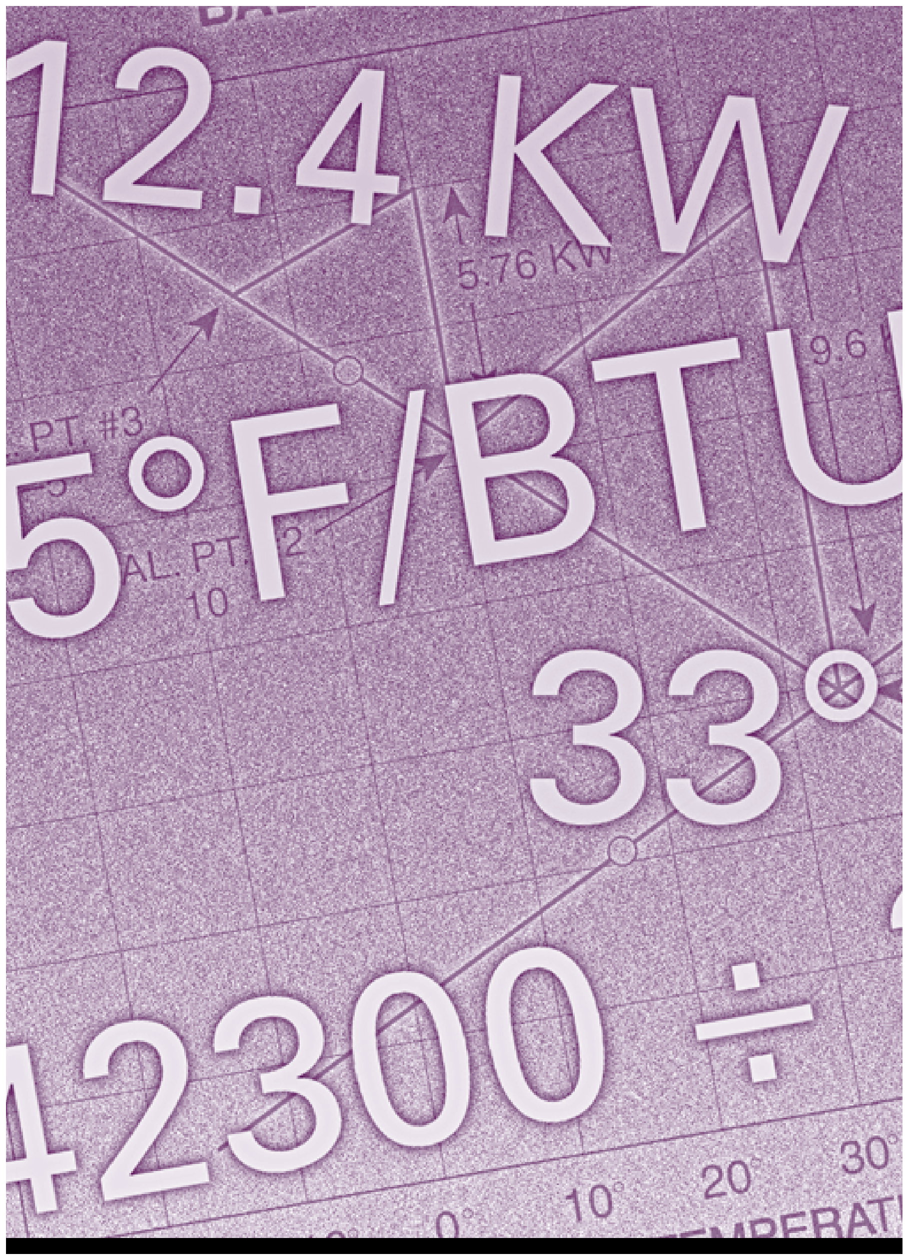
TRANE®

Application Guide

Heat Pump Guidelines



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Section 1 – Introduction

The heat pump today is basically a practical and dependable means of air conditioning and heating, but heat pumps have their place, and there is and always will be a need for a factual realistic approach in selling and applying the heat pump.

Source Of Heat

The principle of the heat pump is as old as the refrigerator since the heat pump is a simple refrigeration machine. The normal concept of a refrigeration unit is that it takes heat away, thereby producing cold. It is necessary to expand upon this concept to explain that the heat is moved to another place, that is, in a refrigerator, the heat is removed from inside the box and expelled into the kitchen, or a room air conditioner absorbs heat from the inside and discharges it outside. The heat pump explanation follows, on cooling it functions just like an air conditioner absorbing heat inside and expelling it outside – and for heating, the machine simply reverses itself and absorbs heat outside and discharges it inside.

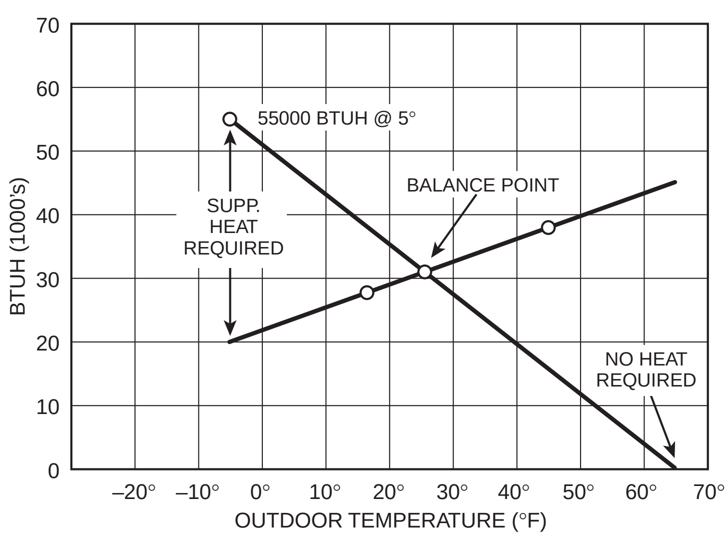

Figure 1

The source of heat for heating can be from one of three elements-water, ground or the air. The use of any one of these sources will require certain compromises. The most practical heat source for widespread use is air, and today the predominant type of equipment in use is referred to as an "air-to-air" unit. The simple explanation required here is that heat exists in air down to 460 degrees below zero so there is always heat available to be captured and moved inside at a higher temperature for heating.

