MANUAL 2100-024I

SPLIT SYSTEM HEAT PUMP COIL ONLY INDOOR SECTION

INSTALLATION INSTRUCTIONS

FOR USE WITH:
OIL
GAS
ELECTRIC
FURNACES

GENERAL

The add-on heat pump coil-only indoor sections were designed for use with certain outdoor heat pump units. The selection of the matching outdoor unit should be primarily based on the cooling capacity required for the application, as is standard practice when sizing a heat pump system. Reference should be made to the specification sheets for performance values of the following approved matching combinations:

	Compressor Unit	Indoor Coil Section
Air Source	18HPQ4	H18QS1
	18HPQ4	H24QS1
	24HPQ4	H18QS1
	24HPQ4	H24QS1
	30HPQ5	H3AQ1
	36HPQ5, 36HPQ6	H3AQ1
	42HPQ1	H4AQ1
	48HPQ4	H4AQ1
	60HPQ5	H5AQ1
Water Source	WQS30, WQSD30	H3AQ1
	WQS36, WQSD36	H3AQ1
	WQS50, WQSD50	H4AQ1

NOTE: ONLY the above combinations are approved for use. DO NOT attempt to mix and match to build up a special system.

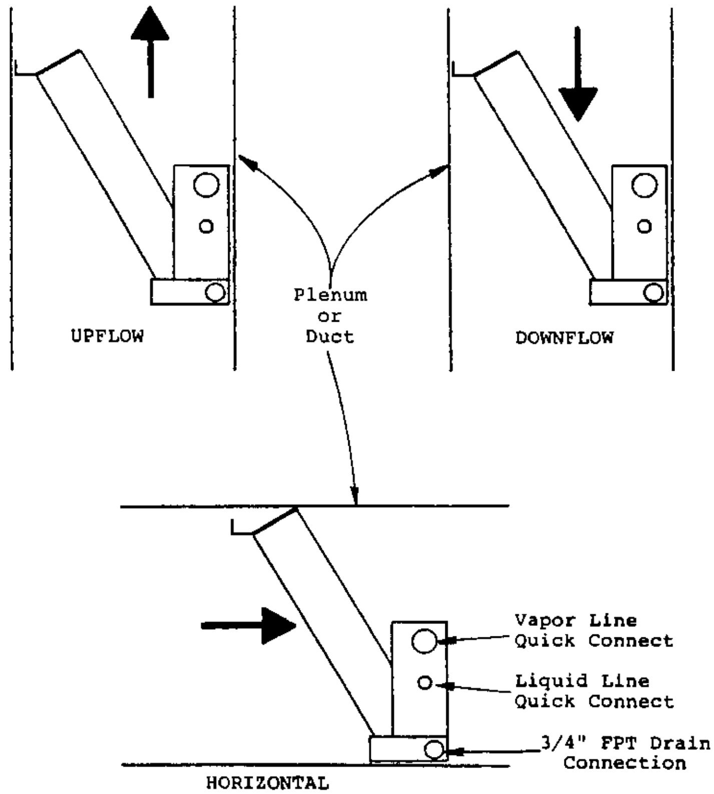
The heat pump add-on coils were initially designed to be used with EFC-Series electric furnace for counterflow applications. It can also be utilized as an add-on heat pump system to existing electric furnace installations to reduce operating costs.

Another increasingly popular concept is to use a heat pump system in conjunction with natural gas, manufactured gas, or fuel oil furnaces. The theme here is to take advantage of the heat pump efficiency during the large number of days when the outdoor temperature is in the mid 40° range or higher, and heating is required as dictated by the indoor wall thermostat. The fossil fuel furnaces are tremendously oversized for the 40° and higher outdoor temperature conditions, and utilization of the heat pump during this temperature range provides a very practical and economical heating system, while also offering the advantages of cooling operation during the summer months.

Each of the above applications demands special installation and control circuit wiring considerations. The instructions contained in this manual pertaining to indoor coil location with respect to the type of heating system should be adhered to when matching with either the air source or water source compressor sections. Briefly, the rule is that the coil is located downstream (outlet or supply air side) on gas and oil; and upstream (inlet or return air side) on electric furnace. More details on the importance of this are contained later in the manual under those specific types of furnace applications. Specific wiring information for the WQS series water source compressor units is contained in the installation instructions packaged with the WQS units. Specific wiring information for the HPQ series air source compressor units is located later in this manual.

