fuel saving of from 7 to 10 per cent may be obtained by reducing the house temperature 6 to 10 deg from about 10:00 p.m. to 5:30 a.m.*

In locating a room thermostat the following rules should be observed:

1. It should always be located towards the center of a relatively open room on the coolest rather than the warmest side of the building.
2. It should never be mounted on an outside wall or other cold surface, or where it is exposed to cold drafts from an outside door.
3. It should never be mounted where it will be affected by direct rays of the sun; by heat from a nearby warm surface such as chimneys, pipes or ducts in a wall, radiators; or by direct currents from a warm air register.
4. It should never be located where normal circulation of air is impeded by furniture or an opened door.
5. It should be located where it is safe from mechanical injury.

In a typical home, a satisfactory location for the thermostat can usually be found on an inside wall of the living room or dining room.

Air-Conditioning Systems

Year 'round residential air-conditioning systems which provide for heating in winter and cooling in summer should be given the same consideration in selecting the control system as required for commercial air-conditioning systems described later in this chapter since the basic principles are the same and the final results must provide for the comfort of the occupants. Economy in first cost may result in both lack of economical operation and discomfort.

ZONE CONTROL

In residential heating, it is often desirable to divide the house into two or more zones for greater accuracy of control and comfort. Each zone may then be maintained individually at the desired temperature level. The division by zones should be based upon exposure and occupancy and the most common division is usually found to be:

1. Living section such as living room, dining room, den.
2. Sleeping section.
3. Service section such as kitchen, pantry, servant's quarters.

Zone control for steam and hot water heating systems is employed where it is desired to control the heating effect of a multiplicity of radiators or convectors, located in various heated spaces, through the use of a single regulator. Under certain conditions, particularly in buildings of limited size, it is possible to consider the entire building as a single heating zone. In such cases, the zone regulator, or *master controller*, may operate directly the automatic firing equipment of the boiler or the reducing valve in the street steam main. In large buildings the demands of satisfactory temperature control, however, will make it necessary to sub-divide the heating system into suitable zones.

There are a number of factors to be considered in zoning, in order that heating requirements in a single zone will be approximately consistent throughout its extent.

1. Exposure may be a factor to be considered, with particular reference to prevailing winds, sun effect, and the shelter afforded by surrounding structures and topographical features.

*Save Fuel for Victory, University of Illinois, Engineering Experiment Station Circular Series No. 47, p. 31.

2. Occupancy may be a determining factor, in that the indoor temperature requirements for the activities carried on in various portions of the building may vary, and the hours of occupancy likewise may differ.

3. The physical characteristics of the building will enter into the sub-dividing of the heating system into zones by reason of the fact that satisfactory temperature conditions throughout a single zone of given extent may not be enjoyed equally in buildings of dissimilar types of construction. Also, the height of the building and its horizontal extent and form are considerations which must be borne in mind.

4. The cost of the zone control equipment for such additional zones as might seem otherwise desirable, often will influence the decision as to the final number of zones to be employed. In buildings of considerable size, accepted practice dictates that there shall be at least one zone for each exposure, although each exposure very possibly should be sub-divided vertically into two or more zones, for the higher structures. Also, the presence of two or more wings, having the same general exposure, may suggest the desirability of more restrictive zoning. In smaller buildings, and in those of larger extent where cost and other conditions limit the number of zones, a common compromise is to combine the North and West exposures in one zone, and the East and South exposures in a second zone. Frequently, when the street floor level is given over to public spaces or to activities which are markedly different from those carried on in the remainder of the building, it is advisable to provide a separate steam main, with conventional room thermostats in each individual area.

For steam heating systems, the radiator output may be varied proportionately to the changes in outdoor temperature, by any of a number of general methods. Those in most common use are:

1. Turning the steam on and off at appropriate intervals as dictated by temperature or time considerations, proportioned to the need for heating.
2. Varying the pressure of steam in the system in accordance with the demand for heat.
3. Throttling the steam pressure, at the demand of the controller, to allow flow through orifices in proportion to the heating requirements.

In hot water heating, the accepted practices are (1) to vary the temperature of the hot water supplied to the system or, (2) to vary the flow of hot water, both proportionately to the heating requirements.

The regulator for each zone usually is of a type which in some manner responds to the outdoor temperature and effect of sun and wind for the zone. Many of the available zone controllers are arranged in such a way as to be affected also by the temperature of the heating system and the indoor temperature in the zone. Whatever the mechanical features of the regulator, its function is to dictate the flow impulse, or rate of flow, in such a way as to maintain the desired indoor temperature in the zone, regardless of the fluctuations in the outdoor temperature. Provisions also may be made to maintain a predetermined low economy temperature in each zone during periods of non-occupancy; to facilitate quick warming-up following such periods; and to follow those portions of the daily cycle of control with normal heating effect during the occupancy period.

A control panel, at a central location, may be arranged so that manual switches for each zone may raise or lower the operating temperature, and time switches, if desired, may be provided for obtaining, automatically, any day-night or other predetermined control program which the operators of the building may desire. The characteristics of the regulators which are operated by the zone controllers depend upon which of the basic systems of zone control is employed in a given installation. Shut-off, mixing or throttling valves and various forms of devices to reset or pilot the action of reducing valves and to control firing means, are some of the more common regulators which are used to control the flow of steam or hot water,