

areas, rather than to attempt to obtain uniform ambient temperature. The permissible temperature rise at working stations is usually about 15 F while the over-all temperature rise is usually between 30 and 50 F.

When the necessary quantity of air has been determined, the ventilation arrangements should be designed so that all of this air will be distributed to locations where the personnel are to be stationed under operating conditions, thus giving them the maximum benefit from the cool air so introduced. This consideration is of vital importance because it must be remembered that the physical well being and alertness of the crew are more important than the operating ambients of the machinery; and by such installation the personnel receives the air before it becomes heated to the temperatures satisfactory for the equipment.

In addition to the air supply, these spaces must be exhausted, preferably by mechanical means. Every attempt should be made to remove air at or close to heat sources so that the mixing of ambient air with that which has been heated to a higher temperature will be at a minimum. The quantity or capacity of the mechanical exhaust systems should take into consideration the expansion of the supply air because of heating and should be also sufficient to insure an indraft through access openings to the space. Generally, in order to accomplish this, the quantity of mechanical exhaust should be about 120 per cent of the supply. In many installations, the combustion air for diesel engines and boilers is taken directly from the machinery space and serves as a partial mechanical exhaust system.

Normally, heat is not required for machinery spaces except for those fitted with electrically operated equipment, which may remain inactive during periods while in port. Such spaces should be equipped so as to heat them to about 50 F during such periods.

Living Spaces

The minimum quantity of air required for any space which is fitted for sleeping or office work, including hospital spaces, should be that which will limit the temperature rise over the outside air conditions to not more than 10 F (a rise of 7 F is more satisfactory if practicable), or a minimum of 30 cfm per person, whichever is the greater. For spaces fitted for eating, recreation, or manual work the rise may be taken at 10 F with not less than 20 cfm per person.

It will be noted that the quantities thus obtained are minimum and should be supplied by mechanical means. This is especially important if the spaces are located inside of the ship and have no direct weather exposures with ample openings, such as portholes or windows, which may remain open even in inclement weather. The same requirement applies to the necessity for mechanical exhaust, although natural exhaust may be used where only a short run of duct is required.

If the air to these spaces is supplied by mechanical ventilation it should enter through registers or diffusing type terminals. The installation of bracket fans within these compartments at proper locations and of sufficient number will aid materially in providing proper distribution for comfort.

Heat should be furnished to these spaces to maintain the following temperatures when operating in the minimum winter conditions:

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

Toilets, Washrooms, Showers and Baths

Spaces for these purposes should be fitted with mechanical exhaust ventilation for odor and steam removal. They should have one or more well-located exhaust terminals overhead; one will usually suffice for the average size space. The supply may be taken naturally. Generally, the surrounding living or working spaces are exhausted through them. The minimum total quantity exhausted should be that which would change the air within the compartment in 6 min, plus 25 cfm for each fixture, plus 50 cfm for each shower head. Air requirements on merchant vessels are commonly estimated on the basis of a 4-min rate of change.

Heating should be obtained by use of convection-type heaters which should maintain 70 to 80 F for bathing or washing spaces and 70 F for toilet spaces when the outside winter temperature is at the design condition.

Galleys, Bakeries, and Food Handling Spaces

The problem of the ventilation of spaces fitted for cooking and food preparation is primarily one of heat and smoke or fume removal. Mechanical exhaust is always required for this purpose. The supply may be natural, but the required exhaust capacity will be most satisfactory if arranged for 50 per cent mechanical and 50 per cent natural.

The exhaust quantities are generally large and may be predicated on restricting the ambient temperature rise to about 15 F over the outside summer design air conditions. It will generally be found that the resulting quantity will change the air in these spaces in about $\frac{3}{8}$ to 1 min, depending on concentration of equipment. All of the exhaust should be arranged so as to remove air from the space through hoods fitted over the cooking equipment and these hoods should contain grease filters over ranges and griddles and should be made readily accessible for frequent cleaning.

The mechanical supply when fitted should blow air directly on the personnel but away from the equipment and so as not to interfere with the flow of exhaust air to the hoods.

Generally, no heat is required for these spaces in winter except that the supply air temperature should not be too low. Usually a preheater delivering air at about 45 to 60 F should be provided.

Laundries

The problems in the ventilation of laundries are somewhat similar to those for galleys. Heat removal is necessary and best accomplished by the installation of mechanical exhaust through hoods fitted over the heat-producing equipment.

The supply for these spaces may be all mechanical, or part mechanical and part natural. The mechanical supply should be distributed through adjustable blast-type terminals at relatively high velocities directed to blow cool air on the torsos of the operating personnel. Experience indicates that this quantity should be sufficient to change the air in the spaces in from 1 to 4 min.

The exhaust should be at least one air change per minute and at least equal to 120 per cent of the total supply so as to insure an indraft of air through the access openings to the space. All exhaust openings within the space should be fitted to be readily accessible for frequent cleaning and lint removal.

No winter heating is required except that the supply air should be delivered at about 40 to 60 F.