*Cycle Y.* A minimum amount of outdoor air (normally 25 to 50 percent) is admitted during the *heating and ventilating stage*. This percentage is gradually increased to 100 percent, if needed, during the *cooling and ventilating stage*.

*Cycle Z.* Except during the *warm-up stage* a variable amount of outdoor air is admitted as needed to maintain a fixed temperature of the air entering the heating element. This is controlled by the air-stream thermostat which is set low enough (often 55 F) to provide cooling when needed.

## Night Control

For maximum economy it is general practice to maintain the building at reduced temperature at night and over weekends and vacations. Several control arrangements to accomplish this are in common use. One uses the unit as a convector at night. Another turns the fans on and off as in the case of a unit heater whenever the unit convective capacity is insufficient. Still another arrangement uses the convective capacity of the unit supplemented by the convective capacity of auxiliary equipment installed within the room. More elaborate arrangements are available, permitting operation at daytime temperatures in some spaces and lowered temperatures in others for maximum economy during night occupancy of part of the building. For general information on controls, see Chapter 43.

## Location of Unit Ventilators

The location of the unit is important. Wherever possible it should be placed against the outside wall and near the centerline of the room. It is difficult to obtain proper air distribution if the unit is installed either on an inside wall or in the corner of the room. Standard unit models are set against the wall, or may be recessed into the wall, and discharge the air stream upward. Ceiling models discharge the air horizontally.

## Air Exhaust Vents

The location and size of exhaust vents are not of particular importance on systems employing unit ventilators. However, many states have regulations which require vents in public buildings. When vents are used, it is important that they be sized and located properly. Vents should be fitted with manual dampers so that the exhaust can be regulated for proper air distribution. Back-draft dampers should be installed in the vent opening to prevent cold air from entering through the vent.

It has become common practice, where regulations permit, to exhaust into the corridor through louvers in the classroom door, with powered or gravity exhaust from the corridor to the outdoors. Thus, the slight pressurizing of the building by the unit ventilators provides the force to exhaust the entire building. It is common practice also to use the exhaust from the classroom as secondary ventilation by passing the exhaust air through wardrobes and lockers. Many state and local codes make this arrangement mandatory.

## Window Downdraft Prevention

Increasing use of large window areas has presented a window downdraft problem caused by chilled air flowing down the windows and into the occupied areas of the room. Three basic means of combatting these downdrafts have been developed for use with unit ventilators. These are shown in Fig. 5 and operate as follows:

*Window sill heating* employs finned radiation of moderate capacity installed along the wall under the window area. Heated air rises by convection upward and counteracts the downdraft by tempering it and diverting it upward to eliminate the cold draft.

*Window sill recirculation* is obtained by placing the return air intake along the window sill. Room or return air to the unit includes the cold downdrafts, takes them out of the occupied area of the room and thus eliminates the problem.

*Window sill discharge* directs a portion of the unit ventilator discharge air into a delivery duct along the sill of the window. The unit discharge air, delivered vertically at the window sill, provides room-wide air distribution and combats downdraft by upwardly-directed streams of air.

## Unit Ventilators For Mechanical Cooling

With increased use of school buildings during the summer months, some school building programs incorporate mechanical cooling or provisions for including it in the future. In either instance, the unit ventilators provide the same function during the heating season as the unit ventilators previously discussed in this chapter, using hot water as the heating medium. Chilled water is used to provide summer air

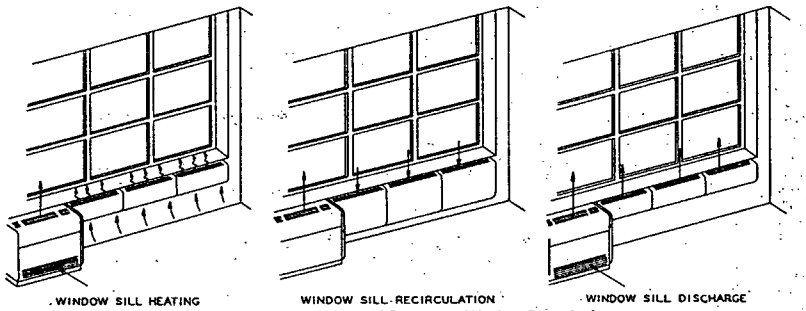


Fig. 5 .... Three Methods of Preventing Window Downdraft



conditioning. Units designed only for heating and ventilating are not suitable for use with chilled water. When provision for future mechanical cooling is made, the supply and return piping, piping insulation, unit ventilators and controls are usually installed initially as required for complete air conditioning. Water chillers, cooling towers, or evaporative condensers, and associated accessories are installed later when mechanical cooling is required.

