NORSK STANDARD NS-EN ISO 15138

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ICS 75.180.20

Petroleums- og naturgassindustri Produksjonsinstallasjoner til havs Oppvarming, ventilasjon og luftkondisjonering (ISO 15138:2000)

Petroleum and natural gas industries
Offshore production installations
Heating, ventilation and air-conditioning
(ISO 15138:2000)

Engelsk versjon

Standarden er fastsatt av Norges Standardiseringsforbund (NSF). Den kan bestilles fra NSF, som også gir opplysninger om andre norske og utenlandske standarder.

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Nasjonalt forord

Den engelskspråklige versjonen av europeisk standard EN ISO 15138:2000 er fastsatt som Norsk Standard NS-EN ISO 15138:2001.

National foreword

The English language version of European Standard EN ISO 15138:2000 has been adopted as Norwegian Standard NS-EN ISO 15138:2001.

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 15138

November 2000

ICS 07.018.20

English version

Petroleum and natural gas industries - Offshore production installations - Heating, ventilation and air-conditioning (ISO 15138:2000)

Industries du pétrole et du gaz naturel - Installations en mer - Chauffage, ventilation et climatisation (ISO 15138:2000)

This European Standard was approved by CEN on 26 October 2000.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN ISO 15138:2000 E

Foreword

The text of the International Standard ISO 15138:2000 has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum and natural gas industries" in collaboration with Technical Committee CEN/TC 12 "Materials, equipment and offshore structures for petroleum and natural gas industries", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2001, and conflicting national standards shall be withdrawn at the latest by May 2001.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

NOTE FROM CEN/CS: The foreword is susceptible to be amended on reception of the German language version. The confirmed or amended foreword, and when appropriate, the normative annex ZA for the references to international publications with their relevant European publications will be circulated with the German version.

Endorsement notice

The text of the International Standard ISO 15138:2000 was approved by CEN as a European Standard without any modification.

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Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

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

Annexes A through F of this International Standard are for information only.

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 which are:

— new and existing;

— normally occupied by personnel and not normally occupied by personnel;

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

NOTE For installations that could be subject to "Class" or "IMO/MODU Codes & Resolutions", the user is referred to HVAC requirements under these rules and resolutions. Should these requirements be of a lesser degree than those being considered for a fixed installation, then this International Standard, i.e. requirements for fixed installation, should be utilized.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

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

3 Terms and definitions

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

3.1
displacement ventilation
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.

3.2
fixed offshore installation
all **facilities** located and installed on **fixed offshore structures**, which are provided to extract oil and gas hydrocarbons from subsea oil and gas reservoirs

3.3
fixed offshore structure
structure permanently fixed to or located on the sea bed, including moored ships and hulls, which is held in position by anchors or tensioned cables and is provided to (structurally) support topsides facilities

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

3.4
fugitive emission
emission which is always present 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 may be detected using bubble-test techniques or tests of a similar sensitivity.

3.5
open area
area in an open-air situation where vapours are readily dispersed by wind

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

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

[ISO 13702:1999, definition 2.1.52]

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	Driven End
DX	Direct Expansion
EN	European Standard
ESD	Emergency Shutdown
F&G	Fire and Gas
HAZOP	Hazard and Operability Study
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
IP	Integrity Protection
LFL	Lower Flammable Limit
LQ	Living Quarters
MODU	Mobile Offshore Drilling Unit
NDE	Non-driven End
NFPA	National Fire Protection Association
NS	Norsk Standard (Norwegian Standard)
QRA	Quantitative Risk Analysis
r.m.s.	Root mean square

5 Design

5.1 Introduction

Clause 5 together with annex A provide requirements and guidance on all aspects of the design of heating, ventilation and air-conditioning (HVAC) systems for offshore installations for the petroleum and natural gas industries. The HVAC systems form part of the safety services of the installation. The safety goals are to:

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

— prevent the formation of potentially hazardous concentrations of flammable gaseous mixtures in hazardous areas by provision of sufficient ventilation for the dilution, dispersion and removal of such mixtures;

- maintain ventilation to all equipment and areas/rooms which are required to be operational during an emergency when the main source of power is unavailable;
- provide a controlled environment in which personnel, plant and systems can operate effectively, including smoke control.

These high-level goals are supported by lower-level goals of a functional nature which are stated later in the appropriate sections of this document.

Subclause 5.2 concentrates on functional requirements in the development of a basis of design for either a new project or major modification to an existing installation. The requirements are related to:

a) platform orientation and layout;

b) hazard identification and hazardous area classification;

c) environmental conditions;

d) choice of natural or mechanical ventilation systems;

e) development of the controls philosophy;

f) material selection;

g) design margins and calculations;

h) design development and validation using wind tunnel testing or Computational Fluid Dynamics (CFD).

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 may be progressed using the guidance and examples of good engineering practice that are identified in this document, 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 document to facilitate presentation. The processes outlined here are equally applicable to major redevelopments to existing installations, but some compromise may need to be made 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 may be significantly greater than for a new design.

The finalized basis of design may be recorded on data sheets such as those provided in annex E.

The completed design should 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. Functional requirements are outlined which will enable the objectives to be achieved. The functional requirements are supported by technical guidance given in annex A, which discusses the suitability of different techniques for different applications and identifies examples of good engineering practice or cost-effective solutions that have been used in some parts of the world. The functional requirements may be satisfied by other methods not identified in this document, but it is the responsibility of the user to assess whether the method is technically acceptable and acceptable to the local regulator.

Subclause 5.3 addresses the fundamental choice in system design, i.e. between natural and mechanical methods of ventilation.

Subclause 5.4 gives functional requirements associated with the design of HVAC systems for different areas of a typical offshore installation which require particular technical considerations due to their location and/or their function.

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 clauses of this International Standard which provide the necessary guidance.

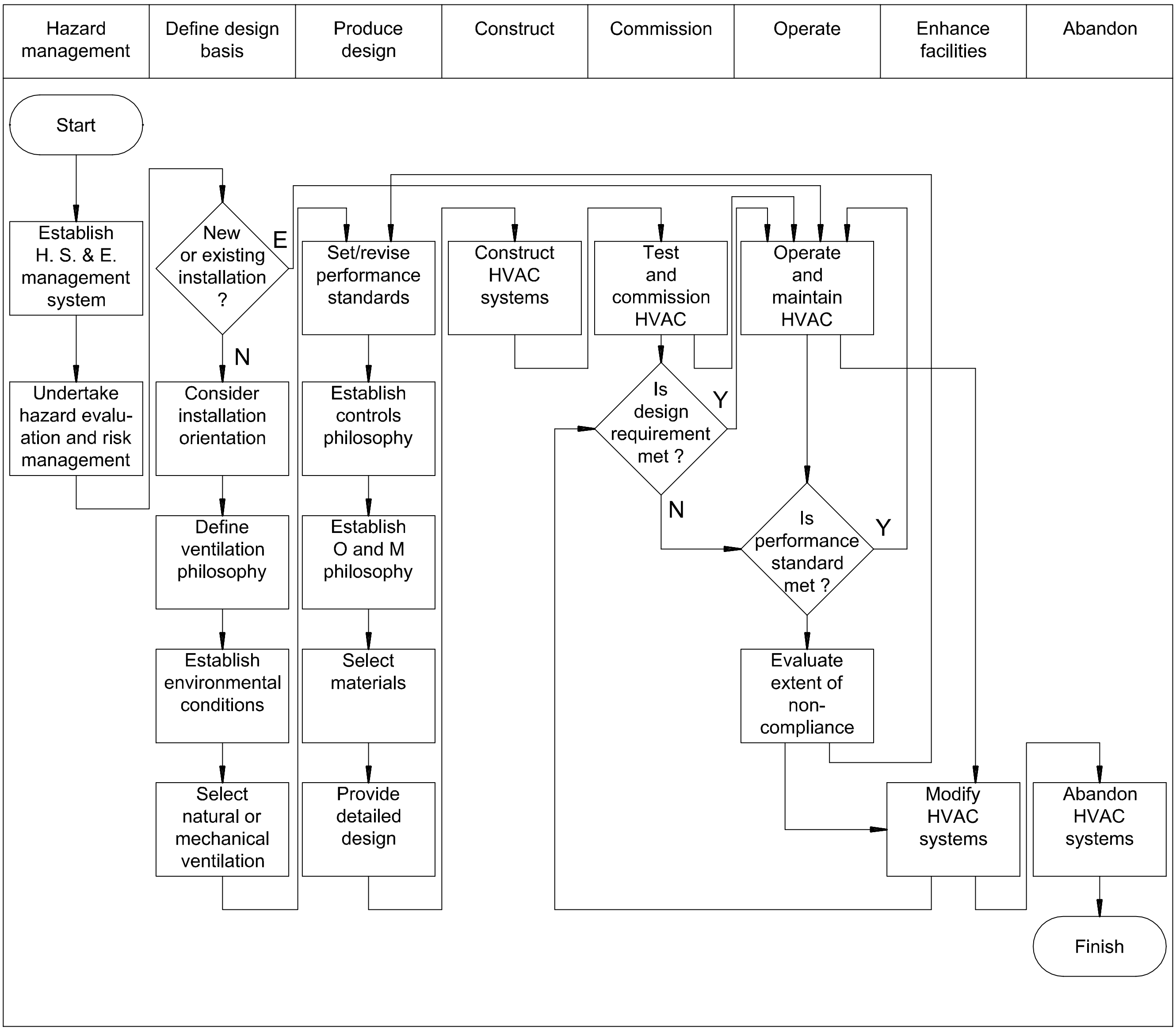

Figure 1 — Application of this International Standard to a project life cycle

5.2 Development of design basis

5.2.1 Orientation and layout

5.2.1.1 Objective

To provide input into the early stages of design development so that areas and equipment that may 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, might have an impact in the decision-making surrounding installation orientation and layout.

Each installation should have a temporary refuge (TR). The TR should in almost all cases be the LQ, where they are provided. The survivability of the TR, which is directly related to the air change rate, may introduce consideration of active HVAC systems for pressurization of the Living Quarters (LQ) 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 will be 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 nonhazardous 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.

