MANUAL 2100-057

Bard
SINCE 1914

HEAT PUMP SIZING

REFRIGERATION, HEATING AND AIR CONDITIONING

BARD MANUFACTURING CO. • BRYAN, OHIO 43506
Dependable quality equipment. . .since 1914

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 one-half ton 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 Btu/h 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 3413.

   Example: $\frac{78,000}{3413}$ Btu/h 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, 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 performance curve matching the unit selected for installation.

   Example: Model 30HPQ3/B36EHQ - 25Kw

   This selection made based upon cooling design calculation of 30,000 Btu/h @ 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 Btu/h 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 Btu/h @ 0°F. (See figure #1).

   Draw a straight line between this point and 70°F and 0 Btu/h. 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 Btu/h in the left hand column coinciding with the outdoor temperature value line across the bottom of the graph. The 0 Btu/h 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 Btu/h.

   This line drawn between the heating design condition and 0 Btu/h 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 2nd stage of the wall thermostat would take over and cycle on the 1st bank of supplemental heat (as mentioned earlier, normally in 10Kw banks). There is a nominal 1½°F differential between 1st and 2nd stage of two-stage wall thermostat.

   The 10Kw heater will supply roughly 34,130 Btu/h (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 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, 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.

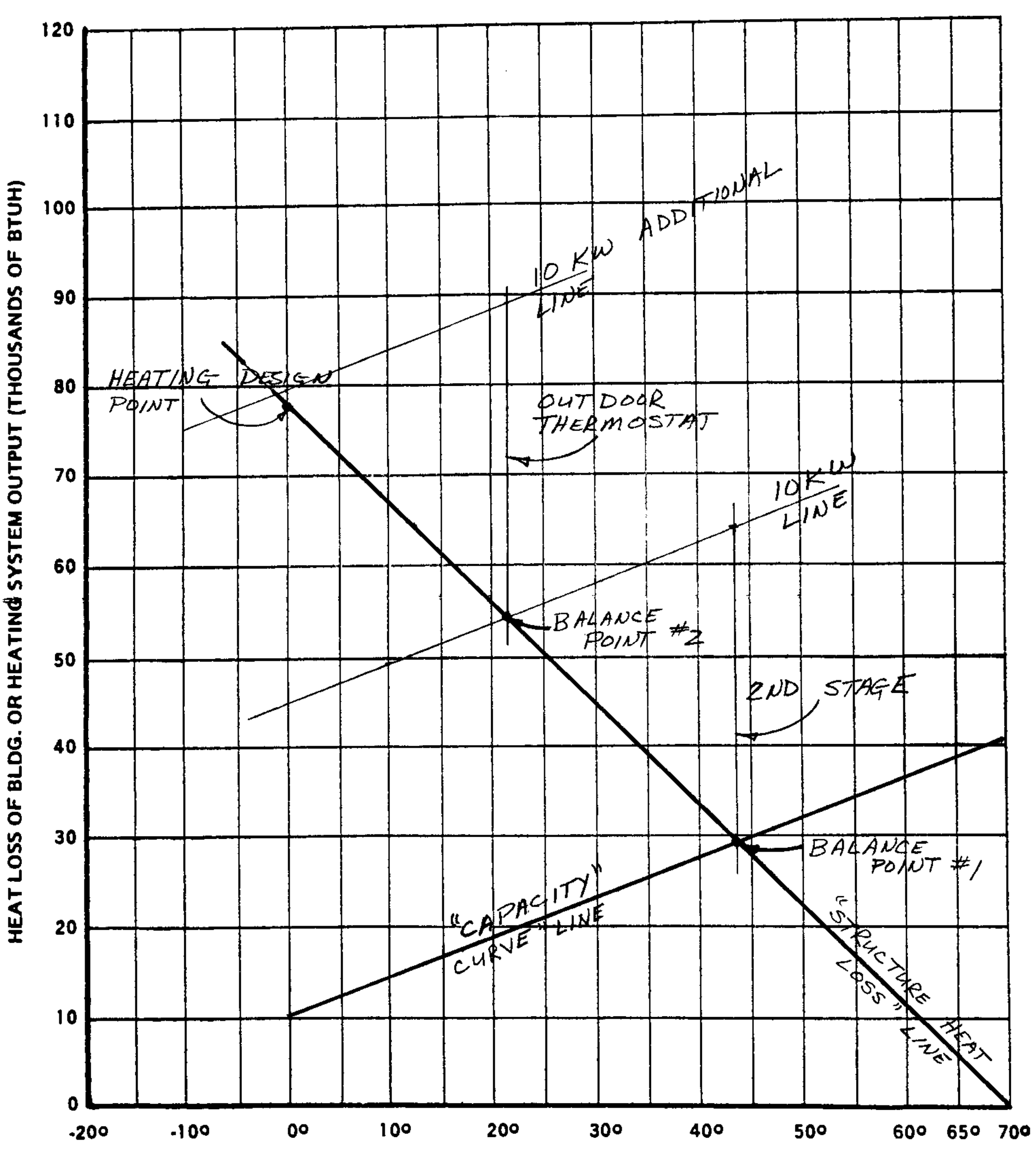


FIGURE #1

AIR TO AIR HEAT PUMP

B008

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 or 75 to 85% of heating load design loss, whichever is larger. 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 water 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 3413).

   Example: $\frac{40,460}{3413}$ Btu/h winter design = 11.85 Kw

   Heaters are rated nominally 15Kw @ 240V - 4.6 Kw @ 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 Btu/h @ 0°F.

   Cooling design calculation of 20,203 Btu/h @ 90°F.

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

   Draw a straight line between this point and 70°F and 0 Btu/h. 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 Btu/h at 70°F outside temperature is called the "Structure Heat Loss" line.

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

   Example: Our unit will supply 28,630 Btu/h 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 2nd stage of the wall thermostat would take over and cycle on the 1st bank of supplemental heat (as mentioned earlier, normally in 10Kw banks). There is a nominal 1½°F differential between 1st and 2nd stage of two-stage wall thermostat.

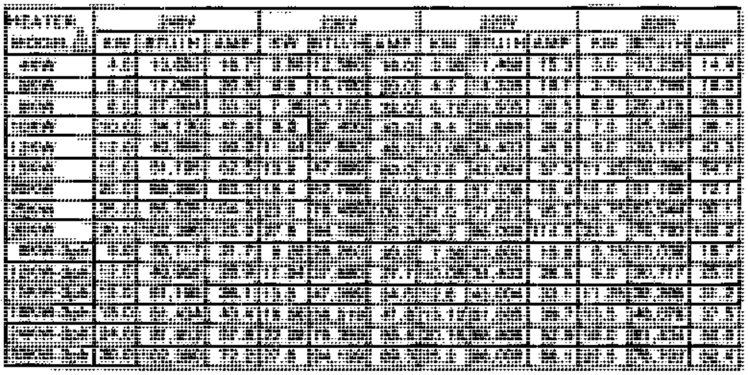
The 5Kw heater will supply roughly 17,065 Btu/h (one watt = 3.413 Btu).

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.

ELECTRIC HEATER TABLE KW vs. VOLTAGE



⚠ All heaters are rated at 240V nominal.

NOTE: The KW, BTU/H, and AMP change with the applied voltage. P/N 7961-023 Rev. A

