INTERNATIONAL STANDARD

ISO 7547

Third edition
2022-04

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

Reference number
ISO 7547:2022(E)

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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

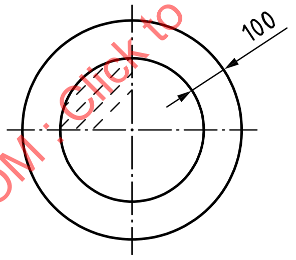


Figure 1 — Side scuttles

Dimensions in millimetres

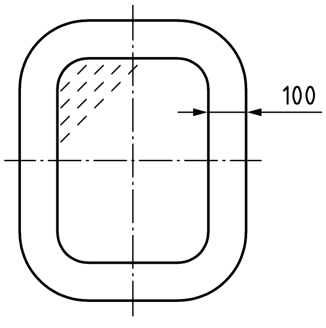


Figure 2 — Rectangular windows

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):

$$\frac{1}{k} = \sum \frac{1}{\alpha} + \frac{\sum \frac{d}{\lambda} + M_{\mathrm{L}} + M_{\mathrm{b}}}{\mu} \tag{2}$$

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)];

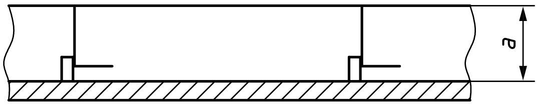
M_L is the thermal insulance for an air gap, in square metres kelvin per watt [(m^2·K) /W];

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,

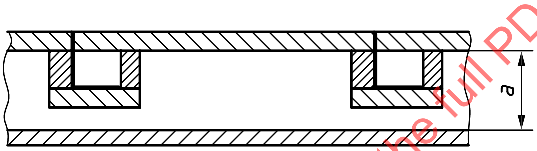
μ = 1,45 for insulation in accordance with Figure 4.



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] m²·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):

$$\Phi_s = \sum A_v k \Delta T_r + \sum A_g G_s \tag{3}$$

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/m² for clear glass surfaces,

G_s = 240 W/m^2 for clear glass surfaces with interior shading.

For corner cabins, the surface which gives the highest Φ_s shall be chosen for the calculation of the heat gain.

Surfaces not included in A_v, because of shadow from overhanging deck or other means of sun protection, shall be calculated at a sun angle of 45°.

NOTE 1 If solar radiation reflecting glass is used, G_s can be reduced.

NOTE 2 The excess temperatures for vertical and horizontal surfaces and the additional heat gain from glass surfaces caused by solar radiation are based on the most extreme average temperatures in subtropical climate and give the “worst condition” occurring during a day.

5.4 Heat gain from persons

Values of sensible and latent heat emitted by a person at an indoor temperature of 27 °C are given in Table 4.

Table 4 — Body activity and heat emission

Activity	Type of heat	Emission W	
Seated at rest	Sensible heat	70	120 (total heat)
	Latent heat	50	
Light work	Sensible heat	85	235 (total heat)
	Latent heat	150	

The total heat values in Table 4 are generally the same at 24 °C. Heat values for females should be 85 % of listed values. Heat emission increases proportionally based on the increasing level of activity and work level.

5.5 Heat gain from lighting and other sources

In spaces with daylight, additional heat gain from lighting shall be ignored. In spaces without daylight, the heat gain from lighting shall be calculated from the rated wattage of the lighting, as advised by the purchaser or as specified by the appropriate authority. Where the rated output is not specified by the purchaser or the appropriate authority, the heat gain from general lighting shall be taken as stated in Table 5, with consideration given to special lighting requirements.

Table 5 — Heat gain from general lighting

Space	Heat gain from general lighting W/m^2		
	Incandescent	Fluorescent	LED
Cabins	15	8	4
Mess- or dining-rooms	20	10	5
Gymnasiums	40	20	10

Refrigerator output shall be taken as 0,3 W/l storage capacity, unless otherwise specified by the purchaser.

Other sources of heat gain, such as from appliances that are in operation for considerable periods during the day, shall only be taken into consideration if specified by the purchaser.

Temporary electrical appliances, such as radio and television sets, and hot water urns, shall be ignored.

The heat gain from equipment in the radio cabin shall be taken as 2,5 kW, unless otherwise specified by the purchaser.

Heat gain from fans shall be taken to give a rise in the temperature of the air of 1 °C/kPa total pressure rise.

The rise in the temperature of the air in ducts shall be limited to +1,5 °C in supply air ducts and +2 °C in return air ducts.

6 Airflow calculation

6.1 Volume of space

The volume of furniture, wardrobes, and similar stationary equipment shall not be deducted in calculating the gross volume of cabins and other spaces.