AIRFLOW DIRECTION--Models H18QS1, H24QS1

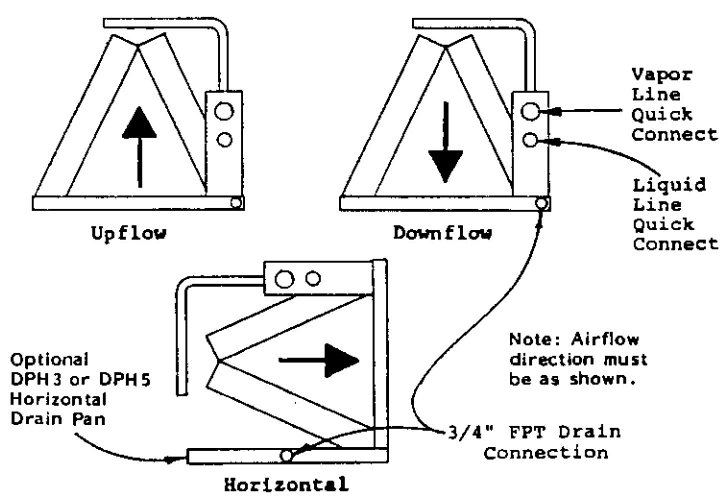
Models H18QS1 and H24QS1 are a slant-coil design, and can be used in all three installation positions with respect to airflow: Upflow, downflow and horizontal. The following illustrations show the correct airflow directions across the coil.



AIRFLOW DIRECTION -- Models H3AQ1, H4AQ1, H5AQ1

Models H3AQ1, H4AQ1 and H5AQ1 are designed for two mounting positions with respect to airflow: Upflow and downflow. By using a *DPH3 or DPH5 optional horizontal drain pan the coils are easily adapted to horizontal airflow installations.

The three mounting positions and correct airflow directions across the coil are shown in the following illustrations:



* DPH3 - Use with H3AQ1 Coil
DPH5 - Use with H4AQ1 or H5AQ1 Coil

AIRFLOW RATINGS IN CFM

Listed below are the rated airflow and also minimum/maximum airflows for each system combination:

System Combination	Rated Airflow	Airflow Range
18HPQ4 - H18QS1	620	550 - 675
18HPQ4 - H24QS1	635	550 - 700
24HPQ4 - H18QS1	730	625 - 800
24HPQ4 - H24QS1	800	650 - 880
30HPQ5 - H3AQ1	1080	875 - 1200
36HPQ5 - H3AQ1	1300	1050 - 1425
36HPQ6 - H3AQ1	1250	1050 - 1425
42HPQ1 - H4AQ1	1625	1335 - 1750
48HPQ4 - H4AQ1	1625	1335 - 1750
60HPQ5 - H5AQ1	1800	1600 - 1850
WQS/WQSD30-H3AQ1	1150	980 - 1250
WQS/WQSD36-H3AQ1	1250	1025 - 1375
WQS/WQSD50-H4AQ1	1625	1500 - 1885

CONDENSATE DRAIN

A single 3/4" FPT drain connection is supplied on all the add-on heat pump coil sections. The same drain connection is used regardless of installation position for coil models H18QS1 and H24QS1. Similarly the same drain connection is used for models H3AQ1, H4AQ1 and H5AQ1 except in the horizontal airflow position. For this application the drain connection on the optional horizontal drain pan is used.

INSTALLATION ACCESSORIES

There are optional plenums and filter racks available for all the indoor coil sections. The optional filter racks as shown or some other means of air filtering are required on any application where the coil is installed upstream from the original filter location, which should be removed so excessive restriction is not placed on the system blower.

Indoor Coil Model	Plenum	Filter Rack
H18QS1	HP3 (1)(2)	FR3 (2)
H24QS1	HP2 (3)(1)	FR3 (2)
H3AQ1	HP3	FR3
H4AQ1	HP5 (4)	FR5
H5AQ1	HP5 (4)	FR5

(1) Contains adapter plate for slant coils.
(2) HS152 plenum will also fit these coils. No filter rack is available. Desirable for use with H60-H80 series gas furnace.
(3) HS20 plenum will also fit this coil for use with H60-H80 series gas furnaces.
(4) Cannot be used with DPH5 drain pan for horizontal applications. A field fabricated plenum is required for horizontal application of these coils.

NOTE: The HP3 plenum and FR3 filter rack were designed to mate with the EFC series electric furnace. There are 3/4" flanges on both the top and bottom of the plenum which permit the plenum to fit on top (return air inlet) of an inverted EFC furnace for downflow application, or support an EFC furnace for upflow application. The FR3 filter rack mates with either end of HP3 plenum as required.

The HP5 plenum and FR5 filter rack are similar in design to the HP3 plenum and FR3 filter rack as described above, but are not designed to fit any particular furnace.

Both the HP3-FR3 combination or HP5-FR5 combination can be used for any application, as they have duct flanges on each end and existing ductwork can be adapted.

ELECTRIC FURNACE APPLICATION--GENERAL

The only add-on heat pump coils generally considered for use with the EFC series electric furnaces are the H18QS1 (1-1/2 ton), H24QS1 (2 ton) and H3AQ1 (2-1/2 and 3 ton). This is because the standard indoor blower coil units available for these Btu size systems are not designed for downflow application. The EFC series furnace is designed for upflow, downflow and horizontal, and therefore a downflow installation can be achieved by using an EFC furnace in combination with either an H18QS1, H24QS1 or H3AQ1 coil section.

