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Petroleum and natural gas industries — Offshore production installations — Heating, ventilation and air-conditioning

Industries du pétrole et du gaz naturel — Plates-formes de production en mer — Chauffage, ventilation et climatisation

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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 on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, SC 6, *Processing equipment and systems*.

This third edition cancels and replaces the second edition (ISO 15138:2007), which has been technically revised.

The main changes compared to the previous edition are as follows:

— minimum and maximum temperatures have been added to 5.2.3.3.4 below Table 2 for clarification;

— a requirement for black start has been added to 5.3;

— requirements for the specific areas stairways/escape routes and air locks have been added to 5.4;

— phase-down and phase-out of high and medium global warming potential (GWP) refrigerants are addressed in 5.4;

— a reference to new filtration standard and note for chemical filtration have been added to Table A.1;

— fail safe criteria for fire damper for safety critical areas have been added to Clause A.9;

— requirements for duct earthing have been added to B.1.1;

— the datasheet for DX cooling coil has been updated with electronic expansion valve;

— the datasheet for heating coils has been updated with data for self-generated noise.

Petroleum and natural gas industries — Offshore production installations — Heating, ventilation and air-conditioning

1 Scope

This document specifies requirements and provides guidance for the design, testing, installation and commissioning of heating, ventilation, air-conditioning and pressurization systems, and equipment on all offshore production installations for the petroleum and natural gas industries that are

— new or existing,

— normally occupied by personnel or not normally occupied by personnel, and

— fixed or floating but registered as an offshore production installation.

This document is normally applicable to the overall facilities. For installations that can be subject to "Class" or "IMO/MODU Codes & Resolutions", the user is referred to HVAC requirements under these rules and resolutions. When these requirements are less stringent than those being considered for a fixed installation, then it is necessary that this document, i.e. requirements for fixed installations, be utilized.

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 7235, *Acoustics — Laboratory measurement procedures for ducted silencers and air-terminal units — Insertion loss, flow noise and total pressure loss*

ISO 8861, *Shipbuilding — Engine-room ventilation in diesel-engined ships — Design requirements and basis of calculations*

ISO 12241, *Thermal insulation for building equipment and industrial installations — Calculation rules*

ISO 12499, *Industrial fans — Mechanical safety of fans — Guarding*

ISO 14694:2003, *Industrial fans — Specifications for balance quality and vibration levels*

ISO 21789, *Gas turbine applications — Safety*

IEC 60079-0, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements*

IEC 60079-10, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas*

IEC 60079-13, *Electrical apparatus for explosive gas atmospheres — Part 13: Construction and use of rooms or buildings protected by pressurization*

IEC 61892-7, *Mobile and fixed offshore units — Electrical installations — Part 7: Hazardous Areas*

EN 1751, *Ventilation for buildings — Air terminal devices — Aerodynamic testing of dampers and valves*

EN 1886, *Ventilation for buildings — Air handling units — Mechanical performance*

EN 50272-2, *Safety requirements for secondary batteries and battery installations — Part 2: Stationary batteries*

API RP 505, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class 1, Zone 0, Zone 1 and Zone 2*

IMO Resolution MSC 61(67): Annex 1, *Part 5 — Test for Surface Flammability*

IMO Resolution MSC 61(67): Annex 1, *Part 2 — Smoke and Toxicity Test*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological 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
active system
system that relies on energized components

3.2
air-displacement unit
supply device to achieve movement of air within a space in piston- or plug-type motion

Note 1 to entry: No mixing of room air occurs in ideal displacement flow, which is desirable for removing pollutants generated within a space.

3.3
fugitive emission
continuous emission on a molecular scale from all potential leak sources in a plant under normal operating conditions

Note 1 to entry: As a practical interpretation, a fugitive emission is one which cannot be detected by sight, hearing or touch but can be detected using bubble-test techniques or tests of a similar sensitivity.

3.4
open area
area in an open-air situation where vapours are readily dispersed by wind

Note 1 to entry: Typical air velocities in such areas are rarely less than 0,5 m/s and frequently above 2 m/s.

