

the responsibility of the Owner or Tenant. Considerations of winter design conditions and utility rates should be compared against operating costs of conventional heating systems, before a decision is made regarding this type of equipment.

Water-cooled unitary equipment is available in all capacities required for small store air conditioning. However, communities in the United States have placed restrictions on the use of city water for condensing purposes which require installation of a cooling tower and circulator pump.

Where roof areas, yard areas or equipment areas with outside walls are available adjacent to the conditioned spaces, air-cooled equipment may prove to be an economic and efficient system. Water-cooled equipment generally provides for most efficient operation, ease of installation, and economy of operation when the equipment room or conditioned spaces are remote from the required conservation equipment.

### AIR DISTRIBUTION

External static pressures available in small store air-conditioning units are limited, and duct systems should be designed to keep duct resistances to a minimum. Duct velocities should range between 800 to 1200 fpm and pressure drops between 0.07 to 0.10 in. per 100 ft of duct run. Average air quantities range from 300 to 400 cfm per ton refrigeration in accordance with the calculated internal sensible heat load. Air distribution can be supplied through exposed ductwork, ductwork along side walls concealed behind curtain walls, or concealed in hung ceilings. Side wall registers usually are selected for face velocities of 500 to 1000 fpm in accordance with the throw requirements. Diffusers for ceiling distribution usually are selected for neck velocities from 600 fpm to 1200 fpm. Registers should be of the double deflection type in order to allow flexibility of air supply pattern. Diffusers should be installed with grids and dampers for proper air pattern and volume.

The duct system should contain enough damper devices for air balancing. Dampers in the return duct and outdoor air duct should be installed for proper outdoor air-return air balance. Volume and splitter dampers should be installed in take-offs from the main supply duct for air balance into the branch ducts. All dampers should be provided with locked quadrant devices for permanent setting.

Further information on air distribution, duct design, and air diffusing equipment will be found in Chapters 11, 12, and 47 of the 1961 GUIDE AND DATA BOOK.

### CONTROL SYSTEM

Controls for small store system should be kept as simple as possible and yet perform the required functions. Unitary equipment generally has factory-installed cooling controls with terminal boxes for external installation of power and control wiring by the electrician. Provisions also are made for heating controls. Additional controls such as night and weekend heat set-back should be added to the control cycle in the cooler winter climates, especially where the store has greater exposure, as may exist in shopping centers.

Automatic dampers should be provided in the outdoor air duct, to close when the fan is turned off, to prevent outdoor air from entering the area after the system is inoperative.

A refinement of outdoor air control can be furnished by providing an automatic damper in the return air duct, working in conjunction with the outdoor air damper and adjusted through a manual potentiometer. The owner can therefore adjust the outdoor air during intermediate seasons and obtain a degree of operational economy.

Heating controls vary with the nature of the heating

medium. Steam and hot water coils can have two position, modulating, or three-way valves, controlled by space thermostats, and wired through a summer-winter switch deriving its power through the fan circuit.

Gas duct heaters generally are furnished with safety controls installed by the manufacturer. Space thermostats can control the heater through a summer-winter switch. It should be noted that all control circuits should be actuated through the load side of the fan circuit.

### COST DETERMINATION

Installation cost may vary with the area involved with the installation with regard to local codes and practices, and cost of labor. A form estimate list should be developed by the engineer and compiled with costs, after the cooling and heating loads are developed. Important items should include equipment costs, plumbing, sheet metal, electric service, steam, hot water or gas piping, equipment delivery, outdoor air openings, cutting, patching, removal of obstructions, scaffolding, painting, refrigerant piping, duct and piping insulation, design costs, and taxes.

### MAINTENANCE

It is advisable that maintenance for air-conditioning units in small stores should be assigned to a reliable service company on a yearly contract in order to protect the initial investment and provide for maximum efficiency. The contract should clearly state the responsibility for filter replacements or cleaning, repair and adjustment of controls, oil and grease, compressor maintenance, replacement of refrigerant, pump repairs, electrical maintenance, winterizing and start-up of system and replacement of materials and extra labor required for repairs.

### PART II: VARIETY STORES

The variety store features a wide range of merchandise, often including a large lunch counter or a separate restaurant. Some stores sell pets of all descriptions, including monkeys, fish, and birds. This variety of merchandise must be considered in designing an air-conditioning system for such a store.

In addition to the sales area which is usually on the first floor and basement, such areas as stock rooms, women's rest rooms, offices, and special storage rooms for perishable merchandise may require air conditioning.

### LOAD CALCULATIONS

The heating and cooling loads should be calculated in accordance with the methods discussed in Chapters 25 and 26 of the 1961 GUIDE AND DATA BOOK. However, some of the design data for the major sources of load will be discussed briefly in this section.

The usual indoor design conditions for variety store air conditioning are 80 F dry-bulb temperature and 50 percent relative humidity, although on the Pacific Coast, many stores are designed for 75-78 F dry-bulb and 55-50 percent relative humidity. The indoor temperature for heating is not as standardized, but one large variety chain specifies a temperature of 75 F in office, stock room, and rest room areas, with 70 F in the sales area.

Special rooms for candy storage, if required, are usually designed for a room temperature of 70 F, with a separate unitary air conditioner.

