

---

---

**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*

STANDARDSISO.COM : Click to view the full PDF of ISO 15138:2007



**PDF disclaimer**

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

STANDARDSISO.COM : Click to view the full PDF of ISO 15138:2007



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2007

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
Case postale 56 • CH-1211 Geneva 20  
Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
Web [www.iso.org](http://www.iso.org)

Published in Switzerland

## Contents

Page

Foreword.....	iv
<b>1 Scope .....</b>	<b>1</b>
<b>2 Normative references .....</b>	<b>1</b>
<b>3 Terms and definitions.....</b>	<b>2</b>
<b>4 Abbreviated terms .....</b>	<b>3</b>
<b>5 Design .....</b>	<b>4</b>
<b>5.1 Introduction .....</b>	<b>4</b>
<b>5.2 Development of design basis .....</b>	<b>7</b>
<b>5.3 System design — General .....</b>	<b>28</b>
<b>5.4 Area-specific system design .....</b>	<b>32</b>
<b>5.5 Equipment and bulk selection.....</b>	<b>42</b>
<b>5.6 Installation and commissioning .....</b>	<b>42</b>
<b>Annex A (normative) Equipment and bulk selection.....</b>	<b>43</b>
<b>Annex B (normative) Installation and commissioning.....</b>	<b>64</b>
<b>Annex C (informative) Operation and maintenance.....</b>	<b>69</b>
<b>Annex D (informative) Datasheets .....</b>	<b>72</b>
<b>Annex E (normative) Standard data for flanges.....</b>	<b>106</b>
<b>Bibliography .....</b>	<b>109</b>

## 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 15138 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

This second edition cancels and replaces the first edition (ISO 15138:2000), which has been technically revised. It also incorporates the Technical Corrigendum ISO 15138:2000/Cor.1:2001.

STANDARDSISO.COM : Click to view the full PDF of ISO 15138:2007

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

## 1 Scope

This International Standard specifies requirements and provides guidance for 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,
- fixed or floating but registered as an offshore production installation.

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 International Standard, i.e. requirements for fixed installations, be utilized.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced standard (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 of 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*

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

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

ANSI/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*

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*

### 3 Terms and definitions

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

#### 3.1

##### **active system**

system that relies on energized components

#### 3.2

##### **adequate ventilation**

air exchange that is acceptable with reference to the classification code

#### 3.3

##### **displacement ventilation**

(air displacement units) movement of air within a space in piston- or plug-type motion

NOTE No mixing of room air occurs in ideal displacement flow, which is desirable for removing pollutants generated within a space.

#### 3.4

##### **fixed offshore installation**

##### **fixed installation**

all facilities, located and installed on fixed offshore structures, that are provided to extract oil and gas hydrocarbons from subsea oil and gas reservoirs

#### 3.5

##### **fixed offshore structure**

structure that is bottom-founded and transfers all actions on it to the seabed

NOTE Vessels and drilling rigs, etc. that are in transit or engaged in exploration and appraisal activities are specifically excluded from this definition.

#### 3.6

##### **fugitive emission**

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

NOTE 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.

#### 3.7

##### **open area**

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

NOTE Typical air velocities in such areas are rarely less than 0,5 m/s and frequently above 2 m/s.

#### 3.8

##### **passive system**

system that does not rely on energized components

**3.9****temporary refuge****TR**

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

**3.10****stagnant area**

area where the ventilation rate is less than adequate

**4 Abbreviated terms**

AC	alternating current
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
CMS	control and monitoring system
CVU	constant-volume terminal reheat unit
DC	direct current
DE	drive end
DX	direct expansion
EN	European Standard
EI	Energy Institute
ESD	emergency shutdown
F&G	fire and gas
GWP	global warming potential
HAZOP	hazard and operability
HSE	health, safety and environment
HVAC	heating, ventilation and air conditioning
HVCA	Heating and Ventilating Contractors' Association
IEC	International Electrotechnical Commission
IMO	International Maritime Organization

IP	Institute of Petroleum
LFL	lower flammable limit
LQ	living quarters
MODU	mobile offshore drilling unit
NDE	non-drive end
NFPA	National Fire Protection Association
NS	Norsk Standard (Norwegian Standard)
ODP	ozone depletion potential
QRA	quantitative risk analysis
r.m.s.	root mean square
TR	temporary refuge

## 5 Design

### 5.1 Introduction

Clause 5 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. Key functional requirements for HVAC systems applicable to all areas of the installation are the following:

- 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 the 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 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 International Standard.

Functional requirements in the development of a basis of design 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 International Standard, 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 International Standard, though it should be recognized that it involves a process of iteration as the design matures and does not take place as the sequential series of steps used in this International Standard to facilitate presentation. 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 study (HAZOP) 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. It is the responsibility of the user to assess whether the requirements in this International Standard are acceptable to the local regulator.

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

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 in 5.4.

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 International Standard that provide the necessary requirements.

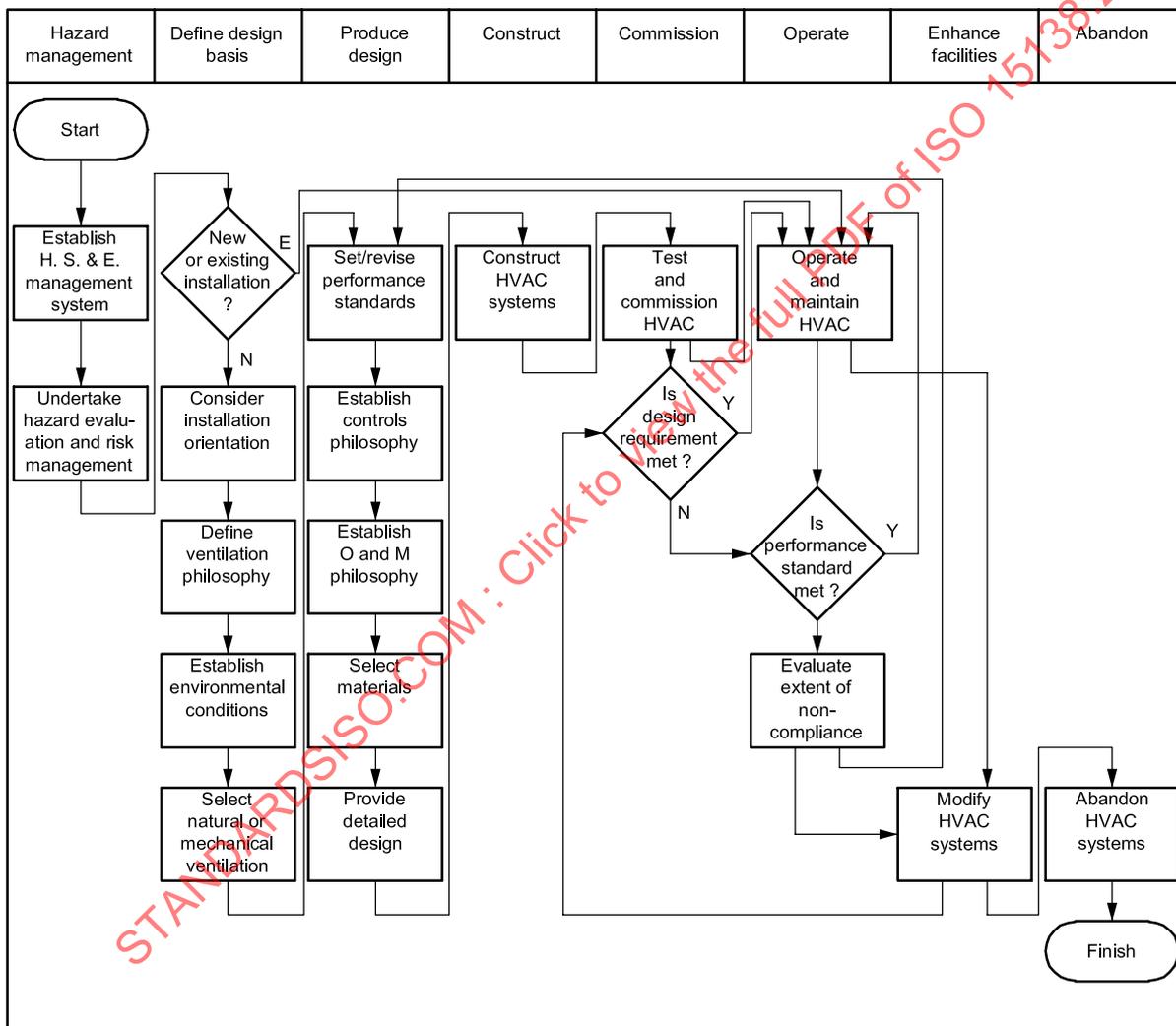


Figure 1 — Application of this International Standard to a project life cycle

## 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 International Standard 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 whilst 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 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.

In the absence of any performance standards set by the local aviation authority, a maximum allowable air temperature rise above the surface of the helideck for helicopter operation shall be agreed by the party that initiates the project.

Computer models are available to simulate hot- and cold-plume dispersion patterns and may be used to establish outlet positions, but the final layout/model shall be wind-tunnel tested at an early stage in platform-design development.

## 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 <sup>[26]</sup>, 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 IP Code, Part 15 <sup>[37]</sup> and ANSI/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

In the absence of local regulations, the requirement for shelter shall be evaluated, which can reveal a subsequent need for an HVAC system.

The design of the HVAC systems shall be based on local regulations or design codes. 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.

There are various agencies that can provide meteorological information. Most of these contribute to a worldwide database that can be accessed by local meteorological services, but there are also individual databases. Those data sets based on observations from passing ships are likely to be extensive, with many observations over a long time period for those locations near to shipping lanes. Satellite measurement is increasing in terms of history, detail and quality, and some agencies can provide data from this source for areas where ship data are not statistically significant. A third alternative, but probably the least reliable, is the extrapolation of data from nearby onshore sites. 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 exceeding the all-year average;
- minimum temperature: 2 % probability of exceeding the all-year average;
- 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 m	Duration of gust		Sustained mean wind duration		
	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  $24 \text{ m/s} \times 1,42 = 34 \text{ m/s}$ .

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 Equation (1):

$$v_h = v_{10} \cdot \left(\frac{h}{10}\right)^n \quad (1)$$

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

$$v_{10} = 7 \text{ m/s} \cdot (1,00/1,22) = 5,738 \text{ m/s}$$

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 Reference [29] 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 [7]. 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 °C	Maximum temperature °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	
	Plant-room Switch room	10	35	65	
	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 max. of 25 °C when outside min./max. design temp. are prevalent.
Light manual work	Laboratories	18	24	50	
	Stores Workshops	16	24	60	
Unmanned without electrical equipment	Utilities module	5	35	80	
Unmanned with electrical equipment	Switch rooms	5	35	70	As an option to cooling, heat may be provided to limit humidity to 80 %.
Equipment rooms with temperature-critical instruments	Battery rooms	15	25	70	35 °C maximum may be accepted for certain types of batteries.
Unmanned	Production Modules	5	35	80	

It is also recommended that the relative humidity be kept between 30 % and 70 %. These limits are set in order to decrease the risk of unpleasant wet or dry skin, eye irritation, static electricity, microbial growth and respiratory diseases.

Sound attenuators shall be located at points in the HVAC systems where they can control both break-out and break-in of noise. Typical positions are at plant-room walls prior to the ductwork leaving the room, and at duct entry into control rooms and other areas requiring low noise levels. Care shall be taken when designing the HVAC systems to allow for the poor sound absorption characteristics of many of the areas served. As all spaces except the cabins and public areas are acoustically “live”, little attenuation of HVAC noise by the space is likely to occur.

Consideration shall be given to reducing the noise levels at source in the first instance.

Outdoor air inlets and outlets shall be attenuated to a value where they do not exceed the local predicted background level by 5 dB or exceed 80 dBA (or national standards) at a distance of 3 m from the outlet, whichever is the more stringent.

Sound power generated by, or transmitted through, the HVAC systems shall not contribute to exceeding the levels stated in local regulations, recognized standards or the guidance given in Table 2. An analysis shall be performed to demonstrate the noise and vibration contribution from the HVAC system.

Where sound attenuators are required in the LQ, galley and laundry extract systems, they shall be suitably designed to reduce the risk of grease/lint accumulation and subsequent fire hazards.

Sound attenuators are not recommended in the shale shaker or mud tank extract systems, where excessive airborne dirt would nullify their effectiveness.

## 5.2.4 Natural/mechanical ventilation

### 5.2.4.1 Objective

The objective is to select a means of providing ventilation to any hazardous or non-hazardous area of an installation.

### 5.2.4.2 Functional requirements

Provide ventilation to any area that requires it, giving consideration to the following:

- a) meteorological conditions, particularly prevailing wind and its strength, external temperature, and precipitation;
- b) risk-driven segregation of hazardous areas;
- c) heating and cooling design loads;
- d) life cycle costs of the purchase and maintenance of mechanical HVAC and associated Emergency Shutdown (ESD) systems;
- e) environmental considerations, such as personnel comfort, particulate control, and noise;
- f) weather integrity of instrumentation and controls;
- g) need for structural integrity;
- h) control and recovery from hydrocarbon loss of containment;
- i) process heat conservation.

Note that many of these factors are controlled by local legislation, which should be consulted for implications.

### 5.2.4.3 Detailed requirements

The major consideration in installation layout and ventilation philosophy is likely to be risk, whether it is measured in terms of potential harm to the individual, asset or the environment. Quantitative risk analysis (QRA) may be undertaken to evaluate the risk benefits of alternative layout arrangements during the option-selection phase, and HVAC engineers can be expected to contribute to the modelling of smoke and gas releases as part of the decision-making process.

The requirements for heat-tracing, insulation, corrosion protection and maintenance cost shall also be considered when evaluating natural ventilation versus enclosed mechanically ventilated areas.

Production areas generally shall be ventilated by natural means, where possible, as this is the least complex and most reliable method. However, effective temperatures, resulting from wind chill or heat exhaustion, 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 hot climates, roofing or other protection may be provided instead of mechanical ventilation.

Mechanical ventilation shall be used when ventilation by natural means is unable to satisfy requirements as given in Clause A.2. Powered systems shall operate satisfactorily in wind conditions varying from still air to design wind velocity and plant margins shall be included in the design or fans conservatively sized in order to ensure the requirements are met during adverse wind conditions.

Free cooling, i.e. cooling by outside air is preferred to cooling by refrigeration. In some parts of the world, it can be practical and energy-efficient to use seawater cooling, for which further requirements are given in Clause A.5. Environmental data from project locations shall be used to determine available free-cooling potential, and shall be verified to ensure that temperature differentials, normally too low to allow margin for error, are correct. Assumed differentials are not acceptable. It is, however, accepted that space temperatures can exceed the design maximum for short periods during peak outside conditions.

Designs shall ensure that ventilation air is provided to control heat gains from personnel, equipment and heat transmitted through the walls of the space(s) served. The practicality of free cooling is always likely to be marginal and hence validation of cooling levels is particularly important. Heat gains from fans, fan motors and conduction into the ductwork shall be particularly included in the cooling-load calculations, as experience demonstrates that underestimation of resultant system temperature rise is a common problem.

Consideration shall be given to the removal of residual heat from equipment that has ceased operation.

Where heat gains are excessive, room air-conditioning units mounted within or local to the space(s) served, such as control centres, switch rooms, telecommunications/electronic equipment and radio rooms, may be used.

Drilling facilities, such as shale-shaker and mud-tank areas/modules, shall have an air change rate determined by the air quantity required for the extraction of fumes, heat and dust, and, of necessity, require outside air supply to meet the extract air requirements of the tanks and shakers. Under normal circumstances, these requirements are met by a powered supply system to provide adequate air distribution to the general space. The exception to this requirement is where the modules are of a semi-open nature where air can be drawn in from a variety of openings. Under these circumstances, natural ventilation may be used for make-up.

The design of HVAC systems in drilling facilities is shown in more detail in 5.4.4.

## 5.2.5 Selection of controls philosophy

### 5.2.5.1 Objective

The objective is to provide a system for controlling HVAC systems from a frequently manned location that provides the operator with essential information on the status of the plant and is integrated with the installation fire and gas (F&G) and ESD systems, so that actions in an emergency minimize the risk to personnel.

### 5.2.5.2 Functional requirements

The control and monitoring system shall

- a) provide the operator with the status of the HVAC plant,
- b) provide the minimum necessary controls for the plant consistent with the operation and maintenance philosophies,
- c) provide a link to the installed F&G and ESD systems, and
- d) comply with the installation smoke and gas control philosophy.

### 5.2.5.3 Detailed requirements

#### 5.2.5.3.1 General

The philosophy outlined in 5.2.5.3 is a requirement for large, integrated installations and is not always appropriate for very small installations and those that are not normally manned where HVAC is not considered to have a role in asset protection.

The systems shall be integrated into the overall monitoring and safety systems of the installation and shall be provided with controls for normal and emergency operations that shall be within, or readily accessible from, a normally manned central location, usually the central control room (CCR).

Decisions regarding the extent of manual control shall be made early in design development. Depending on the manning and operating philosophies, the cost of additional signal capacity to HVAC panels and the consequence of failure to act, it might not be considered necessary to route some indication back to the HVAC panel and annunciate automatic alarms. Examples are “filter dirty” indication and alarms, and humidity indication and alarms.

All controls and indicators serving similar types of equipment shall be grouped in a logical sequence, either in a dedicated HVAC-panel or integrated with a central control and monitoring system (CMS).

Where this is not practical, panels local to the HVAC plant may be installed. In all cases, a common alarm shall be indicated at the F&G panel in the CCR. In addition, fire/gas damper status shall be indicated at the F&G panel in the CCR.

Control panels supplied as part of packaged equipment shall be interlocked with either central or local HVAC panels.

#### 5.2.5.3.2 HVAC shut down philosophy

The HVAC shutdown philosophy is an essential part of the installation ESD and F&G philosophies. It is, therefore, important that the HVAC shutdown philosophy to be determined early in design development. Where mechanical ventilation systems are installed, careful attention shall be paid to their operation and/or shutdown in conjunction with fire and gas detection and protection systems. The nature of the shutdown philosophy related to fire detection can vary among different operators and among different statutory regulators.

#### 5.2.5.3.3 Control and monitoring — Normal operation

##### 5.2.5.3.3.1 Dedicated and integrated HVAC panels

All controls and indicators serving similar types of equipment shall be grouped in a logical sequence. A typical arrangement for a large, integrated installation is as follows:

#### a) Controls

- |   |   |
|---|---|
| — start                                     | All fans  |
| — stop                                      | All fans  |
| — automatic changeover switch with selector | For each run/standby fan set (including shut-off dampers) |
| — open + close                              | All fire/gas dampers, as required by the F&G philosophy   |

**b) Indicators**

— run	All fans
— stop	All fans
— tripped	All fans
— filter dirty	Each filter (not separate vane sections)
— on/tripped	Each heater
— lamp test	
— on/tripped	Each package equipment item
— open	Each fire/gas damper protecting fire-rated bulkheads or providing boundary isolation to a TR
— close	Each fire/gas damper protecting fire-rated bulkheads or providing boundary isolation to a TR
— loss of pressurization	Any area requiring pressurization, and each gas turbine hood

**c) Alarms**

A common alarm indication shall be provided to a normally-manned control location for the following:

- fan trip;
- heater trip;
- filter dirty;
- package equipment trip;
- loss of pressurization;
- fire/gas damper operating-mode failure.

**5.2.5.3.3.2 Local control of fans**

A manual on/off station shall be provided local to each fan.

Extract fans serving local fume-producing activities or equipment, such as welding and paint-spraying booths or positions and fume cupboards, shall be provided with start/stop control, complete with run indication, local to the equipment or working position.

**5.2.5.3.3.3 Fire/gas damper controls**

Control of the actuators shall be through a signal from one or more of the following four sources:

- a) remote manual operation;
- b) local manual operation;
- c) automatic closure by the installation of a fire- and gas-detection panel;
- d) automatic fail-safe by release of a local heat-detection device.

Where several fire/gas dampers serve an area module, they shall be grouped such that automatic operation of any one shall automatically initiate operation of all the others.

Local, remote, manual or automatic functioning and interlocks shall be based on an area safety assessment.

#### 5.2.5.3.3.4 Loss of differential pressure

Differential pressure between areas requiring such protection shall be alarmed when the differential reduces to a predetermined level that is deemed inadequate to maintain protection.

In each non-hazardous area adjacent and connecting to a hazardous area, each extract fan shall be prevented from starting until its associated supply fan run-up velocity has been reached and the supply shut-off damper has opened.

A time delay shall be incorporated to minimize the nuisance value associated with door opening.

#### 5.2.5.3.3.5 Temperature control

Duct- or unit-mounted water/steam heat exchangers (heating and cooling coils) shall be automatically temperature-controlled by a duct- or room-mounted sensor modulating a heating-medium proportional controller.

Uncontrolled seawater heating/cooling coils may alternatively be considered.

Duct-mounted electric heaters shall be controlled using either one- or two-step direct-switching thermostats or contactors or thyristors.

Appropriate thermal protection and interlocks for safe maintenance shall be provided.

All unit heaters shall have hand-operated on/off fan control. Additionally, electrically heated units shall be complete with integral automatic supply and upper limit temperature controls.

Where a HVAC system employs duct-mounted coils for both heating and cooling, controls shall be interlocked to ensure complementary operation.

Outdoor-air and recirculation dampers, where fitted, shall be automatically controlled by external ambient and recirculation air temperature sensors, and shall be fixed such that sufficient outdoor air is introduced, as given in Clause A.2. An override facility shall be provided within the HVAC control system, to supply full outdoor air if smoke is detected in occupied spaces.