3.5
passive system
system that does not rely on energized components

3.6
temporary refuge
TR
place where personnel can take refuge for a predetermined period while investigations, emergency response and evacuation pre-planning are undertaken

3.7
stagnant area
area where the ventilation rate is less than adequate

4 Abbreviated terms

AC/h	air changes per hour
AHU	air-handling unit
AMCA	Air Movement and Control Association Inc.
API	American Petroleum Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BS	British Standard
CCR	central control room
CFD	computational fluid dynamics
CIBSE	Chartered Institution of Building Services Engineers
CVU	constant-volume unit
D&ID	duct and instrumentation diagram
DX	direct expansion
EN	European Standard
ESD	emergency shutdown
F&G	fire and gas
GWP	global warming potential
HSE	health, safety and environment
HVAC	heating, ventilation and air conditioning
HVCA	Heating and Ventilating Contractors' Association
IACS	International Association of Classification Societies
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
IP	Institute of Petroleum
LQ	living quarters
MODU	mobile offshore drilling unit
NFPA	National Fire Protection Association
NS	Norsk Standard (Norwegian Standard)
TR	temporary refuge

5 Design

5.1 General

This clause provides requirements on all aspects of the design of heating, ventilation and air-conditioning (HVAC) systems for offshore installations for the petroleum and natural gas industries.

For requirements and guidance on air change rates and pressurization requirements, reference is made to classification codes for the specific project.

The HVAC systems form part of the safety services of the installation. The key functional requirements for HVAC systems applicable to all areas of the installation are as follows:

a) sufficient ventilation, heating and cooling capacity in all adverse weather conditions;

b) acceptable air quality in all adverse weather conditions;

c) reliable performance through concept selection, the design having the following features in decreasing order of importance:

   1) simplicity, with a preference for passive systems;

   2) inherent robustness by providing design margins for systems and equipment;

   3) fault/status indication and self diagnostics;

   4) sparing of systems and equipment;

   5) maintainability through testability, inspectability and ease of access.

The following additional requirements apply to specific areas in the installation to ensure their safety goals are met:

— maintain survivability in the TR by preventing ingress of potentially flammable gas-air mixtures through appropriate siting, isolation, pressurization, provision of multiple air-intake locations, sufficient number of air changes, gas detection and emergency power supply;

— prevent the formation of potentially hazardous concentrations of flammable gaseous mixtures in hazardous areas by the provision of sufficient ventilation and air distribution for the dilution, dispersion and removal of such mixtures, and contain such mixtures, once formed, through maintaining relative pressures, avoiding cross-contamination and providing dedicated systems for hazardous areas;

— prevent, through pressurization, the ingress of potentially flammable gas-air mixtures into all designated non-hazardous areas;

— maintain ventilation to all equipment and areas/rooms that are required to be operational during an emergency when the main source of power is unavailable;

— provide a humidity- and temperature-controlled environment as required in which personnel, plant and systems can operate effectively, free from odours, dust and contaminants, including smoke control.

These high-level goals are supported by the lower-level functional requirements that are stated later in the appropriate subclauses of this document.

Functional requirements for the development of a design basis for either a new project or major modification to an existing installation are the focus of 5.2. These requirements are related to the following:

— platform orientation and layout (5.2.1);

— hazard identification and hazardous-area classification (5.2.2);
— environmental conditions (5.2.3);
— choice of natural or mechanical ventilation systems (5.2.4);
— development of the controls philosophy (5.2.5);
— operating and maintenance philosophy (5.2.6);
— materials selection (5.2.7);
— design margins and calculations (5.2.8);
— design development and validation using wind-tunnel testing or computational fluid dynamics (CFD) (5.2.9).

Ventilation may be natural (i.e. the wind) or mechanical or a combination of both. Throughout this document, the use of the term “ventilation” should be taken to include either natural or mechanical ventilation, as appropriate.

Natural ventilation is preferred over mechanical ventilation, where practical, since it is available throughout gas emergencies, does not rely on active equipment and reduces effort required for HVAC maintenance.

For new designs, the development of a design basis shall be progressed using the practices that are identified in this document, though it should be recognized that the design involves a process of iteration as it matures and does not happen as a sequential series of steps as is presented in this document for simplicity. The processes outlined here are equally applicable to major redevelopments of existing installations, but it can be necessary to make some compromise as a result of historical decisions regarding layout, equipment selection and the prevailing level of knowledge at the time. The challenge of providing cost-effective solutions in redevelopment can be significantly greater than for a new design.

The finalized basis of design may be recorded on datasheets such as those provided in Annex D.