For guidance, reference is made to clause A.1.

5.2.2 Hazardous area classification and the role of HVAC

5.2.2.1 Objective

To adopt in the design and operation processes a consistent philosophy for the separation of hazardous and nonhazardous 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 to be used in particular areas of the installation and also provides input to the performance standards for HVAC systems in those areas.

For guidance, reference is made to clause A.2.

5.2.3 Environmental conditions

5.2.3.1 Objective

To determine an environmental basis of design that enables HVAC systems to be designed 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.

For guidance, reference is made to clause A.3.

5.2.4 Natural/mechanical ventilation

5.2.4.1 Objective

To select a means of providing ventilation to any hazardous or nonhazardous area of an installation.

5.2.4.2 Functional requirements

Provide ventilation to any area which may require it, giving consideration to:

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

For guidance, reference is made to clause A.4.

5.2.5 Selection of controls philosophy

5.2.5.1 Objective

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, if required;

d) comply with the installation smoke and gas control philosophy.

For guidance, reference is made to clause A.5.

5.2.6 Operating and maintenance philosophy

5.2.6.1 Objective

To provide an HVAC design which provides as high a degree of operational availability, so far 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, plant operating margins, 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.

For guidance, reference is made to clause A.6.

5.2.7 Materials and corrosion

5.2.7.1 Objective

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 may be affected by their operation.

5.2.7.2 Functional requirements

The design shall recognize the saliferous atmosphere and relative humidity that will be 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 in conjunction with flammable atmospheres may be required for some components.

For guidance, reference is made to clause A.7.

5.2.8 Design margins and calculations

5.2.8.1 Objective

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

5.2.8.2 Functional requirements

The design shall be documented in accordance with suitable industry standards, i.e. those of ASHRAE, CIBSE 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.

For guidance, reference is made to clause A.8.

5.2.9 Wind tunnel and CFD modelling

5.2.9.1 Objective

To undertake a modelling programme that reproduces installation conditions within a reasonable accuracy, so that design options may be consistently evaluated and the chosen option optimized with a high degree of confidence that the design performance will be replicated by actual measurements.

5.2.9.2 Functional requirements

If required, a modelling programme shall be undertaken to predict

— natural ventilation rates and frequencies;

— wind pressure distribution around the installation to fix 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.

For guidance, reference is made to clause A.9.

5.2.10 Performance standards

5.2.10.1 Objective

To define performance standards for HVAC systems which may be used as a basis for managing risk throughout the life of the installation.

5.2.10.2 Functional requirements

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

For guidance, reference is made to clause A.10.

5.3 System design — General

5.3.1 Natural ventilation

5.3.1.1 Objective

Natural ventilation shall, wherever possible, be provided to

— dilute local airborne concentrations of flammable gas 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, compliance with the following basic requirements is necessary if ventilation of an area/module by natural means alone is to be considered sufficient:

— 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.

For guidance, reference is made to clause A.11.

5.3.2 Mechanical ventilation

5.3.2.1 Objective

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 contamination between areas and maintain acceptable working and living environments for personnel and non-destructive conditions for equipment.

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

a) nonhazardous areas;

b) hazardous areas;

c) living quarters;

d) areas to be in operation during emergency situations;

e) auxiliary systems for naturally ventilated areas;

f) drilling areas;

g) substructure;

h) areas with contaminated air (separate extract).

The minimum ventilation air volumes shall be documented.

For guidance, reference is made to clause A.12.

5.3.3 Secondary ventilation systems

5.3.3.1 Objective

To provide a system to supplement natural or mechanical ventilation when the distribution of air 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.

For guidance, reference is made to clause A.13.

5.4 Area-specific system design

5.4.1 Process and utility areas

5.4.1.1 Objective

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 nonhazardous areas. The system design shall include a fan-powered supply plant which draws 100 % of its outside air from a nonhazardous area and supplies it to the module.

Airflow in terms of air changes per hour for a nonhazardous area shall be sufficient to meet the pressurization requirements determined by the local regulation or hazardous area code classification adopted, free-cooling and personnel needs. Specific exhaust requirements, e.g. fume cupboards, welding benches/booths, etc., may also require consideration.

At outside maximum and minimum design temperatures, areas shall not exceed the temperature set by local regulation, applicable codes of practice or company standards. Refer to Table A.2 in A.3.4.

Air change rates determined in 5.2.2 shall be applied, but at a rate sufficient to dilute fugitive hydrocarbon emissions. Any free-cooling requirements for the area shall also be met.

For guidance, reference is made to clause A.14.

5.4.2 Living quarters

5.4.2.1 Objective

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 (in terms of air changes per hour) shall be established from requirements for heating or cooling outdoor air and the need for pressurization.

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.

For guidance, reference is made to clause A.15.

5.4.3 Drilling and drilling utility areas

5.4.3.1 Objective

To provide mechanical or natural ventilation to satisfy requirements.

5.4.3.2 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.

For guidance, reference is made to clause A.16.

5.4.4 Gas turbine enclosures

5.4.4.1 Objective

To provide sufficient ventilation to satisfy requirements.

5.4.4.2 Functional requirements

The ventilation system shall be designed to remove heat from machinery and to dilute flammable gas.

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

For guidance, reference is made to clause A.17.

5.4.5 Emergency plant ventilation

5.4.5.1 Objective

To provide sufficient ventilation to equipment that may be required to operate in an emergency under the conditions that may be present at the time.

5.4.5.2 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.

For guidance, reference is made to clause A.18.

5.4.6 Battery and charger rooms

5.4.6.1 Objective

To provide sufficient ventilation to satisfy requirements.

5.4.6.2 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.

For guidance, reference is made to clause A.19.

5.4.7 Laboratories

5.4.7.1 Objective

To provide sufficient ventilation to satisfy requirements.

5.4.7.2 Functional requirements

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

For guidance, reference is made to clause A.20.

5.4.8 Purge air systems

5.4.8.1 Objective

To provide sufficient ventilation to satisfy requirements.

5.4.8.2 Functional requirements

HVAC services for air supplies to components and plant requiring to be kept purged, such as draw-works and rotary table motors, shall at all times have outside air drawn from a nonhazardous source.

For guidance, reference is made to clause A.21.

5.4.9 Rooms protected by gaseous extinguishing agents

5.4.9.1 Objective

To provide sufficient ventilation to satisfy requirements.

5.4.9.2 Functional requirements

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

For guidance, reference is made to clause A.22.

5.4.10 Engine-room ventilation in diesel-engined ships

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

Annex A
(informative)

Guidance to clause 5 Design

A.1 Guidance to 5.2.1

Results of wind tunnel model tests or CFD calculations on the installations should be considered in order to determine the external zone(s) of wind pressure in which to locate the intake(s) and outlet(s) for the HVAC system(s). Particular care should 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 may be classified as nonhazardous and have stable wind conditions. However, consideration should 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.

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

Air intakes should 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;

— supply and support vessels.

The siting of gas turbines and generators usually poses a challenge to layout designers. They should be located in a nonhazardous area and with consideration to the following points.

a) The air intake should be sited 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 should be located such that powder and dust is 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 should be avoided and be demonstrated by wind tunnel tests or CFD. These tests should also show that exhaust flue 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 air temperature rise above the surface of the helideck should be agreed for helicopter operation.

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

A.2 Guidance to 5.2.2

The application of a recognized hazard identification and assessment process may identify a role for the separation and segregation of inventories on an installation. Area classification codes specify separation distances between hazardous and nonhazardous areas in order to avoid ignition of those releases which 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 "as safe as is reasonably practicable" approach to 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 can be calculated from data in API 4589 [29], using the methodology given in API RP 505 [28].

It is recommended that areas be classified using the general guidance of IEC 60079-10. Specific guidance for classifying petroleum facilities can be found in documents such as The Institute of Petroleum Area Classification Code for Petroleum Installations, Model Code of Safe Practice Part 15 (IP Code Part 15) and API RP 505 [28].

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

— provide a suitable atmosphere for personnel and equipment;

— remove excess heat;

— provide enhanced rate of ventilation to mitigate against the build-up of potentially explosive atmosphere.

A.3 Guidance to 5.2.3

A.3.1 External meteorological conditions

In the absence of local regulations, the need for shelter should be evaluated and may reveal a subsequent need for an HVAC system.

The design of the HVAC systems should be based on local regulations or design codes. Conservative selection of criteria may carry a cost, weight and power penalty.

Seasonal extremes of temperature, humidity and wind speed vary widely throughout the world, and local regulations governing working conditions may also dictate the allowable extremes in occupied or unoccupied spaces. Local environmental information should be specified in the basis of a design that does not result in additional capacity being installed to cater for a small proportion of the year during which meteorological extremes are encountered.

Sub-local effects on the external environmental conditions should 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, should 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 should 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 may provide data from this source for areas where ship data is not statistically significant. A third alternative, but probably the least reliable, is the extrapolation of data from nearby onshore sites.

The following provides typical data that could 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 average 3 s gust 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 may be recorded at a different height on an installation. The corrections factors in Table A.1 should be applied to the commonly reported 1-h mean wind velocities.

Table A.1 — Wind corrections factors

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

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

Wind velocity factors at other heights can be obtained from the reference value at 10 m using the power law profile in equation (A.1):

$$v_h = v_{10} \times (h/10)^n \quad \text{(A.1)}$$

where

v_{10} is the velocity at 10 m above sea level;

v_h is the velocity at height h above sea level;

n is the power law exponent.

EXAMPLE 2 A wind measured at an average velocity of 7 m/s at deck level 50 m above mean sea level would have a velocity at the 10 m base of

$$v_{10} = 7 \text{ m/s} \times (1{,}00/1{,}22) = 5{,}77 \text{ m/s}.$$

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

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

A.3.2 Maximum sea temperature

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

A.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 and the coincident relative humidity occur. 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 should be noted that maxima of room-cooling load may 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 can be applied from reference [32] 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 should also be considered.

