

## SHIP AIR CONDITIONING

In air conditioning a ship, the designer is faced with all problems that would normally arise on shore installation plus additional factors. Mechanical ventilation is an absolute necessity for the comfort of passengers and ships' personnel, and for utility and preservation of cargo and stores. Ships are constructed with water-tight bulkheads dividing the vessel into several compartments. This complicates the running of duct work and results in a multiplicity of both supply and exhaust fans. Temperature and humidity requirements of various spaces aboard ship vary widely. Passenger staterooms and public spaces must have year-round air conditioning with is also being applied more and more to the quarters of the officers and crew. Boiler rooms, galleys, laundries, etc., must have ventilation, and some must have tempered air. Cargo spaces are quite likely to need dehumidification in addition to ventilation.

Inasmuch as ventilation is such a necessary factor aboard a ship, the majority of recently built vessels have been utilizing the air distribution system for heating purposes.

A ship is a self-contained structure quite likely to be away from repair ports for long periods. Adequate spare parts, therefore, form an integral part of equipment furnished. The same type of equipment should be used in as many places as possible throughout the ship, in order to reduce the number of spare parts to be carried.

Preliminary system design is simplified by uniformity of conditions which apply to most ships. Among such conditions are: (1) the necessity for the vessel to supply its own power, (2) the availability of an unlimited supply of low cost steam at suitable pressure, (3) limitations of available space and permissible weight.

The problem of heat transfer and insulation must be given careful consideration. The thermal conductivity of ship building material, such as steel, copper and brass, is many times the value of building material used ashore. The length of ducts between heat sources and fans necessitates extra duct insulation. Hull insulation must be of high quality, with attention given to fireproofness, low density, low thermal conductivity, ruggedness, vermin resistance, and ease of application. Board types are most common.

Duct insulation must have the same characteristics as hull insulation. Semi-rigid and rigid board are most common. Corrugated asbestos is not used because in the presence of moisture, it tends to disintegrate. There is a growing use of natural cork on chilled air ducts because of great difficulty in applying an adequate vapor seal due to space limitations.

## SHIP HEATING AND VENTILATING

It is usually most economical in weight and space to use steam duct heaters for heating spaces served by mechanical supply systems. Spaces which do not have mechanical supply, or do not require ventilation in cold weather, are heated by steam convectors or, where the load is large, by unit heaters. Ventilation air, except that supplied to auxiliary and main machinery spaces, is usually preheated to temperatures of 50 to 70 F. No recirculation is used in ventilation and heating systems, but a manual reduction (25 to 50 percent) of air quantity is made during the heating cycle. All heaters are automatically controlled, and preheaters are designed and installed to minimize possibility of freezing of condensate.

Preheaters are frequently located close to the outside air intake in order to conserve insulation and, for the same reason, zone reheaters are located as close as possible to each zone. Where a reheater serves only one space, it is commonly located in the space.

Combinations or variations of duct type and convection or radiant heaters are used, depending upon basic design requirements, such as weight and space limitations, and the economic justification of the cost of the type selected.

Because of many different requirements of various spaces aboard ship, some design temperatures and humidities are given in Table 1. The resulting quantities of air should be checked against typical heating and ventilation practices for ships.\*

TABLE 1. DESIGN CONDITIONS FOR SHIPS

| AREA                      | OUTSIDE DESIGN TEMPERATURES |               |               | INSIDE CONDITIONS |                    |        |
|---------------------------|-----------------------------|---------------|---------------|-------------------|--------------------|--------|
|                           | Heat-<br>ing                | Ventilating   | Cooling       | DB &<br>R.H.      | Effective<br>Temp. |        |
|                           | F                           | F             | F             | F                 | %                  | F      |
| Living Quarters . . . . . | 0                           | 95            | 95(DB) 80(WB) | 80                | 50                 | 73-74  |
| Public Spaces . . . . .   | 0                           | 95            | 95(DB) 80(WB) | 80                | 55                 | 73-74½ |
| Naval Vessels . . . . .   | +10                         | 88(DB) 80(WB) | 88(DB) 80(WB) | 85                | 50                 | 75-78  |

## Living Spaces

The minimum quantity of ventilation air required for any sleeping or office space, including hospital space, should be that which will limit the temperature rise over the outside air to not more than 10 deg (a rise of 7 deg is more satisfactory), or a minimum of 30 cfm per person, whichever is the greater.

In spaces fitted for eating, recreation, or manual work, the rise may be taken at 10 deg with not less than 20 cfm per person. The same requirement applies to mechanical exhaust, although natural exhaust may be used where only a short run of duct exists.

Heat should be furnished to maintain the following temperatures:

|                                                           |            |
|-----------------------------------------------------------|------------|
| Staterooms, Berthing, Messing and Office Spaces . . . . . | 70 F       |
| Working Spaces and Shops . . . . .                        | 60 F       |
| Hospital Spaces . . . . .                                 | 75 to 78 F |

## Machinery Spaces

The prime purpose of machinery space ventilation is to maintain a habitable temperature for the operating personnel. It is more practicable to use *spot cooling* of personnel at working areas than to attempt to obtain uniform ambient temperature. The permissible temperature rise (above outside) at working stations is usually 15 deg, while the overall temperature rise is usually between 30 and 50 deg.

These spaces must be exhausted adequately, preferably by mechanical means. Every attempt should be made to remove air at or close to the heat sources. The capacity of the mechanical exhaust systems should be greater than the supply, taking into consideration the expansion of the supply air, to insure an indraft through access openings to the space.

Heat is not required for machinery spaces, except for those fitted with

\* See Ventilation and Heating of Maritime Commission Ships, by J. W. Markert (*Heating and Ventilating* Feb. 1943, p. 333).