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HEATING EQUIPMENT AS RELATED TO LOW-COST HOUSING

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The object of an investigation of heating equipment in connection with the low-cost housing program must be to determine what types of heating plants are most appropriate for the kinds of houses which it is proposed to build.

The heating equipment installed should be substantial, durable and reliable but the cost limitations preclude the use of materials or equipment designed for luxury.

A number of factors may affect the choice of a type of heating plant. Locality is a factor in two ways; because climate and the relative cost of the ordinary fuels are both dependent upon it. Of the three usual types of heating plants, steam, hot water, and hot air, each has advantages and disadvantages peculiar to itself and it is desirable to select, in each case, the type of plant best suited to the conditions.

Not all heating equipment manufacturers use the same equipment and methods for testing and rating their products. There is a lack of uniformity in test methods for heating boilers, radiators and convectors. Many of the larger manufacturers maintain laboratories and have established standards for the performance of their own products, but there is not always an adequate way to interpret the data given by one company about its product in terms of that given by another, so that in bidding it cannot be known that all parties are proposing to furnish equipments which are equivalent in capacity and effectiveness.

To end this difficulty, a testing apparatus for radiators and convectors is under construction and a testing apparatus for steam and hot water heating boilers is in prospect. In design, the apparatus follows the codes of the American Society of Heating and Ventilating Engineers, but there will be exceptions if the desirability forsuch is indicated as the work progresses.

Other laboratories which have engaged in testing radiators and convectors emphasize the effects of outdoor, wall and window temperatures, and positions in the room on radiator and convector performance. To investigate the magnitude of these effects, two equipments for testing these devices have been installed in a test house. With these, the effect of changes in the relevant temperatures can be examined as the winter advances.

In addition to the studies of the more conventional heating devices, occasional investigations of newly developed and unusual devices are planned in order to know and take advantage of anything of merit which might be brought to light and which has not been used before.

There is reason to suppose that first cost often influences the size and type of heating systems installed in houses built for sale, more than considerations of economy of operation. Of course, there is necessarily a limit to the amount which can logically be added to the lowest possible first cost for the sake of an increased efficiency, but it is also obviously illogical not to invest more in the installation if the amount invested can be saved in five or ten years of normal operation by reducing the fuel consumption.

It is proposed to undertake first the rating of radiators and convectors, and to start work on the rating of boilers as soon as possible. These items of the program may therefore be discussed in some detail.

The name "radiator" was used to designate the familiar cast iron appliance which transfers heat from a steam or hot water heating system to the rooms in a building. The name has come into general use in spite of the fact that the "radiator" transfers much more heat by convection than by radiation. Before the introduction of the present day small tube radiators, the design had become rather conventional and radiators were very much alike in the general shape and size of tubes. At that time it was sufficient to specify the size of the radiator in terms of its (geometrical) surface area, expressed in square feet. The custom of specifying the size in terms of square feet of area has continued, and is still widely used in Government specifications and elsewhere. Experiments made with the older form of radiators indicated that under certain conditions, which included room temperature of 70°F and steam at 215°F, the heat transfer through one square foot of radiator surface was about 240 Btu per hour. This value was very generally accepted and in many cases the expressions, "one square foot of radiator surface" and "heat transfer of 240 Btu per hour" were used interchangeably as having essentially equivalent meanings.

When the small tube radiators were introduced, it was not obvious that a square foot of surface in this form would be as effective in transferring heat as a square foot of surface in the then conventional type of radiator and this suspicion became a certainty when the newer types, with extended surface, which were named "convectors," were introduced. In dealing with appliances of this type, the square foot

of geometrical surface was no longer a measure of the effective size of the radiator, and it was necessary to rate radiators and convectors in terms of the rate at which they could transfer heat to air under standard conditions. It was doubtless for the purpose of retaining contact with past practice and experience that the size of the newer types of radiators were specified in terms of equivalent square feet of the older type of radiator, and the then familiar figure of 240 Btu per hour was pressed into service in making the transition. Thus many kinds of radiators are now rated in terms of square feet E.D.R. (equivalent direct radiation), which means simply that one square foot E.D.R. corresponds to ability to transfer 240 Btu per hour under standard test conditions.

It is evident that it is now necessary to rate radiators in terms of their ability to transfer heat and that test results will be obtained in Btu per hour under standard conditions. Whether the test results are given directly in terms of Btu per hour, or are divided by 240 in order to express them in terms of square feet E.D.R. is evidently of minor importance.

Probably most of the radiator tests that have been made up to the present time have been made by measuring the amount of steam condensed by the radiator in the test. Some workers have considered the method very satisfactory, and others have condemned it as being subject to large and uncertain errors. A few tests have been made at the National Bureau of Standards by another method in which the heat lost by the radiator is supplied by an electric heating coil, so that the heat loss can be measured electrically. This method is the same in principle as the methods used both at the Bureau and in other laboratories, for the very precise measurements of the properties of water and steam which form the basis of modern tables of properties of steam.

The ratings obtained will be of use in connection with purchases of standard types of radiators, and the test will provide a quick means of judging whether new types of heat transfer appliances are of sufficient promise to warrant test in service. The use of tests in connection with purchases is very evident. For example, it is possible that two radiators of the same surface area, but greatly different in form, might differ considerably in heat transfer capacity. If the difference in heat transfer capacity were 10%, it would be necessary on the whole to use about 10% more of one than the other, and if purchases amounted to $1,000,000 and costs per square foot were the same, the test might lead to a saving of about $100,000. This

argument cannot be carried too far, however. If the difference were 1%, it might cost almost as much to establish the difference as could (hypothetically) be saved, and an attempt to test to an accuracy of 0.1% would cost many times as much as could be saved on the largest purchases which might be made.

The tests of heat transfer capacity give information on the one feature of a radiator that has positive value. In order to secure the heat transfer capacity of a radiator, it is necessary to provide space for it, and space so sacrificed represents a loss. Thus a radiator, while it must be judged first on its ability to transfer heat must also be judged on space occupied, cost, cost of installation, weight, appearance etc.

There is no one generally accepted method for rating heating boilers now in use. It is, therefore, proposed to establish a test apparatus and method for these devices at this Bureau to afford a uniform basis of choice for the purposes of the Government. In addition to this, an attempt will be made to find a test procedure acceptable as a standard by the industry.

In this work as well as in that on radiators and convectors, ratings in terms of Btu per hour will be favored although tabulated data will include ratings in square feet of equivalent direct radiation initially, at least, in order to connect properly with past practice.

Based on the data obtained in the laboratory as indicated, and by observation from the field an attempt will be made to indicate as specifically as may be the types of heating plants which can be most practically and economically adapted to the various types of houses.