A.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 regulation. An alternative approach based on a measurement of population acceptance is given in ISO 7730 [8]. The ISO method applies only to manned areas. Table A.2 gives guidance which may be used if the approach outlined in the ISO standard is not adopted.

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 should be located at points in the HVAC systems where they can control both break-out and break-in of sound. 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 sound levels. Care should 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.

Outdoor air inlets and outlets should be attenuated to a value where they do not exceed the local predicted background level by 5 dB or exceed NR 55 at a distance of 3 m from the outlet, whichever is the more onerous.

Sound power generated by, or transmitted through, the HVAC systems should not contribute to exceeding the levels stated in local regulations, recognized standards or the guidance given in Table A.2. An analysis should 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 should be suitably designed to reduce the risk of grease/lint accumulation and subsequent fire hazard.

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

Table A.2 — Recommended indoor environmental conditions

Description	**Examples**	**Minimum temperature** °C	**Maximum temperature** °C	**HVAC noise limit** dB (A)	**Comments**
Manned areas – sedentary work	Control room Radio room	19	24	45	
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	
	Temporary LQ and Offices	19	24	40	
	Drystore Gymnasium	16	21	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	35	70	25 °C maximum may be determined by the use of some regeneration batteries

A.4 Guidance to 5.2.4

The major consideration in installation layout and ventilation philosophy is likely to be risk, whether it be 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 may be expected to contribute to the modelling of smoke and gas releases as part of the decision-making process.

Production areas generally should 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, should 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.

Fully open modules provide the ideal arrangement for natural ventilation. If weather protection is required, it can be provided in the form of weather louvres. The performance of properly designed weather louvres is superior to alternative forms of weather protection.

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

In hot climates, roofing or other protection may be provided instead of mechanical ventilation.

Mechanical ventilation should be used when ventilation by natural means is unable to satisfy requirements.

Powered systems should operate satisfactorily in wind conditions varying from still air to design wind velocity and plant margins should be included in the design or fans conservatively sized in order to ensure the requirements are met during adverse wind effects.

Free cooling, i.e. cooling by outside air is preferred to cooling by refrigeration, where practical. In some parts of the world it may be practical and energy efficient to use seawater cooling, for which further guidance is given in clause B.4. Environmental data from project locations should be used to determine available free-cooling potential, and should 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 may exceed design maximum for short periods during peak outside conditions. Designs should 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 should be particularly included in the cooling-load calculations, as experience demonstrates that underestimation of resultant system temperature rise is a common problem.

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

It may be necessary, where heat gains are excessive, to use 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.

Drilling facilities, such as shale shaker and mud tank areas/modules, should have an air change rate determined by the air quantity required for the extraction of fumes, heat and dust, and will 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 can be used for make-up.

The design of HVAC systems in drilling facilities is discussed in more detail in clause A.16.

A.5 Guidance to 5.2.5

A.5.1 General

The philosophy outlined in this subclause is representative of good practice on large, integrated installations, and may not be appropriate to very small installations and those that are not normally manned where HVAC is not considered to have a role in asset protection.

The systems should be integrated into the overall monitoring and safety systems of the installation, and should be provided with controls for normal and emergency operations which should be within, or readily accessible from, a normally manned central location, usually the Central Control Room (CCR).

Decisions regarding the extent of manual control should 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 may not be considered necessary to take 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 should 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 HVAC plant may be installed. In all cases a common alarm should be indicated at the F&G panel in the CCR. In addition, fire/gas damper status should be indicated at the F&G panel in the CCR as a minimum.

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

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 be determined early in design development. Where mechanical ventilation systems are installed, careful attention should 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 may vary among different operators and among different statutory regulators. Two alternative HVAC shutdown philosophies for a large integrated offshore installation are described below.

A.5.2 Philosophy 1

In the event of a gas release, the objectives are to dilute and remove the resulting gas cloud and limit migration to other areas. The strategy to achieve this is normally to

— keep the HVAC system running upon detection of gas within a hazardous area in order to dilute and remove the gas;

— isolate the HVAC system upon detection of gas in an HVAC inlet, since it is assumed that the gas is being drawn in from other areas;

— isolate the HVAC system to a nonhazardous area upon detection of gas in the inlet to or within the nonhazardous area, since it is assumed that the gas is being drawn in from other areas.

In the event of a fire, the ventilation system should keep on running and thereby

— reduce the pressure build-up and thereby reduce the spread of smoke;

— secure evacuation from the area and possible manual fire-fighting.

This philosophy is based on a system design where the prevention of fire and smoke spread is built into the design from the initial phase. The following design parameters should therefore be incorporated:

a) displacement ventilation provided with supply at low levels and extract at high levels;

b) assessment should determine whether duct penetrations through area fire-barriers should be fire-rated or provided with fire dampers. The fire rating of the penetration and any associated fire damper should be at least equal to that of the boundary it penetrates;

NOTE For installations designed to IMO/MODU Codes, this may be mandatory.

c) fire dampers which are automatic fail-safe by release of a local heat-detection device;

d) manual/remote operation of fire dampers;

e) fans powered from sources which will function at such times.

A.5.3 Philosophy 2

In the event of a gas release, the objectives and the strategy to achieve this are normally the same as for philosophy 1, but in the event of a fire the area should be isolated in order to

— limit the spread of the fire;

— limit the supply of combustion air to the fire;

— reduce the movement of smoke to other areas where it may impede emergency response.

Mechanical HVAC presents a path for any of the above and should therefore incorporate the following.

a) Assessment should determine whether duct penetrations through area fire barriers should be fire rated or provided with fire dampers. The fire rating of the penetration and any associated fire damper should be at least equal to that of the boundary it penetrates.

NOTE For installations designed to IMO/MODU Codes, this may be mandatory.

b) Fire dampers should automatically close and, where appropriate, HVAC should shut down manually or automatically, to isolate an area upon detection of fire in the area.

c) Boundary fire dampers for enclosed TR facilities should automatically close upon detection of smoke at the HVAC inlet or a fire in any area where there may be a risk of smoke impingement upon the TR facility. Consideration may be given to the installation of smoke-control systems.

To pre-empt gas or smoke ingress to HVAC ducts, it is recommended that these actions with respect to LQ/TRs are also coincident with any planned shutdown of the process facilities.

A.5.4 Control and monitoring — Normal operation

A.5.4.1 Dedicated and integrated HVAC panels

All controls and indicators serving similar types of equipment should 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 should 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.

A.5.4.2 Local control of fans

A manual on/off station should 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, should be provided with start/stop control, complete with run indication, local to the equipment or working position.

A.5.4.3 Fire/gas damper controls

Control of the actuators should 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 should be grouped such that automatic operation of any one should automatically initiate operation of all the others.

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

A.5.4.4 Loss of differential pressure

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

In each nonhazardous area adjacent and connecting to a hazardous area, each extract fan should be prevented from starting until its associated supply fan run-up velocity has been reached and the supply shut-off damper has opened. Failure of a supply fan should stop its associated extract fan, but failure of an extract fan should not stop its associated supply fan.

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

A.5.4.5 Temperature control

Duct- or unit-mounted water/steam heat exchangers (heating and cooling coils) should 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 should be controlled using either one- or two-step direct-switching thermostats or contactors or thyristors.

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

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

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

Outdoor-air and recirculation dampers, where fitted, should be automatically controlled by external ambient and recirculation air temperature sensors, and should be fixed such that sufficient outdoor air is introduced as given in clause A.2. An override facility should 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 should not exceed the T-rating for the area as specified in IEC 60079-0 [14].

A.5.5 Control and monitoring — Emergency conditions

The HVAC-systems should receive signals from the ESD/F&G/manual trips consistent with the selected shut-down and tripping philosophy.

Once stopped, the fans should be prevented from being re-started 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 should be restarted in accordance with the initial 'start-up' procedure.

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

It may 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 may continue to operate during an emergency, consistent with the TR philosophy. The need for space cooling depends on the rate of temperature rise due to electrical/electronic equipment heat. Emergency-powered cooling should be provided only when maximum operating-space temperatures or the permissible "heat stress" is exceeded within the required emergency operating period. It should be recognized that equipment heat dissipation during an emergency may be significantly less than under normal circumstances.

Where room air conditioners are installed and are required to operate to provide cooling during emergencies, they should only recirculate air. Outside air should normally be supplied from the central system and should be isolated in emergencies through fire/gas damper operation.

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

A.6 Guidance to 5.2.6

The functional requirements can 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;

— criticality of key components in normal or emergency conditions.

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

Where a system and equipment are designed for continuous operation, consideration should be given to the "sparing" philosophy. Sparing of equipment is preferred to minimize down-time and improve the availability of essential services. This need is normally served 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 may however be practicable 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 may 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 should be provided on each fan to prevent backflow and facilitate maintenance. Controls should ensure that damper opening and closure is coincident with associated fan operation.

Central refrigeration plant should have a specified level of standby to provide adequate cooling capacity where loss of cooling cannot be tolerated.

One objective of equipment selection should be to reduce spares stock quantities and to incorporate maximum standardization of components to enable interchangeability between all HVAC systems on an installation. Special attention may need to 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 need for operational availability, the system should be designed to maximize intervals between maintenance periods and the emphasis should 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.

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

a) Plant and equipment should be floor-mounted wherever possible;

b) plant and equipment should have good access for maintenance purposes;

c) permanent access platforms should 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 should be provided;

e) ample withdrawal/removal space should be provided for all items of plant and equipment;

f) designs should include provision for lifting and handling of plant and components during construction/maintenance.

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

A.7 Guidance to 5.2.7

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 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 which:

— 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 weight savings and corrosion-resistant capabilities, but it should be recognized that the temperature of sparks from aluminium may be above the auto-ignition temperature of certain hazardous gases.

For short lifetimes, as for example on upgrade or refurbishment work, it may 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 which could have been avoided by a more conservative, but expensive, choice of materials at the outset.

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

The specification of ductwork in mild steel which is painted or galvanized after fabrication may, depending on local market conditions, prove more cost-effective than thinner stainless steel. Additionally, offshore construction of HVAC systems seldom involves an accuracy which removes the need 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 should 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 should 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.