If outside air at 30°F is refrigerated to 20°F, this is accomplished by the removal of heat. The heat is removed by being absorbed into the refrigerant. This absorbed heat is carried by the refrigerant to the compressor unit where it is compressed, thereby raising the temperature so that the heat can be expelled and used for heating the inside.

"Air-to-air" heat pump capacity decreases as the outdoor temperature falls because the heat is more dispersed at lower temperatures, and more difficult to capture. This is in reverse to the requirements for heating since a building needs more heat as the outdoor temperature decreases. Heat Pumps should always be selected on cooling requirements and never oversized by more than one-half ton cooling capacity. Supplementary heat must be added to compensate for the declining capacity of the heat pump. Using this approach to equipment sizing allows for a realistic first cost and an economical operating cost. Graphically, this selection can be illustrated as in Figure 1.

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Why A Heat Pump?

A heat pump is installed because it is the most economical means of heating with electricity-plus the added feature that the unit cools the occupied area with the same basic equipment.

C.O.P.

This ratio of heat output to heat energy input, expressed in related units, is referred to as the C.O.P. or the "Coefficient of Performance." Electrical resistance heating is a process of converting electrical energy directly to heat. The heat pump uses electrical energy to move heat and the result is that an average of 2 to 3 times as much heat can be moved for each KW compared to that produced by the use of straight resistance heating. This comparison may be illustrated as follows:

1 KW input to resistance heaters produces 3,413 Btuh.

1 KW input to a heat pump, operating at C.O.P. of 2.5 produces approximately 8,533 Btuh.

Control Of Supplemental Heaters

The ratio of heat output to heat energy input is also an indication of the need for precise control of supplemental resistance heaters to obtain optimum operating cost. The heat pump should be allowed to operate when its output is sufficient to handle the load, and the supplemental heaters energized only when the heating capacity is not sufficient. The supplemental heaters should be used only to supplement the output of the heat pump and then only as required.

Balance Points

The most effective means of controlling supplemental heaters is with indoor and outdoor thermostats. The indoor thermostat should have a second stage, or a second set of contacts, which operate only when the heat pump, operating through the first stage, does not maintain the desired indoor temperature.

The outdoor thermostat can be in series with the indoor thermostat second stage and be set to energize the supplemental heaters at the outdoor temperature below which the heat pump will not provide sufficient heat. This outdoor temperature is known as the first "Balance Point," a condition where the heating output of the heat pump closely matches the heat loss of the structure being heated. The simple, inexpensive combination of the outdoor-indoor control avoids the unnecessary "on" time of supplemental heaters which may be otherwise encountered and thus provides for lower operating cost. Many electronic (Smart) thermostats prohibit the unnecessary use of resistance heat so that outdoor thermostats are not required.

There may be more than one "balance point" required in the control sequence of a specific heat pump application. When this occurs, additional supplemental heaters are required, each with its own outdoor thermostat, and all controlled through the second stage of the indoor thermostat. The second stage of the indoor thermostat "sets up the circuit," and the outdoor thermostats being set to close at progressively lower balance points and outdoor temperatures hold the supplemental heaters off the power circuit until these outdoor temperatures occur. As long as the outdoor temperature remains below the temperature setting of any one outdoor thermostat its heater remains energized, if required to maintain room conditions. When the outdoor temperature rises above the thermostat setting the contacts open and de-energize that supplemental heater stage. Therefore, no supplemental heater is energized longer than necessary.

Balance Point Determination

Reference Figure 2. A unit-capacity-to-structure-heat-loss "balance point" occurs each time the capacity of the Heat Pump, and any applied supplemental heat, matches the heat loss of the structure at a specific combination of the indoor-outdoor temperatures. The first balance point is that indoor-outdoor temperature combination where the capacity of the Heat Pump alone becomes insufficient to maintain the desired indoor design temperature.

The next balance point occurs at the indoor-outdoor temperature combination where the Heat Pump plus the first stage of supplemental heat is insufficient to maintain the design indoor temperature. The second stage of supplemental heat must be applied at this point or corresponding temperature. All other balance points are treated in the same manner. This is illustrated in Figure 2 and in the following paragraphs.

The calculated heat gain of the example house in Figure 2 is 35000 Btuh at 95° outdoors and 75° indoors. A three ton heat pump system has been selected.

We must next examine the heating requirements of the house and select a resistance heater to supplement the heat pump's heating capacity at the lower outdoor temperatures.

The calculated heat loss of the house is 55,000 Btuh at 5° outdoors (70° indoors).

A line is drawn in Figure 2 from 55000 Btuh at 5° outdoors to 0° Btuh at 65° outdoors (Internal heat sources make up the difference between 65° and 70°).

The heating capacity of a TWX036C/TWE036C Heat Pump System is plotted at 17° and 47°. A straight line drawn through these two points indicates the approximate heating capacity at other outdoor temperatures.

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How much supplementary heat is needed? Three calculation methods have been used over the years:

1. 100% of the calculated heat loss at design conditions. The assumption here is that the heat pump could fail on a design day, and that 100% backup (to maintain 70° indoors) is desired. (55000 Btuh in this case)

2. Enough heat to make up the difference between the design heat loss and the capacity of the heat pump at the design outdoor temperature, (55000-15000) (from Figure 2) equals 40000 Btuh in this case.

3. Sufficient heat to maintain 55° indoors on a design day. 55000 ÷ (70-5) = 846 Btuh/°F 846 x (55-5) = 42,300 Btuh. The assumption here is that in the unlikely event of the system failing on a design day, 55° would be a livable indoor temperature.

Most electric utilities today do not want the demand of a heater large enough for 100% backup.

