

A suggested procedure⁹ for the design and installation of a warm air perimeter heating system is given in Manual 4 of the *National Warm Air Heating and Air Conditioning Association*. This procedure follows the general outline:

1. Calculate design heat losses from individual spaces in the structure. (See Chapter 11.) Calculate design heat losses below grade using table in Form 5,¹⁰ which accompanies Manual 4.
2. Lay out perimeter system design, locating ducts, registers, and return air grilles or intakes.
3. Determine length from furnace to each register using shortest distance.
4. Determine register sizes from tables in Form 5.
5. Determine size of return-air intake and ducts from tables in Form 5.

The furnace may be either the down-flow or the conventional up-flow type. In most cases, the down-flow type is preferred since it requires a minimum amount of floor area and ductwork, and eliminates the need for a duct to bring the warm air down from the top of the furnace, or a duct to bring the return air down to the blower inlet.

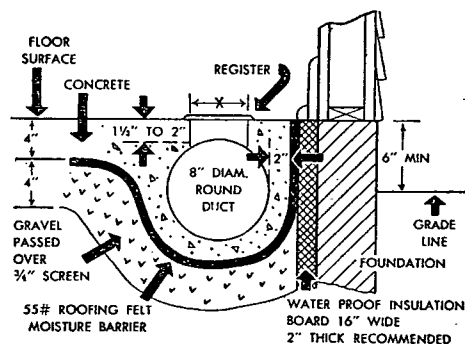


FIG. 5. CROSS-SECTION OF SLAB CONSTRUCTION CONTAINING PERIMETER DUCT⁹

Several arrangements of perimeter ducts may be used, but the most common is the type having a complete loop of a continuous duct around the edge of the slab, supplied by radial feeders extending from the furnace sub-floor plenum to the perimeter duct, as is shown in Fig. 4. A schematic cross-section of the slab construction, with the perimeter duct installed, is shown in Fig. 5.

The slab should be constructed on a well-drained site where drainage is away from the slab, and where there is no standing water at any time of the year. With slab construction a suitable porous fill and a waterproof membrane as a moisture barrier beneath the slab, are required by the *Federal Housing Administration*. They are highly necessary with warm air perimeter heating. Insulation must be placed between the edge of the slab and the foundation, and must extend completely around the slab to reduce the heat losses from the edge of the slab. Fig. 5 also shows many of the essential features of the slab and under-slab construction.

COOLING METHODS

A slight cooling effect may be obtained under certain conditions by the circulating basement air. A more positive cooling effect may be obtained

by the use of an air washer where the temperature of the city or well water is sufficiently low (55 F or lower), and where a sufficient volume of water can be provided. Unless the temperature of the leaving water is below the dew-point temperature of the indoor air at the time the washer is started, both the relative and absolute humidities will be somewhat increased.

Coils of copper finned tubing through which cold water is pumped are available for cooling. They require less space than air washers, and have the advantage that no moisture is added to the air when the temperature of the water rises above the dew-point. Ample coil surface and fan capacity are necessary with this type of cooling.

It is thoroughly feasible to use ice or mechanical refrigeration in connection with a warm air system and to cool the building by this method, provided the building is reasonably well constructed and insulated. Windows and doors should be tight, and awnings should be supplied on the sunny side of the building. See also Chapters 29, 36 and 37.

Conclusions drawn from studies¹¹ conducted in the *University of Illinois Research Residence*, subject to the limitations of the test are:

1. An uninsulated building of ordinary residential type may require the equivalent of three tons of ice in 24 hr on days when the maximum outdoor temperature reaches 100 F if an effective temperature of approximately 72 ET is maintained indoors.
2. The use of awnings at all windows in east, south, and west exposures may result in savings of from 20 to 30 percent in the required cooling load.
3. The cooling load per degree difference in temperature is not constant, but increases as the outdoor temperature increases.
4. The heat lag of the building complicates the estimation of the cooling load under any specified conditions and makes such estimates, based on the usual methods of computation, of doubtful value.
5. The seasonal cooling requirements are extremely variable from year to year, and the ratio between the degree-hours of any two seasons occurring within a 10-year period may be as high as 7.5 to 1. Hence, an average value of the degree-hours cooling per season is comparatively meaningless.
6. The duct system in a forced-air heating installation can be successfully converted to a system for conveying cool air for the purpose of cooling the structure. No condensation of moisture was observed when the duct temperatures were not less than 65 F.
7. Cooling by means of water at a temperature of 60 F is not satisfactory unless an indoor temperature of less than 80 F is maintained.
8. In the selection of cooling coils, the additional frictional resistance of the coil to flow of air must be given consideration.
9. Cooling the structure by introducing large quantities of outdoor air at night tended to reduce the amount of cooling required on the following day, and was a practical means of providing more comfortable conditions in those homes where cooling systems were not available.

DESIGN OF COOLING SYSTEM

The general procedure which may be used for the design of a summer cooling system in a forced-air installation is:

1. Calculate heat gain for each room or space to be conditioned. (See Chapters 9 and 12). Allowance for addition of outside air must be included in this calculation.
2. Select a temperature of air leaving supply inlets. In *University of Illinois Research Residence* tests, a value of from 65 to 70 F was found satisfactory.
3. Determine indoor conditions to be maintained. In the *Research Residence*, 80 F dry-bulb and 45 percent relative humidity were found satisfactory.
4. Determine the quantity of air to be introduced into each room.
5. Estimate heat loss in duct system between cooling unit and supply registers.
6. Calculate the sensible and latent heat to be removed by the cooling unit.