A.8 Guidance to 5.2.8

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

Fans should be selected to operate on the steep part of their performance pressure/volume curve to ensure minimal volume fluctuations during adverse wind conditions. The operating point used should be at the required volume, as determined by the basis of design, with the pressure loss based on the actual system resistance, filters being taken at their average pressure drop, plus any pressurization load that may be required in nonhazardous modules.

The accumulation of individual equipment operating margins should 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, he should demonstrate that he has 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, i.e. the doubling of small motor sizes is unlikely to create a problem, where as the same approach on large motors may alter the size of generators, cabling and switchgear.

The performance of the combined supply and extract system should then be checked for adverse wind conditions. A value of design wind velocity consistent with that given in A.3.1 should be used, with the effect being calculated using a computer-aided engineering package recommended by ASHRAE, CIBSE or similar authority. This load will 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 should be evaluated, along with the effect of the changes in infiltration. Variations in the process performance should also be considered, as they may affect heat gains and fugitive gas leaks to the space.

Where practical, the fan and motor should be selected to cater for 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 should 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 should be checked for wind gusts producing velocities with a probability of exceedance of 0,1 %, to ensure the systems will naturally recover 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.

A.9 Guidance to 5.2.9

A.9.1 General

CFD and wind-tunnel modelling are powerful tools to help design safer and cheaper installations. However, it is important to remember that the application of wind tunnel and CFD models to the goal is never routine. They are bespoke techniques requiring careful implementation by experts. CFD and wind tunnels give the wrong results if not properly applied. In particular, the results of wind tunnel and CFD models should always be accompanied by a clear statement of validation and of the uncertainties: are the results correct within ±10 %, 100 % or an order of magnitude? Without this, the information is of limited use. The following subclauses provide advice on the use of wind-tunnel models and CFD.

A.9.2 Wind-tunnel modelling

For external flows, the model scale should not be less than 1:150 and the model cross-section should be small compared to the wind tunnel cross-section (i.e. blockage by the model < 10 %). The use of scale models built for other purposes, such as display, is not acceptable because the model will not have the appropriate surface roughness height. Smooth poly(methyl methacrylate) models are not acceptable for the same reason. The model should have the main structural features of the installation. The finer detail (0,5 m and less) can be modelled by surface roughness elements. The roughness should be estimated from the details of the particular installation in question.

NOTE Further information on the rules for surface roughness is contained in reference [42].

The model Reynolds number should (conservatively) exceed 10 000 for sharp-edged platform structures of interest, such as the Temporary Refuge. For full-size circular-section structures where the Reynolds number is less than 1 000 000, the rule above applies. If the full-size Reynolds number exceeds 1 000 000, then it is not possible to model these as accurately. If the results of the wind-tunnel testing are strongly dependent on these structures, then the results should be treated with extra caution.

For internal flows or situations where there is a coupling between the internal and external flows, such as in well-ventilated modules, wind-tunnel models representing the entire facility are in many cases not appropriate. This is discussed further in A.9.4.

In smoke tests, concentrations at the points of interest should be measured and not estimated from video footage. Correction of the measured values to allow for the flame extension and smoke evolution point should be applied. The Froude number, buoyancy and the relative velocity between the free stream and the fire efflux rate should equal the full-scale values.

A.9.3 Computational fluid dynamics

A.9.3.1 General

The alternative to wind-tunnel studies is computational fluid dynamics. CFD has few of the scaling problems of wind-tunnel models, but requires careful implementation if one is to minimize new problems. Like wind-tunnel studies, CFD is never a handle-turning exercise. The major problems of CFD are discussed below.

A.9.3.2 Grid independence

Between 150 000 grid points and 300 000 grid points are required for a basic model of the turbulent dispersion about an offshore installation to predict the smoke concentration to no better than ±10 % and no worse than an order of magnitude. Increasing the number of grid points increases costs, roughly speaking, to a power of 2 to 2,5, but usually the value of this in terms of increased accuracy will not be known in advance.

A.9.3.3 Turbulence models

There are four main categories of turbulence model:

a) algebraic (zero-equation) models;

b) one-equation models;

c) two-equation models;

d) second-order closure models.

The k-φ model commonly used in industry is a two-equation model (k is the turbulent kinetic energy and φ is the dissipation rate of the turbulent kinetic energy.) The advantages of the k-φ turbulence model are relative mathematical simplicity and the resulting numerical stability [43]. The disadvantage is that, strictly, k-φ is incorrect other than for very simple flows. It becomes progressively less reliable with curvature of the streamlines, in adverse pressure gradients and in separated regions (all of which are found on oil and gas installations).

However, the k-φ turbulence model is frequently used well beyond its strict applicability and gives apparently good results in some industrial problems. A few comparisons with large scale experiments on offshore structures have indicated that on average, the flow and concentrations can be predicted to within a factor of 1,5.

More sophisticated models may give much better results and be more soundly based, but they are difficult to run and are sometimes unstable for large-scale industrial flows.

A.9.3.4 Differencing schemes

CFD solutions are strongly dependent on the discretization or difference scheme of the governing equations. It is a matter of experience and trial and error as to which gives the best results.

A.9.3.5 Wall roughness and boundary conditions

Leschziner [44] indicates that the region around walls can exert a crucial influence and states that the boundary conditions in turbulent flows are never complete.

For dispersion estimates around an installation, the current models and geometry approximations are not able to predict the flows near a boundary correctly.

Furthermore, a model of an installation model should be constructed inside a grid that extends away from the installation model. The six external faces of this box should also have the flow specified on them. It is important that these faces be sufficiently far from the installation that this can be done without introducing uncertainty. This is broadly equivalent to the requirement that the wind-tunnel cross-section is large compared to the model cross-section. To be able to predict the overall dispersion characteristics, the marine boundary layer (velocity and turbulent profiles) should be used as upstream boundary conditions in the models.

A.9.3.6 Parameter setting

The k-φ model has at least six adjustable parameters. It is important to make sure they have the correct values. In the standard k-φ model, the effects of buoyancy on turbulence are not included. This term is essential for buoyant flow predictions and should be included in every calculation. Omission or incorrect values of this term results in wrong gas/smoke trajectories.

A.9.3.7 The source term

As in wind-tunnel studies, the source term (for example, a fire in a module) can be difficult to model. The source should have the correct temperature and if possible the correct turbulence levels. Again, correction of the estimated concentration to allow for the flame extension is required.

A.9.4 External pressure distributions and exhaust plumes

Both wind tunnels and CFD modelling may be undertaken to assess the wind-pressure distribution around the installation. The pressure distribution can then be used to assist in the positioning of inlets and outlets and to confirm wind loadings on fan systems. In addition, both techniques can be applied for predicting the behaviour of generator-exhaust plumes and their effect on helideck operation. Wind tunnels have the advantage that they allow the modelling of the fluctuating temperature components, which are important for helicopter operation. CFD gives average values because of the turbulence models used.

A.9.5 Hazard modules

The aim is to minimize the hazards from gas build-up which could result in an explosion by providing mechanical and/or natural ventilation to disperse fugitive emissions. Natural ventilation rates and requirements for forced ventilation should therefore be assessed for these fugitive emissions. Natural ventilation rates can be estimated using CFD models, but this is probably a disproportionate effort. Zone models are simpler and in most cases are adequate for this need. For prediction of the forced ventilation patterns, CFD may be more appropriate. For all other hazards, the installations should be assessed against gas build-up and explosion consequences. The risk frequencies from gas ingress and explosions should be expressed as exceedance curves, i.e. the probability of exceeding a certain gas volume. These can then be linked to explosion risks.

The need to predict realistic explosion overpressures determines the need to predict realistic gas-cloud geometry and composition from any specified release. Both wind tunnel and CFD models could be used to predict the gas build-up, but this is an area where considerable research is directed and all models are not fully validated. Special expertise is essential if high confidence in predicted gas-cloud composition and shape is required. The following guidelines can be applied until the results of research work are available.

Wind-tunnel modelling tends to introduce large errors in modelling these flows because of scaling effects. The coupling between the internal and external flows is not yet validated. The discharge coefficient across the module faces, which determines the flow inside the module, varies with Reynolds number over the velocity range available in the wind tunnels. The flow inside the modules is also governed by the process equipment distribution and pipework. It is therefore difficult to reproduce the effects in a wind tunnel model, owing to the low values of Reynolds number used when the model includes the entire structure. If wind-tunnel models are used for modelling gas build-up, two separate models should be used, one of the overall structure at which the boundary conditions upwind of the module in question will be measured and a separate model using the measured upwind conditions to measure the gas dispersion in the module. Care is required that the release is correctly scaled, such that the model rate has the same momentum and energy of the real release. The CFD models do not have the Reynolds number scaling problems, but have not been validated for predicting gas build-up. If used, either a two-model approach, similar to the wind tunnel, or a computational grid greater than 300 000 should be adopted. All the comments made previously also apply to these flows. Similar to wind tunnels, care is required in the estimate of the initial release conditions, both in terms of velocity and turbulence.

A.9.6 Smoke and gas modelling around the site

A variety of obstructions are likely to be present on offshore installations, and the complexity of these obstructions affects the behaviour of smoke plumes. Historically, work on smoke plumes has been based on free plumes in unobstructed space. In reality, the mixing and dilution process is more complex than this. On the one hand, increased turbulence around the installation increases the dispersion of smoke, while on the other hand, smoke released into the wakes of modules may be partly sheltered from the wind so the dispersion would be reduced. It is now well accepted that free-field models are very conservative.

Irrespective of the modelling technique used for smoke dispersion, it is essential that the correct boundary conditions be used. In reality, the smoke is released at the flame edge and not at the source of the release, and this needs to be taken into account when the plume behaviour is estimated. Again, the type of fire needs to be considered. Experimental evidence indicates that the smoke evolution point varies for jet and pool fires. For jet fires the evolution point tends to be near the flame tip, while for pool fires the evolution point starts at about 1/3 of the flame length.

