gas passages must not be so small as to cause excessive resistance to the flow of gases where natural draft is employed. Inserting baffles so that the heating surface is arranged in series with respect to the gas flow increases boiler efficiency and reduces stack temperature and increases the draft loss through the boiler.

Heat Transfer Rates

Practical rates of heat transfer in heating boilers will average about 3300 Btu per square foot per hour for hand-fired boilers and 4000 Btu per square foot per hour for mechanically fired boilers when operating at *design load*. When operating at *maximum load*[1] these values will run between 5000 and 6000 Btu per square foot per hour. Boilers operating under favorable conditions at the above heat transfer rates will give exit gas temperatures that are considered consistent with good practice.

TESTING AND RATING CODES

The Society has adopted four solid fuel testing codes, a solid fuel rating code and an oil fuel testing code. A.S.H.V.E. Standard and Short Form Heat Balance Codes for Testing Low-Pressure Steam Heating Solid Fuel Boilers—Codes 1 and 2—(Revision of June 1929)[2], are intended to provide a method for conducting and reporting tests to determine heat efficiency and performance characteristics. A.S.H.V.E. Performance Test Code for Steam Heating Solid Fuel Boilers—Code No. 3—(Edition of 1929)[2] is intended for use with A.S.H.V.E. Code for Rating Steam Heating Solid Fuel Hand-Fired Boilers[3]. The object of this test code is to specify the tests to be conducted and to provide a method for conducting and reporting tests to determine the efficiencies and performance of the boiler. The A.S.H.V.E. Standard Code for Testing Steam Heating Boilers Burning Oil Fuel[4] is intended to provide a standard method for conducting and reporting tests to determine the heating efficiency and performance characteristics when oil fuel is used with steam heating boilers. In 1938 the Society adopted a Standard Code for Testing Stoker-Fired Steam Heating Boilers[5] which is intended to provide a test method for determining the efficiency and performance characteristics of any stoker or boiler combination burning any type of solid fuel such as anthracite or bituminous coal.

The *Steel Heating Boiler Institute* has adopted a method for the rating of low pressure boilers based on their physical characteristics and expressed in square feet of steam or water radiation or in Btu per hour as given in Table 2. The detailed requirements of this code were outlined in Chapter 13 of THE GUIDE 1939. The *Institute of Boiler and Radiator Manufacturers* has also adopted a method of rating cast-iron heating boilers based upon performance obtained under tests. This code became effective August 1, 1939 for sectional boilers of 20 in. width grate or less, but the Institute intends eventually to expand the code to apply to all

[1]For definitions of design load and maximum load see page 248.
[2]See A.S.H.V.E. TRANSACTIONS, Vol. 35, 1929, pp. 322 and 332.
[3]See A.S.H.V.E. TRANSACTIONS, Vol. 36, 1930, p. 42.
[4]See A.S.H.V.E. TRANSACTIONS, Vol. 37, 1931, p. 23.
[5]See A.S.H.V.E. TRANSACTIONS, Vol. 44, 1938, p. 366.

TABLE 2. STEEL HEATING BOILER STANDARD RATINGS[a]

HAND-FIRED RATING						MECHANICALLY-FIRED RATING				
Catalog			Net Load	Heating Surface Sq Ft	Grate Area Sq Ft	Catalog			Net Load	Furnace Volume, Oil, Gas or Bituminous Coal Cu Ft
Steam Radiation Sq Ft	Water Radiation Sq Ft	Btu per Hour in Thousands	Steam Radiation Sq Ft			Steam Radiation Sq Ft	Water Radiation Sq Ft	Btu per Hour in Thousands	Steam Radiation Sq Ft	
1,800	2,880	432	1,389	129	7.9	2,190	3,500	525	1,695	15.7
2,200	3,520	528	1,702	158	8.9	2,680	4,280	643	2,089	19.2
2,600	4,160	624	2,020	186	9.7	3,160	5,050	758	2,461	22.6
3,000	4,800	720	2,335	215	10.5	3,650	5,840	876	2,853	26.1
3,500	5,600	840	2,732	250	11.4	4,250	6,800	1,020	3,335	30.4
4,000	6,400	960	3,135	286	12.2	4,860	7,770	1,166	3,830	34.8
4,500	7,200	1,080	3,540	322	13.4	5,470	8,750	1,312	4,330	39.1
5,000	8,000	1,200	3,945	358	14.5	6,080	9,720	1,459	4,834	43.5
6,000	9,600	1,440	4,770	429	16.4	7,290	11,660	1,749	5,850	52.1
7,000	11,200	1,680	5,608	500	18.1	8,500	13,600	2,040	6,885	60.8
8,500	13,600	2,040	6,885	608	20.5	10,330	16,520	2,479	8,490	73.8
10,000	16,000	2,400	8,197	715	22.5	12,150	19,440	2,916	10,125	86.8
12,500	20,000	3,000	10,417	893	25.6	15,180	24,280	3,643	12,650	108.5
15,000	24,000	3,600	12,500	1,072	28.4	18,220	29,150	4,372	15,183	130.2
17,500	28,000	4,200	14,584	1,250	30.9	21,250	34,000	5,100	17,708	151.8
20,000	32,000	4,800	16,667	1,429	33.2	24,290	38,860	5,829	20,242	173.5
25,000	40,000	6,000	20,834	1,786	37.4	30,360	48,570	7,286	25,300	216.9
30,000	48,000	7,200	25,000	2,143	41.2	36,430	58,280	8,743	30,359	260.3
35,000	56,000	8,400	29,167	2,500	44.7	42,500	68,000	10,200	35,417	303.6

[a]Adopted by the *Steel Heating Boiler Institute* in cooperation with the *Bureau of Standards, United States Department of Commerce Simplified Practice Recommendations R 157-35.*

sizes of boilers. Methods of testing hand-fired and oil-fired boilers are specified and are referred to as *IBR* testing codes.

BOILER OUTPUT

Boiler output as defined in A.S.H.V.E. Performance Test Code for Steam Heating Solid Fuel Boilers (Code No. 3) is the quantity of heat available at the boiler nozzle with the boiler normally insulated. It should be based on actual tests conducted in accordance with this code. This output is usually stated in Btu and in square feet of equivalent heating surface (radiation). According to the A.S.H.V.E. Standard Code for Rating Steam Heating, Solid Fuel Hand-Fired Boilers, the performance data should be given in tabular or curve form on the following items for at least five outputs ranging from maximum down to 35 per cent of maximum: (1) fuel available, (2) combustion rate, (3) efficiency, (4) draft tension, (5) flue gas temperature. The only definite restriction placed on setting the maximum output is that priming shall not exceed 2 per cent. These curves provide complete data regarding the performance of the boiler under test conditions. Certain other pertinent information, such as grate area, heating surface and chimney dimensions, is desirable also in forming an opinion of how the boiler will perform in actual service.

The output of large heating boilers is frequently stated in terms of *boiler horsepower* instead of in Btu per hour or square feet of equivalent radiation.