Since the BC48A (for use with 42HPQ1 and 48HPQ4 models) and the BC60A (for use with model 60HPQ5) are designed for upflow, downflow and horizontal use, there should be no reason to attempt to match the H4AQ1 or H5AQ1 coil assemblies to an electric furnace. A possible exception to this would be an add-on to an existing electric furnace installation. If this is the case, there are a few important items for consideration.

1. Only the EFC25 and EFC30 should be considered for use. These are the only two furnace models with sufficient blower capacity to meet the airflow requirements for the heat pump system.
2. The HP5 plenum does not mate exactly with the EFC furnace cabinet, and a sheet metal transition would be required.

ELECTRIC FURNACE APPLICATION--INSTALLATION

The heat pump A-coil must be installed on the return air side of any electric furnace application. This is mandatory so that the heat output from the electric strip heaters, energized at the lower outdoor temperatures, does not drive into the heat pump coil and cause the refrigerant condensing pressure and temperature to raise to points well beyond the design limitations of a heat pump system, and cause the compressor to be de-energized by the manual reset high pressure switch.

CONTROL CIRCUIT WIRING-CONTROL CIRCUIT DIAGRAMS

Each different KW size EFC electric furnace requires some variations in wiring, because of the different amount of controls on the EFC. Listed below are the appropriate control circuit wiring diagrams based upon EFC size and also the number of field installed outdoor thermostats (ODT-070) recommended for each application.

Heat Pump System	Furnace Model	Control Diagram	Quantity (1) of O.D. Stats
18HPQ4-H18QS1 18HPQ4-H24QS1 24HPQ4-H18QS1 24HPQ4-H24QS1	EFC10-1	CDEF-1	1
30HPQ5-H3AQ1 36HPQ5, 6 -H3AQ1	EFC10-1-B	CDEF-2	1
30HPQ5-H3AQ1 36HPQ5, 6 -H3AQ1	EFC15-1 EFC20-1	CDEF-3	1
42HPQ1-H4AQ1 48HPQ4-H4AQ1 60HPQ5-H5AQ1	EFC25-1 EFC30-1	CDEF-4	2

(1) Outdoor thermostats are optional. See notes on control diagrams.

The circuitry covered by the Control Diagrams allows for heat pump on 1st stage of wall thermostat, with option for compressor cut-off at 0°F or higher as field selected. It also allows for a maximum of 10Kw to be controlled by W2 (second stage) of the wall thermostat, any installed Kw over that amount being controlled by an O.D. stat acting as 3rd stage heat thermostat.

GAS OR OIL FURNACE APPLICATON

Applicaton of heat pump coil only sections to fossil fuel furnaces require certain special consideratons. The first is that return air applicatons are generally termed unacceptable because of (a) local codes do not permit, (b) may void heat exchanger warranty of furnace manufacturer and, (c) past experience with return air applications generally very poor.

If we were concerned with heating cycle only, the reasons stated above would present no problems. However, during the cooling cycle the heat exchanger becomes chilled or cooled well below surrounding space temperatures due to the low air temperature coming off of the coil, and induces condensation to form on the heat exchanger.

As we consider placing the coil on the more traditional outlet (or leaving) air side of the furnace, we are faced with a new set of circumstances which must be considered.

Thermal Balance Point. The point at which the heat pump output capacity and the heat loss from the building being heated are equal is called the balance point, with the heat pump operating 100 per cent of the time. As the outdoor temperature goes down, the Btu capacity of the heat pump falls off while at the same time the heat loss from the structure increases. A means of placing the fossil fueled furnace in operation at outdoor temperatures below the balance point must be provided. In all instances, the gas or oil furnace must be of sufficient capacity to heat the building even under the most extreme outdoor temperature, without the aid of the heat pump.

There is no one given outdoor temperature at which the balance point will occur, it will be different for each application of heat pump to a building, and can even vary from day to day based upon cloud cover, relative humidity outdoors, and wind conditions. Of course, the design of the building (insulation, types of windows, doors, etc., and other items that affect the heat loss) also determine where the balance point will occur for a given size heat pump system.

The Fuel Saver Module in conjunction with the wall thermostat will automatically sense and respond to all of the variable factors that influence the heating requirements for any given structure.

Defrost Cycle. Heat pumps operating during outdoor temperatures below the low 40°F range and colder will gradually accumulate a frost build-up on the outdoor coil. A defrost cycle control system is built into all outdoor heat pump sections that will periodically and automatically clear the outdoor coil of this frost accumulation. This is accomplished by the heat pump system temporarily reverting back to the cooling cycle, using the hot refrigerant gas flowing through the outdoor coil to melt the frost. The outdoor fan motor also stops during this period to speed up the process. During this time of defrost cycle operation, there will be a cooling effect taking place at the indoor coil section, the same as would occur during the summer cooling system.