A.10 Guidance to 5.2.10

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 will generally be quantitative and should clearly define the level of performance needed for compliance.

An important principle to be adopted in the setting of performance criteria is that their number and level of detail should be commensurate with the magnitude of the risk to be managed. Thus caution should 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 may not be directly measurable, but nevertheless they should be capable of verification from either analytical studies, or from the results of assessments of low-level performance criteria.

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

a) The items selected should make a significant contribution to the management of risk;

b) the parameters selected should be directly relevant to the achievement of the system goals;

c) the parameters selected should be capable of verification.

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

— the functional parameters of the particular system (a statement of the purpose and the essential duties that the system is expected to perform);

— the integrity, reliability and availability of the system;

— the survivability of the system under the conditions which may be present when required to operate;

— the dependency on other systems which may 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 should be particularly focused on those elements which are critical in achieving satisfactory health, safety and environmental conditions.

- Procedural or operational criteria should not be neglected in favour of hardware-type criteria.

- Criteria should be directly measurable and should not require extensive computational effort after measurement.

- Measurement and recording of data to confirm compliance with performance criteria should 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 will be undertaken in a conscientious and efficient manner.

- Measured parameters should, wherever possible, be clearly identifiable as contributing to risk reduction. If this is not obviously so, efforts should 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, periodic review and updating of 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.

A.11 Guidance to 5.3.1

It is preferred to ventilate production areas by natural means. The adequacy of this form of ventilation should be demonstrated by wind-tunnel testing and/or CFD to ensure sufficient air flow into, within and out of modules.

To ensure sufficient air movement (distribution) throughout a naturally ventilated module, it may be necessary to provide secondary (scouring) ventilation. Refer to clause A.13. Modules that cannot be sufficiently ventilated by natural means should be provided with mechanical assistance, as above, or be enclosed and provided fully with mechanical means to achieve the required ventilation rate.

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

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

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

A.12 Guidance to 5.3.2

A.12.1 General

Hazardous and nonhazardous systems should be designed to prevent possible contamination of nonhazardous systems caused by reverse flow through ductwork systems in the event of partial system failure.

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

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

— extent of offshore hook-up;

— topside weight;

— space requirements;

— power requirements;

— maintenance requirements.

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

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

Where nonhazardous areas are adjacent to hazardous areas, a differential pressure should be maintained to meet the requirements of the chosen hazardous-area classification code. A form of relief venting from the space should 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 guidance on the selection of this equipment is given in clause B.9.

In order to ensure the installation of an effective HVAC system consideration must be given to the following aspects during design of mechanical ventilation systems:

A.12.2 Differential pressure

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

Construction of enclosures required to be pressurized should 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 should be taken at the design stage and monitored throughout the installation life.

A.12.3 Effect of wind

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

From an operating aspect, wind may adversely affect fan performance and area pressurization, and plant margins should be included in the design in order to ensure the requirements are met during adverse wind effects. Refer to clause A.8. Powered systems should operate satisfactorily in wind conditions varying from still air to design wind velocity, though the specified values will be exceeded when wind velocities greater than design occur.

A.12.4 Inlets and outlets

The potential for contamination and reverse flow through the ductwork in the event of partial system failure should 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 [32], for this purpose.

Air from nonhazardous areas should be exhausted to a nonhazardous area.

Air inlets and outlets from the various systems should be protected from wind-driven rain and snow entering the plant. Refer to clause B.2.

A.12.5 Duct systems

Duct systems should 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 A.3:

Table A.3 — Recommended maximum velocities in duct systems

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

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

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

A.13 Guidance to 5.3.3

Partial secondary ventilation may 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 may accumulate, hazard assessment may indicate requirement for additional extract. 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 may be present;

b) by creating localized areas of high turbulence around plant and equipment that have been identified as a potential leak source for hydrocarbon or noxious gas, or in areas of potential accumulation; drain gullies or ceiling beam spaces, in order to move any accumulations into the general room-air stream.

A.14 Guidance to 5.4.1

Where a mechanically ventilated hazardous area is adjacent and connected to a nonhazardous area, the extract ventilation system for the enclosed hazardous area should ensure that the area is not positively pressurized. In other instances, powered exhaust ventilation need not be supplied except where specific collection of hydrocarbons, fumes or process heat removal is required.

Thermal modification should not be provided for hazardous areas unless a specific need is demonstrated. Additional heating or cooling for maintenance personnel should be provided by temporary portable equipment suitable for the area classification.

Enclosed hazardous-area pressures should be dictated by local ambient conditions, with no attempt being made to control these values. However, where enclosed hazardous areas or their associated zones include or are abutted by any part of a nonhazardous area that includes a penetration(s) which may be unsealed (i.e. not gas-tight), such as a door, the pressure of that area should, by design, be negative, using the nonhazardous area as the reference.

Heating, where provided by mechanical means, should be from a heater located in the supply duct. It may 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 may go above design maximum for short periods during peak outside conditions. Designs should 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 may be necessary, where heat gains are excessive, to use room air-conditioning units mounted within, or local to the space(s) served, such as the CCR and emergency switch-rooms.

Internal design relative humidity is not required to be controlled, other than by heating to maintain relative humidity below 80 % in selected areas, such as electrical rooms and in the accommodation area to protect the health of the occupants.

A.15 Guidance to 5.4.2

A.15.1 General

In the absence of local legislation or code of practice, the guidance given in clause A.3 should be used. During periods in summer or winter, when outside conditions exceed the maximum and minimum design values, it is accepted that the inside temperature may not be to specification.

As a default condition, a minimum flowrate of 8,4 l/s of outdoor air per person should be supplied to each occupied space as recommended by ISO 7547.

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

— cabins;

— public areas;

— emergency areas;

— galley.

The main supply system(s) should be either a fixed 100 % outdoor air plant, or a outdoor air/recirculated air plant which may require automatic temperature- or enthalpy-controlled changeover from full outdoor air to part recirculation. It should not be allowed to operate at 100 % recirculation.

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.

A.15.2 Extract system

Extract ventilation systems in the LQ should 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 centralised 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 gaseous extinguishing systems and battery rooms.

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

The dedicated extract systems should have their own fans, located either within an internal plant room or external to the LQ module discharging the exhaust air to atmosphere. Fans should not be mounted in ceiling voids.

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

Extract openings in all areas, except the galley, should be fitted with fixed louvred grilles.

Control-room floor and ceiling voids where gaseous extinguishant may be injected should be ventilated to assist purging after release.

A.15.3 Heating, cooling and humidification

A heater should be located in the main air-handling unit (AHU). It should be capable of raising the supply air temperature to the required design supply level.

Where general cooling cannot be avoided, the cooling coil or evaporator should be located in the AHU. It should be capable of lowering the temperature and reducing the moisture content of the supply air. Cooling coils and evaporators should be supplied with cooling medium from a dedicated refrigeration plant or from the seawater cooling system.

Humidification, if fitted, should comply with the guidance given in clause B.5.

All refrigeration systems should be designed to use a zero-ozone-depleting environmentally acceptable refrigerant, and the consequences to personnel of refrigerant leakage should be evaluated.

A.15.4 Galley systems

The galley system should 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 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.

Air may be supplied to the galley via high-velocity nozzles, with supplies to all remaining areas via adjustable ceiling diffusers.

Supply ductwork to the galley should be connected to the main supply duct outside the galley boundaries. Supply ducting to other areas should not be taken through the galley areas.

The galley should be provided with canopies or hoods over all cooking equipment, which should be fitted with cleanable grease filters. Provision should be made for fire detection and protection in the hoods, exhaust ductwork and fat-frier systems as per local regulations, NFPA 96 [39] or a similar standard.

Exhaust canopies or hoods should also be installed over dishwashers and any other heat-producing items of equipment. Additionally, supply air may be introduced locally or via an air curtain to improve the working environment around hot equipment such as galley ranges and friers.

A fire/gas damper should be fitted at each extract connection to a galley cooking equipment hood or canopy, in addition to dampers at fire barriers. These dampers should close in accordance with the emergency shutdown logic.

A.15.5 Laundry systems

Warm-air clothes-drying machines are a serious potential source of fire. This is primarily due to inadequate filtration systems permitting the build-up of lint, unsuitable duct design and material selection. To minimize the risk from these systems, the following design guidance should be adopted:

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 should be of high capacity and disposable;

f) minimize length of extract duct from laundry machine to atmosphere;

g) use suitably fire-rated ducts, particularly where circumstances preclude application of the design principles stated above.

A.15.6 Temporary modules

Supply and extract ventilation systems using the methods described above should 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 should be supplied with mechanical extract.

In these modules, air should not be recirculated. Humidity control and cooling may not be required. Heating, if required, should be provided from a duct-mounted electric heater battery to meet the requirements of clause B.3.

Internal pressurization should be provided to suit the classification of the area in which the module is situated. Pressures should always be positive with respect to atmosphere, with toilet areas having a lower pressure than the general area selected value.

Duplication of HVAC plant is not necessary. The HVAC systems should 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 should be provided as for a permanent LQ.

A.15.7 Temporary refuge (TR)

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

— 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;

— consequences on personnel or the atmosphere of a build-up of contaminants;

— maintaining of pressurization of the TR during the incidents, but with sufficient air flow 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 in respect of the harmful characteristics of the smoke, toxic or flammable plume. The criteria should include: latent heat, temperature, toxicity (including irritant and narcotic effects of smoke), and effect on visibility or obscuration;
- provision of portable gas meters.

A.16 Guidance to 5.4.3

A.16.1 General

Ventilation in drilling facilities may present particular demands above those for other hazardous areas. These issues are covered in the following paragraphs.

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 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 can be used for make-up.

These areas should be subject to an air change rate determined by the air quantity required for the extract of fumes, heat load, etc. from the mud tanks and shale shakers enclosure.

The extracted air should be ducted to a suitable area where it will not affect personnel or equipment.

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

A.16.2 Shale shaker units and cutting cleaning units

Shale shakers should either be fully 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 should be given to the need for ease of access for replacement of the filter screens and maintenance requirements. These considerations should dictate enclosure design, and are likely to confirm the need for an openable front with removable/hinged side-leaves.

