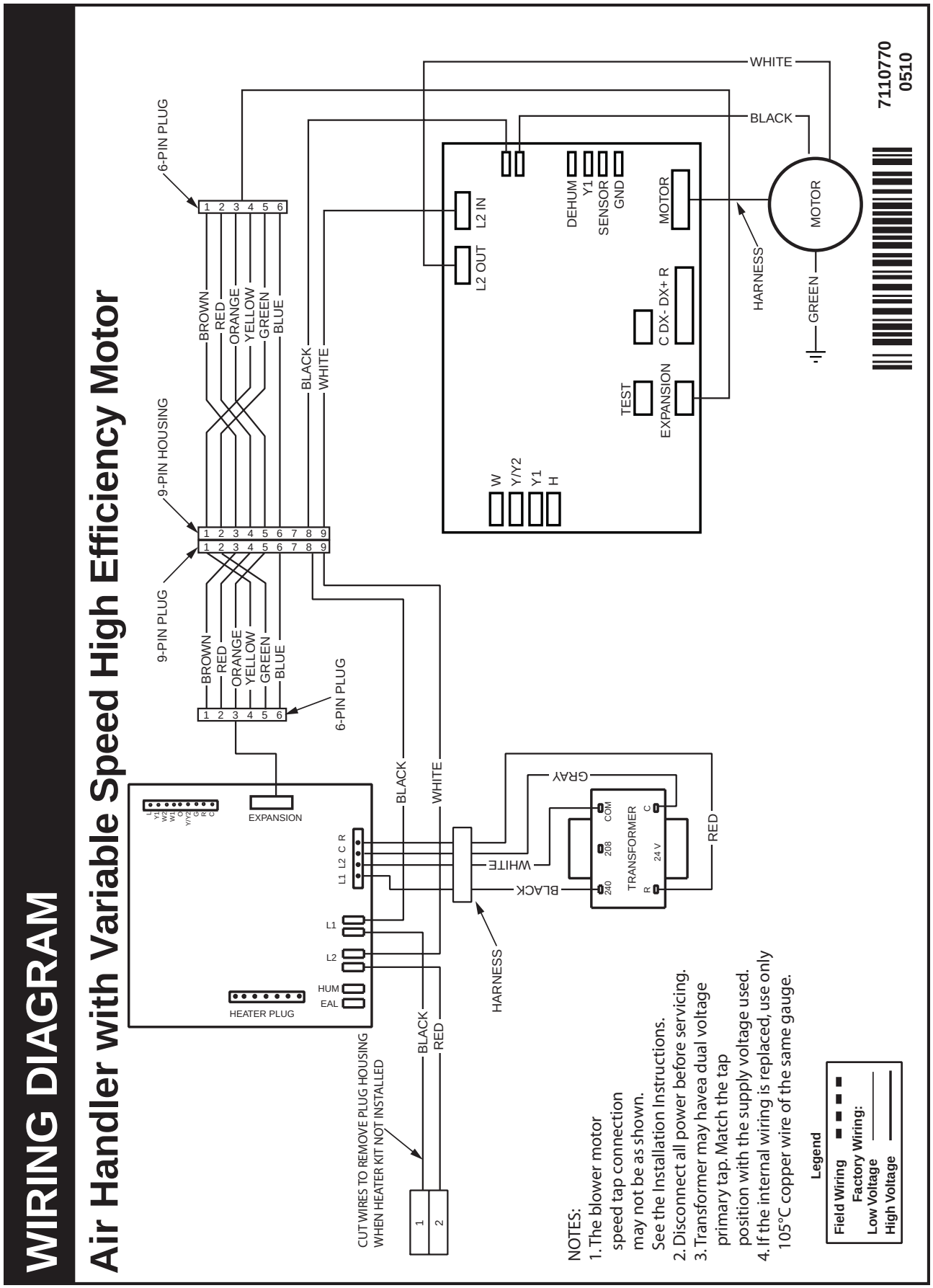


Figure 19. Wiring Diagram for B6VM Series Air Handler

B6BM																	
CABINET	CAPACITY	HEAT KIT MODEL NUMBER H6HK-	240 VAC, 50 & 60 HZ, SINGLE PHASE								208 VAC, 50 & 60 HZ, SINGLE PHASE							
			MCA				MOP				MCA				MOP			
			CIRCUIT A	CIRCUIT B	CIRCUIT C	SINGLE CIRCUIT	CIRCUIT A	CIRCUIT B	CIRCUIT C	SINGLE CIRCUIT	CIRCUIT A	CIRCUIT B	CIRCUIT C	SINGLE CIRCUIT	CIRCUIT A	CIRCUIT B	CIRCUIT C	SINGLE CIRCUIT
A	24	None	1.6	-	-	1.6	15	-	-	15	1.6	-	-	1.6	15	-	-	15
		005H-XX	26.6	-	-	26.6	30	-	-	30	23.3	-	-	23.3	25	-	-	25
		008H-XX	41.2	-	-	41.2	45	-	-	45	35.9	-	-	35.9	40	-	-	40
		010H-XX	51.6	-	-	51.6	60	-	-	60	45.0	-	-	45.0	45	-	-	45
		009Q-XX	-	-	-	28.7	-	-	-	30	-	-	-	18.8	-	-	-	30
B	24	None	1.6	-	-	1.6	15	-	-	15	1.6	-	-	1.6	15	-	-	15
		005H-XX	26.6	-	-	26.6	30	-	-	30	23.3	-	-	23.3	25	-	-	25
		008H-XX	41.2	-	-	41.2	45	-	-	45	35.9	-	-	35.9	40	-	-	40
		010H-XX	51.6	-	-	51.6	60	-	-	60	45.0	-	-	45.0	45	-	-	45
		009Q-XX	-	-	-	28.7	-	-	-	30	-	-	-	18.8	-	-	-	30
A	30	None	3.1	-	-	3.1	15	-	-	15	3.1	-	-	3.1	15	-	-	15
		005H-XX	28.1	-	-	28.1	30	-	-	30	24.8	-	-	24.8	25	-	-	25
		008H-XX	42.7	-	-	42.7	45	-	-	45	37.4	-	-	37.4	40	-	-	40
		010H-XX	53.1	-	-	53.1	60	-	-	60	46.5	-	-	46.5	50	-	-	50
		015H-XX	53.1	25.0	-	65.6	60	30	-	80	46.5	21.7	-	68.1	50	25	-	70
		009Q-XX	-	-	-	30.2	-	-	-	35	-	-	-	26.6	-	-	-	30
		015Q-XX	-	-	-	46.4	-	-	-	50	-	-	-	40.6	-	-	-	45
B	30/36	None	2.6	-	-	2.6	15	-	-	15	2.6	-	-	2.6	15	-	-	15
		005H-XX	27.6	-	-	27.6	30	-	-	30	24.3	-	-	24.3	25	-	-	25
		008H-XX	42.2	-	-	42.2	45	-	-	45	36.9	-	-	36.9	40	-	-	40
		010H-XX	52.6	-	-	52.6	60	-	-	60	46.0	-	-	46.0	50	-	-	50
		015H-XX	52.6	25.0	-	64.7	60	30	-	80	46.0	21.7	-	67.6	50	25	-	70
		020H-XX	52.6	50.0	-	102.6	60	60	-	110	46.0	43.3	-	89.3	50	45	-	90
		009Q-XX	-	-	-	29.7	-	-	-	30	-	-	-	26.1	-	-	-	30
		015Q-XX	-	-	-	45.9	-	-	-	50	-	-	-	40.2	-	-	-	45
B	42/48	None	3.1	-	-	3.1	15	-	-	15	3.1	-	-	3.1	15	-	-	15
		005H-XX	28.1	-	-	28.1	30	-	-	30	24.8	-	-	24.8	25	-	-	25
		008H-XX	42.7	-	-	42.7	45	-	-	45	37.4	-	-	37.4	40	-	-	40
		010H-XX	53.1	-	-	53.1	60	-	-	60	46.5	-	-	46.5	50	-	-	50
		015H-XX	53.1	25.0	-	65.6	60	30	-	80	46.5	21.7	-	68.1	50	25	-	70
		020H-XX	53.1	50.0	-	103.1	60	60	-	110	46.5	43.3	-	89.8	50	45	-	90
		009Q-XX	-	-	-	30.2	-	-	-	35	-	-	-	26.6	-	-	-	30
		015Q-XX	-	-	-	46.4	-	-	-	50	-	-	-	40.7	-	-	-	45
C	48	None	5.4	-	-	5.4	15	-	-	15	5.4	-	-	5.4	15	-	-	15
		005H-XX	30.4	-	-	30.4	35	-	-	35	27.0	-	-	27.0	30	-	-	30
		008H-XX	45.0	-	-	45.0	45	-	-	45	39.7	-	-	39.7	40	-	-	40
		010H-XX	55.4	-	-	55.4	60	-	-	60	48.7	-	-	48.7	50	-	-	50
		015H-XX	55.4	25.0	-	80.4	60	30	-	90	48.7	21.7	-	70.4	50	25	-	80
		020H-XX	55.4	50.0	-	105.4	60	60	-	110	48.7	43.3	-	92.0	50	45	-	100
		024H-XX	55.4	50.0	25.0	130.4	60	60	60	150	48.7	43.3	21.7	113.7	50	45	45	125
		029H-XX	55.4	50.0	50.0	155.4	60	60	60	175	48.7	43.3	43.3	135.4	50	45	45	150
		009Q-XX	-	-	-	32.4	-	-	-	35	-	-	-	28.8	-	-	-	30
		015Q-XX	-	-	-	48.7	-	-	-	50	-	-	-	42.9	-	-	-	45
C	60	None	6.3	-	-	6.3	15	-	-	15	6.8	-	-	6.8	15	-	-	15
		005H-XX	31.3	-	-	31.3	35	-	-	35	28.4	-	-	28.4	30	-	-	30
		008H-XX	45.8	-	-	45.8	50	-	-	50	41.1	-	-	41.1	45	-	-	45
		010H-XX	56.3	-	-	56.3	60	-	-	60	50.1	-	-	50.1	60	-	-	60
		015H-XX	56.3	25.0	-	81.3	60	30	-	90	50.1	21.7	-	71.8	60	25	-	80
		020H-XX	56.3	50.0	-	106.3	60	60	-	110	50.1	43.3	-	93.4	60	45	-	100
		024H-XX	56.3	50.0	25.0	131.3	60	60	30	150	50.1	43.3	21.7	115.1	60	45	25	125
		029H-XX	56.3	50.0	50.0	156.3	60	60	60	175	50.1	43.3	43.3	136.8	60	45	45	150
		009Q-XX	-	-	-	33.3	-	-	-	35	-	-	-	30.2	-	-	-	35
		015Q-XX	-	-	-	49.6	-	-	-	50	-	-	-	44.3	-	-	-	45

Table 10. B6BM Minimum Circuit Ampacity & Maximum Overcurrent Protection

B6(E,V)M																	
CABINET	CAPACITY	HEAT KIT MODEL NUMBER H6HK-	240 VAC, 50 & 60 HZ, SINGLE PHASE								208 VAC, 50 & 60 HZ, SINGLE PHASE							
			MCA				MOP				MCA				MOP			
			CIRCUIT A	CIRCUIT B	CIRCUIT C	SINGLE CIRCUIT	CIRCUIT A	CIRCUIT B	CIRCUIT C	SINGLE CIRCUIT	CIRCUIT A	CIRCUIT B	CIRCUIT C	SINGLE CIRCUIT	CIRCUIT A	CIRCUIT B	CIRCUIT C	SINGLE CIRCUIT
A	24/30	None	4.5	-	-	4.5	15	-	-	15	4.8	-	-	4.8	15	-	-	15
		005H-XX	29.5	-	-	29.5	30	-	-	30	26.4	-	-	26.4	30	-	-	30
		008H-XX	44.1	-	-	44.1	45	-	-	45	39.1	-	-	39.1	40	-	-	40
		010H-XX	54.5	-	-	54.5	60	-	-	60	48.1	-	-	48.1	50	-	-	50
		015H-XX	54.5	25.0	-	68.1	60	30	-	80	48.1	21.7	-	69.8	50	25	-	70
		009Q-XX	-	-	-	31.6	-	-	-	35	-	-	-	28.2	-	-	-	30
		015Q-XX	-	-	-	47.8	-	-	-	50	-	-	-	42.3	-	-	-	45
B	24/30/ 36/42	None	4.5	-	-	4.5	15	-	-	15	4.8	-	-	4.8	15	-	-	15
		005H-XX	29.5	-	-	29.5	30	-	-	30	26.4	-	-	26.4	30	-	-	30
		008H-XX	44.1	-	-	44.1	45	-	-	45	39.1	-	-	39.1	40	-	-	40
		010H-XX	54.5	-	-	54.5	60	-	-	60	48.1	-	-	48.1	50	-	-	50
		015H-XX	54.5	25.0	-	68.1	60	30	-	80	48.1	21.7	-	69.8	50	25	-	70
		020H-XX	54.5	50.0	-	104.5	60	60	-	110	48.1	43.3	-	91.4	50	45	-	100
		009Q-XX	-	-	-	31.6	-	-	-	35	-	-	-	28.2	-	-	-	30
		015Q-XX	-	-	-	47.8	-	-	-	50	-	-	-	42.3	-	-	-	45
C	48/60	None	6.3	-	-	6.3	15	-	-	15	6.8	-	-	6.8	15	-	-	15
		005H-XX	31.3	-	-	31.3	35	-	-	35	28.4	-	-	28.4	30	-	-	30
		008H-XX	45.8	-	-	45.8	50	-	-	50	41.1	-	-	41.1	45	-	-	45
		010H-XX	56.3	-	-	56.3	60	-	-	60	50.1	-	-	50.1	60	-	-	60
		015H-XX	56.3	25.0	-	81.3	60	30	-	90	50.1	21.7	-	71.8	60	25	-	80
		020H-XX	56.3	50.0	-	106.3	60	60	-	110	50.1	43.3	-	93.4	60	45	-	100
		024H-XX	56.3	50.0	25.0	131.3	60	60	60	150	50.1	43.3	21.7	115.1	60	45	45	125
		029H-XX	56.3	50.0	50.0	156.3	60	60	60	175	50.1	43.3	43.3	136.8	60	45	45	150
		009Q-XX	-	-	-	33.3	-	-	-	35	-	-	-	30.2	-	-	-	35
		015Q-XX	-	-	-	49.6	-	-	-	50	-	-	-	44.3	-	-	-	45

Table 11. B6(E,V)M Minimum Circuit Ampacity & Maximum Overcurrent Protection

CONTROL SIGNAL & MODE	OPERATION	TOTAL KW	BOARD ACTION
W1 only EHEAT	ON	5 KW	Stage 1 Heat on instantly
			Heat blower on after 3 second delay
		10 KW	Stage 1 Heat on instantly
			Heat blower on after 3 second delay
		15 KW	Stage 1 Heat on instantly
			Heat blower on after 3 second delay
			Stage 2 Heat on after 5 second delay
		20 KW	Stage 1 Heat on instantly
			Heat blower on after 3 second delay
			Stage 2 Heat on after 5 second delay
			Stage 3 Heat on after 10 second delay
		25 KW	Stage 1 Heat on instantly
			Heat blower on after 3 second delay
			Stage 2 Heat on after 5 second delay
			Stage 3 Heat on after 10 second delay
		30 KW	Stage 1Heat on instantly
			Heat blower on after 3 second delay
			Stage 2 Heat on after 5 second delay
			Stage 3 Heat on after 10 second delay
			Stage 4 Heat on after 15 second delay
	OFF		Heat stages off instantly
			Blower off after 15 second delay

Table 12. Control Board Operation

CONTROL SIGNAL & MODE	OPERATION	TOTAL KW	BOARD ACTION
W1 & W2 EHEAT	ON	5 KW	Stage 1 Heat on instantly
			Heat blower on after 3 second delay
		10 KW	Stage 1 Heat on instantly
			Heat blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
		15 KW	Stage 1 Heat on instantly
			Heat blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
			Stage 3 Heat on after 10 seconds delay
		20 KW	Stage 1 Heat on instantly
			Heat blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
			Stage 3 Heat on after 10 seconds delay
			Stage 4 Heat on after 15 seconds delay
		25 KW	Stage 1 Heat on instantly
			Heat blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
			Stage 3 Heat on after 10 seconds delay
			Stage 4 Heat on after 15 seconds delay
			Stage 5 Heat on after 20 seconds delay
		30 KW	Stage 1Heat on instantly
			Heat blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
			Stage 3 Heat on after 10 seconds delay
			Stage 4 Heat on after 15 seconds delay
			Stage 5 Heat on after 20 seconds delay
			Stage 6 Heat on after 25 seconds delay
	OFF		Heat stages off instantly
			Blower off after 15 second delay
W1 & Y/Y2 AUX HEAT	ON	5 KW	Stage 1 Heat on instantly
			Cool blower on after 3 second delay
		10 KW	Stage 1 Heat on instantly
			Cool blower on after 3 second delay
		15 KW	Stage 1 Heat on instantly
			Cool blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
		20 KW	Stage 1 Heat on instantly
			Cool blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
			Stage 3 Heat on after 10 seconds delay
		25 KW	Stage 1 Heat on instantly
			Cool blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
			Stage 3 Heat on after 10 seconds delay
		30 KW	Stage 1 Heat on instantly
			Cool blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
			Stage 3 Heat on after 10 seconds delay
			Stage 4 Heat on after 15 seconds delay
	OFF		Heat stages off instantly
			Heat blower turns off after 40 second delay

Table 12. Control Board Operation - Continued

CONTROL SIGNAL & MODE	OPERATION	TOTAL KW	BOARD ACTION
W1, W2 & Y/Y2 AUX HEAT	ON	5 KW	Stage 1 Heat on instantly
			Cool blower on after 3 second delay
		10 KW	Stage 1 Heat on instantly
			Cool blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
		15 KW	Stage 1 Heat on instantly
			Cool blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
			Stage 3 Heat on after 30 seconds delay
		20 KW	Stage 1 Heat on instantly
			Cool blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
			Stage 3 Heat on after 10 seconds delay
			Stage 4 Heat on after 15 seconds delay
		25 KW	Stage 1Heat on instantly
			Cool blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
			Stage 3 Heat on after 10 seconds delay
			Stage 4 Heat on after 15 seconds delay
			Stage 5 Heat on after 20 seconds delay
		30 KW	Stage 1Heat on instantly
			Cool blower on after 3 second delay
			Stage 2 Heat on after 5 seconds delay
			Stage 3 Heat on after 10 seconds delay
			Stage 4 Heat on after 15 seconds delay
			Stage 5 Heat on after 20 seconds delay
			Stage 6 Heat on after 25 seconds delay
	OFF		Heat stages off instantly
			Heat blower turns off after 40 second delay
G FAN	On		Fan blower on after 3 second delay
	Off		Fan blower off instantly
Y/Y2 HEAT PUMP & COOL	On		Cool blower on after 3 second delay
	Off		Cool blower off after 40 second delay
Y1 HEAT PUMP & COOL	On		Cool blower on after 3 second delay
	Off		Cool blower off after 40 second delay
Y1 & Y/Y2 HEAT PUMP & COOL	On		Cool blower on after 3 second delay
	Off		Cool blower off after 40 second delay

Table 12. Control Board Operation - Continued

INSTALLATION / PERFORMANCE CHECK LIST

INSTALLER NAME:		
CITY:	STATE:	
INSTALLATION ADDRESS:		
CITY:	STATE:	
UNIT MODEL #		
UNIT SERIAL #		
Minimum clearances per page 4?	YES	NO
Is the unit properly installed and leveled?	YES	NO
Does condensate drain properly in both drain tubes?	YES	NO
Has the owner's information been reviewed with the home-owner?	YES	NO
Has the literature package been left near the appliance?	YES	NO

ELECTRICAL SYSTEM:		
Electrical connections tight?	YES	NO
Line voltage polarity correct?	YES	NO
Supply Voltage: _____(V)		
Has the thermostat been calibrated?	YES	NO
Is the thermostat level?	YES	NO
Is the heat anticipator setting correct?	YES	NO

ATTENTION INSTALLERS:

It is your responsibility to know this product better than your customer. This includes being able to install the product according to strict safety guidelines and instructing the customer on how to operate and maintain the equipment for the life of the product. Safety should always be the deciding factor when installing this product and using common sense plays an important role as well. Pay attention to all safety warnings and any other special notes highlighted in the manual. Improper installation of the air handler or failure to follow safety warnings could result in serious injury, death, or property damage.

These instructions are primarily intended to assist qualified individuals experienced in the proper installation of this appliance. Some local codes require licensed installation/service personnel for this type of equipment. Please read all instructions carefully before starting the installation. Return these instructions to the customer's package for future reference.

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709172B (Replaces 709172A)

SAFETY DATA SHEET
REFRIGERANT R410A

SECTION 1: IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND OF THE COMPANY / UNDERTAKING

1.1. Product Identifier

Product name: REFRIGERANT R410A

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use: Refrigerant.
Advised Against: No specific uses advised again have been identified, other than restrictions in the F-Gas Regulations.

1.3. Details of the supplier of the safety data sheet

Company name:

National Refrigerants Ltd.
4 Watling Close
Sketchley Meadows Business Park
Hinckley LE10 3EZ
Tel: +44(0)1455 630790
Fax: +44(0) 1455 630791
Email: sds@nationalref.com

1.4. Emergency telephone number

Emergency Tel: +44(0) 1865 407333

SECTION 2: HAZARDS IDENTIFICATION

2.1. Classification of the substance of mixture

Classification under Directive 67/548/EEC or 1999/45/EC: This substance is not classified as dangerous according to Directive 67/548/EEC or 1999/45/EC.
Most important adverse effect: Rapid evaporation of the liquid may cause frostbite.
Vapour is heavier than air and can cause suffocation.

2.2. Label elements

Directives 67/458/EEC or 1999/45/EC: This substance is not classified as dangerous according to Directive 67/548/EEC or 1999/45/EC.
Special labelling of certain mixtures: Contains fluorinated greenhouse gases covered by the Kyoto Protocol

2.3. Other hazards

SECTION 3: COMPOSITION / INFORMATION ON INGREDIENTS

3.1. Substances

Hazardous Ingredients:

3.2 Mixtures

DIFLUOROMETHANE (R32)

EINECS	CAS	67/548/EEC Classification	CLP Classification	Percent

200-839-4	75-10-5	F+; R12	H220: Flammable gas H280: Pressurised gas	48.5 – 50.5%

PENTAFLUOROETHANE (R125)

EINECS	CAS	67/548/EEC Classification	CLP Classification	Percent
206-557-8	354-33-6		H280: Pressurised gas	49.5 – 51.5%

SECTION 4: FIRST AID MEASURES

4.1. Description of first aid measures

Skin contact: Take off all contaminated clothing immediately if not stuck to the skin. Flush area with lukewarm water. Do not use hot water. If frostbite has occurred call a physician.

Eye contact: Hold eyelids apart and flush eyes with plenty of water for at least 15 minutes. Get medical attention.

Ingestion: This is not considered a potential route of exposure.

Inhalation: Remove from exposure, lie down. Move to fresh air. Keep patient warm and at rest. Artificial respiration and/or oxygen may be necessary. Consult a physician.