Unless local codes or utility requirements dictate otherwise, a heater that meets the requirements of methods #2 and #3 above is a good choice.

The larger need in this case is #3 (42,300 Btuh) 42300 ÷ 3413 = 12.4 kw @ 240V. Be sure to derate heaters for lower voltages.

The nearest heater size for the TWE036C Air Handler is the BAY96X1415 (15.36 kw @ 240V). Two stages are provided: 9.6 kw on first stage and 5.76 kw on second stage for a total of 15.36 kw (approx. 52400 Btuh). This heater will maintain approx. 67° on a design day. 52,400 ÷ 846 Btuh/°F = approx 62°. 5° O.D. design plus 62° = 67°.

Figure 2 indicates a first balance point (heat pump only) of 33°.

Bringing on the first stage of the heater gives us a second balance point of 10°.

The third balance point (with the second stage of 5.76 kw added) is -5°.

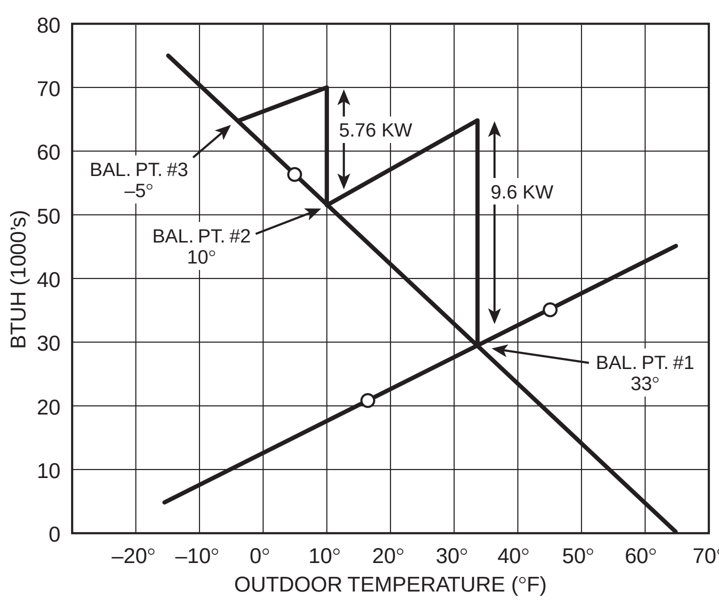

Figure 2

The vertical line at 33° on Figure 2 represents the 9.6 kw first stage of the heater. (32,765 Btuh) added to the capacity of the heat pump. The sloping line (parallel to the heat pump capacity line) to the 10° balance point represents the capacity of the heat pump plus the 5.76 kw.

The vertical line at the 10° balance point represents the 5.76 kw second stage of the heater. The sloping line from this point to -5° represents the capacity of the heat pump plus both stages of the heater.

It is common practice to use two-stage thermostats in Heat Pump applications with supplemental heaters. The Heat Pump is controlled by the first stage. The second stage energizes the first supplemental heater and sets up the circuit for the second heater which is controlled by an outdoor thermostat. Another control system employs sequencers which are energized by the thermostat second stage and they, in turn, energize the heaters, one-by-one, in a delayed program. Thus, the full load of the supplemental heaters is not thrown across the power supply at one time.

Outdoor thermostats are usually set to energize the heaters about 3°F. above the calculated balance points. This will prevent "cold air" complaints due to small discrepancies in the actual balance point on a given day.

Curve Plotting

Balance point plotting for any Heat Pump may easily be accomplished by preparing a graphic chart similar to figure 2, inserting the heating curve of the unit (taken from heating performance curves or tables) and proceeding as outlined above.

Heating performance tables show indoor temperatures of 70, 75 and 80°F. The temperature used on the balance point chart must be the same as used in the heat loss calculation for the structure.

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Time Delay

Time delay relays can be installed in the control circuit of the supplementary heaters, if desired, to prevent all heaters from being energized at once at temperatures which allow all outdoor thermostats to be closed.

Manual Heat Switch

A manually operated switch is located in the thermostat to permit operation of the supplemental heaters without the Heat Pump.

Heater Derating Due To Low Voltage Decrease

Most electric resistance heaters are rated for full Btuh output at 240 volts input. As voltage is decreased the BTU output also decreases. To determine Btuh output at 230, 220 and 208 volts, proceed as shown in the following tables.

230 volts: multiply output at 240 volts by .92

220 volts: multiply output at 240 volts by .84

208 volts: multiply output at 240 volts by .75

These correction factors apply to single or three phase current.

Defrost Cycle

During the heating cycle the outdoor coil must be at a lower temperature than outside air in order to extract heat from that air for use inside. When the outside air temperature falls to approximately 40°F the surface temperature of the outside coil will be below the freezing point. At this or any lower outside temperature any moisture in the air will condense out on the surface of the coil and freeze to frost or ice. As the frost or ice continues to build up on the surface of the coil, the amount of air passing through the coil is progressively reduced, and unit output is reduced slightly.

Since a predetermined amount of air is required for proper operation, a means is provided for automatic removal of the frost or ice. This defrosting or deicing is accomplished by a defrost control which reverses the operation of the unit to the cooling cycle which heats the outdoor coil (it becomes a condenser coil rather than an evaporator coil) thereby eliminating the ice buildup.

During the defrost cycle the machine is cooling the inside at the same time heat is required, so supplemental resistance heaters are energized automatically to nullify the cooling effect. The use of resistance heating during the defrost cycle does not materially increase the operating cost of the unit, since the average time required for defrost is approximately three to five minutes. A simple but most reliable means of defrost is a necessity for air-to-air heat pumps, and it must be automatic.

Insulating For The Heat Pump Home

The application of the heat pump should be approached with the attitude of providing the best overall economy for the user. One of the most important factors is insulation of the building. Insulation is very inexpensive when its cost is compared to the savings in first cost of equipment and to operating cost.