The completed design shall be subject to hazard-assessment review. The hazard and operability (HAZOP) study technique may be used for this.

In 5.2, objectives are identified which establish the goals. Detailed requirements that enable the objectives to be achieved are outlined.

In 5.3, the fundamental choice in system design, i.e. between natural and mechanical methods of ventilation, is addressed.

In 5.4, the functional requirements associated with the design of HVAC systems for different areas of a typical offshore installation that require particular technical considerations due to their location and/or their function are given.

Figure 1 is intended to illustrate the processes undertaken at various stages of the installation life cycle and to identify reference documents and the appropriate subclauses of this document that provide the necessary requirements.

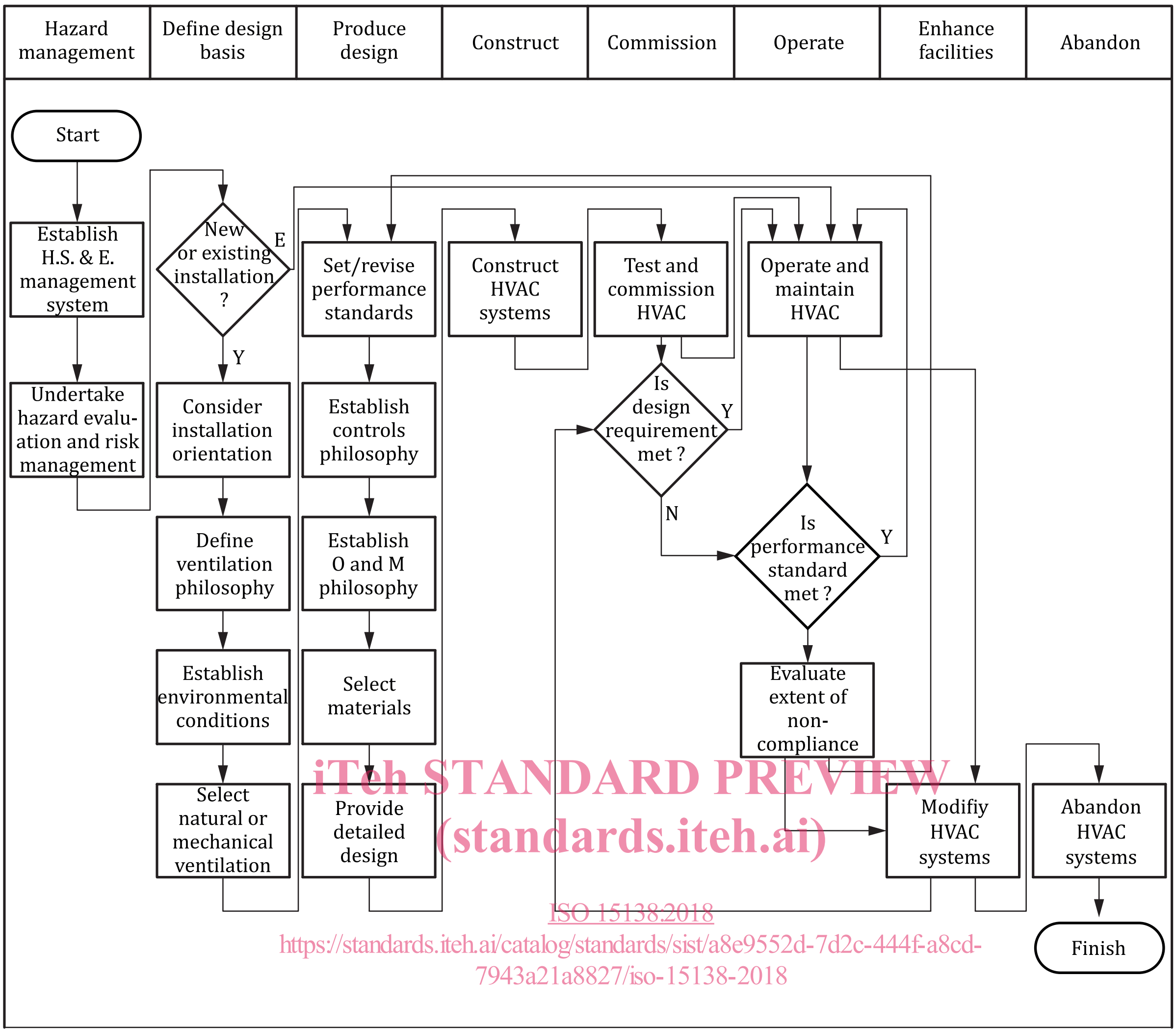

Figure 1 — Application of this document to a project life cycle

5.2 Development of design basis

5.2.1 Orientation and layout

5.2.1.1 Objective

The objective is to provide input into the early stages of design development so that areas and equipment that can have a requirement for HVAC, or be affected by its provision, are sited in an optimum location, so far as is reasonably practicable.

