

equipment and ventilating means available for control. In the following paragraphs the general requirements of two types of control are discussed.

1. *Individual Room Control.* The most accurate and flexible form of control for any structure is that calling for the regulation of each individual room by control equipment reacting to conditions in that room only. Such control necessitates a thermostat in each room, located to properly measure the conditions of the room, controlling the radiator, unit heater, damper, unit air conditioner or other heating or cooling source, for that room. This arrangement permits the maintenance of any desired conditions in any room, entirely independent of any other room. In the case of large rooms, where one thermostat location will not serve to properly measure the conditions throughout the room, and where two or more sources of heating or cooling are provided in the room, additional thermostats may be used, each controlling its respective section. This form of control, due primarily to the number of control devices required over the entire building, normally is the most expensive. However, where maximum flexibility and the most accurate control are desired, individual room control should be used.

Room thermostats are available for various functions. *Dual* thermostats operate heating devices at normal temperatures during periods of normal occupancy but at lower temperatures, for economy, at other times. The change-over may be by clock or manual switches, and one or any number of thermostats may be on a single switch. *Summer-Winter* thermostats, as described for All Year Central Fan Systems, are used for reversing the operation of certain dampers or valves to make them function for both heating and cooling.

One precaution to be observed in the location of room instruments is to make sure that each is in control of all the heating and cooling devices that affect its temperature, except where two thermostats are used to operate at different temperatures.

2. *Single Thermostat Control.* A great majority of the buildings under automatic control have the comfort temperature maintained by a single thermostat operating directly on the source of heat or cooling for the entire building. In average size residences and in other small buildings, it is possible to select a thermostat location which will give entirely satisfactory results throughout the structure. This location must be one which truly represents average conditions and one which will not have unusual temperature effects. For example, a thermostat near an outside door may function improperly when the door is open. After the proper location is selected, the system is balanced to provide the proper temperature distribution.

Details of control by single thermostats will be found under the heading, Control of Automatic Fuel Appliances, in this chapter.

Zone Control

As the size of buildings increases, it becomes increasingly difficult to provide proper regulation for the entire structure from a single thermostat control. In such instances, where the advantages of individual room control are not obtainable by reason of its cost, an intermediate form of control system is available, commonly described as *zone control*. In this

form of control system a building is divided into areas or zones such that the general requirements and the general conditions through the areas are relatively constant as to exposure and occupancy, and then each zone is provided with control equipment which functions to regulate the conditions in that particular zone. As in the case of individual room control, each zone may be regulated to its own needs which may vary from the needs of other zones within the same structure.

The number of zones to be used is determined by several factors, such as:

1. Size of building.
2. Number and character of exposures.
3. Variation in occupancy or other inside conditions.
4. Cost of additional zones.

The greater the number of zones, the closer is the approach to the results and cost of individual room control. However, zone control has advantages even where individual room control is installed as it lightens the work of the room control. With room control, fewer zones are needed. In buildings of large floor area, it is usually desirable to have a separate zone for each exposure. If one wall is protected by an abutting building for half its height, two zones may be necessary. First floor conditions may vary enough from those of the rest of the building to justify a separate zone. In large buildings with several exposures toward any compass point, as occurs in wings and courts, all the northern exposures, for example, may be put on one zone control, or each north wall may have its own control. Court exposures are apt to be affected by surrounding walls and thus to require separate treatment.

In high buildings it is often important to consider zoning for stack or chimney effect in winter, caused by the difference in density between the warm air on the inside of a building and the colder air on the outside. Where the lower eight or ten stories are protected from winds by surrounding buildings, it may accentuate the need for zoning to correct the chimney effect, and on windy days there will be a marked difference in the heat requirements for the different horizontal sections at different elevations. An arrangement to provide for difference in heat requirement for exposure and chimney effect would give 12 zones; namely, north, east, south, and west lower, middle and top zones.

For steam heating systems the automatic control arrangement varies with the means of obtaining reduced temperatures. Some of the methods in common use are described in Chapter 13. From the control standpoint they are classified as follows:

1. Throttling steam to allow flow in proportion to the needs for heating.
2. Turning the steam on and off, leaving it on for longer or shorter periods as required.
3. Varying the pressure differential between supply and return lines, and varying the absolute pressures in both, so as to change the amount of steam passing through the radiators, due to the differences in pressure drop and due to the differences in volume per pound of steam.

The controlling thermostats may be inside or outside instruments or a combination of the two. Ordinary inside thermostats alone are likely to give disappointing results because an unusual condition at the thermostat upsets the whole zone, and because a slight temperature drop may allow