6.2 Supply airflow

6.2.1 Air supply for air-conditioning

The air supply to each air-conditioned space shall be calculated using whichever of the following criteria gives the highest value:

a) airflow to maintain the conditions of 4.2;

b) airflow to maintain the conditions of 4.3;

c) outdoor supply airflow not less than 0,008 m^3/s per person for which the space is designed.

Private sanitary rooms (bath, shower or W.C.) ventilation shall be based on 10 air changes per hour-see 6.4.1.

NOTE 1 National regulations can specify a minimum number of air changes.

NOTE 2 For crowded areas, such as mess rooms and changing rooms, 6.2.1 c) can be adjusted to 0,007 m^3/s per person.

NOTE 3 See Annex A (A.11), for additional technical guidance regarding calculation of heating, ventilation and air conditioning (HVAC) airflow rates.

6.2.2 Air supply for ventilation

Supply of conditioned air to ventilated spaces, such as those listed below in a) to e), shall be provided directly or by transfer of less vitiated air from an adjacent space, and shall be sufficient to permit the exhaust airflow requirements of 6.4 to be met:

a) public sanitary rooms (bath, shower, urinal or W.C.);

b) laundry;

c) drying-and ironing-rooms;

d) changing-rooms;

e) cleaning-lockers.

NOTE It is assumed that supplementary means of heating are provided for ventilated spaces where necessary.

6.3 Temperature of supply airflow

The temperature of the cooling air supplied to the space shall not be more than 15 °C lower than the average temperature nor, for the heating mode, more than 22 °C higher than the average temperature of the space.

6.4 Exhaust airflow

6.4.1 Volume of airflow

The exhaust airflow in saloons, mess- and dining-rooms and common day-rooms shall be the same as the supply airflow.

The exhaust airflow in hospitals, pantries and smoking rooms (if installed) shall be at least 20 % more than the supply airflow.

The exhaust airflow in private sanitary rooms (bath, shower or W.C.) shall be 0,02 m^3/s or a minimum of 10 air changes per hour, whichever gives the highest value.

The exhaust airflow in common sanitary rooms (baths, shower, urinal or W.C.), laundries and drying- and ironing-rooms shall be a minimum of 15 air changes per hour and in changing-rooms, washrooms and cleaning-lockers a minimum of 10 air changes per hour.

Public sanitary rooms in passenger ships, including ferries, shall be given special consideration. The exhaust airflow shall be a minimum of 15 air changes per hour or the volume calculated from 0,04 m^3/s, whichever gives the highest volume.

6.4.2 Exhaust system

The exhaust system from the spaces listed below in a) through d) shall be fed directly to the open air, and not used for recirculation. Additionally, the exhaust systems for each of these spaces or group of spaces shall be separate from each other:

a) hospitals;

b) sanitary rooms;

c) laundry;

d) pantry.

NOTE Sanitary rooms located in hospitals can be included as part of the hospital exhaust system.

6.5 Air balance

The system shall be positively balanced. It shall be applicable on every deck.

In rooms where there is one tumble dryer or more, the balance between supply and exhaust air shall be taken into account in consultation with the manufacturer.

Hospitals, galleys, food preparation areas and other rooms, such as smoking rooms (if installed), where foul odours can be present, shall be maintained at a slightly lower pressure than that in the adjoining accommodation.

Annex A
(informative)

Guidance and good practice in the design of ventilation and air-conditioning systems in ships

A.1 System and ducting

The layout of the plant and duct sizes should allow air supply without recirculation.

A.2 Supply air

In hospitals, a non-return flap should be installed in the supply air duct.

A.3 Exhaust air

In laundries and drying-and ironing-rooms, exhaust air devices should be installed over areas with high heat emission and high humidity.

A.4 Air movement in the occupied areas

The air movement in the occupied areas should be within limits shown in Figure A.1. Air velocity for the upper value is applicable only in spaces where people are active.

NOTE For normal applications for human comfort, the occupied areas are geometrically limited to 0,15 m from all room surfaces with a height of 1,80 m above the floor.

A.5 Temperature variation in the occupied areas

The maximum difference in temperature between any points within the occupied areas (see A.4) should not exceed 2 K.