Shale shaker enclosures, if fitted, should 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, should also ensure optimum transport of contaminants with minimum drop-out.

Cutting cleaning units should be provided with extract enclosures and ventilation or be open and naturally ventilated similar to that for shale shaker units.

A.16.3 Mud tanks

Although during the initial design phase some mud tanks may 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 should, therefore, be assumed to be active and should 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 muds and improving the capture of flammable vapours by the ventilation system.

Tanks with solid plated covers should have minimum penetration for pipework, agitator shafts, valve handles, instrument entries and inspection/access hatches. The void between the covers and mud surface should be constantly purged with ventilation of the entire freeboard. A negative pressure should 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 should be connected directly to the covers, with make-up air being drawn through the previously mentioned penetrations or through supplementary air-entry slots. Consideration should be given to providing local low-level extract hoods over mud gutters, to remove any contaminants that may be discharged.

Mud tank enclosures should 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, should also ensure optimum transport of contaminants with minimum drop-out.

A.16.4 Air cleaners

Air scrubber units, in the form of integrated air washers and plenum settlement chambers, should 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 should 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 should 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 may not be possible due to physical constraints.

A.16.5 Cement units

If the drilling cement unit doubles as part of the installation well kill system, its diesel engine, where installed, should be arranged to operate in an emergency. In this case HVAC services should be provided as described for the diesel fire pump (see clause A.18).

A.17 Guidance to 5.4.4

If the area around the turbine hood is classified as nonhazardous, the hood ventilation system should be arranged so that a negative pressure of 50 Pa is maintained inside the hood with respect to outside the hood. This enables an enclosed turbine room to be classified as nonhazardous even though the turbine hood enclosure is classified as hazardous. This differential pressure may be the combined effect of the underpressure inside the turbine hood and the overpressure in the turbine room.

If the area outside the turbine hood is classified as hazardous, the design philosophy will change, as it is then dependent on the location of the potential ignition sources and the rating of the hazardous area.

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

These should:

a) ensure good air distribution within the enclosure to prevent local overheating;

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 nonhazardous area, either internally or externally.

The ventilation system should provide adequate air changes to meet these requirements. Enclosure ventilation, including prepurging, should otherwise meet the requirements of a recognized vendor or certified authority standard.

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

Personnel entry into the enclosure while the gas turbine is operating should be possible, but should be discouraged.

A.18 Guidance to 5.4.5

Where firepumps and/or emergency generators are enclosed in fire-rated compartments, during normal platform operation, i.e. diesel system not running, the HVAC "normal running" systems should 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 should maintain a positive minimum pressure of 50 Pa where required. Extract ventilation may be via louvred 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 is necessary.

Rates of ventilation should 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 should be fully integrated with that of the room system.

These separate systems should generally form part of the emergency supply and/or firepump 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 will apply, 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 should only shut when the last-resort device is activated, and the machine should run to destruction.

A.19 Guidance to 5.4.6

The battery system should 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 should be installed, with extracts from the room at a high level over the battery racks.

Supply air should be introduced into the battery room at a low level and should maintain the battery and charger rooms at a pressure above adjacent hazardous areas and/or below nonhazardous 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. If a common system is impractical, separate supply and extract systems should be provided for each room.

Extract fans should 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.

Further guidance on ventilation rates is given in IEC 61892-7 [15] and API RP 505 [28].

A.20 Guidance to 5.4.7

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

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

A.21 Guidance to 5.4.8

Conditioned air should be supplied, if required, to the item being purged.

Standby fans should be provided in line with the sparing philosophy. Duplicate fans should be provided with automatic changeover. Fan controls should 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.

A.22 Guidance to 5.4.9

Rates of leakage through dampers and doors should 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.

Annex B
(informative)

Equipment and bulk selection

B.1 General

This annex is intended to provide technical guidance that may assist in the selection of the most cost-effective component intended to be provided in an HVAC system, and detailed guidance to support the completion of the data sheets in annex E. The data sheets represent a preferred means of standardization, since it is accepted that design contractors may have well-established and proven systems to facilitate procurement which project managers may prefer to use.

B.2 Louvres

B.2.1 Function

Intakes to and discharges from all mechanical HVAC systems and/or naturally ventilated areas where weather protection is required should be protected from ingress of adverse weather and/or animal life and airborne contaminants by the installation of louvres.

B.2.2 Guidance

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

Where a louvre is installed without a downstream moisture-separator and/or filter, the performance should be in line with that given in clause B.3. This should 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 should be given to the pressure drop when fitting louvres 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.

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

Drains should be provided on multipass components, and protected, if required, against freezing.

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

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

There should be even airflow distribution downstream of louvres.

Where acoustic louvres are provided, the data sheet should specify the insertion loss. The performance of acoustic louvres may not meet that of a similar size weather louvre.

Data sheet: See clause E.1.

B.3 Moisture separators and filters

B.3.1 Function

Moisture separators and filters should 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 louvres.

B.3.2 Guidance

The composition of the intake air should be assessed for moisture content and solid particulates, since both may have adverse effect on 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 airstream.

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 will vary depending on specialist manufacturer.

Typical moisture separation efficiency for a louvre is 96 %, measured for droplet sizes from 30 μm in diameter and larger at a system air velocity of 1 m/s and at a loading of 72 $l/m^2 \cdot h$, (system air velocity to be based on gross louvre area).

The louvre/filter/ coalescer separator assembly should reduce the salt-in-air content at the output to $0{,}01 \times 10^{-6}$ by mass against the NGTE (National Gas Turbine Establishment) Standard 30 knot aerosol. The performance should 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 will 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 will depend on the particulate air filtration requirements of the area being served by the HVAC system.

Typical requirements for particular areas are listed in Table B 1.

Table B.1 — Performance requirement

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

Filters or prefilters 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 should not be expected to 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 louvres 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 should meet engine manufacturers' requirements.

All moisture separator and filter materials should 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 should be made for the whole assembly to be self-draining with tapped outlets for connection to a platform drainage system, protected if required against freezing. The drainage trap should be sized so that no back-siphonage occurs when the differential pressure across the filter is at its maximum design pressure.

Data sheet: See clause E.2.

B.4 Heating coils and unit heaters

B.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.

B.4.2 Guidance

B.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-powered units. Fluid supply may be the platform heating medium, steam, seawater or a water/glycol mixture.

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

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

B.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 airstream.

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

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

Fluid heaters should preferably not be located in rooms containing electrical switchgears

Fluid heaters should be provided with drainage and venting facilities.

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

Data sheet: See E.3.1.

B.4.2.3 Electric heaters

Electric heater elements should 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 should have a maximum temperature rating in line with the chosen certification requirements, such as T3 as established in IEC 60079-0 [14]. In addition, the watt output per unit area of element surface should be restricted to a level where the surface temperature of the element cannot exceed 150 °C under normal operating air flow conditions.

Extended contact surfaces in the form of fins should 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 plant, e.g. in an air-handling unit. However, under no circumstances should the requirement for 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 data sheet. 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 a not greater than 3 % or as dictated on the data sheet.

All electric heaters should 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.

Data sheet: See E.3.2.

B.4.2.4 Unit heaters

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

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 louvre 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.

Data sheet: See E.3.3.

B.5 Cooling coils and fan coil units

B.5.1 Function

Ambient temperature conditions and desired space temperatures determine the requirement or not for air cooling. The cooling system should 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 needs. 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.

B.5.2 Guidance

B.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 should be designed to be easily removable from ducts or equipment, and arranged in sections as necessary. Intermediate support plates should 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 airstream

Cooling coils should be designed and selected to avoid moisture carry-over into the airstream, thus avoiding the use of downstream eliminator blades. This generally means face velocities not exceeding 3 m/s.

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

Cooling coils should be provided with easy accessible drainage and venting facilities.

B.5.2.2 DX cooling coils

DX cooling coils form part of refrigeration packages (see clause B.13) which should use a zero-ozone-depleting environmentally acceptable refrigerant.

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

Data sheet: See E.4.1.

B.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 should be made from corrosion-resistant materials.

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

Data sheet: See E.4.2.

B.5.2.4 Fan coil units

Fan coil units should be of the split refrigeration type, with room or area casing-mounted fan and DX coil. Where DX coils are used, they should be served by a remote refrigerant compressor and condenser package (see clause B.13).

Data sheet: See E.4.3.

B.6 Humidifiers

B.6.1 Function

Humidifiers may 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 plantroom in a protected environment and is provided to serve normally manned areas such as the LQ and CCR. Where necessary however, the equipment should be suitable for operation in hazardous areas.

B.6.2 Guidance

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

Humidifiers should 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.

Care should be taken to ensure 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 should 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 should be fitted to ensure the humidifier will not operate if the fan is shut down.

Data sheet: See clause E.5.

B.7 Fans

B.7.1 Function

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

a) the duty point should be selected to maintain optimum efficiency for the selected fan design when considering

— power consumption

— sound level

— fan efficiency

— steepness of performance curve;

b) have non-overloading characteristics for the design operating limits;

c) should be suitable for continuous running;

d) should be inherently non-sparking.

B.7.2 Guidance

B.7.2.1 Fans

Centrifugal 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 may prove a problem, such as the drilling package, fans with the motor outside the air stream 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 should 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.

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 should be dynamically balanced. The balance standard should be in accordance with a recognized standard such as ISO 1940-1:1986, Quality Grade G6.3. The maximum vibration velocity for the assembled fan should not exceed an rms-value of 7,1 mm/s in the 10 Hz to 1 000 Hz range, over the full pitch angle range, when measured at the fan mounting feet.

All rotating parts of the fan and motor should be protected with suitable guards in accordance with ISO 12499 [12].

All fans being used in hazardous areas should be provided with anti-sparking rubbing plates.

Data sheet: See clause E.6

B.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 should 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 should be determined at the driver coupling and should include all transmission losses.

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

B.8 Sound attenuators

B.8.1 Function

Sound attenuators should be selected to reduce ductborne noise created by ventilation fans, dampers or other noise sources in ventilation system.

