Storerooms and Cargo Spaces

The ventilation of these spaces should be predicated upon the kind and type of stores or cargo to be carried.

For materials which would not be adversely affected by summer temperatures, no ventilation is required. Also, storerooms or cargo spaces below the water line, in which temperatures would not normally exceed 100 F with the sea water assumed as 85 F maximum, may not require ventilation for certain cargoes. As spaces in these two categories are frequently damp some means of moisture removal must be provided. Chemical dessicants are satisfactory where it is essential to prohibit openings through watertight structure. In other cases a supply of dry air is provided from a central silica gel dehumidification system and distributing ducts, with recirculation used to accelerate the drying process.

Where storage spaces must be ventilated to obtain a change of air in about 15 to 30 min, in some cases the ventilation is determined by the maximum temperature which the cargo or stores can withstand without damage.

Spaces in which inflammable liquids are carried, or where inflammable vapors may be generated, require special consideration. They should be fitted with mechanical exhaust with terminals so located as to remove explosive or combustible vapors. The supply to these spaces may be natural and arranged so that good distribution, free from pockets, is assured.

If stores and cargo, which require some special and constant temperature or humidity control, are carried, special air conditioning equipment must be installed to suit the particular requirements.

SHIP INSULATION

In order to properly limit one of the major ventilation heat loads which is that made necessary by heat transmission, and to prevent condensation, it is necessary to use insulation judiciously. The principal sources of heat in a ship are the power plant and sun load. The confinement or exclusion of this heat in the structure of a ship is not easy, principally because of the complex structural nature of the beams, stiffeners, bulkheads, decks and hull. The continuous metal paths offer easy means of heat flow throughout the structure.

Insulation like any other component hull part of the ship cannot be used indiscriminately because of weight and space limitations. Therefore higher heat transmission coefficients are accepted for insulated structures of certain classes of vessels, than would be considered satisfactory ashore. On passenger and cargo vessels, the structure is frequently covered with a metal sheathing in order to improve appearance. Such sheathing reduces the resistance to heat flow because the necessary supports form a metallic contact that by-passes the insulation.

Hull insulation may be either sheathed fill or blanket and board type and should possess certain desirable physical characteristics, namely:

1. *Fireproofness.* The material must be incombustible and when subjected to high temperatures by fires within compartments it must not give off smoke or harmful gases. If cements are used to secure the material they too must satisfy the same combustible restrictions. When the exposed surface of the insulation is to be finished with paint, the paint should be fire retardant. Insulation properly used will retard the spread of fires within ships. Government regulations govern the construction and insulation of bulkheads to prevent the spread of fire on vessels.

2. *Density.* A 6,000 ton warship may have from 13 to 25 tons of hull insulation, depending on the type of insulation. It is obviously desirable to minimize this dead weight commensurate with other considerations.

3. *Thermal Conductivity.* It is important that the conductivity of insulation used be 0.33 Btu per (hour) (square foot) (Fahrenheit degree per inch), or less.

4. *Ruggedness.* As any exposed or internally applied material is subjected to rough usage aboard ship it must be able to withstand much pounding from the seas and vibration from the ship's machinery.

5. *Verminproof.* For sanitary reasons it is essential that insulation harbor no vermin.

6. *Applicability.* Because of the necessity of speeding construction of vessels and minimizing costs, insulating materials must lend themselves to easy and ready application. Generally, when cements are used the application is slow and laborious.

For duct insulation mineral wool or spun glass are the most commonly used materials. Corrugated asbestos is not recommended because the presence of moisture tends to disintegrate it. Semi-rigid insulation is generally used because it is simplest to install. Blanket type insulations are applied only to round or curved surfaces, and are secured with twine and lagged with sewed-on canvas. Semi-rigid type insulation, secured by adhesive, flat wire bands, and corner clips, is lagged with canvas only where exposed. Blanket type insulation is at least 1 in. thick. The thickness of semi-rigid insulation is frequently selected in accordance with the values given in Table 2.

TABLE 2. DUCT INSULATION THICKNESS FOR USE IN SHIPS

APPLICATION	THICKNESS IN.
Tempered air ducts in unheated spaces where a temperature differential greater than 35 F exists	½
Cold air ducts, supply and exhaust passing through heated spaces	1
Exposed ducts in heated spaces, carrying reheated air	½
Concealed ducts carrying reheated air, adjacent structure exposed	1
Concealed ducts carrying reheated air, adjacent structure not exposed	½
Ducts serving only the space in which they are located	None
Exhaust ducts carrying hot gases (galley, forges, etc.), in living and working spaces	1
Supply ducts in machinery spaces and similar hot spaces, serving spaces other than the hot spaces through which they pass	1
Heaters	1
Ducts subject to excessive sweating	½

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

BIBLIOGRAPHY

The Ventilation of Ships, by R. McDonald (*Journal of the Institution of Heating and Ventilating Engineers* (Br) October, 1939).

Ventilation and Air Conditioning of the S. S. Panama (*Heating and Ventilating*, September, 1939, p. 47).

Air Conditioning the New Mauretania (*Heating, Piping and Air Conditioning*, July, 1939, p. 431).

Heating, Ventilating and Air Conditioning on Shipboard, by J. H. Clarke (*Heating, Piping and Air Conditioning*, August, p. 467; September, p. 529; October, p. 610, 1940).

Care of Cargo at Sea, by O. D. Colvin, W. H. E. Hahne and M. R. Colby (*Transactions*