Installer Personnel

The installer must have within his organization the personnel and abilities to coordinate the three important requirements of air handling, electrical, and refrigeration, which are a part of each job. Failure to maintain high standards in any one of the three can result in a poor operating system.

There are some minor differences in Heat Pump selection, application and installation when compared to conventional cooling and heating systems. Therefore, one must be alert to these differences and install each Heat Pump accordingly.

Any product providing superior performance compared to the performance of another product must of necessity be different, in one way or another, to the other product. The difference may be in the individual product or in the method of application and installation. The Heat Pump is different in both respects – it combines superior design, manufacture and function with the requirements for quality application and installation. Quality application and installation cannot, unfortunately, be incorporated into the unit at the factory. It must be supplied and incorporated into the system by the installing dealer. When all of these qualities are present a superior system will result.

The major items to remember when engineering and installing a Heat Pump system are:

1. Heating and cooling are provided by the same unit.
2. Automatic switchover between functions is available.
3. Same air quantity used for both heating and cooling.
4. A declining heating output with respect to outdoor temperature.
5. Leaving air temperature is lower on heating than in conventional equipment.
6. Supplemental heaters are required in most applications.
7. The necessity for prevention of capacity losses, especially during the heating cycle.
8. Quality engineered duct systems are required.
9. Each brazed split type Heat Pump system must be carefully installed, thoroughly evacuated, and properly charged with refrigerant.
10. Each air distribution system must be carefully balanced when completed system is checked out and started.

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Section 2 – Equipment Selection

Importance Of Heat Load Calculations

The selection of a Heat Pump unit for a specific application must always be preceded by a careful analysis of the cooling and heating loads of the structure to be conditioned.

Rules Of Thumb

The necessity for precise calculation strictly prohibits the use of "Rules of Thumb" when calculating loads for Heat Pump application. This is especially important with respect to the heating load, as will be explained later, there is no substitute for organized engineering in heat pump application and installation.

Specific Heating Output

The heat pump differs from conventional heating equipment during the heating cycle in that it has a specific Btuh output for each degree of variation in outdoor temperature. For instance, if the indoor temperature is maintained at 70°F the heating capacity of a particular Heat Pump may be 36,000 Btuh at 40°F outdoor temperature and 19,000 Btuh at 10°F. outdoor temperature.

The variation in heating capacity with variation in outdoor temperature is a fairly linear function and, for this particular unit averages approximately 350 BTU per degree decrease or increase in outdoor temperature. The output of a gas or oil-fired furnace does not vary with outdoor temperature.

Furthermore, the leaving air temperature of the heat pump is considerably less than that of the gas or oil furnace and places even greater emphasis on the need for properly locating the supply outlet. Added to this is the fact that the indoor fan delivers the same quantity of air throughout the year. During the heating season the heat pump circulates this greater volume of air at lower temperatures than in any conventional system, and as a result, air velocities out of grilles may be satisfactory in summer but highly unsatisfactory during the winter unless special precautions are taken to assure (1) accurate heat load calculations, (2) top quality system design, and (3) the best possible installation procedure and workmanship.

When these precautions are observed the heat pump system becomes a highly satisfactory year-round air conditioning system providing the ultimate in comfort and economy.

Summer design conditions and unit selection are the same for the Heat Pump as for air conditioning only units.

Rules For Capacity Selection Of Heat Pump

Two good rules to remember in selecting a Heat Pump unit are:

1. The cooling capacity should be such that comfort conditions generally prevail. No excessive sacrifice of temperature and humidity control should be permitted in favor of unit oversizing for the heating function.

2. The heating capacity should be such that the design heat loss of the house be economically handled by the combined output of the heat pump plus any necessary supplemental heaters.

Power Consumption And Operating Cost Analysis

It should be remembered that any operating cost estimate is at best an estimate and should not be represented as more than that. There are far too many variables involved, over which the application engineer or this installer have no control, in the average Heat Pump application for any estimate to be classified as absolutely accurate. Such an analysis can be reasonably accurate only when the system is operated exactly as assumed in the cost estimate.

Power consumption depends primarily on three things: equipment efficiency, climate, and living habits of the user, including the indoor temperature required in the conditioned space.

If the equipment is maintained properly the margin of error in the efficiency of the unit is not substantial. Winter climates are reasonably consistent from year to year, whereas summer climates tend to vary greatly from year to year. Power consumption for cooling from one year to the next may be as much as three times greater. Living habits vary with individuals and may easily make a difference of 50% in power consumption as habits change, or between different families living in identical houses having identically applied Heat Pump systems. To be reasonably accurate an operating cost estimate must be completed for each individual application.

Considering the above, it is apparent that any calculation of power consumption can deviate greatly from what is actually experienced. Therefore, it behooves the estimator to clearly state and qualify his figures as an estimate for the conditions for which they were made, with a further qualification that living habits, which generally cannot be accurately predicted, can cause an appreciable departure from the estimate.

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Section 3 – System Design Standards

1. Equipment Selection

1.1 The Heat Pump units shall be selected according to the recommendations contained in section 2 of this manual, and all applicable information contained in appropriate Heat Pump product data.

1.2 Each Heat Pump application shall be preceded by a careful survey of the proposed job; taking into consideration all facets of house construction and usage, design indoor and outdoor conditions, availability of electricity, condensate drains, type of duct system required, location of outdoor and indoor unit, the location of indoor thermostat, supply and return grilles, and other information pertinent to the application.

1.3 Final choice of the Heat Pump unit shall depend upon the primary function of the system and the degree of control of indoor summer dry bulb temperature and summer indoor wet bulb temperature desired by the customer.

1.4 Heat gain and heat loss calculations should be completed for each application, using the load calculation method and form recommended for the type of application.

2. Equipment Location And Orientation

2.1 The Heat Pump outdoor unit, in split systems, should be located in such a manner that minimum refrigerant line lengths are required.

2.2 Heat Pump outdoor units should be positioned on a concrete pad having sufficient rectangular dimensions and ground depth to assure proper support of the unit at ail times without shifting, sinking or tilting for any reason. Concrete pad to be isolated from structure.