A.6 Refrigerating machinery

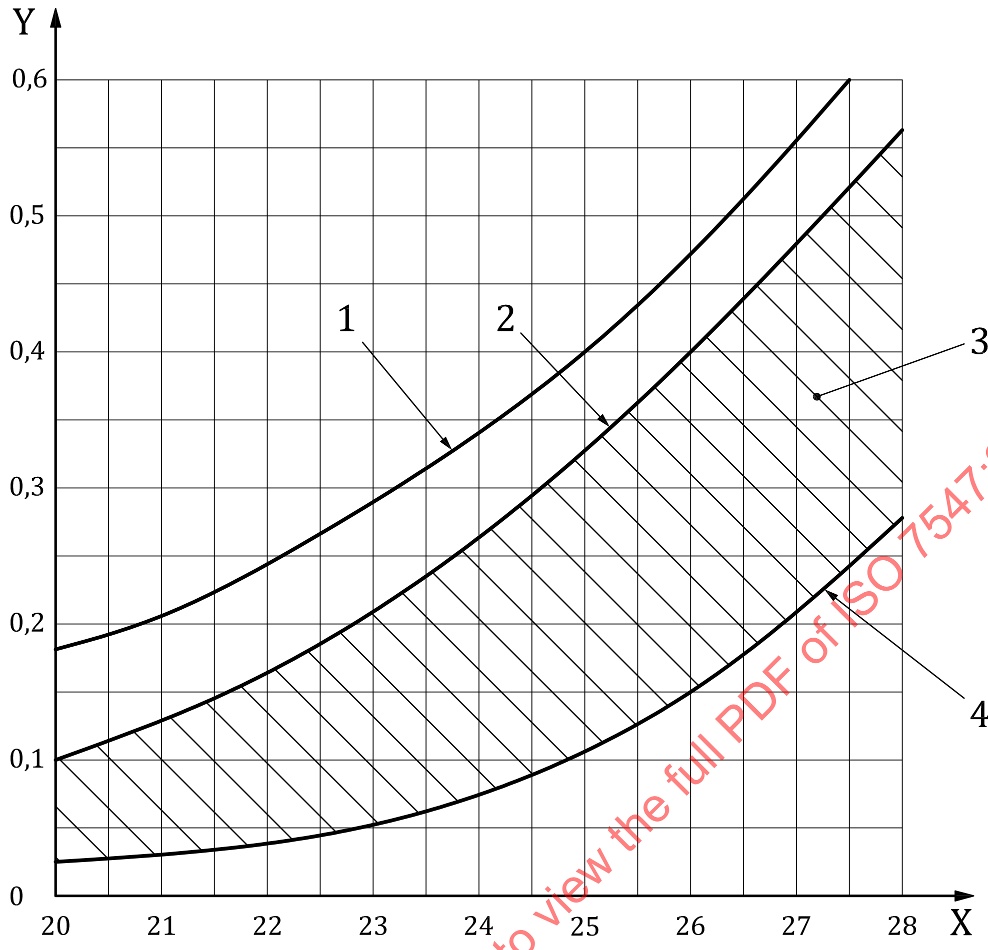
For a seawater system, the size of the condenser should be based on an inlet water temperature of +32 °C. For systems up to 7,5 kW, the compressor motor selected should be the next size up for worldwide application.

For systems larger than 7,5 kW, the compressor motor should be capable of driving the compressor at an inlet water temperature of +35 °C or, alternatively, have a fixed overload capacity in percentage corresponding to an inlet water temperature increase from 32 °C to 35 °C and some commonly occurring evaporation temperature.

For an indirect cooling system, the condenser should be designed for +36 °C on inlet cooling water and the compressor motor for +38 °C.

When calculating the total heat transfer of the condenser, a fouling factor of 0,000 09 $m^2 \cdot K/W$ should be used. The fouling factor for a closed chilled water system should be half the seawater fouling factor in a condenser.

When calculating the cooling effect, a specific mass of air of 1,20 kg/m^3 should be used.



Key

X temperature of the air, °C

Y mean velocity of the air, m/s

1 upper value

2 mean value

3 comfortable climate

4 lower value

Figure A.1 — Air movement in occupied areas

A.7 Sound

For ships subject to the SOLAS Convention[4], the Code on Noise Levels on Board Ships[5] became mandatory on 1 July 2014. Chapter 4 of the Code states the maximum acceptable sound pressure level per type of space. Chapter 6 of the Code states the acceptable weighted sound reduction index, R(w), of the divisions forming the accommodation space. The R(w) value for the corridor to cabin division is a function of the corridor-to-cabin bulkhead, so the cabin door should not be included in determining the R(w) value. Generally, systems should be so designed that the A-weighted sound pressure level from the air distributing system measured 1 m from the air terminal device should not exceed 55 dB(A).

A.8 Temperature control

Individual temperature control should be fitted to each accommodation space. This can be obtained in a number of ways such as controlling the airflow, thermo-expansion valves, three-way regulating valves, solenoids and others.

