tion. Thus, it may be possible that, with air entering at 100 F dry-bulb, 60 F wet-bulb, a leaving condition of 62 F dry-bulb, nearly saturated, can be obtained. Under some conditions of latent and sensible heat load, this evaporative cooling may be adequate.

At times when the outdoor wet-bulb temperature is not low enough to permit the use of straight evaporative cooling, it is still possible to use pre-cooling convectors with refrigeration, well water, or a cooling tower, as the basic source of sensible heat removal to reduce the wet-bulb temperature of the air before it enters the spray chamber. Where internal heat loads are high, this scheme may be more economical than one using return air. Where the required supply air dew-point is too low to permit straight evaporative cooling, and where the sensible heat load is not too great, intentional partial saturation may be employed. That is, the low dew-point of the outdoor air is utilized by permitting some of this air to pass through the humidifying sprays untreated, or to by-pass the humidifier. All of these remarks with regard to evaporative cooling are based on the assumption that all of the supply air will be taken from outside. Provision should be made in most cases for the return of some air from the conditioned spaces for control purposes, as well as for economy of fuel in winter.

PRECOOLING

Where sufficiently cold water from wells or streams is available, a saving in refrigeration may be obtained by the use, in location ahead of the dehumidifier, of precooling coils through which the cold water is circulated. The resultant cooling of the air decreases the load to be carried by the dehumidifier and refrigeration plant. In normal practice the water, after passing through the precooling coils, may be further utilized in the refrigeration plant condenser. The economic advantages of this scheme are apparent, and it is frequently used.

SENSIBLE COOLING WITH UNWETTED COILS

Under favorable atmospheric conditions where a large wet-bulb depression exists and the dew-point of the outdoor air is sufficiently low at all times, acceptable cooling may be obtained by removing only the sensible heat from the outdoor air delivered to the rooms. Under this condition of a great wet-bulb depression, a temperature-reducing coil may be located in the air stream and supplied with water from a cooling tower. When humidity control is desired, sprays to saturate or partially saturate the air may be used down-stream from the unwetted coil. Saturation or partial saturation after the coil will reduce further the dry-bulb temperature and the air quantity required. This system has very definite application in hot dry climates.

RUN-AROUND SYSTEM

An interesting method of control is found in the use of combined reheating and precooling, usually termed the run-around system. Typically, three coils are placed in series in the air stream. The primary one receives liquid that has been cooled in the third coil. The center coil is maintained at a temperature colder than the dew-point of the air. The primary coil thus precools the air, and the third coil reheats the saturated air from the center coil. The third coil is heated by the relatively warm water coming to it from the primary coil. The run-around scheme has the advantage of permitting a higher supply air dew-point temperature than would be possible otherwise. This is due to the fact that continuous reheating is available, which is not a large penalty on the refrigeration plant since it provides precooling at the same time. This reheating at peak load creates an artificial sensible heat gain which increases the ratio of sensible heat to total heat and, for a given room temperature, results in a higher apparatus dew-point. Thus, while the volume of supply air is increased, the low-side temperature level of the refrigeration plant is raised and this may effect savings in initial and operating costs. The run-around system has the disadvantage of providing a decreasing amount of heat for reheating as the demand for reheating increases.

SELECTION OF TYPE OF SYSTEM

If the perimeter of the building is large with regard to the area, and if there are many rooms, induction convectors of either the low or high pressure type may be employed. Occasionally a dual system, one duct carrying air at a warmer temperature than the other, may be considered.

Low buildings with large floor areas may be divided into sections or zones with separate central air supply systems to facilitate temperature control. In the case of large department stores it may be possible to provide a single conditioner, with a fan delivering the conditioned air to local mixing fans which supply the various departments or spaces. This application is limited by the practicability of running the large conditioned air ducts to the various recirculating fans. Each vertical section of the building also may be supplied by a separate fan delivering conditioned air to local mixing fans. In many cases the most economical and satisfactory scheme may be to employ a hot water or steam reheater in each branch duct. Where vertical sectionalizing is not indicated, the building may be divided into horizontal groups, each handled by a central system and adequately zoned. In some large buildings, apparatus rooms for the systems may be located in the basement and attic and on intermediate floors.

In high buildings the necessity for horizontal sectionalizing may be suggested by the size of air supply and return risers, and by the extent to which they encroach upon usable space. Each story should be cut off by doors from other stories, as otherwise the cool air tends to collect in the lower story and the warm air is forced to the upper story.

Balconies and large lobbies in theatres and similar high rooms frequently justify the use of separate zoning fans, to counteract the tendency of the heavier, cooler air to collect at the lower levels of these spaces.

Fans operate at full capacity continuously in many systems, and therefore should be selected for good efficiencies. In winter when higher temperature differentials are used, it is sometimes practicable to deliver smaller air quantities than when cooling.

In climates where winter temperatures fall below freezing, the tempering coils should be of the steam-distributing type; or if they are heated by a liquid, this liquid should contain some anti-freezing substance such as ethylene glycol. If hot water is used in cold climates, the control of air temperature should be obtained by means of face and by-pass dampers rather than by throttling the valves, to prevent damage due to freezing.

If zone reheaters placed in supply duct branches are employed, they should be of such type as to be heated over the entire surface so that no temperature-stratification can occur in the delivered air. Steam-distributing-tube coils or mechanically circulated water coils are satisfactory in such cases, and throttling valves may be used.

Refrigeration equipment must be carefully selected to satisfy the partic-