5.2.1.2 Functional requirements

Installation layout requires a great deal of coordination between the engineers involved during design and the operation, maintenance and safety specialists. Attention shall also be paid to the minimization of construction, offshore hook-up and commissioning. It is not the intention of this document to detail a platform-layout philosophy, but to identify areas where considerations of the role of HVAC, and requirements for it, can have an impact in the decision making surrounding installation orientation and layout.

Installations can have a temporary refuge (TR). The TR is in almost all cases the living quarters (LQ), where they are provided. The survivability of the TR, which is directly related to the air leakage rate, can introduce consideration of active HVAC systems for pressurization of the TR or enclosed escape and evacuation routes. Active systems require detailed risk-assessment exercises to be undertaken as part of the design verification, and passive systems are generally preferred since they do not rely on equipment functioning under conditions of emergency.

Hazardous areas, particularly those containing pressurized hydrocarbon systems, should be located as far as practicable from the TR, so that any gas leaks are naturally dispersed.

The layout shall include correct positioning of ventilation inlets and outlets, engine inlets and exhausts, vents and flares to allow for safe operation, particularly of the TR. Hot exhausts shall not interfere with crane, helicopter, production or drilling operations or the LQ, and shall be directed so as not to be drawn into gas-turbine air intakes.

Air intakes to hazardous and non-hazardous areas shall be located as far as is reasonably practicable from the perimeter of a hazardous envelope and not less than the minimum distance specified in the prevailing area classification code. The location of the air inlet shall also be evaluated for availability in emergency situations.

5.2.1.3 Detailed requirements

Results of wind-tunnel model tests or CFD calculations on the installations shall be used as a basis for determining the external zone(s) of wind pressure in which to locate the intake(s) and outlet(s) for the HVAC system(s). Particular care shall be taken in locating air intakes and discharges with regard to the location's coefficient of pressure and its subsequent effect on fan-motor power.

The underside of a platform can be a convenient location for HVAC inlets and outlets because a large proportion of the below-platform zone can be classified as non-hazardous and have stable wind conditions. However, consideration shall be given to the effects of the wind and waves and the location of items such as dry-powder dump chutes and cooling-water discharges when locating the outdoor air intakes and extract discharges below the platform. The air inlets/outlets shall be protected against the dynamic wind pressure.

Air intake and discharge from the same system on conventional installations shall, where reasonably practical, be located on the same face of the installation or in external zones of equal wind pressure. Particular care shall be taken in orienting air intakes and discharges on systems serving adjacent hazardous and non-hazardous areas, such that while the wind can affect the absolute values of pressurization in each area, the differential pressure requirements between them does not vary to a significant degree. For floating production systems (FPS), however, the downwind area can provide an appropriate intake location but it shall be positioned to avoid ingestion of smoke or contaminants and capable of operation in adverse weather (reference is also made to 5.3.2).

Air intakes shall be located to avoid cross-contamination from

— exhausts from fuel-burning equipment,

— lubricating oil vents, drain vents and process reliefs,

— dust discharge from drilling dry powders,

— helicopter engine exhaust,

— flares,

— other ventilation systems, and

— supply and support vessels.

The positioning of the air intake and exhaust of gas turbines and generators requires careful consideration. They shall be located in a non-hazardous area and with consideration of the following points.

a) The air intake shall be located at the maximum possible distance from hazardous areas and as high above sea level as possible to avoid water ingress (an absolute minimum of at least 3 m above the

100 year storm wave level). If enclosed, the intakes shall be located such that powder and dust are not ingested. Since most particulate matter in the air is generated on the platform from drilling operations and grit blasting, the preferred arrangement is for air intakes to be located above the upper-deck level.

b) Recirculation from the exhaust back to the inlet shall be avoided and may be demonstrated by wind-tunnel tests or CFD. These tests shall also show that exhaust flue gas emissions do not interfere with helicopter, production, drilling and crane operations.