Where heaters are used in a hazardous area, the heater coil temperature shall not exceed the T-rating for the area, as specified in IEC 60079-0.

#### 5.2.5.3.4 Control and monitoring — Emergency conditions

The HVAC-systems shall receive signals from the ESD/F&G/manual trips consistent with the selected shutdown tripping philosophy.

Once stopped, the fans shall be prevented from being restarted until the hazard has been cleared and the signal has been reset through the ESD/F&G systems.

Upon total loss and subsequent reinstatement of electrical power, the HVAC systems shall be restarted in accordance with the initial start-up procedure.

Black-start ventilation shall be achieved initially by natural ventilation and secondly by portable fans. The main ventilation plant shall be made operational as a matter of priority.

It can be necessary for HVAC cooling equipment serving the CCR, emergency switch rooms, telecommunications/electronic equipment and radio operator's room to be connected to the emergency electric power supply so that they can continue to operate during an emergency, consistent with the TR philosophy. The requirement for space cooling depends on the rate of temperature rise due to electrical/electronic equipment heat. Emergency-powered cooling shall be provided only when maximum operating-space temperatures or the permissible "heat stress" is exceeded within the required emergency

operating period. It shall be recognized that equipment-heat dissipation during an emergency can be significantly less than under normal circumstances.

Where room-cooling units are installed and are required to operate to provide cooling during emergencies, they should normally only recirculate air. Outside air supply shall be isolated in emergencies through fire/gas damper operation.

All externally mounted electrical components, such as air-cooled condensers, that are required to operate in an emergency shall be suitable for zone 1.

## 5.2.6 Operating and maintenance philosophy

### 5.2.6.1 Objective

The objective is to provide an HVAC design that provides as high a degree of operational availability as is reasonably practicable, within the constraints imposed by installed cost, maintenance resources and the consequences of failure.

### 5.2.6.2 Functional requirements

The design shall include the necessary standby arrangements, design margins, plant operating modes, availability of power supply, access provisions and requirements for routine maintenance to enable a specified operational availability to be achieved at minimum cost over the lifetime of the installation.

### 5.2.6.3 Detailed requirements

The functional requirements may be achieved by giving consideration to

- installed cost of a component or system,
- reliability under continuous running or intermittent use, and the consequence of failure,
- simplicity of design and operation,
- standardization of components and holding of spares,
- ease of maintenance and consideration of access, special tools, and
- criticality of key components in normal or emergency conditions.

Equipment normally operates continuously, but there can be times when it is idle or operates intermittently. The design shall provide for these variations.

Where a system and equipment are designed for continuous operation, consideration shall be given to the "sparing" philosophy. Sparing of equipment is preferred to minimize down-time and improve the availability of essential services. This requirement is normally fulfilled by providing all fans as duplicate sets giving a specified level of standby, with the exception of those extract units serving non-essential services. It can, however, be practical to adopt a single, 100 % supply fan philosophy if the economics of production shutdown have been fully evaluated. Similarly, the adoption of 2 × 50 % supply fans and 1 × 100 % extract fan can be acceptable on some supply and extract systems, if contingency plans for breakdowns have identified the consequences of changes in differential pressure, the likelihood of rapid repair and the availability of alternative means of ventilation.

On duplex fan systems, dampers shall be provided on each fan to prevent backflow and facilitate maintenance. Controls shall ensure that damper opening and closure is coordinated with associated fan operation.

The central refrigeration plant shall have a specified level of standby to provide adequate cooling capacity where loss of cooling cannot be tolerated.

One objective of equipment selection shall be to reduce spare stock quantities and to incorporate maximum standardization of components to enable interchangeability between all HVAC systems on an installation. Special attention shall be paid to air filters and other consumables. To achieve standardization, certain equipment may be upgraded or increased in size.

Due to the high cost of maintenance and the requirement for operational availability, the system shall be designed to maximize intervals between maintenance periods and the emphasis shall be placed on maintenance on a predictive rather than run-to-failure basis. Consideration should be given to the adoption of a condition-monitoring philosophy. Long-term reliability of components, materials and systems is essential, and particular attention should be given to life cycle costs.

The plant shall be well placed for ease of maintenance in order to ensure better overall reliability. Lack of withdrawal space inevitably increases maintenance costs and shall be avoided. The following general principles shall be followed.

- a) Plant and equipment shall be floor-mounted wherever possible.
- b) Plant and equipment shall have good access for maintenance purposes.
- c) Permanent access platforms shall be provided for all items of equipment requiring regular maintenance or inspection, where adequate access from floor level is not possible.
- d) Ample head room and good lighting shall be provided.
- e) Ample withdrawal/removal space shall be provided for all items of plant and equipment.
- f) Designs shall include provision for lifting and handling of plant and components during construction/maintenance.

All components requiring regular servicing shall have removal and maintenance space envelopes developed and coordinated with other disciplines. Ideally, withdrawal and maintenance spaces should be common. These envelope drawings shall indicate the position and test loads of all lifting points and the actual withdrawal route. Routes for large items shall be developed to crane lift points or laydown areas.

In order to avoid problems during hook-up and subsequent maintenance, no part of any system requiring maintenance shall overhang the sea.

## 5.2.7 Materials and corrosion

### 5.2.7.1 Objective

The objective is to specify materials and protective coatings for equipment and components that minimize, as far as is reasonably practicable, life cycle costs for the installation and potential harm to personnel who are affected by their operation.

### 5.2.7.2 Functional requirements

The design shall recognize the saliferous atmosphere and relative humidity that are present throughout the installation life.

Non-combustible, non-toxic materials shall be used throughout; such materials, when heated, shall not emit toxic fumes.

The design shall recognize that operation under fire-engulfed conditions can be required for some components.

### 5.2.7.3 Detailed requirements

Of the potential sources of corrosion on an installation, the following have the largest impact on HVAC:

- a) drilling chemicals in dust, paste and liquid forms;
- b) galvanic attack;
- c) products of combustion;
- d) salt aerosols.

Materials listed in item a) are mainly concentrated around drilling storage areas, but they are carried as wind-borne dusts to surrounding areas following release from storage tank vents and dump chutes.

Items b), c) and d) occur throughout the installation.

The consequences of corrosion can be reduced by philosophies that

- minimize opportunity through control of environment, e.g. through control of humidity, effective filtration, etc.;
- specify inherently corrosion-resistant materials;
- make use of corrosion-resistant coatings; or
- use corrosion allowances to extend the period before replacement.

Stainless steels are usually preferred as a means of minimizing corrosion. Other materials, such as aluminium and composite, offer mass savings and corrosion-resistant capabilities. As a general caution, it should be recognized that the temperature of sparks from aluminium and many other alloys or carbon steel can be above the auto-ignition temperature of certain hazardous gases.

For short lifetimes, as for example on upgrade or refurbishment work, it can be cost-effective to adopt mild steel specifications for ductwork, etc., but in most areas of the world, experience indicates that technical advances extend planned life longer than designers anticipate, with the result that high maintenance and replacement costs are incurred. These costs can be avoided by a more conservative, but expensive, choice of materials at the outset.

Coating of mild steel components offers a potential saving over stainless steel (for example, in fan impellers), but coatings can suffer damage, thereby giving rise to potential for out-of-balance problems; therefore, materials and components made from inherently non-corroding materials are usually preferred.

The specification of ductwork in mild steel that is painted or galvanized after fabrication can, depending on local market conditions, prove more cost-effective than the thinner stainless steel. Additionally, offshore construction of HVAC systems seldom involves an accuracy that removes the requirement for construction tolerances, and the additional work associated with on-site alteration of stainless steel components should not be overlooked. Good design should avoid the requirement for on-site alterations by "designing in" potential adjustment on site.

All items likely to suffer from corrosion prior to being made operational shall be protected to ensure that they are in satisfactory condition at the time of mechanical completion. This applies to minor components, such as fire damper bearings, just as much as to larger packaged items.

Consideration shall also be given to the sparking potential of components, particularly fans, naval brass or leaded brass rubbing rings and plates fitted to the casing, belt guard and impeller.

## 5.2.8 Design margins and calculations

### 5.2.8.1 Objective

The objective is to ensure that design integrity is demonstrated in the provision of cost-effective HVAC systems by calculations that take due account of the accuracy of HVAC system input data and extremes of design environmental conditions.

### 5.2.8.2 Functional requirements

The design shall be documented in accordance with suitable industry standards, e.g. those of ASHRAE [29], CIBSE [30] or similar recognized authorities.

Specification of equipment shall recognize the maturity of the design and the level of information provided by other disciplines in the design process.

### 5.2.8.3 Detailed requirements

Evaluation of the ductwork-system resistances and interaction of supply and extract systems with respect to room pressures and wind effects may be calculated manually or by a suitable computer program endorsed by CIBSE, ASHRAE or another similar, recognized authority. The calculations shall be revised and updated as finalized discipline information and wind-tunnel tests, etc., become available.

Fans shall be selected to operate on the steep part of their performance pressure/volume curve to ensure minimal volume fluctuations during adverse wind conditions. The airflow variations shall not exceed  $\pm 10\%$  at the projects dimensioning wind speed. The operating point used shall be at the required volume, as determined by the basis of design, with the pressure loss based on the actual system resistance, with filters being taken at their average pressure drop, plus any pressurization load that is required in non-hazardous modules.

Maximum fan and/or system pressure in a no-air-flow situation (fans running against closed dampers) shall be considered with respect to any system or area consequence this can have.

The accumulation of individual equipment operating margins shall not form the basis of the overall system design. The purpose of including these margins is to ensure flexibility in the duty of peripheral equipment, rather than gross oversizing of fan duties.

If the designer is convinced that a margin is required, it shall be demonstrated that the following have been taken into account:

- the stage of the design and the confidence in the ductwork routing and air volumes;
- the sensitivity of adding margins to the design with respect to the required motor size, e.g. the doubling of small motor sizes is unlikely to create a problem, whereas the same approach on large motors can alter the size of generators, cabling and switchgear.

The performance of the combined supply and extract system shall then be checked for adverse wind conditions. A value of design wind velocity consistent with that given in 5.2.3.3 shall be used, with the effect being calculated using a computer-aided engineering package recommended by, e.g., ASHRAE [29] or CIBSE [30]. This load can produce both positive and negative effects on the system pressure loss, resulting in variations in the supplied volume and module pressure. It should not be assumed that these changes are detrimental to the total safety of the system performance before first fully analysing their consequences. The influence on adjacent modules shall be evaluated. Variations in the process performance shall also be considered, as they can affect heat gains by, and fugitive gas leaks into, the space.

Where practical, the fan and motor shall be selected to accommodate capacity changes to compensate for system deterioration and possible modifications to the distribution duct routes (e.g. by using different belts and pulleys, adjusting inlet guide vanes or varying motor velocity).

Where duty/standby fans are required, they shall be selected so that they are capable of starting against a 5 % backdraught volume. Depending on the arrangement and quality of the run and standby shut-off dampers, a margin of up to 5 % should be added to the fan design duty.

The final selection shall be checked for wind gusts producing velocities with a probability of exceedance of 0,1 %, to ensure the system recovers naturally after these adverse effects.

Small-volume fans require special consideration. For example, a system resistance should not double as a consequence of the addition of the wind load. The use of cowl-type inlets and outlets should be considered to mitigate the effects of wind loading. Components such as filters and attenuators, along with ductwork, should be increased in size to reduce the system resistance; in other words, the system should be designed around a practical fan selection. This approach ensures good fan efficiency, thereby reducing the generated noise, vibration and power requirements

## 5.2.9 Wind-tunnel and computational fluid dynamics (CFD) modelling

### 5.2.9.1 Objective

The objective is to undertake a modelling programme that reproduces installation conditions within a reasonable accuracy, so that design options can be consistently evaluated and the chosen option optimized with a high degree of confidence that the design performance will be confirmed by actual measurements.

### 5.2.9.2 Functional requirements

A modelling programme, either CFD and/or a wind-tunnel test, shall be undertaken to predict

- natural ventilation rates and frequencies,
- wind pressure distribution around the installation to determine air inlet and outlet positions,
- requirements for secondary ventilation,
- gas build-up inside hazardous modules,
- helideck configurations and operating envelopes,
- hot-plume and contaminant (noxious exhaust and hydrocarbon) smoke or gas flows around the installation,
- weather protection for the working environment.

### 5.2.9.3 Detailed requirements

#### 5.2.9.3.1 General

The goal of CFD and wind-tunnel modelling is to undertake a modelling programme that reproduces installation conditions as accurately as possible so that design options can be consistently evaluated and the chosen option optimized with a high degree of confidence that the design performance will be reflected by actual measurements.

It is important to remember that these are bespoke techniques requiring careful implementation by experts. CFD and wind-tunnel modelling can give the wrong results if not properly applied.

Traditionally, both wind-tunnel and CFD modelling have been used to undertake the above scopes of work.

The development of ever-more-powerful computers and enhanced CFD software has, however, firmly tilted the balance in favour of CFD.

Where an existing wind tunnel is available, it can be useful in performing certain supplementary studies such as

- a) helideck wind environment,
- b) overall wind forces and moments, and
- c) wind pressure distribution.

Other studies are best performed by CFD.

It should be noted that for studies b) and c) in particular, it is important that the Reynolds number effects on cylindrical structural elements and equipment be addressed. This is particularly important for gravity-base installations where the large-diameter concrete shafts can critically affect the flow patterns over the installation. If due allowance is made for Reynolds scaling effects, there can be either a departure from true scaling, full scale to model, apparent in the cylindrical structural tubing and equipment, or an implementation of enhanced surface roughness. If these Reynolds number corrections have not been implemented on the wind-tunnel model, the results can well be unsuitable for the studies of wind pressures and overall wind forces and moments.

### 5.2.9.3.2 Computational fluid dynamics (CFD) — Preparation for analysis

#### 5.2.9.3.2.1 General

CFD modelling shall be undertaken by companies or personnel experienced in this field of work with a track record in building CFD models from drawings and/or installation CAD files in a neutral format, such as IGES. The input of the appropriate level of detail is particularly important to balance the accuracy of the result with the speed of computing.

#### 5.2.9.3.2.2 Computer model

The computer model shall be constructed from tetrahedral or hexahedral elements. Grated floors, walkways, etc., shall be modelled by a suitable porous boundary condition. The platform features shall be modelled with sufficient detail. Areas of congestion, such as nests or runs of small piping, cable tray, etc., shall be represented by a porous modelling approach. Appropriate drag coefficients of equipment and structures shall be included in accordance with Darcy's equations. The mesh shall extend downwind of the platform by at least six times the along-wind length of the platform. It shall also extend away from the platform by more than two times this length upwind and across wind. This bounding mesh shall be constructed such that the cell size increases away from the platform. The cell size shall be approximately uniform for three cell layers around the platform geometry or at least expand in a gradual manner, depending on the location of the geometry with respect to the regions of interest. The density of the cells shall increase in the regions of importance, particularly where large numerical gradients are predicted. The use of mesh adaption during the run is advantageous for dispersion and fire studies.

The influence of the grid on the results shall be minimized to prevent artificial dispersion of the flow characteristics. This is especially important around the regions of interest, such as above the helideck during a wind environment study and along the plume in a dispersion study. Changes of cell size in the computational mesh shall be gradual, particularly in a grid of tetrahedral cells. Meshes of hexahedral cells shall be aligned with the general direction of the flow where possible. The quality of the mesh shall be kept as high as possible by keeping the shape of the cells as regular as the surrounding geometry allows.

#### 5.2.9.3.2.3 Boundary layer modelling

The boundary layer over the sea is determined by the mean wind velocity; the greater the wind speed, the rougher the sea's surface and, therefore, the higher the surface drag; the higher the surface drag, the greater the wind shear and turbulence intensity.

To specify the boundary layer at the windward face(s) of the computational mesh for a given mean wind speed,  $U$ , the mean wind speed, the dissipation rate, and the turbulence kinetic energy,  $k$ , shall be entered as

functions of height above the sea surface. When the differential shear stress model is used, the shear stress shall be entered as a function of this height. The roughness factor of the sea surface shall be modelled such as to maintain the boundary layer defined upstream throughout the computational domain for each wind speed analysed.

#### 5.2.9.3.2.4 Computational model

For most studies the isotropic or  $k-\epsilon$  model can be used, but with at least a second-order differential. In order to resolve the vertical and along-wind turbulence components, the helideck wind environment studies shall be considered using a differential shear stress model.

#### 5.2.9.3.3 CFD — Analysis

##### 5.2.9.3.3.1 Helideck wind environment

CFD shall be modelled using a non-isotropic model; for example, the differential shear stress model. The purpose of the non-isotropic model is to enable the turbulence to be resolved into its vertical and along-wind components for the analysis of helicopter operational safety on take-off and landing.

The results for each wind direction shall be presented in the form of colour-coded isopleth maps of the mean and r.m.s values for both the along-wind and vertical components. Two sets of isopleth maps shall be produced, orientated as follows:

- in the vertical plane across the helideck centre, transverse to the wind direction;
- in the vertical plane over the helideck centre, in line with the wind direction.

##### 5.2.9.3.3.2 Gas turbine exhaust plume dispersal

The exhaust outlet shall be resolved sufficiently and the CFD analysis shall exploit adaptive meshing techniques to optimize the computational mesh around the dispersing exhaust plume.

The wind directions analysed shall be those carrying the exhaust plumes towards specified locations. The wind speeds shall be selected on the basis of a preliminary numerical analysis. The results shall be presented in the form of colour-coded sectional maps of temperature above ambient at each selected location. These sectional isopleth maps shall be supplemented by colour-coded isopleth maps of temperature above ambient in the vertical plane cutting the axis of the dispersing plume.

The results shall be interpreted in terms of helicopter operations, crane operations, drilling operations and safety of personnel.

##### 5.2.9.3.3.3 Natural and partially natural ventilation

Ventilation assessment shall determine the following per module or area:

- the airflow patterns within the naturally ventilated areas on the platform;
- the net (or overall) air change rate and ventilation efficiency (VE1), which shall be computed for each naturally ventilated area;
- the local air change rate and ventilation efficiency (VE2), which shall be computed for each naturally ventilated area.

The flow over the platform and through the naturally ventilated areas shall be analysed for eight equally spaced wind angles plus those wind angles  $\pm 22,5^\circ$  from the normal to the fire/blast walls, giving a total of 12 angles.

The net or overall ventilation efficiency, VE1, shall be such that the net air change rate in a naturally ventilated module or area be at least 12 air changes per hour for 95 % of the time. For this purpose, it is sufficient to ensure that the net air change rate is 12 or more for a wind speed that is exceeded 95 % of the year (the 5 % cumulative value of yearly wind speed).

The local air change rate and ventilation efficiency, VE2, is modelled to assess airflow patterns and local air change rates throughout the module. VE2 is used to define whether the module is adequately ventilated and for what percentage of time at least 12 air changes per hour are achieved in all parts of the module or area.

The CFD analysis shall be in two phases:

- a steady state analysis, from which the overall, or net, ventilation rate in air changes per hour shall be computed;
- a transient analysis shall be conducted with a neutrally buoyant tracer from which the air-change rate at every point within each naturally ventilated area shall be computed.

The analysis shall be combined with the site wind-frequency data to predict the percentage of time that the air change rate exceeds 12 per hour. The range of wind speeds about the 5 % cumulative value shall be scaled about this pivotal value with correction for variation in wind shear.

The airflow patterns and air exchange over rates shall be presented as colour-coded isopleth maps in the form of horizontal slices through each naturally ventilated area. From the isopleth maps of local air changeover rates for the 5 % cumulative wind speed, the zones of locally entrained or trapped air where the 12 air changes per hour are not met are readily identified. The results shall be analysed with respect to possible problems that can occur from fugitive gas build-up and excessive chill factors.

#### 5.2.9.3.3.4 Gas-leak dispersion

Gas leaks can occur in two forms: the first is when the sonic jet emerges in a confined area and breaks up on surrounding equipment, walls, floors, etc., which destroys the initial high momentum. The second is when the sonic gas release does not impinge on anything near the source; it forms a jet release. It is not practical to analyse the sonic release during the supersonic phase after emergence; therefore, the effective source modelled within the computational mesh shall be at a point beyond that point at which the jet becomes subsonic. The contractor shall, however, justify his approach.

The gas dispersion shall be modelled as a transient event, starting from initiation, then dispersion, followed by leak detection, and then after closure of isolating valves and leak fall-off as the inventory between the isolating valves depletes. The CFD analysis shall exploit adaptive meshing techniques to optimize the computational mesh around the gas dispersion plume.

Gas-dispersal modelling shall take into account the effects of buoyancy.

The results shall be presented in the form of a time sequence of colour-coded, sectional isopleth maps at key locations for each of a number of selected wind conditions. The isopleth maps shall be supplemented by a series of isometric views of the time-varying envelope of the lower flammable limit (LFL) of the gas.

For each key location and wind condition, the time history of the gas concentration from the leak shall be plotted. The concentration representing the LEL shall be indicated together with that concentration representing an unacceptable level of any toxic component of the gas (such as H<sub>2</sub>S) and, therefore, impairment with respect to personnel at that location.

#### 5.2.9.3.3.5 Fire combustion gas/smoke dispersion

Fires can be an evaporating hydrocarbon pool, gas jet or mixed fires. They can be partially enclosed (compartment fire) or external, for example, a sea fire, weather-deck-pool fire or an external jet fire.

For an internal (compartment) fire, the modelling procedures shall be described and justified by quoting reference sources of empirical data.

