2. Prevent the transmission of noise and vibration to the house structure and to ducts and piping. Use properly loaded isolation mounts for compressors, even when on concrete floors, and provide vibration isolators on blowers and refrigerant lines and vibration loops in the refrigerant system. Install flexible connections between the cooling unit and the ductwork.

3. Control air-borne noise with sound-absorbing material or other acoustical treatment. Install sound-absorbing material within ductwork and, where practicable, use one or more elbows between the equipment and the registers or grilles.

AIR DISTRIBUTION METHODS

Systems should be designed and installed by competent engineers in accordance with authoritative information such as given in the design manuals of the *Air-Conditioning and Refrigeration Institute*[3] and the *National Warm Air Heating and Air Conditioning Association*.[4] The sizes of the ducts of year-round air conditioning systems are often larger than those of equivalent winter heating systems since large quantities of cool air, at 55 F to 65 F, must be circulated through them.

Several manufacturers have developed reliable methods of duct design. Such methods should be used when recommended, since they take into account the specific air flow and static pressure characteristics of the systems to which they apply. They should, however, be applied with caution to systems and equipment other than those for which they were developed.

Cooled air admitted to rooms from ducts through supply outlets is from 15 F to 25 F colder, and therefore heavier, than the air in the room, and has a natural tendency to fall toward the floor. Unless the supply outlets are properly selected, located, and adjusted, the air distribution is likely to result in a low velocity of cool air falling on the occupants or a high velocity stream of cool air striking a wall or other obstruction and deflecting on the occupants. A further complication is introduced when the same outlets are used for heating in which case the delivered air at temperatures considerably above room temperature has a tendency to rise.

Where cooling is installed with ducts and air outlets which serve the cooling function only, the practice and experience of comfort air conditioning for offices and commercial buildings apply directly to residential installation. Although cooling and heating by means of the same duct work and air outlets has been common practice in commercial and industrial applications, greater care must be taken in residential applications. It has been found that low air-flow rates are desirable for warm-air heating systems,[5] much lower than would be used for cooling systems. It is therefore recommended that, in a residence located in a moderate or cold climate, provision be made for different air-flow rates for summer and winter. In warmer climates, however, where air conditioning is the primary consideration, the summer air-flow rate may be used the year around.

The registers may be placed either in the high sidewall or in the perimeter location. For the high sidewall applications, it is necessary that the deflection of the air be different for summer than it is for winter to prevent the jet from dropping into the living zone (60 in. above the floor and below) where the velocity should be not greater than 35 fpm. For registers located at the perimeter of the residence,[6] it is not necessary to change the deflection from summer to winter.

The air distribution system should be designed for the largest air-flow rate which is to be used, as outlined in Manual No. 9 of the *National Warm Air Heating and Air Conditioning Association*. For small-pipe perimeter systems, it is necessary to have more outlets than for the larger duct systems. In some applications, it may be necessary to close off some registers during the winter so that adequate register-air velocities will be obtained.

These registers would then be opened during the summer to give a sufficient number of outlets.

Recent investigations have shown[7] that the use of perimeter duct systems for air conditioning gives excellent results, and that objectionable air motion does not occur within the living zone except with most conventional registers in the immediate vicinity of the registers. Care must be taken, however, to use only registers or diffusers that are specifically designed for perimeter application. This is necessary to permit the introduction of the air into the room in a pattern which does not cause drafts. Floor diffusers which distribute the air in a fan-shaped pattern along the wall or low sidewall diffusers which blanket the wall are recommended. For supply-air temperatures not more than 15 deg below room-air temperatures, diffuser face velocities of 500 fpm are recommended.[8] For supply-air temperatures 20 deg below room-air temperature, the diffuser face velocity should not be less than 700 fpm.

TABLE 1. APPROXIMATE KW INPUT PER 12,000 BTUH COOLING CAPACITY

ITEM OF POWER LOAD	TYPE OF HEAT REJECTION[a] WATER COOLED CONDENSER			
	City Water	Atmospheric Cooling Tower	Mechanical Draft Cooling Tower	Air Cooled Condenser
Refrigeration Compressor	1.00	1.00	1.00	1.35
Blower for Air Conditioner	0.10	0.10	0.10	0.10
Blower for Rejection Air	—	—	0.15	0.15
Pump, Cooling Water	—	0.15	0.15	—
Total KW per 12,000 Btuh	1.10	1.25	1.40	1.60

[a] Other heat rejection means include wells, spray ponds, evaporative condensers, water coils in the ground, finned water coils in air, etc.

Many registers designed for outside wall application may not be satisfactory for cooling when applied to low velocity systems because the cool air is apt to remain at the floor.

Ceiling diffusers may also be used, but they may lead to difficulty during the heating season if the warm air remains at the ceiling, resulting in cold floors.

High return locations at inside walls are very effective with outside wall or floor perimeter distribution systems for both the heating and cooling season. In multi-story or split-level dwellings there should be a minimum of one return on each level with a high central return on the upper level to minimize the effects of hot air rising through halls and stairways to upper levels. With ceiling or high inside wall distribution, the returns should be located on the outside walls under windows for best results.

CONTROLS

Control devices and systems and their application in residential air conditioning are discussed in Chapter 38, Automatic Control.

OPERATING COSTS

The operating cost of residential cooling equipment during a particular summer depends on variables such as the amount of sunshine and rain, the number of abnormally hot or cool days, the efficiency of the equip-