B.8.2 Guidance

When selecting the appropriate attenuator, the following guidance should be considered:

a) maximum available space limitations (face area and length);

b) acceptable insertion losses in frequency bands from 63 HZ up to 8 000 Hz. Check dominating or critical frequencies. 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 total pressure loss over the attenuator. Aerodynamically shaped inlets and outlets is recommended. Avoid installation of attenuators in turbulent areas, shortly after bends or other critical areas;

e) noise transmitted through duct wall (duct break-out or break-in) should specially be considered on rectangular light-gauge duct. High noise levels may be critical if the duct system enters into areas requiring low sound levels. Similarly, duct break-in should also be considered;

f) in absorptive silencers' attenuators, the material should have adequate strength and cohesion to resist erosion and sagging. For higher velocities, absorption material should be protected by a perforated plate (perforation grade 30 % to 40 % is recommended) to prevent fibre migration. The absorption material should be fire-retardant and rot-, damp- and vermin-proof. Special care should be taken in the selection of absorption material to avoid problems generated by high air moisture content and excessive airborne dirt;

g) ISO 7235 [6] for testing of attenuators should be used.

Data sheet: See clause E.7.

B.9 Fire dampers (when provided)

B.9.1 Function

Fire dampers shall be of a standard that maintain 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.

B.9.2 Guidance

B.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 which will ensure reliability of operation during an emergency. As they may be left unused for long periods, construction shall be robust using materials which 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.

B.9.2.2 Components and indicators

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

a) the fire damper should be fitted with proximity or limit switches to indicate status closed and/or open positions. These switches should not "change over" until the blades are within 5 % of the desired position;

b) a local blade-position indicator should 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 should ensure that the blades will close firmly, and against the maximum duct airflow and pressure;

d) 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. The assembly should be so designed that the trigger can easily be replaced without disassembly of pipework or components;

e) in addition, a local manual-opening device may be required by some authorities or design codes.

B.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 should 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 should be designed to ensure closure under slow compressed-air bleed-off and with turbulent duct air flow.

Fire dampers should be designed to close within 4 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 should have certification acceptable to the certification authority and be tested to a recognized standard such as EN 1363-2 [20] or IMO Resolution A.754(18) [37]. Project data sheets should indicate required ratings.

The blade operation linkages and control devices should be located out of the air stream in an integral enclosure that can easily be removed to allow maintenance. The design should prevent overtravel and resultant blade distortion in both open and closed positions.

The failure temperature of the thermal device, if fitted, should be as specified on the data sheet.

Data sheet: See clause E.8.

B.10 General dampers

B.10.1 Function

Dampers other than for fire protection may 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, hydraulic or compressed-air mechanical actuator, while manual dampers are those dampers operated by hand lever, ambient air pressure or gravity. Examples of such components and their method of operation are as follows:

- nonreturn 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.

B.10.2 Guidance

B.10.2.1 General

Whichever component is required, it should 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 should 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 may be generated adjacent to the fan.

The static pressure loss through shut-off and volume-control dampers, when in the open blade position with a face air velocity of 10 m/s, should not exceed 65 Pa. Pressure loss through nonreturn or backflow and pressure-relief dampers should be suitable for their function.

B.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 can 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.

B.10.2.3 Pressure-relief and pressure-control dampers

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

B.10.2.4 Shut-off dampers

Shut-off dampers should have parallel or opposed-action aerofoil-section blades. Blade operating linkages should be located out of the air stream in an integral enclosure that can easily be removed to allow maintenance. Linkage stops should be provided to prevent overtravel in both open and closed positions. Blades should operate within the overall casing length.

Shut-off dampers may be manually or mechanically operated.

Mechanical shut off dampers should be complete with a spring-return actuator capable of overcoming the maximum torque imposed by the damper. The damper should fail "closed" on loss of pneumatic air or electrical supply, and should be provided with proximity or limit switches to indicate blade-position status.

Shut-off damper airstream leakage rates should not exceed 0,15 m^3/s per square metre of damper duct face area, with a total pressure differential across the closed damper of 2 000 Pa.

B.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 air flow under the dictates of the modulating control system.

Data sheet: Mechanical dampers: see E.9.1. Manual dampers: see E.9.2.

B.11 Grilles and diffusers

B.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.

B.11.2 Guidance

Whichever component is required, it should be suitable for installation in any plane at any terminal unit. Material selection is influenced by aesthetics, the severity of the environment and the need 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 should 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 should 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 should 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 would not be 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 should 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 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 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 could be used.

In applications where air transfer is required into a toilet area/cubical to maintain a specific airflow pattern, transfer grilles can 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 should consist of two frames into which one chevron blade insert is attached.

Data sheet: See clause E.10.

B.12 Air handling units (AHUs)

B.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 provided most cost effectively by an air handling unit. Alternatively, a heat recovery unit may provide further economies.

The implicit purpose of an AHU (as opposed to duct-connected components) is:

a) optimization of component performance by equalization of face velocity;

b) guaranteed predelivery 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;

h) reduced installation cost.

B.12.2 Guidance

B.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 airtightness over a period of time.

Although most AHUs are located internally and 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 where possible be of the "draw-through" type, so that even air distribution is achieved across subcomponents and leakage is minimized. They should incorporate all major equipment items required for the main air-supply plant which have been described in previous clauses of this International Standard.

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

A base frame should 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;

e) the facility for common electrical earthing connections.

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

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

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

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

B.12.2.2 Louvres in AHUs

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

B.12.2.3 Moisture separators and 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 cross-sectional area.

B.12.2.4 Heaters in AHUs

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

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

B.12.2.5 Cooling coils in AHUs

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

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 should be fitted.

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

B.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 could 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.

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

B.12.2.8 Mixing dampers (air recirculation systems) in AHUs

An air recirculation system dictates a need for three dampers operating in unison to ensure correct air mixing. It may be convenient if the outdoor air and recirculation dampers form an integral part of the AHU. If these dampers are to be 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 authority over the duct distribution system. Dampers used for this purpose are required to be multiblade opposed-action, to ensure a linear control over the full range of the blade movement.

B.12.2.9 Access consideration in AHUs

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

Access sections should be provided to allow inspection of each subcomponent. Wherever possible access sections should serve two adjacent subcomponents. Retention details for subcomponents should 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 should 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 can be reduced to 450 mm providing the reach length to any item within the unit requiring servicing does not exceed 400 mm.

B.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. This needs to be communicated to the supplier, and may use individual data sheets for the key components provided in annex E.

Data sheet: See clause E.11.

B.13 Refrigeration packages

B.13.1 Function

There may 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, should be preferred over individual items, for reasons similar to those given for AHUs.

B.13.2 Guidance

B.13.2.1 General

The refrigeration system should 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 should only be used if it is an absolute requirement to achieve 0 % capacity, and it is not possible through the use of the compressor unloading facilities.

The refrigeration system should 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 individual support base frames, complete with antivibration mountings and compressor acoustic enclosures as necessary. Manufacturers' standard-range equipment should be used wherever possible.

B.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 the refrigerant being contaminated.

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

Compressors connected in parallel should 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.

Compressors for central refrigeration plant should of the multistage reciprocating, direct-drive, open serviceable type with automatic cylinder-loading system arranged for unloaded start-up. Automatic pumpdown control should be provided.

Alternatively, open or semi-hermetic type screw compressors with internal automatic stepless unloading system with arrangement for unloading start-up may be used for larger capacities.

The compressors should be built and tested to recognized standards, such as ISO 917 [1], ISO 9309 [9] and BS 4434 [25].

B.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 need not be subjected to any special hazardous-zone electrical requirements. Cooling water for these units normally comes from the service seawater supply. However, in the event that there is a need to run the refrigeration during a hazardous shutdown situation, say in a control room or muster area, thwn it may be desirable to take the water feed from the deluge secure supply. Alternatively, units can be cooled with freshwater from the central freshwater cooling system if available.

Air-cooled condensers can be supplied for any duty likely to be required. However, for duties above 100 kW the units tend to become unacceptably large, and consequently the use above this duty is discouraged.

B.13.2.4 Water-cooled condensers

The condensers should be shell-and-tube type, with integral finned tubes 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.

Shell and tubes should comply with a recognized industry standard such as BS 2871-3 [24] seamless for tubes and BS 5500 [26] for shells.

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

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

B.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 should 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 suction lines should be provided with shut-off and pressure-relief valves.

B.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 of which are set out in clause B.4.

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

B.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-pumpdown 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.

Data sheet: See clause E.12.

B.14 Constant-volume terminal reheat units (CVUs)

B.14.1 Function

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

B.14.2 Guidance

B.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 data sheets 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.

B.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 ± 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 offered 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.

B.14.2.3 Air heater 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 B.3.

B.14.2.4 Sound attenuator in CVUs

The attenuator should comply with insertion losses, total pressure drop, flow self-generated noise limits as stated on the data sheet and meet the requirements for duct-mounted attenuators set out in clause B.7 of this International Standard.

Data sheet: See clause E.13.

B.15 Ducts

B.15.1 Function

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

B.15.2 Guidance

The material of construction should be suitable for the design life and operating environment, for which stainless steel, coated carbon steel and composites may be suitable. The following categories in Table B.2 are types of commonly applied options:

Table B.2 — Duct classes

Duct class	Material	Thickness or dimensions	Operating conditions
A	Stainless steel EN 10088 [22] material No. 1.457 1 or UNS S31603	3 mm	High-strength duct Duct exposed to weather and saliferous atmosphere Fire-rated duct
B	Stainless steel EN 10088 [22] Material No. 1.440.1 or UNS S31600	EUROVENT 2/3 (circular) EUROVENT 2/4 (rectangular)	Internal duct in corrosive environments such as laboratories, paint stores
C	Stainless steel EN 10088 [22] Material No. 1.440.1 or UNS S31600 EN 10088 [22] Material No. 1.457 1 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
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

Duct systems should be constructed to a recognized standard such as EN 1505 [17], EN 1506 [18], prEN 1507 [21] and prEN 12237 [23], and may be categorized according to the duct pressure class.

