
HEAT PUMP SIZING



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STRUCTURE HEAT LOSS AND BALANCE POINTS

AIR TO AIR HEAT PUMPS

To utilize the system performance curves or equipment specification sheets published by Bard Manufacturing Company as a tool in determining how many outdoor thermostats to use and at what temperature to set each individual thermostat, there is certain information that must be previously determined:

1. Using ACCA Manual J, calculate both the cooling and heating capacities required for the structure based upon the areas summer and winter design conditions.
2. Having determined the cooling and heating capacities required, make the unit selection primarily based on cooling capacity. It has become a generally accepted practice to use the next larger size unit if the cooling calculation falls between unit rating sizes (recommended that the unit selected is not greater than 25% larger than is calculated). Remember, the heat pump units are generally referred to in nominal tonnage sizes (2-1/2 ton, 3 ton, etc.), and the actual rated Btuh may be slightly greater or less than nominal tonnage ratings. Be sure to take into consideration that the unit capacity varies with outdoor temperature. Referring to the application chart on the specification sheets, the unit can be selected from the temperature column nearest the cooling design temperature.
3. Having made the unit selection, the heating capacity at various outdoor temperatures can be determined from the application charts or the performance curves. From this information you can determine how much of the total heat required can be supplied by the heat pump. Any heating capacity over and above that available from the heat pump system must come from an alternate source, in most cases supplemental resistance electric heating elements installed either in the indoor blower coil cabinet or in the form of a duct heater.

In most areas of the country the supplemental resistance heat is sized as near as possible to 100%. There are some geographic regions where it has been acceptable to size the supplemental heat at approximately 85% with no problems encountered.

4. Determination of the total installed KW of the supplemental electric heaters is made by taking the

heating load calculation (@ the outdoor winter design condition) and dividing that value by 3,413.

Example: $\frac{78,000}{3,413}$ Btuh winter design = 22.85KW

Heaters are rated nominally 25KW @ 240V — 23KW @ 230V

Would probably elect to use nominal 25KW heater.

5. The electric heaters used in most Bard units are nominal 5KW increments (4.6KW @ 230V). A unit built with 10KW heater is actually two 5KW heaters, nominally mounted on the same end plate.

Whenever there is a 10KW heater installed, it is controlled by one two-pole contactor. In essence we are then switching a 10KW load. If this is unacceptable, an outdoor thermostat can be used to hold off one of the 5KW heaters based on outdoor temperature.

6. Having determined the above items 1 - 5, we can now select the appropriate performance curve matching the unit selected for installation.

Example: Model 30HPQ3/B36EHQ — 25KW

This selection made based upon cooling design calculation of 30,000 Btuh @ 90° F.

Total installed electric heat — see item 4 example.

7. Using the correct performance curve, or develop your own performance curve for particular unit by using a specification sheet, locate the outdoor design temperatures (heating) and unit rated Btuh on a (B008) graph. After you have located the points, connect them for the performance curve line for the unit selected) plot the heating design point, in this example 78,000 Btuh @ 0° F. See Figure 1.

Draw a straight line between this point and 70° F and 0 Btuh. The 70° F value is used because it is generally assumed that if it is 70° F outside temperature, there is enough self-heating in a typical structure that no additional heat is required. (Some people prefer to use 65° F rather than 70° F for this self-sufficiency point.)

NOTE: Not all the performance curves are drawn with 0 Btuh in the left hand column coinciding with the outdoor temperature value line across the bottom of the graph. The 0 Btuh point will have to be marked on the graph on the 70° F (or 65° F) vertical line. Each heavy horizontal line represents 10,000 Btuh.

This line drawn between the heating design condition and 0 Btuh at 70° F outside temperature is called the **structure heat loss** line.

8. At whatever point the heating capacity curve intersects the **structure heat loss** line is called the **balance point**.

The heat pump balance point is the outdoor temperature at which the heat pump would be operating 100% of the time and supplying just enough heat to match the heat loss from the structure. At outdoor temperatures above the #1, or heat pump balance point, the heat pump would cycle on demand from the wall thermostat.

