general ventilation are obtained This distribution also provides closer control of the ambient working temperature

Makeup air temperatures are usually maintained at approximately the same as the desired room temperature Since this air is being used for ventilation and replacement purposes and is not relied on for heating the building, the usual temperature range will be 65-80 F However, in modern high-speed machining areas where equipment heat load is a factor, lower air temperatures can be used Makeup air is also used for spot cooling applications at very high heat stress operations In these cases the final air temperature and air motion depend on the workers' requirements

Makeup air equipment

There are three basic equipment types (1) heat exchangers using steam or hot water, (2) direct-fired heat exchangers using oil or gas, and (3) open flame heaters.

1 Steam and hot water units should be provided with distributing-tube coils (nonfreeze) and automatic controls to minimize the possibility of freezing the heating coils during subzero conditions. Controls will include modulating valves, thermostats and motor-operated outside louvers. Multiple coil units with preheat and reheat coils usually give closer control of discharge air temperature than single coil units. Condensate return piping must be sized for the large volumes of returned water and coils must be vented properly to assure proper flow at various positions of the main valve

2 Direct-fired units must be vented to the outside and must be provided with adequate safety controls as specified by the American Gas Association and various underwriting firms Attention must be given to proper location from the standpoint of air distribution and restrictions for hazardous locations

3 Open-flame heaters are those units in which the fuel is burned directly in the makeup air stream with no outside venting These units are usually gas fired and the combustion safety controls must be of the approved type Care must be taken in their location also, especially where hazardous materials are involved. Since these units present a potential danger of carbon monoxide gas, additional requirements must be met

   a The makeup air volume must be sufficient to dilute any possible carbon monoxide to less than 25 ppm.

   b Controls must stop the supply fan and close the main gas valve in case of any flame failure

   c. Controls should be arranged to interlock the makeup air unit with exhaust fans (or the main exhaust fan) to prevent the unit from being operated without sufficient exhaust ventilation

Heating of process makeup air

The material in this section is taken from American *Gas Association's A Complete Guide to Direct Gas-Fired Heating of Process Makeup Air,* published in *Actual Specifying Engineer* Magazine (Dec 1961, Feb and March 1962).

The three most common heating media for low-temperature industrial heating processes are oil, gas, and steam, and all have some application in heating makeup air Makeup air heating should not be confused with space heating, which heats the building whether or not processing lines are functioning within it However, makeup air can be supplied to an entire building area as well as directly compensating for air being exhausted at one point or being lost through loading dock doors.

General factors which must be considered are

1. Proper location, size, and construction of air intakes
2. Filtering of makeup air if necessary
3. Air handling equipment must be adequate to keep air in the building under positive pressure, even with exhaust systems in use This will reduce drafts and minimize dispersal of contaminants in the work area.
4 Automatic controls must be provided to assure delivery of makeup air at acceptable temperatures to persons working in the area They should be located in a place as clean and free of vibration as possible
5 Proper startup and shutdown procedures must be enforced
6 Controls and safety devices should be