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Ships and marine technology — Air-conditioning and ventilation of accommodation spaces and other enclosed compartments on board ships — Design conditions and basis of calculations

Navires et technologie maritime — Conditionnement d'air et ventilation des emménagements et autres compartiments fermés à bord des navires — Conditions de conception et bases de calcul

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

This third edition cancels and replaces the second edition (ISO 7547: 2002), as well as ISO 8862:1987, ISO 8863:1987, ISO 8864:1987 and ISO 9099:1987, which have been technically revised. It also incorporates the Technical Corrigendum ISO 7547:2002/Cor.1:2008.

The main changes are as follows:

— incorporation of smaller ship ventilation standards (ISO 8862, ISO 8863, ISO 8864, ISO 9099) into this document;

— minor editorial changes made in conformity with the ISO/IEC Directives, Part 2, 2021.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Ships and marine technology — Air-conditioning and ventilation of accommodation spaces and other enclosed compartments on board ships — Design conditions and basis of calculations

1 Scope

This document specifies design conditions and methods of calculation for air-conditioning and ventilation of accommodation spaces on board seagoing merchant ships for all conditions, except those encountered in extremely cold or hot climates (i.e. with lower or higher conditions than those stated in 4.2 and 4.3). This document also provides special considerations for machinery control-rooms, wheelhouse, and dry provision store rooms in Annexes C, D and E.

NOTE Statutory requirements, rules and regulations can be applicable to the individual ships concerned.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 80000-5, *Quantities and units — Part 5: Thermodynamics*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 80000-5 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
accommodation
space used as public rooms, cabins, offices, hospitals, cinemas, games and hobby rooms, hairdressing salons and pantries without cooking appliances

3.2
machinery control-room
space containing the system of the main alarm displays and the controls for the propulsion machinery

3.3
wheelhouse
enclosed area of the bridge, excluding radio cabin

3.4
air-conditioning
form of air treatment whereby temperature, humidity, *ventilation* (3.5) and air cleanliness are all controlled within limits prescribed for the enclosure to be air-conditioned

3.5
ventilation
provision of air to an enclosed space, sufficient for the needs of the occupants or the process

3.6
relative humidity
ratio, in humid air, expressed as a percentage, of the water vapour actual pressure to the saturated vapour pressure at the same *dry bulb temperature* (3.7)

3.7
dry bulb temperature
temperature indicated by a dry temperature-sensing element shielded from the effects of radiation

EXAMPLE The bulb of a mercury-in-glass thermometer is an example of a dry temperature-sensing element.

3.8
dry provision store room
enclosed compartment, provided with lighting and *ventilation* (3.5), for storage of provisions for the ship's crew

4 Design conditions

4.1 General

The air-conditioning and ventilation system shall be designed for the indoor air conditions specified in 4.2 and 4.3 in all accommodation spaces defined in 3.1 at the stated outdoor air conditions and the outdoor supply airflow, ventilation and air balance given in 6.2.1, 6.2.2 and 6.5 respectively.

Machinery control rooms, the wheelhouse, and dry provision store rooms shall meet the additional ventilation and air conditioning requirements of Annexes C, D and E, respectively.

Hot air heating systems for ship wheelhouse windows shall meet the additional requirements of Annex F.

NOTE All temperatures stated are dry bulb temperatures.

4.2 Summer temperatures and humidity

Summer temperatures and humidity are as follows:

a) outdoor air: +35 °C and 70 % relative humidity;

b) indoor air: +25 °C and 55 % relative humidity;

c) engine room air: +45 °C.

NOTE In practice, the indoor air conditions obtained, especially humidity, can be different from those stated.

4.3 Winter temperatures

Winter temperatures are as follows:

a) outdoor air: −20 °C;

b) indoor air: +22 °C.

NOTE This document does not specify requirements for humidification in winter. In practice, the indoor air conditions obtained can be different from those stated.

4.4 Outdoor air

The minimum quantity of outdoor air in the total air supplied shall be not less than 0,008 m^3/s per person, based on the occupancy numbers for accommodation spaces provided in 4.5.

NOTE See also 6.2.1 c) for outdoor air requirements based on the personnel occupancy design of the space.

4.5 Occupancy

The number of persons allowed in the various accommodation spaces shall be as follows, unless otherwise stated by the purchaser.

a) Cabins:

— the maximum number of persons for which the cabin was designed.

b) Public rooms, such as saloons, mess- or dining-rooms and recreation rooms:

— the number of persons who can be seated or, in the case where the purchaser does not specify it:

i. one person per 2 m^2 floor area for saloons;

ii. one person per 1,5 m^2 floor area for mess- or dining-rooms;

iii. one person per 5 m^2 floor area for recreation-rooms.

c) Captain's and chief engineer's day-room:

— four persons.

d) Other private day-rooms:

— three persons.

e) Hospital:

— the number of beds plus two.

f) Gymnasium, games-room:

— four persons.