At outdoor temperatures below the #1 balance point, the heat pump would be operating 100% of the time because it could not supply as much heat as would be lost through the structure walls, ceiling, etc.

9. At this point, the second stage of the wall thermostat would take over and cycle on the first bank of supplemental heat (as mentioned earlier, normally in 10KW banks). There is a nominal 1-1/2° F differential between first and second stage of the two-stage wall thermostat.

The 10KW heater will supply roughly 34,130 Btuh (one watt = 3.413 btu).

Draw a line vertically from the #1 balance point to a point 34,000 Btu above the #1 balance point, and then draw a new heating capacity line, until this new line intersects the **structure heat loss** line.

This would be the #2 balance point, and the outdoor temperature at which we must now bring in additional supplemental heat by means of an outdoor thermostat.

It is suggested that the outdoor thermostat be set a few degrees above the calculated balance point to allow for small discrepancies which are sure to exist.

10. Depending upon the amount of installed electric heat and the manner in which you desire to stage that heat, any number of balance points can be determined.

If different KW increments of electric heat are involved, simply work accordingly by figuring 3.413 Btu/watt.

WATER TO AIR HEAT PUMPS

To utilize the specification sheet published by Bard Manufacturing Company as a tool to determine unit size for a particular structure, there is certain information that must be previously determined:

1. Using ACCA Manual J, calculate both the cooling and heating capacities required for the structure based upon the areas summer and winter design conditions.
2. Having determined the cooling and heating capacities required, make the unit selection primarily based on cooling load plus 25% or 75 to 85% of heating load design loss, whichever is larger. Ground loop systems usually sized for cooling and well systems sized for cooling or heating. If unit is too oversized for cooling, it will not air condition properly in summer. Oversized equipment does not operate at optimum efficiency and has a high first cost. Be sure to take into consideration that the unit capacity varies with supply water temperatures.
3. Having made the unit selection, the heating or cooling capacities at various ground temperatures can be determined from specifications. From this information you can determine how much of the total heat required can be supplied by the heat pump. Any heating capacity over and above that available from the heat pump system must come from an alternate source, in most cases supplemental resistance electric heating elements installed either in the indoor blower coil cabinet or in the form of a duct heater. On a retrofit installation the existing fossil fuel furnace may be used for supplemental heat.

In most areas of the country the supplemental resistance heat is sized as near as possible to 100%. There are some geographic regions where it has been acceptable to size the supplemental heat at approximately 85% with no problems encountered.

4. Determination of the total installed KW of the supplemental electric heaters is made by taking the heating load calculation (@ the outdoor winter design condition) and dividing that value by 3,413).

Example: $\frac{40,460 \text{ Btuh winter design}}{3,413} = 11.85\text{KW}$

Heaters are rated nominally 15KW @ 240V — 4.6KW @ 230V

Would probably elect to use nominal 15KW heater.

5. The electric heaters used in most Bard units are nominal 5KW increments (4.6KW @ 230V). A unit built with 10KW heater is actually two 5KW heaters, normally mounted on the same end plate.

Whenever there is a 10KW heater installed, it is controlled by one two-pole contactor. In essence we are then switching a 10KW load. If this is unacceptable, an outdoor thermostat can be used to hold off one of the 5KW heaters based on outdoor temperature.

6. Having determined the above items 1 - 5, we can now select the appropriate unit performance for installation.

Example: Model WPV30

This selection made based upon a heating design calculation of 40,460 Btuh @ 0° F.

Cooling design calculation of 20,203 Btuh @ 90° F.

Using a (B008) graph, plot the heating design point, in this example: 40,460 Btuh @ 0° F. See Figure 2.

Draw a straight line between this point and 70° F and 0 Btuh. The 70° F value is used because it is generally assumed that if it is 70°F outside temperature, there is enough self-heating in a typical structure that no additional heat is required. (Some people prefer to use 65° F rather than 70° F for this self-sufficiency point.)

This line drawn between the heating design condition and 0 Btuh at 70° F outside temperature is called the **structure heat loss** line.

