damage the panels, and to a manual boiler bypass or other means of reducing the water temperature to prevent too rapid drying out of new panels (see Chapter 24, Panel Heating). Due to the increase in MRT (mean radiant temperature) within a panel heated space which necessarily takes place *as the heating load increases*, the air temperature under such conditions, theoretically, should be lowered in the order of 1 or 2 degrees to maintain comfort. In ordinary structures with normal infiltration loads the required reduction in air temperature is small and, consequently, a conventional room thermostat may be used.

In panel heating systems, lowered night temperatures will produce unsatisfactory results with heavy panels such as concrete floors. These panels cannot respond to either quick increase or decrease in heating demand within the relatively short time required, with the result that there will be a very slow reduction of space temperature at night and a correspondingly slow pick-up in the morning. Panels of light weight construction, such as plaster or metal ceilings and walls, may respond to changes in demand with sufficient rapidity that moderately satisfactory results can be expected from lowered night temperatures. However, very little fuel saving can be expected even with the light panels unless the lowered temperature is maintained for long periods. If reduced non-occupancy temperatures are employed, some means of providing a higher-than-normal rate of heat input for rapid warm-up is necessary, or a long warm-up period should be provided for, as explained under Zone Control Systems.

INDIVIDUAL ROOM CONTROL

The ideal temperature control system for any building is one that promotes maintenance of the desired temperature in every room at all times regardless of location and occupancy. Individual room temperature control is desirable for securing proper thermal environment in schools, hospitals and offices.

Control of the temperature in each room, or possibly of adjacent rooms having the same orientation (as in an apartment), overcomes many of the problems encountered when attempting to regulate the temperature of a building as a whole or of large areas or zones. Each individual thermostat controls the heat input to its particular space regardless of occupancy or exposure to sun and wind. The advantage of individual room control is in fuel economy and comfort for the occupants. Each room should have a thermostat that controls valves or dampers on all the controllable sources of heating and cooling. One such uncontrolled source may prevent proper operation of the control system.

CONTROL OF CENTRAL FAN SYSTEMS

Local practice, local climatic conditions and economic factors influence control system design.

The following sections describe some of the more common methods of controlling the different pieces of equipment used in central fan systems. The complete control system is made up by combining the selected method for each item into an integrated arrangement with proper consideration being given to the interrelation of the several parts, necessary sequence of operations, etc.

Outdoor Air Damper Control

Outdoor air for ventilation is usually controlled by a damper arrangement to provide a homogeneous mixture of outdoor air and recirculated air. Outdoor air to meet minimum ventilation requirements should be available whenever the fan is running and is usually provided in one of the following ways:

a. By a minimum outdoor-air damper which opens when the fan is started. A maximum outdoor-air damper may also be provided if additional outdoor air for natural cooling is desired.

b. By an outdoor-air damper opening to a minimum position when the fan is started. Additional outdoor air is provided by further opening of the damper under automatic control.

Recirculated-air and exhaust-air dampers are synchronized to operate with the outdoor air dampers. Mechanical interconnections are preferable but separate operators on each of the dampers can be used when mechanical interconnections are impractical. Control of outdoor air quantities beyond the minimum amount can be accomplished by:

a. A thermostat set for about 55 F and having its bulb located where there is a true mixture of outdoor air and return air.

b. A thermostat in the outdoor air which will gradually open the outdoor-air damper as the outdoor-air temperature increases during mild heating weather.

c. A combination of outdoor-air and return-air thermostats operating to select the cooler source of air when cooling is required.

d. The preheater thermostat, arranged so that after the preheat valve is closed the outdoor-air damper gradually opens.

e. The apparatus dew-point thermostat, arranged so that the outdoor-air damper opens before mechanical cooling is used.

In most arrangements provisions are made to prevent admission of more than minimum outdoor air required for ventilation both during heating operation and when the outdoor-air temperature is too high to provide some natural cooling. Provisions should also be made to close the outdoor-air damper and open the return-air damper whenever the fan is stopped.

Preheater Coil Control

The function of a preheater is to temper the outdoor air to prevent the possibility of freezing beyond the coil. Care must be taken to avoid freezing in the coil itself. The proper selection, installation and sizing of steam traps are very important to assure rapid elimination of condensate to prevent freezing.

Steam-distributing-type coils usually are controlled by a thermostat located downstream from the coil and operating a valve in the steam supply line. Where a large temperature rise is required, two or more coils in series should be used, each having a separate valve. The valves should be arranged to operate in sequence, with the valve on the upstream coil opening first.

Non-distributing-type coils should be controlled by a thermostat located ahead of the preheat coil and adjusted to completely open the valve before the incoming air temperature drops to 35 F, to avoid freezing in the coil.

It is important that the preheat coil and its valve be selected so as to prevent overheating the conditioned space when the valve is fully open at 35 F incoming temperature. The use of preheat coil-face and bypass dampers will permit proportional control from a thermostat located beyond the preheat coil, and will prevent such overheating. The coil valve should be wide open whenever the incoming air temperature is below 35 F.

Hot water preheat coils should be controlled by face and bypass dampers operated by a thermostat downstream from the coil, with continuous water circulation when the outdoor air is below freezing. A pressure switch to stop the fan in case of pump failure is often employed. Further freeze protection can be accomplished by a thermostat in the coil outlet arranged