It is desirable to supply supplemental heat during the defrost cycle period, so as to avoid the discharging of cool air into the building. Laboratory and field testing has shown that firing of the gas or oil furnace during the defrost cycle is permissible and can in fact even shorten the time required for defrosting the outdoor coil because of the introduction of heat immediately ahead of the indoor coil assembly.

IMPORTANT: Since the size of the fossil fueled furnace is known only to the installer of the system, it is possible that there would be an excessively large Btu capacity furnace involved, especially in an add-on situation (it is not uncommon for some fossil fueled furnaces, especially oil-fired, to be vastly oversized). Should this instance be encountered, it is possible that because of the furnace Btu output involved, an excessively fast temperature rise air temperature entering the refrigerant coil mounted on the furnace may result in higher discharge pressures and temperatures than the compressor protective devices will tolerate and cause tripping of these protective devices.

It is the responsibility of the installer to understand this operation of the system in detail, and should this occur, set the temperature of the changeover thermostat to a higher temperature. This will lessen the amount of frost accumulation, shorten the length of the actual defrost cycles and thus the time of simultaneous operation of heat pump and furnace.

An alternative to this is to not allow the furnace to cycle "on" during the defrost period. The Fuel Saver Module wiring diagram shows which 24V wiring connection is not to be made to defeat the supplemental heat during defrost.

Economic Balance Point. There is an "economic balance point" or "breakeven point" which can be calculated for all situations, based upon actual energy rates for the various fuels and the efficiency ratings of the add-on heat pump and the furnace involved.

Depending upon the local electrical rates and the cost of the other fuel involved, the use of an outdoor thermostat may be desirable to control the changeover from heat pump to furnace at the most cost effective outdoor temperature. The procedure to make this determination is quite simple and outlined below. The tables referenced are located later in this manual, and the same information is also shown in the Fuel Saver Module Installation Instructions. To determine the economic balance point using a module, do the following steps:

a) Locate the table for fossil fuel used by furnace. (Table 1 - Natural Gas; Table 2 - Propane; and Table 3 - Fuel Oil).

b) Now locate the furnace AFUE efficiency rating for the furnace on the bottom of table the heat pump is being matched with.

c) Next draw a line straight up, until it intersects the fuel unit cost curve for the fuel in your area. (Fuel unit cost scale on right side of table).

d) Then draw a horizontal line from the intersection point to the Btuh per $1.00 column on left side of table. You now have determined the Btuh output of heating per one dollar of energy cost for that fuel.

EXAMPLE 1: (Table 3)

An oil furnace with a 65% AFUE efficiency @ $1.30 per gallon would equal 70,000 Btuh per dollar of energy (oil) cost.

e) Now go to Table 4 (air source or water source heat pump) and locate the Btuh per dollar [step (d) above] on left side of table. Draw a horizontal line from the Btuh per $1.00 until it intersects the cost per kWh in your locality.

f) Then draw a vertical line down to the heat pump COP (Coefficient of Performance) scale at bottom of table. You now have found the lowest COP at which the heat pump should be operated economically.

EXAMPLE 2: (Table 4)

A 65% AFUE efficient oil furnace will supply 70,000 Btuh per dollar of fuel cost, at a fuel cost of $1.30 per gallon. A heat pump also will produce 70,000 Btuh output per dollar at an electric rate of $.06 per Kw. The heat pump will produce this at a COP of 1.21.

g) Refer to the "Heating Application Data" section of the heat pump specification sheet to determine at what outdoor temperature the heat pump will produce a 1.21 COP. This temperature is the "Economic Balance Point" at which the outdoor thermostat is set at to shut the heat pump off and operate entirely on the furnace.

h) Now set the outdoor thermostat to turn off the compressor at the "Economic Balance Point" temperature determined in (step g) above.

SEQUENCE OF OPERATION - Heat Pump/Fossil Fuel Furnace

a) Fan AUTO-ON function and operation in cooling mode remain the same as in any air conditioning or heat pump system.

b) When in heating mode, each initial call for heat will place heat pump in operation.

c) If the heat pump cannot handle the heating requirements of the structure during any given cycle, the space temperature will begin to drop. If it drops approximately 1½°F, the 2nd stage of the wall thermostat will activate the Fuel Saver Module, turning off the heat pump and starting the furnace.

