a. Efficiency with hard or soft coal, gas, or oil firing, as the case may be.

b. Grate area with hand fired coal, or fuel burning rate with stokers, oil, or gas

c. Combustion space in the furnace.

d. Type of heat liberation, whether continuous or intermittent, or a combination of both.

e. Convenience in firing and cleaning.

f. Adaptability to changes in fuel and kind of attention.

g. Height of water line.

h. Miscellaneous items such as draft available, possibility of future extension, possibility of break-down, and head room in the boiler room.

i. The most economical size of boiler is usually one that is just the right size for the load. Either larger or smaller boilers may be less economical.

Cast-Iron Boilers

Net load ratings of cast-iron boilers are usually available from manufacturers' catalogs. They may also be obtained conveniently from published tables of $I=B=R$ ratings,[7] or from recommendations of the *Heating, Piping and Air Conditioning Contractors National Association*,[8] and can be used in selection of boilers, unless the heating system contains an unusual amount of bare pipe, or the nature of the connected load is such that the normal allowances for pipe loss and pickup do not apply. In such a case, the selection must be based on the gross output.

Steel Heating Boilers

SBI catalog ratings, in accordance with the previously mentioned *Steel Boiler Institute* code, are intended to correspond with the estimated *design load*. When the heat emission of the piping is not known, the net load to be considered for the boiler may be determined from Tables 1 and 2. The difference between design load and net load represents an amount which is considered normal for piping loss of the ordinary heating system.

Boilers with less than 294 sq ft of heating surface and having *SBI* net ratings (steam) of not more than 5000 sq ft if mechanically fired and 4120 sq ft if hand-fired, are classified as *Table 2 Steel Boilers*, formerly Residential boilers. An insulated *Table 2 boiler* for oil, gas, or stoker firing may carry a *net load* expressed in square feet of steam radiation of not more than seventeen times the square feet of heating surface in the boiler, provided the boiler has been tested in accordance with the *SBI* Code for testing oil-fired steel boilers at output rates of 125, 150 and 175 percent of the steam *SBI* net rating. The *SBI* net rating for a water boiler, automatically fired, expressed in Btu per hour, is 270 times the Steam *SBI* net rating in square feet. The net water rating is 12½ percent greater than the steam rating because a lower piping and pickup factor is generally required in a water system. The *SBI* net rating (sq ft steam) for hand-fired *Table 2 boilers* is not greater than fourteen times the heating surface. If the heat loss from the piping system exceeds 20 percent of the installed radiation, the excess is to be considered as part of the *net load*.

Heating Surface and Grate Area Basis

Where neither the *net load* nor *gross output* ratings based upon performance tests are available, a good general rule for conventionally designed boilers is to provide 1 sq ft of boiler heating surface for each 14 sq ft of equivalent radiation (240 Btu per sq ft) (hr) represented by the design

load. This is equivalent to allowing 10 sq ft of boiler heating surface per boiler horsepower. In this case it is assumed that the *maximum load* including the warming-up allowance will be provided for by operating the boiler in excess of the *design load*, that is, in excess of the 100 percent rating on a boiler-horsepower basis. *SBI* ratings for hand firing are based on 10 sq ft of heating surface per boiler horsepower.

Due to the wide variation which may be encountered in manufacturers' ratings for boilers of approximately the same capacity, it is advisable to check the grate area required for heating boilers burning solid fuel by means of the following formula:

$$G = \frac{H}{C \times F \times E} \qquad (1)$$

where

G = grate area, square feet.

H = required *gross output* of the boiler, Btu per hour (see Selection of Boilers).

C = desirable combustion rate for fuel selected, pounds of dry coal per square foot of grate per hour (see Table 4).

F = calorific value of fuel, Btu per pound.

E = efficiency of boiler, usually taken as 0.60.

Example 1: Determine the grate area for a required *gross output* of the boiler of 500,000 Btu per hour, a combustion rate of 6 lb per hour, a calorific value of 13,000 Btu per pound, and an efficiency of 60 percent.

$$G = \frac{500{,}000}{6 \times 13{,}000 \times 0.60} = 10.7 \text{ sq ft}$$

The boiler selected should have a grate area not less than that determined by Equation 1. With small boilers, where it is desired to provide

TABLE 4. PRACTICAL COMBUSTION RATES FOR COAL-FIRED HEATING BOILERS OPERATING AT MAXIMUM LOAD ON NATURAL DRAFT OF FROM ⅛ IN. TO ½ IN. WATER[a]

KIND OF COAL	SQ FT GRATE	LB OF COAL PER SQ FT GRATE PER HOUR
No. 1 Buckwheat Anthracite	Up to 4	3
	5 to 9	3½
	10 to 14	4
	15 to 19	4½
	20 to 25	5
Anthracite Pea	Up to 9	5
	10 to 19	5½
	20 to 25	6
Anthracite Nut and Larger	Up to 4	8
	5 to 9	9
	10 to 14	10
	15 to 19	11
	20 to 25	13
Bituminous	Up to 4	9.5
	5 to 14	12
	15 and above	15.5

[a] Steel boilers usually have higher combustion rates for grate areas exceeding 15 sq ft than those indicated in this table.