NOTE The number of persons in gymnasiums can vary based on the ship size and design.

g) First-aid-room:

— two persons.

h) Offices:

— two persons.

i) Machinery control-room:

— three persons.

5 Calculation of heat gains and losses

5.1 Applicability

For the calculation of summer conditions, 5.2 to 5.5 inclusive shall apply. For the calculation of winter conditions, only 5.2 shall apply.

5.2 Heat transmission

5.2.1 Method of calculation

Formula (1) shall be used for calculating the transmission losses or gains, in watts, for each separate surface:

$$\Phi = \Delta T\left[\left(k_{\mathrm{v}} A_{\mathrm{v}}\right)+\left(k_{\mathrm{g}} A_{\mathrm{g}}\right)\right] \tag{1}$$

where

ΔT is the difference in air temperature, in kelvins, (for the difference of air temperature between air-conditioned and non-air-conditioned internal spaces, see 5.2.2);

k_{v} is the total heat transfer coefficient, in watts per square metre kelvin, for the surface area A_v (see 5.2.3);

A_{v} is the surface area, in square metres, excluding side scuttles and rectangular windows (glazing +200 mm) (see Figures 1 and 2);

k_{g} is the total heat transfer coefficient, in watts per square metre kelvin, for the surface area A_g (see 5.2.3);

A_{g} is the surface area, in square metres, of side scuttles and rectangular windows (glazing +200 mm) (see Figures 1 and 2).

Dimensions in millimetres

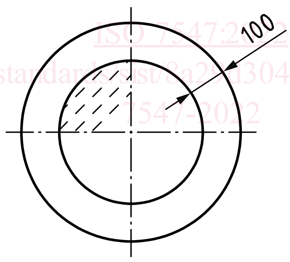


Figure 1 — Side scuttles

Dimensions in millimetres

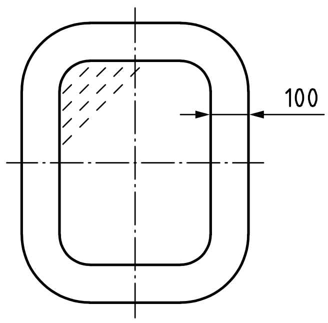


Figure 2 — Rectangular windows

5.2.2 Temperature differences between adjoining internal spaces

For differences of air temperature, ΔT, in kelvins, between conditioned and non-air-conditioned internal spaces, see Table 1.

Table 1 — Temperature differences between adjoining internal spaces

<table>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">Deck or bulkhead</th><th colspan="2">ΔT, K</th></tr>
<tr><th>Summer</th><th>Winter</th></tr>
<tr><td>1</td><td colspan="2">Deck against tank provided with heating</td><td>43</td><td rowspan="3">17</td></tr>
<tr><td>2</td><td colspan="2">Deck and bulkhead against boiler-room</td><td>28</td></tr>
<tr><td>3</td><td colspan="2">Deck and bulkhead against engine-room and against non-air-conditioned gallery</td><td>18</td></tr>
<tr><td>4</td><td colspan="2">Deck and bulkhead against non-heated tanks, cargo spaces and equivalent</td><td>13</td><td>17</td></tr>
<tr><td>5</td><td colspan="2">Deck and bulkhead against laundry</td><td>11</td><td>17</td></tr>
<tr><td>6</td><td colspan="2">Deck and bulkhead against public sanitary space</td><td>6</td><td>0</td></tr>
<tr><td rowspan="3">7</td><td rowspan="3">Deck and bulkhead against private sanitary space</td><td>a) with any part against exposed external surface</td><td>2</td><td>0</td></tr>
<tr><td>b) not exposed</td><td>1</td><td>0</td></tr>
<tr><td>c) with any part against engine/boiler-room</td><td>6</td><td>0</td></tr>
<tr><td>8</td><td colspan="2">Bulkhead against alleyways, store rooms, equipment rooms, or elevator trunks</td><td>2</td><td>5</td></tr>
<tr><td colspan="5">NOTE It is understood that means of heating are provided in exposed sanitary spaces.</td></tr>
</table>

5.2.3 Total heat transfer coefficients

The values for the total heat transfer coefficients, k, in watts per square metre per kelvin, given in Table 2, assume that adequate thermal insulation is provided on all surfaces exposed to outdoor conditions or adjoining hot or cold spaces, or hot equipment or pipework.

The values given in Table 2 shall be used where appropriate, unless otherwise advised by the purchaser. For other cases, a method for the calculation of the heat transfer coefficient is given in 5.2.4.