For a jet fire, the estimation of flame lift-off, flame-base diameter, flame length and diameter at the end of the flame shall be described, quoting reference sources for empirical data. The expansion (dispersion) of the combustion gas/smoke plume during the combustion or chemical reaction phase is less than that during the subsequent dispersion phase. The smaller cone angle during the combustion phase is not recognized (unless a full eddy break-up model is used). A description shall be included as to how this problem is overcome numerically.

The studies shall treat all fires as transients, predicting the time histories of the combustion gas/smoke plume dispersion from ignition, fire detection, closure of isolating valves and the reduction in fuel flow as the inventory is depleted. The time histories of temperature above ambient, CO concentration, oxygen depletion and optical density/visibility for the designated locations shall be produced. A description shall be given as to how the inventory depletion is calculated. The estimation of CO concentration, oxygen depletion and optical density/visibility in terms of combustion gas/smoke concentration shall be justified and empirical data sources shall be identified. The radiation heat flux shall also be computed.

The smoke and gas dispersal modelling shall take into account the effects of buoyancy.

For each fire scenario, the results shall be presented in the form of a time sequence of colour-coded, isothermal sectional maps at key locations for each of a number of selected wind conditions. The CFD analysis shall exploit adaptive meshing techniques to optimize the computational mesh around the dispersing gas/smoke plume.

For each key location and wind conditions, the following time histories shall be plotted:

- temperature above ambient;
- CO concentration;
- oxygen depletion;
- optical density (visibility);
- radiation flux.

Each of the above can be a hazard to personnel above specified limits and, therefore, represents an impairment. The time to impairment for each of the identified potential hazards shall be tabulated for each key location.

## 5.2.10 Performance standards

### 5.2.10.1 Objective

The objective is to define performance standards for HVAC systems that shall be used as a basis for managing risk throughout the life of the installation.

### 5.2.10.2 Functional requirements

Performance standards are statements that can be expressed in qualitative or quantitative terms of the performance required of the system, item of equipment, person or procedure, and that are used as a basis for the management of risk throughout the installation's life. They shall be set commensurate to the magnitude of the risk to be managed and shall clearly define the level of performance required for compliance.

### 5.2.10.3 Detailed requirements

Performance criteria are normally established on a company or project level, and are the standards of performance of personnel, equipment and systems, identified as necessary for the achievement of the screening criteria or to move towards company objectives. Performance criteria are generally quantitative and measurable and shall clearly define the level of performance required for compliance.

An important principle to be adopted in the setting of performance criteria is that their number and level of detail shall be commensurate with the magnitude of the risk to be managed. Thus, caution shall be exercised to avoid setting performance criteria at a level of detail that makes little contribution to the management of the risks on an installation.

In developing performance criteria for an installation, it can be helpful to consider a hierarchy of criteria. High-level performance criteria can be applied to the installation as a whole (e.g. ability of the structure to survive defined extreme environmental conditions) or to major systems that comprise part of the installation (e.g. the frequency of impairment of the TR). In some cases, high-level performance criteria might not be directly measurable, but nevertheless they shall be capable of verification from either analytical studies or from the results of assessments of low-level performance criteria.

Low-level performance criteria may relate to the principal systems used to manage major accidents on the installation. Three characteristics shall apply to performance criteria at this level.

- a) The items selected shall make a significant contribution to the management of risk.
- b) The parameters selected shall be directly relevant to the achievement of the system goals.
- c) It shall be possible to verify the parameters selected.

In developing the parameters for the lower-level performance criteria, the following elements shall be considered:

- functional parameters of the particular system (a statement of the purpose and the essential duties that the system is expected to perform);
- integrity, reliability and availability of the system;
- survivability of the system under the conditions that can be present when required to operate;
- dependency on other systems which might not be available when the system is required to operate.

Performance criteria are normally set by an iterative process involving seeking a situation in which risks are as low as reasonably practicable. This is accomplished by initially setting performance criteria considered to be adequate based upon experience and normal operating practices. These initial performance standards are tested to see whether they produce conditions in which risks are as low as reasonably practicable, and then modifying them as necessary to achieve this objective.

In the setting of performance standards, the following aspects are important.

- Performance criteria shall be particularly focused on those elements that are critical to achieving satisfactory health, safety and environmental conditions.
- Procedural or operational criteria shall not be neglected in favour of hardware-type criteria.
- Criteria shall be directly measurable and shall not require extensive computational effort after measurement.
- Measurement and recording of data to confirm compliance with performance criteria shall, wherever possible, be part of the normal operational and recording tasks associated with the particular activity. This reduces the possibility of duplication of effort and increases the probability that the task is undertaken in a conscientious and efficient manner.
- Measured parameters shall, wherever possible, be clearly identifiable as contributing to risk reduction. If this is not obviously so, efforts shall be made to explain the relevance of the particular performance criterion to the personnel involved.

It is essential to have an established system of standards, such as that described above, against which to judge the acceptability of the results of the HSE evaluation and as the basis for risk management decision making. The system of setting, periodically reviewing and updating the standards and the comparison of the

evaluation results with those standards is an integral part of the HSE Management System and the framework within which informed management can take place.

### 5.3 System design — General

#### 5.3.1 Natural ventilation

##### 5.3.1.1 Objective

Natural ventilation shall, wherever possible, be provided in order to

- dilute local airborne concentrations of flammable/toxic gases due to fugitive emissions;
- reduce the risk of ignition following a leak by quickly removing accumulations of flammable gas.

##### 5.3.1.2 Functional requirements

It is important to note that the distribution of air within an area/module is considered to be at least as important as the quantity of air supplied. As a consequence, in order to consider that ventilation of an area/module by natural means alone is sufficient, it is necessary to comply with the following basic requirements.

- Minimum ventilation rate shall be provided throughout the area.
- Minimum ventilation rate shall be as stated for mechanical ventilation.

Consideration shall be given to the working environment by the adoption of a natural ventilation philosophy.

##### 5.3.1.3 Detailed requirements

It is preferable to ventilate production areas by natural means. The adequacy of this form of ventilation shall be demonstrated by wind-tunnel testing and/or CFD to ensure sufficient airflow into, within and out of modules (see 5.2.2). Single stagnant areas shall not exceed 5 % of the module volume.

To ensure sufficient air movement (distribution) throughout a naturally ventilated module, it can be necessary to provide secondary (scouring) ventilation. Refer to 5.3.3. Modules that cannot be sufficiently ventilated by natural means shall be provided with mechanical assistance, as above, or be enclosed and provided with fully mechanical means to achieve the required ventilation rate.

Fully open modules provide the ideal arrangement for natural ventilation. If weather protection is required, it may be provided in the form of weather louvers if cost and mass are acceptable. The performance of weather louvers is far superior to alternative forms of weather protection. Correctly designed and installed, louvers also promote internal air circulation through good diffusion.

Alternative forms, utilizing open slots or perforated sheets, can be suitable, but are unlikely to create a good diffusion effect and they might not contribute significantly to moisture removal. Increased resistance to airflow and diffusion can dictate the requirement for additional mechanical ventilation.

Whatever method is selected, the effectiveness shall be verified through the use of measurements under normal operating conditions.

#### 5.3.2 Mechanical ventilation

##### 5.3.2.1 Objective

The objective is to provide mechanical ventilation when ventilation by natural means is unable to satisfy requirements.

### 5.3.2.2 Functional requirements

The HVAC systems shall be designed to

- prevent ingress of gas and smoke, control contamination between areas and maintain acceptable working and living environments for personnel (e.g. COSHH approach EH40 <sup>[39]</sup>) and non-destructive conditions for equipment;
- ensure that hazardous substances are contained or controlled at their source by means of local exhaust ventilation;
- prevent the formation of potentially hazardous concentrations of flammable gaseous mixtures in hazardous areas by providing sufficient ventilation for the dilution, dispersion and removal of such mixtures.

The system design shall include a fan-powered ventilation plant which draws 100 % of its outside air from a non-hazardous area and provides it to the target areas.

For practical reasons, systems may be separated for the following areas:

- a) non-hazardous areas;
- b) hazardous areas;
- c) living quarters;
- d) areas in operation during emergency situations;
- e) areas fitted with secondary ventilation systems;
- f) drilling areas;
- g) substructure;
- h) areas with contaminated air provided with separate extract, such as shale shakers/mud pits, welding bays, laboratories, galley, laundry, etc.

### 5.3.2.3 Detailed requirements

#### 5.3.2.3.1 General

Hazardous and non-hazardous systems shall be designed to prevent possible contamination of non-hazardous systems caused by reverse flow through ductwork systems in the event of partial system failure.

Equipment shall normally operate continuously, but there are times when it can be idle or can operate intermittently. The design shall provide for these variations.

Designs shall endeavour, without prejudice to safety and operability, to minimize the following:

- extent of offshore hook-up;
- topside mass;
- space requirements;
- power requirements;
- maintenance requirements.

Additionally, the requirement for system testing and commissioning, i.e. location of balancing dampers and airflow testing, shall be considered early in the design development.

The capacity of the mechanical ventilation system shall be adequate to meet the objectives and requirements of 5.1 and 5.2. The system flow-distribution design may utilize single-system or primary and secondary ventilation systems.

The minimum fresh ventilation air volumes shall be documented.

Where non-hazardous areas are adjacent to hazardous areas, a differential pressure shall be maintained to meet the requirements of the chosen hazardous-area classification code. A form of relief venting from the space shall be provided to ensure that the doors can be opened during normal and emergency operations. For those applications where no powered extract system is proposed, pressure-relief dampers may be fitted. Further requirements on the selection of this equipment is given in Clause A.10.

In order to ensure the installation of an effective HVAC system, consideration shall be given during design of mechanical ventilation systems to the aspects given in 5.3.2.3.2 to 5.3.2.3.5.

#### **5.3.2.3.2 Differential pressure**

Differential pressure may be achieved either by imbalance of design airflows or through pressurization control using mechanical dampers.

Construction of enclosures required to be pressurized shall ensure low leakage of pressurization air, for which pipe and cable seals and airtight construction are essential. A realistic approach to leakage through doors, dampers and fabric shall be taken at the design stage and monitored throughout the installation's life.

#### **5.3.2.3.3 Effect of wind**

All equipment, ductwork and supports shall be designed to withstand all structural loadings as listed in the facilities structural design parameters established by the project.

From an operating perspective, wind can adversely affect fan performance and area pressurization, and plant margins shall be included in the design in order to ensure the requirements are met during adverse wind effects (see 5.2.8). Powered systems shall operate satisfactorily in wind conditions varying from still air to design wind velocity, though the specified values can be exceeded when wind velocities greater than design occur.

#### **5.3.2.3.4 Inlets and outlets**

The potential for contamination and reverse flow through the ductwork in the event of partial system failure shall be assessed, and inlets separated from outlets by a distance determined by the size of the opening, the potential flammability of the exhausted air, and the extract velocity. There are various calculation methods available, e.g. in Reference [29], for this purpose.

Gas dampers shall be installed in all air intakes to ensure that any delay in detector/damper response time is covered.

In accordance with standards, air intakes shall always be located in non-hazardous areas. An exception may be made for air intakes to enclosures for process equipment that is located within a classified hazardous area. For these enclosures, it may be acceptable to take air from areas with the same classification, i.e. free-standing, noise-reducing enclosure for process equipment, analyser house, etc.

Air from non-hazardous areas shall be exhausted to a non-hazardous area.

Air inlets and outlets from the various systems shall be protected from wind-driven rain and snow entering the plant; see Clause A.2.

### 5.3.2.3.5 Duct systems

Duct systems shall be designed to recognized standards, such as ASHRAE and CIBSE guides, and sized to give the design throughput at velocities that do not give rise to unreasonable noise.

Supply- and extract-duct systems should be sized to suit the recommended maximum velocities in Table 3.

**Table 3 — Recommended maximum velocities in duct systems**

Area	Velocity	
	Maximum m/s	Preferred m/s
Hazardous areas and non-hazardous areas normally unoccupied	15	10 in main runs
LQ high-velocity supply ducting, non-hazardous areas normally occupied	10	6 in branch ducts
LQ extract and recirculation ducts	7,5	5 in main runs

The use of velocities in excess of the above requires the consideration of noise-reduction measures and the consequences of high energy loss.

All duct systems shall be sized to be self-balancing as far as possible. Where this is not practicable, duct systems shall be designed to include balancing dampers at each branch duct to allow fully proportional balance, except those systems that utilize constant-volume control valves.

### 5.3.3 Secondary ventilation systems

#### 5.3.3.1 Objective

The objective is to provide an additional system to supplement natural or mechanical ventilation in areas where the distribution of air by the main system is not adequate.

#### 5.3.3.2 Functional requirements

Stagnant areas formed by structural steelwork, decking plates, sumps and equipment, etc. shall be assessed and ventilated accordingly.

Consideration shall be given to the dilution of fugitive hydrocarbon emissions and dissipation of internal heat gains.

A uniform ventilation pattern shall be provided between primary supply and extract points.

Secondary systems may draw air from the areas served.

#### 5.3.3.3 Detailed requirements

Partial secondary ventilation can be adequate where primary mechanical or natural ventilation also promotes a degree of internal air distribution and circulation.

In areas where heavier-than-air gases can accumulate, hazard assessment can indicate a requirement for additional extracts. This may be provided by a locally ducted mechanical system.

On new designs, a secondary system can often have advantages when compared to traditional (essentially primary) systems with respect to efficiency, cost, mass, space and ease of design/installation.

There are two methods for the use of high-velocity secondary systems:

- a) by inducing the room air to sweep the entire area in a predetermined direction and, in the process, dilute and entrain any hydrocarbon or noxious gas, and/or high-temperature air that can be present;
- b) by creating localized areas of high turbulence around plant equipment that has been identified as a potential leak source for hydrocarbon or noxious gas, or in areas of potential accumulation;
- c) by draining gullies or ceiling beam spaces, in order to move any accumulations into the general room-air stream.

## **5.4 Area-specific system design**

### **5.4.1 Process and utility areas**

#### **5.4.1.1 Objective**

The objective is to provide mechanical ventilation when ventilation by natural means is unable to satisfy requirements.

#### **5.4.1.2 Functional requirements**

Systems provided for hazardous areas shall be entirely separate from those serving non-hazardous areas. Non-hazardous areas adjacent to hazardous areas shall be kept at a positive pressure compared to the hazardous area. Specific exhaust requirements, e.g. fume cupboards, welding benches/booths, etc., also require consideration.

At outside maximum and minimum design temperatures, areas shall not exceed the temperature set by local regulations, applicable codes of practice or company standards. See Table 2.

Air change rates determined in 5.2.2 shall be applied and the ventilation shall be sufficient to dilute fugitive hydrocarbon emissions. Any free-cooling requirements for the area shall also be met.

#### **5.4.1.3 Detailed requirements**

Where a mechanically ventilated hazardous area is adjacent and connected to a non-ventilated, non-hazardous area, the extract ventilation system for the enclosed hazardous area shall ensure that the area is kept at a negative pressure.

Additional heating or cooling for maintenance personnel should be provided by temporary, portable equipment suitable for the area classification.

Heating, where provided by mechanical means, may be from a heater located in the supply duct. It can be necessary to provide a number of heaters for separate compartments, or for area zones where varying conditions are required.

The preferred method of cooling is free cooling, but other methods may be adopted when this means is impractical or uneconomical, or a close control of the environment is required. It is accepted that space temperatures can go above design maximum for short periods during peak outside conditions. Designs shall ensure that sufficient ventilation air is provided to control heat gains from equipment and heat transmitted through the walls of the space(s) served.

It can be necessary, where heat gains are excessive, to use room air-conditioning units mounted within, or local to, the space(s) served, such as in the CCR and emergency switch rooms.

## 5.4.2 Living quarters

### 5.4.2.1 Objective

The objective is to provide a controlled environment for personnel.

### 5.4.2.2 Functional requirements

HVAC systems shall be designed to maintain internal-air conditions defined by local legislation or codes of practice at maximum and minimum outside air conditions, taking into account detectable and latent loads from lighting, personnel and other sources.

Ventilation rates shall be established from requirements for heating or cooling and the need for pressurization and personnel comfort.

The air change rates for galley and laundry shall include consideration of the cooling-load requirements imposed by the equipment and the efficiency of extract hoods and systems.

The design of supply and extract systems shall include adequate protection to prevent cross-contamination or the circulation of odours through the LQ on partial or total system failure.

### 5.4.2.3 Detailed requirements

#### 5.4.2.3.1 General

In the absence of local legislation or code of practice, the requirements given in 5.2.3 shall apply. During periods in summer or winter when outside conditions exceed the maximum and minimum design values, it is accepted that the inside temperature might not be to specification.

As a default condition, a minimum flow rate of 8,4 l/s of outdoor air per person shall be supplied to each occupied space as recommended by ISO 7547<sup>[6]</sup>.

Single-duct systems are generally the most cost-effective and shall be provided to

- cabins;
- public areas;
- emergency areas;
- galley.

The main supply system(s) shall be either a fixed, 100 % outdoor air plant or an outdoor air/recirculated air plant that can require automatic temperature- or enthalpy-controlled changeover from full outdoor air to part recirculation. System operation with 100 % recirculation shall be evaluated for only emergency operation.

The main supply, extract/recirculation and cooling plant should be located in a plant room. The supply should be a ducted system connecting to constant-volume control valves or balancing dampers. Air may be supplied through ceiling diffusers or through air-displacement units. The reheating should comply with the supply principle chosen, i.e. reheating terminal boxes in conjunction with ceiling diffusers or wall-mounted panel heaters, together with air-displacement units.

#### 5.4.2.3.2 Extract system

Extract ventilation systems in the LQ shall be provided to serve the following areas:

- general extract ventilation from cabins, offices, recreation areas, dining room, locker room, toilets (provided with some protection to prevent cross-contamination) and corridors through a centralized, ducted system;
- dedicated extract systems from the galley and associated stores, laundry, toilets (unless provided with some protection to prevent cross-contamination) sick bay, rooms fitted with toxic-gas extinguishing systems and battery rooms.

When recirculation is provided, the extract from the toilets shall be by a dedicated system.

The dedicated extract systems shall have their own fans, located either within an internal plant room or external to the LQ module, discharging the exhaust air to atmosphere.

The individual, dedicated extract systems serving galley, laundry, toilets, sick bay, workshops (and electronic equipment rooms) shall exhaust air to atmosphere.

#### 5.4.2.3.3 Heating, cooling and humidification

Where applicable, heaters (steam, water or electric) and/or cooling coils may be located in the main air-handling unit (AHU) in order to raise or lower the air temperature to the required design supply level.

Recovery from extract air may be used for heating/cooling of supply air.

Cooling coils and evaporators shall be supplied with cooling medium from a dedicated refrigeration plant or from the seawater cooling system.

All refrigeration systems shall be designed to use a zero-ozone-depleting, environmentally acceptable refrigerant or a refrigerant with a low global-warming effect.

Humidification, if fitted, shall comply with the requirements in Clause A.6.

#### 5.4.2.3.4 Galley systems

The galley supply system shall be designed to induce a flow of air from the dining room and across the serving area to the galley, in order to prevent cooking odours from entering the dining room. Alternatively, an air curtain may be provided around individual items of equipment, such as fryers, to improve the local working environment. Boost outdoor-air supply and exhaust systems, in addition to normal systems, may be considered for the peak heat loads in the galley, so that excessive loss of conditioned air is avoided.

Supply ductwork to the galley shall be connected to the main supply duct outside the galley boundaries. Supply ducting to other areas shall not be taken through the galley areas. Consideration shall be given to locate the supply outlets away from food-preparation areas.

A dedicated extract system for the galley shall be provided.

The galley shall be provided with canopies or hoods over all cooking equipment, which shall be fitted with cleanable grease filters and/or an automatic filter washing system.

Provision shall be made for fire detection and protection in the hoods, exhaust ductwork and fat-fryer systems in accordance with local regulations, and NFPA 96 or a similar standard.

Exhaust canopies or hoods should also be installed over dishwashers and any other heat-producing items of equipment.

#### 5.4.2.3.5 Laundry systems

To minimize the risk of inadequate filtration permitting the build-up of lint and consequent risk of fire, the following design principles shall be adopted for the warm-air clothes-drying machines.

- a) Position filters as close as possible to the drying-machine outlet.
- b) Avoid vertical duct runs.
- c) Avoid concealed ductwork.
- d) Include adequate access doors for complete cleaning and inspection of the system. Provide specific means for quick removal and replacement of system components.
- e) Filters shall be of high capacity and disposable (or easily cleanable).
- f) Differential pressure gauge to be provided across filters.
- g) Minimize length of extract duct from laundry machine to atmosphere.
- h) Use suitably fire-rated ducts.

#### 5.4.2.3.6 Temporary LQ modules

Supply and extract ventilation systems using the methods described above shall be provided to achieve the required air change rates. Mechanical supply is required to the main area to create the desired air distribution and pressurization, and all toilet areas shall be supplied with mechanical extract.

In these modules, air shall not be recirculated. Humidity control and cooling might not be required. Heating, if required, should be provided from a duct-mounted electric-heater battery to meet the requirements of Table 2.

Internal pressurization shall be provided to suit the classification of the area in which the module is situated.

The HVAC systems shall be installed such that module fire-barrier integrity is not compromised.

Where the temporary LQ is intended for prolonged use, the same level of environment quality shall be provided as for a permanent LQ.

### 5.4.3 Temporary refuge (TR)

#### 5.4.3.1 Objective

The objective is to provide a place where personnel can take refuge for a predetermined period whilst investigations, emergency response and evacuation pre-planning are undertaken.