2.3 Each outdoor unit, and each self-contained unit whether outdoor or indoor, shall be supported by appropriate vibration absorbers to eliminate vibration and allow air to circulate under the unit.

2.4 Heat Pump units having free vertical discharge of outdoor air should not be installed or mounted beneath wide and/ or low roof overhang, dense foliage, trees, or other objects which may obstruct or block free flow of the air, or cause recirculation of air between the discharge and inlet. Vertical discharge units can be ducted according to limits listed in product data application bulletins.

2.5 Heat Pump outdoor sections having horizontal air inlet and outlet shall not be installed or mounted close to walls and other obstructions which may restrict free flow of outdoor inlet air.

2.6 Heat Pump units of any type or model should not be mounted or installed in such a manner as to restrict service access.

2.7 Heat Pump outdoor section should be installed or mounted in such a manner that any objectionable noise will not be directed into closely adjacent buildings.

2.7.1 Noise shields, baffles and sound absorbers can be installed around the outdoor unit when unit noise is considered objectionable.

2.8 Heat Pump outdoor sections shall be mounted and installed in such a manner that snow, and ice due to blowing rain in cold weather, cannot block the outdoor coil. In deep snow areas the unit should be mounted on supports high enough to prevent drift blockage, possibly 12" to 36" off of the ground.

2.9 Heat Pump indoor sections should be suspended, mounted on vibration absorbers or otherwise supported in such a manner that the section will operate with a minimum of vibration and a minimum of noise.

2.10 Enclosures or other concealment devices surrounding indoor air handlers shall be so constructed as to permit reasonably easy access to the unit for service and maintenance purpose and shall be equipped with removable panels to permit complete removal and replacement of replacement parts.

2.11 The location for roof mounted units shall be carefully chosen and the unit mounted on appropriate support beams.

3. Heat Pump Duct Systems

3.1 Each Heat Pump supply and return duct system shall be very carefully designed in accordance with best recommended duct design procedure. Design air quantity shall be maximum the year around. (Approx. 400 CFM/Ton)

3.1.1 Heat Pump duct design procedure shall be similar to that contained in the chapters of the ASHRAE Guide and Data Book. Fundamental Edition, entitled ''Air Duct Design" and "Space Air Distribution."

3.2 Air velocities in the supply and return duct shall be within the ''recommended" range as shown in table 1, or as recommended in the ''Air Duct Design" chapter of the ASHRAE Guide and Data Book, Fundamentals Edition. Air velocities for residential applications shall not exceed the ''recommended" range.

3.3 Heat Pump duct systems should be constructed of sheet metal or fiberglass material, carefully assembled and installed to avoid any leakage of air into or out of ducts.

3.4 Acceptable duct systems should be constructed of materials specified in paragraph 3.3 and should form a continuous path for the air from a positive connection at the air conditioner at both supply and return connections to the farthest air outlet or return except as noted elsewhere in these specifications for closet application.

3.4.1 Flexible connectors should be installed at the unit for both supply and return trunks.

3.4.2 Each branch take off from main trunks should be by smooth transition from trunk to branch.

3.4.3 Where square elbows are necessary properly designed and installed turning vanes should be used.

3.5 Supply duct shall not be located in a concrete slab except under the following conditions:

3.5.1 The perimeter of the slab must be insulated according to National Environmental Systems Contractors Association (NESCA) recommendations.

3.5.2 If rectangular ducts are installed, they should be internally insulated with not less than one (1) inch rigid board insulating material.

3.5.3 Slab ducts shall be graded toward a common plenum in which a water pump may be placed in order to remove any water which may enter the duct system. Ordinary trapped drains may not be used in the common plenum because of the possibility of flooding, due to the back-flooding of drainage sewers or drains.

3.6 All supply ducts, except those constructed of at least one (1) inch of fiberglass material or equivalent, should be internally insulated with not less than one (1) inch of rigid board insulation, or, externally insulated with not less than two (2) inches of fiberglass insulation or equivalent covered with vinyl or foil vapor barrier.

3.7 Fiberglass duct with a vapor seal covering, such as Owens-Corning, Knauf, Certain Teed, Manville, or equal, may be used in lieu of the exposed duct with internal or external insulation as specified in paragraph 3.6.

3.8 Each branch supply duct should be equipped with a volume damper to provide accurate balancing of air distribution system.

3.9 Return duct systems shall be designed and installed in accordance with the following specifications.

3.9.1 For maximum performance and comfort conditions the return duct should have one or more grilles in each of the rooms.

3.9.2 A single central low wall or floor return grille with high side-wall supply systems is to be avoided where ever possible. It may be employed when all three of the following circumstances exist.

a. The total area of the house does not exceed 1,800 square feet.

b. There are no large picture windows or sliding glass doors in any conditioned area, such as den, living room, or bedrooms.

c. The central return is open on to or right at the living room so that it pulls into the air conditioner any cold air which may accumulate on the living room floor.

3.9.3 A single central return may be used with a perimeter system providing the return grille is high in the wall or is in the ceiling. Otherwise, the perimeter system should have return grilles located around the house in the most advantageous floor level position.

3.9.4 Where the indoor unit rests on a raised platform forming the top of a return plenum, the interior of the plenum should be sealed to prevent air leakage and the floor of the plenum should be insulated with not less than two (2) inches of insulation.

Residential
Recommended Air Velocities

	RIGID	**FLEX**
Supply Main Duct	700 – 900 F.P.M.	600 – 800 F.P.M.
Supply Branch Duct	500 – 700 F.P.M.	400 – 600 F.P.M.
Return Main Duct	600 – 800 F.P.M.	500 – 700 F.P.M.
Return Branch Duct	400 – 600 F.P.M.	300 – 500 F.P.M.
Return Grille	400 – 600 F.P.M.*	
Filter Grille	300 F.P.M. or 2 CFM per sq. in.	

* Based on Gross Area of Grille.

