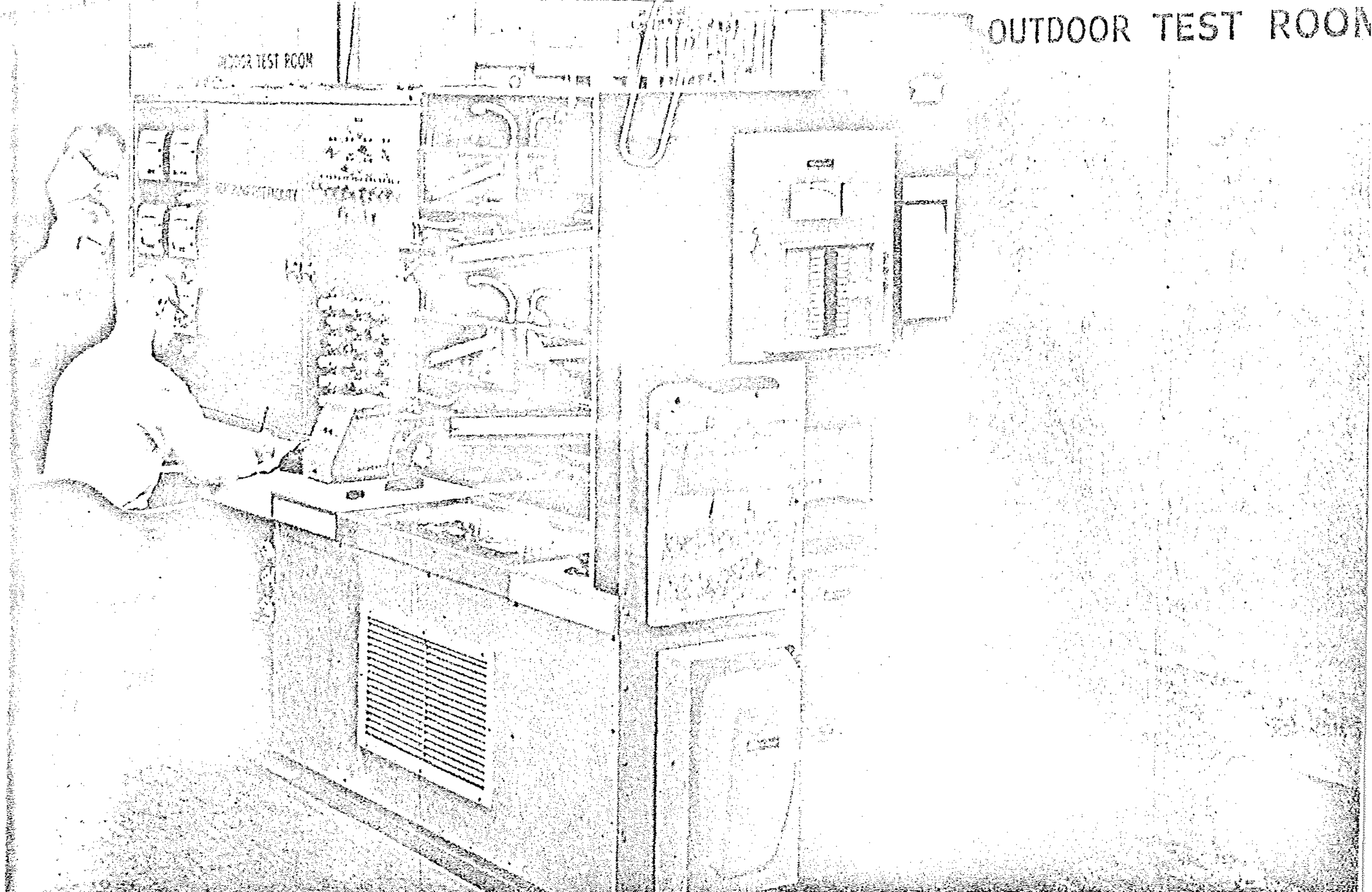

Control console of the heat pump test facility at Electrical Testing Laboratories, New York, where heat pump equipment is ...ed under the Certification Program of the Air-Conditioning and Refrigeration Institute. President Hoffman A. Beagle of ... (left), and ARI Chief Engineer Frederick J. Reed look on as Technician Charles Burger of the ETL staff takes readings on ... test underway in the indoor and outdoor test rooms, shown at left and right of console.

HEAT PUMPS : SELECTION AND APPLICATION

Classification of Heat Pump Types • Applied Heat Pump Systems • Equipment Selection and Feasibility Considerations • Controls for Unitary Heat Pump Systems • Applications • ARI Organization and its Certified Ratings • Heat Pump Equipment

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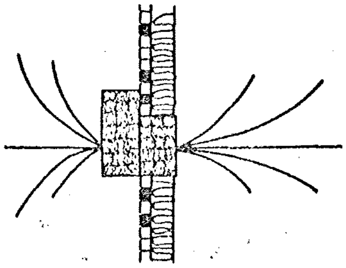


CLASSIFICATION OF HEAT PUMP TYPES

THE air conditioning and refrigeration industry has, over the past 15 years, developed the heat pump from what was once considered a novelty or engineering curiosity into a practical device which is competing for a significant portion of the comfort heating market.

In addition to manufacturers, the heat pump is receiving considerable publicity and promotion from electric utilities which are interested in fostering the use of electrical energy for heating buildings. Architects and engineers are showing increased interest in construction and owning cost savings which can be realized by specifying heat pumps. In some areas the heat pump is successfully competing with other methods of heating on either an initial or operating cost basis, and sometimes both. Where air conditioning is a prime requirement, the heat pump is a logical consideration for supplying both cooling and heating.

Today, heat pumps are being manufactured in a wide variety of types and sizes. They are used in homes, apartment houses, stores, supermarkets, factories, schools, and offices.

In recognition of the status the heat pump has attained and the growing importance of it, this article has been prepared to acquaint those interested in this remarkable product with its basic principles and terminology.

The heat pump does not create heat but takes heat from an available source and delivers it to a space requiring it at a higher temperature. This characteristic gives the heat pump some unique advantages over the more familar heating apparatus.

Advantages to Owner

1. *Equipment room floor space*—Since the same equipment is used for both heating and cooling, space normally taken up for a conventional heating system is available for other purposes.
2. *Area and building cleanliness*—Since there is no fuel to handle, no smoke stacks to create fumes and soot, and no boiler tube cleaning or soot removal, cleaning maintenance and general unsightliness is eliminated.
3. *Standby losses* — Since no standby boiler is needed during intermediate seasons with a heat pump system, operating costs are lower.
4. *Changeover operation* — Since changeover from heating to cooling and back is fully automatic with a heat pump system, operating personnel for shutting down or starting up the systems are not required. Occupant comfort is increased due to availability of building heating or cooling during any season of the year.
5. *Electrical power* — Costs of generating electricity are expected to continue their present economic trends but oil and gas costs have been increasing at a greater rate in most cases. Heat pumps rely on electric power primarily and so the indication is that heat pump operating costs will remain stable.
6. *Lower building cost*—Since no smoke stack is required, the equipment room can be a roof penthouse.
7. *Water treatment* — Expensive boiler water treatment is not necessary and hence maintenance problems are reduced.
8. *Insurance rates*—In some localities, insurance companies offer lower rates due to the absence of a boiler and its necessary smoke stack.
9. *Progressive owner* — Public image is enhanced based on heat pump owner being a progressive businessman who keeps up with the latest developments.
10. *Maintenance agreements* — Maintenance problems are handled by one group hence eliminating any division of responsibility between heating and cooling maintenance people.
11. *Heating coils*—Lower water temperature range (100 to 155 F) in heating coils, therefore dust particles, which burn at approximately 137 F, won't burn and cause odors in occupied areas.

Terminology

There are many basic terms used in connection with the heat pumps and it will be helpful here to review and define them in the sense they will be used in this article. Although the definitions may not agree with all industry usage, the meanings are generally accepted versions.

The *heat source* is the medium from which heat is obtained by the heat pump. Conversely, this medium becomes the *heat sink* when the system is operated on the cooling cycle and heat from a conditioned space is rejected to the medium. This medium may be air, water, earth or other large capacity body, and hence the terms *air source, water source* and *earth source* heat pump.

An abbreviated terminology is used in the classification of heat pumps. For example, an *air-to-water* heat pump would define a heat pump extracting heat from the outdoor *air*, pumping it up to a higher temperature level and delivering it to a *water* distribution system within the building. On the other hand, a *water-to-air* heat pump would take heat from a *water* source such as a well, lake or canal and, pumping it to a higher temperature, deliver it to an *air* distribution system in the building. Other commonly used types of heat pumps that will be discussed are air-to-air and *water-to-water*.

Coefficient of Performance (COP) expresses the efficiency of

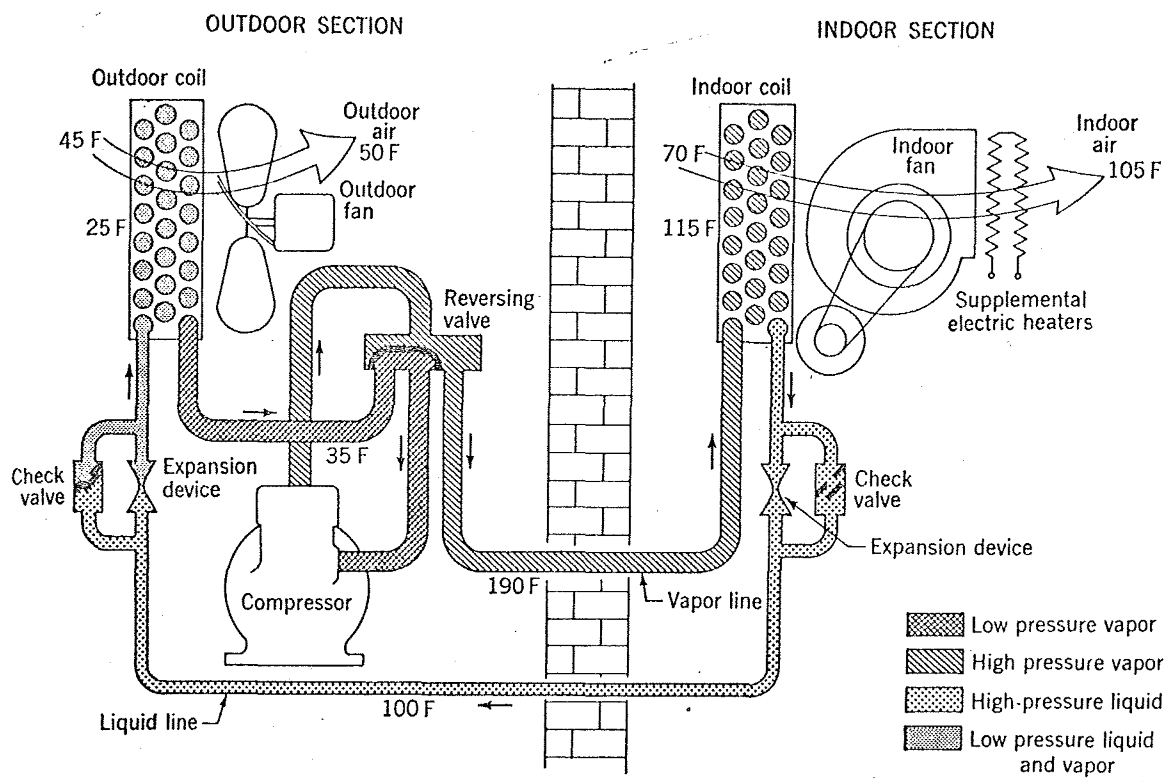


Fig. 1. Heat pump on cooling cycle.

a heat pump and is defined as the ratio of total useful heat output to the heat equivalent of the input energy required to operate the compressor motor and auxiliaries. In practical systems the COP varies from 1.5 to 5. The greater the difference in temperature between the heat source and sink, the lower the COP for any given heat pump. The COP among different heat pumps operating at the same heat source and sink temperatures may be different depending on the dynamic characteristics of the compressor and heat exchangers.

Another useful term is *Performance Factor* (PF) which is similar to COP, but used when referring to values extending over a period of time such as a day, month or season. Knowing the seasonal PF for a heat pump enables its operating cost to be compared to other methods of heating. The COP, is an instantaneous value, and when used for this purpose could give misleading results. However, it is very useful in making comparisons between individual heat pump designs.

The Heat Pump Cycle

To illustrate operation of the heat pump, a simplified cross-section of the refrigerant piping and basic components is shown in Fig. 1. It is typical of the many thousands of air-to-air split system heat pumps in operation today in residential and commercial buildings. On cooling cycle, high pressure liquid refrigerant is fed to the indoor coil through the expansion device where it evaporates, picking up heat from indoor air. Emerging low pressure vapor passes through the vapor line, through the reversing valve to the compressor where it is brought to a high pressure vapor and sent back through the reversing valve to the condenser. This vapor gives up heat to the outside air and is condensed back into a liquid. It passes out of the condenser, around the expansion device via the check valve and into the liquid line to complete the cycle.

To operate on heating cycle the slide in the reversing valve moves left as shown in Fig. 2. The compressor then delivers high pressure vapor to the indoor coil where, in condensing it gives up heat to the indoor air. The liquid refrigerant by-passes the expansion device via the indoor check valve and is conducted to the outdoor expansion device through the liquid line. Here it is fed into the outdoor coil where it is evaporated at a low enough pressure and temperature to absorb heat from the outdoor air. The refrigerant emerges from the outdoor coil as low pressure vapor where it is directed by the reversing valve back to the compressor.

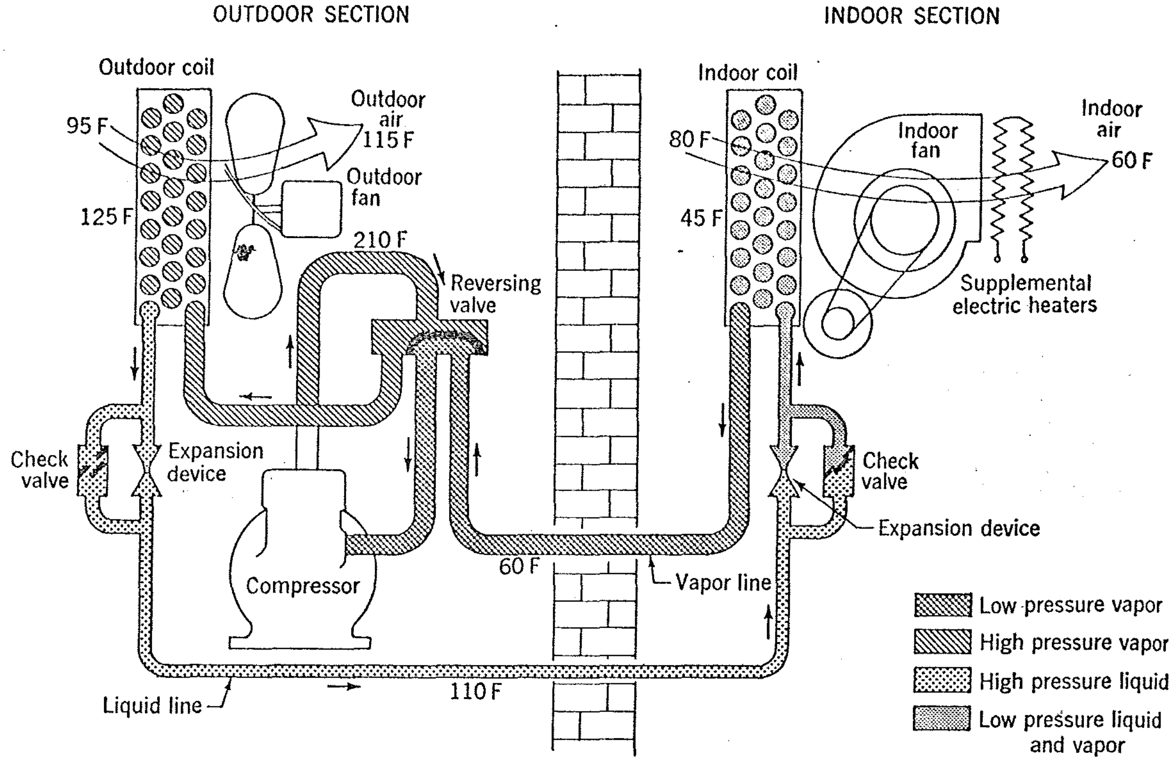


Fig. 2. Heat Pump on heating cycle.

CLASSIFICATION OF HEAT PUMPS

Unitary Heat Pump Systems

Air Conditioning and Refrigeration Institute Standard 240-64 defines a *Unitary* heat pump as one or more factory-made assemblies which normally include an indoor conditioning coil, compressor(s), and chiller-condenser or outdoor coil, including means to provide both heating and cooling functions. Further, they have found the following basic order of classification the most convenient way of identifying the many types of unitary heat pumps.

Single-Package Heat Pumps

HSP-A: Air-source
HSP-W: Water-source

Split System Heat Pumps

HRCA: Heat Pump with Remote Outdoor Coil, Air-source

HRCU-A: Heat Pump with Remote Outdoor Unit, Air-source

HRCU-W: Heat Pump with Remote Outdoor Unit, Water-source

Heat Pump Components

Figs. 1 and 2 show the basic components of a unitary heat pump. It can be seen that components of a complete refrigeration cycle are present plus some additional ones to provide the functions of a heat pump. In the refrigeration circuit there must be a four-way valve or equivalent device to reverse the refrigerant flow when changing from heating to cooling or vice-versa. Some means must be provided for feeding refrigerant to the outdoor coil so it can function as an evaporator on heating cycle. This can be accomplished by adding an additional expansion valve or capillary tube suitable for the purpose. Check valves are commonly used to by-pass liquid around the refrigerant feeding device of both indoor and outdoor coils when they are operating as condensers. Use of receivers is sometimes avoided in unitary heat pumps, especially smaller sizes, since they tend to complicate refrigerant piping and make liquid subcooling in condensers more difficult. Subcooling is desirable because it promotes greater operating efficiency. When a receiver is used it must be designed for thru-type operation, that is, it must handle flow of liquid in either direction.

Most unitary heat pumps come equipped with, or make provision for, addition of supplemental electric resistance heat. These heaters are used to supplement the heat pump's output when it becomes less than the load called for due to a drop in heat source temperature. They also provide emergency heat in the event of a failure of the entire heat pump apparatus. The indoor circulating fan is depended upon to carry heat from the supplementary heaters. Should forced air circulation fail, high temperatures can build up quickly and it becomes necessary to provide temperature limiting thermostats to cut off the electric heat. These are automatic reset type and will cycle the heaters until the fault is corrected. Sometimes for added protection fusible links are provided in heater wire terminals. If these melt, the heaters would be inoperative until the links were replaced.

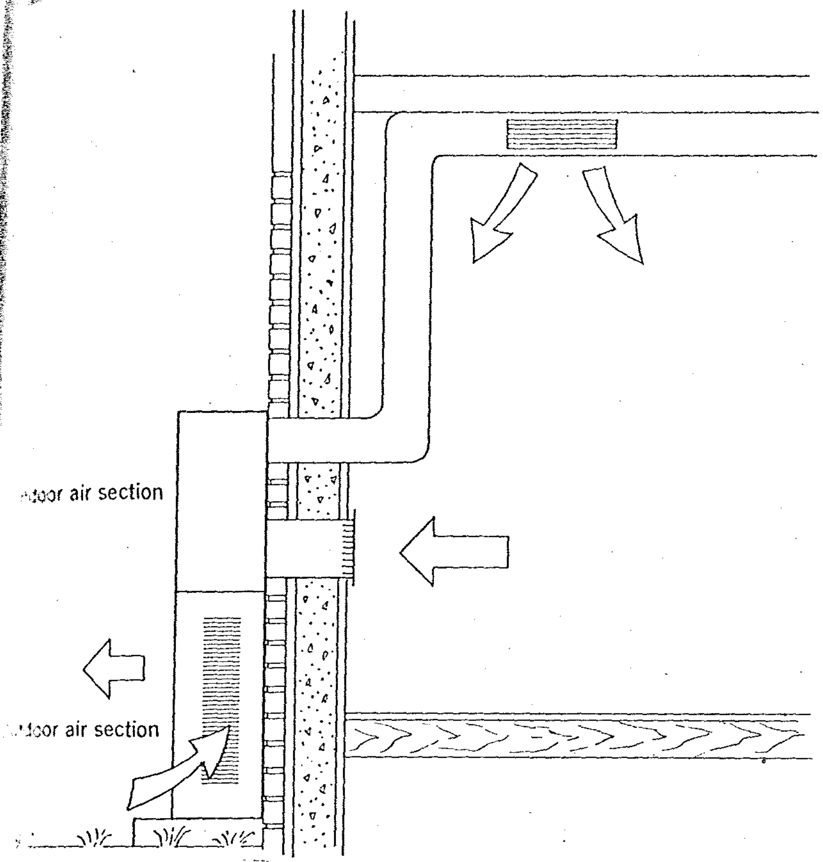


Fig. 3a. A vertical cabinet, single package type heat pump mounted outside on wall or slab.

Control Operations

Controls may be arranged in various ways but the fundamentals can be applied to all unitary heat pumps. In addition to the cooling thermostat similar to that found on an air conditioner, the room control has a heating thermostat. Also quite common is a second heating stage thermostat connected to the supplementary electric heat, providing outdoor temperature is low enough (usually below 45°F) as sensed by an outdoor thermostat. The purpose of an outdoor thermostat is to prevent operation of supplementary electric resistance heat as long as the heat pump itself can carry the load.

Heat pumps using outside air as a heat source must have some means provided to automatically defrost the outdoor coil if it is intended to operate at temperatures below about 45°F. The most universally used method of defrost for air-to-air heat pumps is to stop the outdoor fan and reverse the system to cooling cycle. The defrost period may take from two to six minutes, depending on conditions. During this period it is common practice to bring on supplementary electric heat to maintain the supply air temperature at a comfortable level.