#### 5.4.3.2 Functional requirements

Where a TR is required, the following aspects shall be considered during design of the HVAC facilities:

- size, number of people and duration;
- location and number of air intakes to maximize the availability of a source of breathable air during the incidents;
- speed of response of inlet-gas detection and time needed to stop the HVAC;
- boundary fire-damper position indication;
- air cooling due to heat stress calculations;

- consequences on personnel or the atmosphere of a build-up of contaminants;
- maintaining the pressurization of the TR during the incidents, but with sufficient airflow to ensure that any leakage or other ingress (e.g. through the use of doors) is diluted and displaced;
- availability of power sources to drive the HVAC system during the incidents;
- criteria for “breathable” air to be set by the operator or local regulator with respect to the harmful characteristics of the smoke, toxic or flammable plume; the criteria shall include latent heat, temperature, toxicity (including irritant and narcotic effects of smoke) and effect on visibility or obscuration;
- provision of portable gas meters.

#### 5.4.4 Drilling and drilling utility areas

##### 5.4.4.1 Objective

The objective is to provide mechanical or natural ventilation to satisfy requirements.

##### 5.4.4.2 Functional requirements

The HVAC system shall be designed to reduce the exposure of personnel to dust, fumes, heat, etc. to the level specified by local legislation or industry codes.

Any special requirement for the ventilation of equipment in normal or emergency operation shall be incorporated in the design.

##### 5.4.4.3 Detailed requirements

###### 5.4.4.3.1 General

Ventilation in drilling facilities can present particular demands above those for other hazardous areas. These issues are covered in the remainder of this subclause and in 5.4.4.3.2 to 5.4.4.3.5.

Local regulations usually apply to the control of dust and noxious substances in drilling areas. In most cases, these require the installation of a local extract system.

Shale-shaker and mud-tank areas/modules, of necessity, require an outside-air supply to meet the extract air requirements of the tanks and shakers. Under normal circumstances, these requirements are met by a powered supply system to provide adequate air distribution to the general space. The exception to this requirement is modules of a semi-open nature into which air can be drawn from a variety of openings. Under these circumstances, natural ventilation may be used for make-up.

These areas shall be subject to an air change rate determined by the area classification or the air quantity required for the extract of fumes, heat load, etc. from the mud tank's and shale shaker's enclosure.

The extracted air shall be ducted to a suitable area where it does not affect personnel or equipment and shall be subject to local regulations.

Due to the nature of the HVAC systems in these areas, components and equipment shall be provided with access for cleaning and maintenance.

###### 5.4.4.3.2 Shale-shaker units and cutting cleaning units

Shale shakers shall either be partly enclosed to ensure capture of fumes at source by extract ventilation, or be open and naturally ventilated, thereby preventing unnecessary unit-operator exposure. Enclosures should form an integral part of the shale shaker-unit supplied by the vendor. Where enclosures are fitted, due consideration shall be given to the need for ease of access for replacement of the filter screens and

maintenance requirements. These considerations shall dictate enclosure design and are likely to confirm the requirement for an opening front with removable/hinged side-leaves.

Shale-shaker enclosures, if fitted, shall be designed so that air velocities through openings, from room to enclosure, ensure complete capture of emitted airborne contaminants. Velocities of air in exhaust ducts upstream of scrubbing units shall also ensure optimum transport of contaminants with minimum drop-out.

Cutting cleaning units shall be provided with extract enclosures and ventilation or shall be open and naturally ventilated similarly to shale-shaker units.

#### 5.4.4.3.3 Mud tanks

Although during the initial design phase some mud tanks can be designated as storage only (inactive), experience has shown that all mud tanks are likely to contain hydrocarbon-bearing liquid (active) at some stage during the life of the platform. All tanks shall, therefore, be assumed to be active and shall be ventilated accordingly.

Rigs can be designed with enclosed mud tanks or with open tanks in enclosed rooms. Enclosed tanks offer the advantages of minimizing the exposure to personnel of oil-based mud and improving the capture of flammable vapours by the ventilation system.

Tanks with solid plated covers shall have minimum penetration for pipework, agitator shafts, valve handles, instrument entries and inspection/access hatches. The void between the covers and mud surface shall be constantly purged with ventilation of the entire freeboard. A negative pressure shall be achieved within the freeboard space by an imbalance between supply air entering the void through leakage paths in the cover plate and the extract-air ducted system. Precise control of this pressure is not a requirement of the system design. Tanks that are adjacent may be ventilated by a common system, if convenient. Extract ductwork shall be connected directly to the covers, with make-up air being drawn through the previously mentioned penetrations or through supplementary air-entry slots. Consideration shall be given to providing local low-level extract hoods over mud gutters to remove any contaminants that are discharged.

Mud tank enclosures shall be designed so that air velocities through openings, from room to enclosure, ensure complete capture of emitted airborne contaminants. Velocities of air in exhaust ducts upstream of scrubbing units shall also ensure optimum transport of contaminants with minimum drop-out.

#### 5.4.4.3.4 Air cleaners

The objective is to control exhaust-air quality to within acceptable limits (e.g. COSHH approach EH40<sup>[39]</sup>); air cleaners can be required.

Air scrubber units, in the form of integrated air washers and plenum-settlement chambers, may be supplied on all extract ventilation systems serving shale shakers in order to minimize the discharge of mud particles to atmosphere. High-efficiency filtration equipment may be considered as an alternative. These scrubbers shall be fitted as close as possible to the extract enclosure take-off points to minimize in-duct contamination from mud-slurry deposits. Ductwork between take-off point and scrubber should preferably be of circular cross-section and designed for easy disassembly for cleaning. Circular cross-sections are also favoured for the remaining ductwork for ease of internal cleaning. Ducts should be fitted with maximum-sized access doors at each change of direction and in long duct runs. All ductwork shall be run to fall back to either the scrubber, the mud tank or shale shaker or, if this is not possible, provided with large-bore drain pipes at all low points. These precautions are required to ensure that water slurry does not collect in the duct sections. It is appreciated that, in existing facilities, optimum HVAC equipment configuration might not be possible due to physical constraints.

#### 5.4.4.3.5 Cement units

If the drilling cement unit doubles as part of the installation well-kill system, its diesel engine, where installed, shall be arranged to operate in an emergency situation. In this case, HVAC services shall be provided as described for the diesel fire pump and draw air from outside.

#### 5.4.5 Gas turbine enclosures

##### 5.4.5.1 Objective

The objective is to provide sufficient ventilation to satisfy requirements.

##### 5.4.5.2 Functional requirements

The ventilation system shall be designed to remove heat from machinery, to dilute flammable gas and to include systems for gas detection in accordance with ISO 21789 to below the lower explosion limit.

Pressurization shall be provided in accordance with the hazardous area classification philosophy adopted for the area.

##### 5.4.5.3 Detailed requirements

Turbines located in a non-hazardous area shall have a negative hood pressure while turbines located in a hazardous area shall have a positive hood pressure.

The gas-turbine vendor shall specify and provide details of the required airflows, pressures, heat loads, temperature limits and any special requirements to facilitate the design of the acoustic-enclosure ventilation system. Turbines for power-generation applications shall have induced-draught systems and, for compressor and pump drive applications, forced-draught systems.

These shall

- a) ensure good air distribution within the enclosure to prevent local overheating with airflow across the turbine from hot to cold surface;
- b) control the temperature in the enclosure, with a maximum based on instrument/electrical equipment specification installed in the enclosure;
- c) maintain a gas-turbine skin temperature, considering the auto-ignition temperature of the fuel in the event of a fuel leak;
- d) maintain the enclosure positive or negative pressure, as required;
- e) take the air supply from a non-hazardous area, either internally or externally.

The ventilation system shall provide adequate air changes to meet these requirements. The remaining heat in the turbine hood shall be considered in a run-down situation.

All materials and equipment within the enclosure shall be able to withstand the increase in temperature that can occur on loss of the cooling fans, provided that the turbine has been shut down and the fuel supply has been shut off. Either electrical wiring, junction boxes and instrumentation, etc. shall be certified to withstand temperatures under these conditions or provision shall be made for cool-down ventilation. Where this is provided, it shall be configured such that the cause for loss of the normal cooling fans, e.g. gas at the ventilation-air inlets, is unlikely to preclude the use of the cool-down system.

#### 5.4.6 Emergency plant ventilation

##### 5.4.6.1 Objective

The objective is to provide sufficient ventilation to equipment that is required to operate in an emergency under the conditions that can be present.

#### 5.4.6.2 Functional requirements

HVAC systems serving emergency plants shall be designed to ensure the equipment continues to function under the conditions prevailing when it is called upon to work.

#### 5.4.6.3 Detailed requirements

Where fire pumps and/or emergency generators are enclosed in fire-rated compartments during normal platform operation, i.e. a diesel system not running, the HVAC “normally running” systems shall supply air to the compartment at a minimum rate to meet the requirements specified in the environmental basis of design (see 5.2.3), and shall maintain the minimum positive pressure as required by the area classification code. Extract ventilation may be via louvered pressure-relief outlets to atmosphere.

If extract outlets are extended by ductwork such that the resultant back-pressure exceeds the internal design pressure for the space, powered extract shall be provided.

Rates of ventilation shall account for residual heat dissipation immediately following engine shutdown.

When engines are in operation, engine cooling air, if required, and combustion air may be provided by a system that forms part of the engine package and is separate from the normal HVAC system. In this event, the fire/gas damper logic shall be fully integrated with that of the room system.

These separate systems should generally form part of the emergency supply and/or fire pump plant package(s) and should be powered from the engine(s). However, the HVAC design may be required to include, with the package supply, engine cooling-air inlets with fire/gas dampers interlocked with the engine operation.

Whilst the engines are not running, normal fire damper logic applies, i.e. either close on manual or fire and gas shutdown signal or normally closed. However, in the case of a fire when the engine is running, any fire damper connected to any part of the package shall shut only when the last-resort device is activated and the machine shall run to destruction.

#### 5.4.7 Battery and charger rooms

##### 5.4.7.1 Objective

The objective is to provide sufficient ventilation to satisfy requirements.

##### 5.4.7.2 Functional requirements

The HVAC system serving battery and charger rooms shall be sized for the removal of all noxious and flammable products and any heat generated.

##### 5.4.7.3 Detailed requirements

The battery system shall be analysed to evaluate the extent of noxious or flammable products produced, based on full battery charger output into a fully charged battery bank. The selected air-change rate is based on the required dilution rate or heat removal. Where contamination of the atmosphere is negligible and does not threaten personnel or the integrity of the installation, a general/local HVAC system may be used as the sole means of room ventilation, providing there is no recirculation.

Where contamination levels are deemed to be hazardous and/or environmentally unacceptable, a dedicated fan-powered extract system shall be installed, with extracts from the room at a high level over the battery racks.

Supply air shall be introduced into the battery room at a low level and shall maintain the battery and charger rooms at a pressure above adjacent hazardous areas and/or below non-hazardous areas, in accordance with the design parameters.

The extract system may also serve the room containing the charger unit, if this is local to the battery room, in order to remove dissipated heat.

Extract fans shall be interlocked with the battery charger if the batteries are known to produce hazardous levels of explosive gas during boost charging, so that loss of extract ventilation prevents charger operation.

Requirements for ventilation of battery rooms shall comply with either EN 50272-2 or ANSI/API RP 505.

#### **5.4.8 Laboratories**

##### **5.4.8.1 Objective**

The objective is to provide sufficient ventilation to satisfy requirements.

##### **5.4.8.2 Functional requirements**

Laboratories shall be provided with (a) dedicated fan-powered extraction system(s) to prevent personnel exposure to exhaust fumes.

##### **5.4.8.3 Detailed requirements**

Fume cupboards shall exhaust directly to atmosphere, with discharge terminals located to avoid personnel contact with exhaust fumes. Recirculation-type fume cupboards shall not be used, in order to prevent accidental discharge of noxious fumes into areas that are likely to be occupied.

Conditioned air shall be supplied to the room as necessary to balance exhausted air and to pressurize the room. Consideration shall also be given to running the fume-cupboard fan continuously.

#### **5.4.9 Purge air systems**

##### **5.4.9.1 Objective**

The objective is to provide sufficient ventilation to satisfy requirements.

##### **5.4.9.2 Functional requirements**

HVAC services for air supplies to components and plant requiring continual purging, such as draw-works and rotary-table motors, shall at all times have outside air drawn from a non-hazardous source.

##### **5.4.9.3 Detailed requirements**

Standby fans shall be provided in line with the sparing philosophy. Duplicate fans shall be provided with automatic changeover. Fan controls shall be integrated into the control system of the equipment served and into the overall safety system of the installation.

Purge-air supply to equipment required to run in an emergency shall be connected to an emergency power supply. When small air quantities are required, e.g. for motors, the instrument air system should be considered as a potential source of purge air.

#### **5.4.10 Rooms protected by gaseous extinguishing agents**

##### **5.4.10.1 Objective**

The objective is to provide sufficient ventilation to satisfy requirements.

#### 5.4.10.2 Functional requirements

Where rooms are provided with gaseous extinguishing systems, ventilation supply and exhaust dampers shall be interlocked with the F&G control to shut prior to gas release.

#### 5.4.10.3 Detailed requirements

Rates of leakage through dampers and doors shall be assessed when sizing the fire-extinguishing system.

Depending on the choice of extinguishing agent, manual release may be chosen in preference to automatic release to reduce personnel exposure to hazardous agents.

If the room is ventilated as part of an integrated system, continued fan operation shall be evaluated.

#### 5.4.11 Engine-room ventilation

##### 5.4.11.1 Objective

The objective is to provide sufficient ventilation to satisfy requirements.

##### 5.4.11.2 Functional requirements

Design requirements and basis of calculation shall be in accordance with ISO 8861.

#### 5.4.12 Watertight compartments

##### 5.4.12.1 Objective

The objective is to maintain the integrity of watertight compartments when HVAC ducts penetrate the barriers.

##### 5.4.12.2 Functional requirements

The penetrations of watertight barriers shall be provided with hydraulically operated valves unless the penetrations are made watertight by a passive protection.

##### 5.4.12.3 Detailed requirements

Where watertight valves are installed, they shall be of the fail-close type and be located on the side of the barrier that provides a lower flood hazard.

The duct between the watertight valve and the barrier shall have the same level of watertight construction.

Valve operation and monitoring shall be done both locally (close to the valve) and in a permanently manned area.

A passive protection, where the use of hydraulically operated valves is avoided, shall also be considered. Individual ducts (pipes) from above the water-damage line and with the same watertight construction level as the compartments may be used for ventilation.

The criteria and requirements of the Classification Society shall be complied with.

### **5.5 Equipment and bulk selection**

Requirements for equipment and bulk selection are provided in Annex A.

### **5.6 Installation and commissioning**

Requirements for installation and commissioning are provided in Annex B.

STANDARDSISO.COM : Click to view the full PDF of ISO 15138:2007

## Annex A (normative)

### Equipment and bulk selection

#### A.1 General

This annex provides technical requirements for the selection of components intended to be provided in an HVAC system, and detailed guidance to support the completion of the datasheets in Annex D.

#### A.2 Louvers and hoods

##### A.2.1 Function

Intakes to and discharges from all mechanical HVAC systems and/or naturally ventilated areas where weather protection is required shall be protected from ingress of adverse weather and/or animal life and airborne contaminants by the installation of louvers on the intakes and either louvers, hoods, swan necks, etc. on the discharges.

##### A.2.2 Functional requirements

The performance requirements of louvers are influenced by the provision or not of downstream moisture-separation and filtration equipment, requirements for which are included in Clause A.3. Where a high degree of moisture and dust removal is required, consideration shall be given to the inclusion of a downstream moisture-separator and/or filter, rather than relying on a louver alone.

Where a louver is installed without a downstream moisture-separator and/or filter, the performance shall be in line with that given in Clause A.3. This shall be based on the level of corrosion protection required for materials and equipment contained in the area being served by the HVAC system, as well as that for the downstream HVAC system duct-mounted components.

Consideration shall be given to the pressure drop when fitting louvers over pressure-relief dampers. Alternatively, cowls or swan necks on inlets and outlets to reduce exacerbation, through wind effect, of salt and other contaminant penetration of equipment components and bearings may be fitted.

Louvers for mechanical ventilation systems should have a low air resistance with high moisture knock-out capability. It is suggested that the pressure drop should not exceed 100 Pa.

Drains shall be provided on multi-pass components and protected, if required, against freezing.

A screen of mesh sized to provide suitable protection against local wildlife shall also be fitted.

Natural-ventilation louvers shall exhibit a performance similar to those installed on mechanical systems, but the air resistance shall be measurable in both directions and the water-droplet separation efficiency shall be maintained in all wind velocities up to the design wind velocity.

There should be an even airflow distribution downstream of the louvers.

Where acoustic louvers are provided, the datasheet should specify the acoustic performance. The flow performance of acoustic louvers can be lower than that of a similarly sized weather louver.

See the datasheet in Clause D.1.

### A.3 Moisture separators and filters

#### A.3.1 Function

Moisture separators and filters shall be installed in HVAC system air intakes, where a “high” degree of moisture and dust removal is required to supplement the “weather protection” performance of louvers.

Where intakes are located in areas that have a high level of windborne sand, specifically designed sand filters shall be installed.

#### A.3.2 Functional requirements

The composition of the intake air shall be assessed for moisture content and solid particulates, since both can adversely effect the longevity of downstream components and the quality of ingested air. A moisture separator removes mist and water droplets, while a form of filter removes solid particulates (dust) from the air stream.

The moisture removal and filtration functions may be undertaken within a single component split into constituent parts, which may include a bag or panel coalescer, a moisture eliminator and filter section. Arrangements vary depending on specialist manufacturer.

Typical moisture-separation efficiency for a louver is 96 %, measured for droplet sizes from 30 µm in diameter and larger at a system air velocity of 2 m/s to 2,5 m/s and at a loading of 72 l/(m<sup>2</sup>·h) (system air velocity is based on gross louver area).

The louver/filter/coalescer separator assembly shall reduce the salt-in-air content at the output to  $0,01 \times 10^{-6}$  by mass against the National Gas Turbine Establishment (NGTE) Standard 30 knot aerosol. The performance shall be maintained under all operating conditions.

In the absence of local regulations, there are several industry standards that may be used for the “solid particulate (dust) removal performance” of filters or filter elements, such as EN 779 [16].

The provision and performance requirements of a moisture separator depend on the level of corrosion protection required for materials and equipment contained in the area being served by the HVAC system, as well as that for the downstream HVAC system duct-mounted components.

The provision and performance requirements of a filter depend on the particulate air filtration requirements of the area being served by the HVAC system.

Typical requirements for particular air intake filtration are listed in Table A.1.

**Table A.1 — Performance requirements**

Intake category	Area/Room	Components (performance)
I	LQ, CCR and areas containing sensitive electrical/control equipment	Louver/filter/coalescer assembly (salt content to $0,01 \times 10^{-6}$ ) plus Filter (F7 to EN 779 [16]) Filter duct-mounted or located in air-handling unit
II	Workshops and stores, equipment rooms, switch rooms, emergency and temporary LQ and offices	Louver (96 %) plus Filter (F5 to EN 779 [16]) Filter duct-mounted or located in air-handling unit
III	Generator rooms, fire pump rooms, process areas	Louver (96 %) Filter not required

Filters or pre-filters should also be provided to reduce the intake of grit, dust and soot from temporary generator exhausts during hook-up and commissioning or construction work.

Pressure drop across moisture separators and filters should be kept to a minimum and shall not exceed 200 Pa when clean, or 400 Pa when dirty. Face velocity should not be expected to exceed 5 m/s.

Moisture separators should, in addition to the stated performance requirement, be capable of coalescing any re-entrained water droplets that are "carried over" from upstream louvers or filters and operate efficiently without any excessive increase in pressure drop when subjected to sea fog, mist, etc.

Engine-protection filters represent a special consideration and shall meet engine manufacturers' requirements.

All moisture-separator and filter materials shall be non-toxic and non-combustible to a suitable standard.

During occurrence of sea fog and wind-driven spray, moisture separators and filters collect significant quantities of water. Arrangements shall be made for the whole assembly to be self-draining with tapped outlets for connection to a platform drainage system and protected, if required, against freezing. The drainage trap shall be sized so that no back-siphoning occurs when the differential pressure across the filter is at its maximum design pressure.

See the datasheet in Clause D.2.

## **A.4 Heating coils and unit heaters**

### **A.4.1 Function**

Ambient temperature conditions and desired space temperatures determine the requirement or not for air heating. Where air heating is required, it should generally be provided from duct-mounted heaters. These may be located at HVAC system inlets for frost protection, in upstream ductwork or within air-handling units for preheating or heating and within supply-distribution ductwork for reheating local to areas being served. In open areas or where no distribution ductwork is provided, heating may be provided by local fan-assisted unit heaters.

### **A.4.2 Functional requirements**

#### **A.4.2.1 General**

Heaters may be of the electric or fluid type, depending on availability of utility services. Electric supply may be three-phase for large units and single-phase for low-power units. The fluid supply for the fluid type may be the platform-heating medium, steam or a water/glycol mixture.

In hazardous areas, electric heaters may be installed, but a more cost-effective and safe solution can be provided by fluid heaters. This is a major consideration at design stage.

All heaters shall be capable of both continuous and intermittent operation and the design should minimize airflow turbulence and air-side static pressure loss.

#### **A.4.2.2 Fluid heaters**

Fluid heater casings should be made from corrosion-resistant materials. Headers and return bends should be enclosed as part of the case, but should be located out of the air stream.