A.9 Humidification during winter

With humidification during the winter, it is strongly recommended that the upper level of humidification be limited to 40 % relative humidity and that the humidification be so controlled that it only takes place during long periods of cold and dry weather. The risk of condensation on cold surfaces and thereby the risk of formation of ice in the insulation should be taken into consideration. Where insulation is fitted on surfaces exposed to the atmosphere, care should be taken to ensure a complete vapour seal, to avoid penetration of warm humid air.

A.10 Use of process steam from boilers

Process steam from boilers should not be used for humidification. Such steam has quantities of chemical substances and can change the smell of air and increase the number of positive ions in air.

A.11 Additional guidance on heating, ventilation and air conditioning (HVAC) airflow rates

Sensible heat loads or gains can be calculated using the Formula: $q_s = F \cdot Q \cdot \Delta T$

where

q_s is the sensible heat ΔT gain (kW);

F is the HVAC conversion factor;

Q is the air flow (m^3/sec);

ΔT is the temperature rise of air (°C).

$$F = (c_{p,a} + W \cdot c_{p,w}) / v$$

where

$c_{p,a}$ is the specific heat of dry air = 1,006 kJ/kg-K;

$c_{p,w}$ is the specific heat of water vapour;

W is the humidity ratio, kg-water/kg-dry air;

v is the specific volume of moist air (m^3/kg).

Example calculation of F for 35 °C dry bulb (DB) temperature and 70 % RH:

$c_{p,a}$ = 1,006 kJ/kg-K;

W = 0,025 3 kg-water/kg-dry air;

$c_{p,w}$ = 1,866 kJ/kg-K, and v = 0,908 m^3/kg.

Calculation of F, at 35 °C DB and 70 % RH, = (1,006 + 0,025 3 · 1,866)/0,908

= 1,16 kW/(m^3/sec)-K

Other values of F, HVAC conversion factor:

HVAC conversion factor (F) for pre-heating from −4 °C to 7,22 °C = 1,32

HVAC conversion factor (F) for air conditioning = 1,2

Annex B
(informative)

Thermal conductivities of commonly used construction materials

Table B.1 — Thermal conductivities of commonly used construction materials

Material			Specific mass of dry material kg/m^3	Practical value of thermal conductivity, λ, at normal moisture content W/m·K
Aluminium			—	200
Mild steel				50
Window glass			2 600	0,8
Wood (heatflow at right angles to fibres)	fir, pine		500	0,14
	beech, oak		700	0,16
Chipboard			600	0,04
			400	0,05
Wood fibre sheets	hard		1 000	0,13
	medium-hard		600	0,06
	soft		300	0,052
Cork sheet (expanded) [a b]			140	0,04
			210	0,05
Mineral wool [a c]	fibreglass	fibre 6 µm	15 to 100	0,04
		fibre 20 µm	40 to 200	0,05
	slag wool, rockwood		35 to 200	0,05
Mineral fibre sheet			400	0,06
Floor coverings	carpet and fibrous underlay			0,045
	cork			0,06
	rubber or plastic tile			0,4
	ceramic tile			1,8

[a] The indicated thermal conductivity only applies where a flow of air that can make an appreciable difference to the insulation cannot arise in the material or flow through it.

[b] The thermal conductivity indicated is only valid where no airflow is possible in the joints between the sheets.

[c] If the insulation is compressed, the thickness in the compressed state should be used as the basis of the heat transfer coefficient.

Annex C
(normative)

Additional requirements for machinery control-rooms

C.1 General

This annex specifies design conditions and suitable methods of calculation for the air-conditioning and ventilation of the machinery control-room on board seagoing merchant ships for all conditions except those encountered in extremely cold or hot climates (i.e. with a lower or higher enthalpy than that stated in C.2.1). Applicable parts of the annex can be used for similar spaces such as the control-room for propulsion machinery.

C.2 Design conditions

C.2.1 General

The system shall be designed for the same conditions as stated in 4.2.

C.2.2 Occupancy

The number of persons allowed in the machinery control-room shall be three, unless otherwise stated by the purchaser.

C.3 Calculation of heat gains

C.3.1 Applicability

For the calculation of heat transmission and solar heat gain (as far as it is applicable), 5.2 and 5.3 shall apply.

Heat losses shall not be taken into account.

NOTE Any required additional heating during winter is assumed to be carried out by separate means of heating, other than by air supply, unless otherwise specified by the purchaser.

In addition to values for the total heat transfer coefficients given in Table 2, the values given in Table C.1 shall be used where appropriate, unless otherwise specified by the purchaser.