General Advice Never give anything by mouth to an unconscious person. When symptome persist or in all cases of doubt seek medical advice.

4. 2. Most important symptoms and effects, both acute and delayed

Skin contact: Low exposure will cause redness and pain. High exposure will cause frostbite, blisters and severe pain.

Eye contact: Cause severe pain and cornea damage.

Ingestion: Not a route of exposure.

Inhalation: Shortness of breath, severe headache, dizziness, nausea, weakness, and unconsciousness. Irregular cardiac activity.

Treatment: Do not give adrenaline or similar drugs.

4.3. Indication of any immediate medical attention and special treatment needed

Immediate/special treatment: Burns pack should be available on the premises.

SECTION 5: FIRE-FIGHTING MEASURES

5.1. Extinguishing media

Extinguishing media: Water spray, Foam, Dry chemical Carbon dioxide (CO_2). Use extinguishing measures that are appropriate to local and surrounding environment. Cool cylinders/tanks with water spray.

5.2. Special hazards arising from the substance or mixture

Special hazards arising from the mixture Vapours may form explosive mixtures with air. Vapours are heavier than air and may spread along floors. Vapours or gases may travel considerable distances to ignition source and flash back. Fire or intense heat may cause violent rupture of packages.
Hazardous thermal decomposition products: carbon oxides, hydrogen fluoride, carbonyl fluoride.

5.3. Advice for fire-fighters

Advice for fire-fighters: In the event of fire wear self-contained breathing apparatus.
Use personal protective equipment.
Wear neoprene gloves during cleaning work after a fire.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Personal precautions: Evacuate personnel to safe areas. Ventilate the area, especially low or enclosed places where heavy vapours might collect.

6.2. Environmental precautions

Environmental precautions: Should not be released into the atmosphere.

6.3. Methods and material for containment and cleaning up

Clean-up procedures: Material evaporates.

6.4. Reference to other sections

Reference to other sections: Refer to Section 7 of SDS. Refer to Section 8 of SDS.

SECTION 7: HANDLING AND STORAGE

7.1. Precautions for safe handling

Handling requirements: *Advice on handling:* Avoid breathing vapours or mist. Avoid liquid contact with skin and clothing. Provide sufficient air exchange and/or exhaust in work rooms.
Advice on protection against fire and explosion: No special measures against fire required.

7.2. Conditions for safe storage, including any incompatibilities

Storage conditions: Do not drag, slide or roll cylinders. Never attempt to lift cylinder by its cap. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder. Keep at temperature not exceeding 52°C. Keep cylinders tightly closed in a dry, cool and well-ventilated place.

Suitable packaging: Store in original cylinder only.
Protect from contamination.

Storage temperature: Less than 52°C

7.3. Specific end use(s)

Specific end use(s) No data available.

SECTION 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

If subsection is empty then no values are applicable

8.1. Control parameters

Hazardous ingredients:
PENTAFLUOROETHAN (HFC125)
Workplace exposure limits

State	8 hour TWA	15 min. STEL
UK	1000 ppm (4900 mg/m^3)	-

8.2. Derived No Effect Level

Difluoromethane Type of Application (Use): Workers
Exposure routes: Inhalation

	Health effects: Chronic effects, Systemic toxicity Value: 7035 mg/m^3 Type of application (Use); Consumers Exposure routes: Inhalation Health effects: Chronic effects, Systemic toxicity Value: 750 mg/m^3
Pentafluoroethane	Type of Application (Use): Workers Exposure routes: Inhalation Health effects: Chronic effects, Systemic toxicity Value: 16444 mg/m^3 Type of application (Use): Consumers Exposure routes: Inhalation Health effects: Chronic effect, Systemic toxicity Value; 1753 mg/m^3

8.3 Predicted No Effect Concentration

Difluoromethane	Value: 0.142 mg/l Compartment: Fresh water Value: 1.42 mg/l Compartment: Water Remarks; Intermittent use/release Value: 0.534 mg/l Compartment: Fresh water sediment
Pentafluoroethane	Value; 0.1 mg/l Compartment: Fresh water Value: 1 mg/l Compartment: Water Remarks; Intermittent use/release Value: 0.6 mg/l Compartment: Fresh water sediment

8.4 Exposure controls

Engineering measures:	Ensure adequate ventilation, especially in confined areas. Local exhaust should be used when large amounts are released.
Respiratory protection:	For rescue and maintenance work in storage tanks use self-contained breathing apparatus. Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.
Hand protection:	Heat insulating gloves
Eye protection:	Safety glasses with side shields. Wear a face shield in addition where the possibility exists for face contact due to splashing, spraying or airborne contact with this material.
Skin protection:	Wear impervious clothing that covers legs and arms.
Protective measures	When using do not smoke
Hygiene measures	Handle in accordance with good industrial hygiene and safety practice.
Environmental:	Gas escapes to be kept to the minimum by engineering processes and operating methods.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

State:	Liquefied gas under pressure.
Colour:	Clear colourless liquid and vapour.
Odour:	Ethereal
Molecular weight:	72.59 g/mole

Boiling Point/range:	- 51.2 to -51.1°C (boiling range)
Flash Point:	Does not flash. Non-flammable
Vapour pressure:	14.706 Bar (14706 hPa) at 20°C
Liquid Density:	1081 kg/m^3 at 20°C

SECTION 10. STABILITY AND REACTIVITY

10.1. Reactivity

Reactivity: Stable under recommended storage and transport conditions.

10.2. Chemical stability

Chemical stability: Stable under normal conditions.

10.3. Possibility of hazardous reactions

Hazardous reactions: Hazardous reactions will not occure under recommended storage and transport conditions.
May react with aluminium.

10.4. Conditions to avoid

Conditions to avoid: Heat, hot surfaces, flames.
The product is not flammable in air under ambient conditiond of temperature and pressure. When pressurised with air or oxygen, the mixture may become flammable or reactive under certain conditions.

10.5. Incompatible material

Materials to avoid: Alkali metals, alkaline earth metals, powdered metals, powdered metal salts.

10.6. Hazardous decomposition products

Hazardous decomposition products Thermal decomposition yields toxic products which can be corrosive in the presence of moisture.

SECTION 11: TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

Acute oral toxicity

Difluoromethane	Not applicable
Pentafluoroethane	Not applicable

Acute inhalation toxicity

Inhalation

Difluoromethane:	LC50/rat: > 520 000 ppm /dog: Not a cardiac sensitizer.
Pentafluoroethane:	LC50/rat: > 800 000 ppm /dog: Cardiac sensitization.

Acute dermal toxicity

Difluoromethane;	Not applicable
Pentafluoroethane:	Not applicable

Skin irritation

Difluoromethane:	Not tested on animals. Classification: Not classified as irritant. Result: No skin irritation. Not expected to cause skin irritation based on expert review of the properties of the substance.
Pentafluoroethane:	Not tested on animals.

Classification: Not classified as irritant
Result: No skin irritation.
Not expected to cause skin irritation bases on expert review of the properties of the substance.

Eye irritation

Difluoromethane:
Not tested on animals.
Classification: Not classified as irritant
Result: No eye irritation.
Not expected to cause eye irritation bases on expert review of the properties of the substance.

Pentafluoroethane:
Not tested on animals.
Classification: Not classified as irritant
Result: No eye irritation.
Not expected to cause eye irritation bases on expert review of the properties of the substance.

Sensitisation

Difluoromethane:
Not tested on animals.
Classification: Not a skin irritant
Result: Does not cause skin sensitisation.
Not expected to cause skin sensitisation bases on expert review of the properties of the substance.

There are reports of human respiratory sensitisation.

Pentafluoroethane:
Not tested on animals.
Classification: Not a skin irritant
Result: Does not cause skin sensitisation.
Not expected to cause skin sensitisation bases on expert review of the properties of the substance.

Repeated dose toxicity

Difluoromethane:
Inhalation rat
No toxicologically significant effects were found,

Pentafluoroethane:
Inhalation rat
No toxicologically significant effects were found,

Mutagenic assessment

Difluoromethane:
Animal testing did not show any mutagenic effects.
Tests on bacteria or mammalian cell cultures did not show mutagenic effects.

Pentafluoroethane:
Animal testing did not show any mutagenic effects.
Tests on bacteria or mammalian cell cultures did not show mutagenic effects.

Carcinogenicity Assessment

Difluoromethane: Not classifiable as a human carcinogen.
Pentafluoroethane: Not classifiable as a human carcinogen.

Toxicity to reproduction assessment

Difluoromethane: No toxicity to reproduction.
Pentafluoroethane: No toxicity to reproduction.

Human experience

Excessive exposures may affect human health as follows:
Inhalation: Sever shortness of breath, narcosis, irregular cardiac activity.

Futher information

Rapid evaporation of the liquid may cause frostbite. May cause cardiac arrhythmia.

SECTION 12. ECOLOGICAL INFORMATION

12.1. Toxicity

Toxicity to fish:

Difluoromethane: LC50/96 h/Fish: 1507 mg/l

Pentafluoroethane: LC_{50}/96 h/Oncorhynchus (rainbow trout): > 81.2 mg/l
Information given is based on data obtained from similar substances.

LC_{50}/96 h/Danio rerio (zebra fish): > 200 mg/l
Information given is based on data obtained from similar substances.

LC_{50}/96 h/Oncorhynchus mykiss (rainbow trout): 450 mg/l
Information given is based on data obtained from similar substances.

Toxicity to Aquatic plants:

Difluoromethane: LC_{50}/96 h/Algae: 142 mg/l

Pentafluoroethane: LC_{50}/72 h/Pseudokirchneriella subcapitata (green algae): >118 mg/l
Information given is based on data obtained from similar substances.

LC_{50}/72 h/Pseudokirchneriella subcapitata (green algae): >114 mg/l
Information given is based on data obtained from similar substances.

LC_{50}/96 h/Algae: 142 mg/l
Information given is based on data obtained from similar substances.

Toxicity to aquatic invertebrates

Difluoromethane EC_{50}/48 h/Daphnia: 652 mg/l

Pentafluoroethane EC_{50}/48 h/Daphnia magna (Water flea): > 200 mg/l
Information given is based on data obtained from similar substances.

EC_{50}/48 h/Daphnia magna (Water flea): > 97.9 mg/l
Information given is based on data obtained from similar substances.

EC_{50}/48 h/Daphnia magna (Water flea): > 97.9 mg/l
Information given is based on data obtained from similar substances.

Ecotoxic values: When discharged may contribute to the greenhouse effect.

Global Warming Potential (GWP) 0 (CO^2 = 1)

Ozone Depletion Potential (ODP) 1980 (R11 = 1)

12.2. Persistence and degradability

Persistence and degradability: No data available.

12.3. Bio accumulative potential

Bio-accumulative potential: No data available.

12.4. Mobility in soil

Mobility: No data available.

12.5. Results of PBT and vPvB assessment

PBT identification: No data available

12.6. Other adverse effects

Other adverse effects:

SECTION 13. DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Disposal operations: Do not allow product to be released into the environment.
Recovery Operations: Consult the manufacturer or supplier for information regarding recovery and recycling of the product. If recovery is not possible, incinerate at a licensed installation.
Disposal of packaging: De-gas and return cylinders to suppliers.
N.B. The user's attention is drawn to the possible existence of regional or national regulations regarding disposal.

SECTION 14. TRANSPORT INFORMATION

14.1. ADR

UN Number: 3163
Class: 2
Classification code: 2A
Hazard Identification Number: 20
Labelling Number: 2.2
Proper Shipping Name: Liquefied Gas N.O.S. (Difluoromethane, Pentafluoroethane)
Tunnel code: (C/E)

14.2. IATA_C

UN Number: 3163
Class: 2
Labelling Number: 2.2
Proper Shipping Name: Liquefied Gas N.O.S. (Difluoromethane, Pentafluoroethane)

14.3. IMDG

UN Number: 3163
Class: 2
Labelling Number: 2.2
EmS: F-C, S-V
Proper Shipping Name: Liquefied Gas N.O.S. (Difluoromethane, Pentafluoroethane)
Marine Pollutant: No

SECTION 15. REGULATORY INFORMATION

15.1. Safety, health and environment regulations/legislation specific for the substance or mixture

Special labelling of certain mixtures: Contains fluorinated greenhouse gases covered by the Kyoto Protocol.

15.2. Chemial Safety Assessment

Chemical safety assessment: A chemical safety assessment has not been carried out by the supplier of this mixture.

16. OTHER INFORMATION

Other information: This safety sheet is prepared in accordance with Commission Regulation (EU) No. 453/2010.
* Indicates text in SDS which has changed since the last revision
.

Text of R-phrases mentioned in Section 3: R12 Extremely flammable

Full text of H-statements referred under Section 3:
H220 Extremely flammable gas
H280 Contains gas under pressure; may explode if heated.

Appendix G

Legal disclaimer: *National Refrigerants Ltd. believes that the information and recommendations contained herein (including data and statements) are accurate as of the date hereof. NO WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE, WARRANTY OF MERCHANTABILITY, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION PROVIDED HEREIN. The information provided herein relates only to the specific product designated and may not be valid where such product is used in combination with any other methods of use of the product and of the information referred to herein are beyond the control of National Refrigerants Ltd. National Refrigerants Ltd. expressly disclaims any and all liability as to any results obtained or arising from any use of the product or reliance on such information.*

GENERAL SAFETY & HANDLING DATA

1. GENERAL

Only trained persons should handle compressed gases.
Observe all regulations and local requirements regarding the storage of Cylinders.
Do not remove or deface labels provided by the supplier for the identification of the Cylinder contents.
Ascertain the identity of the gas before using it.
Know and understand the properties and hazards associated with each gas before using it.
When doubt exists as to the correct handling procedure for a particular gas contact the supplier.

HANDLING AND USE

Wear stout gloves.
Never lift a Cylinder by the cap or guard unless the supplier states it is designed for that purpose.
Use trolley or other suitable device or technique for transporting heavy Cylinders, even for a short distance.
Where necessary wear suitable eye and face protection. The choice between safety glasses, chemical goggles, or full face shield will depend on the pressure and nature of the gas being used,

Where necessary for toxic gases see that self-contained positive pressure breathing apparatus or full face airline respirator is available in the vicinity of the working area.
Employ suitable pressure regulating device on all Cylinders when gas is being emitted to systems with lower pressure rating than that of the Cylinder.
Ascertain that all electrical systems in the area are suitable for service with each gas.

Never use direct flame or electrical heating devices to raise the pressure of a Cylinder, Cylinders should not be subjected to temperatures above 45^{o}C.
Never re-compress a gas mixture without consulting the supplier. Never attempt to transfer gases from one Cylinder to another.
Do not use Cylinders as rollers or supports, or for any other purpose other than to contain the gas as supplied.
Never permit oil, grease or other readily combustible substances to come into contact with valves of Cylinders containing oxygen or other oxidants.
Keep Cylinder valves clean and free from contaminants particularly oil and water.

Do not subject Cylinders to mechanical shocks which may cause damage to their valves or safety devices.

Never attempt to repair or modify Cylinder valves or safety relief devices. Damaged valves should be reported immediately to the supplier.
Close the Cylinder valve whenever gas is not required even if the Cylinder is still connected to the equipment.

2. STORAGE

Cylinders should be stored in a well-ventilated area.
Some gases will require a purpose built area.
Store Cylinders in a location free from fire risk and away from sources of heat and ignition. Designate as a no smoking area.

Gas Cylinders should be segregated in the storage according to the various categories.

The storage area should be kept clear and access should be restricted to authorized persons only, the area should be clearly marked as a storage area and appropriate hazard warning signs displayed (Flammable, Toxic etc.).
The amount of flammable or toxic gases should be kept to a minimum.
Flammable gases should be stored away from other combustible materials.

Cylinders held in storage should be periodically checked for general condition and leakage.

Cylinders in storage should be properly secured to prevent toppling or rolling.
Vertical storage is recommended where the Cylinder is designed for this.
Cylinder valves should be tightly closed and, where appropriate, valves should be capped or plugged.
Protect Cylinders stored in the open against rusting and extremes of weather.
Cylinders should not be stored in conditions likely to encourage corrosion.
Store full and empty Cylinders separately and arrange full Cylinders so that the oldest stock is used first.

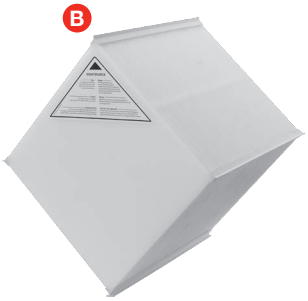
FOR FURTHER INFORMATION CONTACT YOUR NEAREST DISTRIBUTION CENTRE

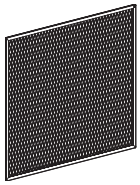
Honeywell

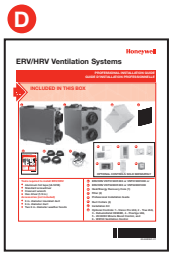
ERV/HRV Ventilation Systems

PROFESSIONAL INSTALLATION GUIDE
GUIDE D'INSTALLATION PROFESSIONNELLE

INCLUDED IN THIS BOX







OPTIONAL CONTROLS SOLD SEPARATELY

Tools required to install ERV/HRV

- Aluminum foil tape (UL181B)
- Standard screwdriver
- Crescent wrench
- Hex driver (1/4 in.)

Accessories (not included)

- 6 in. diameter insulated duct
- 6 in. diameter duct
- Two 6 in. diameter weather hoods

- A1 ERV/HRV VNT5150H1000 or VNT5150E1000 or
- A2 ERV/HRV VNT5200H1000 or VNT5200E1000
- B Heat/Energy Recovery Core (1)
- C Filter (2)
- D Professional Installation Guide
- E Duct Collars (4)
- F Installation Kit
- G Optional Controls: 1- Vision Pro IAQ, 2 - True IAQ, 3 - Dehumidistat H8908D, 4 - Prestige IAQ, 5 - 20/40/60 Minute Boost Control, and 6 - W8150 Ventilation Control

69-2480EF-01

Installation Checklist

Included in This Box

A1 ERV/HRV VNT5150H1000 or VNT5150E1000 or
A2 ERV/HRV VNT5200H1000 or VNT5200E1000
B Heat/Energy Recovery Core
C Filter (2)
D Installation Guide
E Duct Collars (4)
F Installation Kit

Control Options (Sold separately)

G1 - Vision Pro IAQ
G2 - True IAQ
G3 - Dehumidistat H8908D
G4 - Prestige IAQ
G5 - 20/40/60 Minute Boost Control
G6 - W8150 Ventilation Control

Tools Required (Not Supplied)

- Aluminum foil tape (UL1818)
- Standard screwdriver
- Crescent wrench
- Hex driver (1/4 in.)

Accessories (not included)

- 6 in. diameter insulated duct
- 6 in. diameter duct
- Two 6 in. diameter weather hoods

Warning: Installation must be performed by a qualified service technician and must comply with local codes.
Remove power to the device before installing or servicing the device.
Failure to connect the device according to these instructions may result in damage to the device or the controls.

INSTALLATION INSTRUCTIONS BEGIN ON PAGE 1

Liste de vérification pour l'installation

Contenu

A1 VRÉ/VRC VNT5150H1000 ou VNT5150E1000 ou
A2 VRÉ/VRC VNT5200H1000 ou VNT5200E1000
B Noyau de récupération de chaleur et d'énergie
C Filtre (2)
D Guide d'installation
E Raccords de conduit (4)
F Trousse de quincaillerie

Commandes en option (vendues séparément)

G1 - Vision Pro IAQ
G2 - True IAQ
G3 - Déshumidistat H8908D
G4 - Prestige IAQ
G5 - Minuteur de ventilation à haute vitesse (20, 40 ou 60 minutes)
G6 - Régulateur de ventilation W8150

Outils nécessaires (non fournis)

- Ruban d'aluminium (UL1818)
- Tournevis standard
- Clé à molette
- Tournevis à tête hexagonale (1/4 po)

Accessoires (non inclus)

- Conduit isolé de 6 po de diamètre
- Conduit de 6 po de diamètre
- Deux hottes anti-intempéries de 6 po

Avertissement : L'installation doit être effectuée par un technicien qualifié et être conforme aux règlements locaux.
Débranchez l'appareil avant de l'installer ou d'en effectuer l'entretien.
Un branchement de l'appareil non conforme aux présentes instructions pourrait entraîner des dommages à l'appareil lui-même ou aux commandes.

INSTRUCTIONS POUR L'INSTALLATION COMMENCENT À LA PAGE 33

ERV/HRV Ventilation System

- Prior to installing, serious consideration must be taken to ensure this ventilation system will operate properly if integrated to any other type of mechanical system, i.e. a forced air system, or an air handling unit. To ensure proper operation and compatibility of both systems, it is required that the unit's airflows (intake and exhaust) be balanced, by following the procedures found in this manual
- Install the unit with space to access the front panel controls and the side access panel for maintenance and service.
- To ensure quiet operation, do not place the device directly on the structural supports of the home.
- The product is for residential applications only. Must be installed in accordance with all national and local regulations, building and safety codes

NEED HELP? For assistance with this product please visit http://yourhome.honeywell.com or call Honeywell Customer Care toll-free at 1-800-468-1502.

Read and save these instructions.

About the ERV/HRV Ventilation System

The Honeywell ERV/HRV Ventilation System provides improved indoor air quality through its high performance and efficiency.

Benefits

- Ventilation with sensible heat recovery (ERV and HRV)
- Ventilation with latent heat recovery (ERV only)
- Simplified mounting (hanging)
- Removable duct collars for easy ducting to the unit
- Intuitive balancing via two variable speed motors and a speed control

CAUTION: Electrical shock and fire hazard. Can cause personal and equipment damage.

- **Before servicing or cleaning the system, always remove the power cord from the AC wall outlet.**
- **Wear protective clothing and safety glasses when installing ventilator and working with sheet metal.**
- **To reduce the hazards of electric shock or fire, do not perform any service to the system other than those stated in the operating manual instructions.**
- **To reduce the risk of electric shock, this ventilation system comes equipped with a 3-prong plug-in. This plug will fit in a polarized outlet only one way.**
- **Do not use ventilation system for outdoor application.**
- **Do not pull or twist power cord when disconnecting it from the ventilation system. Grasp the plug firmly, not the cord.**
- **Do not modify the power plug in any way; if modified, risk of electric shock, fire, or even damage to the unit may occur.**
- **Do not use the ventilation system for removal of flammable fumes, gases or connect directly to any appliances.**
- **Use a 120 VAC outlet only.**
- **Do not use an extension cord.**
- **Do not obstruct or cover the air intake or air outlet of the ventilation system.**
- **Do not modify, repair or disassemble this system. These tasks are to be performed by authorized serviced personnel only. Fire, electrical shock and/or bodily injury may occur if these warnings are not followed.**
- **To prevent injuries, do not operate the ventilation system, while servicing or maintaining. There are impeller wheels turning at a very high speed that must fully stop rotating prior to accessing the inside of the unit.**
- **Always assess how the operation of the ventilation system may interact with vented combustion equipment (i.e. Gas Furnace, Oil Furnace, Combustion, Appliances, etc.)**
- **Ensure unit is properly installed and suspended to prevent falling or dropping injuries.**

Determining Your Ventilation Needs

How much fresh air do you need?