Fluid heaters shall be designed to be easily removable from ducts or equipment and arranged in sections as necessary. Intermediate support plates shall be provided, where necessary, to add rigidity to the coil.

Fluid heaters shall be provided with some form of frost protection, such as trace heating, to prevent freezing in winter conditions.

Fluid heaters shall not be located in rooms containing electrical switchgears.

Fluid heaters shall be provided with drainage and venting facilities.

See the datasheet in D.3.1.

#### A.4.2.3 Electric heaters

Electric heater elements shall be mounted so they can be withdrawn whilst leaving the casing *in situ*.

Electric heaters should be arranged in stages, each stage giving an even distribution over the total cross-sectional area of the air stream.

Electric heater elements shall have a maximum temperature rating in line with the chosen certification requirements, such as T3 as established in IEC 60079-0. In addition, the watt output per unit area of element surface shall be restricted to a level where the surface temperature of the element cannot exceed 150 °C under normal operating airflow conditions.

Extended contact surfaces in the form of fins shall not be used on electric heater elements.

Face velocities should normally be greater than 2,5 m/s and less than 8 m/s except when connecting directly to other items of the plant, e.g. in an air-handling unit. However, under no circumstances shall the specified maximum coil-surface temperature be exceeded.

Single-phase power supplies should normally be restricted to 3 kW, with three-phase supplies being used above this value, or as stated by the datasheet. Where three-phase supplies are used, the number of elements should be split to ensure that the out-of-balance load across each phase is not greater than 3 % or as dictated on the datasheet.

All electric heaters shall be fitted with suitable "high air temperature" or "high element-surface temperature" thermal cut-outs or both.

Consideration should be given to the specification of anti-condensation heaters to protect electric heater elements from deterioration when not in use.

See the datasheet in D.3.2.

#### A.4.2.4 Unit heaters

Unit heaters shall be of the heavy-duty, industrial type and may use electricity or a thermo fluid as the heating source.

Fans may be of the centrifugal, axial or propeller type with a wire-mesh protection guard fitted on the fan inlet.

Unit heater-fan motors and electrical components, including controls and safety devices, shall be suitable for the area classification in which they are located.

Unit heater outlets should be fitted with horizontal adjustable louver blades to provide adequate deflection from nearly vertical upward to nearly vertical downward. These blades should be of robust construction and provided with a blade-locking device. The blades should not be interlinked.

See the datasheet in D.3.3.

## A.5 Cooling coils and fan coil units

### A.5.1 Function

Ambient temperature conditions and desired space temperatures determine whether or not air cooling is required. The cooling system shall be designed to maintain the required internal environmental conditions within specified limits, when it has been proven that free cooling from the outdoor-air supply system is unable to meet these requirements. Where air cooling is required, it should generally be provided from air-handling unit-mounted cooling coils. In open or essential areas, or for emergency conditions, or where no distribution ductwork is provided, cooling may be provided by local fan coil units.

### A.5.2 Functional requirements

#### A.5.2.1 General

Cooling coils may be of the direct expansion refrigerant (DX) or fluid type, depending on availability of utility services. DX cooling coils are refrigerant evaporators operating in conjunction with refrigeration systems. Fluid supply may be the platform-cooling medium, seawater or a chilled water/glycol mixture.

Cooling coils shall be designed to be easily removable from ducts or equipment and should be arranged in sections as necessary. Intermediate support plates shall be provided, where necessary, to add rigidity to the coil.

Cooling-coil casings should be made from corrosion-resistant materials. Headers and return bends should be enclosed as part of the case, but should be located out of the air stream.

Cooling coils shall be designed and selected to avoid moisture carry-over into the air stream, thus avoiding the use of downstream eliminator blades. This generally means face velocities not exceeding 2,5 m/s.

Cooling coils shall be provided with a drip pan and drain sized for extreme ambient conditions.

Cooling coils and drains shall be provided with some form of frost protection, such as trace heating, to prevent freezing of the coil and drain in winter conditions, when applicable.

Cooling coils shall be provided with easily accessible drainage and venting facilities.

#### A.5.2.2 DX cooling coils

DX cooling coils shall use a zero-ozone-depleting, environmentally acceptable refrigerant or a refrigerant with a low global-warming effect. Refrigerant vents should be discharged externally and refrigerant-gas detectors with remote alarm should be located at appropriate locations in the plant room.

DX cooling coils should be constructed from de-oxidized copper tube and corrosion-resistant or protected fins.

See the datasheet in D.4.1.

#### A.5.2.3 Fluid cooling coils

Cooling medium or chilled water/glycol coils should be constructed from copper tube and corrosion-resistant or protected fins.

Seawater cooling coils should be constructed from titanium header and tubes or similar anti-erosion material to prevent erosion of tubes, particularly at bends, to prolong life. Casings shall be made from corrosion-resistant materials.

Seawater cooling coils may also be used as heating coils during winter, thus reducing the requirement for a heating medium or electric power used for heating.

Fluid cooling coils shall not be located in rooms containing electrical switchgears.

Fluid cooling coils shall be provided with drainage and venting facilities.

See the datasheet in D.4.2.

#### **A.5.2.4 Fan coil units**

Fan coil units may be of either the split refrigeration type or the local liquid coil type. The split refrigeration type has a room or area casing-mounted fan and DX coil served by a remote refrigerant compressor and condenser package (see Clause A.13).

See the datasheet in D.4.3.

### **A.6 Humidifiers**

#### **A.6.1 Function**

Humidifiers can be required to ensure minimum humidity levels and to control the air humidity in rooms served by HVAC systems. In the majority of cases, the equipment is located within an equipment plant room in a protected environment and is provided to serve normally manned areas such as the LQ and CCR. Where necessary however, the equipment shall be suitable for operation in hazardous areas.

#### **A.6.2 Functional requirements**

To avoid bacteriological contamination from standing water, humidifiers shall be of the steam type designed to inject steam into the ducted airstream.

Humidifiers shall generate fresh, odourless and sterile steam from the platform's water system, whether using unsoftened, softened or demineralized water. Steam should normally be introduced to ductwork by a single injection point or by a dispersion panel fitted with calibrated orifices to ensure even steam distribution and rapid absorption. Dispersion panel devices are generally preferred, since they provide shorter absorption distances, enabling more compact installations, with less risk of steam recondensing on downstream obstructions.

It shall be ensured there is no carryover or contamination in the injected steam from additives to the platform water system.

Each humidifier should be a complete, self-contained packaged unit, with all components mounted on a fabricated chassis insulated and totally enclosed in steel sheet cladding. The package should include all necessary internal safety devices and be suitable for control by the air-conditioning control system.

Fluctuations in the internal duct pressure shall not affect humidifier operation.

All internal parts handling water, steam or air should be constructed of stainless steel. The injection ducts should be of stainless steel.

Humidifiers should be suitable for control by a modulating humidistat positioned within the main extract-air duct sending a signal to the controller. On detection of high humidity, the humidistat should isolate the power supply to the humidifier. An interlock shall be fitted to ensure the humidifier does not operate when the fan is shut down.

See the datasheet in Clause D.5.

## A.7 Fans

### A.7.1 Function

Fans are the prime mover in an HVAC system and are required to circulate air around HVAC ducts. They shall meet the following requirements.

- a) The duty point shall be selected to maintain optimum efficiency for the selected fan design when considering
  - power consumption,
  - sound level,
  - fan efficiency, and
  - steepness of the performance curve.
- b) The fans shall have non-overloading characteristics for the design operating limits.
- c) The fans shall be suitable for continuous running.
- d) The fans shall be inherently non-sparking.

### A.7.2 Functional requirements

#### A.7.2.1 Fans

Centrifugal-fan (including chamber-fan) impellers should preferably be backward-curved single-skin or, exceptionally, aerofoil section. In addition, in some applications such as contaminated exhaust systems, impellers should be of "self-cleaning" design. The fan arrangement shall be as given on the datasheet.

Mixed-flow fan impellers should be of the type where the impeller blade extends over the curved part of the flow path, causing the air to enter axially turning outwards.

Axial fans should have adjustable-pitch impellers, unless other capacity-adjusting devices are provided.

In certain areas where build-up of contamination can prove a problem, such as the drilling package, fans with the motor outside the airstream are preferred.

Fan selections should not be made at excessive velocities towards the upper limit of the unit's operating range, as this creates excessive noise and creates undesirable loads on bearing drive units and impellers. If there is no alternative but to operate in this range, the system resistance should be reduced by improved design.

Where a duty is required other than the selected duty point, inlet guide vanes may be used to impart a controlled amount of swirl entering the impeller to alter the pressure/volume characteristic and reduce the power at partial load operation.

The fan-shaft first critical velocity shall be at least 20 % in excess of the recommended maximum operating velocity.

Fan inlets and outlets should be kept free of obstruction, with the nearest component (fire damper, non-return damper, gas detector, etc.) located as far as possible from the fan case.

Fans for duct mounting shall be provided with flexible connections and anti-vibration mountings.

Vibration monitors may be fitted to all fan units to detect out-of-balance loads due to build-up of contaminants or damage to the impellers.

A thermocouple may be attached to the bearing blocks to monitor the temperature to give early warning of inadequate or excessive lubrication.

The fan impeller shall be dynamically balanced. The balance standard shall be in accordance with recognized standards, such as ISO 1940-1 [2] and ISO 14694. Fans with driver power equal to or less than 37 kW (BV-3) shall meet balance quality grade G 6.3, while fans with driver power higher than 37 kW (BV-4) shall meet balance quality grade G 2.5.

The maximum vibration limits for the assembled fan shall not exceed the peak and r.m.s. values given in ISO 14694:2003, 8.3.

All rotating parts of the fan and motor shall be protected with suitable guards in accordance with ISO 12499.

All fans being used in hazardous areas shall be constructed from anti-sparking material and shall be provided with antistatic belts.

For belt-driven fans, the drive belts shall be selected for appropriate duty, e.g. continuous or intermittent.

See the datasheet in Clause D.6.

#### **A.7.2.2 Fan motors**

There are a variety of drive mechanisms that can be used to power the fans. Most units are electrically powered, although pneumatic and hydraulic drives may be used for special applications.

Electrical motors shall comply with a recognized standard for low-voltage induction motors and be sized such that the design loading of the motor will not exceed 90 % of the motor's nameplate rating at 1,0 service factor.

The maximum power requirements of the driven equipment shall be determined at the driver coupling and shall include all transmission losses.

Where pneumatic and hydraulic motors are used, systems should be fitted with filter/regulator/lubricator units.

### **A.8 Sound attenuation**

#### **A.8.1 Function**

Sound attenuators and sound attenuation material should be selected to reduce duct-borne noise created by ventilation fans, dampers or other noise sources in the ventilation system.

#### **A.8.2 Functional requirements**

When selecting the appropriate attenuation, the following guidance should be considered.

- a) The maximum available space (face area and length) can be limited.
- b) Check dominating or critical frequencies for acceptable insertion losses in frequency bands from 63 Hz up to 8 000 Hz. Primary attenuators should be designed to reduce low frequencies, and secondary medium or high frequencies created by dampers, etc.
- c) Flow noise created by the attenuator should be at least 10 dB lower in all frequency bands than the attenuated sound power level after the silencer.

- d) Optimize the total pressure loss over the attenuator. Aerodynamically shaped inlets and outlets are recommended. Avoid installation of attenuators in turbulent areas, shortly after bends or other critical areas.
- e) Noise transmitted through duct walls (duct break-out or break-in) should be considered, especially on rectangular light-gauge ducts. High noise levels can be critical if the duct system enters areas requiring low sound levels. Similarly, duct break-in should also be considered.
- f) In attenuators, the material shall have adequate strength and cohesion to resist erosion and sagging. When fibre absorption material is used, it shall be protected by a perforated plate (perforation grade 30 % to 40 % is recommended) to prevent fibre migration. The absorption material shall be fire-retardant, non-carcinogenic and rot-, damp- and vermin-proof. Special care should be taken in the selection of absorption material to avoid problems generated by high moisture content in the air and excessive airborne dirt.
- g) Attenuators shall be tested in accordance with ISO 7235.

See the datasheet in Clause D.7.

## A.9 Fire dampers

### A.9.1 Function

Fire dampers shall be of a standard that maintains the integrity of designated fire-rated barriers when penetrated by HVAC ducts. Fire damper installations shall have a fire rating at least equal to the barrier they penetrate.

### A.9.2 Functional requirements

#### A.9.2.1 General

Any penetrations through fire-rated barriers are undesirable, but those through H-rated barriers incur high cost penalties and should, therefore, be proposed only if unavoidable. The only exception is where ducts pass through an area without serving that area (no breaks in the duct) and are fully rated to at least match the highest-rated barrier bounding that area.

The essential service function of fire dampers requires that they are of a design that ensures reliability of operation during an emergency. As they can be left unused for long periods, construction shall be robust, using materials that are inherently non-corroding in the conditions present on an installation.

Multiple use of fire dampers as pressure controllers, volume control dampers, etc. shall not conflict with the certification requirements.

All fire dampers shall fail to the closed position, except under special conditions such as emergency generator room enclosures.

#### A.9.2.2 Components and indicators

Each fire damper shall be fitted with components and indicators, preferably housed in a protective casing, as follows, to provide operation and status indication:

- a) The fire damper shall be fitted with proximity or limit switches to indicate status closed and/or open positions. These switches shall not change over until the blades are within 5 % of the desired position.
- b) A local blade-position indicator shall be provided to indicate damper open and closed positions.

- c) A pneumatic, single-action spring-return actuator or a spring-return electric motor shall drive the damper open on supply of air or electric power and close the fire damper on loss of the same. Alternatively, spring-close, manual-open dampers may be considered. Spring selection shall ensure that the blades close firmly and against the maximum duct airflow and pressure.

Actuator selection shall allow the spring to remain in compression for most of its life, also for the possibility to adjust the spring for increased bearing friction in arduous locations. The actuator shall be sized 40 % above the damper-closing torque.

- d) In addition, a local manually opening device may be required by some authorities or design codes.

A thermal device assembly designed to activate the damper actuator and close the damper in the event of an unacceptable temperature rise in the duct may be provided as an option. If provided, the assembly shall be so designed that the trigger can easily be replaced without disassembly of pipework or components.

### A.9.2.3 Performance

Fire dampers should be designed to minimize turbulence and static pressure losses. The damper-control mechanism should operate uniformly and smoothly from the open to the closed positions, ensuring freedom from erratic movement.

Fire dampers shall be capable of opening and closing in any attitude or orientation over the full compressed-air pressure range and the HVAC system air-pressure range, up to maximum differential pressure, using 100 % fan pressure.

Fire dampers shall be designed to ensure closure under slow compressed-air bleed-off and with turbulent duct airflow.

Fire dampers shall be designed to close within 2 s of receiving the actuating signal, or as determined by platform safety philosophy. Air-pressure quick-exhaust valves are considered to improve the speed of closure, particularly of grouped dampers.

Fire dampers shall have a certification acceptable to the certification authority and be tested to a recognized standard. Project datasheets shall indicate required ratings.

The blade operation linkages and control devices shall be located out of the airstream in an integral enclosure that can easily be removed to allow maintenance. The design shall prevent over-travel and resultant blade distortion in both open and closed positions.

The failure temperature of the thermal device, if fitted, shall be as specified on the datasheet.

See the datasheet in Clause D.8.

## A.10 General dampers

### A.10.1 Function

Dampers other than for fire protection can be required for dedicated duties. Such dampers may be either mechanically or manually operated, depending on location and duty. For the purposes of this International Standard, mechanical dampers are those dampers operated or controlled by an electric, pneumatic or hydraulic actuator, while manual dampers are those dampers operated by a hand lever, ambient air pressure or gravity. Examples of such components and their method of operation are as follows:

- non-return or backflow dampers (self-acting), to prevent reverse flow of air through standby fans in duty/standby fan arrangements;
- volume-control or balancing dampers (manual), to assist balancing during system commissioning;

- pressure-relief (manual) and pressure-control (mechanical) dampers, to control pressure in pressurized areas;
- shut-off dampers (manual or mechanical), to isolate duct airstreams for maintenance, to prevent ingress of gas or to prevent reverse flow of air through standby fans in duty/standby fan arrangements;
- modulating dampers (mechanical), to control quantities of supply and recirculated air in recirculation HVAC systems.

## A.10.2 Functional requirements

### A.10.2.1 General

Whichever component is required, it shall be suitable for installation in any plane at any angle, with the exception of pressure-relief dampers, which are usually fixed in the vertical position only.

All dampers shall be constructed to withstand, and be able to close against, the expected total head pressure created by its closure. Pressures in the order of 2 500 Pa can be generated adjacent to the fan.

The actuator shall be sized 40 % above damper closing torque.

### A.10.2.2 Volume-control or balancing dampers

Volume-control or balancing dampers should be of the opposed-blade type, capable of being manually adjusted and locked in any position. Single-blade dampers may be used for small ducts (any single dimension up to and including 250 mm). The damper should be designed to operate in ventilation systems with velocities up to 25 m/s.

### A.10.2.3 Pressure-relief and pressure-control dampers

Pressure-relief dampers should have parallel-action blades controlled automatically by a tension spring or counterbalance mass, set to restrict the blade opening until a preset pressure is exceeded. The pressure-relief set point shall be site-adjustable.

Pressure-control dampers should generally be pneumatically operated with a pilot positioner to modulate to preset differential pressures, as determined by the control system.

### A.10.2.4 Shut-off/gas dampers

Shut-off/gas dampers may have parallel or opposed-action blades. Blade operating linkages shall be located out of the airstream in an integral enclosure that can easily be removed to allow maintenance. Linkage stops shall be provided to prevent over-travel in both open and closed positions. Blades shall operate within the overall casing length.

Shut-off dampers may be manually or mechanically operated.

Mechanical shut-off/gas dampers shall be complete with an actuator capable of overcoming the maximum torque imposed by the damper. The damper shall be provided with a proximity or limit switch to indicate the closed position.

Shut-off/gas damper leakage rates shall meet Class 3 (for blades) and Class B (for case) in accordance with EN 1751.

### A.10.2.5 Modulating dampers

Modulating dampers should be similar in construction to mechanical shut-off dampers, but should include a pilot positioner to modulate and control airflow under the dictates of the modulating control system.

See the datasheet in D.9.1 for mechanical dampers and in D.9.2 for manual dampers.

## A.11 Grilles and diffusers

### A.11.1 Function

Grilles and diffusers are required to effectively distribute supply air to, and capture extract air from, spaces being served by HVAC systems.

### A.11.2 Functional requirements

Whichever component is required, it shall be suitable for installation in any plane at any terminal unit. Material selection is influenced by aesthetics, the severity of the environment and the requirement to withstand mechanical impact. Two different categories usually define material selection and surface protection for each type of terminal device:

- heavy duty: exposed areas subject to mechanical strain and corrosive atmosphere; materials of construction should be heavy-gauge stainless steel or protected mild steel;
- light duty: LQ areas, control rooms; materials of construction for non-exposed applications may be of light-duty commercial construction.

All grilles and diffusers may be provided with integral, opposed-blade balancing dampers. These are intended for final adjustment of terminal air volumes and not for general system-distribution balancing.

When a primary system is adequate to achieve satisfactory air distribution, either adjustable-drum diffusers or two-way deflection blade grilles may be used.

Air displacement units should be considered in high-heat areas or if contaminants are possible. The location of supply and extract points should be carefully considered to ensure efficient removal of heat or contaminant.

In areas where early smoke detection is an important issue, such as switchgear rooms, CCR and LQ cabins, air supply using displacement units shall be considered.

Where the purpose of the grille is only to prevent rubbish accumulating in the duct and the balancing damper requires protection from unauthorized adjustment, a simple framed, flanged metal-mesh grille is adequate.

High-velocity jet nozzles (either single or multiple concentric rings) should be used in process modules where supply-duct distribution is limited and long throws for spot cooling are required, rather than high local entrainment for global area cooling.

Fixed-blade rectangular ceiling diffusers, producing either four-, three-, two- or one-way throw may be used in locations where light duty units are not sufficiently robust, e.g. mud labs and stores.

Where the purpose of the grille is only to dump air into an area where the distribution is via secondary ventilation, then a simple framed metal-mesh grille is adequate.

Where only a simple distribution pattern is required but there is the possibility of mechanical damage, for example in a process area storeroom, a one-way fixed blade unit may be used.

In uncluttered process areas where the primary duct can adequately distribute the air and the grille is out of the reach of personnel, adjustable two-way deflection grilles may be used.

Supply air may be provided through air displacement units or ceiling diffusers of square, rectangular, circular and/or linear type.

Where a grille is in a normally manned area, and aesthetics are important, then fixed-blade grilles having a one-way deflection of 45° to restrict vision into the duct should be used. In laundry or galley areas, where the level of contamination does not warrant special extract terminals but mild contamination can still be expected, then the angle of deflection should be 0° to ensure ease of cleaning.

In toilet and shower areas where small air volumes are involved, exhaust valves may be used as an alternative to grilles.

Where simple distribution is acceptable, for example in a storeroom in the LQ module, one-way fixed-deflection grilles may be used.

In areas in the LQ, such as a changing room or tea room, where diffusers are unsuitable, a two-way deflection grille can be used.

In applications where air transfer is required into a toilet area/cubical to maintain a specific airflow pattern, transfer grilles may be used. Their application (normally indoors) requires that they be opaque and can be fitted into sheet material down to a thickness of 25 mm. To meet this requirement, the construction may consist of two frames into which one chevron blade insert is attached.

