## LOCATION OF SPACE CONTROLLERS

Space controllers such as room thermostats must be placed where they will measure the variables they are to control and where the condition is representative of the whole area served by the controller. If the return-air duct is used to represent space conditions, the controller should be located as near the space as possible to eliminate the effect of any heat gain or loss in the duct.

Room thermostats should usually be placed in occupied areas on inside walls or columns. They should never be placed in spaces such as corridors, lobbies, and foyers unless they are used for the control of these areas only.

In a typical home which is not zoned a satisfactory location for a room thermostat can usually be found on an inside wall of the living room or dining room. It should always be located toward the center of a relatively open room on the coolest rather than the warmest side of the building. It should not be mounted on an outside wall or other cold surface where it is exposed to cold drafts from an outside door. Neither should it be mounted where it will be affected by direct rays of the sun, by heat from a nearby warm surface such as a chimney, pipes or ducts in the wall, or radiators, or by direct air currents from a register. The location should provide ample air circulation unimpeded by furniture or other obstructions, and should afford protection from mechanical injury.

## THE CONTROL OF STEAM FLOW

The size of an automatic steam valve is based on the required capacity at maximum load, under the conditions which will exist at that time. Equation 52, Chapter 4, for mass flow through an orifice or nozzle can be rewritten as

$$w = CA\sqrt{P_1 - P_2} \qquad (1)$$

*where*

$w$ = the flow of steam in pounds per hour.
$A$ = the area of the port opening in square inches.
$P_1$ = the steam supply pressure, pounds per square inch, absolute.
$P_2$ = the downstream pressure, pounds per square inch, absolute.
$C$ = a constant for a given steam supply pressure and a given valve body.

Valves for two-position operation usually are selected of a size adequate to supply the required maximum capacity with a reasonably low pressure drop ($P_1 - P_2$). It is necessary only to be sure that the valve will close against the system pressure and will have ample capacity when fully open.

Proportional valves for steam service must be carefully sized if stable control is to be achieved. In general the tendency is to oversize such valves and no controller can produce its best results if handicapped by a valve which is too large. The function of the valve is to vary the value of area $A$ in Equation 1 and it is desirable that the flow vary in proportion to the value of $A$. The correct maximum required capacity must first be determined. There should be no factor of safety in this determination, and it should be based on actual heating requirements rather than on the condensing capacity of the coil, since the coil may be larger than necessary. It is also necessary to base the valve size on the actual supply pressure ($P_1$) which will exist at the valve, since this supply pressure affects both the density of the steam and the pressure drop which will be selected.

Selecting the proper pressure drop ($P_1 - P_2$) across the valve when it is wide open and is supplying the maximum steam requirement is the most



important consideration in determining the valve size. For purposes of discussion it will be assumed that $P_1$ is constant and that the valve is supplying steam to a heating coil which has air entering at a constant temperature and velocity. Any pressure drop between the valve and the coil will be neglected so that $P_2$ represents the pressure in the coil. The condensing capacity of the coil varies with changing values of $P_2$. When the valve is fully open, $P_2$ assumes a value such that the capacity of the valve and the condensing rate of the coil are in balance. If this value of $P_2$ is relatively large, then as the valve is partially closed $P_2$ will decrease until the capacity of the valve and the condensing rate of the coil are again in balance. Reducing the value of $A$ in Equation 1 results in an increase in the value of $\sqrt{P_1 - P_2}$ and partially offsets the effect of closing the valve. This effect is greatest when $P_2$ is nearly equal to $P_1$ and diminishes as $P_2$ decreases.

The minimum value which $P_2$ can assume is established by the return line pressure (or vacuum) of the system. However, $P_2$ may reach a value which results in the critical velocity through the valve before it has been reduced to its minimum value. If so, any reduction of $P_2$ beyond this value has no further effect on the valve capacity. The critical velocity exists when $P_2$ is approximately 58 percent of $P_1$. The undesirable effect caused by variations in $P_2$ can be eliminated by selecting a valve size such that $P_2$ is at or near its minimum value, or the value corresponding to the critical velocity, whichever is higher, when the valve is wide open.

On low pressure steam applications it is good practice to base the valve size on a pressure differential equal to 75 or 100 percent of the gage supply pressure. When the supply pressure is high enough so $P_2$ at the critical velocity (58 percent of $P_1$) is above atmospheric pressure, the valve size can be based on a pressure differential of 42 percent of $P_1$ absolute. All valves of the same size do not have the same capacity for a given pressure differential. Having established the supply pressure and the pressure differential, the valve manufacturer's tables or charts should be consulted in selecting the proper size of valve for the required capacity.

It is important that the supply pressure to an automatic steam valve be constant because it is difficult for a thermostat to produce stable results if the pressure is constantly changing. This situation arises, for example, when a steam boiler is operated by a two-position pressure controller. A pressure reducing valve, which will supply a constant pressure to the steam mains while permitting the boiler pressure to fluctuate between the limits of the pressure controller, is recommended. Lacking this, the differential of the pressure controller should be set as narrow as is consistent with efficient boiler and burner operation. On vacuum return systems the vacuum pump also should operate on a narrow differential.

The use of two automatic control valves in parallel will often provide more stable control than a single larger valve, especially on large coils or steam-to-water heat exchangers. The valves should be sized so that one valve handles about one-third of the total capacity and the other about two-thirds. They are controlled in sequence so that the small valve operates during periods of light load and the large valve begins to open only after the load exceeds the capacity of the small valve.

The steam piping from the valve to the coil inlet, and from the outlet to the trap should be the full size of the coil tapping or size specified by the manufacturer of the coil and should conform to good standard practice as illustrated in Chapter 20. It is very important that condensate be promptly drained from the coil. When the coil is at reduced pressure, as