Good air quality is based in part on the capacity of the home's ventilation system. Usually, the unit's capacity is measured in CFM (Cubic Feet per Minute) or L/s (Liters per second) of fresh air being distributed in the living space. Use the ASHRAE 62.2 Ventilation Standard, the Room Count Calculation Method, or the Air Change Per Hour (ACH) Method to determine your ventilation needs.

ASHRAE 62.2 Ventilation Standard

ASHRAE 62.2 CFM Sizing Chart					
Floor Area (ft^2)	**Number of Bedrooms / CFM**				
	0-1	**2-3**	**4-5**	**6-7**	**>7**
< 1500	30	45	60	75	90
1501 - 3000	45	60	75	90	105
3001 - 4500	60	75	90	105	120
4501 - 6000	75	90	105	120	135
6001 - 7500	90	105	120	135	150
> 7500	105	120	135	150	165
ANSI/ASHRAE STANDARD 62.2-2007 - Ventilation Air Requirements; values in cfm					

The above chart outlines the minimum requirements for continuous ventilation.

Room Count Calculation Method

Living Space	**Number of Rooms**	**x CFM (or L/s)**	**=**	**CFM Required**
Master Bedroom		x 20 cfm (or 10 L/s)	=	
Basement		x 20 cfm (or 10 L/s)	=	
Single bedroom		x 10 cfm (or 5 L/s)	=	
Living Room		x 10 cfm (or 5 L/s)	=	
Dining Room		x 10 cfm (or 5 L/s)	=	
Family Room		x 10 cfm (or 5 L/s)	=	
Recreation Room		x 10 cfm (or 5 L/s)	=	
Other		x 10 cfm (or 5 L/s)	=	
Kitchen		x 10 cfm (or 5 L/s)	=	
Bathroom		x 10 cfm (or 5 L/s)	=	
Laundry Room		x 10 cfm (or 5 L/s)	=	
Utility Room		x 10 cfm (or 5 L/s)	=	
		Total Ventilation Requirement	=	

Air Change Per Hour (ACH) Method

TOTAL cubic feet X 0.35 per hour = total cubic feet per hour

Take total and divide by 60 to get cubic feet per minute (CFM)

Example: A 25 ft. x 40 ft. (1,000 sq. ft.) house with basement

1,000 sq. ft. x 8 ft. high x 2 (1st floor + basement) = 16,000 cu. ft.

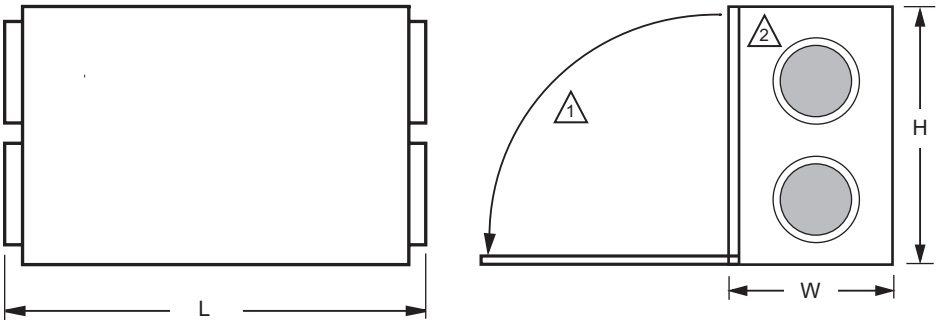
16,000 cu. ft. x 0.35 ACH = 5,600 cubic feet per hour

5,600 cu. ft. / 60 Minutes = 93 cubic feet per minute (CFM)

93 CFM is your ventilation need

Specifications

Dimensions in inches (mm):



1 FRONT CLEARANCE OF 25 INCHES (635 MM) IS REQUIRED FOR SERVICING UNIT.

2 ALL DUCT CONNECTIONS ARE 6 IN. (150 MM).

VNT5150H1000 or VNT5150E1000: H = 22 1/2 in. (572 mm), W = 11 1/2 in. (295 mm), L = 29 1/2 in. (749 mm)
VNT5200H1000 or VNT5200E1000: H = 22 1/2 in. (572 mm), W = 16 1/2 in. (422 mm), L = 29 1/2 in. (749 mm)

M28919

Physical Specifications:

Model	Product Weight	Shipping Weight	Heat/Energy Core Dimensions	Filter Dimensions
VNT5150H1000 VNT5150E1000	42 lbs. (19 kg)	47.5 lbs. (21.55 kg)	H = 12 in. (305 mm) W = 10 in. (254 mm) L = 12 in. (305 mm)	H = 12 in. (305 mm) W = 10 in. (254 mm)
VNT5200H1000 VNT5200E1000	50 lbs. (22.68 kg)	57.5 lbs. (26.08 kg)	H = 12 in. (305 mm) W = 15 in. (381 mm) L = 12 in. (305 mm)	H = 12 in. (305 mm) W = 15 in. (381 mm)

Operating Ranges:

Ambient Temperature: 34 to 135 ºF (1 to 57 ºC)

Humidity: 0-99% RH

Electrical Ratings:

Input Voltage: 120 VAC, 60 Hz

Input Current: 1.5 A

Output Power to Terminals: 5 VDC, 1.0 A maximum

- **Drain tubing diameter:** 1/2 in. (12.7 mm)
- **Flexible Duct (2):** 6 in. round for inlet and outlet. Flexible vinyl, compatible for connection to rigid or flexible ducting with sheet metal screws and/or tape.
- **Cabinet:** 20 gauge galvanized steel

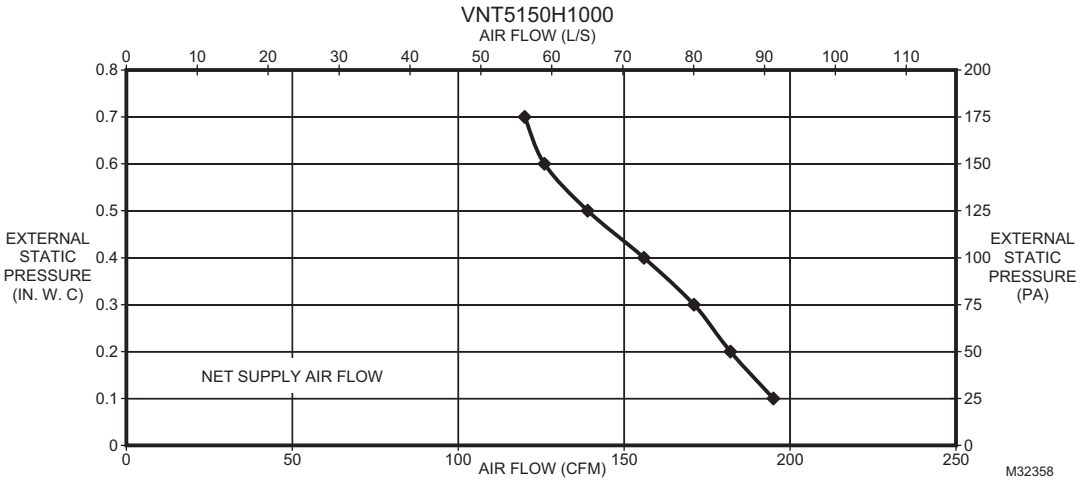
Standards and Certifications:

Install the ERV/HRV Ventilation System according to national and local regulations, building, and safety codes.

Specifications (continued)

VNT5150H1000 Ventilation Performance

External Static Pressure		Net Supply Air Flow		Gross Air Flow			
				Supply		Exhaust	
Pa	in. W.C.	L/s	CFM	L/s	CFM	L/s	CFM
25	0.1	92	195	92	196	113	241
50	0.2	85	182	86	183	105	223
75	0.3	80	171	81	172	91	193
100	0.4	73	156	74	157	84	178
125	0.5	65	139	66	140	75	159
150	0.6	59	126	60	127	65	137
175	0.7	56	120	57	120	57	120
200	0.8	50	107	50	107	48	103
225	0.9	45	95	45	96	40	86
250	1.0	37	79	38	80	34	73



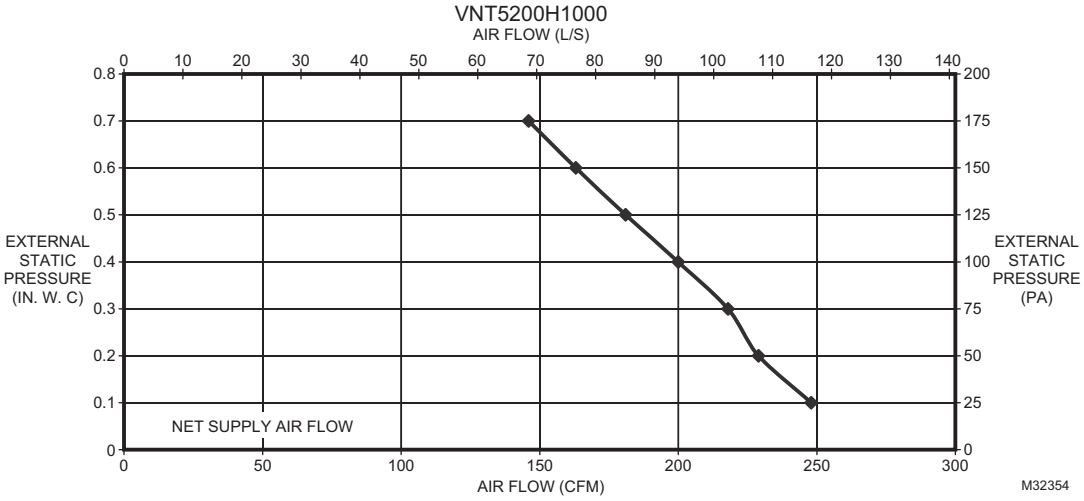
VNT5150H1000 Energy Performance

	Supply Temperature		Net Supply Air Flow		Average Power	Sensible Recovery	Apparent Sensible
	°C	°F	L/s	CFM	Watts	Efficiency %	Effectiveness %
Heating	0	32	31	66	88	66	78
	0	32	42	89	104	64	76
	0	32	56	119	114	63	72
	-25	-13	32	67	86	59	77

Specifications (continued)

VNT5200H1000 Ventilation Performance

External Static Pressure		Net Supply Air Flow		Gross Air Flow			
				Supply		Exhaust	
Pa	in. W.C.	L/s	CFM	L/s	CFM	L/s	CFM
25	0.1	117	248	118	250	130	277
50	0.2	108	229	109	231	119	253
75	0.3	102	218	103	220	110	234
100	0.4	94	200	95	202	101	216
125	0.5	85	181	86	183	92	197
150	0.6	77	163	78	165	82	175
175	0.7	69	146	70	148	71	151
200	0.8	61	129	61	131	60	128
225	0.9	52	110	52	111	49	104
250	1.0	45	96	46	97	40	86



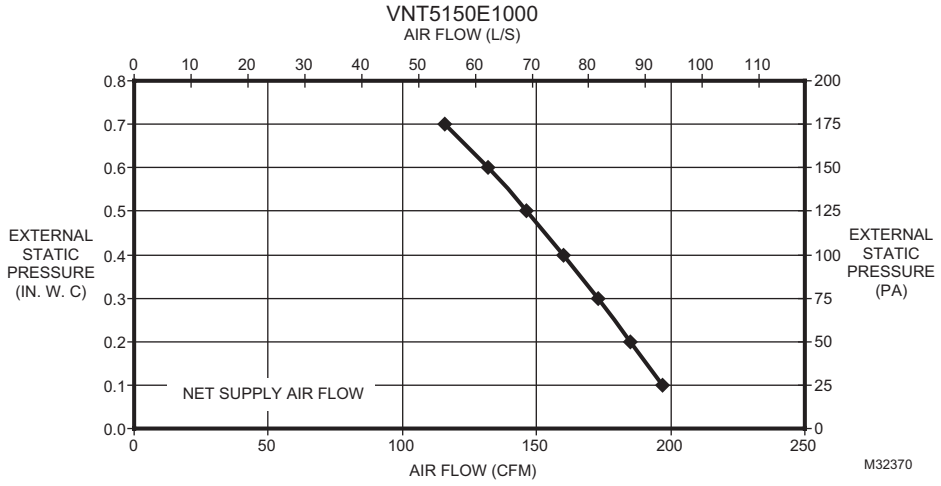
VNT5200H1000 Energy Performance

	Supply Temperature		Net Supply Air Flow		Average Power	Sensible Recovery	Apparent Sensible
	°C	°F	L/s	CFM	Watts	Efficiency %	Effectiveness %
Heating	0	32	55	118	106	61	71
	0	32	75	160	132	58	65
	0	32	87	185	150	55	62
	-25	-13	57	120	105	58	72

Specifications (continued)

VNT5150E1000 Ventilation Performance

External Static Pressure		Net Supply Air Flow		Gross Air Flow			
				Supply		Exhaust	
Pa	in. W.C.	L/s	CFM	L/s	CFM	L/s	CFM
25	0.1	92	197	96	204	93	199
50	0.2	87	185	93	199	88	186
75	0.3	82	173	88	186	82	175
100	0.4	75	160	83	176	76	162
125	0.5	69	146	76	162	70	148
150	0.6	62	132	72	152	63	134
175	0.7	55	116	67	143	55	117
200	0.8	48	102	60	127	48	103
225	0.9	41	88	54	114	42	89
250	1.0	38	81	42	89	39	82



VNT5150E1000 Energy Performance

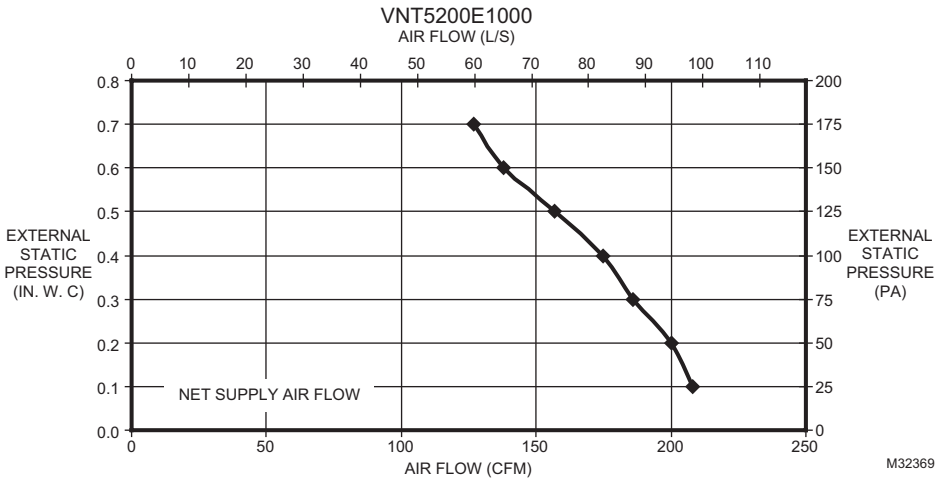
	Supply Temperature		Net Supply Air Flow		Average Power	Sensible Recovery	Apparent Sensible
	°C	°F	L/s	CFM	Watts	Efficiency %	Effectiveness %
Heating	0	32	30	64	75	52	67
	0	32	45	96	100	44	64
	0	32	55	117	126	40	62
	-15	5	30	64	80	52	67
	35	95	30	64	75		

Total Recovery Efficiency = 49%

Specifications (continued)

VNT5200E1000 Ventilation Performance

External Static Pressure		Net Supply Air Flow		Gross Air Flow			
				Supply		Exhaust	
Pa	in. W.C.	L/s	CFM	L/s	CFM	L/s	CFM
25	0.1	98	208	102	218	99	210
50	0.2	94	200	99	210	95	202
75	0.3	87	186	93	199	88	188
100	0.4	82	175	88	188	83	176
125	0.5	74	157	78	167	75	159
150	0.6	65	138	72	152	65	139
175	0.7	60	127	64	135	60	128
200	0.8	53	112	60	127	53	113
225	0.9	44	94	54	114	45	95
250	1	38	81	41	86	39	82



VNT5200E1000 Energy Performance

	Supply Temperature		Net Supply Air Flow		Average Power	Sensible Recovery	Apparent Sensible
	°C	°F	L/s	CFM	Watts	Efficiency %	Effectiveness %
Heating	0	32	35	74	75	58	69
	0	32	50	106	100	51	66
	0	32	70	149	126	44	64
	-15	5	35	74	80	58	69
	35	95	35	74	75		

Total Recovery Efficiency = 53%

External Control Options

The ERV/HRV unit may be used with one of the following external controls:

Prestige™ (YTHX9321R5012) and Prestige™ IAQ Comfort System (YTHX9421R5028)

- Controls both heating/cooling and ventilation.
- Wireless sensor for displaying outdoor temperature and humidity.
- Advanced ventilation programming includes economizing and extreme condition shutdown.
- Maintenance and service reminders.
- High definition color display.

VisionPRO (TH8321U1097)and VisionPRO IAQ Total Comfort System (YTH9421C1010)

- Controls both heating/cooling and ventilation.
- Sensor included for displaying outdoor temperature.
- Intuitive user interface for easy 7-day temperature programming.
- Easy-to-read backlit digital display.
- Maintenance and service reminders.
- Controls other indoor air quality equipment.

TrueIAQ Digital Control (DG115EZIAQ)

- Automatic adjustments maintain fresh air in home.
- Sensor for displaying outdoor temperature and humidity.
- Advanced ventilation programming includes economizing and extreme condition shutdown.
- Maintenance and service reminders.
- Controls other indoor air quality equipment.

Manual Dehumidistat (H8908DSPST) and Automatic Ventilation Controls (W8150A1000)

- Manual humidity control with intuitive comfort settings.
- Automatic W8150 ventilation control to ASHRAE standard, or for continuous operation.

Boost Control Digital Timer (50053952-020)

- Ventilation boost control for 20/40/60 minutes.

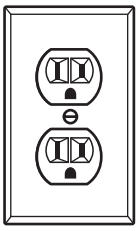
Install to Fit Your Application

NOTE: Prior to installing, serious consideration must be taken to insure this ventilation system will operate properly if integrated with any other type of mechanical system, i.e. a forced air system, or an air handling unit. To insure proper operation & compatibilities of both system, it is required that the airflows of ventilation systems be balanced, by following the procedures found in this manual.

Limitations: The product is for residential applications only. Must be installed in accordance with all national and local regulations, building and safety codes. Flex duct is recommended for connecting to the ERV/HRV collars to reduce vibration noise.

Electrical Requirements:

120 VAC outlet. Ground fault interrupter (GFI) and dedicated circuit recommended.



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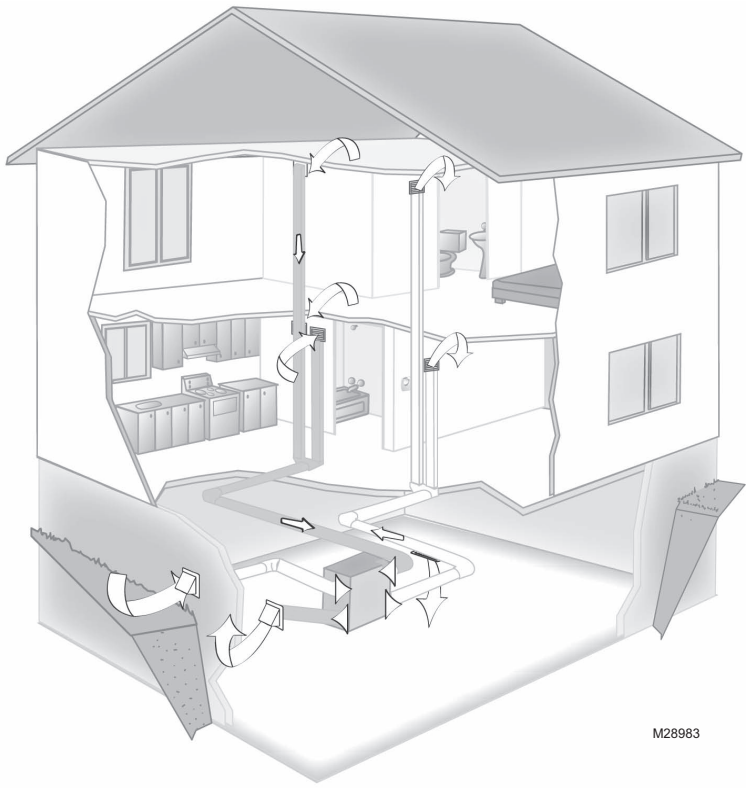


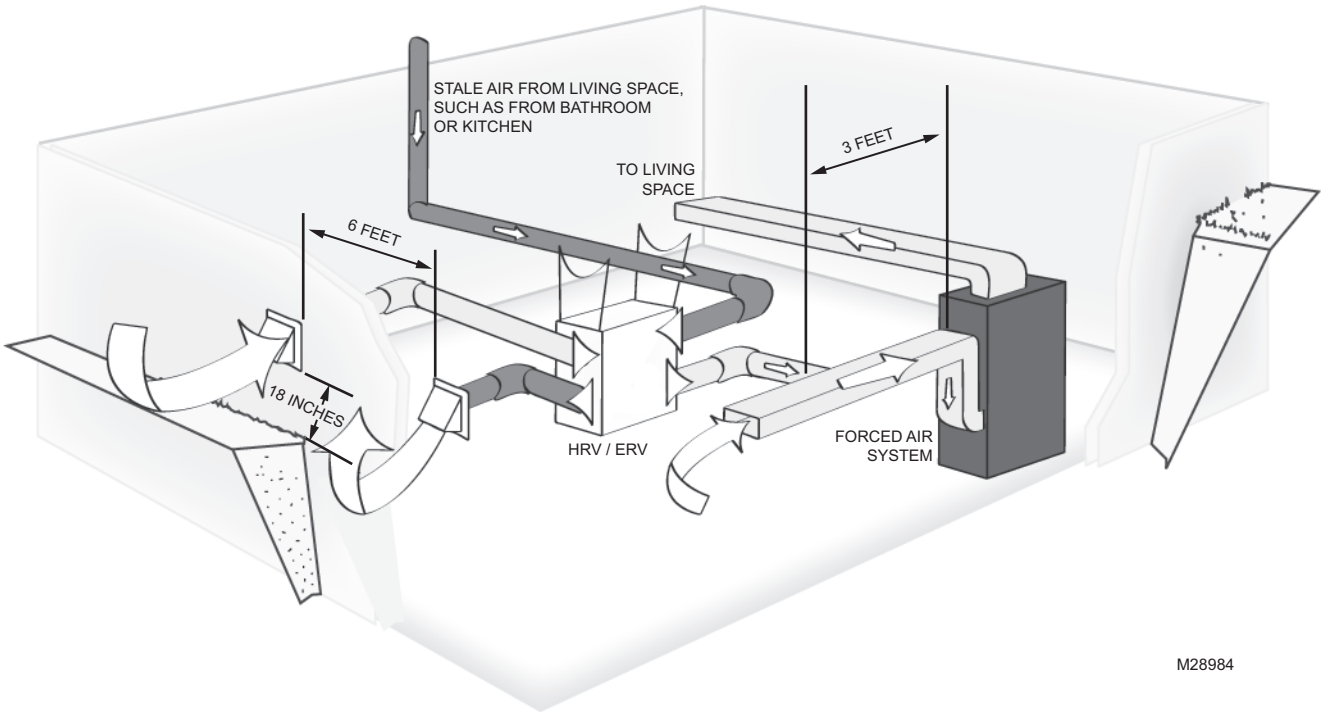
M28983

This application uses a devoted duct system for the supply and the exhausting of stale air accumulated in the home.