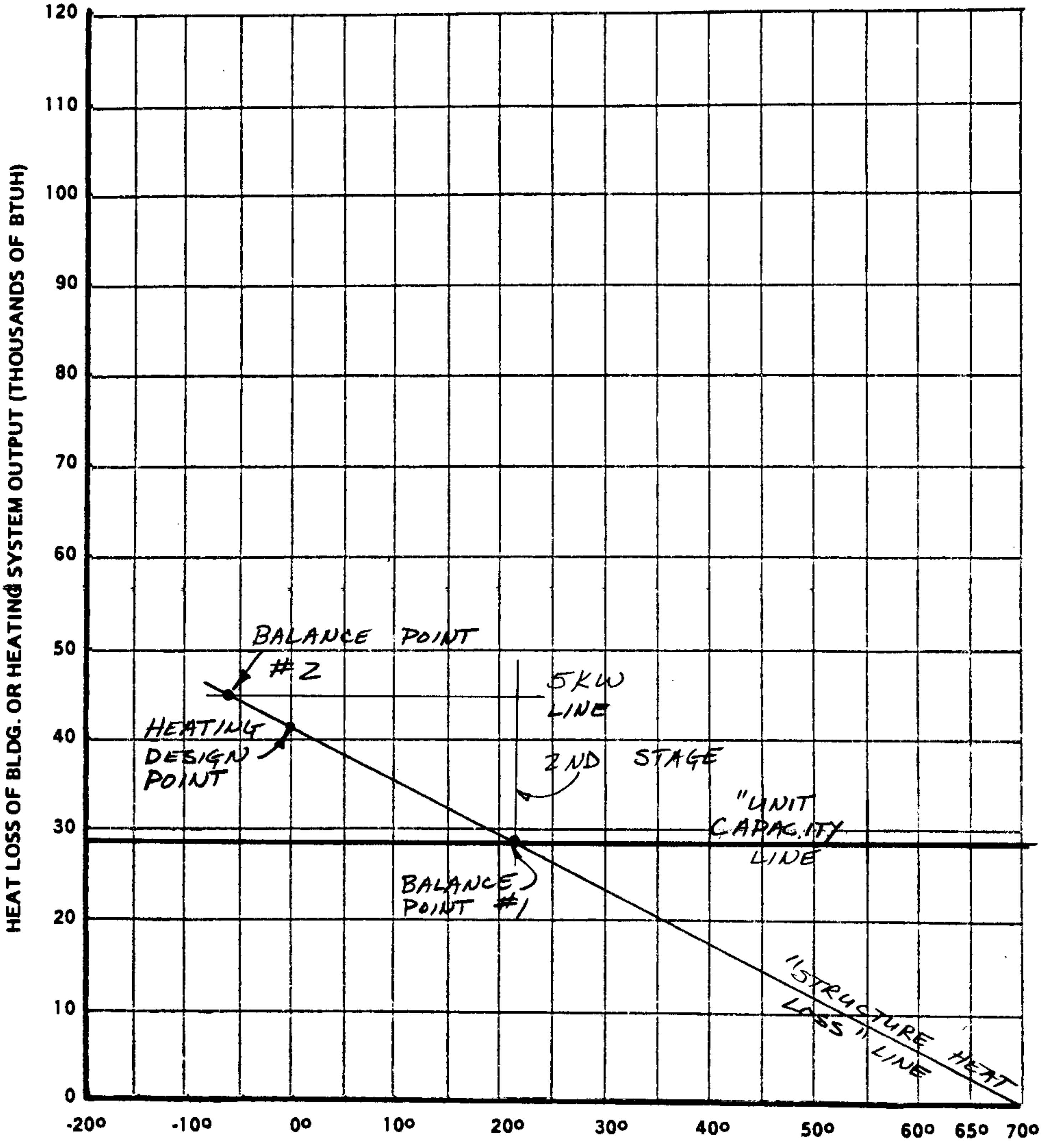