From Pub. No. 32-3011-1

Table 1

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3.9.5 All return ducts running in unconditioned areas including crawl spaces, attics, garages, etc., should be insulated with not less than two (2) inches of fiberglass insulation, or equivalent, having a vinyl or foil vapor barrier. The only exception to this should be when the ducts are internally insulated with not less than one (1) inch of rigid board insulation, or, when round or rectangular fiberglass duct material is used.

3.9.6 Air velocity in return ducts shall be as recommended in the ASHRAE Guide and Data Book, or as shown in table 1.

4. Registers, Grilles And Filters

4.1 Supply registers used with Heat Pump duct systems should be best quality, adjustable double deflection types, providing the proper face velocity, recommended distribution air pattern, and pleasing appearance.

4.2 Return grilles should provide sufficient free area.

4.3 Supply registers should be located and positioned according to paragraph 3.

4.4 Maximum face velocity from supply grilles should be limited to 600 FPM. Recommended face velocity is 500 FPM or less.

4.5 Maximum face velocity through return grilles should be limited to 400 FPM. Recommended velocity is about 300 FPM. Filter face velocities of 300 FPM are recommended.

A good rule of thumb for sizing filters and filter/grilles is two CFM per square inch of filter area.

4.6 One or more filter return grilles may be used in lieu of the unit filter and filter rack providing the free area of such a filter grille or grilles is sufficient to provide grille face velocities not greater than specified in paragraph 4.4 and provided all return air is directed through such filter grilles. Duct collars between the filter grille and unit are recommended although these may be omitted where central returns are employed and the air handler enclosure or closet is tightly closed. Filter grilles should have easy access for the removal and replacement of the filters.

4.7 All return grilles located near the air handler should be so located and installed as to reduce the possibility of fan noise transmission into the conditioned area. Where a central return grille must be located directly beside or behind the air handler, the duct collar leading to the unit should be internally insulated to dampen noise transmission. At least one 90 degree turn or two 45 degree turns are recommended in the air stream between the grille and the unit air inlet.

4.8 Filters may be of the permanent or semi-permanent washable types or of the disposable types. Either type should be of the size recommended by the product data covering the unit being applied.

4.8.1 Free access should be provided for filter removal and replacement in each installation. Where the unit filter and filter rack are retained in the installation the unit shall be located and mounted to permit removal and replacement of the filters.

4.9 All of the supply registers and return grilles, if of the adjustable type, should be properly adjusted and the system balanced for airflow as promptly as possible after system completion, startup and checkout is accomplished.

5. Condensate And Defrost Drains

5.1 Each indoor air handler should have installed a condensate drain pipe and trap according to Installers Guide recommendations.

5.2 Each outdoor unit installed indoors should have installed a properly sized defrost water drain pipe and trap plus a defrost overflow drain pipe according to product and installation data recommendations.

5.3 Where defrost water drain pipe runs through an area subject to outdoor air temperature (paragraph 5.2) the drain pipe should be protected against ice freezing within the pipe and drain by use of electric heater wire wrapped around the pipe and trap, or by some other equally effective method.

5.4 The defrost drain of outdoor units installed outdoors need not be piped and trapped and may have free flow of defrost water from the drain fitting.

5.5 A protective drip pan or overflow pan with insulated drain line, should be installed beneath either indoor or outdoor units installed in attics or in any location where overflow water may damage interior finish and/or the construction.

5.6 Condensate drain pipes should be insulated with the same material recommended for suction lines, and by the same method, when such pipes run through areas where damage may occur to the structure due to secondary condensation on the surface of the drain pipe.

6. Refrigerant Lines

6.1 Refrigerant piping shall be of the commercially recommended dehydrated and sealed copper tubing or type “K” or “L” tubing, but in no case shall type ‘’M” tubing be used.

6.2 Refrigerant lines for brazed system Heat Pumps shall be sized according to product and installation data recommendations. Long sweep elbows should be used. (Refer to Pub. No. 22-3040, ‘’Refrigerant Piping Manual”)

6.3 The entire length of the gas line in a split system Heat Pump installation must be insulated with Armaflex, Rubatex or equal.

6.4 Suction and liquid lift for all split type Heat Pumps should not exceed the maximum limitations specified in product and installation data without prior approval of application engineering.

6.5 Refrigerant lines should not be embedded in concrete of slab floor but may be run through conduit or large pipe which is embedded in concrete. Gas lines must be insulated.

6.8 Best commercial practice should be used at all times when cutting and brazing refrigerant lines. The use of a hacksaw is forbidden. Always use a tubing cutter to avoid the entry of ''sawdust" into tubing. Flaring, where required or necessary, should be accomplished with a good commercial flaring tool.

6.9 Flattening, sharp bends, kinks, twists and breaks in refrigerant tubing must be avoided at all times. A kink or excessive flattening of the liquid or suction line will adversely affect the operating characteristics of the Heat Pump.

6.10 Refrigerant lines running through the building should be properly supported at intervals in such a manner that the tubing will not be placed under strain or form oil traps. Refrigerant lines should not be rigidly attached to such supports but should have sufficient flexibility to prevent any refrigerant line noise from transferring into the support and the building.

6.11 All brazing must be with Silfos, or equal, and shall be accomplished in the best prescribed manner to assure tight joints. To avoid oxidation and scaling within the tubing a small amount of nitrogen should be continuously bled through the tubing during the brazing operation.

6.12 Uninsulated liquid and gas lines must be kept separate.

6.13 Liquid and gas lines must not be insulated together.

6.14 Separately insulated liquid and gas lines may be taped together.

6.15 Never install a drier or filter in the connecting lines of a heat pump system. Reverse refrigerant flow will carry the trapped contaminants to other parts of the system. The factory installed liquid line drier has check valves to prevent reverse refrigerant flow. If a suction line drier is required after a compressor burnout, it must be installed between the compressor and the switchover valve, in order to prevent reverse flow. (Use the appropriate suction line drier kit.)