A device is also necessary to sense the need for initiation of defrost. Some designs use a timer which calls for defrost at regular intervals. The interval will vary depending on design, and some units provide a means of adjusting the length of interval to suit climatic conditions in a given geographical area.

An equally popular method of control is the use of an air pressure switch which senses an increase in static pressure differential across the outdoor coil due to frost accumulation between fins.

Another control is needed to terminate the defrost cycle. It is customary to stop the outdoor air fan during defrost since continued operation would unnecessarily extend the defrost period or even prevent it from terminating entirely. With the outside circulation cut off and hot gas from the compressor discharging into the coil, the defrost occurs in a matter of minutes. A convenient method for terminating the defrost cycle is to use a pressure control that will switch the system back to the heating cycle when the pressure has reached a predetermined level, usually equivalent to a condensing temperature of around 120 F. This temperature can also be instrumental in terminating the defrost period by use of a rapid response thermostat in the coil tubes or line carrying liquid from the outside coil.

A feature readily available in

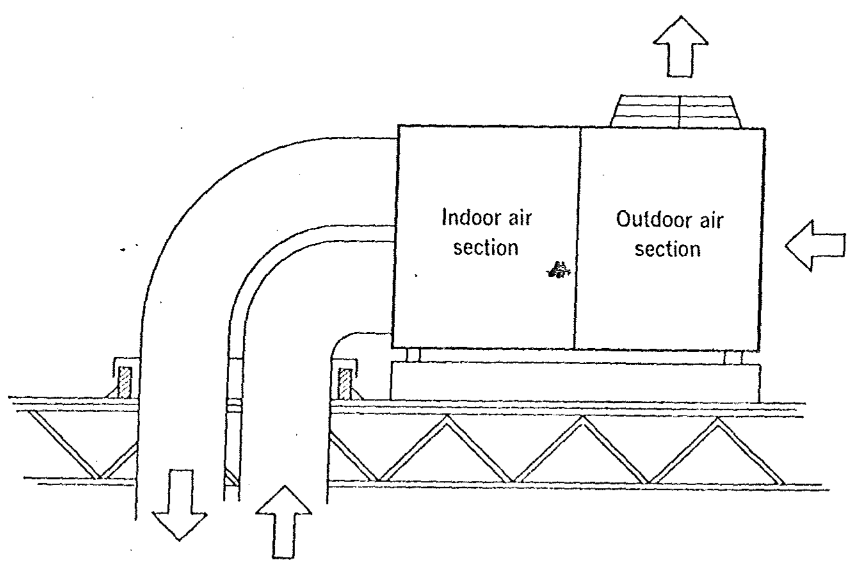


Fig. 3b. Horizontal cabinet, single package type heat pump mounted on roof.

most unitary heat pumps is an automatic or a manual selector switch, integral with or adjacent to the room thermostat, which permits supplementary electric heaters to be energized (under control of the room thermostat but with the outdoor thermostat bypassed), during emergencies when the heat pump compressor and associated refrigeration equipment are inoperative. A pilot light on the room thermostat or emergency heat switch indicates when the supplementary heaters are operating in this manner.

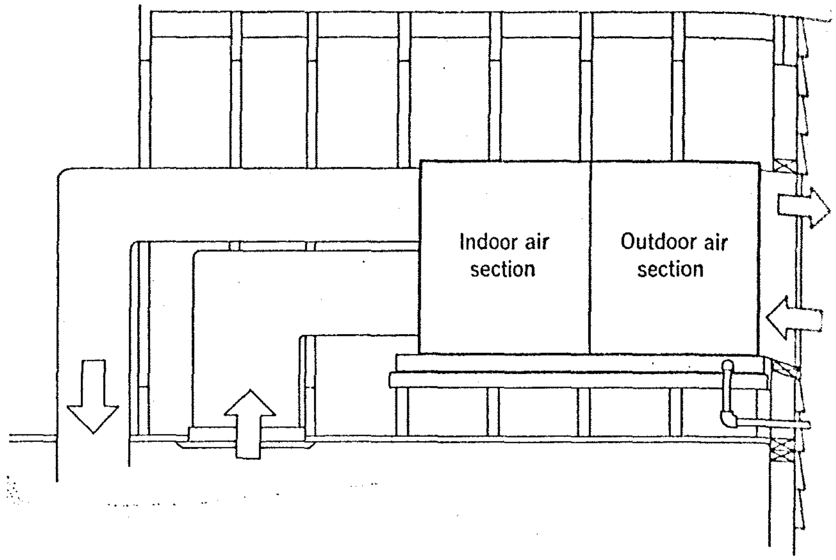


Fig. 3d. Horizontal, single package unit mounted in attic, flush to outside wall.

Single Package Heat Pumps

Air-source heat pumps in this category may be classified by the way in which the indoor and outdoor sections are oriented within the cabinet. Generally speaking, a horizontal unit is considered one in which these two sections are side by side, while in a vertical unit the two sections are stacked one above the other. The cabinet may be designed wholly or partially weather-proof depending on how it is intended to be installed. For units intended to be installed completely out-of-doors, as on a roof, the entire cabinet must be designed to withstand the weather. Typical arrangements are shown in Fig. 3a., 3b., and 3c. Some of the advantages of locating the unit outdoors are: (1) minimum restriction in the outdoor air circuit, reducing initial and operating cost for the outdoor fan, (2) ease of removal of melted frost from outdoor coil, and (3) elimination of need for installer to supply outside air ducts and weather louvers. Among disadvantages to be considered are: (1) servicing during heating season can be difficult due to inclement weather conditions, and (2) the indoor section must be well insulated and sealed for efficient operation since it is subjected to the outdoor ambient temperature.

Some units are designed to be installed as in Figs. 3d., 3c., and 3f. A unit designed for installation as in Fig. 3f requires a blower capable of producing high

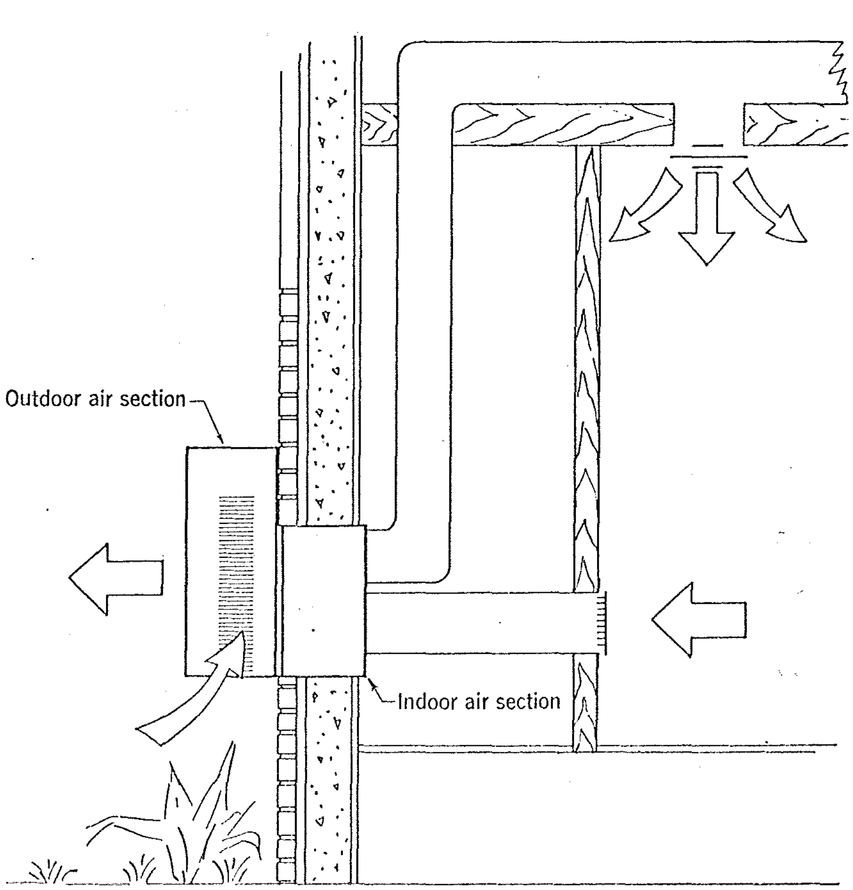


Fig. 3c. Horizontal, single package unit mounted thru the wall.

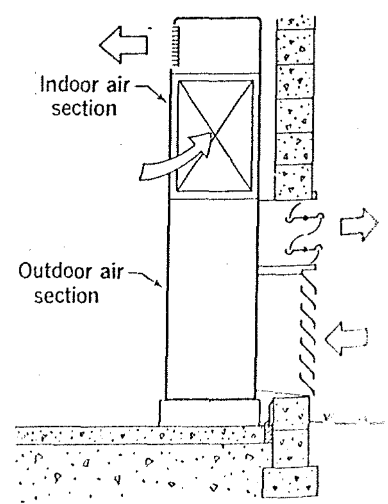


Fig. 3e. Vertical cabinet, single package, mounted inside conditioned space with outside air connection thru the wall.

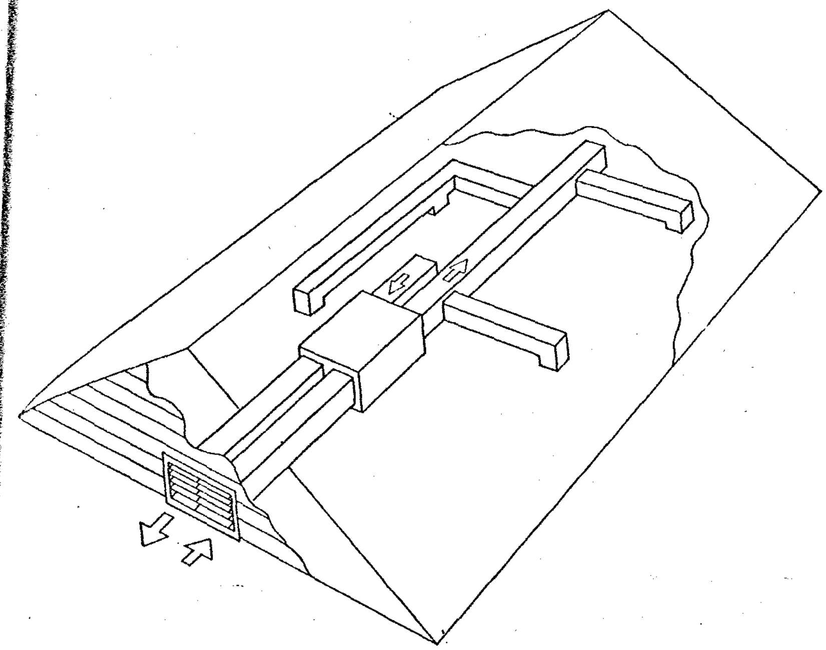


Fig. 3f. Horizontal, single package located in attic with both indoor and outdoor air ducted.

static pressures in the outdoor section to overcome the extra resistance of outdoor air ducts and weather louvers. If a unit is installed within the building but outside the conditioned space, special attention must be given to removal of outdoor coil condensate. In certain climates it may be necessary to use electric heater cable on condensate lines to insure that the condensate does not refreeze and block coil draining during the defrost cycle. This problem can often be solved by running condensate lines in heated areas of the building.

Vertical cabinet models are most often used for installation entirely within the conditioned space. They are designed to be located near an outside wall for ready access to outside air. They may be used with a supply plenum and grille for free air delivery in certain types of commercial applications as shown in Fig. 3e. They may also be used with distribution duct work for residential installations.

Small water-source heat pumps in sizes from ¾—4 Hp are available in horizontal and vertical cabinet models for installation in closets or equipment rooms within conditioned spaces. A typical arrangement of parts in the unit cabinet is shown in Fig. 4a. The foremost application of these units is in high-rise apartment buildings where the source water is conveyed to each apartment through a piping system from a central pumping station.

If used in areas where the source water is brackish, it is common practice to use a stainless steel heat exchanger to transfer heat between the source water and fresh water loop used to supply the units. A schematic of a typical piping arrangement is shown in Fig. 4b. This arrangement can be economically justified where there are several hundred heat pumps in a system. For individual installations, or where only a few heat pumps are involved, units are supplied with water-to-refrigerant heat exchangers made of material designed to resist the corrosive effects of brackish water. The source water is then pumped directly through the unit without the additional expense of a water-to-water heat exchanger. See Fig. 4c.

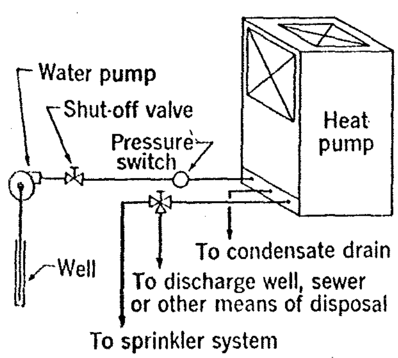


Fig. 4c. Typical well water system for single package water-to-air heat pump.

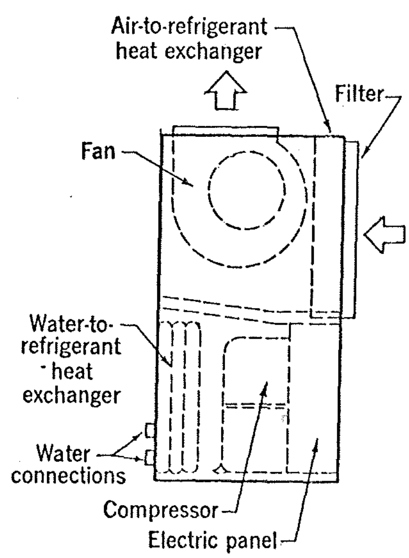


Fig. 4a. Vertical single package water-to-air heat pump typical of type used for apartment house application.

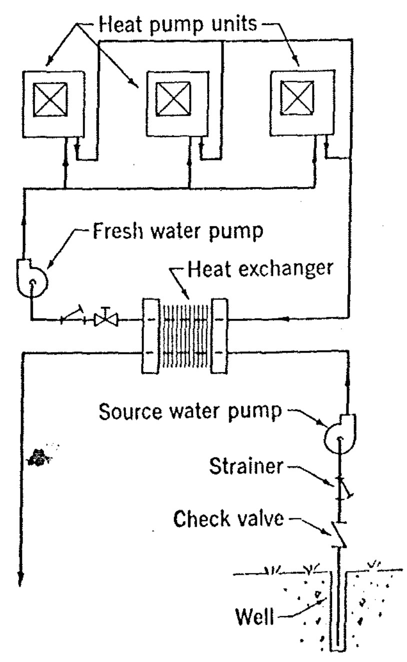


Fig. 4b. Typical heat exchanger installation.

Larger water-to-air unitary heat pumps are available from a few manufacturers in sizes up to 20 Hp for large residential and small commercial applications. They are usually built with vertical cabinets.

Split System Heat Pumps

The most commonly used arrangement in this category is the air-to-air heat pump where the outdoor section (consisting of compressor, controls, outdoor coil and fan) is located remotely from, but coupled to the indoor sections by means of liquid and vapor refrigerant piping lines. The indoor fan section may be furnished in either a horizontal or vertical cabinet. Vertical cabinet models are often designed so they can be used for either upflow or downflow of indoor air. Indoor and outdoor sections must be piped in the field with refrigerant grade tubing, evacuated and charged. However, in 5-Hp sizes and below, some manufacturers are furnishing units designed to be connected with factory charged tubing using refrigerant connectors which may be coupled under pressure. Installation can then be made with no field evacuation and charging of line fittings.

Slab or ground-level installations of split systems are most common for residential, small commercial and apartment buildings with only one or two floors. Fig. 5 is typical.

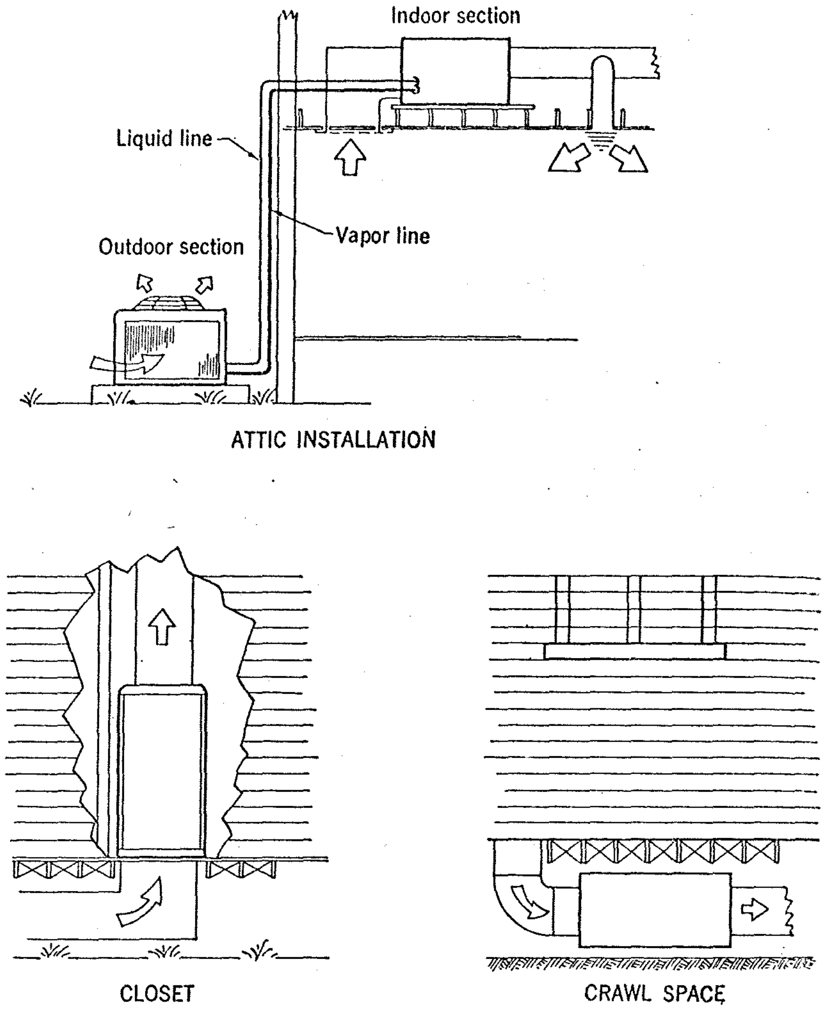
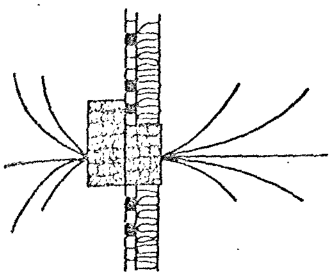


Fig. 5. Typical examples of slab or ground-level installations.

Such installations place major sound producing components outside the conditioned space and give quiet operation for the owner. However, it could be a source of annoyance to a nearby neighbor. This and other factors, such as possible damage to the outdoor section by passersby, obstructions by surrounding shrubbery and conditions where trash could collect and obstruct the outside air circuit should be considered in selecting a suitable location. Because refrigerant lines are easily run, the installer has considerable flexibility in where the unit may be placed and an advantageous site should not be overlooked for the mere expedient of saving a few feet of tubing.

Since heat pumps must operate year-round in all types of weather, protected locations should be used where possible to insure reliability of operation. Orienting the outside air coil so that it does not face the prevailing wind will often aid materially in reducing the length of the defrost cycle in severe winter weather. Snow accumulation can be detrimental to heat pump operation and in climates where this is a factor, the unit should be mounted in a manner so that snow will not interfere with operation. On outdoor units, water draining from the coil as a result of defrosting can refreeze and accumulate to prevent complete drainage and partially block the lower portion of the coil. Proper elevation of the unit and provision for water drainage will help alleviate this problem.

It should be emphasized in installing split system heat pumps that a vapor line connecting indoor and outdoor sections carries compressor discharge gas on the heating cycle as well as suction gas during the cooling cycle. Since there is more likely to be gas pulsations and hence vibration in a discharge line, special precautions should be taken to isolate this line from the building structure. Insulation is also essential on this line and should be capable to withstanding temperatures up to 250 F. The molded plastic foam pipe insulations are ideal for this use.



APPLIED HEAT PUMP SYSTEMS

AIR source systems are more common than water source due to the availability of air as compared to the expense involved in well drilling and water treatment. The major drawback to air as a source-sink is the inherent characteristic that the heat pump has less heating capability and lower overall efficiency during the coldest weather when the largest quantity of heat is required. When a system is sized for the summer cooling load, it will generally have insufficient heating capacity to match the building load at winter design conditions, particularly in northern climes. To make up this deficit, supplementary electric booster heaters are generally required.

An alternate method is to provide booster compressors which are only used during colder weather. The additional cost of the booster equipment is usually difficult to justify since the extra heat is only required for a small percentage of the heating season.

Fig. 1 illustrates a typical air to air heat pump system. On applied heat pump applications, the compressor is generally located indoors near the indoor coil. The illustration is for operation on the heating cycle at a O F outside air temperature where the air is cooled to –10 F with a –20 F evaporator. The heating and cooling cycles of operation are basically the same as described earlier. If supplementary electric heaters are used, they are located in the air stream downstream from the indoor coil so the coolest air enters the heat exchanger serving as a condenser.

For cooling operation, the four-way refrigerant valve is reversed to guide discharge gas to the outdoor coil and suction gas from the indoor air coil. The indoor coil expansion valve now controls flow to the operating evaporator and the outdoor coil expansion valve is bypassed through the check valve.

As frost accumulates on the outdoor coil during the heating cycle, it must periodically be removed to permit efficient operation of the heat pump system. To accomplish this, the four way refrigerant valve is reversed to the cooling cycle and heat is removed from the indoor air by the compressor and discharged to the outdoor coil, whose fan is shut down, until the frost is removed. During the defrost cycle, indoor supplementary heaters are generally energized, at least partially, to prevent a cooling effect in the conditioned spaces for the short duration of defrost cycle.