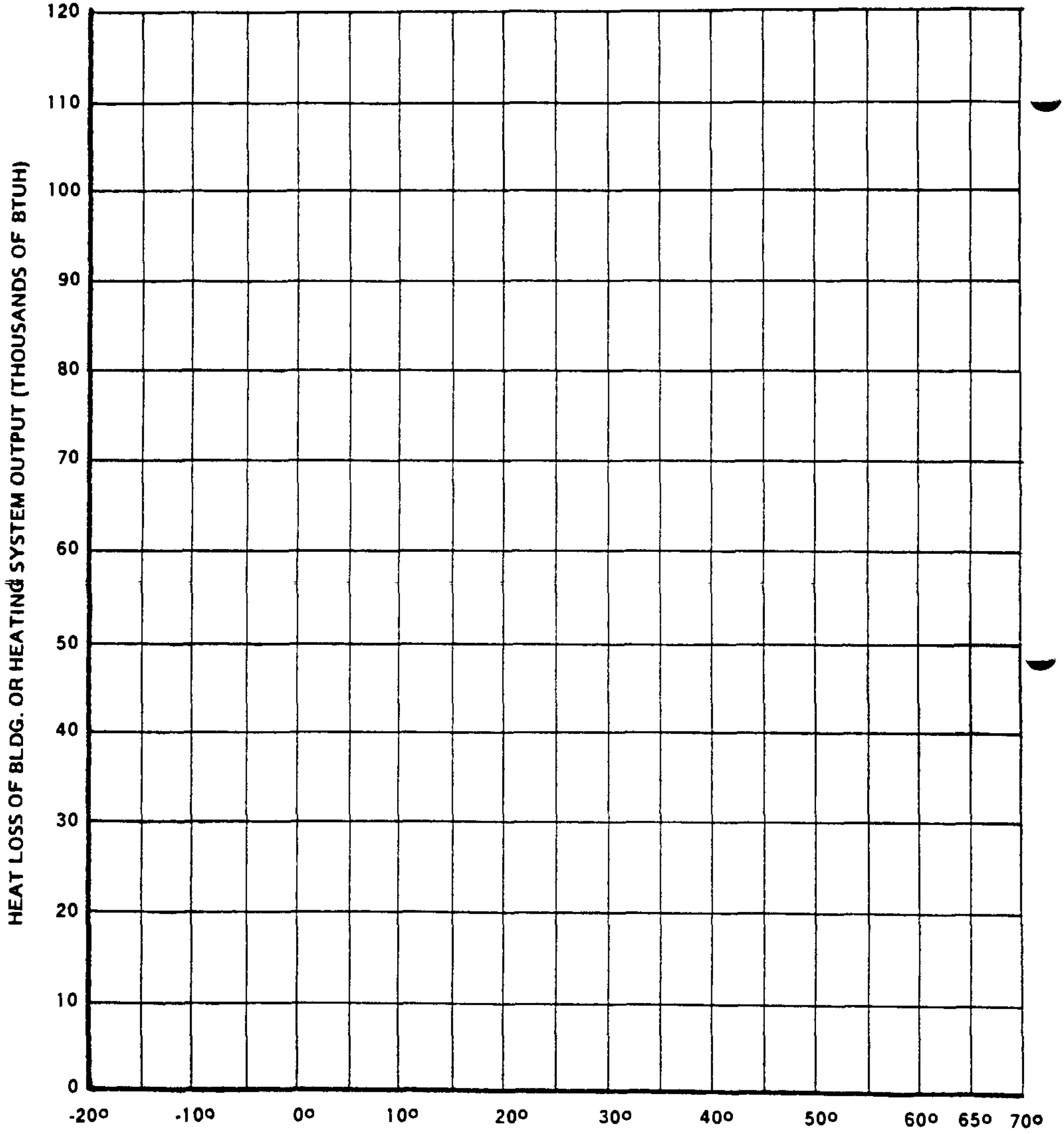