7. Electrical

7. 1 The electric power service entrance to the building should be large enough to handle the normal house load plus the load of the Heat Pump and a full complement of supplemental heaters. If not, a new service entrance should be installed.

7.2 Heat Pump and supplemental heater disconnect switches and fuses should be as recommended in the product and installation data for the unit, and local and national codes should apply.

7.3 The branch circuit wire sizes to the Heat Pump and the supplemental heaters should be as recommended in the product and installation data for the unit, and local and national codes should apply.

7.4 Power and control wiring shall conform to diagrams as contained in the unit installation data.

7.5 All controls should be those recommended for the unit.

7.6 All power and control wiring should be thoroughly traced and inspected, and any corrections made, before power is applied to any part of the system.

7.7 All power wiring shall conform to national and local codes as well as to product data recommendations.

8. Evacuation And Charging

8.1 The entire refrigerant system must be evacuated per instructions contained in the product installation and service data sheets and manuals. E.P.A. rules for refrigerant recovery must be followed.

8.2 At no time shall the Heat Pump unit compressor be utilized for system evacuation.

8.3 The refrigerant system should be charged with the recommended amount of R-22. No other refrigerant is to be used.

9. Testing And Balance

9.1 The system should be thoroughly checked out before being operated to assure that all phases of the installation have been performed satisfactorily and the system is complete in every way.

9.2 A second checkout should be made with the entire system in operation. This procedure shall include a systematic check of voltage and current, suction and head pressures, operation of all controls, unit defrost cycle, heating cycle, outdoor and indoor fan performance, adjustment of registers and grilles, and general balancing of the air distribution system.

The most satisfactory system balance is accomplished in new construction by making a preliminary balance before the tenant or owner moves in and then completing the job after he has lived in the house for a few days. He is then able to tell you which room or areas need additional adjustment to satisfy his requirements.

Tighten the screw lock on all supply registers after the final balancing adjustment has been made.

9.3 The customer should be thoroughly instructed in the use and operation of his Heat Pump system, with specific attention to operation of the Heat Pump thermostat, and the importance of maintaining clean air filters.

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Section 4 – Low Ambient Operation In Cooling

It is not unusual for commercial and industrial structures to require cooling operation of applied Heat Pumps when the outdoor temperature is lower than the indoor design temperature. This is called ''low ambient cooling" or "low ambient operation."

The necessity for low ambient operation is due to the heat gain produced by constant internal heat sources which is of sufficient value to more than offset the normal heating requirements of the structure during periods of low ambient temperatures.

When the internal and total heat gain of a structure, including solar and air-to-air gain, are plotted against the actual heat loss calculated as if no internal gain existed, the point at which the internal heat gain curve intersects the total loss curve is called the ''equalization point" or the point at which the internal gain balances or equals the heating requirements of the structure. This point will usually occur at some outdoor temperature lower than the design indoor temperature. Cooling will be required above the point but below it additional heating must be supplied to provide sufficient capacity to meet the total requirements from the equalization point down to the design outdoor temperature.

The additional heating is provided by the Heat Pump or by the applied resistance heaters or by both.

The AY28X084 low ambient cooling kit for heat pump systems consists of an evaporator defrost control (the same as the AY28X079 control), plus a relay which bypasses the EDC during defrost. The control capillary is to be inserted between the fins of the indoor coil on the leaving air side covering the entire finned height of the coil. When any part of the coil drops to approximately 25°F., the control opens the ''Y" circuit and shuts off the compressor. When the coil temperature reaches approximately 65°F., the control closes and restarts the compressor. The indoor fan continues to operate during this ''off" period drawing room air across the coil.

Low ambient limits vary considerably by model. Refer to the product data manual for the model in question to determine the (cooling) low ambient limit.

Section 5 – Education: Customer, Dealer and Dealer Employee

The two factors contributing most to owner dissatisfaction with an air conditioning system, and especially with a heat pump system, are the absence of customer or owner education, and satisfactory dealer-customer relations. All too often the owner of a new air conditioning system is left to his own ingenuity to solve the "mysteries" of operation, preventive maintenance, and service availability.

Often the absence of operating instructions, which should be provided by the installing dealer, places owner system operation in the ''mystery" category and elevates preventive maintenance and service availability to the position of absolute nuisance for dealer and for the customer.

This is especially common in new house construction where the system is installed and completed prior to possession by the owner. The dealer often ''completes" the installation and moves out; leaving the builder and the owner to their own devices in placing the system in operation.

All too often the installer omits one little detail of the installation which prohibits operation of the system by simple manipulation of the thermostat. The system should be checked out for thermostat operation before the owner moves in.

There are two common methods of customer product education as far as system operation is concerned. The first is direct vocal instructions, and the second is by printed instructions, either handed directly to the customer or left for him to find.

The most effective method makes use of both vocal and printed instructions covering important points of useful information relating to his system and its operation, followed by a direct presentation of the printed material.

It is understood, of course, that personal instruction is not always possible, for one reason or another. The best possible alternative is to leave the printed instructions inside the house, at a point where it is almost impossible for the home owner to overlook, ignore or remove them without some difficulty.

The Heat Pump Use and Care Book is included with each unit. This booklet should be delivered directly to the customer, or, when this cannot be done, should be left hanging on the indoor thermostat.

Following is an example of the operating instruction, which could be attached to the thermostat.

TRANE®

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How To Operate Your Heat Pump

Your Heat Pump heating and cooling system has been carefully installed, checked out, and operated by us and it should be ready to operate for you by operation of the thermostat.

1. The Thermostat

On a wall in your home is a high quality, closely calibrated thermostat. The thermostat is a delicate instrument and must be treated as such. Do not subject it to hard knocks or other shocks and do not permit the children to play with it at any time.

Do not operate any of the switches on the thermostat until you have read these instructions through.

The thermostat will operate the Heat Pump in either the heating or cooling cycle by positioning the "system" switch on the lower face of the instrument to "heat" or "cool". (Or "automatic" with automatic changeover thermostats)

When the "system" switch is at "off" the Heat Pump system is off.