The air to air system is commonly used in the tonnage range up through 30 tons summer cooling capacity and occasionally up to 50 tons. This type of system is limited to a single indoor coil restricting its operation to only one zone. Multiple indoor coils are not practical because of problems of liquid draining, and controlling capacity of condensers in parallel in different locations.

Fig. 2 shows a typical air to water system. The basic difference between it and the air to air system is that the indoor heat exchanger now becomes a refrigerant to water type. Refrigerant reversing valves illustrated are the three-way type, but on smaller systems where commercially available, a single four-way valve can be substituted. The indoor heat exchanger serves as a water chiller during the cooling cycle. Chilled water is then circulated to multiple fan coil units which are individually controlled to maintain comfort conditions in each zone. During the heating cycle, the indoor heat exchanger becomes a water cooled condenser with warm water circulated to the same fan coil units. The system's

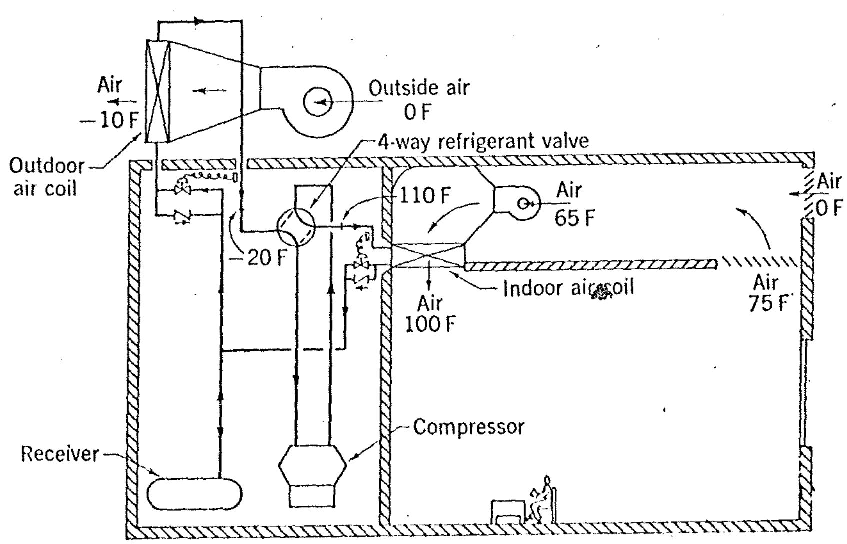


Fig. 1. Air to air heat pump system (heating cycle).

cycle of operation is generally controlled by an outdoor thermostat which may be manually overridden. Interlocks to space thermostats are provided so they are always controlling for the same cycle of operation as the heat pump.

For defrosting, the cycle is reversed to cooling, but the outdoor fan is turned off. Heat is removed from the warm circulated water and supplemental heaters, if used.

Air to water systems range in size from about 30 tons summer cooling capacity to over 800 tons. Their big advantage over air to air systems is that multiple zones can be provided on the same system. Also, where factory packaged equipment is used, less refrigerant field piping is required.

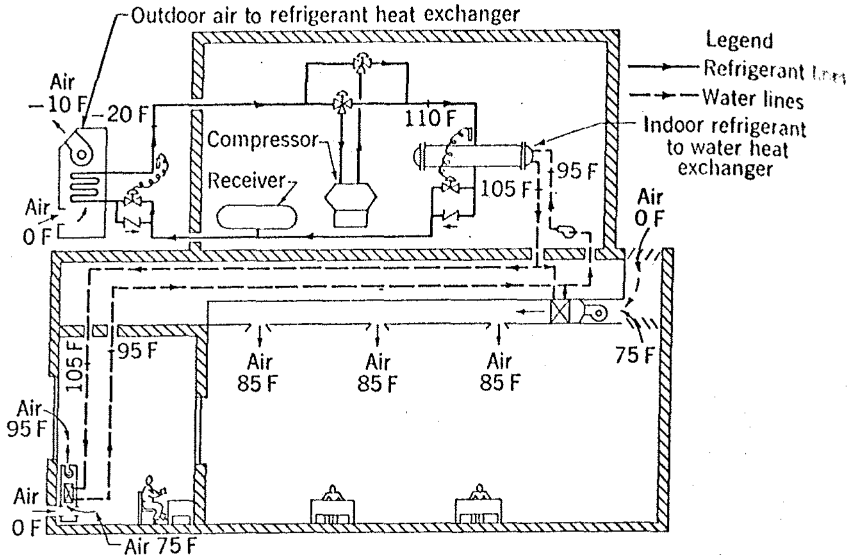


Fig. 2. Air water heat pump system (heating cycle).

Water Source Systems

On paper, water source systems are ideal since the most commonly used sources of water remain at a relatively constant temperature throughout the year. The water temperature must be high to prevent freezing, therefore, the system will operate at a fairly high evaporator temperature which will usually provide sufficient heating capacity during the coldest weather without the need for supplemental heat. Furthermore, the high evaporator temperature results in a favorable system efficiency, and correspondingly attractive operating costs.

However, abundant sources of suitable water are becoming increasingly scarce and the application of this type of system is rather limited. Frequently, sufficient water may be available from wells, but the condition of the water often will either cause corrosion in heat exchangers or it may induce scale forming. Other considerations to be made are costs of drilling, piping, and pumping and means for disposing of used water.

A water to air system is illustrated in Fig. 3. As with air source types, the refrigerant cycle must be reversed to alternately provide heating and cooling. This cycle is basically the same as the air to air system shown in Fig. 1, except that a water chiller-condenser is substituted for the outdoor air unit. Water temperatures underground vary from about 50 F to 65 F, depending upon the location. In Fig. 3, 55 F well water is circulated to the chiller where it is cooled to 45 F and returned to another well or more suitable means of disposal. Heat extracted from the water is rejected in the indoor heat exchanger to the mixture of outside and return air in order to satisfy space conditions. When the cycle is reversed, the indoor coil becomes an evaporator and the water chiller-condenser rejects building heat to the well water supply.

As with the air to air system, the water to air type is limited to operation on a single zone. Capacities generally range up to about 30 tons and occasionally as high as 50 tons.

A water to water system is illustrated in Fig. 4. On this type the water flow is reversed rather than the refrigerant flow for economic reasons. In other words, both chiller and condenser are non-reversible and the chiller will always provide chilled water whereas the condenser provides warm water, regardless of operating cycle.

During the cooling cycle, source-sink water is circulated through reversing water valves to the condenser where heat is rejected and the resulting warm water is drained to a sewer or another well. For the heating cycle, well water is circulated directly to the chiller where heat is removed from it and rejected to

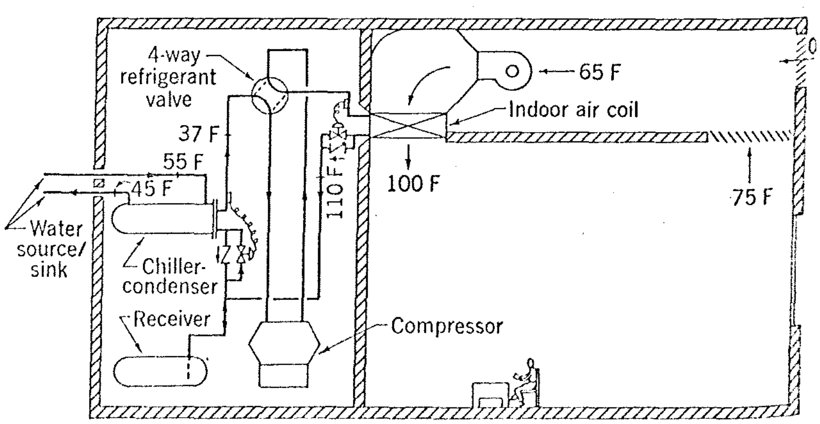


Fig. 3. Water to air heat pump (heating cycle).

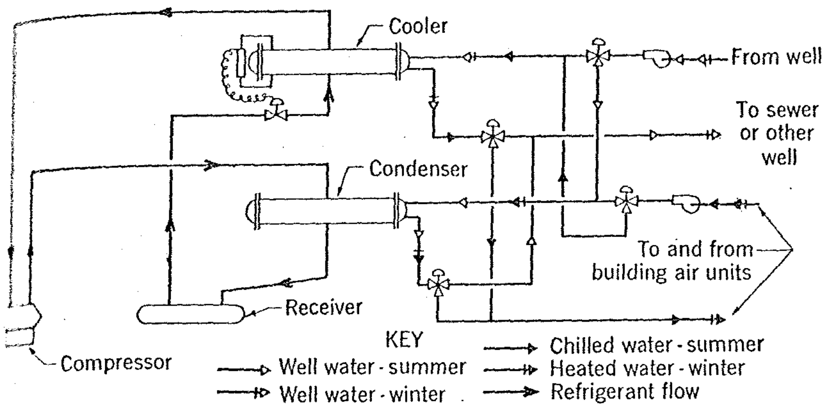


Fig. 4. Water to water heat pump.

the condenser which now has its water circulated to heating and cooling coils.

Its range of sizes varies from about 20 tons upward, with existing installations of over 1000 tons summer cooling capacity. Its advantage over the water to air system is that it can be used with multiple zones, each individually thermostatically controlled. Also, a standard packaged water chiller can be used as the heat pump with modifications made in the control circuits.

Simulteaneous Heating and Cooling Systems

Previously discussed systems provide either heating or cooling, but not simultaneously. On larger commercial and industrial buildings, it is often necessary to provide heating in one area and cooling in another. On the above-mentioned heat pumps, where water is used to heat and cool spaces within a building at the same time, this can be accomplished in two ways. One way is to make provision for excess fresh air to each of the air handling units. The system is then operated to provide heating any time the outside air temperature is below a predetermined value for the most critical zone. Other zones which may require cooling obtain it by using larger quantities of outside air which, for this cycle, should be at 60 F or below. At higher outside air temperatures, the system provides cooling, and no heating should be required except where close humidity control is desired. An alternate method is to use multiple heat pumps, with each handling an individual zone in the building.

A better but more expensive arrangement is to apply a heat pump that can simultaneously provide heating and cooling to the spaces, regardless of season. In addition, the air handling equipment, water piping and controls must also be provided at an additional expense over a more conventional heating or cooling system. Types of systems applicable to this heat pump are multi-zone, dual duct, induction unit, three-pipe and four-pipe systems.

Fig. 5 shows a typical building load graph as a function of outside air temperature for an application where simultaneous heating and cooling would be desirable. The building cooling requirements are shown to be 1200 MBh at 100 F outside air and 300 MBh at 0 F. The heating requirements are 800 MBh at 0 F and zero at 74 F. Interior zones requiring mechanical cooling, however, do not make the excess heat available to the perimeter of the building where it is required, unless the heat is transferred through the heat pump system.

It can be seen that at 55F outside air the cooling requirement is substantially greater than the heating requirement so all heat removed from the interior cannot be distributed to the perimeter. Where provision is made for up

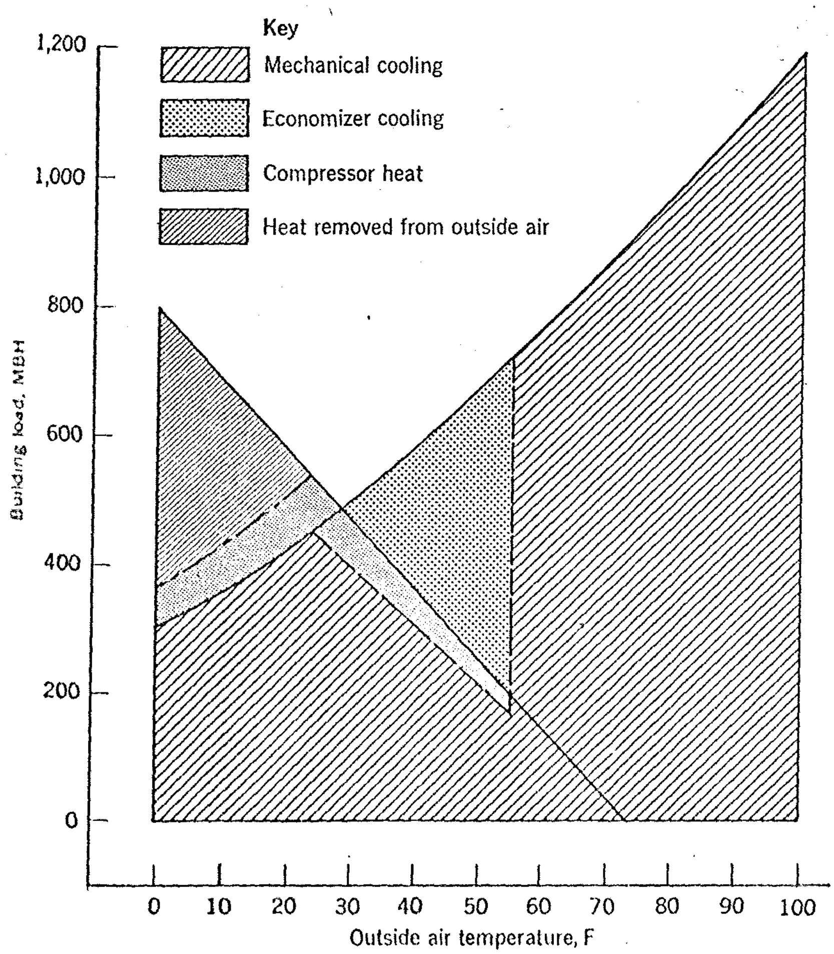


Fig. 5 Load analysis (simultaneous heating and cooling with economizer cooling.

to 100% ventilation air at air handlers, the heat pump system can be unloaded to the point where it removes only enough heat from interior spaces to satisfy the perimeter. Compressor capacity is regulated to match the heating load which is supplemented with heat from the interior area plus the heat of compression. At these intermediate temperature levels, this system does not provide sufficient cooling, so the fresh air dampers are modulated to increase the quantity of outside air used for cooling requirements.

As the outside air temperature falls to 25 F, heat removed from interior spaces plus the heat pump motor gain is in balance, theoretically, with perimeter heat loss. At this point, the fresh air dampers would be reset to provide air for ventilation purposes only. At lower outside air temperatures, heat removed from interior spaces would be supplemented by the heat pump with heat removed from outside air, well water, storage or supplemental means. Such a system is shown in Fig. 9, which will be described later.

Fig. 6 shows an instantaneous boot strap simultaneous heating and cooling system on a dual duct air handling system. The cycle is not reversible as the chiller always provides cold water to the cold deck and the auxiliary condenser always provides warm water to the hot deck. The shaded portion of the diagram depicts a conventional packaged water chiller and is modified by addition of an auxiliary condenser with its refrigerant circuited in series with the standard condenser which is connected to the cooling tower. When cooling requirements are greater than heating requirements, both condenser water pumps may operate with the three way water valve in the cooling tower circuit positioned to maintain a sufficiently high head pressure in order to satisfy the water temperature requirement to the hot deck. Consequently, sufficient heat is provided to satisfy heating requirements and the excess is automatically rejected to the cooling tower.

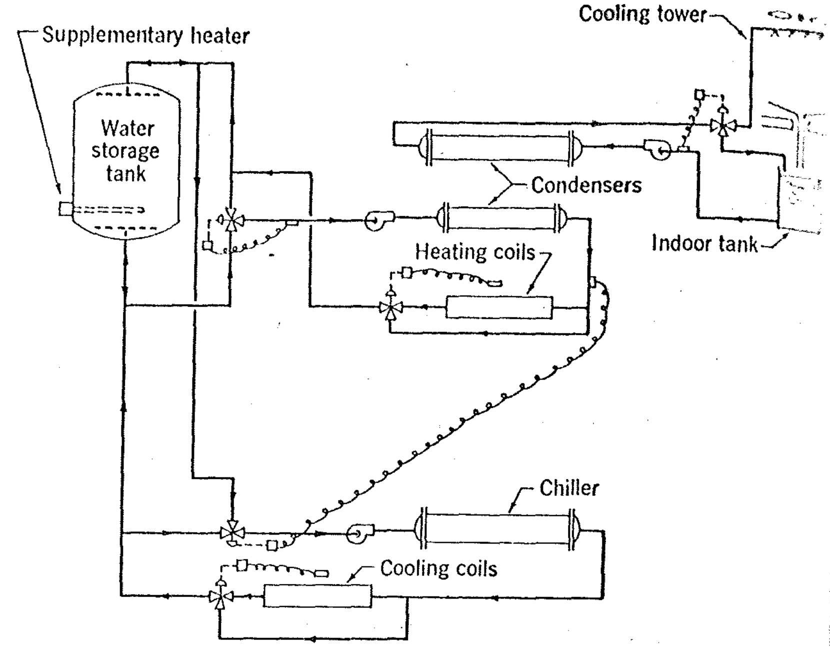


Fig. 7. Bootstrap system with storage.

When heating requirements a greater than cooling, the cooli tower water pump is turned o and all heat is rejected to the h deck via the auxiliary condens Except in rare instances, supp mental heat will be required a this can be supplied by an electr water heater or an oil or gas fir boiler. The advantage of this sy tem is in lower operating co than with separate heating a cooling systems since the he pump will satisfy both heati and cooling requirements throu out much of the year as opposed operation of a separate boiler a water chiller at the same time. F the dual duct system illustrat with a single fan, the system op ation would not practically be co trolled as shown in Fig. 6. A effort to provide space cooling w fresh air, would greatly incre the heating load since the sa low temperature enters the deck as the cold.

A boot strap simultaneous he ing and cooling heat pump w water storage is illustrated in F 7. Again, two condensers are p vided, one for the cooling to circuit and another for the w heatng circuit. Using a si condenser for this dual functi considered impractical becaus maintenance problems and sh ened life of the indoor water cuit due to cooling tower w

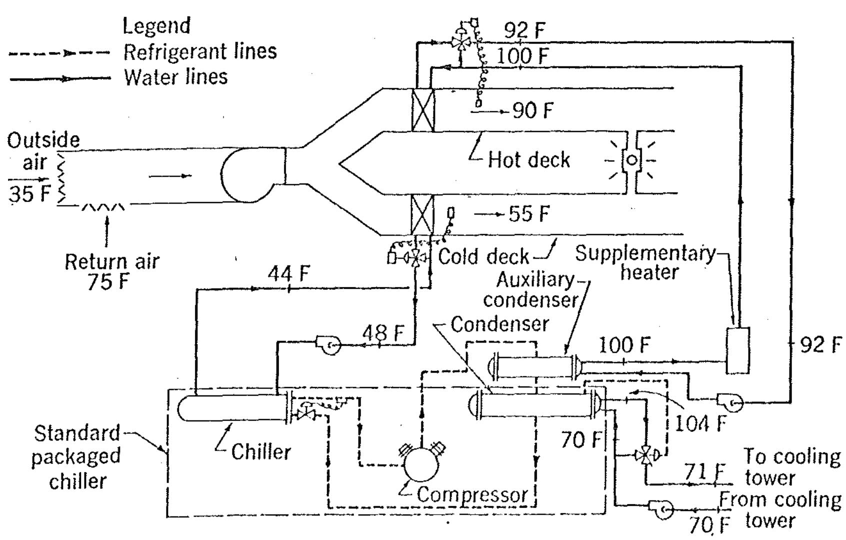


Fig. 6. Instantaneous bootstrap system.

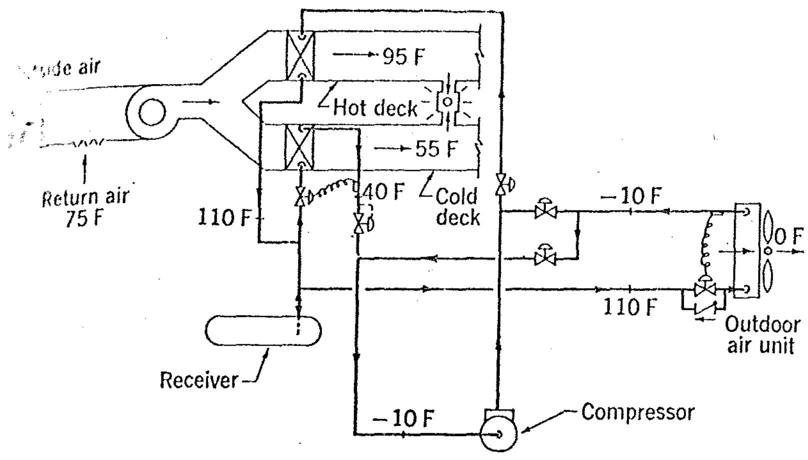


Fig. 8. Simultaneous heating and cooling air to air heat pump (heating > cooling).

ntamination. This circuit differs adically from Fig. 6 in that a arge water storage tank is used.

Many buildings are occupied ring the day and unoccupied at ght. With occupancy, internal urces of heat from lights, peo-, motors, etc., plus sun effect ll frequently require more cool-g than the skin of the building versely needs for heating. With instantaneous system, excess at must be rejected to the cool-g tower, but with the storage stem, warm water can be stored om the condenser circuit during ytime to become available for ating during the night when in-rnal sources of heat are non-ex-tent. At night time in mild eather, water from the storage nk can be directly circulated to eating coils. When the water mperature reaches the level here it cannot furnish sufficient at to spaces, valves function to liver the water to the chiller. he compressor is then started, e water is cooled down by the iller and elevated to a higher d more usable temperature in e condenser, which now circu-tes warm water through a closed op to heating coils.

The water storage system will ually require supplemental heat take care of protracted cold eather periods and long week-ds or holidays when the build-g is unoccupied.

A simultaneous heating and oling air to air heat pump is own in Fig. 8. This type can be orporated with either a dual ct or multizone air handling stem. It is not practical for use th multiple air handling units because of condenser drainage problems. The indoor evaporator coil is non-reversible providing cool air whenever required. Likewise, the indoor condenser is non-reversible as it only furnishes heat. The outdoor coil serves as a condenser when the building cooling load exceeds the heating load, and as an evaporator when heating requirements are greater than cooling.