5.2.4 Calculation of the heat transfer coefficient

The heat transfer coefficient shall be calculated according to Formula (2):

$$\frac{1}{k} = \sum \frac{1}{\alpha} + \frac{\sum \frac{d}{\lambda} + M_L + M_b}{\mu} \qquad (2)$$

where

k is the total heat transfer coefficient, in watts per square metre kelvin [W/(m²·K)];

α is the coefficient of heat transfer for surface air, in watts per square metre kelvin [W/(m²·K)], as follows:

α = 80 W/(m²·K) for outer surface exposed to wind (20 m/s),

α = 8 W/(m²·K) for inside surface not exposed to wind (0,5 m/s);

d is the thickness of material, in metres;

λ is the thermal conductivity, in watts per metre kelvin [W/(m·K)];

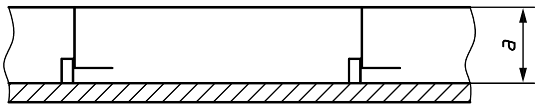
M_L is the thermal insulance for an air gap, in square metres kelvin per watt [(m^2·K) /W];

M_b is the thermal insulance between different layers of material, in square metres kelvin per watt [(m^2·K) /W];

μ is a correction factor for steel structure as follows:

μ = 1,2 for insulation in accordance with Figure 3,

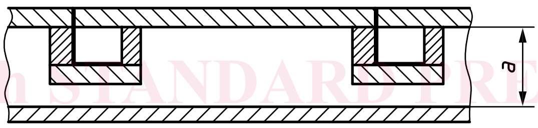
μ = 1,45 for insulation in accordance with Figure 4.



Key

a air gap thickness

Figure 3 — Plane insulation of uniform thickness



Key

a air gap thickness

Figure 4 — Corrugated insulation of uniform thickness

Table 2 — Total heat transfer coefficient

No.	Surfaces	Total heat transfer coefficient W/(m^2·K)
1	Weather deck not exposed to sun's radiation and ship side and external bulkheads	0,9
2	Deck and bulkhead against engine-room, cargo space or other non-air-conditioned spaces	0,8
3	Deck and bulkhead against boiler-room or boiler in engine-room	0,7
4	Deck against open air or weather deck exposed to sun's radiation and deck against hot tanks	0,6
5	Side scuttles and rectangular windows, single glazing	6,5
6	Side scuttles and rectangular windows, double glazing	3,5
7	Bulkhead against alleyway, non-sound reducing	2,5
8	Bulkhead against alleyway, sound reducing	0,9
9	Control-room bulkhead and ceiling against engine room	0,8
10	Control-room floor against engine room	1,2
11	Window, triple glazing	2,5
NOTE Guidance on values of thermal conductivities of commonly used materials is given in Table B.1.		

For the thermal insulance, M_L, of non-ventilated air gaps, see Table 3.

Table 3 — Thermal insulance of non-ventilated air gap

Boundary surfaces of air gap	Air gap thickness, a [a] mm	Thermal insulance [b] $m^2 \cdot K/W$
Both surfaces having high emissivity	5	0,11
	20	0,15
	200	0,16
One surface having high emissivity, other surface low emissivity	5	0,17
	20	0,43
	200	0,47
Both surfaces having low emissivity	5	0,18
	20	0,47
	200	0,51
High emissivity surfaces in contact [c]	0	0,9

[a] See Figures 3 and 4.

[b] The term “thermal insulance” is used according to the definition given in ISO 80000-5. In many countries, this term is known as “thermal resistance” with a symbol R.

[c] Aluminium foil and other polished surfaces are assumed to have low emissivity (0,2). All other surfaces are assumed to have high emissivity (0,9).

5.2.5 Measurement of transmission areas

The transmission areas for bulkheads, decks and ship sides shall be measured from steel to steel.

5.3 Solar heat gain

The solar heat gain, Φ_s, is calculated, in watts, according to Formula (3):

$$\Phi_s = \sum A_\mathrm{v} k \Delta T_\mathrm{r} + \sum A_\mathrm{g} G_\mathrm{s} \tag{3}$$

where

A_v is the surface area exposed to solar radiation in square metres (side scuttles and rectangular windows are not included);

k is the total heat transfer coefficient in accordance with 5.2.3 or 5.2.4 for a ship structure (deck, outer bulkhead) within the surface A_v;

ΔT_r is the excess temperature (above the outside temperature of +35 °C) caused by solar radiation on surfaces as follows:

ΔT_r = 12 °C for vertical light surfaces,

ΔT_r = 29 °C for vertical dark surfaces,

ΔT_r = 16 °C for horizontal light surfaces,

ΔT_r = 32 °C for horizontal dark surfaces;

A_g is the glass surfaces (clear opening) exposed to solar radiation, in square metres;

G_s is the heat gain per square metre from glass surfaces as follows:

G_s = 350 W/m^2 for clear glass surfaces,