Honeywell recommends installing fresh air grilles in all bedrooms and living areas and to exhaust the stale air from the bathroom, kitchen, and laundry room.

Install to Fit Your Application (continued)

B Exhaust at the Source and Supply in the Return



This application uses a devoted duct system for the exhausting of stale air accumulated in the home. The fresh air is introduced into the return air duct and is distributed through the home by the existing supply air ductwork of the forced air system.

Make sure when using this application that your fresh air duct connection to the forced air system return air duct is at least 3 feet from the forced air system. You should check with your local code or the forced air system's manufacturer.

The forced air system's blower does not have to run when the unit is operating, but is recommended for maximum effectiveness.

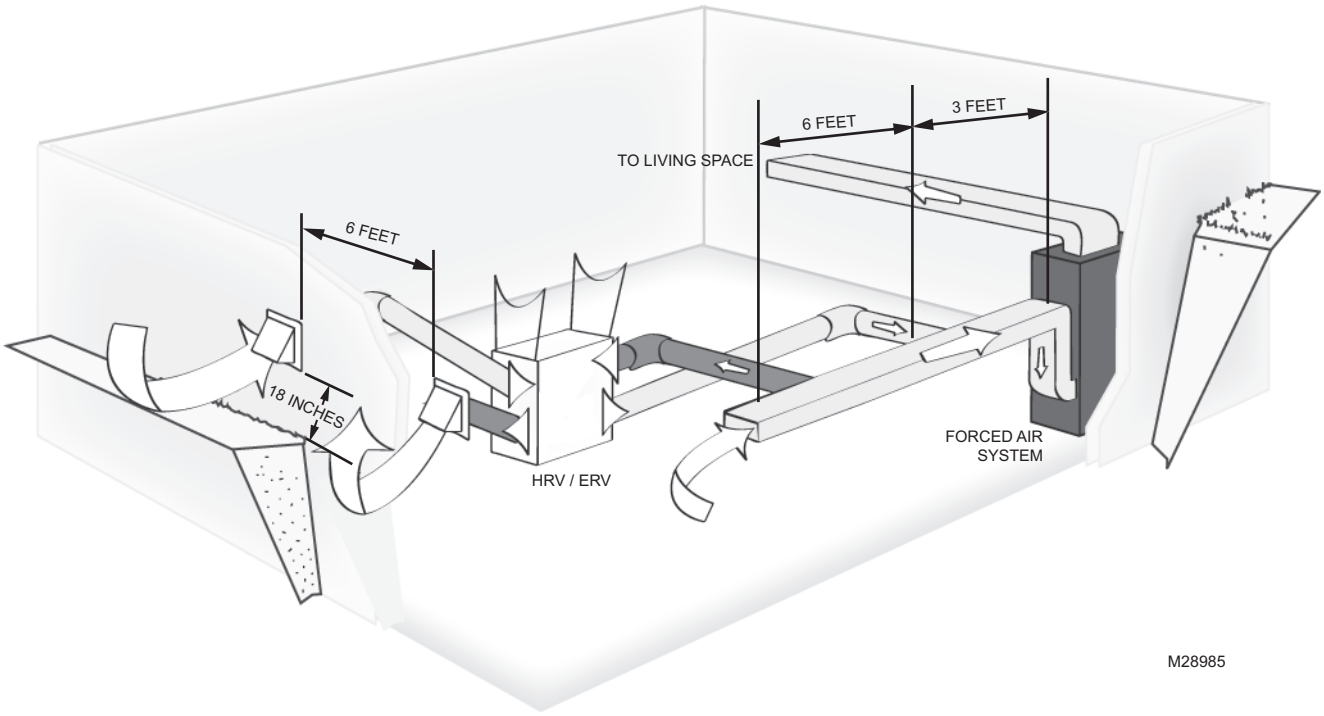
NOTE: For the minimum distance between the fresh air connection and the forced air system, check with your local building codes and forced air system manufacturer.

NOTE: For dwellings with multiple forced air systems, Honeywell recommends one ERV/HRV unit per system.

NOTE: Refer to the Wiring section (beginning on page 18) for instructions to connect the unit to operate the forced air system with the ERV/HRV unit.

Install to Fit Your Application (continued)

C Exhaust and Supply in the Return



When using this application make sure that there is a minimum of 6 feet between the fresh air and exhaust air connections of the ERV/HRV unit in the return air duct. Supply air from the ERV/HRV unit must be at least 3 feet from the forced air system. These distances can be different from one region to another; you should check with your local code or the forced air system's manufacturer.

NOTE: For minimum distance between return and forced air system, check with your local building codes and forced air system manufacturer.

NOTE: Fresh air must always be down-stream from the exhaust air in the return air duct of the forced air system.

NOTE: Furnace blower is required to operate when ventilation is required. Set the furnace blower to run continuously, or interlock electrically (low voltage).

Installation Steps

1 Installation Kit

Ensure that you have all of the following installation items:

4 Duct Collars

Installation Kit:

- 2 Flexible 6 in. Vinyl Ducts
- 1 Condensation Drain Line (10 in.)
- 1 Drain Adapter with Nut
- 4 Tie Wraps (30 in.)
- 16 Hex-head screws (1/4 x 5/8 in.)
- 4 Hex-head screws (1/4 x 1 in.)
- 4 Washers
- 1 Drain cap (VNT5250E100 and VNT5200E1000 only)
- 1 power cord, 120 Vac (not shown)

2 Installation Area

The ERV/HRV unit should be installed in a mechanical room or as close to an outside wall as possible.

The ERV/HRV unit must always be installed in an area where the air is conditioned to avoid freezing the condensate line.

The contractor should install the unit in an area that allows the homeowner easy access for maintenance. It is very important to install an electric receptacle (120 Vac) near the unit, a separate circuit breaker is also recommended. It is best to have access to a condensate drain near the ERV/HRV unit to avoid having to use a condensate pump.

NOTE: Installation is not recommended in unconditioned areas such as an attic or crawl space where the temperature can fall below 32 °F (0 °C).

NOTE: Ducting in unconditioned areas must be fully sealed and insulated.

Installation Steps (continued)

3 Hanging the ERV/HRV

The ERV/HRV unit enables you to save time and effort by offering a simplified hanging system.

TIP: Removing the core unit makes installation easier since the unit weighs less without the core inside.

1. Attach straps to joist using the supplied washers and four 1 in. hex-head hanging screws.

2. Pull on middle of strap while gently lifting unit upward to raise the unit.

3. Make final adjustments to ensure that the HRV/ERV is level.

NOTE: If the unit is not level, improper drainage will occur and could lead to moisture and leakage problems.

Installation Steps (continued)

4 Installing the flex duct to the ERV/HRV

TIP: Honeywell recommends using approximately 16 inches of flexible duct (supplied in kit) between the unit and the rigid duct for noise dampening. The flex duct is mounted to the unit the same way as the insulated flex.

1. Insert the vinyl duct over the hooks on the duct collar and seal with a supplied 30 inch tie wrap.

2. Insert insulation inside the outer ring of the duct collar.

3. Finish by taping the duct on the collar.

4. Slide collar onto unit.

5. Secure collar with the supplied 5/8 in. hex-head screws.

IMPORTANT: Always fix and secure each collar using four of the 5/8 in. screws supplied. This step is critical in order to prevent condensation accumulation.

TIP: Attach the flex duct to the collar first, and then attach the collar to the unit.

Installation Steps (continued)

5 Installing the condensation drain line

Insert the threaded drain adapter through the bottom of the unit and hand tighten the plastic nut supplied with the drain kit.

Use a wrench to tighten the nut another half turn to ensure a complete seal.

Install the condensate tubing by pushing the clear plastic tubing over the drain adapter.

Make a condensate trap by looping the clear plastic tubing. This loop will prevent foul odors from entering the unit.

Use a condensate pump if you don't have access to the floor drain.

Drainless Application

NOTE: If installing an ERV unit (VNT5150E1000 or VNT5200E1000) in a region where the outdoor temperature does not drop below freezing, the condensate drain line does not need to be installed and the unit may be installed as a drainless application.

1. Insert the threaded drain adapter through the bottom of the ERV with the drain connection inside of the unit as shown in the figure.
2. Fit the rubber washer over the drain adapter and then attach the plastic nut.
3. Hand tighten the plastic nut supplied with the drain kit.
4. Use a wrench to tighten the nut another half turn to ensure a complete seal.
5. Attach the drain cap to the drain adapter inside the unit.

Installation Steps (continued)

6 Connecting the power cord

ERV/HRV Power Cord

Insert the power cord on top of the unit. Press firmly to make sure the power cord is secure.

IMPORTANT: Do not plug the power cord into the wall receptacle at this time.

Electric Wall Outlet

Honeywell recommends that the unit has a dedicated receptacle with 120 VAC.

Avoid connecting the unit to the wall receptacle with an extension cord.
Honeywell does not recommend the use of an extension cord.

Ensure that the receptacle's polarization is correct.

NOTE: If the LED light on the ERV/HRV control panel remains green, the motors do not energize, and the controls do not operate; this can indicate that the polarization in the main AC outlet is inverted.

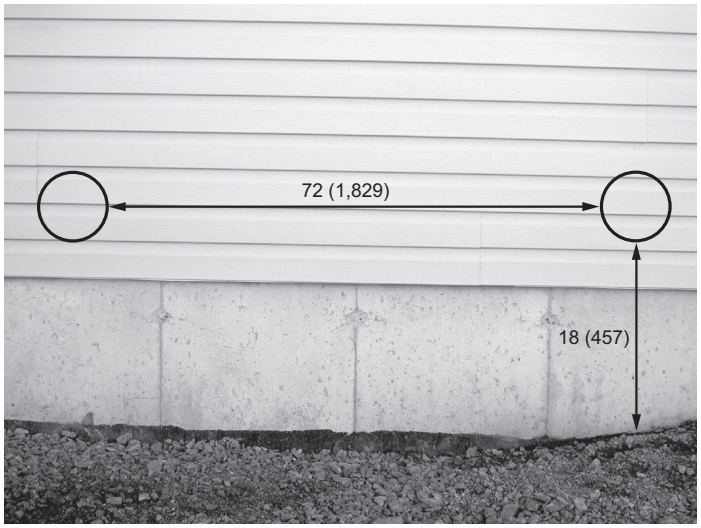
IMPORTANT: Always consult a qualified technician to ensure proper installation of main power.

7 Installing outside hoods for the fresh air and the exhaust

Locate the outside hoods at least 18 inches (0.46 m) above grade and at least 72 inches (1.83 m) apart.

NOTE: Do not locate the fresh air vent hood close to known sources of pollutants such as dryer vents.

IMPORTANT: Always consult your local code for spacing requirements in your area.



M32372

Automated Defrost

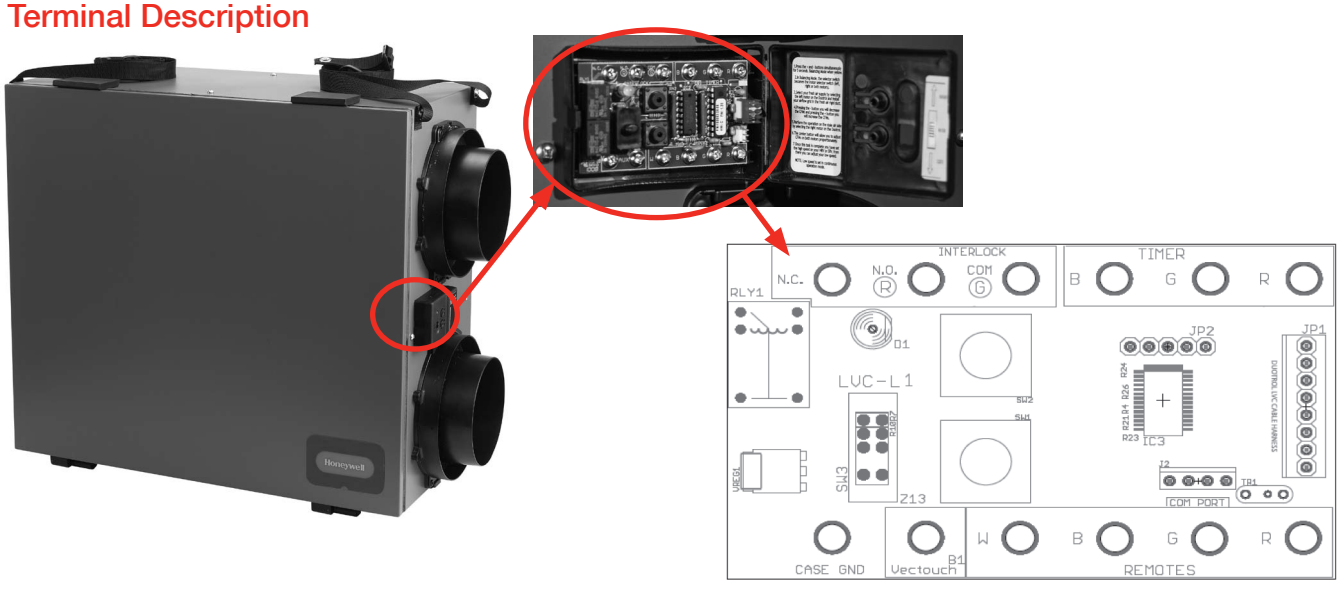
The ERV and HRV units are equipped with an automatic defrost feature to eliminate any ice build up on the core.

- Automatic defrost is initiated once every hour when the fresh air supply temperature drops to 23°F (-5°C) or colder.
- The defrost cycle operates by turning off the supply fan while continuing to operate the exhaust fan.
- The exhaust fan speed is adjusted proportionally based on the outdoor temperature, initially operating at low speed.
- As the outdoor temperature continues to drop, the exhaust fan speed will increase, and will operate at maximum speed when the outdoor temperature is -4°F (-20°C) or less.
- Defrost cycle runs for 4 minutes with the supply fan off, followed by 40 minutes of continuous normal operation.
- Defrost cycles will continue to repeat as long as the temperature is 23°F (-5°C) or less.

Wiring

CAUTION: Voltage hazard.
Can cause equipment damage.
Disconnect power from the unit before beginning installation.

Terminal Description



M28986

The wiring terminal block is located behind the control module door on the side of the unit.

To access the terminal block, open the control panel door by swinging it open and to the right as shown above.

Wiring (continued)

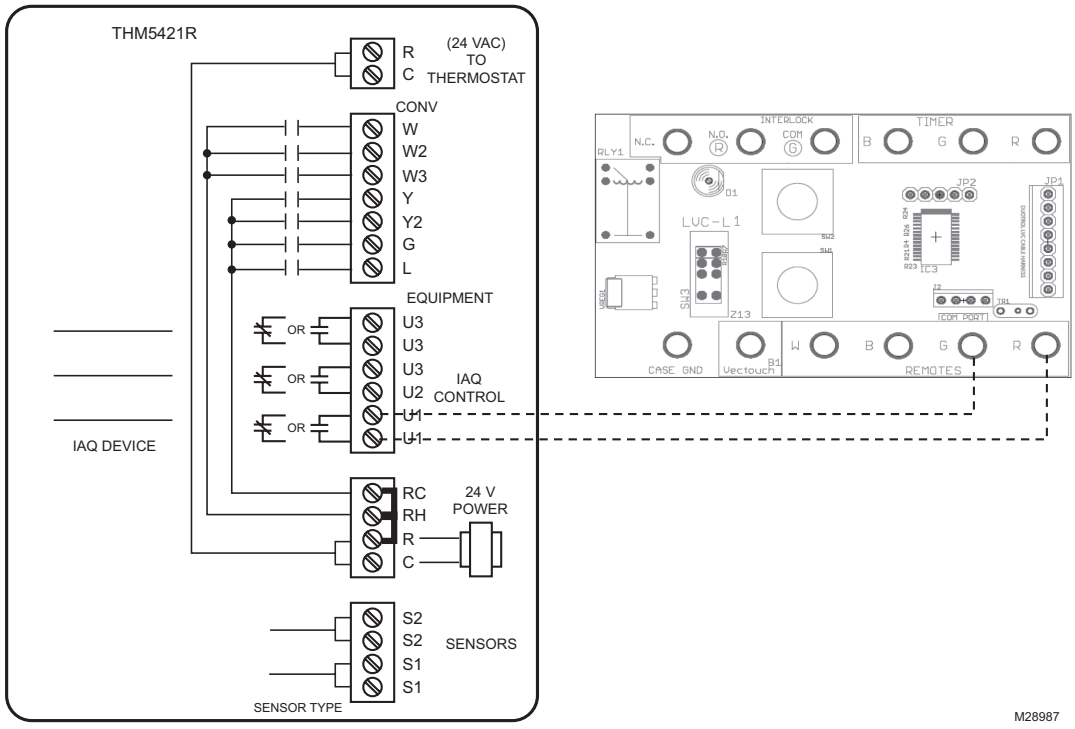
Wiring with Remote Controls

CONT mode - Ventilator runs continuously on low speed. A ventilation call from a control boosts the ventilator into high speed.

INT mode - The ventilator is OFF until a ventilation call from a wall control turns it on in high speed..

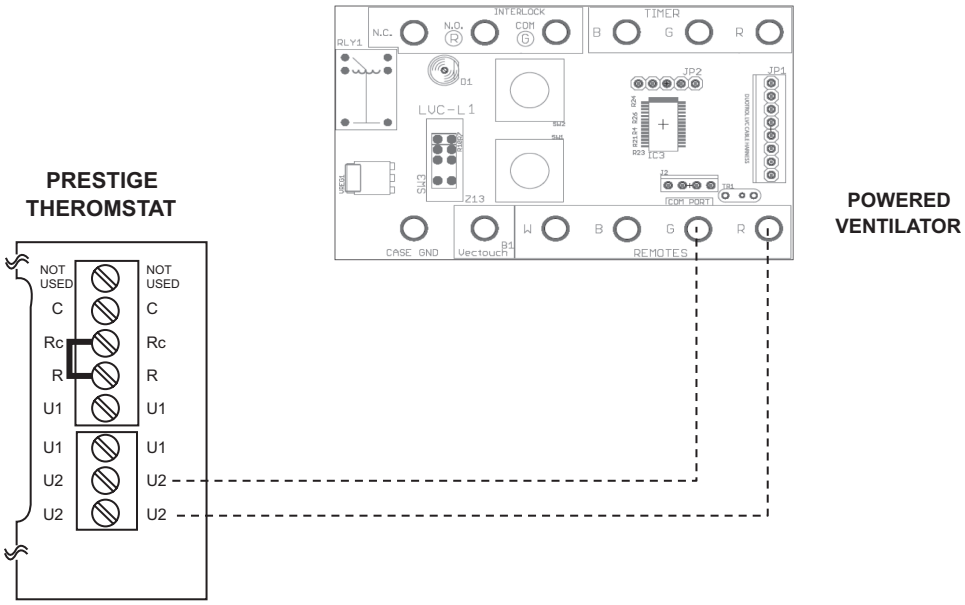
Controls Wiring

Follow this diagram if using a Prestige™ 2-wire IAQ and RF EIM.



Wiring (continued)

Follow this diagram if using a Prestige™ Thermostat (Interlock not shown).

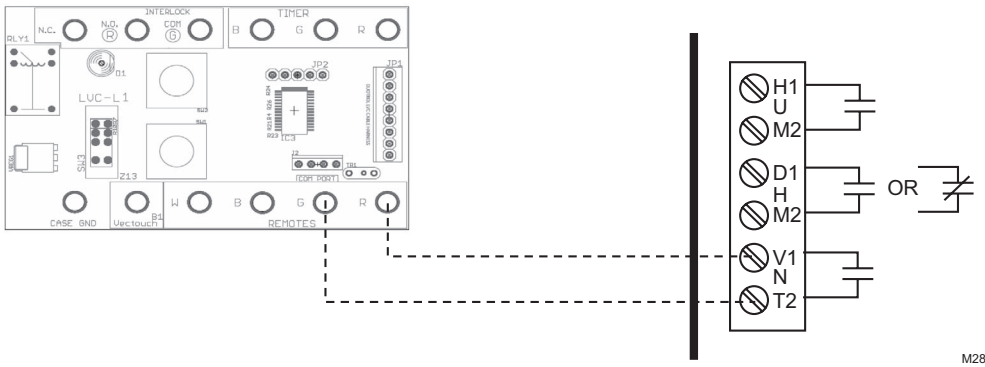


U1/U1 Configurable IAQ relay for humidifier, dehumidifier, or vent
U2/U2 Configurable IAQ relay for humidifier, dehumidifier, or vent

M28988

Follow this diagram if using a VisionPRO IAQ.

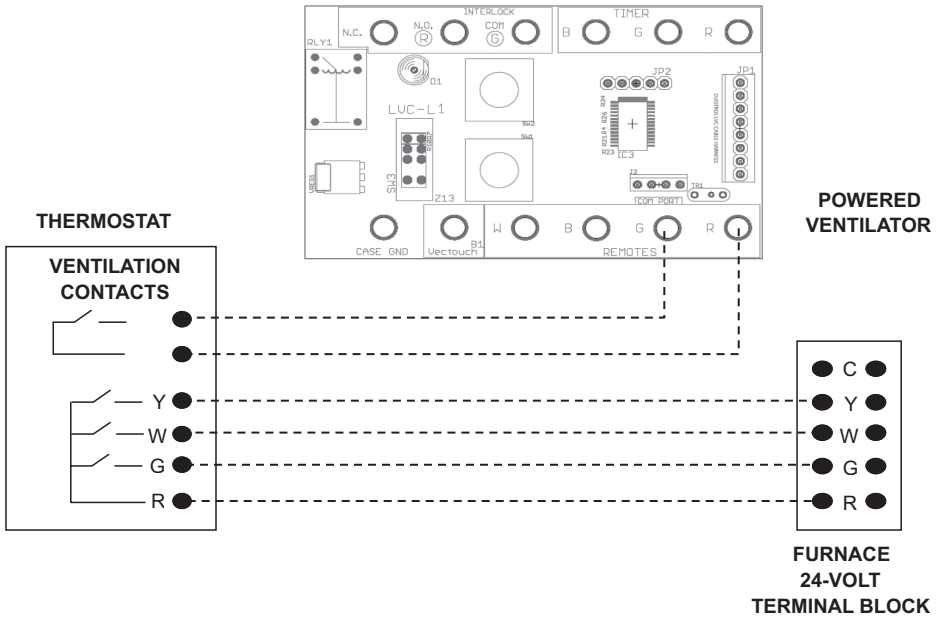
VisionPRO IAQ Equipment Interface Module



M28989

Wiring (continued)

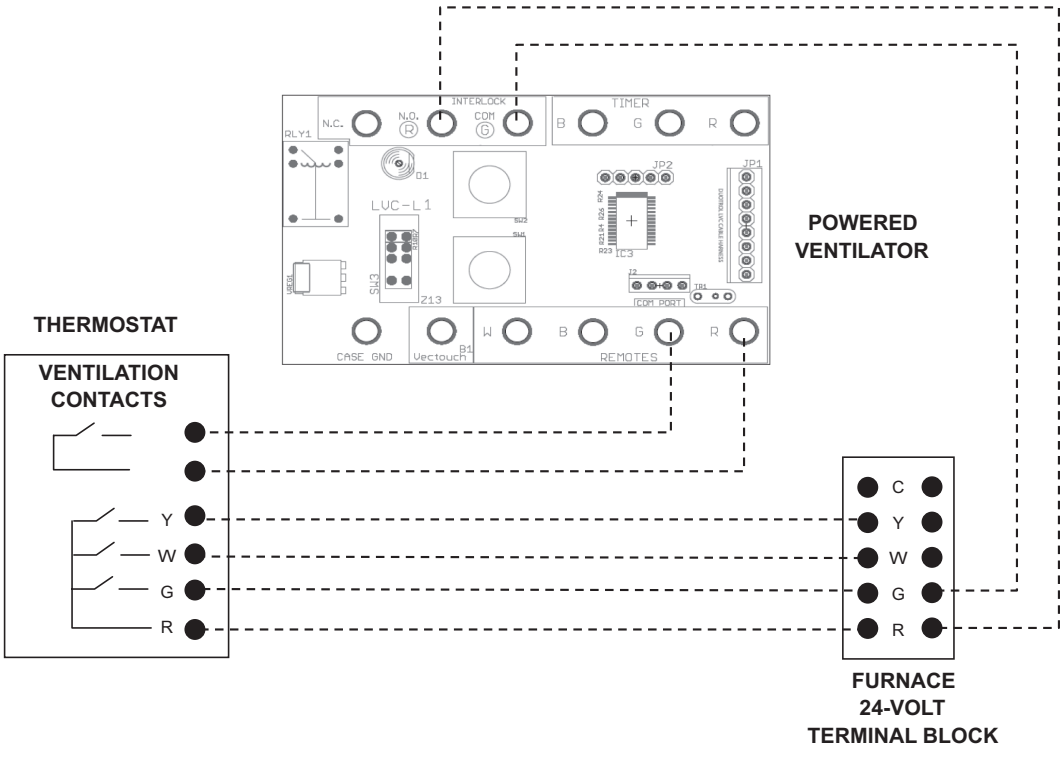
Follow this diagram for General Ventilator Wiring



M28990

ERV/HRV is used in conjunction with a conventional HEAT/COOL thermostat or other wall control.