TABLE 1

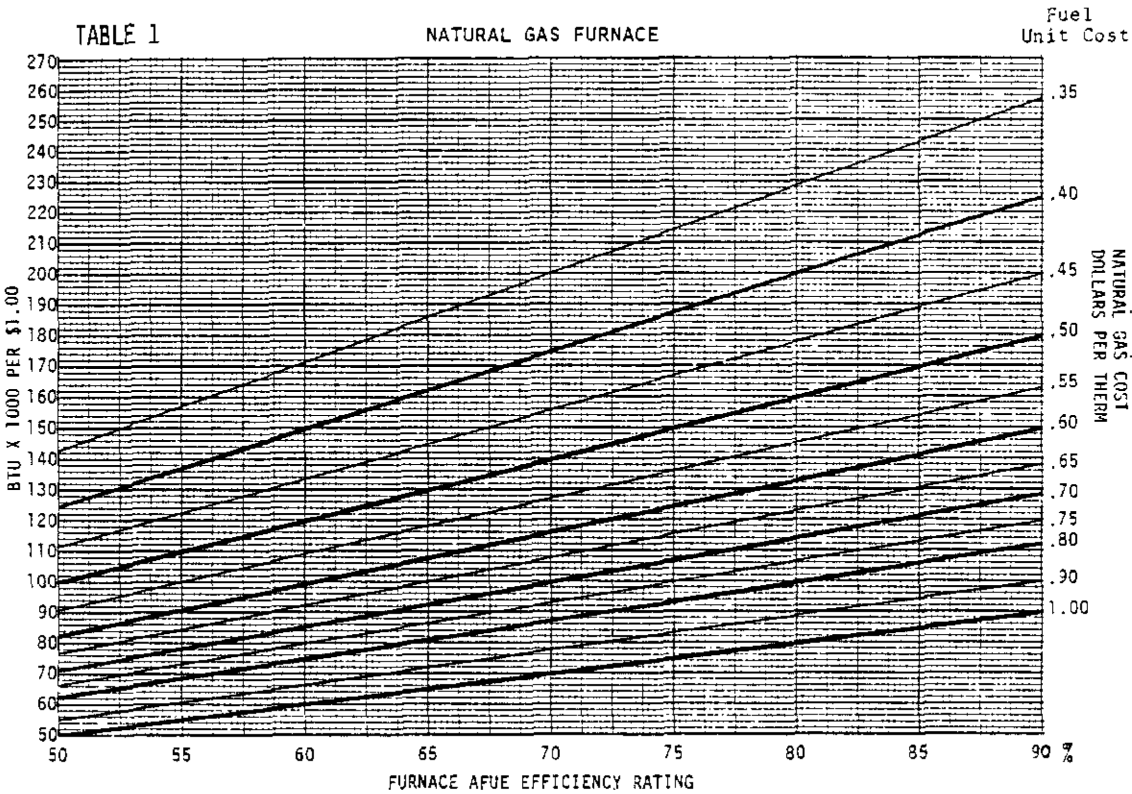


TABLE 2

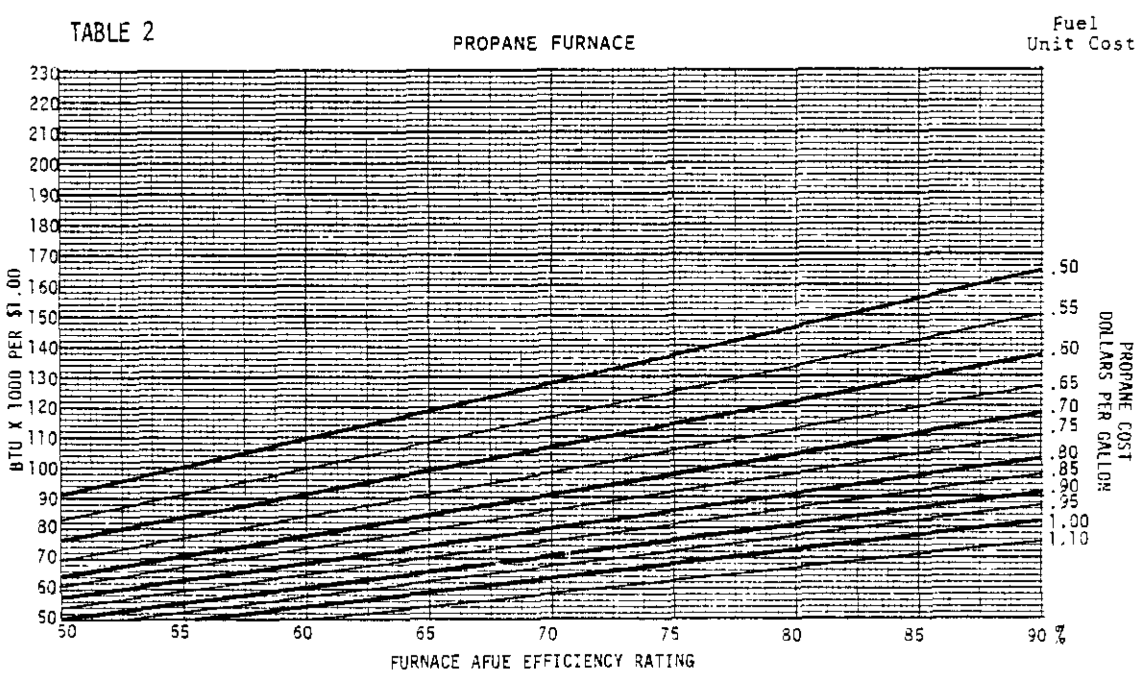
