

greater in the horizontal passages in the heating plant, the breeching, and the smokepipe, than in the vertical chimney liner. An increase in the liner diameter of one inch above that required for a clean chimney will probably make adequate allowance for soot deposits in all but the worst cases. Where smoky combustion is likely to occur and the mass flow rates on a clean chimney basis approach those listed in Table 2, the next larger commercial size liner should be used. Smoky combustion with oil-burning devices, particularly with vaporizing oil burners, is likely to be caused by inadequate draft which is often due to insufficient chimney height. For coal, inadequate chimney height or chimney area may be a contributing cause, but smoky combustion with coal is related to fuel characteristics and firing methods. Therefore, an increase in chimney area will usually not cure smoky combustion of a coal-burning device, but can be expected to lengthen the interval between cleanings.

New standard sizes of clay flue linings were recently developed by the

TABLE 3. DRAFTS REQUIRED BY TYPICAL RESIDENTIAL HEATING DEVICES OR APPLIANCES

| DEVICE                                         | DRAFT,<br>INCHES WATER    | STACK TEMPERA-<br>TURE° F DEG |
|------------------------------------------------|---------------------------|-------------------------------|
| Space Heater, Oil Burning, Pot Burner.....     | 0.06 to 0.08              | 1000                          |
| Warm Air Furnace, Oil Burning, Pot Burner..... | 0.06                      | 860                           |
| Warm Air Furnace, Hand Fired.....              | 0.06 <sup>b</sup>         | 900                           |
| Floor Furnace, Oil Burning, Pot Burner.....    | 0.06                      | 860                           |
| Mechanical Oil Burner, Less than 5 gph.....    | 0.03 <sup>a</sup>         | —                             |
| Mechanical Oil Burner, More than 5 gph.....    | 0.05 <sup>a</sup> or less | —                             |
| Cooking Stove, Solid Fuel.....                 | 0.04 <sup>b</sup>         | 400                           |
| Space Heater, Coal Burning.....                | 0.06 <sup>b</sup>         | 900                           |

<sup>a</sup> Draft in firebox. <sup>b</sup> For chestnut sized anthracite. <sup>c</sup> 18 in. from heater.

industry and approved by the *American Standards Association*, in order to effect economies that can be derived from coordination of the dimensions of building materials. These linings are known as modular clay flue linings, and the dimensions and tolerances are summarized in *ASA Standard A62.4-47*. As the effective areas of these liners are somewhat smaller than those of the corresponding linings used previously, they cannot be used in certain municipalities where building codes specify minimum areas based on the older dimensions.

#### DRAFT REQUIREMENTS OF APPLIANCES

Typical flue-gas temperatures and drafts required at rated output for several kinds of domestic heating appliances<sup>12</sup> are contained in Table 3. Chimney height and chimney area for cast iron boilers are specified in the *I=B=R Testing and Rating Code of the Institute of Boiler and Radiator Manufacturers*.

Mechanically-fired devices such as oil burners and stokers are equipped with blowers, and therefore, the chimney is not required to overcome the resistance of the fuel bed or burner. Nevertheless, a draft in the firebox, of about 0.03 in. of water is desirable so that leakage, if any, will be into the firebox rather than outward from it.

Insufficient draft for natural-draft appliances is likely with installations in attics or in one-story basementless houses. Automatic oil-burning

space heaters, floor furnaces, and warm air furnaces employing natural-draft vaporizing burners require a draft of 0.06 to 0.08 in. water for outdoor temperatures of 60 F. Coal-burning heaters and furnaces which attain design rating of 0 F would require about the same draft. For such requirements, data from Figure 8 and Table 1 show that an effective chimney height, above chimney inlet, should be a minimum of 8 to 12 ft. Because temperature drop and friction loss in the flue pipe cannot be calculated accurately,<sup>7</sup> and the resistance of various chimney connections is uncertain, the minimum calculated heights should have a generous factor of safety applied to allow for these and other uncertainties. Where ample height cannot be provided, forced or induced draft should be provided. Extreme care should be used in the application of forced draft to avoid producing a pressure in the combustion chambers, because they are not usually designed to avoid the leakage of toxic gases which might result.

Induced draft by means of motor-driven fans or blowers will solve low-draft problems, but would usually be employed for residential systems only as a last resort. Operation of a blower entails some cost, introduces maintenance requirements, and may be dangerous in event of power failure unless suitable protective devices are used. Induced draft fans designed to resist effects of high temperature and corrosion are available. Fans not carefully designed or modified to meet these conditions should not be applied to this service.

#### CHIMNEYS FOR GAS APPLIANCES

The Approval Requirements of the *American Gas Association* are such that a gas-fired appliance must be able to operate at its rated input (plus 10 or 15 percent) without a chimney connection, and without producing carbon monoxide. The primary functions of the chimney for the gas-fired appliance are to remove the products of combustion from the living space and to assure safety to the building. The chimney therefore becomes essentially a vent and, in fact, the vents tested and listed by *Underwriters' Laboratories* for use only with gas appliances were for some time designated as *Type B Gas Appliance Vents*. Their use is limited to appliances approved by the *American Gas Association* and operating with flue gas temperatures not in excess of 550 F at the inlet of the draft hood. A draft hood is always required in connection with a *Type B* flue. The *Type B-W* gas flue is further limited to the venting of wall heaters having an input of not more than 50,000 Btu per hr.

Because of the low temperatures to which gas flues are limited care should be taken to ascertain that the appliance is not convertible to fuels other than gas and that the appliance is approved by the *American Gas Association*. It is well also to be certain that gas fuel will continue to be available to the building.

Chimneys for venting appliances designed for burning gas, can therefore be low in height, but must have adequate area. The height is usually established by the building height. Chimney sizes are usually selected on the basis of heat input of the appliance. The chimney sizes adopted by the *American Standards Association* and the *National Board of Fire Underwriters* in 1950 for gas appliances<sup>13</sup> are shown in Fig. 10.

Additional provisions of *ASA Standard Z21.30-1950* relating to chimney size are:

1. In no case shall the vent area be less than the area of a 3-in. diameter pipe.
2. When more than one appliance vents into a flue or vent, the flue or vent area