Follow this diagram for Standard Furnace Interlock Wiring with Forced Air System

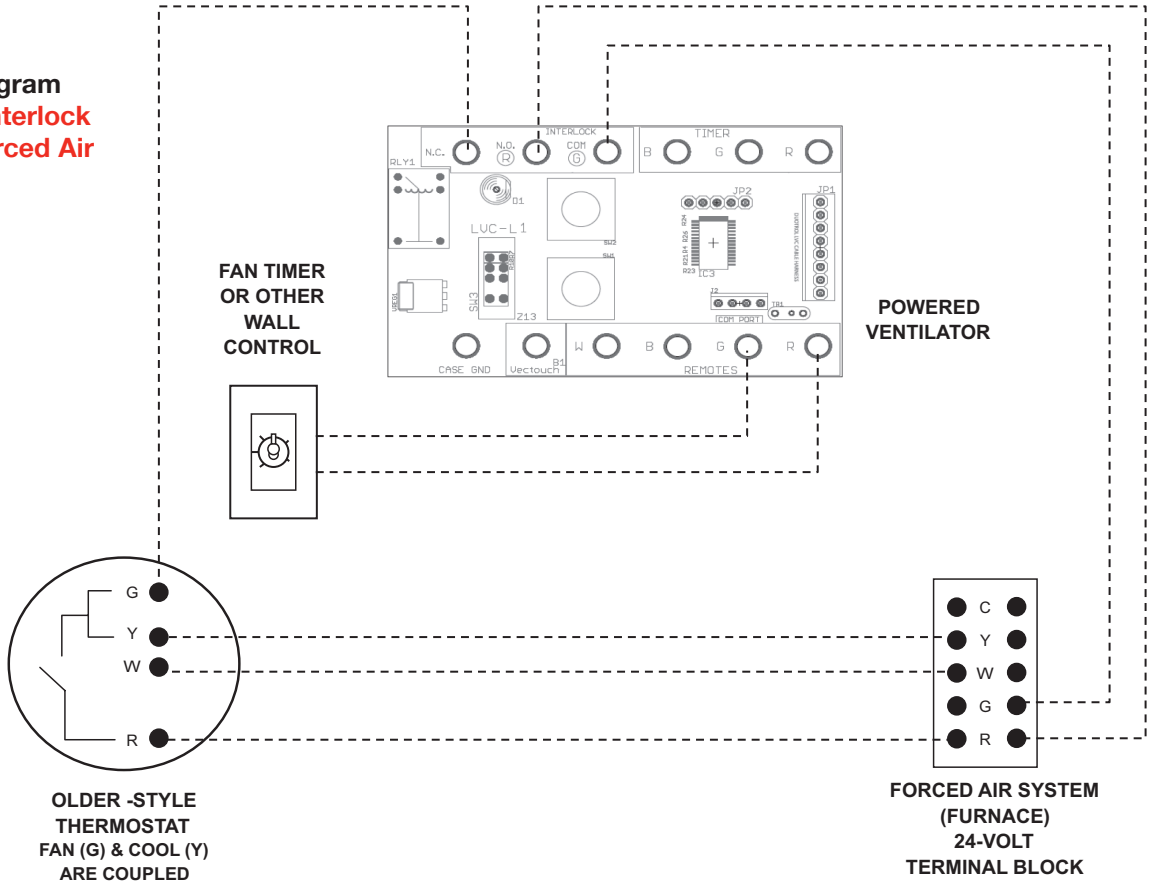


M28991

ERV/HRV is interlocked with the forced air system and is used in conjunction with a conventional HEAT/COOL thermostat with ventilation contacts (could use a different wall control for ventilator).

Wiring (continued)

Follow this diagram for Alternate Interlock Wiring with Forced Air System

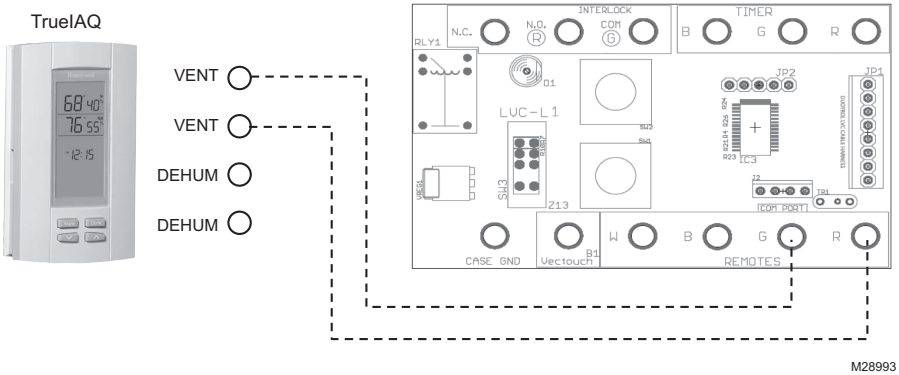


The ERV/HRV is interlocked with the forced air system and is used in conjunction with older-style thermostats where the G and Y terminals are coupled together in the thermostat (fan and cool are simultaneously energized).

This wiring method will prevent turning on the cooling system when the ventilator turns on the furnace fan.

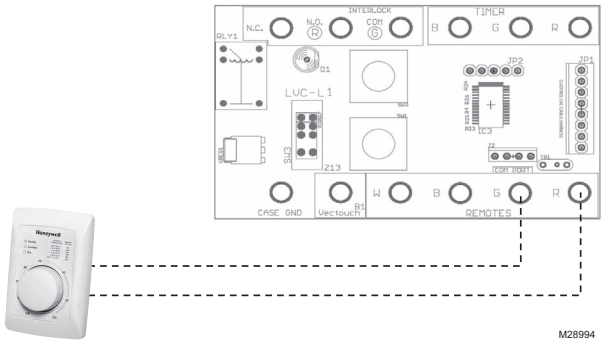
NOTE: Only use this wiring method for systems where G and Y are coupled at the thermostat.

Follow this diagram if using a TrueIAQ (DG115EZIQ).

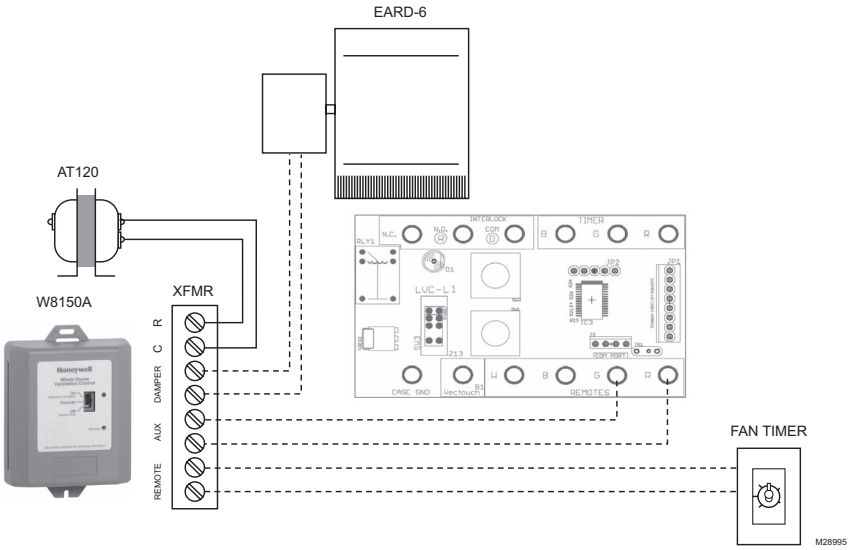


Wiring (continued)

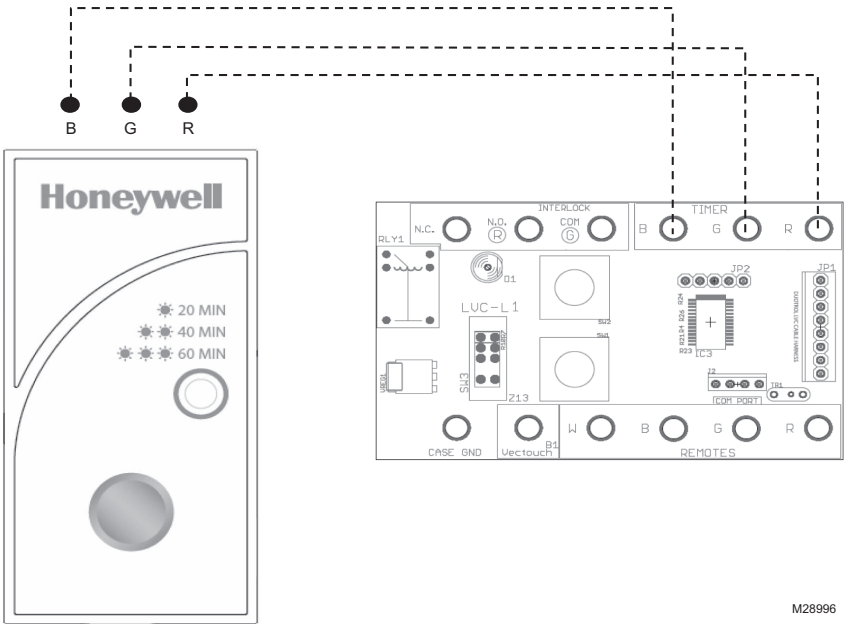
Follow this diagram if using a Dehumidistat.



Follow this diagram if using a W8150 Ventilation Control



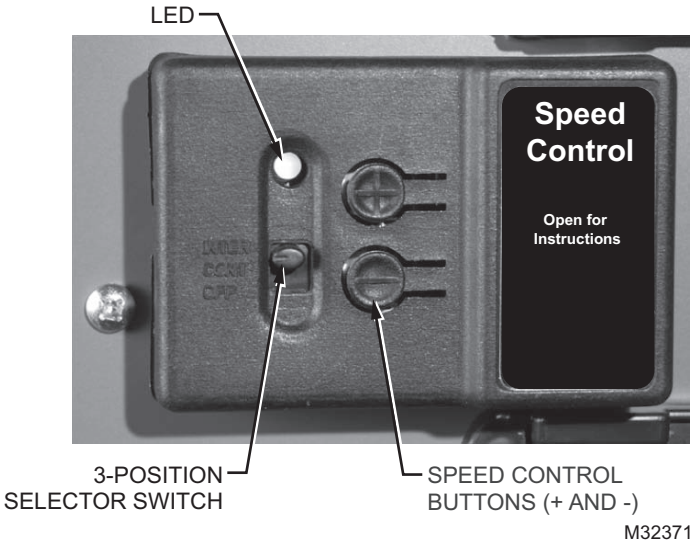
Follow this diagram if using the Honeywell 20/40/60 Minute Boost Control Timer.



Control Panel

The control panel has a 3-position selector switch and “+” and “–” buttons for speed control. The color of the LED indicator indicates the current function of the selector switch.

- GREEN LED = Mode Control (normal operating mode)
- YELLOW LED = Balancing Control



Speed Control used as a Mode Control

When the LED indicator is green, the selector switch functions as a Mode Selector. The selections are:

- **INTER (Intermittent):** When the selector switch is in the intermittent position the unit will run only when there is a call for ventilation by any external control. At that time the unit will run on high speed until the condition is satisfied.
- **CONT (Continuous):** When the selector switch is in the continuous position the unit will run continuously on low speed except when there is a call for override by any control.
- **OFF:** When the selector switch is in the off position the unit will not operate even when there’s a call for ventilation by an external control.
- **(+) and (–) buttons:** Used to adjust the continous speed setting.

Speed Control used as a Balancing Control

In balancing mode the LED indicator is yellow, and the selector switch functions as a Balancing Control to set the high speed of the motors for balancing purposes (Fresh air, Exhaust air, and Both motors). The selections are:.

- **INTER:** Selects the exhaust air motor.
- **CONT:** Selects both exhaust and fresh air motors.
- **OFF:** Selects the fresh air motor.

NOTE: Continuous low speed is 50% of the set high speed.

NOTE: See Balancing Steps on page 25.

Speed Control used as a Motor Control

- **+ Button:** Increase the speed of the selected motor.
- **– Button:** Decrease the speed of the selected motor.

NOTE: See Balancing Steps on page 25.

Balancing Steps

NOTE: Perform the balancing steps with the HVAC equipment fan turned ON if the ERV/HRV unit is ducted into an HVAC system.

1

a. Ensure that the speed control selector switch is in either the INTER or CONT position.

b. Press the (+) and (–) buttons simultaneously for 5 seconds until the LED indicator light turns yellow, which indicates that you are in balancing mode.

When in balancing mode, the selector switch becomes the motor selector switch. The switch positions become: INTER = Right motor (exhaust air), CONT = Both motors, and OFF = Left motor (fresh air).

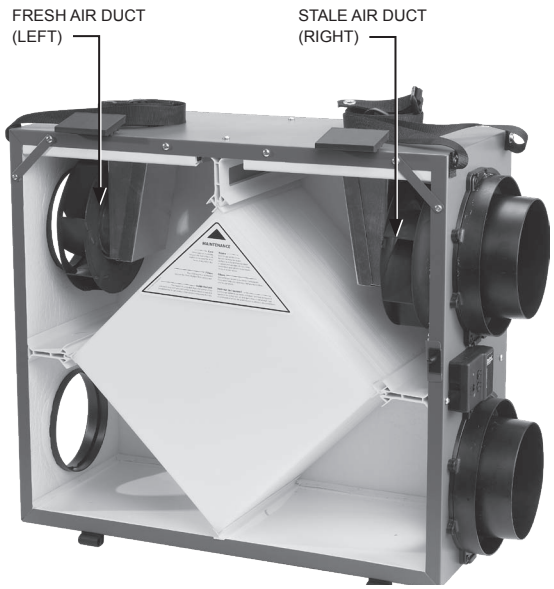
2

a. Use a pitot tube or flow station to measure the air flow in the fresh air duct and exhaust air duct.

b. Move the mode selector switch to adjust the air flow in the duct with the higher reading.
INTER: Exhaust air (right)
OFF: Fresh air (left)

c. Press the (+) or (–) buttons to adjust the air flow to the desired high speed setting.

d. Move the mode selector switch to the CONT position (to proportionally adjust the speed of both motors at the same time.

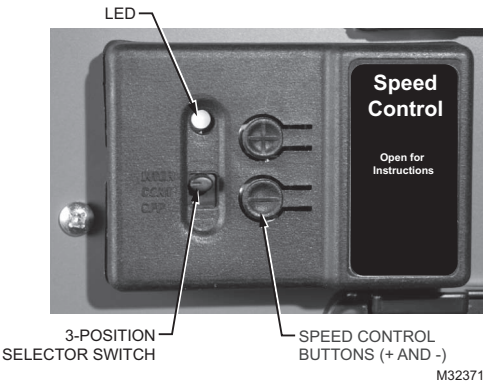


3

a. Press the (+) and (–) buttons simultaneously to exit balancing mode .

b. Indicator light turns green.

c. Continuous speed will be 50% of measured CFM.

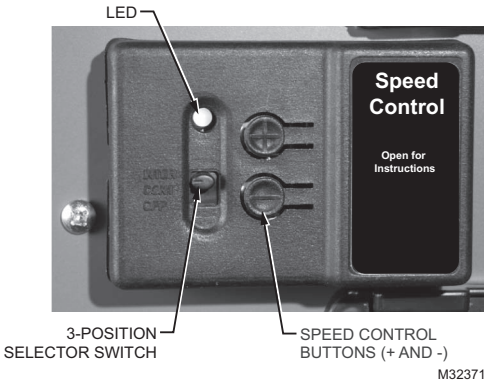


Balancing Reset

NOTE: Once balancing is completed, balancing cannot be changed without resetting the unit.

To reset:

1. Press the (+) and (–) buttons simultaneously for 10 seconds.
2. Indicator light will turn yellow at 5 seconds.
3. Indicator light will turn green at 10 seconds.
4. Release both buttons.
5. Unit has been reset and can be put into balancing mode again.



Checkout

- Apply power to the unit. Move the selector switch to the CONT position to verify that the unit turns on in continuous speed.
- Initiate a ventilation call from each of the external controls. Verify that the ERV/HRV unit turns on in high speed.
- Return the selector switch to the desired position and the external controls to the desired settings.
- Inspect the ducting to ensure that there are no kinks and correct as necessary.

Maintenance

Quarterly or as Needed

1. **Filters.**
   Four times per year or as needed, vacuum the filters. Replace filters as needed.

Annually or as Needed

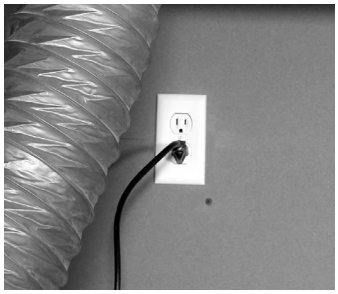
1. **Inside the Unit.**
   Once a year or as needed, clean the interior of the unit (walls and drain pan) with a mild and non abrasive soap. It is recommended to use products that are environmentally-friendly.

2. **Energy Recovery Core Unit (VNT5150E1000 and VNT5200E1000)**
   Once a year or as needed, vacuum the four surfaces, let soak in warm water and mild soap for 15 minutes, then spray rinse and let dry.

3. **Heat Recovery Core Unit (VNT5150H1000 and VNT5200H1000)**
   Once a year or as needed, vacuum the four surfaces, let soak in warm water and mild soap for 15 minutes, then spray rinse and let dry.

NOTE: See Cleaning Steps on page 28 for the above maintenance items.

Cleaning Steps



1. Disconnect the AC power from the unit or the wall.

2. Open the side door panel by opening the two latches on the top of the side panel and lowering the panel to its fully open position Remove both filters from the top left and right sides of the Core, then vacuum both filters.
   Slide out the Core, and clean according to the instructions on the previous page.

3. Clean inside of unit with a damp cloth and wipe dry when finished.

4. Replace the Core and the two filters, re-latch the side panel, then reconnect the AC power to the unit.

Troubleshooting

CAUTION: Servicing the ERV/HRV unit with its electrical circuitry can cause personal injury. Always make sure that power to the unit is disconnected prior to making any connections. Failure to disconnect the power could result in electrical shock. Service should only be performed by a qualified service technician.