7. Draw a horizontal line across the graph at the Btuh heating capacity of the heat pump at the rated supply water temperature and flow rate.

Example: Our unit will supply 28,630 Btuh at a water temperature of 55° F and a flow rate of 4 gallons per minute.

8. At whatever point the heating capacity line intersects, the **structure heat loss** line is called the **balance point**.

The heat pump balance point is the outdoor temperature at which the heat pump would operate

100% of the time and supply just enough heat to match the heat loss of the structure. At outdoor temperatures above the #1, or heat pump balance point, the heat pump would cycle on demand from the wall thermostat.

At outdoor temperatures below the #1 balance point, the heat pump would be operating 100% of the time because it could not supply as much heat as would be lost through the structure walls, ceiling, etc.

9. At this point, the second stage of the wall thermostat would take over and cycle on the first bank of supplemental heat (as mentioned earlier, normally in 10KW banks). There is a nominal 1-1/2° F differential between first and second stage of two-stage wall thermostat.

The 5KW heater will supply roughly 17,065 Btuh (one watt = 3.413 Btu).

Draw a line vertically from the #1 balance point to a point 17,000 Btu above the #1 balance point, and then draw a new heating capacity line from that point, parallel with the heat pump capacity line, until this new line intersects the **structure heat loss** line. This would be the #2 balance point.

10. Depending upon the amount of installed electric heat and the manner in which you desire to stage that heat, any number of balance points can be determined.

If different KW increments of electric heat are involved, simply work accordingly by figuring 3.413 Btu/watt.

TABLE 1
ELECTRIC HEATER TABLE (KW VS. VOLTAGE)

Heater ①		240V			230V			220V			208V		
Model		KW	BTUH	AMP	KW	BTUH	AMP	KW	BTUH	AMP	KW		
BTUH	AMP												
4KW	4.0	13,652	16.7	3.68	12,560	16.0	3.36	11,468	15.3	3.0	10,239	14.4	
5KW	5.0	17,065	20.8	4.6	15,700	20.0	4.2	14,335	19.1	3.75	12,799	18.0	
8KW	8.0	27,304	33.3	7.36	25,120	32.0	6.72	22,935	30.5	6.0	20,478	28.8	
10KW	10.0	34,130	41.6	9.2	31,400	40.0	8.4	28,669	38.2	7.5	25,598	36.1	
12KW	12.0	40,956	50.0	11.04	37,680	48.0	10.08	34,403	45.8	9.0	30,717	43.3	
15KW	15.0	51,195	62.5	13.8	47,099	60.0	12.6	43,004	57.3	11.25	38,396	54.1	
20KW	20.0	68,260	83.3	18.4	62,799	80.0	16.8	57,338	76.4	15.0	51,195	72.1	
25KW	25.0	85,325	104.2	23.0	78,499	100.0	21.0	71,673	95.5	18.75	63,944	90.1	
30KW	30.0	102,390	125.0	27.6	94,199	120.0	25.2	86,008	114.5	22.5	76,793	108.2	
9KW-3PH	9.0	30,717	21.7	8.28	28,260	20.8	7.56	25,802	19.8	6.75	23,038	18.7	
12KW-3PH	12.0	40,956	28.9	11.04	37,680	27.7	10.08	34,403	26.5	9.0	30,717	25.0	
15KW-3PH	15.0	51,195	36.1	13.8	47,099	34.6	12.6	43,004	33.1	11.25	38,396	31.2	
18KW-3PH	18.0	61,434	43.4	16.56	56,519	41.6	15.12	51,605	39.7	13.5	46,076	37.5	
24KW-3PH	24.0	81,912	57.8	22.08	75,359	55.4	20.16	68,806	52.9	18.0	61,434	50.0	
30KW-3PH	30.0	102,390	72.2	27.6	94,199	69.3	25.2	86,008	66.1	22.5	76,793	62.4	

① All heaters are rated at 240V nominal.

Note: The KW, Btuh and Amp change with the applied voltage.