See the datasheet in Clause D.10.

## A.12 Air-handling units (AHUs)

### A.12.1 Function

Installations provided with an LQ and/or integrated utilities areas usually demand a high throughput of supply air, which generally needs to be controlled within specific temperature and humidity constraints for personnel comfort. For energy conservation purposes, a certain proportion of extract air may be recirculated and mixed with supply air. These requirements are usually met most cost effectively by an air handling unit. Alternatively, a heat-recovery unit may provide further economies.

The implicit purposes of an AHU (as opposed to duct-connected components) are

- a) optimization of component performance by the equalization of face velocity,
- b) guaranteed pre-delivery performance testing,
- c) protection of the subcomponent items from mechanical damage, corrosion and contamination,
- d) improved accessibility to all components for maintenance,
- e) minimal total connected components length by optimization of design,
- f) minimal noise break-out by use of acoustic infill panels,
- g) minimal heat loss and external condensation by use of thermal-infill insulation to panels and frame sections, and
- h) reduced installation cost.

### A.12.2 Functional requirements

#### A.12.2.1 General

The design of both external and internal AHUs is similar, with the exception that external units should be fitted with a corrosion-resistant (generally stainless steel) pitched roof to prevent water/corrosive fluids pooling on the top of the unit, particularly between the section joints, causing corrosion and loss of air-tightness over a period of time.

Although most AHUs are located internally and are not subject to harsh environmental conditions once installed, experience has shown that AHUs should be built of sufficiently high quality to resist damage and corrosion whilst the unit is in the fabrication yard and/or during ship-out.

AHUs should preferably be of a design such that even air distribution is achieved across subcomponents and leakage is minimized. They should incorporate all major equipment items described in previous clauses of this International Standard required for the main air-supply plant.

Face velocities across plant items should be uniform. For limiting velocities, reference shall be made to the relevant plant item specifications.

A base frame shall be fitted to provide

- a) rigid support to the sectional construction,
- b) a structure that can be certified as a lifting frame,
- c) support of the unit off the platform steelworks,
- d) sufficient space below the unit to permit drain traps to be installed, and
- e) the facility for common electrical earthing connections.

In sections where there is the possibility of water collecting, the floor pan shall be of continuous sheet construction designed to run to a trapped drain. These traps shall be of sufficient depth to prevent the liquid seal from being either blown or sucked out during fan start-up when it is subjected to the total fan head pressure.

Motors should be mounted to permit easy removal, maintenance and replacement.

Units should be provided with flanges for the connection of ducting to both air inlet and discharge.

There are certain limiting design restrictions that shall be observed when locating the AHU's subcomponents, as listed in A.12.2.2 to A.12.2.8.

#### **A.12.2.2 Louvers in AHUs**

Liquid carryover, always possible from louvers, requires that drainage be provided both downstream of the louver and from its drain tray. Distance to downstream components that are sensitive to water shall be adequate to permit drop-out of any carryover. For an average face velocity over the louver of 2,5 m/s, this is on the order of 600 mm. Advice on precise data for the actual velocities shall be obtained from the louver manufacturer.

#### **A.12.2.3 Filters in AHUs**

There are no limiting values on distances between these items and other subcomponents, providing the adjacent subcomponents cannot damage or contaminate the filter, and operating velocities are within manufacturer's recommendations over the total filter cross-sectional area.

#### **A.12.2.4 Heaters in AHUs**

High off-coil temperatures and radiation from heaters can affect filter media. Confirmation shall be obtained from the filter supplier that the filter medium is not affected by radiated heat.

Provision shall be made to prevent air from bypassing the heater design contact surfaces.

#### **A.12.2.5 Cooling coils in AHUs**

Cooling-coil headers and return bends should be located outside the airstream.

Moisture carryover is a potential problem with these plant items. This may be prevented on low velocity coils by the installation of drip trays. However, on units where higher coil-face velocities are necessary (above 3 m/s) or the level of condensation is excessive, downstream eliminators shall be fitted.

Drain capacity shall be designed for extreme water condensation conditions.

#### A.12.2.6 Humidifiers in AHUs

Where humidifiers are fitted, preference should be given to fitting the steam generator outside the AHU casing.

Steam lances shall be located upstream of cooling coils to ensure that water carried over from steam lances is taken care of by an eliminator in the cooling-coil section.

#### A.12.2.7 Fans in AHUs

When evaluating the type of fan to be used, the following features should be considered.

- Axial- and mixed-flow fans have high inlet and outlet velocities, which can lead to uneven velocity profiles over connected subcomponents.
- Double-inlet centrifugal fans, when located in a plenum chamber, have low inlet velocities and usually lower outlet velocities than axial and mixed-flow units.
- Chamber fans have high inlet velocities and very low outlet velocities, which gives an even velocity profile over downstream subcomponents.

When duplex fans are fitted, the design of the AHU shall ensure that it is possible to remove one fan unit for servicing whilst the other unit remains operational.

#### A.12.2.8 Mixing dampers (air recirculation systems) in AHUs

An air-recirculation system dictates the requirement for three dampers operating in unison to ensure correct air mixing. It can be convenient if the outdoor air and recirculation dampers form an integral part of the AHU. If these dampers are used in a modulating action, then their performance should be matched to that of the exhaust damper. All three dampers should have a sufficiently high face velocity to ensure adequate distribution throughout the duct system. Dampers used for this purpose are required to be of the multi-blade opposed-action type to ensure a linear control over the full range of blade movement.

#### A.12.2.9 Access consideration in AHUs

The design of the AHU shall recognize the requirement for access, maintenance, observation and withdrawal of all plant items.

Access sections shall be provided to allow inspection of each subcomponent. Wherever possible, access sections should serve two adjacent subcomponents. Retention details for subcomponents shall be so designed that there is adequate provision for their removal from the AHU.

An AHU having an opening height between the inner face of the floor and roof post of 1 500 mm or more is classed as a "walk-in" unit. Access sections when fitted to these units shall have a clear width of not less than 550 mm. AHUs with opening heights less than 1 500 mm should be designed for side or top access. Under these circumstances, the access distance between components may be reduced to 450 mm providing the reach length to any item within the unit requiring servicing does not exceed 400 mm.

#### A.12.2.10 Controls and instrumentation

Consideration should be given to the provision of local controls and integration with the platform control and monitoring system. It is necessary that this be communicated to the supplier; individual datasheets for the key components provided in Annex D may be used.

See the datasheet in Clause D.11.

## A.13 Refrigeration packages

### A.13.1 Function

There can be a requirement to handle a cooling load on an installation, particularly in tropical climates. Refrigeration packages, comprising compressors, motors, condensing equipment, piping and controls are preferred over individual items, for reasons similar to those given for AHUs.

### A.13.2 Functional requirements

#### A.13.2.1 General

The refrigeration system shall be suitable for continuous, full-load operations and complete with integral automatic capacity control to maintain the desired unit capacity at all times, from minimum compressor capacity to 100 % duty. Hot-gas bypass and injection to the DX cooling coil shall be used only if an absolute requirement exists to achieve 0 % capacity that is not possible to achieve through the use of the compressor-capacity control facilities.

A closed-loop water system should be considered for final heat rejection to reduce the quantity of refrigerant.

Refrigerants with zero or low ozone-depletion potential (ODP) and low global-warming potential (GWP) shall be used.

The refrigeration system shall be capable of both continuous and intermittent duties with long idle periods. For both applications, facilities should be provided to ensure that maintenance demands are kept to a minimum.

Each refrigeration package should be mounted on an individual support base frame, complete with anti-vibration mountings and compressor acoustic enclosures as necessary. Manufacturers' standard-range equipment should be used wherever possible.

#### A.13.2.2 Refrigeration compressors

Compressors may be open, semi-hermetic or hermetic, providing the electrical equipment complies with the classification of the area in which it is located. Reciprocating, scroll and screw compressors may be used.

When selecting hermetic compressors for large DX systems, it should be remembered that a burn-out motor failure can lead to contamination of the refrigerant.

Where a standby compressor is installed, it shall be arranged to start automatically following the failure of the duty compressor. The switch-over between duty and standby compressors should be on a regular basis.

Compressors connected in parallel shall be equipped with oil-equalizer and crankcase pressure-equalizer lines, to maintain lubrication under all operating conditions.

Compressors for refrigeration units for individual rooms may be hermetically or semi-hermetically sealed.

The compressors shall be built and tested to recognized standards, such as ISO 917 [1], ISO 9309 [8], EN 378-1 [12], EN 378-2 [13], EN 378-3 [14] and EN 378-4 [15].

#### A.13.2.3 Refrigeration condensers

Condensers may be either water- or air-cooled, but under normal circumstances preference is shown for the use of water-cooled units, as they can form an integral part of the compressor skid and it is not necessary to subject them to any special hazardous-zone electrical requirements. Cooling water for these units normally comes from the service seawater supply. However, in the event that it is necessary to run the refrigeration during a hazardous shutdown situation, say in a control room or muster area, then it can be desirable to take the water feed from the deluge secure supply. Alternatively, units may be cooled with fresh water from the central fresh-water cooling system, if available.

Air-cooled condensers may be supplied for any duty for which a requirement is likely to exist. However, for duties above 100 kW, the units tend to become unacceptably large and, consequently, their use above this duty is discouraged.

#### A.13.2.4 Water-cooled condensers

The water-cooled condensers should be of the shell-and-tube type with liquid sub-cooling and should have removable heads for cleaning and tube withdrawal.

Tubes and tube endplates should be manufactured from material suitable for the duty, such as 90/10 cupro-nickel alloy or titanium. Shells should be carbon steel.

The design of the water-cooled condenser shall comply with a recognized industry standard, such as ISO 16812 [11].

Fouling factors shall be applied to the selection of the condensers. Suitable guidance is given by ASHRAE.

Water-cooled condensers may be mounted on a base frame common with the refrigeration compressors.

#### A.13.2.5 Air-cooled condensers

The unit fans should be direct-drive. Condenser coils should preferably be constructed of copper fins mechanically bonded onto copper tubes. Fouling factors shall be applied to both tubes and fins. The casing should be designed to make the unit fully weatherproof and suitable for installation in an outdoor marine environment. The liquid and gas lines should be provided with shut-off valves and pressure-relief valves.

#### A.13.2.6 Evaporators

The evaporators may be of the shell-and-tube type for chilled water systems or direct-expansion cooling coils, the requirements for which are set out in A.5.2.2.

Where used for cold-store applications, defrosting arrangements shall be provided where the temperature is controlled to below freezing point.

#### A.13.2.7 Controls

Each packaged refrigeration unit should be complete with a control panel of the manufacturer's standard range, wherever reasonably practicable, and should contain all or part of the following:

- a) main isolator/crankcase heater isolator; combined door interlock;
- b) compressor motor starters;
- c) on-off switches; automatic compressor start at minimum load;
- d) overload protection;
- e) control circuit fuses;
- f) capacity control system (if electric);
- g) auto-pump-down control;
- h) remote signal for operation;
- i) suction and discharge pressure gauges;
- j) oil pressure gauge;
- k) high-pressure cut-out;

- l) low-pressure cut-out;
- m) low-oil-pressure cut-out;
- n) condenser waterflow cut-out;
- o) condenser water-temperature gauge;
- p) remote signal facilities; common status run;
- q) status/alarm for each unit; common alarm fault;
- r) timer device to avoid rapid cycling;
- s) warning lamps;
- t) running lamps;
- u) reset buttons for the safety devices;
- v) hours-run meter for each machine;
- w) condenser fan-motor starters and head-pressure control, as appropriate.

The temperature control system may be solid-state/pneumatic, with proportional and integral action suitable for operation of the machines in parallel.

Facilities for interconnection with the main HVAC control panel should be incorporated.

See the datasheet in Clause D.12.

## **A.14 Constant-volume terminal reheat units (CVUs)**

### **A.14.1 Function**

CVUs may be fitted at the discharge end of a supply duct as an alternative to duct-mounted reheaters, to provide individual room temperature control.

### **A.14.2 Functional requirements**

#### **A.14.2.1 General**

CVUs should be suitable for operation when connected to supply systems where the on-unit static pressure can range from a minimum of 200 Pa to a maximum of 1 000 Pa, and the on-unit velocities can vary from a minimum of 5 m/s to a maximum of 15 m/s. Reference should be made to the datasheets for the precise service conditions.

Each unit is built up of a combination of the following components:

- constant-volume regulators or balancing damper;
- sound attenuator;
- air heater;
- air diffuser.

#### **A.14.2.2 Constant-volume regulators in CVUs**

The regulator should be designed as a self-actuating device, the motive force being supplied solely by the incoming distributed air supply. It should ensure that the volume throughput is maintained within  $\pm 5\%$  of the design set point for a constant entry supply temperature.

The set point should be manually adjustable whilst the unit is *in situ*, without the need for special tools.

The unit should preferably be selected at the midpoint of its design range. Where this is not possible, then the larger of the potential unit selections should be selected to ensure that the generated noise levels are as low as is reasonably practical.

Plastic or rubber compounds in the form of diaphragms or bellows should not form part of the construction of this unit.

#### **A.14.2.3 Air heaters in CVUs**

The heater should generally be electric and capable of both continuous and intermittent operations and meet the requirements for duct-mounted heaters set out in Clause A.4.

#### **A.14.2.4 Sound attenuators in CVUs**

The attenuator should comply with insertion losses, total pressure drop and flow self-generated noise limits as stated on the datasheet and meet the requirements for duct-mounted attenuators set out in Clause A.8.

See the datasheet in Clause D.13.

### **A.15 Dehumidifiers**

#### **A.15.1 Function**

Dehumidifiers can be required to ensure maximum humidity levels and to control the air humidity in rooms/enclosures to reduce/prevent corrosion and/or bacterial growth. In the majority of cases, the equipment is located within a protected environment and is provided to serve normally unmanned areas such as double bottoms and void spaces. Where necessary, however, the equipment shall be suitable for operation in hazardous areas.

#### **A.15.2 Functional requirements**

Dehumidifiers for this purpose should be of the absorption type where the humidity is exchanged from the process air to the regeneration air through a high-efficiency silica gel (or similar) rotor.

Fans and heater included in the unit shall comply with requirements specified elsewhere in this International Standard.

Each humidifier should be a complete, self-contained packaged unit, with all components mounted on a fabricated chassis and totally enclosed in stainless steel sheet cladding. The package should include all necessary internal control and safety devices, and be suitable for interface with the platform main control and monitoring system.

See the datasheet in Clause D.14.

**A.16 Ducts**

**A.16.1 Function**

Ducting is required to transport air to and from spaces being served by HVAC systems.

**A.16.2 Functional requirements**

The material of construction shall be suitable for the design life and operating environment, for which stainless steel, coated carbon steel and composites can be suitable.

Duct systems shall be constructed to a recognized standard such as EN 1505 [17], EN 1506 [18], EN 1507 [19] and EN 12237 [22], and may be categorized according to the duct pressure class.

Exhaust systems serving mud tanks and shale shakers shall be suitable for the dirty atmosphere to which they are exposed. Facilities shall be provided that permit access for frequent cleaning of all system components, equipment and the complete ducting systems. Access platforms and/or walkways can be necessary.

The following categories in Table A.2 are types of commonly applied options.

**Table A.2 — Duct classes**

Duct class	Material	Thickness or dimensions	Operating conditions
A	Stainless steel EN 10088 (all parts) [21] material No. 1.4404 or UNS S31603	3 mm	High-strength duct (plenum chambers) Duct exposed to weather and saliferous atmosphere Fire-rated duct
B	Stainless steel EN 10088 (all parts) [21] material No. 1.4401 or UNS S31600	EUROVENT 2/3 (circular) EUROVENT 2/4 (rectangular)	Internal duct in corrosive environments such as laboratories, battery rooms, paint stores, etc.
C	Stainless steel EN 10088 (all parts) [21] material No. 1.4401 or UNS S31600 EN 10088 (all parts) [21] material No. 1.4404 or UNS S31603	0,8 mm for Ø 80 mm to Ø 200 mm 1,0 mm for Ø 250 mm to Ø 315 mm 1,25 mm for Ø 400 mm to Ø 630 mm 1,5 mm for Ø 800 mm	Internal duct in production and utility areas Duct exposed to weather and saliferous atmosphere and/or mechanical strain
D	Carbon steel painted or hot-dipped galvanized	4 mm	High-strength duct Fire-rated duct
E	Pre-galvanized sheet steel	EUROVENT 2/3 EUROVENT 2/4	Internal duct in controlled environments such as LQs
F	Stainless steel EN 10088 (all parts) [21] material No. 1.4401 or UNS S31600 EN 10088 (all parts) [21] material No. 1.4404 or UNS S31603	0,8 mm for Ø 80 mm to Ø 200 mm 1,0 mm for Ø 250 mm to Ø 315 mm 1,25 mm for Ø 400 mm to Ø 630 mm 1,5 mm for Ø 800 mm	Fire-rated duct (Class C with fire-rated expanding joints/gaskets approved by certifying authority)

Galley extract systems and terminal reheat boxes in the LQ supply-air system shall also incorporate sufficient access to permit full system and component cleaning.

Inspection/access doors shall be 600 mm × 600 mm if the duct size permits. If the duct is smaller, the door should be as large as possible.

Flexible ducting should not be used on the installation except as a final connection in the LQ between terminal boxes and their associated ceiling diffusers, which shall be limited to a maximum length of 600 mm. Flexible ducting should not be used to correct misalignment in ducts.

Ducting connections to fan inlets and outlets shall terminate in a non-combustible, heavy, industrial-type, flanged, flexible connection able to withstand the system operating pressure range with minimum maintenance.

For circular and rectangular duct flanges, reference is made to Annex E.

All interface flanges on equipment covered by this International Standard shall be made in accordance with Annex E.

STANDARDSISO.COM : Click to view the full PDF of ISO 15138:2007

## Annex B (normative)

### Installation and commissioning

#### B.1 Installation

##### B.1.1 Joints

Different metallic materials should be isolated to prevent galvanic corrosion.

Ducts with limited access after installation should preferably be welded and/or all connections specially secured.

The jointing system should be of a well recommended type with a certified pressure class.

All duct fasteners (nuts, bolts, set screws, locknuts, washers) should be of carbon steel protected by electro-galvanizing for galvanized duct and stainless steel for stainless steel duct. Aluminium fasteners should not be used except with aluminium ducts. Any self-tapping screw should be of stainless steel. Dissimilar-metal contact should be avoided.

Joints in fire-rated duct or between fire dampers and the duct shall maintain the integrity of the particular fire-rated division.

##### B.1.2 Hangers and supports

The choice of methods for fixing depends on the type of structure and on the limitations that are imposed by the structural design. The fixings shall be of a strength and durability compatible with the duct and any attached equipment.

Internal hangers and supports generally should comply with a recognized standard, such as HVCA DW/144 [35]. External hangers and supports, and those exposed to external ambient conditions, shall be designed to withstand wind-imposed loads in addition to static loads.

The design of supports for vertical ducts is dictated by site conditions, and spacing may be greater than for horizontal ducts. Ducts should be supported from the stiffening angles or the angle flanges, but where this is impracticable, additional supporting angles should be provided.

The addition of insulation to ducts generally should not affect the method of support, providing vapour barriers are not required. Ducts with vapour barriers require the installation of insulating blocks to prevent direct connection between support and duct.

Supports should not be welded to the duct unless specified on the drawings.

When being erected, duct runs shall not be forced into place to suit the installed support, thereby introducing undue stresses into the duct.

Surfaces of supports that are inaccessible after erection shall receive a protective coating before assembly.

Duct supports shall be located such that the equipment can be removed from the system without a major dismantling of duct.

Additional stiffening should be installed to accommodate loads imposed during skidding, transportation and lifting. These temporary members should be painted to clearly indicate that they are required only during module location offshore.

Vibration isolation hangers can be needed in noise-sensitive areas.

Duct supports shall be designed to sustain a 2 *g* force in any direction. Where the system has a post-explosion role, the duct supports shall be designed accordingly.

### **B.1.3 Equipment installation**

Equipment shall be installed in accordance with the supplier's installation instructions and/or as specified on contract drawings and/or documents.

Duct-mounted equipment shall not be used as a load-bearing support.

Fire dampers shall be installed in the same manner as tested; otherwise the certification could be nullified.

### **B.1.4 Duct insulation**

All supply-air systems should be insulated where thermal conservation and anti-condensation protection is required. The insulation shall be complete with vapour barriers where the ventilation air temperature is likely to be below the ambient dew-point temperature. Extract and internal return air systems should not be insulated.

All insulating materials shall be non-combustible or meet the requirements of IMO Resolution MSC 61(67).

Installation and repair of duct insulation shall be in accordance with either recognized standards or requirements given in Table B.1.

It is necessary to assure the protection of personnel against harmful fume generation when passive protection systems are installed.

Where ducts penetrate fire-rated barriers, a sleeve of least 900 mm long shall be provided. The sleeve shall have the same fire rating as the barrier.