Problem	Recommended Troubleshooting Steps
ERV/HRV unit not running	1. Verify polarization of electrical receptacle. 2. Verify breaker in electrical box. 3. Verify that the external control or mode selector are activated to call for ventilation. 4. Unplug the unit and verify that the external control(s) are wired correctly to the wiring terminal block.
Air is too dry	1. Increase humidity level on the dehumidistat. 2. Switch ventilation mode from continuous to intermittent. 3. Install a humidifier.
Air too humid	1. Reduce the humidity level on the controller. 2. Make sure that the clothes dryer is vented to the outdoors. 3. Wait for outside temperature to change. For example, it can be very humid at times in the summer. 4. Verify balancing of the ERV/HRV unit (see Balancing Steps on page 25).
LED on control panel remains green	If the LED light on the ERV/HRV control panel remains green, the motors do not energize, and the controls do not operate. This can indicate that the Polarization in the main AC outlet is inverted

Honeywell OS and Parts List

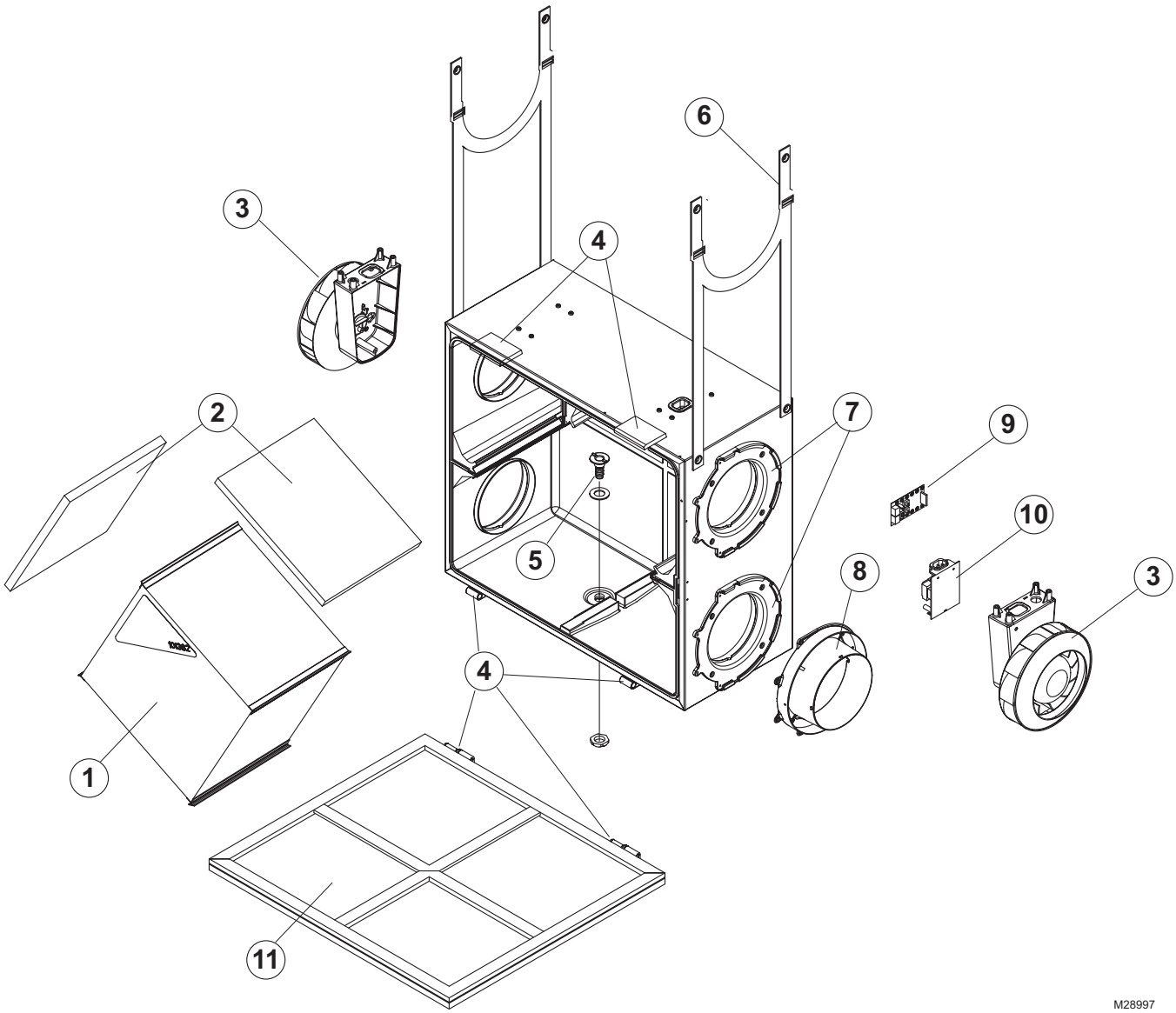
Honeywell OS List		
Honeywell OS Number	**Controls**	**Ventilator Type**
VNT5150H1000	No	HRV
VNT5150E1000	No	ERV
VNT5200H1000	No	HRV
VNT5200E1000	No	ERV

Parts List (see illustration on page 31 for figure number references)		
Figure Number	**Honeywell Part Number**	**Description**
1	50053952-001	Polypropylene 10" HRV Core - VNT5150H1000
	50053952-002	Polypropylene 15" HRV Core - VNT5200H1000
	50053952-003	Enthalpy 10" ERV Core - VNT5150E1000
	50053952-004	Enthalpy 15" ERV Core - VNT5200E1000
2	50053952-005	Replacement Filter Kit VNT5150 (Kit quantity 2)
	50053952-006	Replacement Filter Kit VNT5200 (Kit quantity 2)
3	50053952-010	Replacement Motor
4	50053952-014	Latch & Hinge Kit
5	50053952-011	Condensation Drain Fitting Kit
6	50053952-009	Adjustable Hanging Straps (set)
7	50053952-008	6" diameter Plastic Keeper
8	50053952-007	6" diameter Plastic Double Collar
9	50053952-012	Replacement LVC electronic board (speed control)
10	50053952-013	Replacement HVC electronic board
11	50053952-015	Front Access Door

Parts List (not illustrated)	
Honeywell Part Number	**Description**
50053952-016	Drain Cap (VNT5150E100 and VNT5200E1000 only)
50053952-020	20/40/60 Minute Timer

Parts Illustration

See the Parts List table on page 30 for items referenced by figure numbers 1 through 11 in the exploded illustration below.



5-Year Limited Warranty

Honeywell warrants this product to be free from defects in the workmanship or materials, under normal use and service, for a period of five (5) years from the date of purchase by the consumer. If at any time during the warranty period the product is determined to be defective or malfunctions, Honeywell shall repair or replace it (at Honeywell's option).

If the product is defective,

(i) return it, with a bill of sale or other dated proof of purchase, to the place from which you purchased it; or

(ii) call Honeywell Customer Care at 1-800-468-1502. Customer Care will make the determination whether the product should be returned to the following address: Honeywell Return Goods, Dock 4 MN10-3860, 1885 Douglas Dr. N., Golden Valley, MN 55422, or whether a replacement product can be sent to you.

This warranty does not cover removal or reinstallation costs. This warranty shall not apply if it is shown by Honeywell that the defect or malfunction was caused by damage which occurred while the product was in the possession of a consumer.

Honeywell's sole responsibility shall be to repair or replace the product within the terms stated above. HONEYWELL SHALL NOT BE LIABLE FOR ANY LOSS OR DAMAGE OF ANY KIND, INCLUDING ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING, DIRECTLY OR INDIRECTLY, FROM ANY BREACH OF ANY WARRANTY, EXPRESS OR IMPLIED, OR ANY OTHER FAILURE OF THIS PRODUCT. Some states do not allow the exclusion or limitation of incidental or consequential damages, so this limitation may not apply to you.

THIS WARRANTY IS THE ONLY EXPRESS WARRANTY HONEYWELL MAKES ON THIS PRODUCT. THE DURATION OF ANY IMPLIED WARRANTIES, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, IS HEREBY LIMITED TO THE FIVE-YEAR DURATION OF THIS WARRANTY. Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

This warranty gives you specific legal rights, and you may have other rights which vary from state to state.

If you have any questions concerning this warranty, please write Honeywell Customer Relations, 1985 Douglas Drive, Golden Valley, MN 55422 or call 1-800-468-1502. In Canada, write Retail Products ON15-02H, Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Toronto, Ontario M1V4Z9.

Automation and Control Solutions

Honeywell International Inc.
1985 Douglas Drive North
Golden Valley, MN 55422

Honeywell Limited-Honeywell Limitée
35 Dynamic Drive
Toronto, Ontario M1V 4Z9

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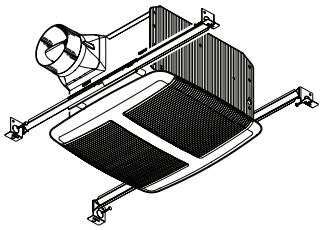


READ AND SAVE THESE INSTRUCTIONS

WARNING

TO REDUCE THE RISK OF FIRE, ELECTRIC SHOCK, OR INJURY TO PERSONS, OBSERVE THE FOLLOWING:

1. Use this unit only in the manner intended by the manufacturer. If you have questions, contact the manufacturer at the address or telephone number listed in the warranty.
2. Before servicing or cleaning unit, switch power off at service panel and lock the service disconnecting means to prevent power from being switched on accidentally. When the service disconnecting means cannot be locked, securely fasten a prominent warning device, such as a tag, to the service panel.
3. Installation work and electrical wiring must be done by a qualified person(s) in accordance with all applicable codes and standards, including fire-rated construction codes and standards.
4. Sufficient air is needed for proper combustion and exhausting of gases through the flue (chimney) of fuel burning equipment to prevent backdrafting. Follow the heating equipment manufacturer's guideline and safety standards such as those published by the National Fire Protection Association (NFPA), and the American Society for Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), and the local code authorities.
5. When cutting or drilling into wall or ceiling, do not damage electrical wiring and other hidden utilities.
6. Ducted fans must always be vented to the outdoors.
7. Acceptable for use over a tub or shower when connected to a GFCI (Ground Fault Circuit Interrupter) - protected branch circuit (ceiling installation only).
8. This unit must be grounded.

CAUTION

1. For general ventilating use only. Do not use to exhaust hazardous or explosive materials and vapors.
2. This product is designed for installation in ceilings up to a 12/12 pitch (45 degree angle). Duct connector must point up. DO NOT MOUNT THIS PRODUCT IN A WALL.
3. To avoid motor bearing damage and noisy and/or unbalanced impellers, keep drywall spray, construction dust, etc. off power unit.
4. Please read specification label on product for further information and requirements.

CLEANING & MAINTENANCE

For quiet and efficient operation, long life, and attractive appearance - lower or remove grille and vacuum interior of unit with the dusting brush attachment.

The motor is permanently lubricated and never needs oiling. If the motor bearings are making excessive or unusual noises, replace the blower assembly (includes motor and impeller).

OPERATION

Use an on/off switch or speed control to operate this ventilator. See "Connect Wiring" for details. Use of speed controls other than the Broan Models 78V and 78W may cause a motor humming noise.

WARRANTY

BROAN-NUTONE THREE YEAR LIMITED WARRANTY

Broan-NuTone warrants to the original consumer purchaser of its products that such products will be free from defects in materials or workmanship for a period of three years from the date of original purchase. THERE ARE NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

During this three-year period, Broan-NuTone will, at its option, repair or replace, without charge, any product or part which is found to be defective under normal use and service.

THIS WARRANTY DOES NOT EXTEND TO FLUORESCENT LAMP STARTERS, TUBES, HALOGEN AND INCANDESCENT BULBS, FUSES, FILTERS, DUCTS, ROOF CAPS, WALL CAPS AND OTHER ACCESSORIES FOR DUCTING. This warranty does not cover (a) normal maintenance and service or (b) any products or parts which have been subject to misuse, negligence, accident, improper maintenance or repair (other than by Broan-NuTone), faulty installation or installation contrary to recommended installation instructions.

The duration of any implied warranty is limited to the three-year period as specified for the express warranty. Some states do not allow limitation on how long an implied warranty lasts, so the above limitation may not apply to you.

BROAN-NUTONE'S OBLIGATION TO REPAIR OR REPLACE, AT BROAN-NUTONE'S OPTION, SHALL BE THE PURCHASER'S SOLE AND EXCLUSIVE REMEDY UNDER THIS WARRANTY. BROAN-NUTONE SHALL NOT BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH PRODUCT USE OR PERFORMANCE. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights, which vary from state to state. This warranty supersedes all prior warranties.

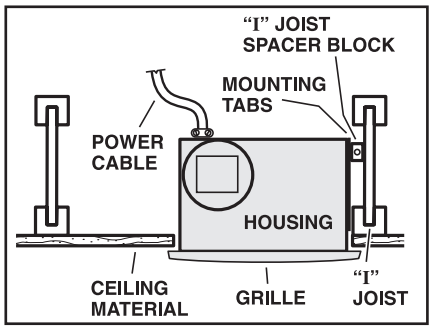
To qualify for warranty service, you must (a) notify Broan-NuTone at the address or telephone number below, (b) give the model number and part identification and (c) describe the nature of any defect in the product or part. At the time of requesting warranty service, you must present evidence of the original purchase date.

Broan-NuTone LLC, 926 W. State Street, Hartford, Wisconsin 53027
www.broan.com 800-558-1711

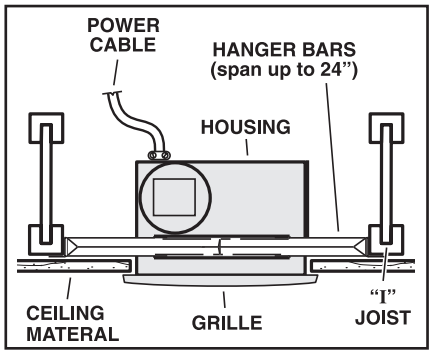
Installer: Leave this manual with the homeowner.

TYPICAL INSTALLATIONS

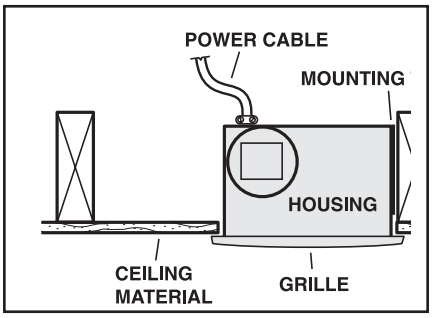
Housing mounted to I-joists.



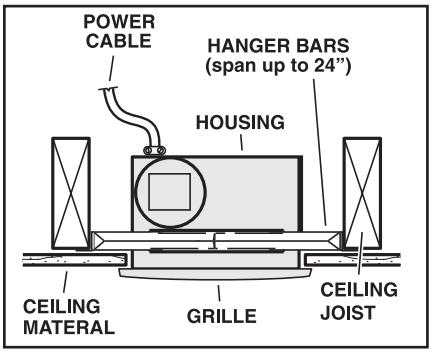
Housing mounted anywhere between I-joists using hanger bars.



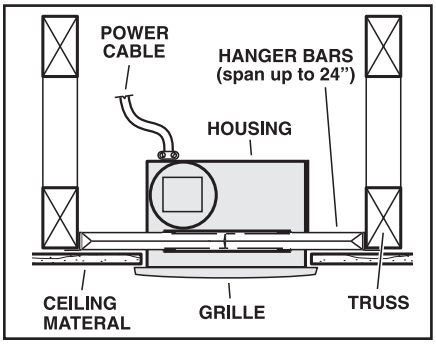
Housing mounted to joists.



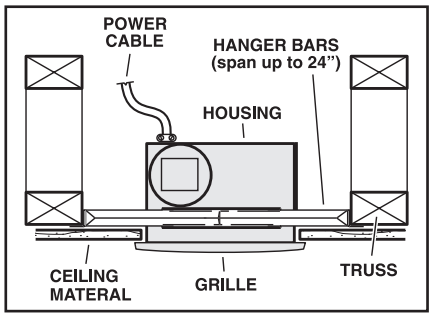
Housing mounted anywhere between joists using hanger bars.



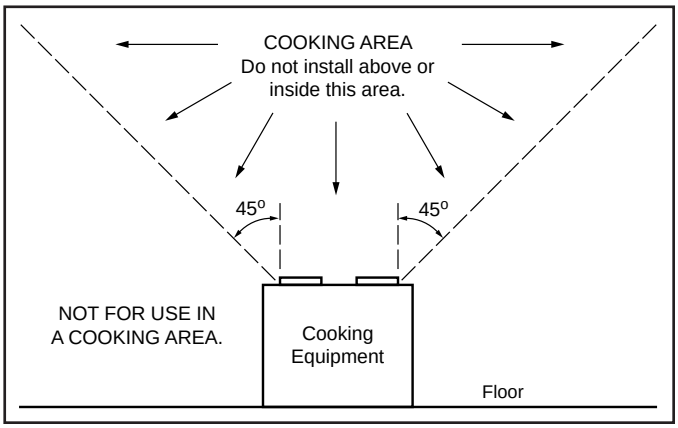
Housing mounted anywhere between trusses using hanger bars.

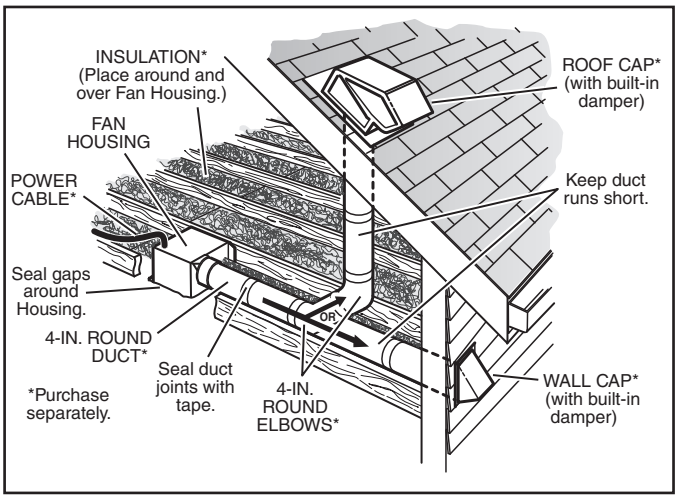


Housing mounted anywhere between trusses using hanger bars.



PLAN THE INSTALLATION





The unit will operate most quietly and efficiently when located where the shortest possible duct run and minimum number of elbows will be needed.

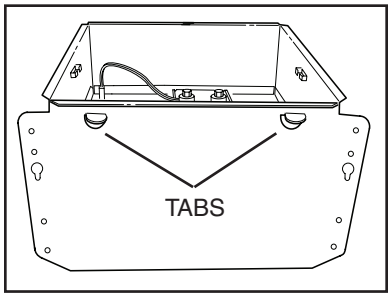
Use a roof cap or wall cap that has a built-in damper to reduce backdrafts.

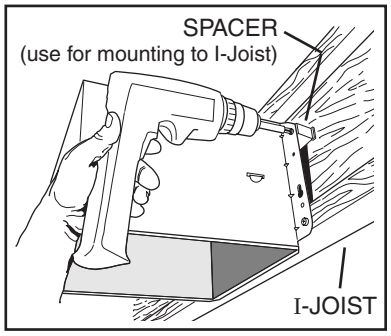
Plan to supply the unit with proper line voltage and appropriate power cable.

INSTALL HOUSING & DUCT

1a. Mount housing to joist or I-joist.

Use a pliers to bend housing **TABS** out to 90⁰. Hold housing in place so that the housing tabs contact the bottom of the joist. The housing mounts with four (4) screws or nails. Screw or nail housing to joist through lowest holes in each mounting flange, then through highest holes. NOTE: Mounting to **I-JOIST** (shown) requires use of **SPACERS** (included) between the highest hole of each mounting flange and the I-joist.

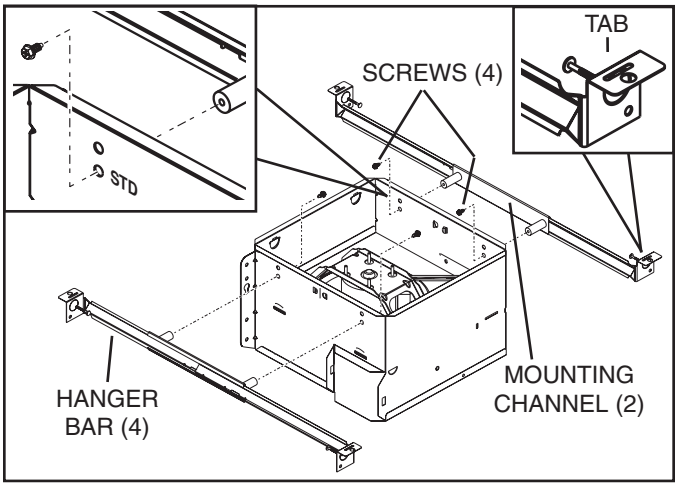




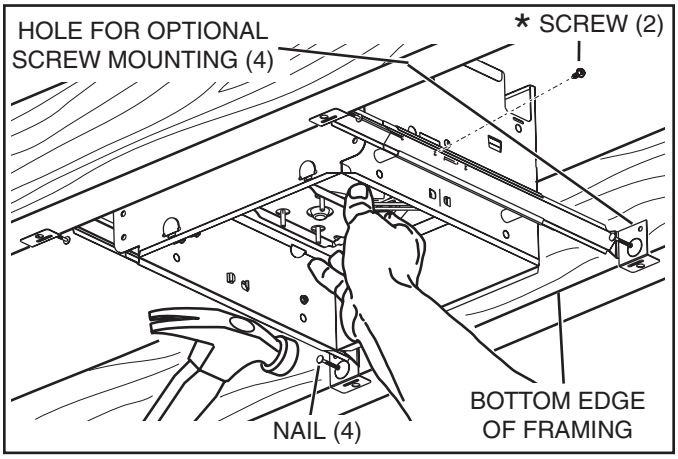
OR

1b. Mount housing anywhere between trusses, joists, or I-joists using hanger bars.

Sliding hanger bars are provided to allow for accurate positioning of housing anywhere between framing. They can be used on all types of framing (I-joist, standard joist, and truss construction) and span up to 24".



Attach the MOUNTING CHANNELS to the housing using the SCREWS supplied. Make sure TABS face "up" as shown. Use the set of channel mounting holes (marked "STD") to mount the housing flush with the bottom of the drywall. Use the other set of holes (not marked) to mount the housing flush with the top of the drywall.



Extend HANGER BARS to the width of the framing.

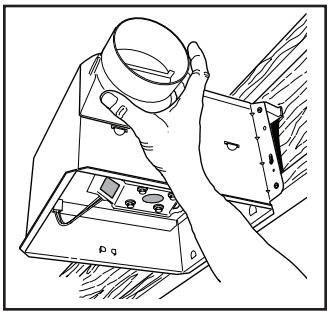
Hold ventilator in place with the hanger bar tabs wrapping around the BOTTOM EDGE OF THE FRAMING.

NAIL ventilator to framing or fasten with screws (not provided) through HOLES near nails.

* To ensure a noise-free mount: Secure hanger bars together with SCREWS or use a pliers to crimp mounting channels tightly around hanger bars.

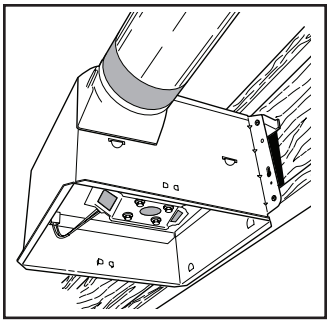
2. Attach damper/ duct connector.

Snap damper / duct connector onto housing. Make sure connector is flush with top of housing and damper flap falls closed.

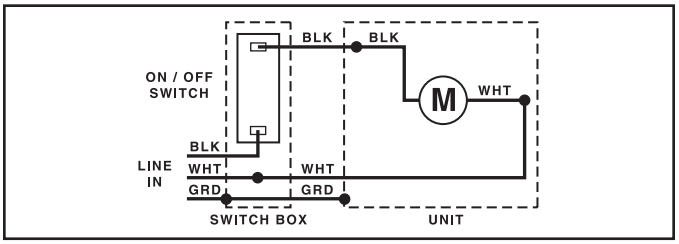


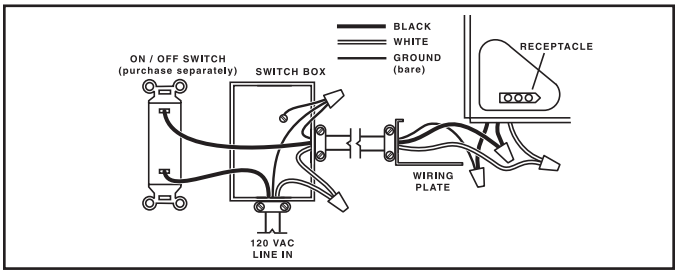
3. Install 4-inch round ductwork.

Connect 4-inch round ductwork to damper / duct connector. Run ductwork to a roof cap or wall cap. Tape all ductwork connections to make them secure and air tight.



CONNECT WIRING



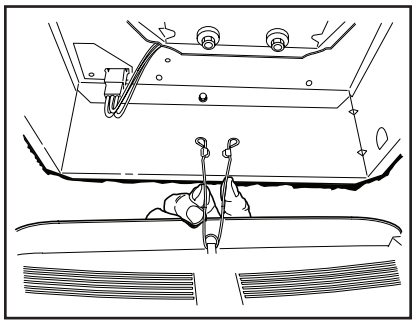


4. Connect electrical wiring.
Run 120 VAC house wiring to installation location. Use proper UL approved connector to secure house wiring to wiring plate. Connect wires as shown in wiring diagrams.