FIGURE 1
AIR TO AIR HEAT PUMP (GRAPH B008)

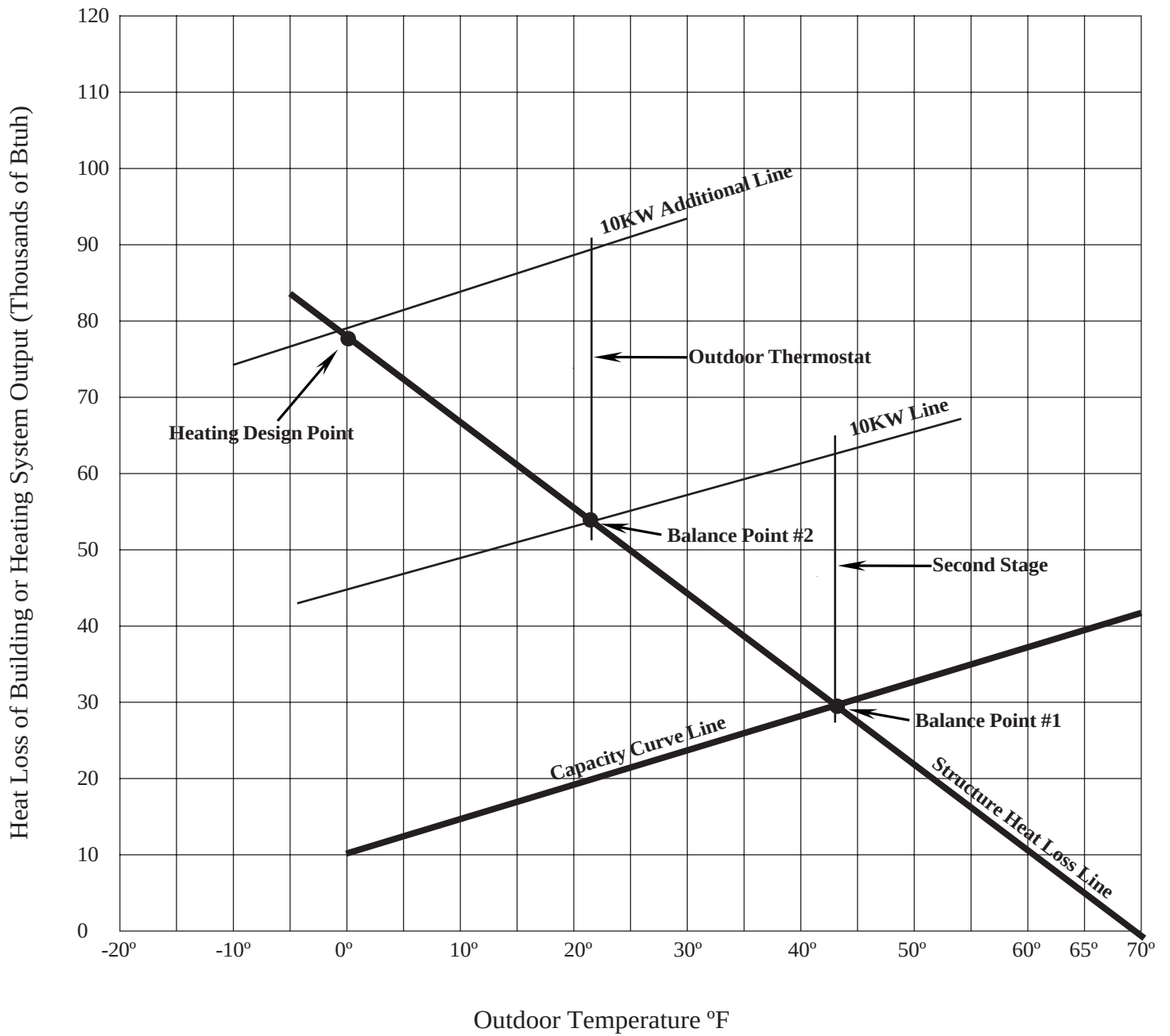


FIGURE 2
WATER TO AIR HEAT PUMP (GRAPH B008)