An air to water simultaneous heating and cooling system is illustrated in Fig. 9. Chiller and condenser are both non-reversible as they respectively circulate chilled water and warm water to cold and hot decks with individual three way water valves, each controlling desired temperature conditions. The outdoor air unit becomes an evaporator when the heat available from the cold air circuit plus the heat of compression are not great enough to satisfy the warm air circuit. When excess heat is available from inside, the outdoor coil becomes the condenser. When running on the heating cycle, the outdoor coil operates in parallel with the water chiller. An evaporator pressure regulator in the suction line leaving the chiller prevents water freeze-up. On the cycle where excess heat is available internally, condenser and outdoor coil operate in parallel as condensers.

For the arrangement shown, separate fans on hot and cold air circuits permit extreme flexibility in operation. Excess ventilation air is introduced to the cold air duct only, to provide economizer cooling in areas with high internal loads without affecting the heating load in the warm air circuit. This permits the system to operate at optimum efficiency and follow the pattern illustrated on the load graph of Fig. 5.

Exhaust Heat Recovery

On most larger commercial and industrial buildings it is necessary to provide positive exhaust to induce sufficiently low internal static pressures throughout and obtain

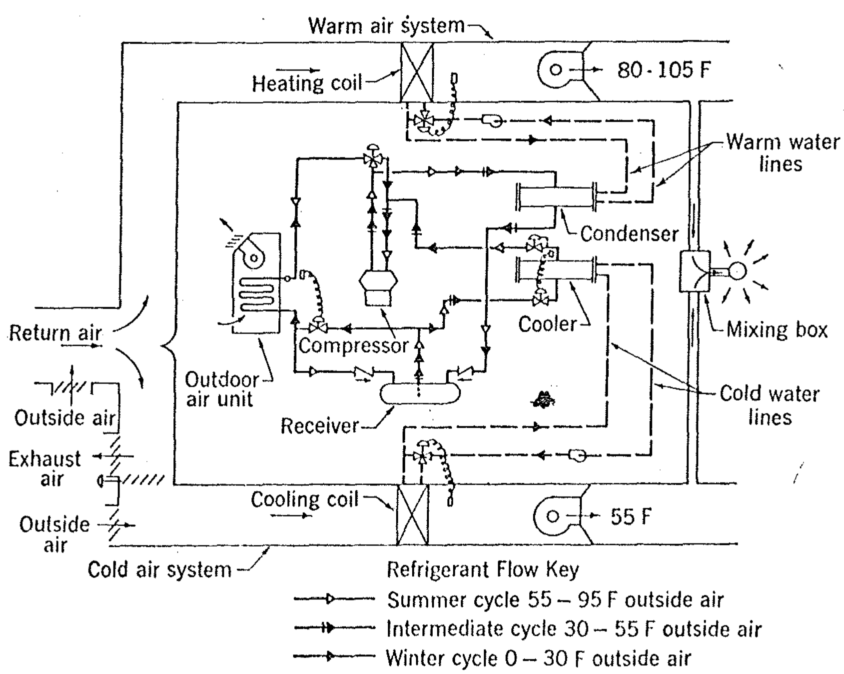


Fig. 9. Air source heat pump on dual-duct system.

uniform ventilation. Since exhaust air temperature is frequently well above outside air temperature, it is desirable to remove heat from exhaust air to permit more efficient operation of the heat pump system. Fig. 10 illustrates one method of recovering heat in this fashion. An evaporator coil is located in the exhaust air plenum and functions in parallel with the outdoor air coil to simultaneously remove heat from both. During mild weather operation, the outdoor coil becomes inoperative and all heat is removed from exhaust air resulting in very efficient operation. Where physically practical, exhaust air may be ducted into the outdoor coil directly, thereby raising the temperature of air entering the outdoor coil to increase the heat pump capacity and efficiency. During cooling cycle, the evaporator coil in the exhaust plenum is inoperative, but the 75 F leaving air mixing with warmer outside air entering the outdoor coil, will further help the capacity and efficiency of the system, causing lower condensing temperatures.

A liquid refrigerant subcooling coil is shown in Fig. 10 which subcools liquid refrigerant leaving the condenser on heating cycle, while preheating ventilation air. When practical to apply this principle, capacity and efficiency of the heat pump system is further improved and preheating helps to offset possible freeze-up hazards of water heating coils.

Another method of heat recovery from exhaust air is illustrated in Fig. 11. This is known as a run-around system. Separate coils are located in the ventilation and exhaust air plenums and interconnected with a circulating pump. A non-freeze solution such as ethylene glycol is added to prevent freeze-up. In this way, the heat transfer fluid flowing through the exhaust air coil is heated so it can give off heat to the ventilation air, reducing the net heat input required of the heat pump system. Precautions must be taken to prevent or periodically eliminate frost forming on the exhaust air coil. This can be done by turning off the circulating pump automatically whenever the frost concentration reaches a critical level, permitting warm exhaust air to melt the frost. Alternately, frost may be prevented by providing a three-way valve to partially bypass the ventilation air coil. For this arrangement, an antifreeze temperature controller, set for perhaps 28 F would bypass sufficient antifreeze solution around the ventilation air coil and maintain a mixture temperature entering the exhaust air coil no lower than 28 F. This procedure limits overall capability of the run-around system during cold weather, but eliminates the defrosting problem.

The run-around system is practical only where a relatively large percentage of ventilation air is exhausted. When a building is unoccupied, ventilation fans are usually shut down and the run-around circuit serves no useful purpose. This principle permits reducing the size of the heat pump required if net occupied building heating load is greater than unoccupied load, but does not permit any reduction in size if the unoccupied load is greater, which is frequently the case. The operating co

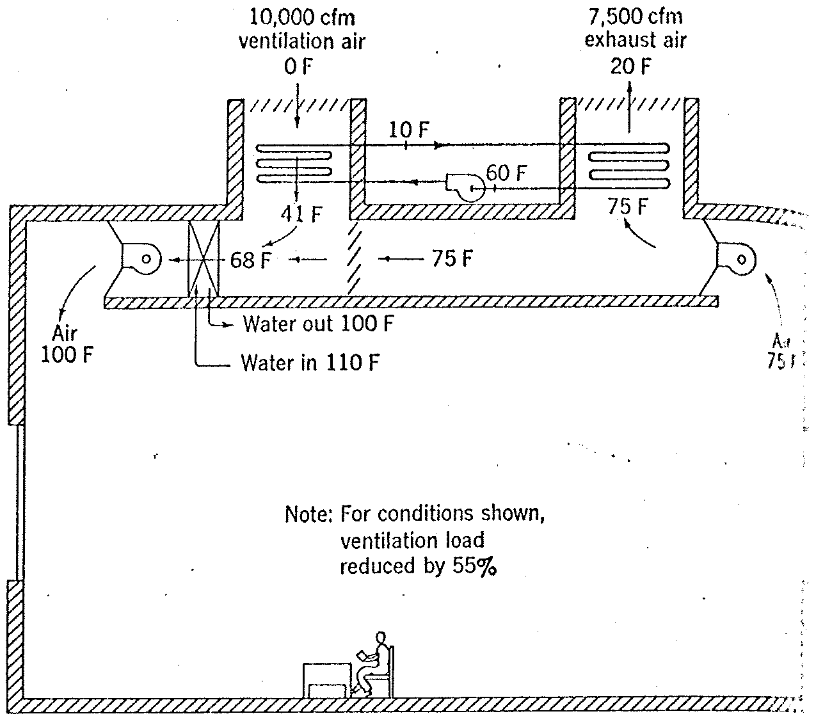


Fig. 11. Reduction in heating load by run-around system.

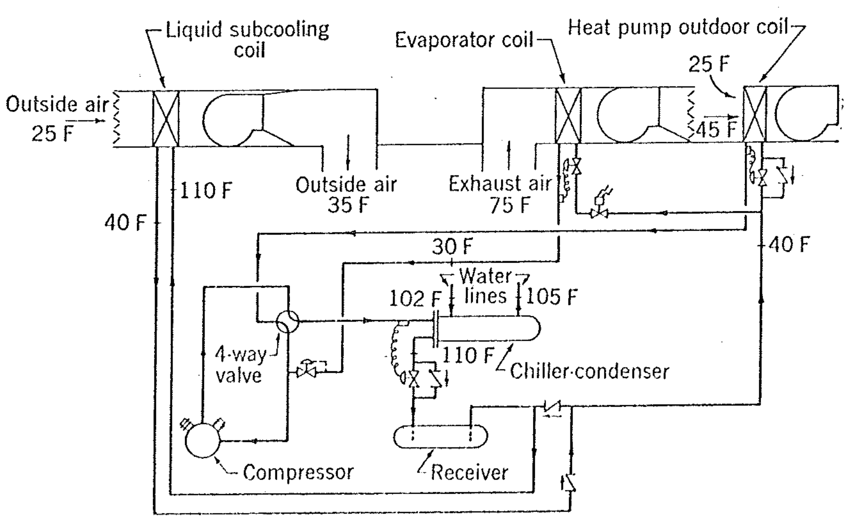


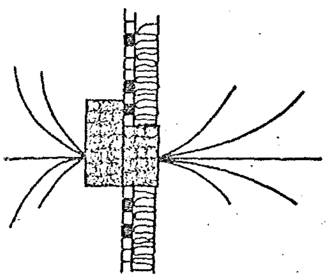
Fig. 10. Heat pump system with heat recovery accessories.

may also be substantially reduced since the only electric energy required is that to drive the circulating pump which is small.

On applied heat pump installations, air to air systems are limited to a single indoor unit and generally range in size through 30 tons. Air to water systems can be used with one or more air handlers and vary in size from about 30 tons upward. Both types of systems are available as factory assemblies or field erected systems.

Water to air systems are used in the same capacity range as air to air systems, and are also available as factory assemblies or field erected systems. Water to water heat pumps are available as factory assemblies in practically any size since a standard water chiller can be converted to a heat pump by modifying the controls.

Where simultaneous building heating and cooling is required, it can be accomplished by applying individual heat pumps to each zone, or special heat pumps can be purchased to provide the simultaneous heating and cooling feature in one system. A few systems are currently available as factory packages; but, for the most part, these are field erected assemblies.



EQUIPMENT SELECTION AND FEASIBILITY CONSIDERATIONS

AT an early stage in planning for heating and cooling of a new building or modification of an existing system, the system designer usually makes what might be considered a feasibility study. In a broad sense, this refers to all major details of possible installations, and covers such points as whether certain types of equipment could be physically accommodated, mode of distribution of the heating and cooling effect, need for zoning, magnitude of heating and cooling loads, local fuel costs, etc. A number of such factors are being considered elsewhere in this article. Of particular interest here is determination of loads and selection of equipment whose capacities (heating and cooling) and other characteristics will best satisfy needs and limitations of the job.

Since a heat pump performs the functions of both cooling and heating, its selection will involve, in common with such combinations, a knowledge of both heat gain and heat loss for a structure. However, because of characteristics of heat pumps, a proper choice will involve some special considerations not required for separate systems. For example, a small or medium size heat pump will have a definite ratio between its cooling and heating capacities (at a given set of design conditions) which may or may not equal the ratio of the calculated cooling and heating loads.

Therefore, in selecting a system, a designer has to choose as a basis either the heating or cooling requirement, determine the need for supplementary heat, and note consequences with regard to investment and operating costs. Recommendations relative to this matter vary somewhat, and further discussion will follow. Before arriving at this stage, however, the system designer needs to have made estimates of heating and cooling loads for the job.

The estimating of loads can be fairly simple or very elaborate, depending on the application and degree of accuracy considered necessary. The source for most of the basic heat transfer data and essential climatic information, as well as the most fundamental procedure is in the ASHRAE Guide and Data Book. Methods, data and advice found there are almost universally accepted, and are recommended for all jobs, including those having unusual or complex features, and requiring the highest possible accuracy.

Unfortunately, these calculations tend to be somewhat tedious and time consuming, and, in some cases, more conservative than necessary. Hence, numerous simplified schemes have been developed. Although all of these have the same origin, the assumptions and arbitrary rules subsequently applied result in some rather wide variances in final answers, particularly in residential work.

In 1959, a joint industry committee was formed, to set up a standard method for calculating residential heating and cooling loads. The outcome of this was A. R. I. Standard 230-62 and corresponding publications of other associations. Although this standard was developed specifically for residential calculations, it may be used for some commercial applications since at present, there is a marked trend for many small neighborhood shops, professional offices, particularly medical and dental offices, to be established in small structures bearing much more resemblance to a residence than to a typical commercial structure. In many cases, these can be calculated using the residential approach.

One of the advantages in using Standard 230-62 is that it contains a table of capacity multiplier factors (see Table 1) which permit the designer to select a unit whose cooling capacity will maintain a specified degree of indoor temperature swing. After the heat gain has been calculated by Standard 230-62, the designer then decides what deviation of indoor temperature from design point can be permitted. He uses this table of the Standard to find the A. R. I. rated capacity of a unit which will meet the requirements. Fig. 1 illustrates the relationship of these factors (for units having air cooled condensers) for two temperature-daily range combinations contained in the table. For an application in an area where a 95° summer design temperature exists, along with a medium daily range, the lower line indicates that, to hold a close control over the indoor temperature (3° swing or less), the estimated cooling load should be multiplied by 1.03 to obtain the A. R. I. rated capacity required. For a less rigid control of conditions (6° swing), a factor of .75 would apply, indicating a 28% reduction in unit capacity. This feature will be found quite helpful in selecting the most economical size of unit for a given cooling job.

The distinguishing characteristic of residential type loads is the relatively large envelope effect and small internal component. Commercial structures, on the other hand, are likely to have rather heavy internal and ventilation heat gains or losses, which may, in the case of an interior zone, make up the entire load. This does not eliminate the need for consideration of envelope load, since, in general, commercial structures exhibit much wider variations in construction than residential.

The standard used for calculating loads on commercial jobs is A. R. I. Standard 530-56. The procedure contained there gives attention to envelope load (including allowances for solar effect where needed) ventilation needs (including humidification or de-humidification), and internal sensible and latent loads. For unusual applications, the Standard recommends reference to the ASHRAE Guide.

It may be noted in passing that on jobs requiring large quantities of ventilation air, economy in operation and equipment costs can be achieved by "air recovery". This involves use of special types of filters to remove odors from recirculated air, thus reducing the amount of outside ventilation air which has to be treated. Another economy measure which may be feasible in some cases involving heat pumps consists in passing exhaust air from the building over the outdoor coil, thus providing more favorable ambient conditions than would ordinarily exist.

When load estimates have been completed, the system designer usually refers to a manufacturer's

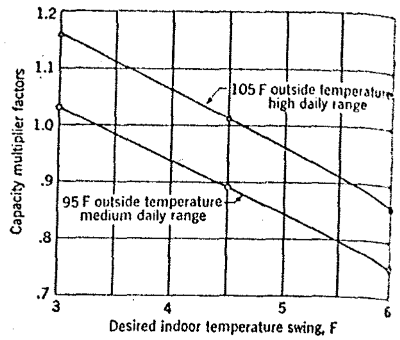


Fig. 1.

catalog to select a unit whose capacities at design conditions appear to be most suitable. Information regarding the requirements for testing and rating, specifications, literature and advertising of unitary heat pumps is contained in A. R. I. Standard 240-64.

To consider the problem of selecting this optimum unit, refer first to Fig. 2 where a series of lines, (CCI), (HCI), (CC2), (HC2), (CC3), and (HC3), represent respectively, cooling and heating capacity of three sizes of heat pumps. These lines show dependence of unit capacity on outdoor temperature which is characteristic of air to air heat pumps. Also shown are lines (HL1) and (CL1) representing heating load and cooling load, for a small commerical building, at various outdoor temperatures (normal comfort levels inside). It can be seen that, for a warm summer, (95 F design)—mild winter, (40 F de-

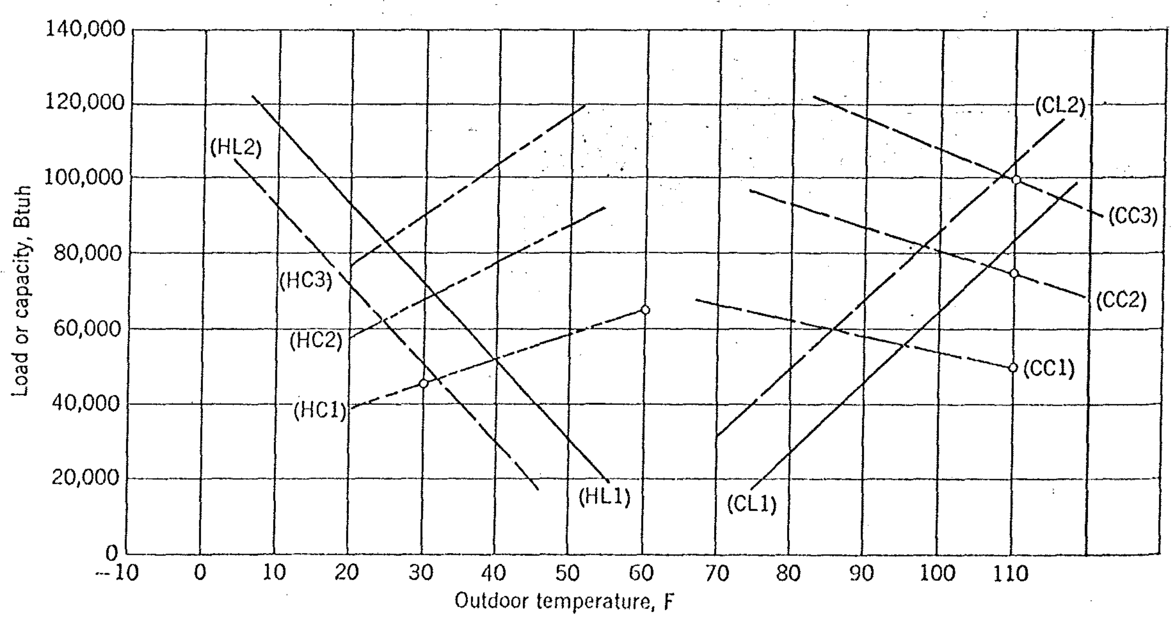


Fig. 2.

Table. 1. Capacity Multiplier Factors

Outside Design Conditions		Desired Indoor Temperature Swing (F)														
Temperature, F	Daily Range	6					4½					3				
AIR COOLED UNITS																
90	M	0.69					0.83					0.97				
	L	0.71					0.84					0.98				
95	H	0.74					0.88					1.02				
	M	0.75					0.89					1.03				
	L	0.77					0.90					1.04				
100	H	0.81					0.95					1.08				
	M	0.82					0.96					1.09				
105	H	0.86					1.01					1.16				
	M	0.87					1.02					1.17				
110	H	0.92					1.07					1.22				
EVAPORATIVELY COOLED UNITS																
		Outside Design Wet Bulb Temperature, F														
		65	70	75	78	80	65	70	75	78	80	65	70	75	78	80
90	M, L	0.74	0.75	0.77	0.78	0.79	0.89	0.90	0.92	0.93	0.94	1.03	1.05	1.07	1.08	1.09
95	H, M, L	0.79	0.80	0.81	0.82	0.83	0.93	0.94	0.96	0.97	0.98	1.07	1.09	1.11	1.12	1.13
100	H, M	—	0.84	0.85	0.87	0.88	—	0.99	1.00	1.02	1.03	—	1.12	1.14	1.15	1.16
105	H, M	—	0.87	0.88	0.89	0.90	—	1.02	1.03	1.05	1.06	—	1.17	1.19	1.20	1.21
110	H	—	—	0.92	0.93	0.94	—	—	1.08	1.09	1.10	—	—	1.23	1.24	1.25
WATER COOLED UNITS																
		Leaving Water Temperature, F														
		90	95	100	105	110	90	95	100	105	110	90	95	100	105	110
90	M, L	0.74	0.77	0.81	0.83	0.86	0.88	0.93	0.97	1.00	1.03	1.03	1.08	1.12	1.16	1.20
95	H, M, L	0.78	0.82	0.85	0.88	0.91	0.93	0.97	1.01	1.05	1.08	1.07	1.12	1.17	1.21	1.25
100	H, M	0.82	0.87	0.91	0.94	0.97	0.97	1.02	1.06	1.09	1.12	1.10	1.16	1.20	1.24	1.28
105	H, M	0.86	0.90	0.94	0.97	1.00	1.00	1.05	1.10	1.14	1.17	1.15	1.20	1.25	1.30	1.34
110	H	0.89	0.94	0.98	1.01	1.04	1.04	1.09	1.14	1.18	1.22	1.18	1.24	1.30	1.34	1.38

This table to be used according to the relationship:
(Calculated Heat Gain)×(Capacity Multiplier Factor)=(Equipment ARI Standard Capacity Rating).

ern) type climate, the smallest of the three heat pumps would just balance the structure loads at the design points of 95 and 40 F. This is the ideal situation, since there is neither an excess nor deficiency of either heating or cooling. If the cooling requirement has been calculated by ARI 230 there will be only slightly more than 3 F variation in indoor temperature during summer design weather, and similar variation in heating weather.

If the same structure were to be found in still warmer climates, one could see from Fig. 2 the amount of deficiency in cooling effect, and decide whether to accept a wider temperature swing (in summer) or to increase unit size. An increase in size would give more installed heating capacity than required, but there would be compensation in that the resulting lower balance point would reduce operating costs some-what.

Moving into a colder zone would have the opposite effect, that is, building heating losses would increase, unit heating capacity would decrease and the ratio of cooling capacity to cooling requirements would increase. In this instance, more than one course of action could be taken. The designer could, as before, increase the unit size so as to match the larger heating requirement; or he could retain the unit size, and add supplementary heat; or possibly he might choose an even smaller unit (if cooling load has decreased), and use still more supplementary heat.