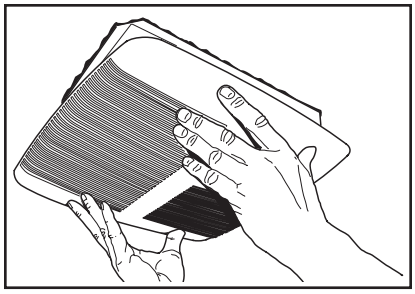
INSTALL GRILLE

5. Finish ceiling.
Install ceiling material. Cut out around housing.

6. Attach grille to housing.
Squeeze grille springs and insert them into slots on each side of housing.



7. Push grille against ceiling.

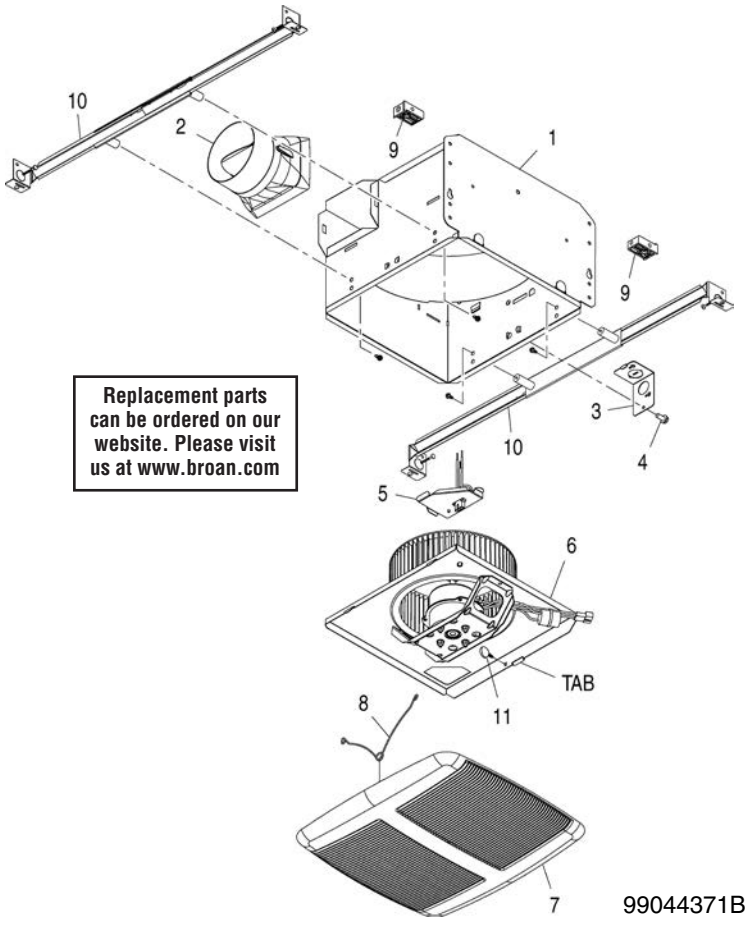


SERVICE PARTS

Key No.	Part No.	Description
1	97016466	Housing
2	97016449	Duct Connector-4”
3	98010102	Wiring Plate
4	99170245	Screw, #8-18 X .375
5	97018010	Wire Panel/Harness Assembly
6	97017782	Blower Assembly (QTR050F)
	97017783	Blower Assembly (QTRE080)
	97017854	Blower Assembly (QTRE110)
7	97016497	Grille Assembly (includes key no. 8)
8	99140199	Grille Spring (2 req’d)
9	97018014	Spacer (2 supplied)
10	QTHB1	Hanger Bars (QTRE080, QTRE110)
11	99420665	Thumbscrew, #8-18 x .375

Order service parts by “Part No.” - not by “Key No.”

SERVICE NOTE To remove Blower Assembly: Unplug motor. Remove thumbscrew (11) from motor plate flange. Find the single **TAB** on the motor plate (located next to the receptacle). Push up near motor plate tab while pushing out on side of housing. Or insert a straight-blade screwdriver into slot in housing (next to tab) and twist screwdriver.



Replacement parts can be ordered on our website. Please visit us at www.broan.com

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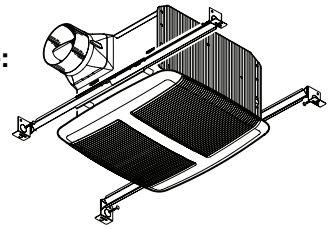


LEA Y CONSERVE ESTAS INSTRUCCIONES

ADVERTENCIA

PARA REDUCIR EL RIESGO DE INCENDIOS, DESCARGAS ELÉCTRICAS O LESIONES PERSONALES, OBSERVE LAS SIGUIENTES PRECAUCIONES:

1. Use la unidad sólo de la manera indicada por el fabricante. Si tiene preguntas, comuníquese con el fabricante a la dirección o al número telefónico que se incluyen en la garantía.
2. Antes de dar servicio a la unidad o de limpiarla, interrumpa el suministro eléctrico en el panel de servicio y bloquee los medios de desconexión del servicio para evitar que la electricidad se reanude accidentalmente. Cuando no sea posible bloquear los medios de desconexión del servicio, fije firmemente un dispositivo de advertencia (por ejemplo, una etiqueta) en un lugar prominente del panel de servicio.
3. El trabajo de instalación y el cableado eléctrico deben ser realizados por una o más personas calificadas, y deben cumplir con todos los códigos y normas correspondientes, incluidos los códigos y normas de construcción específicos de protección contra incendios.
4. Se necesita suficiente aire para que se lleve a cabo una combustión adecuada y para la descarga de los gases a través del tubo de humos (chimenea) del equipo quemador de combustible, a fin de evitar las contracorrientes. Siga las directrices y normas de seguridad del fabricante del equipo de calentamiento, tales como las publicadas por la Asociación Nacional de Protección contra Incendios (National Fire Protection Association, NFPA), la Sociedad Americana de Ingenieros de Calefacción, Refrigeración y Aire Acondicionado (American Society for Heating, Refrigeration and Air Conditioning Engineers, ASHRAE) y las autoridades de los códigos locales.
5. Al cortar o perforar a través de la pared o del cielo raso, no dañe el cableado eléctrico ni otros servicios ocultos.
6. Los ventiladores con conductos deben siempre conectarse hacia el exterior.
7. Es aceptable utilizar este producto sobre una regadera o tina si se conecta a un circuito secundario protegido por un GFCI (interruptor accionado por pérdida de conexión a tierra) (instalación del techo solamente).
8. Esta unidad debe conectarse a tierra.

PRECAUCIÓN

1. Sólo para usarlo en ventilación general. No lo use para descargar materiales ni vapores peligrosos o explosivos.
2. Este producto se diseña para la instalación en techos hasta una echada de 12/12 (ángulo de 45 grados). NO MONTE ESTE PRODUCTO EN UNA TECHO.
3. Para evitar daños a los cojinetes del motor y rotores ruidosos y/o no equilibrados, mantenga la unidad de accionamiento al resguardo de rocío de yeso, polvo de la construcción, etc.
4. Lea la etiqueta de especificaciones del producto para ver información y requisitos adicionales.

LIMPIEZA Y MANTENIMIENTO

Para lograr un funcionamiento silencioso y eficiente, como también larga vida y una apariencia atractiva, baje o retire la rejilla y aspire el interior de la unidad con el accesorio del cepillo para sacudir polvo.

El motor está permanentemente lubricado y nunca necesitará aceite. Si los cojinetes del motor están haciendo ruido excesivo o inusual, reemplace el motor con el motor de servicio exacto. El impulsor también debe ser reemplazado.

OPERACIÓN

Opere este ventilador mediante un interruptor de encendido/apagado o control de velocidad. Vea los detalles en la sección "Conexión eléctrica". El uso de los controles de la velocidad con excepción de los modelos 78V y 78W de Broan puede causar un ruido del tarareo del motor.

GARANTÍA

GARANTIA BROAN-NUTONE LIMITADA POR TRES AÑOS

Broan-NuTone garantiza al consumidor comprador original de sus productos que dichos productos carecerán de defectos en materiales o en mano de obra por un período de tres años a partir de la fecha original de compra. NO EXISTEN OTRAS GARANTIAS, EXPLICITAS O IMPLICITAS, INCLUYENDO, PERO NO LIMITADAS A, GARANTIAS IMPLICITAS DE COMERCIALIZACION O APTITUD PARA UN PROPOSITO PARTICULAR.

Durante el período de tres años, y a su propio criterio, Broan-NuTone reparará o reemplazará, sin costo alguno cualquier producto o pieza que se encuentre defectuosa bajo condiciones normales de servicio y uso.

LA PRESENTE GARANTÍA NO CUBRE LOS TUBOS FLUORESCENTES NI SUS ARRANCADORES, BOMBILLAS DE HALÓGENO E INCANDESCENTES, FUSIBLES, FILTROS, CONDUCTOS, TAPONES DE TECHO O PAREDES Y DEMÁS ACCESORIOS PARA CONDUCTOS. Esta garantía no cubre (a) mantenimiento y servicio normales o (b) cualquier producto o piezas que hayan sido utilizadas de forma errónea, negligente, que hayan causado un accidente, o que hayan sido reparadas o mantenidas inapropiadamente (por otras compañías que no sean Broan-NuTone), instalación defectuosa, o instalación contraria a las instrucciones de instalación recomendadas.

La duración de cualquier garantía implícita se limita a un período de tres años como se especifica en la garantía expresa. Algunos estados no permiten limitaciones en cuanto al tiempo de expiración de una garantía implícita, por lo que la limitación antes mencionada puede no aplicarse a usted.

LA OBLIGACION DE BROAN-NUTONE DE REPARAR O REEMPLAZAR, SIGUIENDO EL CRITERIO DE BROAN-NUTONE, DEBERA SER EL UNICO Y EXCLUSIVO RECURSO LEGAL DEL COMPRADOR BAJO ESTA GARANTIA. BROAN-NUTONE NO SERA RESPONSABLE POR DAÑOS INCIDENTALES, CONSIGUIENTES, O POR DAÑOS ESPECIALES QUE SURJAN A RAIZ DEL USO O DESEMPEÑO DEL PRODUCTO. Algunos estados no permiten la exclusión o limitación de daños incidentales o consiguientes, por lo que la limitación antes mencionada puede no aplicarse a usted.

Esta garantía le proporciona derechos legales específicos, y usted puede también tener otros derechos, los cuales varían de estado a estado. Esta garantía reemplaza todas las garantías anteriores.

Para calificar en la garantía de servicio, usted debe (a) notificar a Broan-NuTone al domicilio o al número de teléfono que se menciona abajo, (b) dar el número del modelo y la identificación de la pieza, y (c) describir la naturaleza de cualquier defecto en el producto o pieza. En el momento de solicitar servicio cubierto por la garantía, usted debe de presentar evidencia de la fecha original de compra.

Broan-NuTone LLC, 926 W. State Street, Hartford, Wisconsin 53027
www.broan.com 800-558-1711

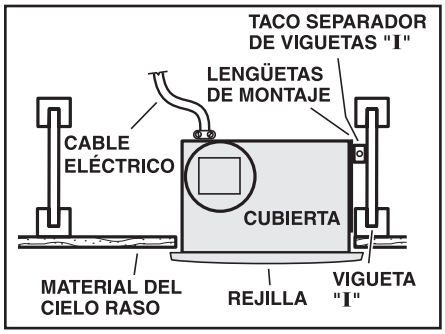
A la persona que realiza la instalación: Deje este manual con el dueño de la casa.

BROAN®

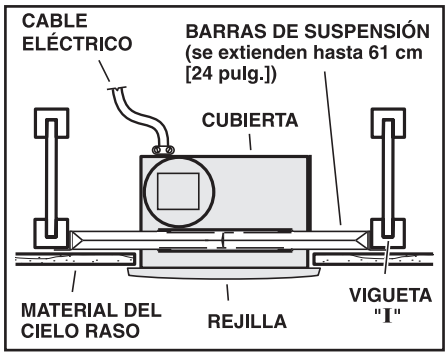
MODELOS QTR050F • QTRE080 • QTRE110

INSTALACIONES TÍPICAS

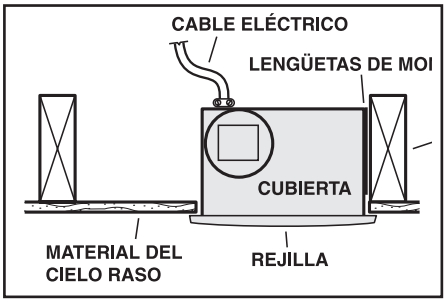
Montaje de la cubierta en viguetas "I".



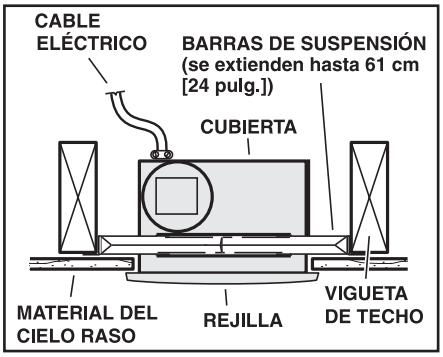
Montaje de la cubierta en cualquier parte entre las viguetas "I" por medio de barras de suspensión.



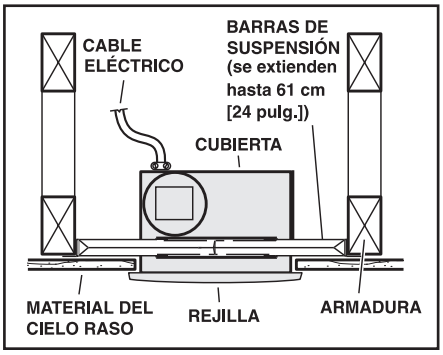
Montaje de cubierta en viguetas.



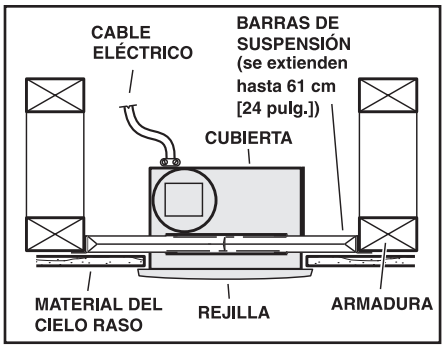
Montaje de la cubierta en cualquier parte entre las viguetas por medio de barras de suspensión.



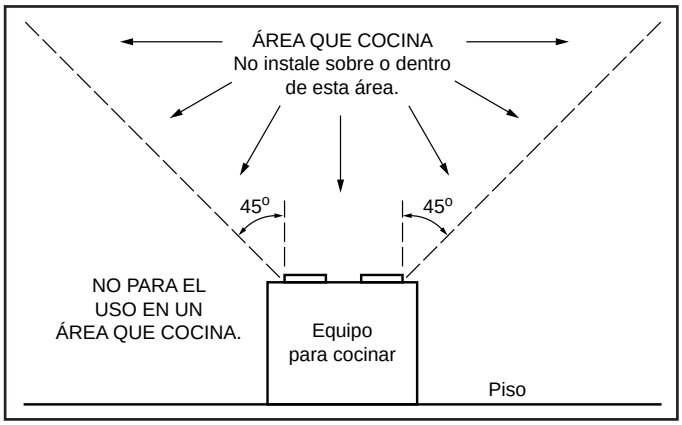
Montaje de la cubierta en cualquier parte entre armaduras por medio de barras de suspensión.

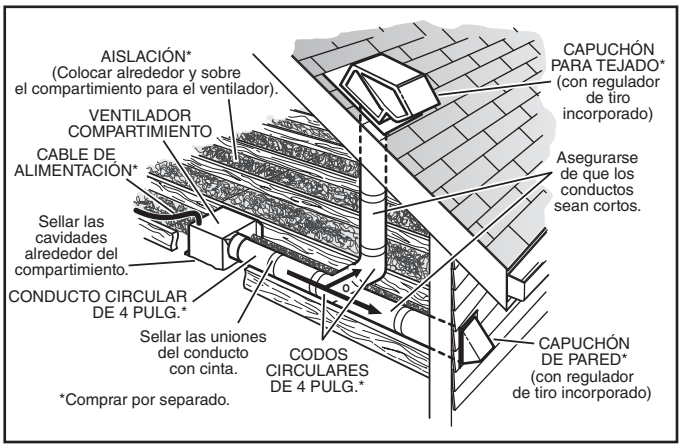


Montaje de la cubierta en cualquier parte entre armaduras por medio de barras de suspensión.



PLANIFICACIÓN DE LA INSTALACIÓN





El ventilador funcionará con más eficiencia y menos ruido si se ubica en un sitio donde requiera el tramo de conducto más corto posible y un mínimo número de codos.

Instale una tapa de techo o de pared que tenga un regulador de tiro incorporado a fin de reducir los contratiros.

Alimente la unidad con el voltaje de línea y el cable eléctrico apropiados.

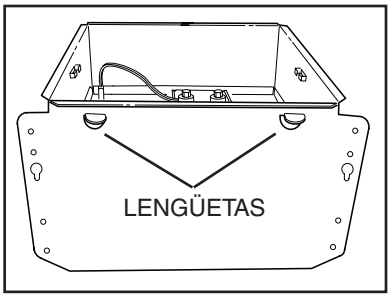
BROAN®

MODELOS QTR050F • QTRE080 • QTRE110

INSTALE LA CUBIERTA Y EL CONDUCTO

1a. Instale la cubierta en las viguetas o viguetas "I".

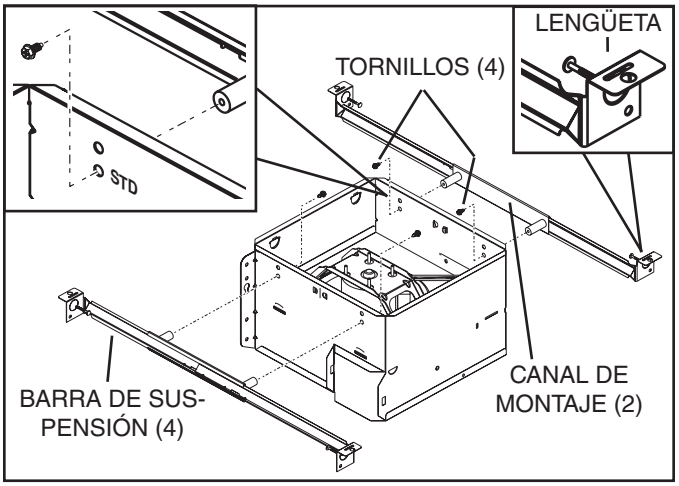
Con un alicate, doble las **LENGÜETAS** de la cubierta a 90°. Sostenga la cubierta en su lugar de manera que las lengüetas de la cubierta hagan contacto con la parte inferior de la vigueta. Para el montaje de la cubierta se utilizan cuatro (4) tornillos o clavos. Atornille o clave la cubierta a la vigueta a través de los orificios más bajos de cada brida de montaje, y seguidamente a través de los más altos. NOTA: Para el montaje en la **VIGUETA "I"**, tal como se ilustra, se requiere utilizar **SEPARADORES** (incluidos) entre el orificio más alto de cada brida de montaje y la vigueta "I."



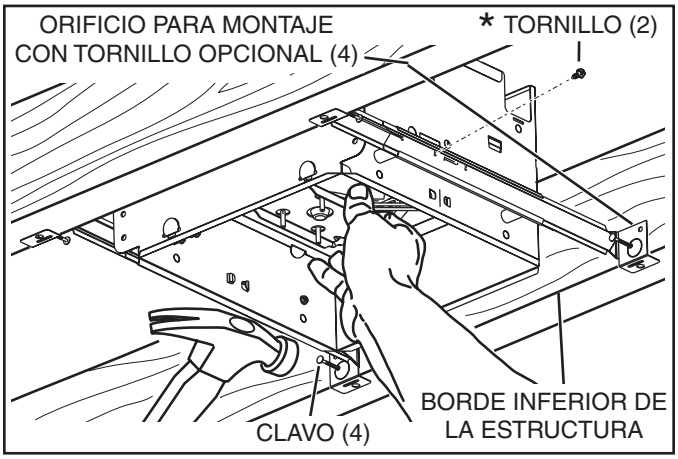
O BIEN

1b. Instale la cubierta en cualquier parte entre las armaduras, viguetas o viguetas "I" por medio de barras de suspensión.

Se proporcionan barras de suspensión deslizantes para facilitar la colocación adecuada de la cubierta en cualquier parte entre la estructura. Estas barras se adaptan a toda clase de estructuras (construcciones de viguetas "I", viguetas estándar y armaduras) y se extienden a un máximo de 61 cm (24 pulg.).



Fije los CANALES DE MONTAJE a la cubierta con los TORNILLOS incluidos. Asegúrese de que las LENGÜETAS estén de cara hacia arriba, tal como se muestra. Utilice el juego de orificios de montaje del canal (marcados como "STD") para montar la cubierta al ras con la parte inferior de la tablarroca. Utilice el otro juego de orificios (sin marca) para montar la cubierta al ras con la parte superior de la tablarroca.



Abra las BARRAS DE SUSPENSIÓN hasta el ancho de la estructura.

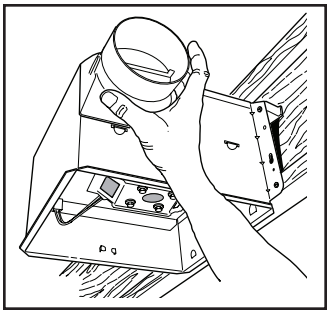
Sostenga el ventilador en su sitio envolviendo las lengüetas de la barra de suspensión alrededor del BORDE INFERIOR DE LA ESTRUCTURA.

CLAVE el ventilador a la estructura o sujételo con tornillos (no incluidos) a través de los ORIFICIOS que están cerca de los clavos.

* Para lograr un montaje silencioso: acople y fije las barras de suspensión con TORNILLOS, o doble los canales de montaje con un alicate bien justos alrededor de las barras de suspensión.

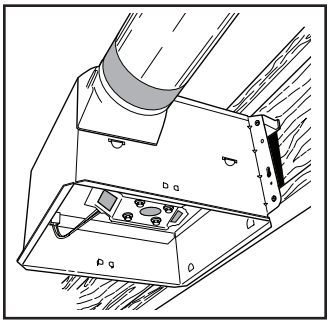
2. Acople el conector del regulador de tiro/conducto.

Conecte a presión el conector del regulador de tiro/conducto en la cubierta. Asegúrese de que el conector esté al ras con la parte superior de la cubierta y que la aleta del regulador caiga cerrada.

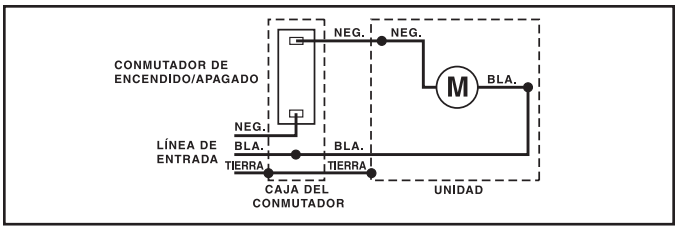


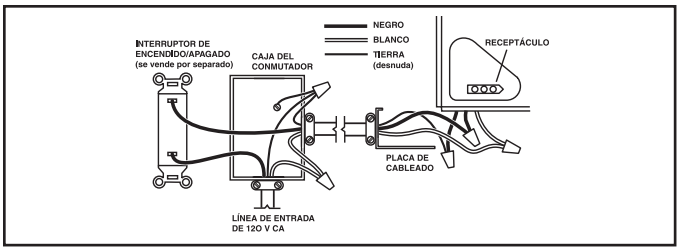
3. Instale el conducto redondo de 4 pulgadas.

Conecte el conducto redondo de 4 pulgadas al conector del regulador/conducto. Extienda el conducto hacia una tapa de techo o tapa de pared. Encinte todas las conexiones de los conductos para fijarlas y hacerlas herméticas al aire.