FIGURE #2

OUTDOOR TEMPERATURE °F

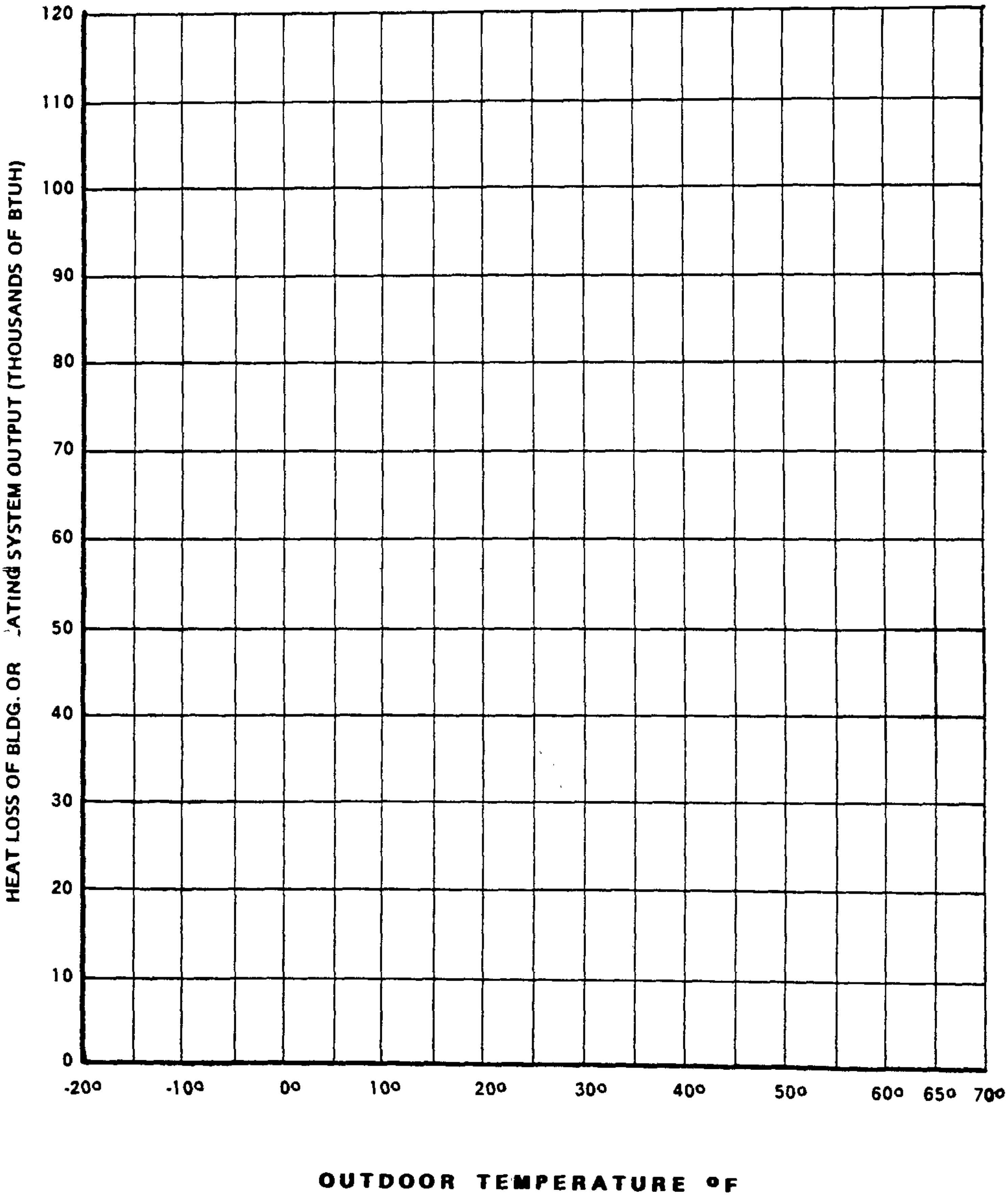
WATER TO AIR HEAT PUMP

B008

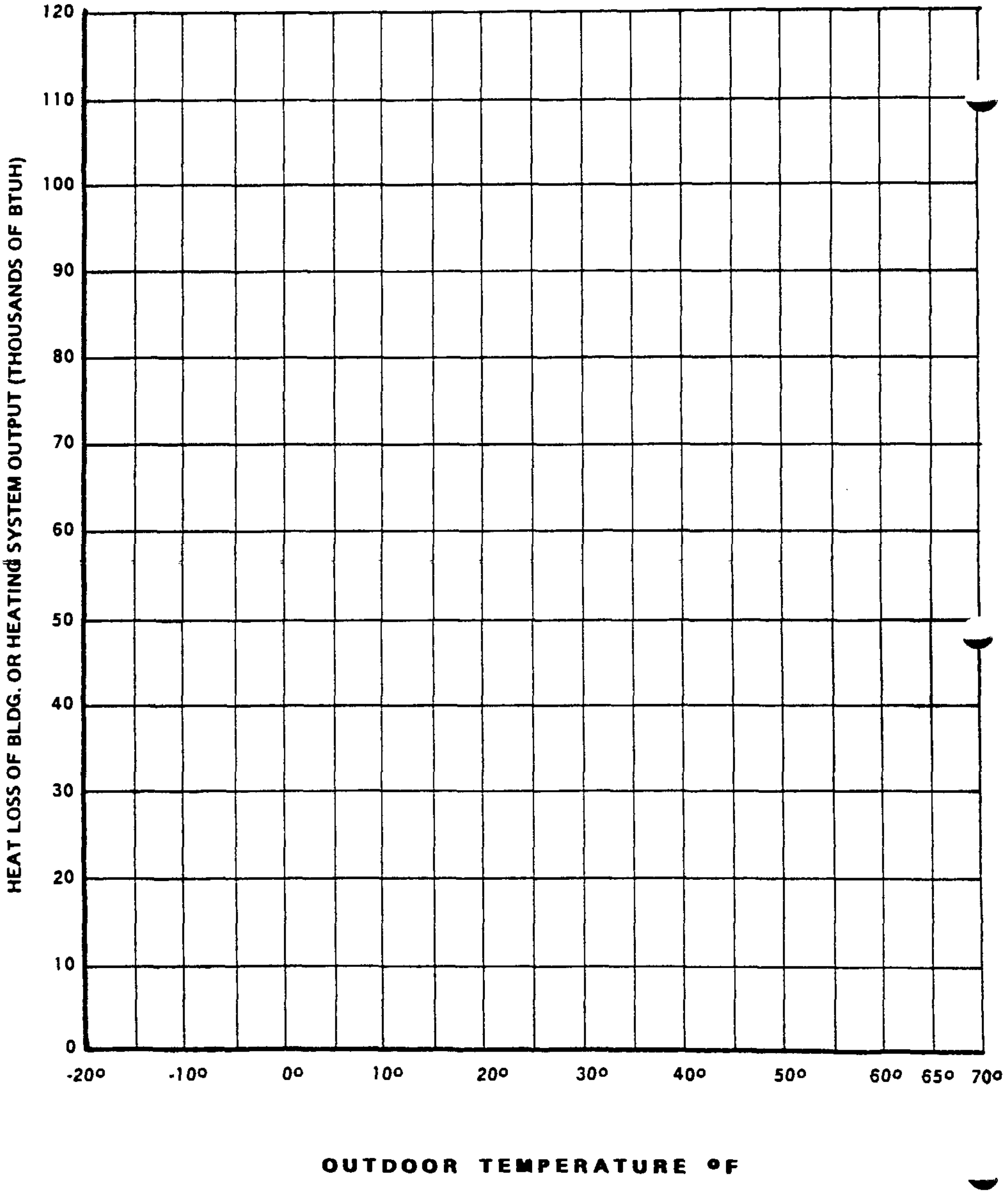


OUTDOOR TEMPERATURE °F

B008


120
110
100
90
80
70
60
50
40
30
20
10
0
HEAT LOSS OF BLDG. OR ATING SYSTEM OUTPUT (THOUSANDS OF BTUH)
-20°
-10°
0°
10°
20°
30°
40°
50°
60°
65°
70°
OUTDOOR TEMPERATURE °F

B008


HEAT LOSS OF BLDG. OR HEATING SYSTEM OUTPUT (THOUSANDS OF BTUH)
120
110
100
90
80
70
60
50
40
30
20
10
0
-20°
-10°
0°
10°
20°
30°
40°
50°
60°
65°
70°
OUTDOOR TEMPERATURE °F

B008