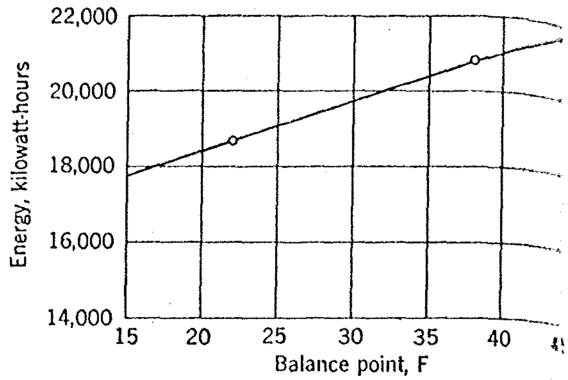
A few numbers may help clarify this point. Suppose our building was located in an area with a winter design temperature of 25 F. From Fig. 2, the design heat loss now becomes 82,000 Btuh. If the balance point were to be held at 25 F, it would require doubling the unit heating capacity (line HC3). Since heating coefficient of performance (ratio of heating ability to power input expressed in common units) of a typical heat pump is around 2.0 at 30 F, there is no doubt that this approach will result in lower operating costs than any arrangement calling for supplementary heat. Against this advantage, we must weigh the fact that equipment investment costs will be sharply increased. The retail cost of the smaller heat pump would be around $2,000, while the larger would sell at about $4,000. Furthermore, contrary to what might be supposed, the extra capacity available for cooling is not an advantage. In a simple system, without capacity modulation, such as would be likely in a small commercial job, excess cooling ability results in too frequent cycling and less control of conditions.

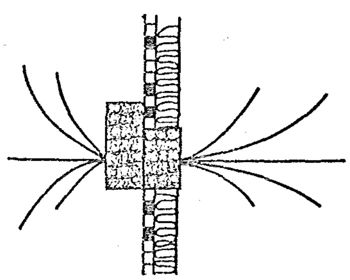
If the smaller unit were retained, the balance point would, of course, remain at 40 F, and, at the design temperature of 30F, 45,000 Btuh of supplementary heat, corresponding to about 13 kw of electrical input, would be required.

It is worth noting here that the trend toward increased illumination levels in offices and various other commercial environments, sometimes results in improved ratio of heating to cooling loads, for heat pump installations. Referring again to Fig. 2, if it is assumed that a new use of the space requires 6500 watts of additional lighting, then the new heat loss is lowered by 22,000 Btuh to line (HL2), while the cooling load line becomes (CL2). Now, use of a heat pump intermediate between the two previous size lines (CC2) and (HC2), will again result in balance near design temperatures.

To complete the picture, the designer should consider how these selections affect operating costs. The calculation of operating costs is a subject in itself which cannot be accommodated within the present space. In Fig. 3, however, results of such calculations for one installation show how total electrical energy for a season's operation (heating only) is affected by the balance point. It can be seen that lowering the balance point from 40 to 25 F results in approximately a 9% reduction in energy, or, if power costs are 1¢ per kwh, a saving of $20.00. Since this is accomplished by going from a nominal 5-hp to a 10-hp unit, the increased investment cost can easily be found from prevailing prices for such equipment. The calculation of the pay-off period is left for the reader.

Fig. 3.





CONTROLS FOR UNITARY HEAT PUMP SYSTEMS

In the application of Unitary Heat Pumps, the operating controls, installation, air distribution, and ventilation air requirements should be planned consistent with the requirements peculiar to heat pump systems. Accordingly, the following should be kept in mind during planning.

1) It is necessary that conditioned air which is circulated over the indoor coil be maintained at the designed quantity for proper operation on both cooling and heating. This is particularly true of the heating cycle to achieve economical operation and to prevent overload. The importance of keeping air filters clean becomes critical to obtain this condition.

2) Many heat pump installations require supplementary heat to match the heating load at low outdoor temperatures and to temper indoor supply air during defrost cycles. In almost all cases, this heat is provided in the form of electric resistance heating and controls should be designed to minimize the use of these heaters

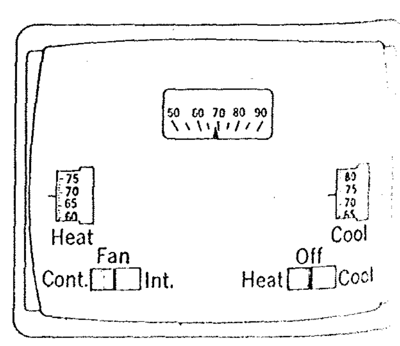


Fig. 1. Manual changeover room thermostat.

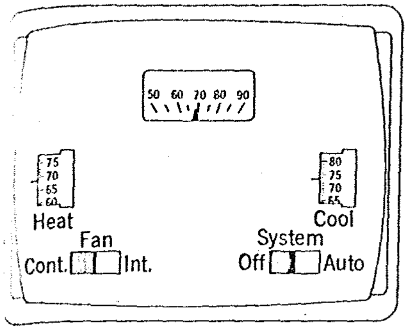


Fig. 2. Automatic changeover room thermostat.

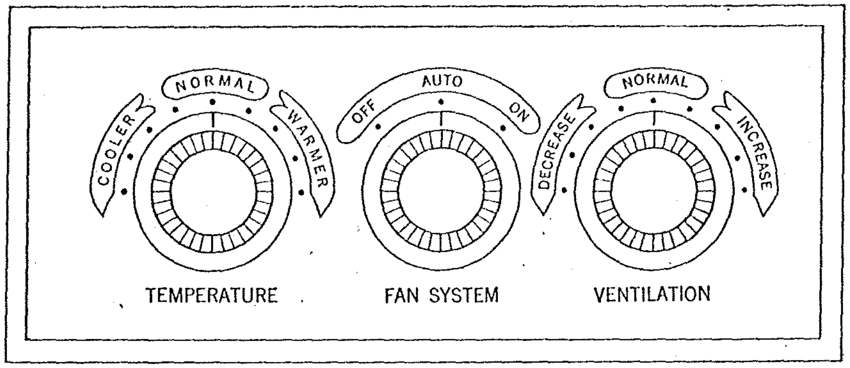


Fig. 3. Control panel-single zone.

for economy reasons. A common way of doing this is by controlling strip heaters from the second stage of indoor room thermostats. The strip heater is not turned on until the temperature falls slightly, indicating that the heat pump is not handling the load. Many times an outdoor thermostat is also added so that the electric heat can't be turned on until the outdoor temperature falls below the balance point of the system.

3) Ventilation air requirements should be held to the minimum required for economical operation on both heating and cooling.

4) Distribution of supply air within the conditioned space should be arranged so there is no direct impingement on occupants.

5) The outdoor section should be installed in such a way that the coil cannot be blocked by snow, or other debris. Also good service access should be provided to both indoor and outdoor sections.

6) Most of these considerations are essential to a good job for ordinary air conditioning or heating installations, regardless of the fuel. They are worthy of restatement only because they are critical to satisfactory heat pump performance. Night set back should be avoided or eliminated for most efficient heating operation.

Controls for unitary heat pumps are usually supplied as part of the package, and shipped with room thermostats, auxiliary heat strips, and outdoor thermostats included or available as accessories. Application of these standard controls is usually clearly explained by the manufacturer's instructions and simple, single zone jobs require only a minimum of field planning. On the other hand, larger tonnage installations which may or may not involve zoning, require that the engineer designing the system consider several factors in order to assure satisfactory performance from these control components.

Almost without exception, the unitary heat pump equipment available today is for 24 volt remote control. Thermostats on heat pumps usually offer automatic or manual heating—cooling changeover options with the switching functions necessary for complete control of the system located in the conditioned space. They can also contain two stage heating control which is essential for economical usage of auxiliary strip heat and two stage cooling control if required. Typical examples of these thermostats are shown in Figs. 1 and 2.

It is recommended with multiple unitary heat pump installations that a central control panel be used. This panel should include controls for starting and stopping unit fans; fresh air damper adjustments; manual summer-winter switches, and fan speed control switches, when used. Optional features that may be included on panel are remote adjustment of thermostat set points; remote space temperature reading; pilot light indication of fan, compressor and/or strip heat operation; and alarms for fan failure, compressor over-load or failure, outdoor fan failure or dirty filters. Only functional items that are actually needed as working tools for the particular situation should be on the panel. For example, if unitary systems are roof mounted and thus not easily accessible, more indication is needed on panels than for units mounted in equipment rooms. Again, if regular maintenance personnel are employed, less indication and alarms are required than when outside contractors are used. Examples of control panels are shown in Figs. 3 and 4.

Ventilation air requirements and controls used should be very carefully considered in the design of any system using heat pumps. Since a need for cooling must exist before a heat pump can be considered feasible, the possibility of using ventilation air for free cooling can provide worth-while economies in operating costs. This is especially true in buildings with high internal heat gains where cooling may be required even at low out-door temperatures. Preassembled packages are available for use with unitary equipment which contain necessary dampers, damper motors and controls for this type of application.

An automatic system of ventilation control is shown in Fig. 5. It uses a mixed air controller to operate the damper motor, thereby modulating fresh and return-air dampers to maintain a constant temperature input to the unitary heat pump. Controls position dampers so that only the minimum amount of ventilation air required is admitted during times of cooling demand when outdoor temperature is above 70 F, or heating demand when outdoor temperature is below 70 F. When outdoor temperature is below 70 F and cooling is required, outside air dampers can be opened to admit 100 per cent fresh air for free cooling. These dampers are also controlled to admit minimum ventilation air by the positioning switch shown in Fig. 5 or by an end switch on the damper motor itself.

Many installations require exhaust systems and dampers which may or may not be part of the package for proper control of indoor pressure levels.

Simplified ventilation systems are preferred in many cases for economy. The most simple configuration is shown in Fig. 6. It employs a spring-return motor on the outside air damper. When the fan is started, the damper opens to admit a fixed percentage of outside air. When the fan stops, the damper closes.

A more complex system, shown in Fig. 7, replaces the 2-position damper motor with a modulating motor. Amount of outside air is varied by a positioning switch on the control panel. This system permits the operator to open the outside air damper 100 per cent, but the modulating motor automatically closes the outside air damper whenever the fan is stopped.

In all cases where provision is made for ventilation air, it should be set to the minimum quantity required by code or design. Where manual positioning switches are provided, their function should be clearly explained in the operating instructions provided.

Unitary heat pump equipment, by its very nature, can provide ideal solutions to many large jobs where zoning is required. The great variety of sizes and types make it possible to mix unit sizes to fit the requirements of almost any zone. The fact that air quantity passed over the indoor coil should be held constant, however, means that the smallest practical zones for this type of equipment should require approximately 1½-tons of cooling capacity and that alternate systems should be considered if many small zones are necessary.

For any installation, proper location of the thermostat should be a serious consideration. Nothing works better than a room thermostat properly mounted in the conditioned space. However, in large spaces with no columns, or where store shelves cover wall space, compromises have to be made. The return-air thermostat is an alternative solution where it is impossible or impractical to mount a room thermostat. The return-air thermostat selected should be a good one to avoid problems caused by poor sensitivity, wide differential, or both. The complete system can operate no better than its thermostat. A return-air thermostat should offer

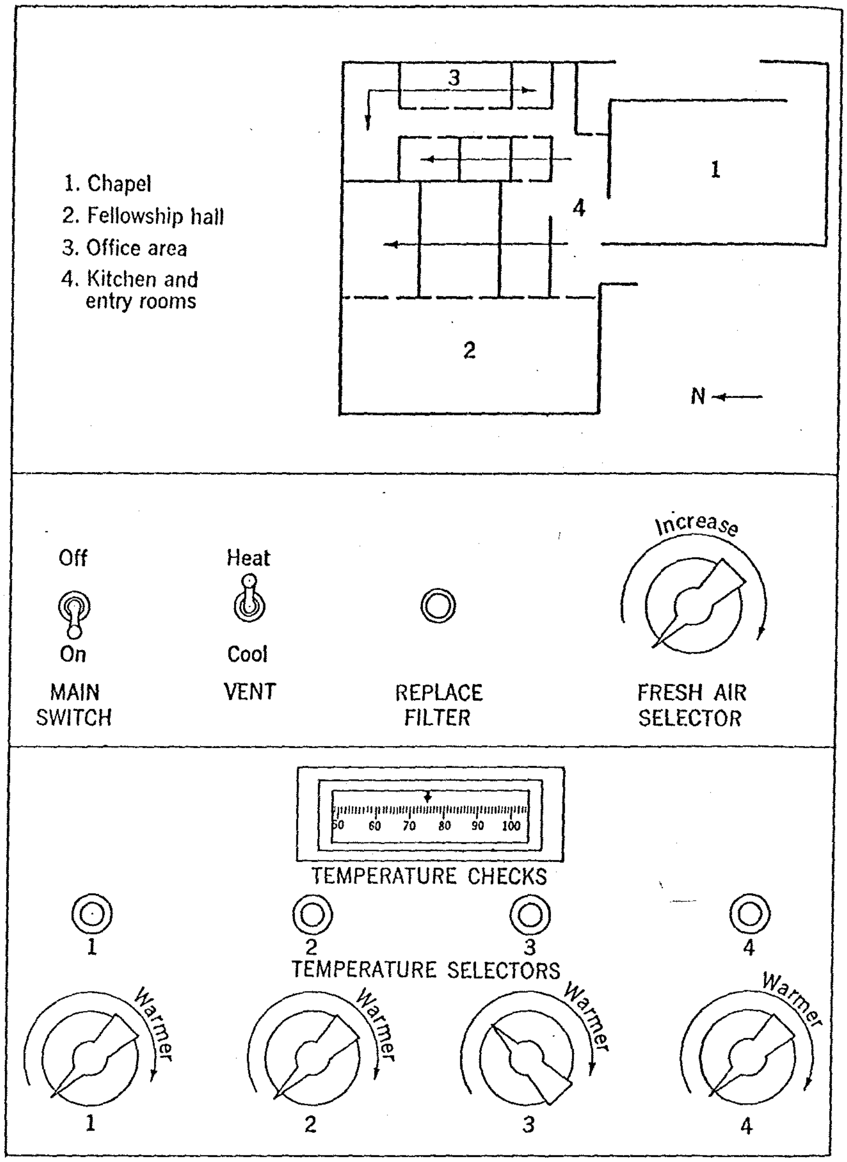


Fig. 4. Control panel—4 to 7 zones.

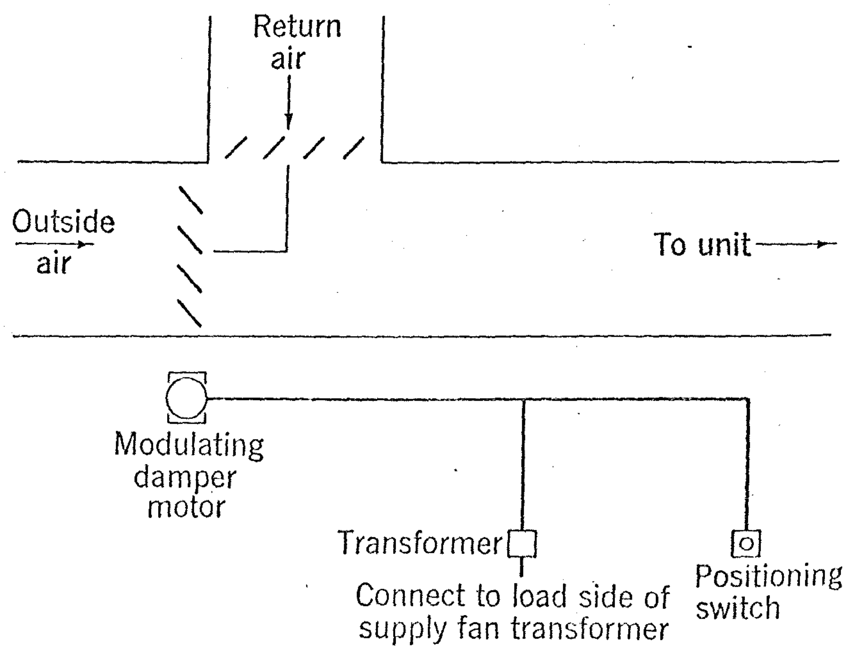


Fig. 7. Ventilation schematic.

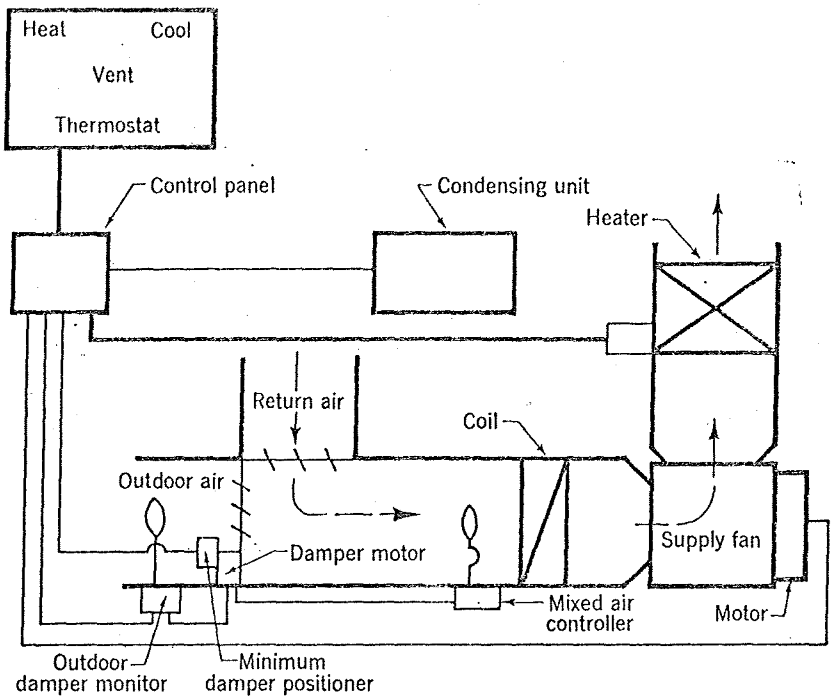


Fig. 5. Power saver schematic.

high sensitivity, fast response, low mass and good repeatability.

Electronic controls are also possible and available. New techniques, such as the transistor, printed circuit, thermistor and miniaturization have taken much of the bulk out of electronic controllers. A typical transistorized amplifier is no larger than a conventional relay, but can provide excellent control if properly selected and applied.

An added bonus with electronic control is remote temperature reset. In the case of rooftop units, resetting return air thermostats can present a problem, but a central panel with remote temperature reset can solve it handily.

Humidity control of conditioned space is an important aspect of almost all installations. From a control point of view, a slightly undersized unit is preferable to an oversized unit. The smaller unit will run longer on the cooling cycle so that moisture removal will be nearly constant. An oversize unit, cycling even in the hottest weather, can re-evaporate moisture into the air so that its latent capacity is minimized. The result can be wide swings in indoor humidity and an unsatisfactory job at times when cooling load is low. No direct humidity control should be attempted unless summer reheat or dehumidification without cooling is available. It should be emphasized that unit sizing to match the heating load at some pre-selected outdoor air temperature can lead to problems of this type. Savings in operating cost on the heating cycle are so marginal that this does not result in the most satisfactory installation.

Access to a unit seems to have a direct bearing on how well it performs, since the most accessible units usually get the best service. A unit should have clear, unobstructed work space around it and adequate lighting. The outdoor portion, or section, should be so located that there is adequate room for defrost water to be cleared from the coil, and a minimum of snow or other debris will be prevented from collecting around the unit.

For rooftop units, a permanent ladder, preferably from within the building, is a must. An access door should be provided to protect damper motors from inclement weather and keep them accessible for service. To be realistic in his design, the engineer must envision servicing these units on the worst winter day.