# UNIT HEATERS

The term *unit heater* denotes an assembly of elements, the principal function of which is heating. The essential elements of a unit heater are a fan and motor, a heating element, an enclosure, and a directional outlet. Filters, dampers, duct collars, combustion chambers, and flues may also be included. Some types are shown in Figs. 6 to 13.

## Classification

The various types of unit heaters in present use can usually be classified according to one or more of the following methods:

1. *By heating medium:* Under this classification there are five heating media to be considered: (*a*) steam, (*b*) hot water, (*c*) gas, (*d*) oil, (*e*) electric.

2. *By type of fan:* Under this classification there are two types of fans to be considered: (*a*) *propeller* and (*b*) *centrifugal*. Propeller fan units may be of the *horizontal-blow* or *down-blow* type. Centrifugal fan units may be of the smaller *cabinet* type, or larger *industrial* type. Either may be arranged for the delivery of air horizontally, or vertically up or down.

3. *By arrangement of elements:* Under this classification there are two types of units to be considered: (*a*) the *draw-through type*, in which the fan draws air through, and (*b*) the *blow-through type*, in which the fan blows air through the heating element. Direct-fired unit heaters are always of the blow-through type.

## Application

Unit heaters have three principal characteristics, as distinguished from gravity heating units: (1) relatively large heating capacities in compact casings, (2) the ability to project heated air in a controlled manner over a considerable distance, and (3) a relatively low installed cost per Btu output. They are therefore usually employed in applications where the heating capacity requirements, or the physical volume of the heated space, or both, are larger than those that can be adequately or economically handled by gravity heating units.

Where the heating capacity requirement is large, the installation of a small number of unit heaters will usually prove more economical than will the use of a multiplicity of gravity heating units of the same total capacity. Where the volume of the space is large, and especially where ceilings are high, unit heaters can provide comfort through uniform heat distribution, and economy of operation by confining of the heat to the occupied zone and eliminating stratification in a manner which is difficult to attain with gravity radiation. Unit heaters located overhead permit 100 percent utilization of floor space. They may often be used to advantage in specialized applications requiring spot heating, or intermittent heating, such as the blanketing of outside doors in industrial plants, or in corridors and vestibules. Unit heaters are also employed where filtration of the heated air is required, and they may be modified to provide ventilation where the introduction of outdoor air is required.

*Unit heaters* are used principally for heating commercial and industrial structures such as garages, factories, warehouses, showrooms, stores and laboratories, and, for heating corridors, lobbies, vestibules, and similar auxiliary spaces in all types of buildings.

Unit heaters may be applied to a number of industrial processes, such as drying and curing, in which the use of heated air in rapid circulation with uniform distribution is of particular advantage. They may be used for moisture absorption, such as fog removal in dye houses, or for the prevention of condensation on ceilings or other cold surfaces of buildings in which process moisture is released. When such conditions are severe, it is necessary that the units be equipped to draw air from outdoors in sufficient volume to provide a rapid air change, and that they operate in conjunction with exhaust ventilators or fans for exhausting the moisture-laden air. (See discussion of condensation in Chapter 10.)

## Factors Affecting Application

There are four major factors to be considered in the application of unit heaters: (1) the heating medium to be employed, (2) the type of unit, (3) the location of the unit for proper heat distribution and (4) the permissible sound level.

## Heating Medium

The selection of the proper heating medium is usually determined on an economic basis, and requires an examination of the first cost, the operating cost, and the conditions of use. Steam and hot water unit heaters are relatively inexpensive, but require a boiler plant and piping system, the per-unit cost of which generally decreases as the number of units installed increases. Gas- and oil-fired units are more costly, but the fuel lines and vent flues required are comparatively inexpensive, and the overall installation cost will usually be lower where a small number of units is used. Electric units are relatively inexpensive to purchase and install, but are usually associated with a high operating cost per Btu output unless electric rates are very favorable.

*Steam or hot water* units are most frequently used in new installations in which the number of units is large enough to justify the expense of a new boiler and piping system, and in existing installations or additions in which the system is of sufficient capacity to handle the additional load. *High-pressure steam* or *high-temperature hot water* units are usually employed in larger installations or where a high temperature medium is also required for process work. Low-pressure steam and conventional hot water units are usually installed in smaller installations and in those primarily concerned with comfort heating.

*Gas-fired and oil-fired* unit heaters are usually preferred in installations in which the number of units required does not justify the expense of a new boiler and piping system, where the space or the time required to construct a new boiler plant is not available, or where individual metering of the fuel supply is required, as in a shopping center. Gas-fired units are usually of the horizontal propeller type or the industrial centrifugal type. Oil-fired units are largely of the industrial centrifugal type. Some codes limit the use of direct-fired unit heaters in certain applications.

*Electric* unit heaters are used where low cost electric power is available, or for isolated locations, intermittent use, supplementary heating or temporary service requirements. Typ-