CONEXIÓN ELÉCTRICA





4. Conecte los cables eléctricos.

Extienda el cableado de la casa de 120 V CA al lugar de la instalación. Utilice una conexión aprobada por UL para afianzar el cableado de la casa a la placa de cableado. Conecte los cables tal como se ilustra en los diagramas de cableado.

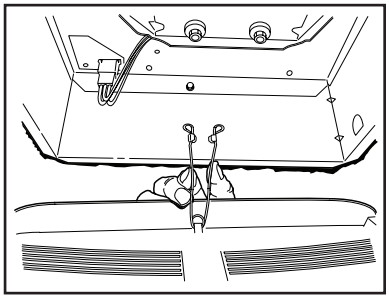
INSTALE LA REJILLA

5. Termine el cielo raso.

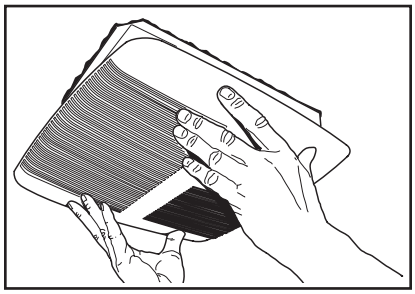
Instale el material del cielo raso. Recorte alrededor de la cubierta.

6. Acople la rejilla a la cubierta.

Apriete los resortes de la rejilla e insértelos en las ranuras que se encuentran a cada lado de la cubierta.



7. Empuje la rejilla contra el cielo raso.



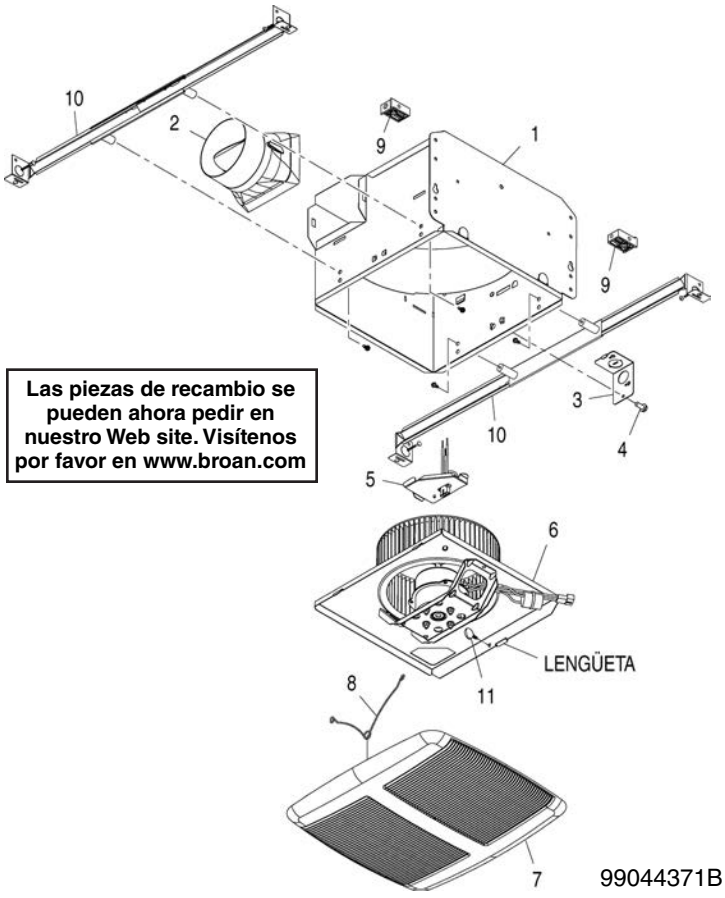
PIEZAS DE REPUESTO

Clave n.º	Pieza n.º	Descripción
1	97016466	Cubierta
2	97016449	Conector del conducto (4 pulg.)
3	98010102	Placa de cableado
4	99170245	Tornillo n.º 8-18 x 0.375
5	97018010	Conjunto del panel de cableado/arnés
6	97017782	Conjunto del ventilador (QTR050F)
	97017783	Conjunto del ventilador (QTRE080)
	97017854	Conjunto del ventilador (QTRE110)
7	97016497	Conjunto de la rejilla (incluye clave n.º 8)
8	99140199	Resorte de la rejilla (se requieren 2)
9	97018014	Separador (se suministran 2)
10	QTHB1	Juego de barra de suspensión (QTRE080, QTRE110)
11	99420665	Tornillo de mariposa n.º 8-18 x 0.375

Al hacer el pedido de una pieza de servicio se debe especificar el número de la pieza (no el número de la clave).

NOTA DE SERVICIO Para desmontar el conjunto del ventilador: Desenchufe el motor. Saque el tornillo de mariposa (11) de la brida de la placa del motor. Localice la **LENGÜETA** única de la placa del motor (se encuentra junto al receptáculo). Empuje hacia arriba cerca de la lengüeta de la placa del motor al mismo tiempo que empuja hacia afuera el costado de la cubierta. O bien, introduzca un destornillador de punta recta en la ranura de la cubierta (junto a la lengüeta) y gírelo.

Las piezas de recambio se pueden ahora pedir en nuestro Web site. Visítenos por favor en www.broan.com



Appendix H

ME428 DVP&R Format													
Report Date			Sponsor						Component/Assembly			REPORTING ENGINEER:	
TEST PLAN										TEST REPORT			
Item No	Specification or Clause Reference	Test Description	Acceptance Criteria	Test Responsi	Test Stage	SAMPLES		TIMING		TEST RESULTS			NOTES
						Quantity	Type	Start date	Finish date	Test Result	Quantity Pass	Quantity Fail	
1	Air Handler Energy Consumption		Total Energy Consumptions < 60 kWh/week	JC, JC, & PW	1	na		tbd	tbd	na	-	-	-
2	Heat Pump Energy Consumption			JC, JC, & PW	1	na		tbd	tbd	na	-	-	-
3	HRV Energy Consumption			JC, JC, & PW	1	na		tbd	tbd	na	-	-	-
4	Bathroom flowrate	PITOT - static tubes	8 air changes/hr	JC, JC, & PW	1	na		tbd	tbd	na	-	-	-
5	Kitchen flowrate	PITOT - static tubes	13 air changes/hr	JC, JC, & PW	1	na		tbd	tbd	na	-	-	-
6	HRV system flowrate	PITOT - static tubes	0.35 air changes/hr	JC, JC, & PW	1	na		tbd	tbd	na	-	-	-
7	Air handler flowrate	PITOT - static tubes	600 cfm	JC, JC, & PW	1	na		tbd	tbd	na	-	-	-
8	Zone Temperature Check	Temperature sensor (TBD controls)	71-76 degrees F	JC, JC, & PW	1	na		tbd	tbd	na	-	-	-
	Humidity Check	Humidity Meter	< 60% relative hum.	JC, JC, & PW	1	na		tbd	tbd	na	-	-	-
9	CO2 Check	CO2 sensor (TBD controls)	< 1000 ppm	JC, JC, & PW	1	na		tbd	tbd	na	-	-	-
10	Overall hvac noise level check	Sound Level Meter	< 50 dBA	JC, JC, & PW	1	na		tbd	tbd	na	-	-	-

Appendix I

U.S. DEPARTMENT OF ENERGY
SOLAR DECATHLON

BUILDING CODE

Last Updated: September 24, 2014

7-2. Return Air

Return air shall not be taken from a bathroom, kitchen, mechanical, or furnace room. (IRC, Sec. M1602.2).

7-3. Outside and Exhaust Air

a. Outside Air

Outside air shall not be taken closer than 10 ft (304.8 cm) from an appliance or plumbing vent, or discharge outlet of an exhaust fan [unless the intake is located at least 3 ft (91.4 cm) below the vent or fan discharge] (IRC, Sec. M1602.2, Item 1).

b. Screens

Outside air inlets shall be equipped with a screen with openings 0.25 in. to 0.5 in. (0.64 cm to 1.3 cm) (IRC, Sec. M1602.3).

c. Exhaust hood systems capable of exhausting in excess of 400 cubic feet per minute (0.19 m^3/s) shall be provided with makeup air at a rate approximately equal to the exhaust air rate. Such makeup air systems shall be equipped with a means of closure and shall be automatically controlled to start and operate simultaneously with the exhaust system. (IRC Sec. M1503.4)

7-4. Bathroom Ventilation

Bathrooms shall be provided with mechanical ventilation systems capable of providing 50 cfm (23.6 L/s) for intermittent ventilation or 20 cfm (9.4 L/s) for continuous ventilation, or with windows allowing a 1.5 ft^2 (0.14 m^2) opening for natural ventilation (IRC, Sec. R303.3).

Section 8. Solar Mechanical

8-1. Drawing Requirements

Provide plan details for any proposed solar mechanical systems. Provide details on collectors, fluid distribution, heat exchangers, etc., along with a key for symbols used in the drawings (IRC, Sec. 106.1.1). Plans should emphasize compliance with IRC M2301.

8-2. Cross Connection

Provide details for the solar hot-water system. Provide details indicating if potable water or other heat transfer liquids will be employed. If other than potable water is used, an approved heat exchanger shall be employed to isolate potable water from transfer fluids (IRC Section R106.1.1).

8-3. Access

Solar collectors, controls, dampers, fans, and pumps shall be accessible for inspection, maintenance, repair, and replacement (IRC, Sec. M2301.2.1).

8-4. Roof-Mounted Collectors

The roof shall be constructed to support all loads imposed by the collectors. If collectors are intended to serve as the roof covering, documentation shall be provided to determine compliance with the roofing provisions in IRC, Chapter 9. If the collectors will be placed over the roof covering, the collectors and supporting structure shall be constructed of noncombustible material or fire-retardant-treated wood equivalent to that required for the roof covering (IRC, Sec. M2301.2.2).

8-5. Pressure and Temperature Relief

Pressure- and temperature-relief valves shall be provided for components under pressure. Relief devices shall be installed in sections of the system so that a section cannot be valved off or isolated from a relief device (IRC, Sec. M2301.2.3). Pressure and temperature relief devices shall have the capacity to be removed and capped prior to inspection to accommodate the required 100 psi (690 kPa) system pressure test required by Section 8-13.

8-6. Vacuum Relief

A vacuum relief valve shall protect system components that might be subjected to pressure drops below atmospheric pressure during operation or shutdown. Plans shall indicate if this system is subject to vacuum conditions (IRC, Sec. M2301.2.4).

8-7. Expansion Tanks

Expansion tanks in solar systems shall be installed in accordance with IRC, Section M2301 in closed-fluid loops that contain heat-transfer fluid (IRC, Sec. M2301.2.6).

8-8. Solar Loop Isolation

Valves shall be installed to allow isolation of the solar collectors from the remainder of the system (IRC, Sec. M2301.2.8).

8-9. Maximum Temperature Limitation

Systems shall be equipped with means to limit the maximum water temperature of the system fluid entering or exchanging heat with any pressurized vessel inside the dwelling to 180°F (82°C). This protection is required in addition to required temperature and pressure relief valves stated in IRC, Section M2301.2.3 (IRC, Sec. M2301.2.9).

8-10. Collector and Thermal Storage Unit Labeling

a. Collectors and storage units shall be listed and labeled to show the manufacturer's name, model number, serial number, collector weight, collector maximum allowable temperatures and pressures, and the type of heat transfer fluids that are compatible with the collector and storage units (IRC, Sec. 2301.3).

b. Identification of system components. All components of the solar hydronic system shall be identified with permanent identification labels. Such labels shall indicate the function of the component (i.e. panel loop supply or return, heat exchanger, domestic loop, etc.) and flow direction.

Exception: Domestic plumbing fixture supply and in-floor radiant heat loops.

8-11. Prohibited Heat-Transfer Media

Flammable gasses and liquids shall not be used as heat-transfer fluids (IRC, Sec. M2301.4).

8-12. Backflow Prevention

All connections from the potable water supply to solar systems shall comply with IRC, Section P2902.4.5 (IRC, Sec.M2301.5).

8-13. Pressure Test

All solar hydronic piping shall be tested hydrostatically at a pressure of not less than 100 psi (690 kPa) for no fewer than 15 minutes. Temperature and pressure relief devices that operate at or less than 100 psi (690 kPa) shall be isolated during the test by removal and capping.

Exception: Systems designed for pressures under 100psi (690kPa) may be tested at lower pressures when approved by the Solar Decathlon Building Official. Such testing must be approved prior to transportation of the structure to the competition site.

Section 9. Plumbing

9-1. Drawing Requirements

a. Provide a labeled isometric diagram of the proposed plumbing system for review. Clearly indicate waste lines, vent lines, potable water supply, heat exchange equipment, and the type of any heat transferring fluid used other than potable water.
b. Provide a key for symbols used in the drawings (IRC, Sec. 106.1.1).

9-2. Water Closet Demonstration

Water closets are installed for demonstration only and shall not be connected to any portion of the sewage disposal system. The water closet may be attached to a PVC or ABS 4 in. to 3 in. (10.2 cm to 7.7 cm) water-closet flange provided with a capped end or with the test plug knock-out in place. No structural member shall be cut or otherwise damaged to accommodate the water-closet flange assembly. No water supply shall be extended to the water closet unless otherwise approved by the Solar Decathlon Building Official. Bowl openings should be provided with a concealed opaque cover to discourage use of the toilet during the temporary exhibit.

9-3. Plumbing Wall – Structural

Recommendation: Create a dedicated plumbing wall with thickness sufficient to allow pipe penetrations within the studs not exceeding 60% of the stud width in nonbearing walls (IRC, Sec. 602.6).

9-4. Shower Mixing Valves

Shower mixing valves shall be pressure balanced, thermostatic mixing, or a combination of the two, with the high limit set at 120°F (48.9°C) to prevent scalding (IRC, Sec. P2708.3).

9-5. Backflow Prevention

Backflow prevention is required to isolate the potable water supply from the solar systems. See IRC Section P2902.2 for permissible devices. Because this project uses supply tanks for potable water, the use of a separate and isolated fill system for the solar component may be deemed acceptable backflow prevention (IRC, Sec. P2902.2).

9-6. Water Heater and Heated Storage Vessel Seismic Support

Water heaters and other heated fluid storage vessels shall be anchored or strapped in the upper one-third and in the lower one-third of the appliance to resist a horizontal force equal to one-third of the operating weight of the water heater, acting in any horizontal direction, or in accordance with the appliance manufacturer's recommendations.

10-2. Paint Disposal

Teams are not permitted to dispose of paint on the competition site. Teams may either take unused paint home or find a local facility that disposes of or recycles paint.

10-3. Material Safety Data Sheets (MSDS)

MSDS are required for all potentially hazardous materials to be used at the event, such as cleaning solvents, glycol, rubber cement, rubbing alcohol, etc.

Section 11. Moveable Features

Teams planning to move or transform major components of their houses beyond the assembly and disassembly phases are required to obtain special approval from a Solar Decathlon safety officer. Possible design features meeting this description include large, unusual, and potentially dangerous features such as moveable rooms and walls, changeable façades, collapsible spaces, and folding beds. This requirement does not apply to smaller, more typical house features that may be reconfigured, such as awnings, operable windows and window coverings, and doors. The following rules apply to qualifying features:

a. After the houses are assembled on the competition site, the safety officer will inspect every house and inform each team whether it has any qualifying features.
b. Teams wanting to determine before the event whether their house has any qualifying features should contact sdrules@nrel.gov.
c. The safety officer cannot thoroughly evaluate the safety of a particular house feature until it is seen in operation; however, the safety officer will try to indicate with a reasonable degree of confidence whether certain features are subject to these rules.
d. Qualifying features shall not be reconfigured during impound.
e. Qualifying features shall not be reconfigured during public exhibit hours unless approved by the Solar Decathlon safety officer. To receive approval, a team must:
f. Include in its Health and Safety Plan an explanation of how it will ensure safety during the movement of qualifying features.
g. Demonstrate the successful execution of the safety plan for qualifying features at some point before public exhibit hours begin.
h. Continue to demonstrate the successful execution of the safety plan for qualifying features during public exhibit hours.
i. If, at any time, the safety officer witnesses unsafe conditions, the movement of qualifying features during public tours may be prohibited for the duration of the event.

Solar Decathlon Active HVAC System

Mechanical Engineering CAL POLY

SOLAR CAL POLY

Goal: Design, analyze, and implement an optimized and innovative active HVAC system for the Cal Poly Solar Decathlon house.

Design Audience: US Department of Energy (sponsor of competition) and rest of Solar Cal Poly team.

Competition:

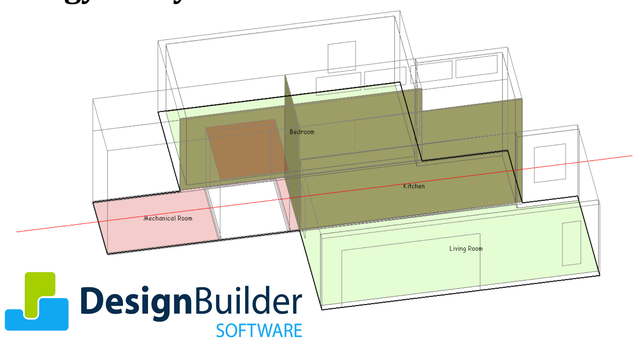
For full points, the house must maintain:

- Temperatures between 71°F and 76°F
- Relative humidity less than 60%
- Cumulative energy consumption less than 175 kWh (over 10 day period)
- Cumulative construction costs less than $250K

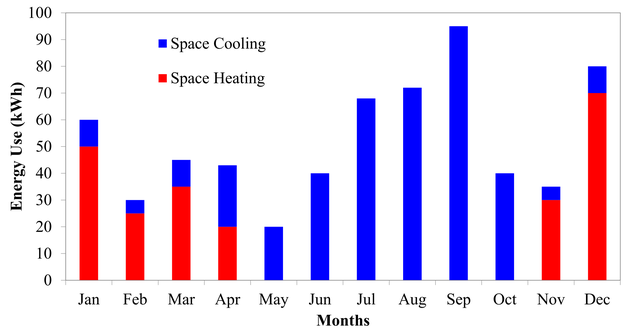
Additional points for:

- Innovation
- Functionality
- Efficiency
- Reliability
- Documentation

Energy Analysis



DesignBuilder SOFTWARE



- Detailed energy analysis was conducted in order to size an appropriate system.
- The model was constructed with three conditioned zones: the bedroom, living room, and bathroom (green), and one unconditioned zone: the mechanical room (red).
- Simulations were run over summer design weeks in Irvine to provide room temperatures, flowrates, heating/cooling loads, and energy consumption totals.
- From these results, it was determined that a 1.5 ton capacity heat pump, coupled with an air handler providing a nominal airflow of 600 cfm was required.
- EnergyPro 6.5 was utilized in order to verify California Title 24 Compliance.

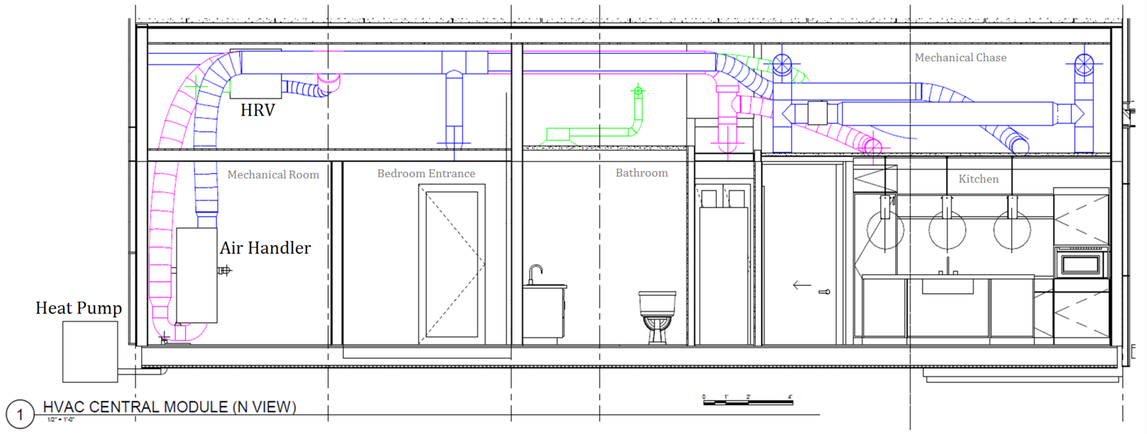
House Rendering

Credit: Solar Cal Poly Architecture Team

Testing and Construction

- Construction of HVAC system to be performed by Maino Construction Co.
- Drawings and specifications submitted, with installation of air handler, HRV and ductwork beginning after construction of interior framework.
- Testing to include verification of house environment maintained within contest parameters, as well as verification of proper sequence of operations through control system.

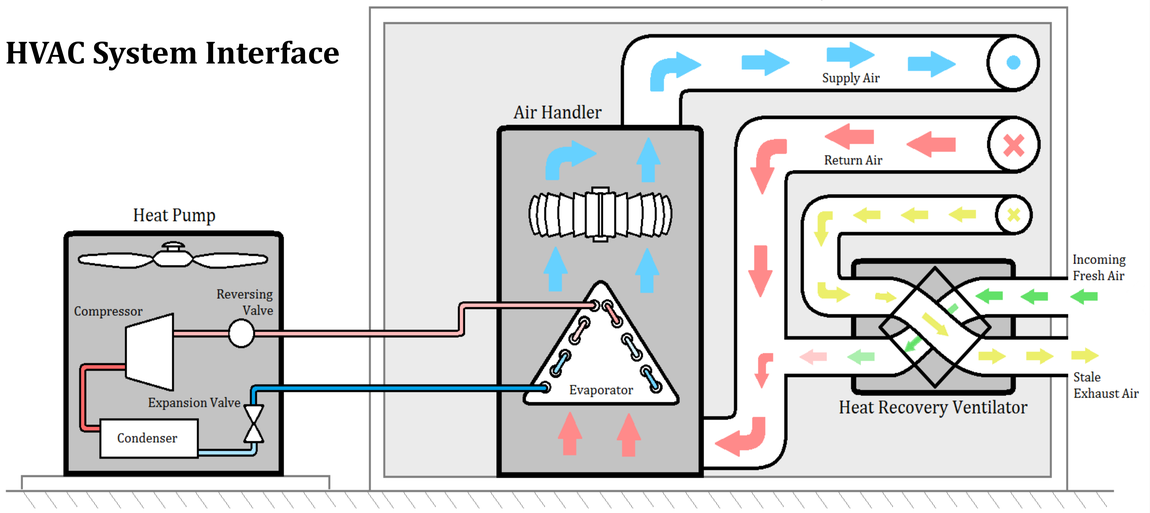
System Layout



- Diagrams above shows north-facing section view of central core of house.
- Blue ducting delivers supply air to house, pink ducting delivers return air to air handler, and green ducting provides ventilation.
- Blue assembly at eastern end of elevated chase provides ventilation through phase change material ducting (Solar Decathlon Passive HVAC Team).

- Indoor heat pump and outdoor air handler function as primary heating and cooling equipment, utilizing a vapor-compression refrigeration cycle.
- Reversing valve within heat pump allows cycle to be run in either direction, depending on heating or cooling mode.
- Heat recovery ventilator (HRV) provides whole-house exhaust and functions as a heat exchanger, increasing the temperature of incoming fresh air.
- The fresh air supply of the HRV connects into to return line of the air handler, acting as the outside air intake.

HVAC System Interface



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2014-2015

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