The party that initiates the project shall establish a maximum allowable air temperature rise above the surface of the helideck for helicopter operation.

Computer models are available to simulate hot- and cold-plume dispersion patterns and may be used to establish outlet positions.

5.2.2 Hazardous area classification and the role of HVAC

5.2.2.1 Objective

The objective is to adopt in the design and operation processes a consistent philosophy for the separation of hazardous and non-hazardous areas and the performance of ventilation in those areas.

5.2.2.2 Functional requirements

IEC 60079-10 shall be used for classification of a hazardous area. The choice of hazardous-area code determines the choice of equipment for use in particular areas of the installation and also provides input to the performance standards for HVAC systems in those areas.

5.2.2.3 Detailed requirements

The application of a recognized hazard identification and assessment process can identify a requirement for the separation and segregation of inventories on an installation. Area classification codes specify separation distances between hazardous and non-hazardous areas in order to avoid ignition of those releases that inevitably occur from time to time in the operation of facilities handling flammable liquids and vapours.

All area classification codes should be interpreted in a practical manner. They offer only best guidance and often the particular circumstances require a safety and consequence review and the subsequent application of the “as safe as is reasonably practicable” approach to the location of classified area boundaries and potential ignition sources nearby. In order to correctly and consistently establish area zoning, historical data from similar plant operating conditions may be used as a basis for assessment.

Ventilation impacts upon hazardous-area classification and provides a vital safety function on offshore installations by

— diluting local airborne concentrations of flammable gas due to fugitive emissions;

— reducing the risk of ignition following a leak by quickly removing accumulations of flammable gas.

The quantity of ventilation air to maintain a non-flammable condition in areas with fugitive emissions may be calculated from data in API 4589,[14] using the methodology given in API RP 505.

Areas shall be classified using the general guidance of IEC 60079-10. Specific guidance for classifying petroleum facilities can be found in documents such as EI 15 (2015) 4th version[33] and API RP 505.

It shall be recognized that a level of ventilation higher than the default lower limit of acceptable ventilation given in the hazardous area codes can be required to

— provide a suitable atmosphere for personnel and equipment,

— remove excess heat, and

— provide an enhanced rate of ventilation to mitigate against the creation of a potentially explosive atmosphere.

5.2.3 Environmental conditions

5.2.3.1 Objective

The objective is to determine an environmental basis for the design of HVAC systems in order to meet the objectives for HVAC.

5.2.3.2 Functional requirements

External and internal environmental bases suitable for the location of the installation shall be established for the design.

5.2.3.3 Detailed requirements

5.2.3.3.1 External meteorological conditions

The requirement for shelter shall be evaluated, which can reveal a subsequent need for an HVAC system.

The design of the HVAC systems shall take design codes into consideration. Conservative selection of criteria can carry a cost, mass and power penalty.

Seasonal extremes of temperature, humidity and wind speed vary widely throughout the world, and local regulations governing working conditions can also dictate the allowable extremes in occupied or unoccupied spaces. Local environmental information shall be specified in the basis of a design. This should not require the installation of additional capacity to accommodate the small proportion of the time during which meteorological extremes are encountered.

Sub-local effects on the external environmental conditions shall be considered for design purposes in case they have any influence on the design, such as heating of the air before the air reaches the intakes, intake contamination, shading of solar radiation, reflection of solar radiation from the sea surface, changes in wind speed and direction and, consequently, wind pressure.

Effective temperatures, resulting from wind chill or heat loading, shall be determined to establish the effects on personnel operating efficiency (where personnel are required to work in thermally uncontrolled areas) and equipment, and, consequently, the extent of any required protection. In determining operating efficiency, consideration shall be given to the nature of the work (sedentary or physical) being undertaken.

The selected data source shall be acceptable to the party that initiates the project.

The following provides typical data that may be used to establish an environmental basis of design in an area where microclimate is not an important factor and variations in any month follow a normal distribution:

— maximum temperature: 2 % probability of being exceeded;

— minimum temperature: 98 % probability of being exceeded;

— design wind speed: 1/12th year — 1 h mean velocity at a reference height of 10 m;

— maximum wind speed: maximum 1/12th year — average 3 s gusts at the height of equipment.

NOTE The 1/12th year mean condition is that which, on average, is exceeded 12 times a year.