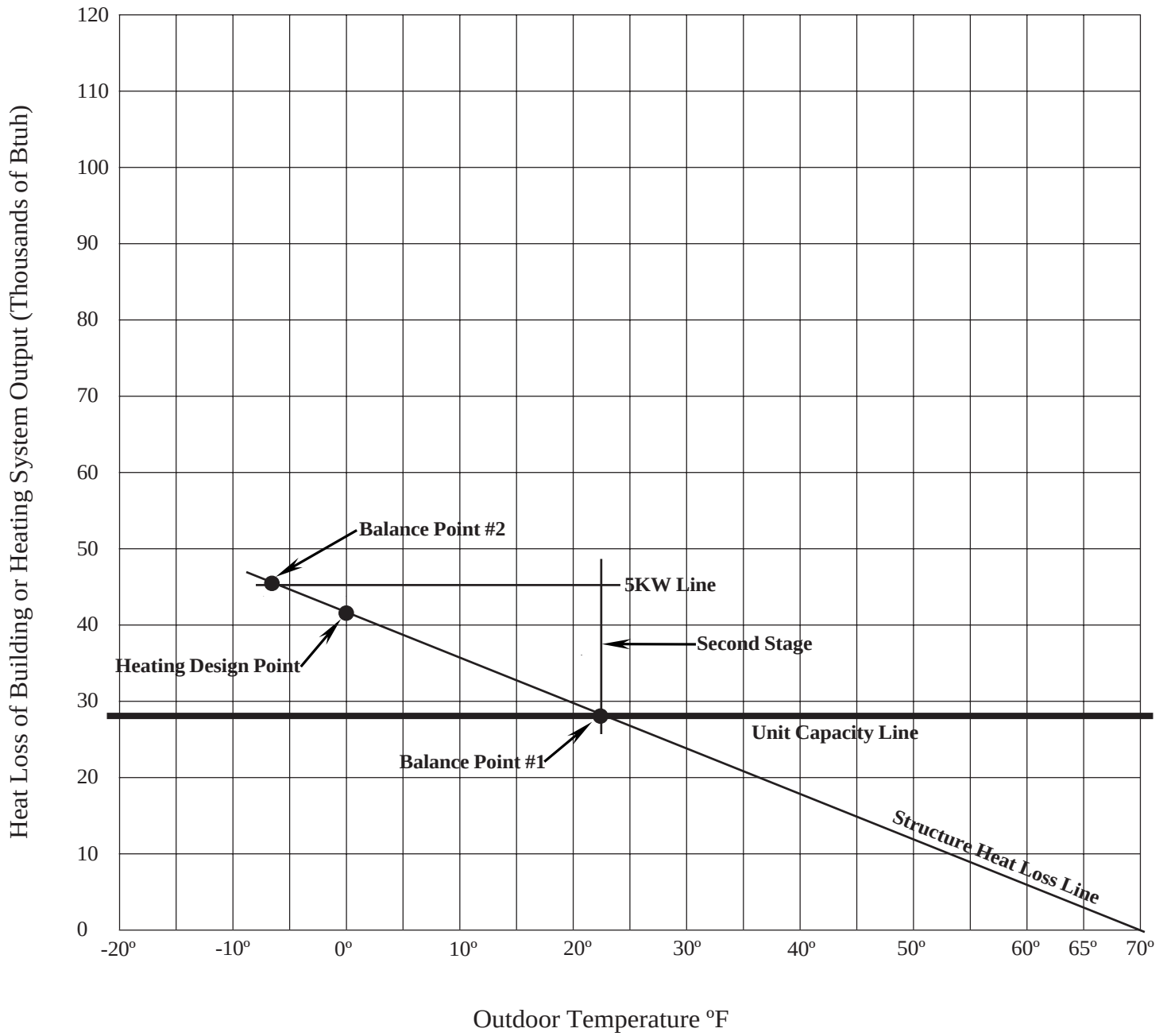


FIGURE 3
GRAPH B008