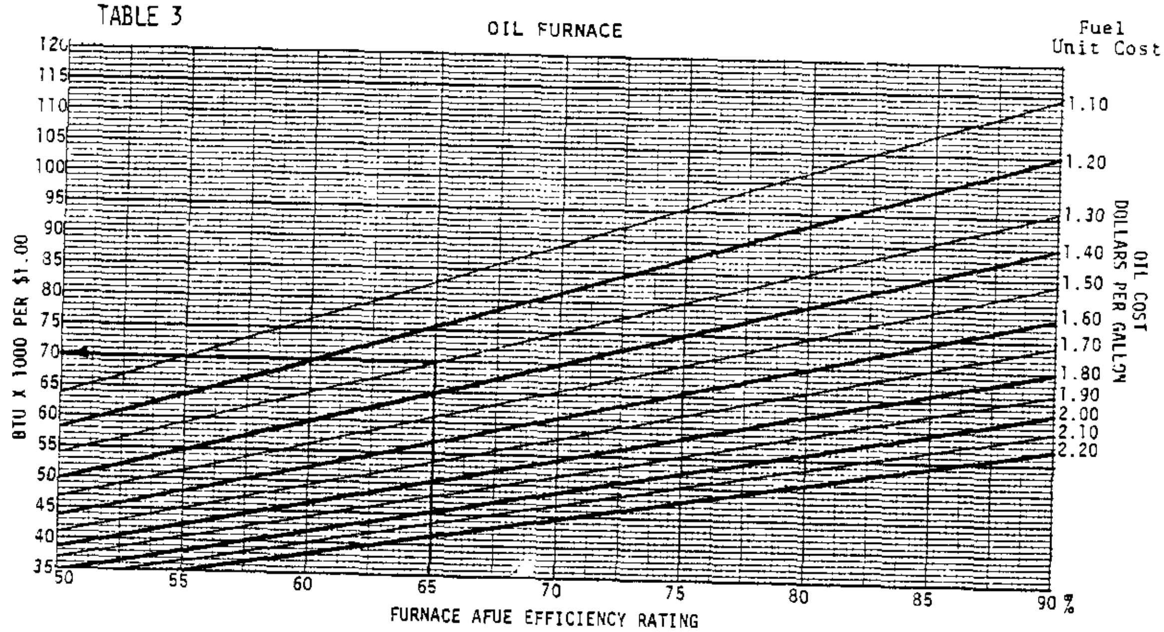
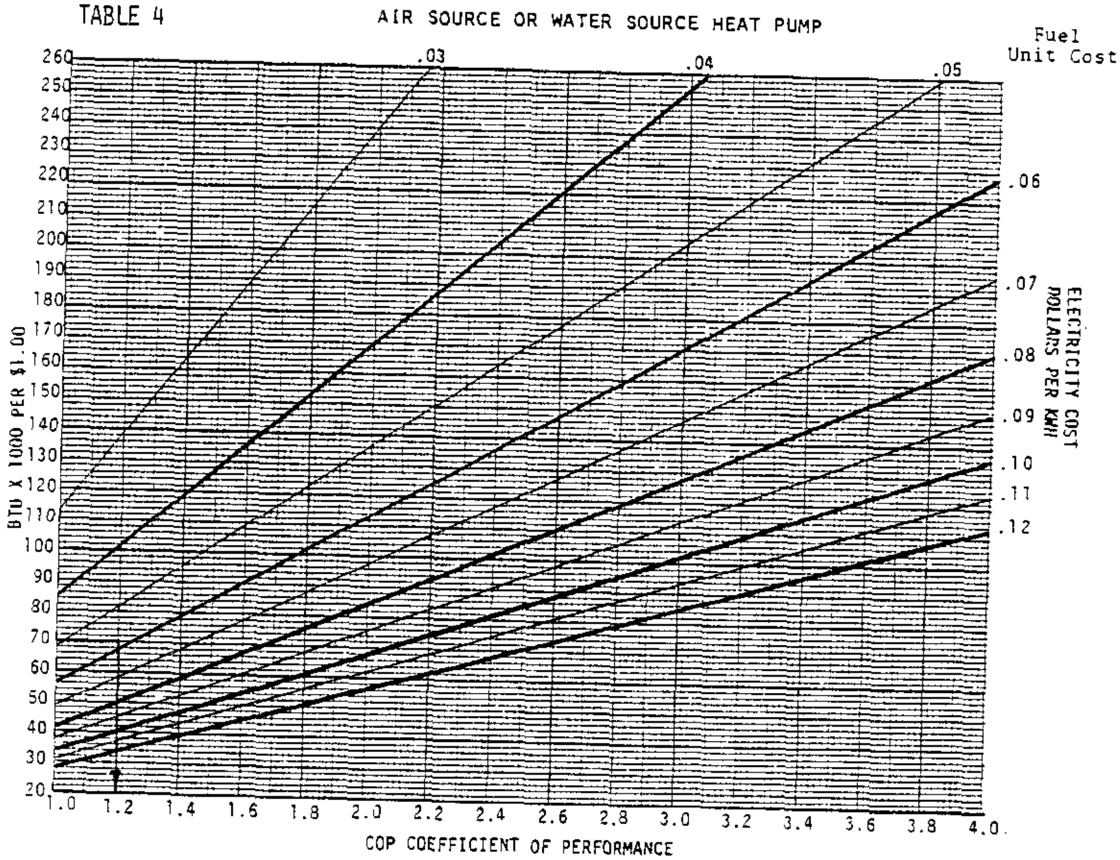