Wind velocity data are usually reported at a standard 10 m height, but can be recorded at a different height on an installation. The correction factors in Table 1 shall be applied to the commonly reported 1 h mean wind velocities.

Table 1 — Wind correction factors

Height above mean sea level	Duration of gust		Sustained mean wind duration		
m	3 s	15 s	1 min	10 min	1 h
10	1,33	1,26	1,18	1,08	1,00
20	1,43	1,36	1,28	1,17	1,09
30	1,49	1,42	1,34	1,23	1,15
50	1,57	1,50	1,42	1,31	1,22
60	1,59	1,52	1,44	1,34	1,25
80	1,64	1,57	1,49	1,39	1,30
100	1,67	1,60	1,52	1,42	1,33
120	1,70	1,63	1,55	1,46	1,36
150	1,73	1,66	1,58	1,49	1,40
Exponent (n)	0,100	0,100	0,113	0,120	0,125

EXAMPLE 1 Given a 1 h mean wind velocity of 24 m/s at 10 m height, the maximum 1 min sustained wind velocity at a height of 50 m is estimated to be 24 m/s × 1,42 = 34 m/s.

The wind-velocity factor, v_h, at another height, h, expressed in metres above sea level, can be obtained from the reference value at 10 m using the power law profile as given in Formula (1):

$$v_h = v_{10} \times \left(h/10 \right)^n \qquad (1)$$

where

v_h is the velocity at height h above sea level;

n is the power law exponent (see Table 1).

EXAMPLE 2 The velocity, v_{10}, at the 10 m base of a wind with an average velocity of 7 m/s (1 h mean velocity) at a deck level 50 m above mean sea level can be calculated as

v_{10} = 7 m/s × (100/122) = 5,378 m/s

In areas where there are high seasonal fluctuations from an average, such as in monsoon, typhoon and tropical regions, consideration may be given to setting design criteria based on the number of days or hours of exceedance if data are available for analysis in this form.

Where there is a significant microclimate, data may be analysed under additional criteria for which the following guidance is appropriate.

5.2.3.3.2 Maximum sea temperature

The maximum sea temperature is the maximum monthly average water temperature during the warmest month at the depth of abstraction, which may be extrapolated from surface temperature measurements.

5.2.3.3.3 Direct and diffuse solar radiation intensities

For detailed design calculation, hourly radiation data for a period of clear days in the warmest month is necessary. The period is considered to coincide with a period in which the maximum temperature occurs, taking into account the associated relative humidity. The traditional method of designing structures assumes that the maximum room-cooling loads and the maximum refrigeration load for air-conditioning occur simultaneously, but it is noted that maxima of room-cooling loads can actually occur in a period which is not coincident with maximum outside temperature.

In the absence of solar radiation data for the location, data may be taken from a similar locality at the same latitude. In the absence of collected data, calculated values may be applied from ASHRAE[15] or a similar reference.

The reflection from the sea surface may be taken as 20 % of the total radiation intensity.

Radiation heat gains from flare stacks shall also be considered.

5.2.3.3.4 Internal environmental conditions

Two approaches may be used for the specification of internal environmental conditions. The traditional approach relies on the specification of absolute values established by experience or local regulations. An alternative approach based on a measurement of population acceptance is given in ISO 7730[5]. The ISO 7730 method applies only to manned areas. Table 2 gives guidance that may be used if the approach outlined in ISO 7730 is not adopted.

Table 2 — Recommended indoor environmental conditions

Description	Examples	Minimum temperature (winter) °C	Maximum temperature (summer) °C	HVAC noise limit dBA	Comments
Manned areas — sedentary work	Control room Radio room	19	24	40	
Living quarter areas	Recreation areas Cabins	19	24	40	
	Dining room	19	24	50	
	Corridors/toilets Laundry Stores/galley	16	25	50	
	Switch room	10	35	65	
	Plant room	10	35	65	Noise level up to 85 dBA can be acceptable, if measures are taken to avoid unacceptable noise levels in adjacent areas.
	Offices	19	24	40	
	Dry store Gymnasium	16	24	50	
	Sick bay	21	25	40	A room controller should allow adjustment of room temperature to a maximum of 25 °C when outside min./max. design temperature are prevalent.
Light manual work	Laboratories	18	24	50	
	Stores Workshops	16	24	60	
Unmanned without electrical equipment	Utilities module	5	35	80	