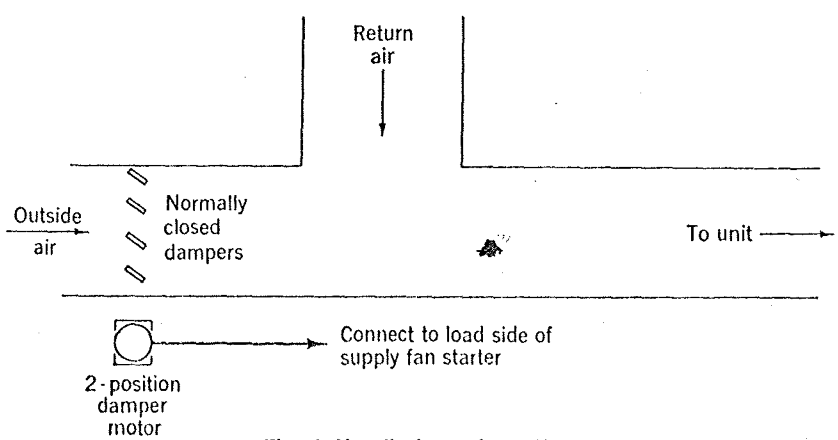
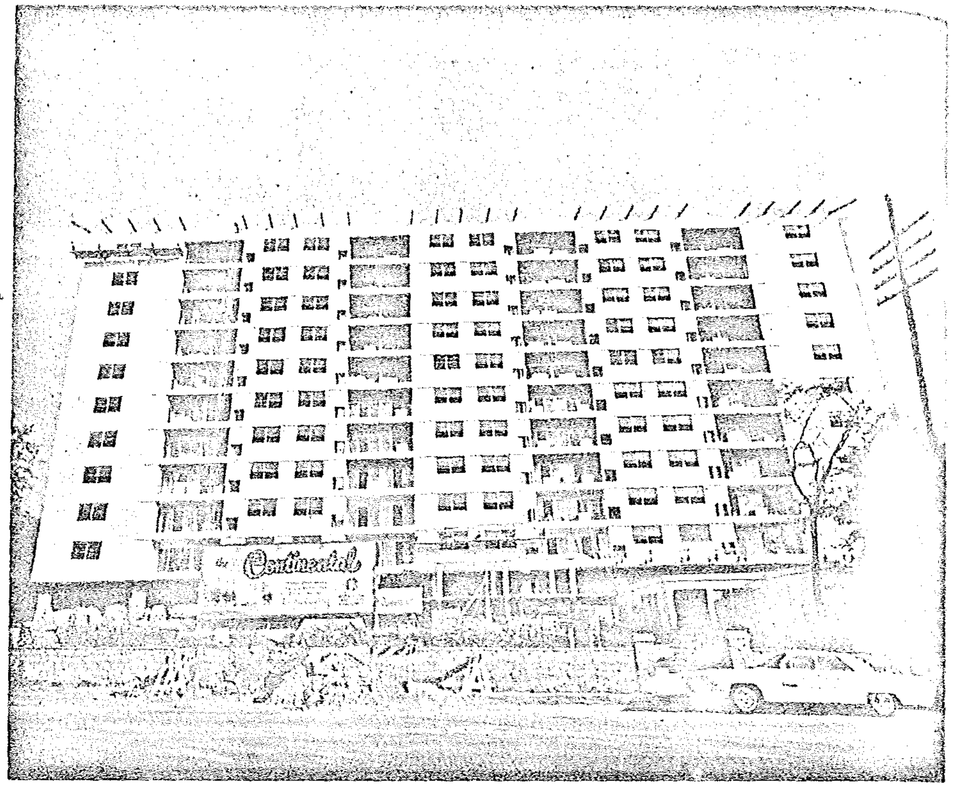
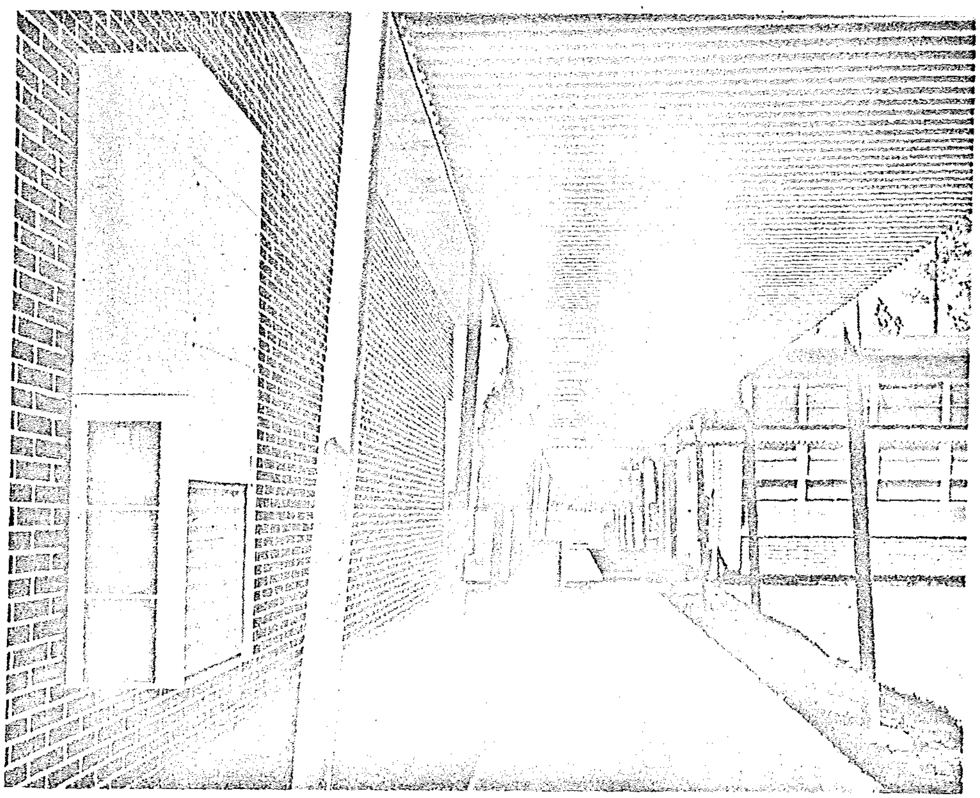


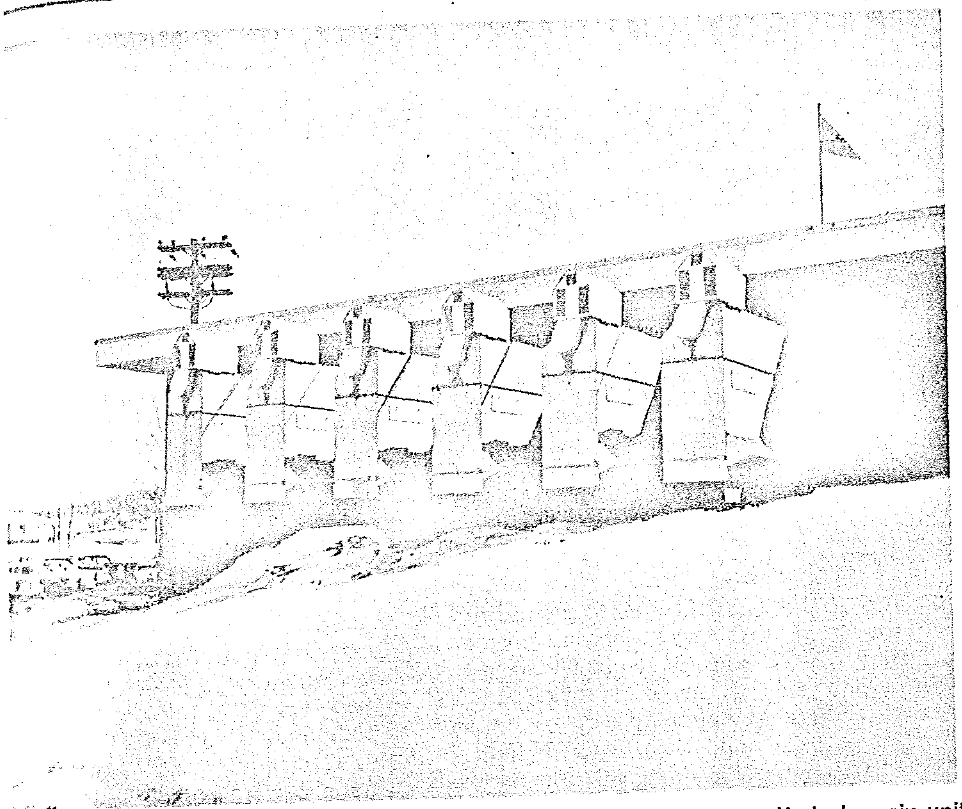
Fig. 6. Ventilation schematic.



In applications of this type at Continental Apartments, Nashville, Tennessee, each apartment and each commercial area on the ground floor can be individually equipped with heat pumps to provide year-round heating and air conditioning comfort. In this case, each apartment has its own individual comfort system.

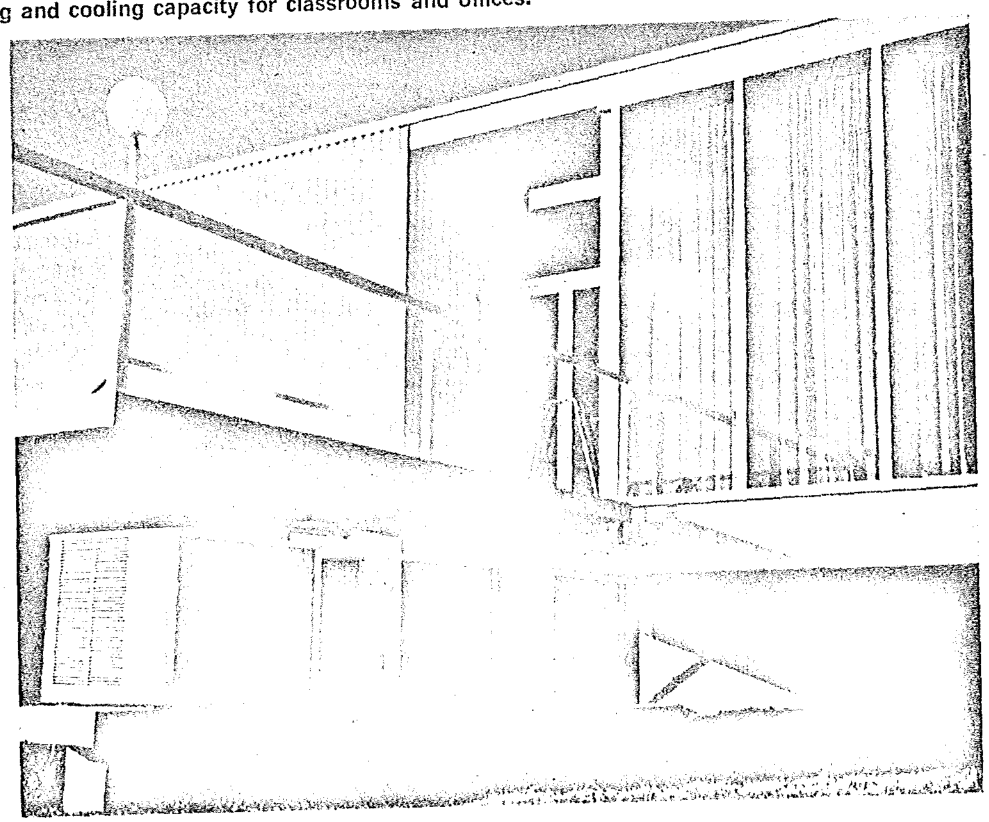
Jordye M. Bacon Primary School, Hinesville, Georgia, contains 102 tons of individual classroom heat pumps. The choice of heat pumps eliminated equipment and construction costs for separate heating and cooling systems.

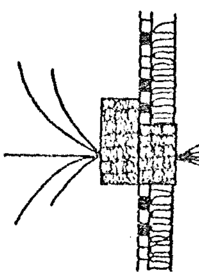




Lloyd's Shopping Center—Newburgh, New York, has six units adjacent to, but outside of the engine room which serve as outdoor air coolers during the winter heating season and evaporative condensers for summer cooling. For heating purposes, these air coolers extract heat from the outside air when outdoor temperature dips below 50 F and supplementary heating is required.

The Electrical Joint Apprenticeship and Training Center, located at the outskirts of Kansas City, Mo., is electrically climate-controlled by three split-system heat pumps. The outdoor sections are mounted on a slab under the pre-cast concrete entranceway and provide approximately 20 tons of heating and cooling capacity for classrooms and offices.





ARI—ORGANIZATION AND CERTIFIED RATINGS

THE AIR - CONDITIONING AND REFRIGERATION INSTITUTE is the trade association for manufacturers of all types of air-conditioning equipment, except room coolers, as well as many types of commercial and industrial refrigerating equipment, certain types of heating equipment, and the parts, components and materials used with them.

ARI was formed in 1953 through a merger of Refrigeration Equipment Manufacturers Association (REMA), and Air Conditioning and Refrigeration Machinery Association (ACRMA), both of which had been headquartered in Washington for several years prior to the merger.

The Institute was further enlarged early in 1965, when manufacturers who had formerly been members of the National Warm Air Heating and Air-Conditioning Association (NWAH&ACA), voted to consolidate with ARI.

Since the products of ARI Member-Companies cover a wide range—from tiny expansion valves to giant centrifugal chillers—the Institute operates primarily through its eighteen product - sections (three of which are divided into sub-sections). Each section is a "trade association within a trade association"; is semi-autonomous in matters affecting its own group members and products, elects its own officers, holds meetings, decides on promotional and statistical programs, standards, certification, and other activities.

In addition to the product-section activities, ARI has a number of general overall programs, including industry-wide promotion and public relations, and such committees as the Traffic Committee, Foreign Trade Committee, and Training Committee.

ARI headquarters is located at 1815 North Fort Myer Drive, Arlington, Va., just across the Potomac from the District of Columbia. The staff of 28, headed by L. N. Hunter, managing director, carries out the individual product-section programs as well as those which involve the entire membership. The Institute's Board of Directors is made up of representatives of all the product-sections plus a number of members-at-large.

Standards

ARI is recognized as the industry authority on equipment standards, and in addition has published a number of such standards. The complete list of ARI standards and other technical publications is printed on the next page.

Preparation and establishment of these standards is one of the primary activities in the field of engineering, where the staff acts under direct supervision of the General Standards Committee of the Institute.

While conformance with ARI standards is voluntary, they provide that equipment or applications *represented* as being in accordance with a specific ARI Standard *shall conform* with all the provisions thereof.

Certification

ARI certification programs, one of which covers unitary heat pumps up to 135,000 Btuh capacity on the cooling cycle, are based on these standards. While conformance with standards is voluntary *outside* a certification program, once a company signs a contract to participate in such a program it must conform completely with the scope of the program, including complete conformance with the specific standard upon which the program is based.

In addition to the Heat Pump Certification Program, which is based on ARI Standard 240-64, the programs now in effect include those for unitary air-conditioners (the first to be set up, based on ARI Standards 210-64 for electrically-operated and 250-62 for heat-operated units); for room air-induction units (based on ARI Standard 445-61); and for room fan-coil air-conditioners (based on Industry Standard 441-61). A number of others are being considered by interested product sections.

Conformance testing under all these programs is carried on at the Electrical Testing Laboratories in New York, which is under contract to ARI to perform such services. In addition, further conformance testing of unitary air-conditioners and heat pumps under the programs, is carried on in the approved laboratories of participating companies, always under the "witness" of an engineer from ETL or ARI.

The Certification Program for Unitary Heat Pumps has been in effect for a little more than a year, and is participated in by 2[illegible] manufacturers, representing more than 90% of total U.S. production of this type of equipment. Under its provisions, all participants must sign enforceable contracts agreeing to the rating of all equipment eligible for certification on the basis of tests made in accordance with ARI Standard 240-64, and to certify these ratings to ARI for inclusion in the *Directory of Certified Unitary Heat Pumps* (which is combined with the Directory of *Certified Unitary Air Conditioners*). The Directory, revised several times each year and distributed without charge by ARI, includes a comprehensive description of the tests required and meaning of the ratings. It is available upon request from:

Director of Engineering
Air-Conditioning and Refrigeration Institute
1815 North Myer Drive
Arlington, Virginia 22209

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by ARI engineers, random testing of certified units at Electrical Testing Laboratories in New York, testing by competitors, and "witnessed" testing in the manufacturers' own labs.

Btuh ratings published in the Directory are for uniform test conditions only, and should be relied on only as a gage of the units' capacities. ARI-standardized multi-point ratings will be found in the catalogs of the manufacturers participating in the program.

ARI TECHNICAL PUBLICATIONS

ARI Standards

200 SERIES—UNITARY AIR-CONDITIONERS

- 210-64 Standard for Unitary Air-Conditioning Equipment .... $ .75
- 230-62 Application Engineering Standard for Year-Round Residential Air-Conditioning $1.00
- 240-64 Standard for Unitary Heat Pump Equipment $ .75
- 250-62 Standard for Unitary Heat-Operated Air-Conditioning Equipment .... $ .50
- 260-64 Standard for Application, Installation and Servicing of Unitary Systems $1.00

400 SERIES—HEAT TRANSFER EQUIPMENT

- 410-64 Standard for Forced-Circulation Air-Cooling and Air-Heating Coils $3.00
- †Standards for Forced-Circulation, Free-Delivery Air-Coolers for Refrigeration .... $ .50
  - † 420-57 *Forced-Circulation, Free-Delivery Air-Coolers for Refrigeration*
  - † 421-57 *Application Engineering Standard for Forced-Circulation, Free-Delivery Air-Coolers for Refrigeration*
- †430-58 Standard for Remote-Type Air-Handling Units $ .60
- 445-61 Standard for Room Air-Induction Units $1.50
- 450-61 Standard for Water-Cooled Refrigerant Condensers .... $ .75
- 480-61 Standard for Refrigerant-Cooled Liquid Coolers, Remote Type .... $ .75
- 495-61 Standard for Refrigerant Liquid Receivers .... $ .35

500 SERIES—AIR-CONDITIONING AND REFRIGERATION SYSTEMS EQUIPMENT

- 511-60 Standard for Ammonia Compressors and Compressor Units .... $ .50
- 514-62 Standard for Open-Type Refrigerant Compressors and Condensing Units, 20 Horsepower and Smaller $1.00
- 515-60 Standard for Sealed Refrigerant Compressors and Condensing Units, 20 Horsepower and Smaller .... $ .50
- 516-60 Standard for Refrigerant 12 and Refrigerant 22 Compressors and Condensing Units, 25 Horsepower and Larger .... $ .50
- 530-56 Application Engineering Standard for Air-Conditioning $1.00
- 550-59 Standard for Centrifugal Liquid-Chilling Packages .... $ .40
- 555-63 Standard for Application and Ratings of Centrifugal Liquid-Chilling Packages .... $ .75
- 590-62 Standard for Reciprocating Water-Chilling Packages $1.00

700 SERIES—VALVES, DRIERS, FITTINGS, AND ACCESSORIES

- 710-64 Standard for Liquid-Line Driers .... $ .75
- †720-55 Standard for Refrigeration Flare Fittings .... $ .25

1000 SERIES—WATER COOLERS

- 1010-62 Standard for Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers .... $ .75

1100 SERIES—MOBILE AIR-CONDITIONING AND REFRIGERATION SECTION

- 1110-64 Standard for Speed-Governed Transport Refrigeration Units Employing Forced-Circulation Air-Coolers $1.00
- 1120-61 Standard for Variable Speed Transport Refrigeration Units Employing Forced-Circulation Air-Coolers .... $ .75

Industry Standards

- **441-61 Standard for Room Fan-Coil Air-Conditioners $1.50
- Complete Set of Standards in permanent three-ring binder $20.00

ARI Calculation and Check Forms

- 230-ALC-1 Residential Air-Conditioning Load Calculation Forms—Pad of 25 Forms @ $1.25
- Cooling Load Estimate Forms (ARI Standard 530-56) —Pad of 50 Forms @ $1.00
- 2601C-1 ARI Service Inspection Blank Forms—Pad of 50 Forms @ $1.00

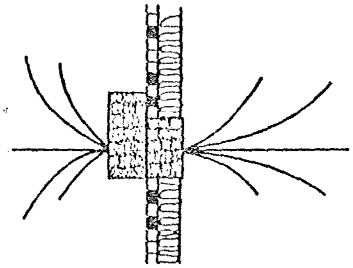
Collateral Publications

- Properties of Commonly-Used Refrigerants (1957 Edition) $2.00
- Corrosion and Its Prevention (1958 Edition) .... $ .75
- Refrigerant Piping Data $3.00

* Cooling Load Estimate Forms are available separately in pads of 50 forms @ $1.00.

† Currently being revised (unavailable).

** Published in cooperation with Air Moving and Conditioning Association, Inc., and Institute of Boiler and Radiator Manufacturers.



HEAT PUMP EQUIPMENT DIRECTORY

The following data were submitted by manufacturers who make heat pumps in order to be used as a guide to what is currently on the market. Some units are not certified because the program does not encompass very large ones.

AIRTEMP DIVISION, CHRYSLER CORPORATION

Trade Name: Airtemp

ARI Certified Units

Type	Designation	Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	3102-00	22,000	21,000	10,000
HSP-A	3102-01	22,000	21,000	10,000
HSP-A	3103-00	25,000	25,000	14,000
HSP-A	3103-01	25,000	25,000	14,000
HSP-A	3104-01	33,000	35,000	19,000
HSP-A	3105-01	46,000	46,000	28,000*
HSP-A	3105-00	47,000	46,000	25,000
HSP-A	3106-00	58,000	58,000	32,000

Type	Outdoor Unit	Indoor Unit	Cooling (Btuh)	Heating (Btuh)	Application Rating, Heating (Btuh)
HRCU-A	3251-00	1452-51	17,500	18,500	11,000
HRCU-A	3252-00	1452-51	22,000	23,000	14,000
HRCU-A	3204-01	1454-00	33,000	32,000	17,000
HRCU-A	3206-01	1456-00	56,000	55,000	30,000
HRCU-A	3209-00	1468-1489	86,000	85,000	46,000
HRCU-A	3212-00	1412-00	110,000	107,000	58,000

Units Not Certified by ARI

Type	Outdoor Unit	Indoor Unit	Cooling (Btuh)	Heating (Btuh)	Application Rating, Heating (Btuh)
HRCU-A	3216-00	1416-00	150,000	146,000	87,800

AMANA REFRIGERATION, INC.

Trade Name: Amana

ARI Certified Units

Type	Designation	Cooling (Btuh)	Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	†PKH2-1B	23,000	24,000	10,000
HSP-A	†PKH2.5-1A	29,000	30,000	17,000
HSP-A	†CPKH3-1, -3	35,000	36,000	17,000
HSP-A	†PKH4-1A, -3A	47,000	49,000	30,000
HSP-A	†PKH5-1A, -3A	57,000	59,000	30,000

Type	Outdoor Unit	Indoor Unit	Cooling (Btuh)	Heating (Btuh)	Application Rating, Heating (Btuh)
HRCU-A	†HRH2-1	LAH2A&LB2/3, LB2/3A	23,000	22,000	10,000
HRCU-A	†HRH2-1	LUH2&LB2/3, LB2/3A	24,000	23,000	13,000
HRCU-A	†HRH2.5-1	LAH3A&LB2/3, LB2/3A	30,000	30,000	17,000
HRCU-A	†HRH2.5-1	LUH3&LB2/3, LB2/3A	30,000	30,000	19,000
HRCU-A	†HRH3-1A, -3A	LAH3A&LB2/3, LB2/3A	35,000	36,000	22,000
HRCU-A	†HRH3-1A, -3A	LUH3&LB2/3, LB2/3A	36,000	36,000	22,000
HRCU-A	†HRH4-1A, -3A	LUH4&LB4/5, LB4/5A	48,000	48,000	28,000
HRCU-A	†HRH5-1A, -3A	LUH5&LB4/5, LB4/5A	58,000	58,000	31,000

† For units operating at 208v., deduct 1,000 Btuh from capacity rating.

BAKER BROS., INC.