**Table B.1 — Insulation requirements**

Service	Duct location	Insulation material <sup>a, b, c</sup>	Purpose
Heat conservation <sup>d</sup>	Internal	Mineral wool or other suitable material	To reduce heat losses
Heat conservation <sup>d</sup>	External	Cellular glass Flexible elastomeric foam (FEF)	To reduce heat losses
Cold conservation <sup>d</sup>	Internal	Flexible elastomeric foam (FEF) Cellular glass	To maintain low temperature or prevent condensation on ductwork
Cold conservation <sup>d</sup>	External	Cellular glass Flexible elastomeric foam (FEF)	To maintain low temperature
Fire proofing A60 <sup>e</sup>	Internal	Mineral wool of rock-type, 110 kg/m <sup>3</sup>	To maintain fire integrity
Fire proofing A60 <sup>e</sup>	External	Alkali earth silica (AES-wool)	To maintain fire integrity
Fire proofing H0 <sup>e</sup>	Internal and external	Alkali earth silica (AES-wool)	To maintain fire integrity
Fire proofing H60 <sup>e</sup>	Internal and external	Alkali earth silica (AES-wool)	To maintain fire integrity
Acoustic insulation, ductwork internal	Internal and external	Mineral wool	To reduce noise

<sup>a</sup> The thermal conductivity shall be a maximum of 0,042 W/m·K at 20 °C mean temperature.

<sup>b</sup> Alternatives shall be qualified. If alternative materials are proposed, the insulation capability should be equivalent to, or better than, the capability for the specified material and thickness.

<sup>c</sup> Insulation should not have an "open" surface allowing fibres to break off and pollute the surroundings. A factory-applied cover is usually preferred to seal the insulation.

<sup>d</sup> For heat conservation and cold conservation, standard pre-insulated ductwork may be used.

<sup>e</sup> All fire insulation and installation methods on fire-rated components shall be certified.

**B.1.5 Insulation jacketing**

All open-cell insulation materials shall have factory-applied alufoil covering with a minimum thickness of at least 18 µm. In addition, exposed insulated ductwork shall have jacketing unless protected by a HVAC shaft or suspended ceiling.

The vapour barrier shall have a maximum vapour transmission ratio of 1,75 perm.

NOTE 1 perm = 1 ng/s · Pa<sup>-1</sup> · m<sup>-2</sup>.

The barrier shall be a fire-retardant, non-toxic, factory-applied cover, reinforced by glass-fibre-threaded tissue.

All thermal insulation thickness shall be determined in accordance with the calculations in ISO 12241.

All jacketing shall be provided in accordance with Table B.2.

Table B.2 — Jacketing requirements

Insulation	Duct location	Jacketing		
		Material	Thickness mm	
			With outer diameter ≤ 1 200 mm	With outer diameter > 1200 mm
Thermal insulation	Internal	Aluminium alloy <sup>a</sup>	0,7	0,9
		Stainless steel <sup>b</sup>	0,5	0,7
		Polymeric	1,0	1,0
	External	Stainless steel	0,5	0,7
		Polymeric	1,0	1,0
Fire insulation	Internal and external	Stainless steel	0,5	0,7

<sup>a</sup> Aluminium alloy jacketing should conform to AlMn1 (AA3103) or equivalent.

<sup>b</sup> Stainless steel jacketing should conform to EN 10088 (all parts) [21] material No. 1.4401-UNS S31600, 2B finish.

### B.1.6 Identification

The duct should be permanently marked to identify its function, in accordance with a recognized standard such as NS-5575 [28].

The identification symbols should be placed as follows:

- a) on ducting in ceiling behind access points;
- b) either side of major components (fans etc.);
- c) on all ducting in HVAC plant rooms;
- d) on ducting in shafts behind access doors and panels;
- e) on ducting entering and leaving modules;
- f) on ducting entering or leaving local equipment/control rooms in open modules/areas;
- g) both sides of firewalls where the duct penetrates;
- h) on each leg of a branch duct where the destination is not immediately obvious.

### B.1.7 Cleaning and protection

All ducts, fittings and equipment should be cleaned before erection.

All protective covers on equipment should be left in place as long as possible during erection.

Equipment should be adequately protected against damage during construction.

All duct elements should be supplied with dust blinds immediately after fabrication. Dust blinds should remain in place until the duct elements are actually required for installation.

Ducting terminated for later hook-up should be equipped with a blind on the open end immediately after installation.

When the duct system is finally installed and ready for mechanical completion, the entire system should be internally cleaned to cleaning class “High” in accordance with Table B.3.

There shall be easy access for internal inspection and cleaning of ducts.

**Table B.3 — Cleaning standards for ductwork**

Cleaning class	Guidance	Typical Frequency	Applies to
Fire risk	Clean to remove grease and lint deposits to < 1 g/m <sup>2</sup> (no visible surface dust).	Quarterly	Kitchen and laundry extracts
High	Inspect and if dust concentration is > 1 g/m <sup>2</sup> (visible surface dust) then clean to < 0,1 g/m <sup>2</sup> .	Yearly	Supply and recirculation ducts in continuously manned areas
Low	Inspect and if dust concentration, etc. is > 6 g/m <sup>2</sup> then clean to < 0,1 g/m <sup>2</sup> .	Every five years	All other ductwork

Materials containing synthetic mineral fibres that are used in the living quarters or in permanently manned areas shall be fully sealed.

Stainless steel duct should be kept externally covered during construction work to avoid contamination from other sources.

**B.1.8 Leakage testing**

A minimum of 10 % of the ducting and equipment shall be tested after installation. If the sample does not pass the test, the ducting and equipment for test shall be extended to demonstrate the system integrity.

For high-pressure systems (higher than 2 000 Pa), more extensive testing should be required.

The tests shall be carried out in accordance with a recognized standard, such as HVCA DW/143 [34] or Eurovent 2/2 [32].

**B.2 Commissioning**

The HVAC system shall be commissioned in accordance with project requirements to demonstrate the system performance characteristics as prepared under 5.2.10.

Commissioning procedures should include the following aspects:

- system balancing to a recognized standard, such as the CIBSE Commissioning Code [30];
- measurements of design airflows and air temperatures;
- differential pressures;
- sound-pressure levels of spaces.

All measurements and settings shall be conducted using calibrated instruments and the results documented.

All holes punched in the duct for the insertion of test instruments should be provided with easily identified, reusable covers; the holes should not be provided in flexible connections.

Covers for holes in fire-rated ducts shall comply with the fire rating of the duct.

Acceptance of the HVAC plant should not take place until satisfactory commissioning has been completed.

## Annex C (informative)

### Operation and maintenance

#### C.1 General

HVAC systems are designed to provide a safe working environment within the various enclosed hazardous and non-hazardous areas of an installation.

All doors leading to enclosed areas should be fitted with signs warning that the module is pressurized/under-pressurized and that the doors should be kept closed except for access or egress. If it is necessary to open module doors for periods longer than that required for normal access or egress, e.g. the moving of equipment, those doors should be manned for the duration of the work.

To ensure that the design objectives of the various HVAC systems are continuously achieved, it is necessary to monitor and carry out routine operational checks. If failure occurs, or if it is necessary to undertake maintenance on HVAC systems, appropriate temporary controls and/or equipment shall be put in place to mitigate any shortfall in protection caused by the failure or maintenance activity.

An operation and maintenance manual prepared for the HVAC systems should contain the following as a minimum:

- a) summary of the control philosophy and interface with F&G and/or ESD systems;
- b) which areas require the maintenance of a positive pressure relative to the hazardous modules;
- c) which areas require the maintenance of a negative pressure relative to the surrounding area (e.g. gas-turbine hoods);
- d) method and frequency of differential pressure monitoring;
- e) air change rate for all areas, irrespective of pressurization requirements;
- f) schematic drawing of each system and its components;
- g) temperature (and humidity, if appropriate) maintained in all areas;
- h) actions and compensating measures to be taken when failure occurs during normal operation of any HVAC system;
- i) routine maintenance activities;
- j) source of information to be consulted for the specification of spare parts and a listing of the stock spares carried.

#### C.2 Loss or reduction of ventilation

After a shutdown of the installation, plant or process, all critical HVAC systems shall be brought into operation prior to the introduction of hydrocarbons and the start-up of any hydrocarbon process.

Prior to undertaking any maintenance work that has the potential to reduce ventilation capacity, the following should be carried out, when relevant, in addition to any planned contingency arrangements:

- Installed gas-detector planned-maintenance routines for the module should be confirmed as up to date.

- Any defective gas-detectors, although acceptable for normal operating conditions, shall not be acceptable under reduced or nil HVAC conditions. In those instances where repair is not possible, installation of alternative manual/portable gas detection can be required prior to the reduction of HVAC.
- A check should be carried out on all sealing arrangements for reciprocating and rotating equipment in the module(s) concerned to confirm that no leaks are present.

In all cases where ventilation is reduced or equipment is out of service, it is recommended that the environment of the areas be continuously monitored for the build-up of toxic or flammable gas by use of the installation's fixed detection system and by sentries using portable meters.

When undertaking maintenance work on HVAC systems whilst the installation is still operational, the following criteria should be met, when relevant:

- a) Ventilation, although reduced in capacity, shall remain sufficient to avoid excessive heat build-up and/or build-up of flammable or toxic gases.
- b) Ventilation shall maintain non-hazardous areas at a positive differential pressure in relation to hazardous areas.
- c) Restrictions on time limits for the duration of reduced ventilation, as stipulated in the contingency arrangements facility system, shall be adhered to.
- d) Before commencement of work on the HVAC system, a stabilization period (approximately 4 h) shall be allowed following ventilation reduction and the affected area(s) monitored for the build-up of heat and/or toxic or flammable gases.
- e) If the work on the HVAC system, including isolations and de-isolations, is estimated to be completed in 4 h or less, then that work may commence without the preceding stabilization period.
- f) If significant changes occur within the module with respect to heat and/or gas levels, the work supervisor and installation manager shall be informed and the situation reviewed.
- g) During the HVAC work, the affected module/work area should be continuously monitored by fire watchers provided with portable gas monitors/alarms. These personnel should be in communication with the CCR.
- h) HVAC inlet ventilation ducts, doorways and any non-hazardous locations where the external module fabric is not leak-tight and that are adjacent to hazardous areas should be monitored for gas ingress.

Any temporary ventilation system should be installed to a standard similar to that which it is replacing and shall interface with the platform safety systems as required.

Where areas are fed by common inlet/outlet ventilation ducts, for either hazardous or non-hazardous areas, consideration should be given during the job planning stage to the likely impact upon the affected area if the ventilation system partially or totally fails while maintenance is progressing.

Work on HVAC systems should be limited to one system at a time, i.e. supply or extract, and the simultaneous maintenance or turning-off of ventilation in adjacent hazardous and non-hazardous modules should be avoided, unless positive separation can be maintained between them.

Before any work starts on HVAC equipment in a non-hazardous module adjacent to a hazardous module/area, checks should be made to ensure the integrity of any bulkhead penetrations connecting two such modules before the ventilation in the non-hazardous area is reduced.

If a pressure-differential reversal occurs between the non-hazardous and hazardous areas when the non-hazardous area ventilation is reduced, then the hazardous area process should be shut down and depressurized to mitigate against possible migration of explosive mixtures into the non-hazardous area.

Controls should be put in place where there is a requirement to remove a transit between areas of different classification. These can include

- a) integrating manual monitoring of the atmosphere,
- b) monitoring transits when left unattended,
- c) briefing door sentries on emergency actions, and
- d) providing portable gas detectors;
- e) providing communication to a manned control centre.

### C.3 Routine operational checks

The following checks should be carried out for all HVAC systems:

- a) Ensure that the correct duty fans are running normally and that the required pressurization, differentials, and, where appropriate, temperatures are being maintained. Any malfunctions should be investigated and corrective action taken.
- b) Standby fans, where fitted, should be tested periodically as part of the responsible person's watch-keeping duties. Where duty/stand-by fans are not designated, they should be regularly cycled to balance operational hours. Where applicable, standby fans should be on auto-start.
- c) Condition monitoring systems, where fitted, should be checked as operational and fit-for-purpose. This is of particular importance on systems that do not have standby facilities (fans).
- d) Fire dampers and watertight valves shall be tested at six-monthly intervals, or as determined by the maintenance strategy.
- e) Leakage rates shall not exceed the specified commissioning requirements.
- f) Drip tray and related drain connections should be cleaned monthly and cooling coils should be cleaned every four years.

## Annex D (informative)

### Datasheets

Table D.1 lists the datasheets included.

**Table D.1 — Datasheets — Numbering and reference**

Text reference clause	Component description	Datasheet reference clause or subclause
A.2	Louvers	D.1
A.3	Moisture separators and filters	D.2
A.4	Fluid heating coils	D.3.1
A.4	Electric heating coils	D.3.2
A.4	Unit heaters	D.3.3
A.5	DX cooling coils	D.4.1
A.5	Fluid cooling coils	D.4.2
A.5	Fan coil units	D.4.3
A.6	Humidifiers	D.5
A.7	Fans	D.6
A.8	Sound attenuators	D.7
A.9	Fire dampers	D.8
A.10	Mechanical dampers	D.9.1
A.10	Manual dampers	D.9.2
A.11	Grilles and diffusers	D.10
A.12	Air handling units	D.11
A.13	Refrigeration packages	D.12
A.14	Constant-volume terminal reheat units	D.13
A.15	Dehumidifiers	D.14

**D.1 Datasheet for HVAC equipment — Louvers**

<b>D.1</b>	<b>HVAC EQUIPMENT LOUVERS DATASHEET</b>	<b>Page 1 of 1</b>
<b>Package No.</b>	<b>Doc. No.</b>	<b>Rev.</b>
Tag No. _____	_____	Location/Module _____
System No. _____	_____	Number required _____
Size and type _____	_____	Enquiry No. _____
Supplier _____	_____	Quote No. _____
Manufacturer _____	_____	Purchase order No. _____
Model _____	_____	Job No. _____
_____	_____	Serial No. _____

<b>1 Technical data</b>			
2	Air flow rate	m <sup>3</sup> /s	
3	Separation efficiency		
4	No. of passes		
5	Face velocity	m/s	
6	Pressure drop	Pa	
7	Duct size	width	mm
8		height	mm
9	Unit length	mm	
10	Drain outlet	L/R	
11	Drain outlet size	mm	
12	Mesh screen	Yes/No	
13	Lifting lugs	Yes/No	
14	Unit mass	kg	
15			
16			
17			
18			
19			
20			
21			
22	<b>Materials</b>		
23	Casing	material	
24		thickness	mm
25	Blades	material	
26		thickness	mm
27	Flange size		
28	Drilled/undrilled		
29	Mesh screen	material	
30		mesh size	mm
31	Drain	material	
32			
33			
34			
35			
36	<b>Notes:</b>		
37	Applicable standard for performance: AMCA 500-D-98 <sup>[37]</sup>		
38			
39			
40			
41			
42			
43			
44			
45			
46			

D.2 Datasheet for HVAC equipment — Moisture separators and filters

D.2		HVAC EQUIPMENT MOISTURE SEPARATORS AND FILTERS DATASHEET		Page 1 of 1	
<b>Package No.</b>		<b>Doc. No.</b>		<b>Rev.</b>	
Tag No.	_____	Location/Module	_____		
System No.	_____	Number required	_____		
Size and type	_____	Enquiry No.	_____		
Supplier	_____	Quote No.	_____		
Manufacturer	_____	Purchase order No.	_____		
Model	_____	Job No.	_____		
		Serial No.	_____		
<b>1 Technical data</b>					
2	Outdoor conditions:	summer: temperature	°C		
3		relative humidity	%		
4		winter: temperature	°C		
5		relative humidity	%		
6	Unit composition:			Coalescer:	Separator:
7				Filter:	Sandfilter
8	Separation efficiency		%		
9	Filter class				
10	Air flow rate		m <sup>3</sup> /s		
11	Face air velocity		m/s		
12	Acceptable salt concentration		10		
13	Maximum acceptable particle size		µm		
14	Pressure drop (clean filter)		Pa		
15	Maximum recommended pressure drop		Pa		
16	Filter indicator required		Yes/No		
17	Type of indicator				
18	Unit orientation		V/H		
19	Duct size:	width	mm		
20		height	mm		
21	Unit length		mm		
22	Service side (in direction of airflow)		L/R		
23	Water trap required		Yes/No		
24	Height of seal in water trap		mm		
25	Trace heating required		Yes/No		
26	Trace heating cable	type			
27	Power supply		V		
28	Power consumption		W		
29	Junction box:	manufacturer			
30		type			
31	Glands	type			
32	Mass		kg		
<b>33 Materials</b>					
34	Filter medium				
35	Coalescer medium				
36	Filter frame	material			
37	Casing	material			
38		thickness	mm		
39	Separator vanes	material			
40		thickness	mm		
41	Drip tray	material			
42		thickness	mm		
43	Drain pipe	material			
44	Drain pipe flange	type			
45		size			
46					
47	<b>Notes:</b>	Applicable standards: EN 779 [18]			

**D.3 Datasheet for HVAC equipment — Heating coils**

**D.3.1 Datasheet for HVAC equipment — Fluid heating coils**

<b>D.3.1</b>	<b>HVAC EQUIPMENT FLUID HEATING COILS DATASHEET</b>	<b>Page 1 of 2</b>
--------------	---	--------------------

Package No.	Doc. No.	Rev.
Tag No. _____	_____	Location/Module _____
System No _____	_____	Number required _____
Size and type _____	_____	Enquiry No. _____
Supplier _____	_____	Quote No. _____
Manufacturer _____	_____	Purchase order No. _____
Model _____	_____	Job No. _____
		Serial No. _____

<b>1</b>	<b>Technical data</b>		
<b>2</b>	<b>General</b>		
3	Total heating load (design)	kW	
4	Heating medium		
<b>5</b>	<b>Design</b>		
<b>6</b>	<b>Heating medium side</b>		
7	Heating medium		
8	Heat exchanger mode		
9	Flow temperature	°C	
10	Return temperature	°C	
11	Specific heat capacity	kJ/kg.°C	
12	Specific mass (density)	kg/m <sup>3</sup>	
13	Heating medium flow rate	kg/s	
14	Heating medium treatment hypochlorite	10 <sup>-6</sup>	
15	Tube velocity	m/s	
16	Pressure drop	kPa	
17	Working pressure	kPa	
18	Design pressure	kPa	
19	Test pressure (air under water)	kPa	
<b>20</b>	<b>Airside</b>		
21	On-coil temperature - min.	°C	
22	Off-coil temperature - max.	°C	
23	Maximum temperature rise	°C	
24	Air volume flow rate	m <sup>3</sup> /s	
25	Air pressure drop	Pa	
26	System static air pressure (max.)	Pa	
27	Coil face velocity	m/s	
28	Heating duty (actual)	kW	
29	Airflow mode		
30			
<b>31</b>	<b>Construction</b>		
32	Airway/duct size - nom. width	mm	
33	Airway/duct size - nom. height	mm	
34	Coil casing depth	mm	
35	Flange size	mm	
36	Flange drilling detail		
37	Number of sections		
38	Section height	mm	
39	Total face area	m <sup>2</sup>	
40	Number of rows		
41	Fin thickness	mm	
42	Fin spacing	mm	
43	Tubes serviceable		
44	Tube diameter	mm	

<b>D.3.1</b>	<b>HVAC EQUIPMENT FLUID HEATING COILS DATASHEET</b>	<b>Page 2 of 2</b>
--------------	---	--------------------

Package No.	Doc. No.	Rev.
45	<b>Construction (continued)</b>	
46	Nozzle orientation (direction A/F)	
47	Nozzle size - flow	mm
48	Nozzle size - return	mm
49	Nozzle type/rating	
50	Header size	mm
51	Air vent size	mm
52	Drain cock size	mm
53	Mass - dry	kg
54	Mass - wet (operating)	kg
55		
56	<b>Materials</b>	
57	Tube material/thickness	mm
58	Tube finish	
59	Header material/thickness	mm
60	Header finish	
61	Fins-material/thickness	mm
62	Fins-finish	
63	Electrofinning thickness	mm
64	Casing material/thickness	mm
65	Casing finish	
66	Tube nozzles material/finish	
67	Drain cock material/finish	
68	Air vent material/finish	
69		
70		
71		
72	<b>Notes:</b>	
73		
74		
75		
76		
77		
78		
79		
80		
81		
82		
83		
84		
85		
86		
87		
88		
89		
90		
91		
92		
93		
94		

STANDARDSISO.COM : Click to view the full PDF of ISO 15138:2007

## D.3.2 Datasheet for HVAC equipment — Electric heating coils

D.3.2		HVAC EQUIPMENT ELECTRIC HEATING COILS DATASHEET		Page 1 of 2
<b>Package No.</b>		<b>Doc. No.</b>		<b>Rev.</b>
Tag No.	_____	Location/Module	_____	_____
System No	_____	Number required	_____	_____
Size and type	_____	Enquiry No.	_____	_____
Supplier	_____	Quote No.	_____	_____
Manufacturer	_____	Purchase order No.	_____	_____
Model	_____	Job No.	_____	_____
		Serial No.	_____	_____
<b>1 Technical data</b>				
<b>2 General</b>				
3	Heating duty (design)		kW	
4	Airflow mode			
5	Electrical power supply		V/Hz/P·h	
6	Area classification			
7	Hazardous area certification			
8	Hazardous area gas groups			
9	Hazardous area temp. classification			
10	Electrical enclosures IP rating			
11	Control method			
12	Control panel supplier			
13	Control panel location			
14	Control panel area classification			
15	Control panel tag number			
16				
<b>17 Design</b>				
<b>18 Airside</b>				
19	Air volume flow rate		m <sup>3</sup> /s	
20	On-coil temperature - min.		°C	
21	Off-coil temperature - max.		°C	
22	Maximum temperature rise		°C	
23	Heating duty (actual)		kW	
24	Air pressure drop		Pa	
25	System static air pressure (max.)		Pa	
26	Coil face velocity		m/s	
<b>27 Elements/Electrical</b>				
28	Element surface temp. - operating		°C	
29	Element surface temp. - maximum		°C	
30	Max. temp. inside element term box		°C	
31	Absorbed power		kW	
32	Full load current		phase amps	
<b>33 Protection/Safety control devices</b>				
34	High airway temperature (TAH)			
35	- TAH required		Yes/No	
36	- TAH trip set point		°C	
37	- TAH type of device			
38	- TAH reset method			
39	- TAH reset location			
40	High element surface temp. (TEH)			
41	- TEH required		Yes/No	
42	- TEH trip set point		°C	
43	- TEH type of device			
44	- TEH reset method			
45	- TEH reset location			