The ''fan" switch controls the operation of the indoor fan and is independent of the ''system" switch. When the "fan" switch is on "auto" (automatic) the fan operates only when the entire Heat Pump system is in operation, and will automatically start and stop when the thermostat makes or breaks the circuit.

When the "fan" switch is in the "on" position, the fan will run continuously regardless of whether or not the system is running for heating or cooling or is off. It will continue to run even though the "system" switch is in the "off" position. To stop it move the "fan" switch to "auto."

Note, there is no fan "off" position on the fan switch. There is a good reason for the absence of an "off" position. If the fan could be turned off when the Heat Pump is in operation for cooling or heating, air movement through the indoor coil would cease and the Heat Pump would cease to operate.

The "on" position of the fan also permits its use for ventilating when neither cooling nor heating is desired.

The "auto" fan switch position provides the best comfort (and economy) for the great majority of homes.

Avoid moving either of the switches or the temperature selector on the thermostat rapidly back and forth through their positions or range. This places undue stress upon the Heat Pump system, and if done too often, may damage some part of the system. If switching, for instance, from heating to cooling, move the "system" switch to "off," wait five or six seconds, and then switch to ''cool."

2. Practice Operation

Follow carefully the practice procedure outlined below and you should fully understand the operation of your Heat Pump.

a. Move thermostat "system" switch to the "off" position.

b. Move the ''fan" switch to the ''on" position. Note that the fan starts and continues to run until you move the switch back to ''auto."

Cooling Operation

a. With the "system" switch still in the "off" position, move the temperature selector to the highest temperature on the indicator.

b. Now move the "system" switch to the "cool" position.

c. Then run the temperature selector down the scale until the Heat Pump starts.

d. Move the "fan" switch from "auto" to "on" and note the fan continues to run. Move it back to "auto." In humid areas, the fan switch should be left in the ''auto" position during cooling operation.

Heating Operation

a. Now move the "system" switch back to "off."

b. Then run the temperature selector down to the lowest temperature on the indicator.

c. Move the ''system" switch to ''heat." Wait two or three minutes.

d. Then run temperature selector up the scale until the Heat Pump starts. Let it run a few minutes and feel the air coming from the nearest outlet. It should be warm.

If you have been accustomed to a gas or oil-fired furnace you will note that the air coming from the outlet is a bit cooler than your previous experience. Do not be alarmed, because the Heat Pump is designed to operate at lower discharge air temperature than the gas or oil-fired system and will provide pleasant and satisfactory heating at this lower air temperature.

e. Move the "fan" switch from "auto" to "on" and note the fan continues to run. Move it back to "auto" or leave it at "on," depending upon which type of fan operation you desire.

f. If this operating practice takes place during warm weather do not operate the Heat Pump on the heating cycle for extended periods of time. If left too long in heating operation when outdoor temperatures are high, the indoor coil will be overloaded with heat and then the Heat Pump will cease to operate.

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3. Filters

For full performance of the Heat Pump, the air filters in the indoor unit must be kept clean either by periodic washing of permanent or semipermanent types, or by replacement of disposable types.

The filters for your Heat Pump system are located either inside the air handler or in a special filter rack attached to the unit at the return duct. Ask the installer to instruct you in filter removal and replacement. If he is unavailable, call us for instructions or proceed as follows:

To check or replace filters, shut down the system by moving the “system” switch on the thermostat to the “off” position and the fan switch to the “auto” position. Then remove the front panel of the indoor unit. This may or may not require the removal of four or more slotted screws, depending on unit model number.

Locate the filter. Grasp the end and pull out, or lift out. Clean the filter and replace by the reverse procedure, or insert a new disposable type filter.

Scott-Foam semipermanent type filters may be washed by removing the filter material from the frame and washing in mild soap in the laundry tub or the kitchen sink. Do not use strong detergents.

If you have any difficulty in replacing filters, call us for help. Most filters have arrows on the frame to indicate the direction of airflow, if you are unable to find the arrows, install the filter with the “clean” side toward the indoor heat pump unit.

4. Damage

Do not permit children to insert sticks, stones or other matter into the coil or fan compartment of the outdoor unit. If the coil fins are permitted to become damaged, operation of the Heat Pump may be seriously affected and it may cease to operate.

5. Outdoor Refrigerant Lines

If the refrigerant lines between the indoor and outdoor units of your Heat Pump system are exposed near the ground on the outside of the house caution all members of your family, or the yard man, not to operate a power lawn mower closely to these lines. If they are cut by the blade of the mower all refrigerant will be lost, necessitating a repair bill which may be avoided by the exercise of proper precaution.

The foregoing information constitutes the fundamentals of operating and caring for your Heat Pump air conditioning system. If you feel you need additional instruction, or if anything should happen which has not been covered above, or if your system fails to operate after the above instructions have been carried out, please call us as promptly as possible.

ABC Heating and Air Conditioning

2121 Public Avenue
Weathertown USA

Night Service: 234-5678
Day Service: 311-1121

Instruction sheets such as the above may be typed and multilithed at very little expense to the dealer. The cost is negligible when compared to the goodwill derived and the benefit to the customer and to you. You may have ideas which can be incorporated into a better set of operating instructions. In any event, the format doesn’t matter a great deal; it’s the content which counts.

The foregoing instructions may be modified for the automatic thermostat with manual heat switch.

Do not cut the power off to the outdoor unit. If, for some reason, you do not want the heat pump to operate, set the system switch to the “off” position. (The fan switch should be in the "auto" position, if fan operation is not desired.)

If the electric power is off for a significant period of time (more than 15 minutes), move the system switch to the “off” position. As indicated above. In cold weather, leave the system switch in the “off” position (power "on" to the outdoor unit) for 30 minutes per lb. of refrigerant in the system, after power has been restored. (Check the outdoor unit nameplate for standard refrigerant charge.)

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Notes

Notes

It's Hard To Stop A Trane.®

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