Trade Name: LaSalle

ARI Certified Units

Type	Designation	Cooling (Btuh)	Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	†CPKH2-1	23,000	24,000	10,000
HSP-A	†CPKH2.5-1	29,000	30,000	17,000
HSP-A	†CPKH3-1, -3	35,000	36,000	17,000
HSP-A	†CPKH4-1, -3	47,000	49,000	30,000
HSP-A	†CPKH5-1, -3	57,000	59,000	30,000

BAKER BROS., INC. (Continued)

Type	Outdoor Unit	Indoor Unit	Cooling (Btuh)	Heating (Btuh)	Application Rating, Heating (Btuh)
HCRU-A	†CHRH2-1	CLAH-2A&CLB2/3	23,000	22,000	[illegible]
HCRU-A	†CHRH2-1	CLUH-2&CLB2/3	24,000	23,000	[illegible]
HCRU-A	†CHRH2.5-1	CLAH-3A&CLB2/3	30,000	30,000	[illegible]
HCRU-A	†CHRH2.5-1	CLUH-3&CLB2/3	30,000	30,000	[illegible]
HCRU-A	†CHRH3-1, -3	CLAH-3A&CLB2/3	35,000	36,000	[illegible]
HCRU-A	†CHRH3-1, -3	CLUH-3&CLB2/3	36,000	36,000	[illegible]
HCRU-A	†CHRH4-1, -3	CLUH-4&CLB4/5	48,000	48,000	[illegible]
HCRU-A	†CHRH5-1, -3	CLUH-5&CLB4/5	58,000	58,000	[illegible]

† For units operating at 208v., deduct 1,000 Btuh from capacity rating

BARD MANUFACTURING CO.

Trade Name: Bard

Units Not Certified by ARI

Type	Designation	Cooling (Btuh)	Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	18WH	18,000	17,000	[illegible]
HSP-A	24WH	23,000	22,000	[illegible]
HSP-A	36WH	35,000	36,000	[illegible]
HSP-A	PH24H	23,000	22,000	[illegible]
HSP-A	PH36H	35,000	36,000	[illegible]
HSP-A	PH48H	47,000	48,000	[illegible]
HSP-A	PH60H	59,000	59,000	[illegible]

Type	Outdoor Unit	Indoor Unit	Cooling (Btuh)	Heating (Btuh)	Application Rating, Heating (Btuh)
HRCU-A	36HP,Q	BC3H,Q	33,000	34,000	[illegible]
HRCU-A	48HP	B48H	45,000	47,000	[illegible]
HCRU-A	60HP	B60H	57,000	59,000	[illegible]

CALIFORNIA HEAT PUMP CORPORATION

Trade Name: Cool-Heat-Pack

ARI Certified Units

Type	Designation	Cooling (Btuh)	Heating (Btuh)
HSP-W	CHP-1V-1, 1H-1	12,000	9,000
HSP-W	CHP-1.5V-1, 1.5H-1	19,000	16,000
HSP-W	CHP-2-1	26,000	20,000
HSP-W	CHP-2.5-3, -1	33,000	27,000
HSP-W	CHP-3-3, -1	40,000	34,000
HSP-W	CHP-4-3, -1	47,000	41,000

‖ Not required for water-source units.

CARRIER AIR CONDITIONING COMPANY
Trade Name: Weathermaker
ARI Certified Units

Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
50DQ002300		20,000	21,000	12,000
50DQ004		35,000	37,000	21,000
50DQ005		49,000	53,000	31,000
50DQ006		60,000	60,000	34,000
50DR006500		61,000	65,000	38,000
50DQ008		87,000	87,000	51,000
50KQ002300		24,000	24,000	‖
Outdoor Unit	Indoor Unit			
38BQ002	40CQ002	22,000	24,000	14,000
38BQ004	28AA004/40AA004	38,000	39,000	25,000
38BQ004	28AA005/40AA004	38,000	42,000	25,000
38BQ004	40CA004	38,000	39,000	19,000
38BQ004	40CB004	38,000	39,000	19,000
38BQ004	28AA005/40AA006	39,000	42,000	24,000
38BQ005	40CA005	45,000	50,000	29,000
38BQ005	40CB005	45,000	50,000	29,000
38BQ005	28AA005/40AA006	51,000	54,000	32,000
38BQ005	28AA006/40AA006	53,000	55,000	33,000
38BQ006	28AA006/40AA006	58,000	64,000	39,000
38BQ008	40BA009	86,000	86,000	50,000
38AC012	40RT012	118,000	114,000	72,000

‖ required for water-source units.

CENTURY ENGINEERING CORPORATION
Trade Name: Century
ARI Certified Units

Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
†CPKH2-1		23,000	24,000	10,000
†CPKH2.5-1		29,000	30,000	17,000
†CPKH3-1, -3		35,000	36,000	17,000
†CPKH4-1, -3		47,000	49,000	30,000
†CPKH5-1, -3		57,000	59,000	30,000
Outdoor Unit	Indoor Unit			
†CHRH2-1	CLAH-2A&CLB2/3	23,000	22,000	10,000
†CHRH2-1	CLUH-2&CLB2/3	24,000	23,000	13,000
†CHRH2.5-1	CLAH-3A&CLB2/3	30,000	30,000	17,000
†CHRH2.5-1	CLUH-3&CLB2/3	30,000	30,000	19,000
†CHRH3-1, -3	CLAH-3A&CLB2/3	35,000	36,000	22,000
†CHRH3-1, -3	CLUH-3&CLB2/3	36,000	36,000	22,000
†CHRH4-1, -3	CLUH-4&CLB4/5	48,000	48,000	28,000
†CHRH5-1, -3	CLUH-5&CLB4/5	58,000	58,000	31,000

†... units operating at 208v., deduct 1,000 Btuh from capacity rating.

CLIMATE MASTER PRODUCTS, INC.
Trade Name: Climate Master
ARI Certified Units

Designation	Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
075 WC	9,000	5,500	‖
075 WCC	9,000	5,500	‖
101 WC	13,500	8,000	‖
151 WC	13,000	11,500	‖
201 WC	26,000	17,500	‖
251, 3 WC	32,000	22,000	‖
301, 3 W	41,000	29,000	‖
301, 3 WC	41,000	29,000	‖
401, 3 W	53,000	35,000	‖
501, 3 W	61,000	42,000	‖
601, 3 W	81,000	57,000	‖
803 W	105,000	70,000	‖

‖ required for water-source units.

COLEMAN COMPANY, INC., THE
Trade Name: Single-Package Heat Pump
ARI Certified Units

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	6162A701		25,000	26,000	16,000
HSP-A	6163-701		36,000	37,000	25,000

Trade Name: Polar Prince

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HRCU-A	6208-701	6208-700	36,000	38,000	25,000
HRCU-A	6209-701	6209-700	62,000	65,000	41,000

FEDDERS CORPORATION
Trade Name: Adaptomatic
ARI Certified Units

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	HA24A-3A		24,000	25,000	12,000
HSP-A	HA28A-3A		28,000	29,000	16,000
HSP-A	HA36A-7, -8		34,000	36,000	20,000
HSP-A	HEA36A7, -8		34,000	36,000	20,000
HSP-A	HEA36B-7, -8		34,000	36,000	20,000
HSP-A	HA48D-3, -8		46,000	48,000	31,000
HSP-A	HAU48D-3		46,000	48,000	37,000‡
HSP-A	HA60D-3, -8		57,000	60,000	38,000

Trade Name: Ductaire

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	HED18C-7		17,000	17,000	11,000
HSP-A	HED24C-3, -3A, -3B		23,000	23,000	14,000
HSP-A	HED30C-3, -3A		27,000	27,000	17,000

Trade Name: Flexhermetic

Type	Outdoor Unit	Indoor Unit	Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HRCU-A	HF24Q-3A	HVB24Q	22,000	24,000	15,000
HRCU-A	HF24S-3	HVB24S	23,000	25,000	16,000
HRCU-A	HF30S-3	HVB33S	27,000	29,000	18,500
HRCU-A	HF33S-7	HVB33S	32,000	34,000	21,000
HRCU-A	HF33Q-7	HVB33Q	32,000	34,000	22,000
HRCU-A	HF40S-7	HVB48S	40,000	42,000	25,000
HRCU-A	HF48Q-3, -8	HVB48Q	46,000	49,000	30,000
HRCU-A	HF60Q-3, -8	HVB60Q	56,000	60,000	38,000

‡ This capacity obtained at the manufacturer's lowest recommended operating temperature of 30 F.

FRIEDRICH REFRIGERATORS INCORPORATED
Trade Name: Friedrich
ARI Certified Units

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	HSY-251		23,000	21,000	13,000
HSP-A	HSY-301		31,000	28,000	19,000
HSP-A	HSY-401		39,000	38,000	28,000
	Outdoor Unit	Indoor Unit			
HRCU-A	RCUY-361	BEY-36	35,000	34,000	22,000
HRCU-A	RCUY-601/603	BEY-60	59,000	59,000	36,000
HRCU-A	RCUY-863	BEY-90	84,000	85,000	60,000

GAFFERS & SATTLER CORPORATION
Trade Name: Gaff-Pak
Units Not Certified by ARI

Type	Designation	Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	H2-1	23,000	24,000	10,000
HSP-A	H2.5-1	29,000	30,000	17,000
HSP-A	H3-1 & H3-3	35,000	36,000	17,000
HSP-A	H4-1 & H4-3	47,000	49,000	30,000
HSP-A	H5-1 & H5-3	57,000	59,000	30,000

GENERAL ELECTRIC COMPANY
Trade Name: Weathertron
ARI Certified Units

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	21WC024F		22,000	24,000	15,000
HSP-A	21WR024F		22,000	24,000	15,000
HSP-A	21WTC24FN & FT		22,000	24,000	15,000
HSP-A	21WC024J		23,000	23,000	15,000
HSP-A	21WC030F		29,000	31,000	21,000
HSP-A	21WR030F		29,000	31,000	21,000
HSP-A	21WTC30FN & FT		29,000	31,000	21,000
HSP-A	21WC036F		36,000	39,000	26,000
HSP-A	21WR036F		36,000	39,000	26,000
HSP-A	21WTC36FN & FT		36,000	39,000	26,000
HSP-A	21WC048A		48,000	52,000	33,000
HSP-A	21WTC48AN		48,000	52,000	33,000
HSP-A	21WC060A		60,000	65,000	45,000
HSP-A	21WTC60AN		60,000	65,000	45,000
	Outdoor Unit	Indoor Unit			
HRCU-A	21WA024J	21WE024J	22,000	22,000	13,000
HRCU-A	21WA030F	21WE030B, C	29,000	31,000	21,000
HRCU-A	21WTA30F	21WTE30BC	29,000	31,000	21,000
HRCU-A	21WTA30F	21WTE30CH	29,000	31,000	21,000
HRCU-A	21WA036F	21WE036B, C	36,000	39,000	28,000
HRCU-A	21WTA36F	21WTE36BC	36,000	39,000	28,000
HRCU-A	21WTA36F	21WTE36CH	36,000	39,000	28,000
HRCU-A	21FA048A	21WE048A	45,000	45,000	31,000
HRCU-A	21WA048A	21WE048B	45,006	45,000	31,000
HRCU-A	21WA060A	21WE060A	55,000	59,000	38,000
HRCU-A	21WA060A	21WE060B	55,000	59,000	38,000
HRCU-A	21WTA96A	21WTE96B	88,000	98,000	66,000
HRCU-A	21WTA96A	21WTE96AH	96,000	98,000	66,000
HRCU-A	21WTA120A	21WTE120AH	120,000	127,000	82,000
HRCU-A	21WTA120A	21WTE120B	120,000	127,000	82,000

GOETTL BROS. METAL PRODUCTS, INC.
Trade Name: Goettl
ARI Certified Units

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	GAP1.5-1		17,000	17,000	11,000
HSP-A	TAP2-1		21,000	22,000	13,000
HSP-A	GAP2-1		25,000	26,000	16,000
HSP-A	GAP2.5-1, -3		30,000	28,000	18,000
HSP-A	GAP3-1, -3		36,000	35,000	22,000
HSP-A	GAP3.5-1, -3		38,000	37,000	25,000
HSP-A	GAP4-1, -3		48,000	46,000	29,000
HSP-A	GAP5-1, -3		59,000	58,000	39,000
HSP-A	GAP7.5-3		79,000*	86,000	50,000
HSP-A	GAP10-3		120,000	112,000	70,000
	Outdoor Unit	Indoor Unit			
HRCU-A	RGAP3-1	GLP3	36,000	35,000	21,000
HRCU-A	RGAP3.5-1, -3	GLP3.5	40,000	39,000	26,000
HRCU-A	RGAP4-1, -3	GLP4	48,000	46,000	29,000
HRCU-A	RGAP5-1, -3	GLP5	58,000	57,000	38,000
HRCU-A	RGAP7.5-3	GLP7.5	79,000	85,000	50,000
RCU-A	RGAP10-3	GLP10	120,000	112,000	70,000

HEAT CONTROLLER, INCORPORATED
Trade Name: Comfort Aire
Units Not Certified by ARI

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
P-A	PH-24-1A		24,000	23,000	14,000
P-A	PH-30-1A		30,000	28,000	18,000
P-A	PH-36-1B		34,000	34,000	21,000
P-A	PH-42-1B		40,000	40,000	25,000
P-A	PH-60-1C, 3B		58,000	57,000	37,000

HEAT CONTROLLER, INCORPORATED (Continued)

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	PH-92		94,000	91,000	[illegible]
HSP-A	PH-122		121,000	116,000	[illegible]
HSP-A	PH-162		155,000	149,000	10[illegible]
HSP-A	PH-182		182,000	174,000	11[illegible]
HSP-W	WK-24		24,000	30,000	
HSP-W	WK-33		31,700	38,700	
HSP-W	WK-44		41,500	50,800	
HSP-W	WK-58		53,500	65,600	
HSP-W	WK-74		65,800	80,500	
HSP-W	WK-103		102,500	127,000	
HSP-W	WK-140		145,000	181,000	
HSP-W	WK-185		185,000	229,000	
HSP-W	WK-230		230,000	286,000	
HSP-W	WK-290		290,000	362,000	
HSP-W	WK-370		370,000	458,000	
HSP-W	WK-460		460,000	572,000	
	Outdoor Unit	Indoor Unit			
HRCU-A	QH-24-1A	Q24BCH	24,000	24,000	14[illegible]
HRCU-A	QH-301A	Q30BCH	29,000	30,000	18[illegible]
HRCU-A	QH-36-1B	Q36BCH	34,000	34,000	21[illegible]
HRCU-A	RH-60-1B, 3A	60BCH-B	59,000	59,000	38[illegible]
HRCU-A	38HVH	38HVH	38,000	42,000	25[illegible]
HRCU-A	48HVH	48HVH	51,000	57,000	38[illegible]
HRCU-A	62HVH	62HVH	63,000	65,000	43[illegible]
HRCU-A	92HVH	92HVH	91,000	99,500	67[illegible]
HRCU-A	122HVH	122HVH	122,000	132,000	91[illegible]
HRCU-A	132HVH	132HVH	126,000	130,000	86[illegible]
HRCU-A	162HVH	162HVH	174,000	190,000	129[illegible]
HRCU-A	202HVH	202HVH	202,000	222,000	150[illegible]
HRCU-A	242HVH	242HVH	244,000	266,000	184[illegible]
HRCU-A	302HVH	302HVH	348,000	380,000	257[illegible]
HRCU-A	402HVH	402HVH	404,000	444,000	300[illegible]
HRCU-A	502HVH	502HVH	578,000	634,000	42[illegible]
HRCU-A	602HVH	602HVH	606,000	666,000	45[illegible]
HRCU-W	CWAH-3		34,080	40,000	24[illegible]
HRCU-W	CWAH-5		63,240	63,000	41[illegible]
HRCU-W	CWAH-7.5		79,080	99,000	66[illegible]
HRCU-W	CWAH-10		111,600	132,000	87[illegible]
HRCU-W	CWAH-15		176,400	224,000	153[illegible]
HRCU-W	CAH-3		34,080	40,000	24[illegible]
HRCU-W	CAH-5		63,240	63,000	41[illegible]
HRCU-W	CAH-7.5		79,080	99,000	66[illegible]
HRCU-W	CAH-10		111,600	132,000	87[illegible]
HRCU-W	CAH-15		176,400	224,000	153[illegible]

HENRY FURNACE COMPANY, THE
Trade Name: Moncrief
ARI Certified Units

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	WHP-181A, B		18,000	17,000	9[illegible]
HSP-A	WHP-202A, B		22,000	21,000	11[illegible]
HSP-A	†HP2E-1		23,000	24,000	10[illegible]
HSP-A	†HP25E-1		29,000	30,000	17[illegible]
HSP-A	WHP-302B		34,000	35,000	25[illegible]
HSP-A	†HP3D-1, -3		35,000	37,000	18[illegible]
HSP-A	†HP4D-1, -3		47,000	49,000	33[illegible]
HSP-A	†HP5D-1, -3		57,000	59,000	39[illegible]
	Outdoor Unit	Indoor Unit			
HRCU-A	HPO-152	HPI-152	17,500	18,000	11[illegible]
HRCU-A	HPO-202	HPI-202	22,000	23,000	15[illegible]

† For units operating at 208v., deduct 1,000 Btuh from capacity rating

Designa

INTERNATIC
Trade
A

PAC-2C-1
PAC-3B-1
‡PAC-4-1A
‡PAC-5-1A

Outdoor Unit
†PS-3D-1D, -3D
†PS-3D-1D, -3D
†PS-3D-1D, -3D
‡PS-4D-1D, -3D
‡PS-4D-1D, -3D
‡PS-4D-1D, -3D
‡PS-5D-1D, -3D
‡PS-5D-1D, -3D
‡PS-5D-1D, -3D

three-phase units opera
rating.
three-phase units operat
rating.

INTERNATIONAL
McGrav
Trade N
ARI

PAPB-1
PAPC-1
PAPD-1, -3

Units N
PAPB-1
PAPC-1
PAPD-1, -3

JANIT
MIDLAND-
Trade
Units N

46-024-010
46-030-010
46-036-010
46-048-010
46-060-010
46-084-030
46-120-030
5051-018
5051-024
5051-036

ratings at 45 F db,
ation rating at 20F.

LENNOX
Trad
ARI

CHP4-201-2
CHP4-251
CHP4-311
CHP4-410

Ratings Cooling (Btuh)	Ratings Heating (Btuh)
R, INCORPORATED (Continued)	
94,000	91,000
121,000	116,000
155,000	149,000
182,000	174,000
24,000	30,000
31,700	38,700
41,500	50,800
53,500	65,600
65,800	80,500
102,500	127,000
145,000	181,000
185,000	229,000
230,000	286,000
290,000	362,000
370,000	458,000
460,000	572,000
24,000	24,000
29,000	30,000
34,000	34,000
59,000	59,000
38,000	42,000
51,000	57,000
63,000	65,000
91,000	99,500
122,000	132,000
126,000	130,000
174,000	190,000
202,000	222,000
244,000	266,000
348,000	380,000
404,000	444,000
578,000	634,000
606,000	666,000
34,080	40,000
63,240	63,000
79,080	99,000
111,600	132,000
176,400	224,000
34,080	40,000
63,240	63,000
79,080	99,000
111,600	132,000
176,400	224,000
...MPANY, THE ...oncrief — Units	
18,000	17,000
22,000	21,000
23,000	24,000
29,000	30,000
34,000	35,000
35,000	37,000
47,000	49,000
57,000	59,000
17,500	18,000
22,000	23,000

Btuh from capacity rating.

INTERNATIONAL HEATER COMPANY

Trade Name: International

ARI Certified Units

Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
PAC-2C-1A		23,000	23,000	14,000
PAC-3B-1A		33,000	33,000	20,000
‡PAC-4-1A, -3A		46,000	46,000	26,000
‡PAC-5-1A, -3A		57,000	57,000	33,000
Outdoor Unit	**Indoor Unit**			
†PS-3D-1D, -3D	PAH-20-3A	35,000	34,000	19,500
†PS-3D-1D, -3D	PAH-40-3A	35,000	34,000	19,500
†PS-3D-1D, -3D	PUC-3D	35,000	34,000	19,500
‡PS-4D-1D, -3D	PAH-20-4A	46,000	46,000	29,000
‡PS-4D-1D, -3D	PAH-40-4A	46,000	46,000	29,000
‡PS-4D-1D, -3D	PUC-4D	46,000	46,000	29,000
‡PS-5D-1D, -3D	PAH-20-5A	57,000	57,000	32,000
‡PS-5D-1D, -3D	PAH-40-5A	57,000	57,000	32,000
‡PS-5D-1D, -3D	PUC-5D	57,000	57,000	32,000

…three-phase units operating at 208v., deduct 1,000 Btuh from cooling …city rating.

…three-phase units operating at 208v., deduct 2,000 Btuh from cooling …city rating.

INTERNATIONAL METAL PRODUCTS DIVISION

McGraw-Edison Company

Trade Name: Arctic Circle

ARI Certified Units

Designation	Cooling (Btuh)	Heating (Btuh)	Application Rating (Btuh)
PAPB-1	26,000	25,000	15,000
PAPC-1	31,000	28,000	17,000
PAPD-1, -3	38,000	35,000	18,000

Units Not Certified by ARI

Designation	Cooling (Btuh)	Heating (Btuh)	Application Rating (Btuh)
PAPB-1	26,000	27,000	16,500
PAPC-1	31,000	28,000	17,000
PAPD-1, -3	38,000	35,000	18,000

JANITROL DIVISION
MIDLAND-ROSS CORPORATION

Trade Name: Janitrol Skyliner

Units Not Certified by ARI

Designation	Cooling (Btuh)	Heating (Btuh)	Application Rating (Btuh)
46-024-010	22,000	22,400	13,500
46-030-010	27,000	28,600	19,500
46-036-010	33,000	34,500	21,500
46-048-010	43,000	45,000	32,000
46-060-010	54,000	55,000	40,300
46-084-030	88,000	86,000	60,000
46-120-030	113,000	110,000	76,500
5051-018	16,000	17,000	9,000
5051-024	23,000	25,000	17,000
5051-036	34,000	37,000	26,000

…ting ratings at 45 F db, 43 F wb.

…ication rating at 20F.