TABLE 3



Example 1. *Assume a 65% AFUE oil furnace at $1.30 per gallon.*

TABLE 4



Example 2. Determine Economic Balance Point for Heat Pump when used with an oil furnace of 65% AFUE @ $1.30 per gallon for oil from example 1 (oil furnace 70,000 Btuh/$) and electric rate of .06 kWh. A 1.21 COP, *heat pump and oil is equal* in operating cost.

d) The furnace will continue to operate, supplying heat until the wall thermostat (both stages 1 and 2) are satisfied. When the thermostat is satisfied the module resets, and the next call for heat will start over with heat pump operating as the primary heating system and the furnace on standby as described above.

e) The module allows for activation of the furnace during the defrost cycle of the heat pump "if desired." It is usually desirable to provide this supplemental heat during the brief defrost cycle period to avoid discharging cool air into the building. A complete discussion on this subject can be found in the Installation Instructions packaged with the Add-On Heat Pump Coil. Connection of a single 24V wire at the module will allow the furnace to cycle on during the defrost cycle. Refer to module wiring diagram.

f) "Emergency heat" function is available on command from the wall thermostat. This locks out the heat pump from operating under any condition and allows furnace operation only. Only during "emergency heat" operation is the heating system under control of the 2nd stage of wall thermostat and in this mode of operation structure is controlled at 1½°F below thermostat setpoint. IMPORTANT: Only in emergency heat mode does furnace blower operate from combination fan/limit switch in furnace. In all other modes, the furnace blower is controlled by the cooling blower relay and starts as soon as there is a call for heat or cool operation. There is additional information on "Indoor Blower Operation" contained in the Installation Instructions for the add-on heat pump coil.

g) Any time the wall thermostat is set for heating and a large change to a higher temperature setting is made, or the system is turned on after being off and the actual space temperature is lower than the thermostat setpoint, the 2nd stage will be closed (calling for heat) and the control system will lock out the heat pump and activate the furnace until the desired space temperature is reached. At that time the control system will reset and the next call for heat will again be heat pump.

CONTROL CIRCUIT WIRING - FUEL SAVER MODULE

All wiring is 24V. An eight (8) wire color coded thermostat cable is recommended. The electrical connection to the module is quite easy. Simply cut the thermostat cable, with the wires coming from the furnace connected to the terminal block designated "FURNACE CONNECTIONS," and the wires from the heat pump to terminal block designated "HEAT PUMP CONNECTIONS." Refer to wiring diagram for complete details. The wiring diagram is attached to the cover of the module and a copy is included later in this manual as well as the module instructions.

CFM FOR ADD-ON HEAT PUMPS

The furnace that you are going to add a heat pump to must be able to deliver enough air to satisfy the heat pump's requirements, usually 400 CFM/Ton.

When the heat pump is in the heating mode, the indoor coil becomes the condensing coil, this is why the amount of air is so critical. Not enough air results in too high of high side pressures and temperatures. The furnace CFM can be calculated by using the following formula:

$$\text{CFM} = \frac{\text{Output (Btu/h)}}{1.08 \times \text{Temp. Rise}}$$

When adding a heat pump to an existing GAS FURNACE, proceed as follows to determine the gas input to the furnace. Shut off all other gas appliances in the home, then set the indoor wall thermostat to call for heat. Go to the gas meter and clock the fastest moving dial, then refer to the chart below.