Table C.1 — Total heat transfer coefficients

Surfaces	Total heat transfer coefficient, k W/m^2·K
Control-room bulkhead and ceiling against engine room	0,8
Control room floor against engine room	1,2
Window, triple glazing	2,5

C.3.2 Heat gain from persons

Values of sensible and latent heat emitted by a person shall be in accordance with 5.4 (activity: seated at rest).

C.3.3 Heat gain from lighting and other sources

Heat gain from general lighting shall be taken as 10 W/ m^2 unless otherwise specified by the purchaser.

In addition, the heat gain from appliances shall be taken as the value at which the appliance generates sensible heat under normal use at the time of peak cooling load.

The purchaser shall give information about the maximum simultaneous and continuous heat gain in kilowatts from each group of electrical equipment and the location of this equipment.

Where the heat gain from the equipment is not specified by the purchaser, it shall be taken as 7 kW.

NOTE It is assumed that the electrical equipment is designed according to IEC 60092-101 and IEC 60092-504 as regards environmental conditions (e.g. temperature, humidity).

C.4 Airflow calculation

C.4.1 Volume of space

Volume of consoles, cabinets, furniture, and other stationary equipment shall not be deducted in calculating the gross volume of the control-room.

C.4.2 Supply airflow

The air supply to the control-room shall be calculated using whichever of the following criteria gives the highest value:

a) airflow to maintain the conditions of C.2.1;

b) outdoor supply airflow not less than 0,008 m^3/s per person.

Wherever relevant, 6.3 shall apply to determine temperature of supply airflow.

C.4.3 Air balance

The system shall provide a positive pressure in the room.

C.4.4 Airflow through electrical cabinets

Air distribution to be arranged to allow an airflow through electrical cabinets according to the manufacturer's requirements.

Annex D
(normative)

Additional requirements for the wheelhouse

D.1 General

This annex specifies design conditions and suitable methods of calculation for the air-conditioning and ventilation of the wheelhouse on board seagoing merchant ships for all conditions except those encountered in extremely cold or hot climates (i.e. with a lower or higher enthalpy than that stated in D.2.1).

It applies to a wheelhouse supplied with air-conditioning and ventilation either by the general accommodation system or by its own individual system.

NOTE The wheelhouse is regarded as a "Control station" according to the International Convention for the Safety of Life at Sea (SOLAS 1974)[4] as amended.

D.2 Design conditions

D.2.1 General

The system shall be designed for the indoor air conditions at the stated outdoor air conditions specified in 4.1, 4.2 and 4.3. The conditions are applicable only when the doors and windows are closed and the climate in the room is stable.

NOTE While the system is designed for these stated conditions, normal use of the vessel and wheelhouse seldom allows them to be fully met.

D.2.2 Occupancy

The number of persons to be considered in the wheelhouse shall be five.

D.3 Calculation of heat gains

D.3.1 Applicability

For the calculation of summer conditions, 5.2 and 5.3 shall apply except as modified in D.3 and D.4. For the calculation of winter conditions, 5.2 shall apply.

Any required additional heating during winter is assumed to be carried out by separate means of heating, other than by air supply, unless otherwise specified by the purchaser.

The external sides and top of the wheelhouse are assumed to have light-coloured surfaces unless otherwise stated by the purchaser.

The maximum value for the total heat transfer coefficient, k, for the wheelhouse roof shall be taken as 0,5 W/(m^2·K). For other surfaces, reference is made to Table 2.

D.3.2 Heat gain from persons

Values of sensible and latent heat emitted by a person shall be in accordance with 5.4 (activity: seated at rest).

D.3.3 Heat gain from lighting and other sources

Heat gain from lighting shall be ignored.

Heat gain from apparatus and equipment shall be based on the input of the equipment during operation.

The purchaser shall give information about the maximum simultaneous and continuous heat gain in kilowatts from each group of electrical equipment and the location of this equipment.

Where the heat gain from the equipment during operation is not specified by the purchaser, it shall be taken as 2 kW.

NOTE It is assumed that the electrical equipment is designed according to IEC 60092-101 and IEC 60092-504 as regards environmental conditions (e.g. temperature, humidity).

D.4 Airflow calculation

D.4.1 Volume of space

Volume of consoles, chart-table, furniture, and other stationary equipment shall not be deducted in calculating the gross volume of the wheelhouse.

D.4.2 Supply airflow

The air supply to the wheelhouse shall be calculated using whichever of the following criteria gives the highest value:

a) airflow to maintain the conditions of D.2.1;

b) outdoor supply airflow not less than 0,008 m^3/s per person.

D.4.3 Air balance

The system shall provide a positive pressure in the room.