LENNOX INDUSTRIES INC.

Trade Name: Lennox

ARI Certified Units

Designation	Cooling (Btuh)	Heating (Btuh)	Application Rating (Btuh)
CHP4-201-2	23,000	22,000	14,000
CHP4-261	24,000	24,000	14,000
CHP4-311	29,000	28,000	17,000
[1] CHP4-410	34,000	36,000	22,000

LENNOX INDUSTRIES INC. (Continued)

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	[1] CHP6-410		34,000	37,000	22,0
HSP-A	[1] CHP6-510		48,000	49,000	22,0
HSP-A	[1] CHP6-650		59,000	59,000	31,0
HSP-A	[1] CHP6-953		86,000	87,000	52,0
HSP-A	[1] CHP6-1353		128,000	119,000	70,0
	Outdoor Unit	**Indoor Unit**			
HRCU-A	HPW1-211	CB1-21	17,000	18,000	12,0
HRCU-A	HP6-211	CB1-21	17,000	19,500	12,0
HRCU-A	HPW1-261	CB1-26	22,000	23,000	15,0
HRCU-A	HP6-261	CB1-26	22,000	22,000	15,0
HRCU-A	HP6-311-1	CB1-41	28,000	29,000	16,0
HRCU-A	[1] HP6-410	CB1-41	34,000	37,000	22,0
HRCU-A	[1] HP6-510V-1	PCB1-65V	46,000	46,000	25,0
HRCU-A	[1] HP6-510V-1	CP341-500	46,000	46,000	25,0
HRCU-A	[1] HP6-510V-1	CRP341-500	46,000	46,000	25,0
HRCU-A	[1] HP6-650V	CP341-500	58,000	58,000	31,0
HRCU-A	[1] HP6-650V	CRP341-500	58,000	58,000	31,0
HRCU-A	[1] HP6-650V	LSPH5-500	58,000	58,000	31,0
HRCU-A	[1] HP6-650V	PCB1-65V	58,000	58,000	31,0
HRCU-A	[1] HP2-753-1	CP521-750	85,000	85,000	50,0
HRCU-A	[1] HP2-753-1	PCB1-95V	85,000	85,000	50,0
HRCU-A	[1] HP6-1353V	PCB1-135V	120,000	120,000	70,0

[1] Also -440 volt, three-phase unit.

OLSEN MANUFACTURING COMPANY, THE C. A.

Trade Names: Luxaire, Southaire

ARI Certified Units

Type	Designation		Cooling (Btuh)	Heating (Btuh)	Application Rating (Btuh)
HSP-A	WHP-181A, B		18,000	17,000	9,00
HSP-A	WHP-202A, B		22,000	21,000	11,00
HSP-A	†HP2E-1		23,000	24,000	10,00
HSP-A	†HP25E-1		29,000	30,000	17,00
HSP-A	WHP-302B		34,000	35,000	25,00
HSP-A	†HP3D-1, -3		35,000	37,000	18,00
HSP-A	†HP4D-1, -3		47,000	49,000	33,00
HSP-A	†HP5D-1, -3		57,000	59,000	39,00
	Outdoor Unit	**Indoor Unit**			
HRCU-A	HPO-152	HPI-152	17,500	18,000	11,00
HRCU-A	HPO-202	HPI-202	22,000	23,000	15,00

† For units operating at 208v., deduct 1,000 Btuh from capacity rating.

PEERLESS CORPORATION
DIVISION OF SPACE CONDITIONING, INC.

Trade Name: Clima-Aire

ARI Certified Units

Type	Designation	Cooling (Btuh)	Heating (Btuh)	Application Rating (Btuh)
HSP-A	VP-18	18,000	17,000	11,000
HSP-A	VP-22	22,000	20,000	12,000
HSP-A	VP-30	27,000	25,000	16,000

Trade Name: Peerless

Type	Designation		Cooling (Btuh)	Heating (Btuh)	Application Rating (Btuh)
HSP-A	SCHP 2463-1		24,000	22,000	[illegible]
HSP-A	SCHP 2864-1		28,000	27,000	[illegible]
HSP-A	SCHP 3563-1, -3		35,000	33,000	[illegible]
	Outdoor Unit	**Indoor Unit**			
HRCU-A	HAPT-1564	HBP1563	15,000	14,000	[illegible]
HRCU-A	HAPT-2264	HBP2264	22,000	20,000	[illegible]
HRCU-A	CPA-262-1	HVEB2030/262HAF-CP	24,000	24,000	[illegible]
HRCU-A	CPA-262-1	HVEB2030/263VS-CP	24,000	24,000	[illegible]
HRCU-A	CPA-362-1, -3	HVEB2030/362HAF-CP	35,000	33,000	[illegible]
HRCU-A	CPA-362-1, -3	HVEB2030/363VS-CP	35,000	33,000	[illegible]

PERFECTION DIVISION HUPP CORPORATION

Trade Name: Perfection

ARI Certified Units

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	PAS21BHN		21,000	23,000	13,000
HSP-A	‡PAS30HBN		31,000	32,000	21,000
HSP-A	‡PAS60HBN		54,000	57,000	32,000
	Outdoor Unit	Indoor Unit			
HRCU-A	PAR20HA	—	21,000	21,000	15,000
HRCU-A	‡PAR30HAN	—	32,000	34,000	23,000

‡ Also available in three phase designated by a prefix 3. For three-phase units operating at 208v., deduct 1,000 Btuh from capacity rating.

RHEEM MANUFACTURING COMPANY

Trade Names: Corsaire, Richmond

ARI Certified Units

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	†SCP24-1		23,000	24,000	10,000
HSP-A	†SBP30-1		29,000	30,000	17,000
HSP-A	†SBP36-1, -3		35,000	36,000	17,000
HSP-A	†SBP48-1, -3		47,000	49,000	30,000
HSP-A	†SBP58-1, -3		57,000	59,000	30,000
	Outdoor Unit	Indoor Unit			
HRCU-A	ADP18B	ABP21AM	17,000	17,000	10,500
HRCU-A	ADP24B	ABP21AM	21,000	21,000	12,500
HRCU-A	ADP24B	ABP23AV	22,000	22,000	13,500
HRCU-A	ADP25B	ABP21AM	22,000	22,000	13,500
HRCU-A	ADP25B	ABP23AV	23,000	23,000	14,500
HRCU-A	ADP30B	ADP30AH	29,000	26,000	17,500
HRCU-A	ADP30B	ADP30CDU	29,000	26,000	17,500
HRCU-A	ADP30B	ADP30MBH	29,000	26,000	17,500
HRCU-A	ADP38B	ADP38AH	37,000	37,000	21,000
HRCU-A	ADP38B	ADP38CDU	37,000	37,000	21,000
HRCU-A	ADP38B	ADP38MBH	37,000	37,000	21,000
HRCU-A	ADP42B	ACP48AH	40,000	40,000	25,000
HRCU-A	ADP42B	ACP48CD	40,000	40,000	25,000
HRCU-A	ADP42B	ACP48MBH	40,000	40,000	25,000
HRCU-A	†AAP48B1	AAP58AH	48,000	48,000	28,000
HRCU-A	†AAP48B1	AAP58CD	48,000	48,000	28,000
HRCU-A	†AAP48B1	AAP58MBH	48,000	48,000	28,000
HRCU-A	†AAP48B3	AAP58AH	48,000	48,000	28,000
HRCU-A	†AAP48B3	AAP58CD	48,000	48,000	28,000
HRCU-A	†AAP48B3	AAP58MBH	48,000	48,000	28,000
HRCU-A	†AAP58B1, 3	AAP58AH	58,000	58,000	31,000
HRCH-A	†AAP58B1, 3	AAP58CD	58,000	58,000	31,000
HRCU-A	†AAP58B1, 3	AAP58MBH	58,000	58,000	31,000

† For units operating at 208v., deduct 1,000 Btuh from capacity ratings.

	Outdoor Unit	Indoor Unit			
HRCU-A	ACP96B1, 3	(2)AAP58AH	92,000	93,000	56,000
HRCU-A	ACP96B1, 3	(2)AAP58CD	92,000	93,000	56,000
HRCU-A	ACP96B1, 3	(2)AAP58MBH	92,000	93,000	56,000
HRCU-A	ACP115B1, 3	(2)AAP58AH	113,000	113,000	74,000
HRCU-A	ACP115B1, 3	(2)AAP58CD	113,000	113,000	74,000
HRCU-A	ACP115B1, 3	(2)AAP58MBH	113,000	113,000	74,000

ROUND OAK DIVISION OF SPACE CONDITIONING, INC.

Trade Name: Clima-Aire

ARI Certified Units

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)
HSP-A	VP-18		18,000	17,000
HSP-A	VP-22		22,000	20,000
HSP-A	VP-30		27,000	25,000

Trade Name: Round Oak

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)
HSP-A	SCHP 2463-1		24,000	22,000
HSP-A	SCHP 2864-1		28,000	27,000
HSP-A	SCHP 3563-1, -3		35,000	33,000
	Outdoor Unit	Indoor Unit		
HRCU-A	HAPT-1564	HBP1563	15,000	14,000
HRCU-A	HAPT-2264	HBP2264	22,000	20,000
HRCU-A	CPA-262-1	HVEB2030/262HAF-CP	24,000	24,000
HRCU-A	CPA-262-1	HVEB2030/263VS-CP	24,000	24,000
HRCU-A	CPA-362-1, -3	HVEB2030/362HAF-CP	35,000	33,000
HRCU-A	CPA-362-1, -3	HVEB2030/363VS-CP	35,000	33,000

SOUTHWEST MANUFACTURING COMPANY

Trade Name: Heatwave

ARI Certified Units

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)
HSP-A	HAQ-21		22,000	24,000
HSP-A	HAP-31, 3		34,000	36,000
HSP-A	HAP-41, 3		46,000	48,000
HSP-A	HAP-51, 3		57,000	59,000
	Outdoor Unit	Indoor Unit		
HRCU-A	PAC-201	PAH-20	23,000	25,000
HRCU-A	PAC-301, 3	PAH-30	34,000	36,000
HRCU-A	PAC-401, 3	PAH-40	47,000	49,000
HRCU-A	PAC-501, 3	PAH-50	57,000	60,000

SPACE CONDITIONING, INC.

Trade Name: Clima-Aire

ARI Certified Units

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)
HSP-A	VP-18		18,000	17,000
HSP-A	VP-22		22,000	20,000
HSP-A	VP-30		27,000	25,000

Trade Name: Peerless

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)
HSP-A	SCHP 2463-1		24,000	22,000
HSP-A	SCHP 2864-1		28,000	27,000
HSP-A	SCHP 3563-1, -3		35,000	33,000
	Outdoor Unit	Indoor Unit		
HRCU-A	HAPT-1564	HBP1563	15,000	14,000
HRCU-A	HAPT-2264	HBP2264	22,000	20,000
HRCU-A	CPA-262-1	HVEB2030/262HAF-CP	24,000	24,000
HRCU-A	CPA-262-1	HVEB2030/263VS-CP	24,000	24,000
HRCU-A	CPA-362-1, -3	HVEB2030/362HAF-CP	35,000	33,000
HRCU-A	CPA-362-1, -3	HVEB2030/363VS-CP	35,000	33,000

THERMAL INDUSTRIES OF FLORIDA, INC.
Trade Names: Polar-Aire, Polar-King
ARI Certified Units

Designation	Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
VP-18	18,000	17,000	11,000
VP-22	22,000	20,000	12,000
VP-30	27,000	25,000	16,000
HP 2	24,000	22,000	†20,000
HP 2.5	30,000	26,000	†24,000
HP 3	36,000	34,000	†31,000
HP 4	47,000	45,000	†41,000
HP 5	59,000	54,000	†51,000
WP 1	14,000	16,000	‖
WP 1.5	19,000	19,500	‖
WP 2	25,000	25,000	‖
WP 2.5	30,000	34,000	‖
WP 3	37,000	43,000	‖
WP 4	54,000	65,000	‖
WP 5	62,000	74,000	‖

[illegible] capacity obtained at the manufacturer's lowest recommended operating temperature of 35 F.

‖ [illegible] required for water-source units.

TRANE COMPANY, THE
Trade Name: Climate Changer
ARI Certified Units

[illegible] One additional numeral will appear in the model number for all units. [illegible] numeral will indicate voltage as follows:
[illegible]—230v., 1 ph.
[illegible]—208/220v., 3 ph.
[illegible]—440v., 3 ph.
[illegible]P501C—230v., 1 ph. model

Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
†SHP20B,D		21,000	22,000	13,000
SHP25C		27,000	29,000	18,000
†SHP30C		35,000	35,000	24,000
†SHP40C		47,000	42,000	26,000
‡SHP50C		58,000	60,000	39,000
‡SHP75A		85,000	84,000	53,000
Outdoor Unit	Indoor Unit			
†RAP20	BUP2	23,000	21,000	12,000
†RAP20BD	BHP2A,B	23,000	21,000	12,000
†RAP25	BUP3	30,000	31,000	19,000
†RAP25C	BHP3A,B	30,000	31,000	19,000
†RAP30	BUP3	36,000	36,000	24,000
†RAP30C	BHP3A,B	36,000	36,000	24,000
†RAP40	BUP5	48,000	42,000	25,000
†RAP40C	BHP5A,B	48,000	42,000	25,000
‡RAP50C	BHP5A,B	57,000	59,000	40,000
‡RAP50C	BUP50A	57,000	59,000	40,000
‡RAP75A,B	BHP7A,B	84,000	85,000	56,000
‡RAP100A	BHP10A	118,000	114,000	72,000

† [illegible]its operating at 208v., deduct 1,000 Btuh from cooling capacity [illegible]

‡ [illegible]its operating at 208v., deduct 2,000 Btuh from cooling capacity [illegible]

TYPHOON AIR CONDITIONING DIVISION HUPP CORPORATION
Trade Name: Typhoon
ARI Certified Units

Designation	Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
TAS21BHN	21,000	23,000	13,000
†TAS30HBN	31,000	32,000	21,000
†TAS60HBN	54,000	57,000	32,000

TYPHOON AIR CONDITIONING DIVISION (Continued)

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	ASC 85		85,000	85,000	58,000
HSP-A	ASC 105		109,000	113,000	69,000
HSP-W	10CS		14,500	16,000	‖
HSP-W	15CS		18,000	19,500	‖
HSP-W	20CS		24,000	25,000	‖
HSP-W	20CSH		24,000	25,000	‖
HSP-W	25CS		30,000	37,000	‖
HSP-W	†30CS		39,000	43,000	‖
HSP-W	†30CSH		39,000	43,000	‖
HSP-W	52AH		35,000	43,000	‖
HSP-W	77AH		67,000	79,000	‖
HSP-W	97AH		89,000	103,000	‖
	Outdoor Unit	Indoor Unit			
HRCU-A	TAR20HA	—	21,000	21,000	15,000
HRCU-A	†TAR30HAN	—	32,000	34,000	23,000
HRCU-A	AB81	81 BC	86,000	88,000	63,000
HRCU-A	AF81	81 BC	86,000	88,000	63,000
HRCU-A	AB121	121 BC	94,000	94,000	67,000
HRCU-A	AF121	121 BC	94,000	94,000	67,000

† Also available in three-phase, designated by prefix 3. For three-phase units operating at 208v., deduct 1,000 Btuh from capacity rating.

‖ Not required for water-source units.

Trade Name: Typhoon
Units Not Certified by ARI

Type	Designation		Ratings Cooling (Btuh)	Ratings Heating (Btuh)
HSP-A	ASC155		170,000	172,000
HSP-A	ASC175		186,000	193,000
HSP-A	ASC241		272,000	285,000
HSP-W	120WA		148,000	172,000
HSP-W	150WA		194,000	239,000
HSP-W	200WA		237,000	303,000
HSP-W	250WA		303,000	374,000
HSP-W	300WA2		384,000	474,000
HSP-W	400WA2		480,000	614,000
HSP-W	500WA2		600,000	736,000
	Outdoor Unit	Indoor Unit		
HRCU-A	AB151	151BC	167,000	167,000
HRCU-A	AB171	171BC	203,000	234,000
HRCU-A	AF151	151BC	167,000	167,000
HRCU-A	AF171	171BC	180,000	187,000
HRCU-A	AF251	251BC	280,000	290,000

WESTINGHOUSE ELECTRIC CORPORATION
Air Conditioning Division
Trade Name: WhispAir
ARI Certified Units

Type	Designation	Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HSP-A	HB018A, B, F	18,000	17,000	9,000
HSP-A	HB022A, B, C	22,000	21,000	13,000
HSP-A	HE022A, B, C	22,000	21,000	13,000
HSP-A	HE022R, S, T	22,000	21,000	13,000
HSP-A	HB036A, B	34,000	35,000	25,000
HSP-A	HE036A, B	34,000	35,000	25,000
HSP-A	HE036R, S	34,000	35,000	25,000
HSP-A	†HE048A, B, C	47,000	47,000	31,000
HSP-A	†HE060A, B, C	59,000	59,000	36,000

Units Not Certified by ARI

‡HRCU-A	HD180E	HD180I	176,000	198,000
HRCU-A	HD240	HD240I	254,000	242,000

WESTINGHOUSE ELECTRIC CORPORATION (Continued)

Trade Name: Westinghouse

Type	Outdoor Unit	Indoor Unit	Ratings Cooling (Btuh)	Ratings Heating (Btuh)	Application Rating, Heating (Btuh)
HRCU-A	HC036E1	HC036I1	35,000	39,000	25,000
HRCU-A	HC048E	HC048I	46,000	52,000	32,000
HRCU-A	HC060E	HC060I	56,000	63,000	39,000
HRCU-A	HD090E	HD090I	88,000	93,000	60,000
HRCU-A	‡HD091E	HD091I	88,000	99,000	60,000
HRCU-A	HD120E	HD120I	121,000	116,000	77,000
HRCR-A	§HD121E	HR121I	119,000	132,000	81,000

† For units operating at 208v., deduct 1,000 Btuh from cooling capacity rating.
‡ For units operating at 208v., deduct 2,000 Btuh from cooling capacity rating.
§ For units operating at 208v., deduct 3,000 Btuh from cooling capacity rating.

WETHER-BEE CORPORATION

Units Not Certified by ARI

Type	Designation	Ratings Cooling (Btuh)	Ratings Heating (Btuh)
HSP-A	31-27AA	27,100	31,900
HSP-A	50-36AA	36,800	50,600
HSP-A	71-50AA	50,500	71,850
HSP-A	105-83AA	83,900	105,200
HSP-A	158-123AA	123,900	158,650
HSP-A	233-185AA	185,800	233,800
HSP-A	30-27AW	27,100	30,000
HSP-A	49-36AW	36,800	49,800
HSP-A	70-50AW	50,500	78,800
HSP-A	103-83AW	83,900	103,700
HSP-A	156-123AW	123,900	156,250
HSP-A	230-185AW	185,800	230,200
HSP-W	2WAU-12	22,500	27,900
HSP-W	3WAU-12	35,200	43,400
HSP-W	5WAU-12	55,000	68,200
HSP-W	7WAU-32	77,500	95,750
HSP-W	10WAU-32	93,500	128,300
HSP-W	20WAU-32	238,000	292,410
HSP-W	3WW-11	35,200	41,000
HSP-W	5WW-11	55,000	68,360
HSP-W	7WW-31	76,000	96,360
HSP-W	10WW-31	93,500	128,300
HSP-W	20WW-31	238,000	292,410
*	2GAA-12	22,500	25,400
*	3GAA-12	37,000	39,950
*	9GAA-12	50,000	61,280

* Solar-earth heat source.

THE WILLIAMSON CO.

Trade Name: Williamson

Units Not Certified by ARI

Type	Designation	Ratings Cooling (Btuh)	Ratings Heating (Btuh)
HSP-A	7328-02	24,000	24,000
HSP-A	7328-25	29,000	31,000
HSP-A	7328-03	34,000	35,000
HRCU-A	6326-03	36,000	35,000
HRCU-A	6326-05	60,000	56,500

WORTHINGTON AIR CONDITIONING COM[PANY]

Trade Names: Climatrol, Mueller Climatro[l], Worthington

ARI Certified Units

Type	Outdoor Unit / Designation	Indoor Unit	Ratings Cooling (Btuh)	Ratings Heating (Btuh)
HSP-A	†335-31B, -33B		36,000	36,000
HSP-A	†335-41B, -43B		48,000	49,000
HSP-A	†335-51B, -53B		59,000	59,000
HRCU-A	†338-31C, -33C	339-231, 232	36,000	37,000
HRCU-A	†338-41C, -43C	339-451, 452	49,000	49,000
HRCU-A	†338-51C, -53C	339-451, 452	59,000	59,000

† For three-phase units operating at 208v., deduct 1,000 Btuh from [cooling] ratings.

YORK CORPORATION SUBSIDIARY OF BORG-WARNER CORPORATI[ON]

Trade Name: York Pathfinder

ARI Certified Units

Type	Designation	Ratings Cooling (Btuh)	Ratings Heating (Btuh)
HSP-A	P24FR-E	20,000	20,000
HSP-A	P36FH	33,000	32,000
HSP-A	P48FH	44,000	44,000
HSP-A	P60FH	55,000	54,000

Trade Name: Triton Heat Pump

Type	Designation	Ratings Cooling (Btuh)	Ratings Heating (Btuh)
HSP-W	DW20H	19,000	18,000
HSP-W	DW30H	31,000	26,000

Trade Name: York Champion

Type	Outdoor Unit	Indoor Unit	Ratings Cooling (Btuh)	Ratings Heating (Btuh)
HRCU-A	CA36H	EB36H	33,000	34,000
HRCU-A	CA48H	EB48H	48,000	43,000
HRCU-A	CA61H	EB61H	57,000	57,000
HRCU-A	CA91H	EB91H	86,000	89,000
HRCU-A	CA12H	EB121H	118,000	125,000

† This capacity obtained at the manufacturer's lowest recommended [outdoor] temperature of 45 F.
‖ Not required for water-source units.