EXAMPLE: Most gas utilities use 1000 Btu per cubic foot of gas. If you were to clock the 1 cubic foot dial and found it took 36 seconds for one revolution, then in one hour the furnace would use 100,000 Btu, but we all know that no furnace is 100% efficient, so suppose we assume this furnace to be 70% efficient, then we should have approximately 70,000 Btu per hour output. Using that figure our formula would look like this:

$$\text{CFM} = \frac{70,000}{1.08 \times \text{T.R.}} \qquad \text{or CFM} = \frac{70,000}{1.08 \times ?}$$

We must still obtain a temperature rise through the furnace. This is done by measuring the return air temperature and the supply air temperature. Let's again assume we were able to measure a 60°F temperature rise through the furnace. Now we can complete our formula.

$$\text{CFM} = \frac{70,000}{1.08 \times 60} \qquad \text{or CFM} = \frac{70,000}{65}$$

Then, our CFM for this furnace would be 1076 CFM.

Seconds for one Rev.	SIZE OF TEST DIAL ¼ cu.ft.	½ cu.ft.	1 cu.ft.	2 cu.ft.	5 cu.ft.	Seconds for one Rev.	SIZE OF TEST DIAL ¼ cu.ft.	½ cu.ft.	1 cu.ft.	2 cu.ft.	5 cu.ft.
10	90	180	360	720	1800						
11	82	164	327	655	1636	36	25	50	100	200	500
12	75	150	300	600	1500	37	–	–	97	195	486
13	69	138	277	555	1385	38	23	47	95	189	474
14	64	129	257	514	1286	39	–	–	92	185	462
15	60	120	240	480	1200	40	22	45	90	180	450
16	56	113	225	450	1125	41	–	–	–	176	439
17	53	106	212	424	1059	42	21	43	86	172	429
18	50	100	200	400	1000	43	–	–	–	167	419
19	47	95	189	379	947	44	–	41	82	164	409
20	45	90	180	360	900	45	20	40	80	160	400
21	43	86	171	343	857	46	–	–	78	157	391
22	41	82	164	327	818	47	19	38	76	153	383
23	39	78	157	313	783	48	–	–	75	150	375
24	37	75	150	300	750	49	–	–	–	147	367
25	36	72	144	288	720	50	18	36	72	144	360
26	34	69	138	277	692	51	–	–	–	141	355
27	33	67	133	267	667	52	–	–	69	138	346
28	32	64	129	257	643	53	17	34	–	136	340
29	31	62	124	248	621	54	–	–	67	133	333
30	30	60	120	240	600	55	–	–	–	131	327
31	–	–	116	232	581	56	16	32	64	129	321
32	28	56	113	225	563	57	–	–	–	126	316
33	–	–	109	218	545	58	–	31	62	124	310
34	26	53	106	212	529	59	–	–	–	122	305
35	–	–	103	206	514	60	15	30	60	120	300

If the furnace is equipped with a direct drive motor, make sure you have it wired to the high speed tap. If it is a belt drive motor, then read the motor's nameplate amps. Then, hook on an amp probe and see if it is possible to speed the blower up by adjusting the variable pulley.

If you are at the limits of the motor, then check with the furnace manufacturer to see if a larger horsepower motor can be installed and also if the blower will give you the needed CFM with a larger motor.

When you have determined that your furnace can handle the required CFM for your heat pump, the indoor coil must be installed and your CFM calculation must be rechecked with the coil in place.

When adding to an OIL FURNACE, you must determine what size nozzle the unit has in the burner and then install a pressure gauge in the oil delivery pumps discharge port and set the pressure at 100 psig. An example might be that we find the burner equipped with a one gallon per hour nozzle, operating at 100 psi. This nozzle will deliver one G.P.H. and a gallon of #2 fuel oil has approximately 140,000 Btu of heat.

The 140,000 Btu is our input and again let us assume that this furnace is operating at 70% efficiency. Then our Btu output is 98,000 Btu, and if we use the rule of thumb that an oil furnace should operate with an 85°F temperature rise, then our formula would look like this:

$$\text{CFM} = \frac{98,000 \text{ Btu/h}}{1.08 \times 85°\text{F}} \quad \text{or} \quad \frac{98,000 \text{ Btu/h}}{92} = 1065 \text{ CFM}$$

When adding on to an electric furnace we must also take one more thing into consideration and that is the heat pump coil must be installed on the return side of the electric furnace. To find out what CFM the electric furnace can deliver, we must measure the voltage and amperage of each heating element or Volts x Amp = Watts. The total Watts x 3.4 Btu = Btu Output. An example might look like this with a 15Kw electric furnace.

240 Volts	x	21 Amps	=	5040 Watts
5040 Watts	x	3 Elements	=	15120 Watts
15120 Watts	x	3.4 Btu/Watt	=	51408 Btu

One word of caution, never go by nameplate rating. Always measure volts and amps.

One more item that is different with an electric furnace and that is, never obtain a supply air temperature reading in sight of the electric element (because of the radiant effect). Now our formula looks like this again:

$$\text{CFM} = \frac{51408 \text{ Btu/h}}{1.08 \times 44°\text{F}} \quad \text{or} \quad \frac{51408 \text{ Btu/h}}{48} = 1071 \text{ CFM}$$