

The warming-up allowance represents the load due to heating the boiler and contents to operating temperature, and heating up cold radiation and piping. The factors to be used for determining the allowance to be made should be selected from Table 3 and should be applied to the estimated design load as determined by Items 1, 2, and 3.

Other items to be considered in boiler selection are:

- Efficiency with hard or soft coal, gas, or oil firing, as the case may be.
- Grate area with hand-fired coal, or fuel burning rate with stokers, oil, or gas.
- Combustion space in the furnace.
- Type of heat liberation, whether continuous or intermittent, or a combination of both.
- Convenience in firing and cleaning.
- Adaptability to changes in fuel and kind of attention.
- Height of water line.
- Miscellaneous items such as draft available, possibility of future extension, possibility of break-down, and head room in the boiler room.

TABLE 3. WARMING-UP ALLOWANCES FOR LOW PRESSURE STEAM AND HOT WATER HEATING BOILERS^{a, b, c}

DESIGN LOAD (REPRESENTING SUMMATION OF ITEMS 1, 2, AND 3)		PERCENTAGE CAPACITY TO ADD FOR WARMING-UP
Btu per Hour	Equivalent Square Feet of Radiation	
Up to 100,000	Up to 420	65
100,000 to 200,000	420 to 840	60
200,000 to 600,000	840 to 2500	55
600,000 to 1,200,000	2500 to 5000	50
1,200,000 to 1,800,000	5000 to 7500	45
Above 1,800,000	Above 7500	40

^aThis table is taken from the A.S.H.V.E. Code of Minimum Requirements for the Heating and Ventilation of Buildings, except that the second column has been added for convenience in interpreting the design load in terms of equivalent square feet of radiation.

^bSee also Time Analysis in Starting Heating Apparatus, by Ralph C. Taggart (A.S.H.V.E. TRANSACTIONS, Vol. 19, 1913, p. 292); Report of A.S.H.V.E. Continuing Committee on Codes for Testing and Rating Steam Heating Solid Fuel Boilers (A.S.H.V.E. TRANSACTIONS, Vol. 36, 1930, p. 35); Selecting the Right Size Heating Boiler, by Sabin Crocker (Heating, Piping and Air Conditioning, March, 1932).

^cThis table refers to hand-fired, solid fuel boilers. A factor of 20 per cent over design load is adequate when automatically-fired fuels are used.

^d240 Btu per square foot.

Selection of Cast-Iron Boilers

The net load is the sum of the radiation load and hot water supply load. 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 ratings⁶, or from recommendations of the *Heating, Piping and Air Conditioning Contractors National Association*⁷ 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 pick-up do not apply. In such a case, the selection must be based on the gross output which is the sum of Items 1, 2, 3, and 4 in the section Factors Involved in Boiler Selection.

⁶I-B-R Ratings for Cast-Iron Boilers (Institute of Boiler and Radiator Manufacturers).

⁷Engineering Standards, Part II, Net Square Feet Radiation Loads in 70 Deg Fahr., Recommended for Low Pressure Heating Boilers, 1943 (Heating, Piping and Air Conditioning Contractors National Association).

Selection Based on Heating Surface and Grate Area

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 square foot) represented by the design load consisting of connected radiation, piping tax and domestic water heating load. As stated in the section on Boiler Output and Efficiency, 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 per cent rating on a boiler-horsepower basis.

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:

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

where

G = grate area, square feet.

H = required total heat 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 1).

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 heat 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 per cent.

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

The boiler selected should have a grate area not less than that determined by Formula 1. With small boilers where it is desired to provide sufficient coal capacity for approximately an eight-hour firing period plus a 20 per cent reserve for igniting a new charge, more grate area may be required depending upon the depth of the fuel pot.

Selection of Steel Heating Boilers

Ratings obtained from the previously mentioned *Steel Heating Boiler Institute* code are intended to correspond with the estimated design load based on the sum of Items 1, 2, and 3 listed previously under Factors Involved in Boiler Selection. When Item 3, the heat emission of the piping, is not known, the net load, consisting of Items 1 and 2, to be considered for the boiler may be determined from Table 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 128 sq ft of heating surface are classified as residence size. An insulated residence boiler for oil or gas, not convertible, may carry a net load expressed in square feet of steam radiation of not more than 17 times the square feet of heating surface in the boiler, pro-