### Lighting

The heat gain from lighting will not be uniform throughout the entire area, with some areas such as jewelry and other

### Store Air Conditioning

specialty displays having as high as 6-8 watts per square foot of floor area. For the entire sales area, an average value of 4-5 watts per square foot may be used. For stock rooms, receiving, marking, toilet and rest room areas, a value of 2 watts per square foot may be used.

### Population Density

The store owner usually will establish the population density for a variety store, based on the location and size of the store, and past experience. This density is usually:

|             |                                      |
|-------------|--------------------------------------|
| First Floor | — 50 sq ft of sales area per person  |
| Basement    | — 100 sq ft of sales area per person |
| Stock Rooms | — 200 sq ft of sales area per person |

It should be noted that these values will vary with store size and location. Large stores in busy downtown sections of large cities may require a value of only 15 sq ft of sales area per person.

### Heat Gain From Cooking Equipment

The food preparation and service areas in a variety store range from small lunch counters with heat-producing equipment (ranges, griddles, ovens, coffee urns, toasters) in the conditioned space to large deluxe installations with separate kitchens beyond the conditioned space.

An exhaust system with one or more hoods over the heat-producing equipment, should be provided to remove cooking odors and heat from the lunch counter or kitchen area. Kitchen hoods should be equipped with grease filters.

The heat released by cooking equipment should be obtained from the manufacturer's data or estimated from Chapter 26 of the 1961 GUIDE AND DATA BOOK. If the heat-producing equipment is located in the conditioned space and exhaust hoods are provided, the heat gain may be reduced by a factor of 50 percent. In addition, a diversity factor may be applied because usually not all the equipment will be in use.

If the heat-producing equipment is located in a separate kitchen beyond the conditioned space, it is common practice to provide a separate ventilation system for the kitchen area, with outdoor air supplied to replace the air being removed by the exhaust system. This outdoor air may be conditioned, depending on the store size and geographic location. The quantity of outdoor air supplied in this separate ventilation system should be slightly less than the exhaust air quantity, to provide a negative pressure in the kitchen area. Thus, the only heat load from the kitchen which must be included in calculating the air-conditioning load for the store area is that required to condition the outdoor air quantity entering the kitchen from the conditioned space (exhaust air quantity minus make-up air quantity).

### Heat Gain from Special Displays and Equipment

The heat released from special merchandising equipment, used for preparing such items as popcorn, pizza, frankfurters, hamburgers, doughnuts, roasted chickens, and cooked nuts, should be obtained from the manufacturer's data.

Many variety stores provide mechanical amusement rides for children. The heat loads from this source also should be obtained from the manufacturer.

### Ventilation

Outdoor air generally is based on: (1) 10 cfm per person in sales areas (15 cfm per person for separate restaurant areas), or (2) one air change plus the total exhaust air quantity, whichever is the larger. A positive pressure should be maintained in the conditioned space.

### TYPES OF SYSTEMS

The important factors in selection of a variety store air conditioning system are: (1) first cost, (2) floor space required for equipment, (3) operating cost, (4) maintenance cost, and (5) simplicity of control.

The central station system (see Chapter 1) has been the most common type used for variety store air conditioning.

Self-contained roof-mounted assemblies are being used in greater numbers today, for single-story buildings, such as in shopping centers.

The roof-mounted units eliminate the need for using sales space for air conditioning equipment and generally are less expensive to install and maintain.

### CONTROLS

The control system should be simple, dependable and fully automatic, since it normally will be operated by store personnel who have little knowledge of the functions of the air conditioning system.

Countless variations and modifications of automatic control are possible, and in use, in chain store systems. Most designers of such installations agree that the systems should be relatively fool-proof, since they are so often operated by unskilled help. While extreme complexity should be avoided, the control should be comprehensive enough to prevent such possible blunders as having steam on the heating coils while the refrigeration is on, or running on a hot day with the outside air damper wide open, or leaving outside air dampers open on a cold night.

The system should be designed so that the store operator is required only to turn a switch to start or stop the system, or to change to night operation.

### MAINTENANCE

Most variety stores do not employ trained maintenance personnel available, but rely on service contracts with either the installer or a local service company. This method relieves the store management of the responsibility of keeping the air conditioning system in proper operating condition.

### PART III: SUPERMARKETS

Modern supermarkets are usually completely air conditioned, with heating and cooling equipment normally combined in one system.

Early installations in supermarkets used primarily unitary air conditioners located in the sales space. The walk-in cooler area and stock rooms were not conditioned. Heating was provided by ceiling-mounted unit heaters, mostly gas- or oil-fired.

The increased size of the newer stores has made it necessary to seek other methods of providing economical complete air conditioning. Valuable sales area is no longer available for equipment other than display and service refrigerated fixtures (see Chapter 59). The limitations of air distribution without ducts from unitary air conditioners would require a greater number of units.

### CENTRAL SYSTEMS

Central systems have largely replaced the unitary equipment in supermarkets. The majority of these systems utilize factory-assembled unitary equipment rather than built-up central stations.

The unitary type central system has several advantages over the built-up central station type. Installation is simplified with the use of factory assembled, pre-wired and pre-piped