D.3.2		HVAC EQUIPMENT ELECTRIC HEATING COILS DATASHEET		Page 2 of 2
Package No.	Doc. No.	Rev.		
46	<b>Design (continued)</b>			
47	High high element surf temperature (TEHH)			
48	- TEHH required	Yes/No		
49	- TEHH trip set point	°C		
50	- TEHH type of device			
51	- TEHH reset method			
52	- TEHH reset location			
53	Airflow failure protection (AFF)			
54	- AFF required	Yes/No		
55	- AFF type of device			
56	- AFF supplier			
57	Temperature control (TC)			
58	- TC required	Yes/No		
59	- TC design set point	°C		
60	- TC type of device			
61	- TC supplier			
62				
63	<b>Construction</b>			
64	Airway/duct size - nom. width	mm		
65	Airway/duct size - nom. height	mm		
66	Coil depth	mm		
67	Overall heater width	mm		
68	Overall heater height	mm		
69	Flange size	mm		
70	Flange drilling detail			
71	Face area of coil	m <sup>2</sup>		
72	No. of element terminal boxes	No.		
73	Location element terminal boxes			
74	Total number of elements	No.		
75	Element length	mm		
76	Individual element power rating	W		
77	Total element surface area	m <sup>2</sup>		
78	Element cross section area	mm <sup>2</sup>		
79	Element bundles removable	Yes/No		
80	Power cable size/gland entry size			
81	Lifting lugs No. and position			
82	Earthing bosses No. and position			
83	Term. box lifting facility required	Yes/No		
84	Term. box lifting facility type			
85	Term. box/casing air space required	Yes/No		
86	Term. box/casing air space dim.	mm		
87	Casing thermally insulated	Yes/No		
88	Mass - operating	kg		
89				
90	<b>Materials</b>			
91	Element material			
92	Sheath material			
93	Sheath finish			
94	Element fill material type			
95	Element fill material density	kg/m <sup>3</sup>		
96	Casing material/thickness	mm		
97	Casing finish			
98	Term. box material/thickness	mm		
99	Term. box material finish			
100	Casing thermal insulation material			
101				

## D.3.3 Datasheet for HVAC equipment — Unit heaters

D.3.3		HVAC EQUIPMENT UNIT HEATERS DATASHEET				Page 1 of 2				
<b>Package No.</b>		<b>Doc. No.</b>				<b>Rev.</b>				
Tag No.	_____	Location/Module				_____				
System No.	_____	Number required				_____				
Size and type	_____	Enquiry No.				_____				
Supplier	_____	Quote No.				_____				
Manufacturer	_____	Purchase order No.				_____				
Model	_____	Job No.				_____				
		Serial No.				_____				
<b>1 General</b>										
2 Unit description										
<b>3 Unit composition</b>										
4	Component description	Tag No.				Ref. Datasheet No.				
5	Intake louver									
6	Air heater									
7	Fan									
8	Fan motor									
9	Air discharge damper									
10	Discharge louver									
11	Control panel									
<b>12 General</b>										
13	Heating duty (design)	kW								
14	Heating medium									
15	Air flow mode									
16	Electrical power supply	V/Hz/P·h								
17	Area classification	Hazardous				Non-hazardous				
18	Hazardous area certification									
19	Hazardous area gas groups									
20	Hazardous area temp. classification									
21	Electrical enclosures IP rating									
22	Control method									
23	Control panel supplier									
24	Control panel location									
25	Control panel area classification									
26	Control panel tag number									
<b>27 Design</b>										
<b>28 Airside</b>										
29	Air volume flow rate	m <sup>3</sup> /s								
30	On-coil temperature - min.	°C								
31	Off-coil temperature - max.	°C								
32	Maximum temperature rise	°C								
33	Unit heater mounting height	m								
34	Required air throw	m								
35	Air discharge velocity	m/s								
36	Heating coil face velocity	m/s								
37	Unit absorbed power	kW								
38	Heating duty (actual)	kW								
39	Air pressure drop	Pa								
40										
41	<b>Noise data (at rated duty)</b>	Sound power levels SWL in dB (ref. 10 <sup>-12</sup> W)								
42		Octave band centre frequency, Hz								
43		63	125	250	500	1 000	2 000	4 000	8 000	dBA
44	Guaranteed data at inlet/outlet									
45	Guaranteed data to surroundings									
46	Max. acceptable to surroundings									

<b>D.3.3</b>	<b>HVAC EQUIPMENT UNIT HEATER DATASHEET</b>	<b>Page 2 of 2</b>
--------------	---	--------------------

Package No.	Doc. No.		Rev.
47	<b>Construction</b>		
48	Unit overall dimensions	width	mm
49		height	mm
50		length	mm
51	Air intake dimensions	width	mm
52		height	mm
53	Air discharge dimensions	width	mm
54		height	mm
55	Casing type		
56			
57	<b>Materials</b>		
58	Unit frame and casing material		
59	Base frame material		
60	Electrical cable type		
61	Electrical cable support type		
62	Cable tray material		
63	Pipe connection material		
64	Pipe connection type		
65	Pipe material/thickness		
66			
67			
68			
69			
70			
71			
72			
73			
74			
75			
76			
77	<b>Notes:</b>		
78	1. Component design, construction and materials as individual datasheets.		
79			
80			
81			
82			
83			
84			
85			
86			
87			
88			
89			
90			
91			
92			
93			
94			
95			
96			
97			

STANDARDSISO.COM · Click to view the full PDF of ISO 15138:2007

## D.4 Datasheet for HVAC equipment — Cooling coils

### D.4.1 Datasheet for HVAC equipment — DX cooling coils

D.4.1	HVAC EQUIPMENT DX COOLING COILS DATASHEET		Page 1 of 2
<b>Package No.</b>	<b>Doc. No.</b>	<b>Rev.</b>	
Tag No. _____	_____	Location/Module _____	_____
System No. _____	_____	Number required _____	_____
Size and type _____	_____	Enquiry No. _____	_____
Supplier _____	_____	Quote No. _____	_____
Manufacturer _____	_____	Purchase order No. _____	_____
Model _____	_____	Job No. _____	_____
		Serial No. _____	_____
<b>1 Technical data</b>			
<b>2 General</b>			
3 Total cooling load (design)	kW		
4 Refrigerant type			
<b>5 Design</b>			
<b>6 Refrigerant side</b>			
7 Evaporating temperature	°C		
8 Evaporating pressure	kPa		
9 Refrigerant coil leaving temp.	°C		
10 Saturated suction temp. @ compressor			
11 Working pressure	kPa		
12 Design pressure	kPa		
13 Test pressure (nitrogen)	kPa		
<b>14 Thermostatic expansion valve (TEV)</b>			
15 Number of TEVs			
16 Number of solenoid valves			
17 TEVs' superheat settings	kPa		
18 TEVs' spring ranges	kPa		
<b>19 Capacity control</b>			
20 No. of cooling stages			
21 Minimum cooling load - % total load			
22 Hot gas injection required			
23 Hot gas header required			
<b>24 Airside</b>			
25 On-coil temperature - dry	db °C		
26 On-coil temperature - wet	wb °C		
27 Off-coil temperature - dry	db °C		
28 Off-coil temperature - wet	wb °C		
29 Air volume flow rate	m <sup>3</sup> /s		
30 Air pressure drop	Pa		
31 System static air pressure (max.)	Pa		
32 Coil face velocity	m/s		
33 Sensible cooling load (actual)	kW		
34 Total cooling load (actual)	kW		
35 Contact factor			
36 Apparatus dew point			
37			
<b>38 Construction</b>			
39 Airway/duct size - nom. width	mm		
40 Airway/duct size - nom. height	mm		
41 Coil depth	mm		
42 Flange size	mm		
43 Flange drilling detail			
44 Number of sections			

<b>D.4.1</b>	<b>HVAC EQUIPMENT DX COOLING COILS DATASHEET</b>	<b>Page 2 of 2</b>
--------------	--	--------------------

Package No.	Doc. No.	Rev.
45	<b>Construction (continued)</b>	
46	Section height	mm
47	Total face area	m <sup>2</sup>
48	Tube surface area	m <sup>2</sup>
49	Number of rows	
50	Fin thickness	mm
51	Fin spacing	mm
52	Tube bundles removable	
53	Isolation valves fitted	
54	Inlet (distributor) connection	mm
55	Outlet header size/connection	mm
56	Hot gas header size/connection	mm
57	Inlet/outlet locations direct'n A/F	
58	Hot gas location direct'n A/F	
59	Connection type/rating	
60	Eliminators required	
61	Drip pan required	
62	Manometric trap required	
63	Drain size/type	
64	Manometric trap seal depth	mm
65	Trap refill point required	
66	Mass - dry	kg
67	Mass - wet (operating)	kg
68		
69	<b>Materials</b>	
70	Tube material/thickness	mm
71	Tube finish	
72	Distributor material/thickness	mm
73	Distributor finish	
74	Discharge header mat/thickness	mm
75	Discharge header finish	
76	Hot gas header mat/thickness	mm
77	Hot gas header finish	
78	Fins material/thickness	mm
79	Fins finish	
80	Electroplating thickness	mm
81	Casing material/thickness	mm
82	Casing finish	
83	Drip pan material/thickness	mm
84	Drip pan finish	
85	Trap material/finish	
86	Tube nozzles material/finish	
87	Drain nozzle material/finish	
88	TEV manufacturer/type	
89	Solenoid valve manufacturer/type	
90		
91		
92		
93		
94	<b>Notes:</b>	
95		
96		
97		
98		

## D.4.2 Datasheet for HVAC equipment — Fluid cooling coils

D.4.2		HVAC EQUIPMENT FLUID COOLING COILS DATASHEET		Page 1 of 2
<b>Package No.</b>		<b>Doc. No.</b>		<b>Rev.</b>
Tag No.	_____	Location/Module	_____	_____
System No.	_____	Number required	_____	_____
Size and type	_____	Enquiry No.	_____	_____
Supplier	_____	Quote No.	_____	_____
Manufacturer	_____	Purchase order No.	_____	_____
Model	_____	Job No.	_____	_____
		Serial No.	_____	_____
<b>1 Technical data</b>				
<b>2 General</b>				
3	Total cooling load (design)	kW		
4	Cooling medium			
<b>5 Design</b>				
<b>6 Cooling medium side</b>				
7	Flow temperature	°C		
8	Return temperature	°C		
9	Cooling medium flow rate	kg/s		
10	Specific heat capacity	kJ/kg °C		
11	Specific mass (density)	kg/m <sup>3</sup>		
12	Cooling medium filtration	µm		
13	Cooling med. treatment hypochlorite	10 <sup>-6</sup>		
14	Tube velocity	m/s		
15	Pressure drop	kPa		
16	Working pressure	kPa		
17	Design pressure	kPa		
18	Test pressure (air under water)	kPa		
<b>19 Airside</b>				
20	On-coil temperature - dry	db °C		
21	On-coil temperature - wet	wb °C		
22	Off-coil temperature - dry	db °C		
23	Off-coil temperature - wet	wb °C		
24	Air volume flow rate	m <sup>3</sup> /s		
25	Air pressure drop	Pa		
26	System static air pressure (max.)	Pa		
27	Coil face velocity	m/s		
28	Sensible cooling load (actual)	kW		
29	Total cooling load (actual)	kW		
30	Air flow mode			
31	Contact factor			
32	Apparatus dew point			
<b>33 Construction</b>				
34	Airway/duct size - nom. width	mm		
35	Airway/duct size - nom. height	mm		
36	Coil casing depth	mm		
37	Flange size	mm		
38	Flange drilling detail			
39	Number of sections			
40	Section height	mm		
41	Total face area	m <sup>2</sup>		
42	Element surface area	m <sup>2</sup>		
43	Number of rows			
44	Fin thickness	mm		
45	Fin spacing	mm		
46	Tubes serviceable			
47	Tube diameter	mm		

D.4.2		HVAC EQUIPMENT FLUID COOLING COILS DATASHEET		Page 2 of 2
Package No.		Doc. No.		Rev.
48	<b>Construction (continued)</b>			
49	Nozzle orientation (direction A/F)			
50	Nozzle size - flow	mm		
51	Nozzle size - return	mm		
52	Nozzle type/rating			
53	Header size	mm		
54	Air vent size	mm		
55	Eliminators required			
56	Drip pan required			
57	Manometric trap required			
58	Drain size/type/rating			
59	Manometric trap seal depth	mm		
60	Trap refill point required			
61	Mass - dry	kg		
62	Mass - wet (operating)	kg		
63				
64	<b>Materials</b>			
65	Tube material/thickness	mm		
66	Tube finish			
67	Header material/thickness	mm		
68	Header finish			
69	Fins material/thickness	mm		
70	Fins finish			
71	Electrofinning thickness	mm		
72	Casing material/thickness	mm		
73	Casing finish			
74	Drip pan material/thickness	mm		
75	Drip pan finish			
76	Trap material/finish			
77	Tube nozzles material/finish			
78	Drain nozzle material/finish			
79				
80				
81				
82				
83				
84				
85	<b>Notes:</b>			
86				
87				
88				
89				
90				
91				
92				
93				
94				
95				
96				
97				

STANDARDSISO.COM · Click to view the full PDF of ISO 15138:2007

D.4.3 Datasheet for HVAC equipment — Fan coil units

<b>D.4.3</b>	<b>HVAC EQUIPMENT FAN COIL UNITS DATASHEET</b>				<b>Page 1 of 2</b>							
<b>Package No.</b>		<b>Doc. No.</b>			<b>Rev.</b>							
Tag No.	_____	Location/Module			_____							
System No.	_____	Number required			_____							
Size and type	_____	Enquiry No.			_____							
Supplier	_____	Quote No.			_____							
Manufacturer	_____	Purchase order No.			_____							
Model	_____	Job No.			_____							
		Serial No.			_____							
<b>1 General</b>												
2 Unit description												
3 Ref D & ID No.												
<b>4 Unit composition</b>												
5	Component description	Tag No.			Ref. Datasheet No.							
6	Fan											
7	Fan motor											
8	Filter											
9	Compressor/compressor motor											
10	Condenser											
11	Evaporator/cooling coil											
12	Control panel											
<b>13 Technical Data</b>												
<b>14 General</b>												
15	Total cooling load (design)	kW										
16 Cooling medium												
17	Condenser type	Air-cooled		<input type="checkbox"/>	Water-cooled		<input type="checkbox"/>					
18	Condenser location	Local		<input type="checkbox"/>	Remote		<input type="checkbox"/>					
19	Electrical power supply	V/Hz/P/h										
20	Area classification	Hazardous		<input type="checkbox"/>	Non-hazardous		<input type="checkbox"/>					
21 Hazardous area certification												
22 Hazardous area gas groups												
23 Hazardous area temp. classification												
24 Electrical enclosures IP rating												
25 Control method												
26 Control panel supplier												
27 Control panel location												
28 Control panel area classification												
29 Control panel tag number												
30												
<b>31 Design</b>												
<b>32 Airside</b>												
33	Air volume flow rate	m <sup>3</sup> /s										
34	Air inlet conditions	db/wb °C										
35	Air outlet conditions	db/wb °C										
36	Required air throw	m										
37	Air discharge velocity	m/s										
38	Cooling coil face velocity	m/s										
39	Unit absorbed power	kW										
40	Cooling duty (actual)	kW										
41	Air pressure drop	Pa										
42 <b>Noise data</b> (at rated duty)				Sound power levels SWL in dB (ref. 10 <sup>-12</sup> W)								
43				Octave band centre frequency, Hz								
44				63	125	250	500	1 000	2 000	4 000	8 000	dBA
45 Guaranteed data at inlet/outlet												
46 Guaranteed data to surroundings												
47 Max. acceptable to surroundings												

<b>D.4.3</b>	<b>HVAC EQUIPMENT FAN COIL UNITS DATASHEET</b>	<b>Page 2 of 2</b>
--------------	--	--------------------

Package No.	Doc. No.	Rev.
48	<b>Construction</b>	
49	Unit overall dimensions	width mm
50		height mm
51		length mm
52	Air intake dimensions	width mm
53		height mm
54	Air discharge dimensions	width mm
55		height mm
56	Casing type	
57		
58	<b>Materials</b>	
59	Unit frame and casing material	
60	Base frame material	
61	Electrical cable type	
62	Electrical cable support type	
63	Cable tray material	
64	Pipe connection material	
65	Pipe connection type	
66	Pipe material/thickness	
67		
68		
69		
70		
71		
72		
73		
74		
75		
76		
77		
78	<b>Notes:</b>	
79	1. Component design, construction and materials as individual datasheets.	
80		
81		
82		
83		
84		
85		
86		
87		
88		
89		
90		
91		
92		
93		
94		
95		
96		
97		
98		
99		
100		
101		
102		
103		
104		
105		

STANDARDSISO.COM · Click to view the full PDF of ISO 15138:2007

## D.5 Datasheet for HVAC equipment — Humidifier

D.5		HVAC EQUIPMENT HUMIDIFIER DATASHEET		Page 1 of 1
<b>Package No.</b>	<b>Doc. No.</b>			<b>Rev.</b>
Tag No.		Location/Module		
System No.		Number required		
Size and type		Enquiry No.		
Supplier		Quote No.		
Manufacturer		Purchase order No.		
Model		Job No.		
		Serial No.		
<b>1 Technical data</b>				
2				
<b>3 Airside:</b>				
4	Air flow rate		m <sup>3</sup> /s	
5	Upstream air temperature:	dry bulb	°C	
6		wet bulb	°C	
7	Downstream air temperature:	dry bulb	°C	
8		wet bulb	°C	
9	Humidification duty		kg/s	
10	Pressure at injection point		Pa	
11	Air velocity at injection point		m/s	
12	Duct size:	width	mm	
13		height	mm	
14	Distance to downstream obstruction		mm	
15	Dispersion panel required		Yes/No	
16				
<b>17 Water side:</b>				
18	Type/quality/making process			
19	Water:	pH value		
20		Conductivity		
21	Nominal flow rate		l/s	
22	Maximum flow rate		l/s	
23	Working pressure		kPa	
24	Dosing recommended			
25				
<b>26 Heater element/Electrical</b>				
27	Power supply		V/Hz/P·h	
28	Power consumption		kW	
29	Full load current		A	
30	Maximum element surface temperature		°C	
31	Glands	Type		
32				
<b>33 Protection/Safety control devices</b>				
34	High airway humidity control required		Yes/No	
35	Humidistat	Type		
36		Set point	% RH	
37	High element surface temperature (HEH)			
38		HEH required	Yes/No	
39		HEH type		
40		HEH trip set point	°C	
41		HEH reset method		
42		HEH reset location		
43				
44				
<b>45 Notes</b>				
46				
47				

D.6 Datasheet for HVAC equipment — Fans

<b>D.6</b>	<b>HVAC EQUIPMENT FANS DATASHEET</b>	<b>Page 1 of 2</b>
------------	--	--------------------

Package No.	Doc. No.	Rev.
Tag No. _____	Location/Module _____	_____
System No. _____	Number required _____	_____
Size and type _____	Enquiry No. _____	_____
Supplier _____	Quote No. _____	_____
Manufacturer _____	Purchase order No. _____	_____
Model _____	Job No. _____	_____
	Serial No. _____	_____

<b>1 Technical data</b>			
2 Fan type		Centrifugal fan: <input type="checkbox"/>	Mixed flow fan: <input type="checkbox"/>
3		Axial flow fan: <input type="checkbox"/>	Chamber fan: <input type="checkbox"/>
4 Fan installation	H/V		
5 Volume flow rate	m <sup>3</sup> /s		
6 Total pressure	Pa		
7 Static pressure	Pa		
8 Fan power consumption	kW		
9 Fan motor speed	r/min		
10 Fan impeller speed	r/min		
11 Max. allowable impeller speed	r/min		
12 Fan efficiency	%		
13 Ref. D & ID No.			
14			
<b>15 Construction</b>			
16 Motor tag No.			
17 Motor datasheet No.			
18 Fan handling (ref. figure next page)			
19 Inlet type	S/D		
20 Inlet chamber	Yes/No		
21 Inlet size (diameter)	mm		
22 Discharge size (W × H, diameter)	mm		
23 Impeller type			
24 Impeller shaft bearing type	DE/NDE		
25 Flexible connection w/flanges	inlet: Yes/No		
26	discharge: Yes/No		
27 Flange standard	inlet:		
28	discharge:		
29 Inlet guard	Yes/No		
30 Discharge guard	Yes/No		
31 Anti-spark track	Yes/No		
32 Inspection door	Yes/No		
33 Inspection door size (W × H)	mm		
34 Casing drain size	mm		
35 Earthing boss	Yes/No		
36 Drive arrangement		Direct drive: <input type="checkbox"/>	Belt drive: <input type="checkbox"/>
37			
38 Direct drive details:		Coupling: <input type="checkbox"/>	Impeller on motorshaft: <input type="checkbox"/>
39 Coupling type			
40 Coupling material			
41 Coupling manufacturer			
42 Belt drive details:			
43 No. of belts			
44 Belt type			
45			