Exhaust systems serving mud tanks and shale shakers should be suitable for the dirty atmosphere to be handled. Facilities should, however, be provided that permit access for frequent cleaning of all system components, equipment and the complete ducting systems. Access platforms and/or walkways may be necessary.

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

Inspection doors should 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 should 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 F.

Annex C
(informative)

Installation and commissioning guidance

C.1 Installation

C.1.1 Joints

Different metallic materials should be isolated to prevent galvanic corrosion.

Duct 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.

For stainless steel flanges, bolts should be stainless steel.

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. Rivets and pop rivets should not be used. No aluminium fasteners should be used except with aluminium duct. 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 duct should maintain the integrity of the particular fire-rated division.

C.1.2 Hangers and supports

The choice between methods of fixing depends on the type of structure and on the limitations which may be imposed by the structural design. The fixings should 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 DW 144. External hangers and supports, and those exposed to external ambient conditions, should 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 spacings 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 should not be forced into place to suit the installed support and thereby introduce undue stresses into the duct.

Surfaces of supports which will be inaccessible after erection should receive a protective coating before assembly.

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

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

Additional stiffening should be installed to cater for 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 may be needed in noise-sensitive areas.

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

C.1.3 Duct insulation

All supply-air systems should be insulated where thermal conservation and anticondensation protection is required. The insulation should 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 should be noncombustible and should not give off fumes, toxic vapours or smoke when heated. Generally, mineral fibre combined with appropriate bonding and surface protection materials should be used.

Installation and repair of duct insulation should be in accordance with recognized standards or guidance given in Table C.1.

Installation of passive protection systems may require attention to protection of personnel against harmful fume generation.

C.1.4 Identification

The duct should be permanently marked to identify its function, in accordance with a recognized standard, such as NS 5575 [32].

The identification symbols should be placed on:

a) ducting in ceiling behind access points;

b) either side of major components (fans etc.);

c) all ducting in HVAC plant rooms;

d) ducting in shafts behind access doors and panels;

e) ducting entering and leaving modules;

f) ducting entering or leaving local equipment/control rooms in open modules/areas;

g) both sides of firewalls where the duct penetrates;

h) each leg of a branch duct where the destination is not immediately obvious.

C.1.5 Cleaning and protection

All duct, 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.

Table C.1 — Insulation guidance

Insulation	Insulation		Jacketing			Purpose
Service	Material	Thickness	Material	Thickness mm		
				Outer diameter $\leqslant$ 1200 mm	Outer diameter > 1200 mm	
Heat conservation, hot	Mineral wool or other suitable material	External ductwork. Min. thickness 50 mm. One layer.	Stainless steel	0,5	0,7	To reduce heat losses
		Internal ductwork. Min. thickness 50 mm. One layer.	Aluminium alloy	0,7	0,9	
Cold conservation, cold	Cellular glass or other suitable material Mineral wool w/ vapour barrier	Temperature difference to surroundings. Max. 10°C, thickness 25 mm. Above 10°C, thickness 50 mm.	Stainless steel	0,5	0,7	To maintain low temperature
			Aluminium alloy	0,7	0,9	
Fire proofing A60	Mineral wool of rock-type, 110 kg/m^3	75 mm.	Stainless steel	0,5	0,7	To prevent accident escalation due to rupture of ducts during fire
			Aluminium alloy	0,7	0,9	
Fire proofing H0	Ceramic fibre, 128 kg/m^3	2 × 25 mm	Stainless steel	0,5	0,7	To prevent accident escalation due to rupture of ducts during fire
Fire proofing H60	Ceramic fibre, 128 kg/m^3	2 × 38 mm	Stainless steel	0,5	0,7	To prevent accident escalation due to rupture of ducts during fire
External condensation, cold	Cellular foam, cellular glass or other suitable material. Mineral wool w/ vapour barrier	Temperature difference to surroundings. Max. 10 °C, thickness 25 mm. Above 10 °C, thickness 50 mm.	Stainless steel	0,5	0,7	To prevent external condensation on ductwork
			Aluminium alloy	0,7	0,9	
Acoustic insulation, ductwork internal	Mineral wool	Design according to noise reduction requirements	Galvanized, perforated (30 %) carbon steel sheet (Inside duct towards air flow	0,5		To reduce noise

The thermal conductivity shall be max. 0,040 W/m·K at 20 °C.

Alternatives shall be qualified.

All fire insulation and installation methods on fire-rated components shall be certified.

NOTE 1 If alternative materials are proposed, the insulation capability should be equivalent to, or better than, the capability for the specified material and thickness

NOTE 2 The vapour barrier should have a maximum vapour transmission ratio of 1,75 PERM (= ng/s · Pa^{-1} · m^{-2}). The barrier should be a fire-retardant, nontoxic, factory-applied cover, reinforced by glass-fibre-threaded tissue.

NOTE 3 No insulation should have an "open" surface allowing fibres to break off and pollute the surroundings. A factory-applied cover is usually preferred to seal the insulation.

NOTE 4 Stainless steel jacketing should conform to EN 10088 [22] Material No. 1.440.1 UNS S31600, 2B finish.

NOTE 5 Aluminium alloy jacketing should conform to AlMn1 (AA3103) or equivalent.

NOTE 6 For heat conservation and cold conservation, standard pre-insulated ductwork may be used.

NOTE 7 For installation, reference should be made to BS 5970 [27].

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 ductsystem is finally installed and ready for mechanical completion, the system should be internally clean along the complete run.

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

Supply-air ducts in the living quarters and in permanently manned areas outside the living quarters shall after mechanical completion be cleaned to achieve a dust coverage in accordance with Table C.2.

Table C.2 — Cleaning classes for supply-air ducts.

Cleaning class	Norm	Maximum	Applies to
A: High	3 %	5 %	Cabins, clinic/ward, sensitive-instrument rooms
B: Normal	5 %	7 %	Permanently and intermittently manned areas in LQ, offices and coffee bars outside LQ, laboratories, permanently manned control rooms and control cabins
C: Low	7 %	10 %	Workshops

Air-extract ducts shall be cleaned to cleaning Class C.

Materials containing synthetic mineral fibres, which 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.

C.1.6 Leakage testing

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

The tests should be carried out in accordance with a recognized standard, such as Eurovent 2/2 [34], and meet the requirements for Air Tightness Class B.

C.2 Commissioning

The HVAC system should be commissioned in accordance with project requirements to demonstrate the system performance characteristics as prepared under 5.2.10 and clause A.10.

Commissioning procedures should include the following aspects:

— system balancing to a recognized standard, such as CIBSE Commissioning Code Series A, Section A.2.7;

— measurements of design airflows and air temperatures;

— differential pressures;

— sound-pressure levels of spaces.

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

All holes provided in the duct for the insertion of test instruments should be provided with easily identified, reusable covers, and should not be provided in fire-rated duct or flexible connections.

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

Annex D
(informative)

Operation and maintenance

D.1 General

HVAC systems are designed to provide a safe working environment within the various enclosed hazardous and nonhazardous 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. Fusible links or other means for keeping the module doors open should not be used.

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 should occur, or it is necessary to undertake maintenance on HVAC systems, appropriate temporary controls and/or equipment should 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 as a minimum:

a) a summary of the control philosophy and interface with F&G and/or ESD systems;

b) which areas have to be maintained with positive pressure in relation to hazardous modules;

c) which areas have to be maintained at negative pressure with respect to the surrounding area (e.g. gas turbine hoods);

d) the method and frequency of differential pressure monitoring;

e) the air change rate for all areas, irrespective of pressurization requirements;

f) a schematic drawing of each system and its components;

g) the temperature (and humidity, if appropriate) to be maintained in all areas;

h) the actions and compensating measures to be taken when failure occurs during normal operation of any HVAC system;

i) the routine maintenance activities;

j) the source of information to be consulted for the specification of spare parts and a listing of the stock spares carried.

D.2 Loss or reduction of ventilation

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

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

— installed gas-detector planned maintenance routines for the module should be confirmed as up to date;

— any defective gas-detectors, which may be acceptable during normal operating conditions, should not be acceptable under reduced or nil HVAC conditions. In those instances where repair is not possible, installation of alternative manual/portable gas detection should 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 while 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, should remain sufficient to avoid excessive heat build-up and/or build-up of flammable or toxic gases;

b) ventilation should maintain nonhazardous 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, should be adhered to;

d) before commencement of work on the HVAC system, a stabilization period (approximately 4 h) should 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 in respect of 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 issued with portable gas monitors/alarms. These personnel should be in communication with the CCR;

h) HVAC inlet ventilation ducts, doorways and any nonhazardous locations where the external module fabric is not leaktight and which are adjacent to hazardous areas should be monitored for gas ingress.

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

Where areas are fed by common inlet/outlet ventilation ducts, for either hazardous or nonhazardous areas, consideration should be given during the job planning stage to the likely impact upon the affected area, should the ventilation system partially or totally fail 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 nonhazardous modules should be avoided, unless positive separation can be maintained between them.

Before any work starts on HVAC equipment in a nonhazardous 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 nonhazardous area ventilation is reduced.

If a pressure-differential reversal should occur between the nonhazardous and hazardous areas when the nonhazardous 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 nonhazardous area.

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

a) integrating manual monitoring of the atmosphere;

b) monitoring of transits when left unattended;

c) briefing door sentries on emergency actions;

d) provision of portable gas detectors;

e) provision of communication to manned control centre.

D.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 watchkeeping 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 which do not have standby facilities (fans);

d) fire dampers should be tested at six-monthly intervals, or as determined by the maintenance strategy.

Annex E
(informative)

Data sheets

Annex	Component description	Data sheet reference
B.2	Louvres	E.1
B.3	Moisture separators and filters	E.2
B.4	Fluid heating coils	E.3.1
B.4	Electric heating coils	E.3.2
B.4	Unit heaters	E.3.3
B.5	DX cooling coils	E.4.1
B.5	Fluid cooling coils	E.4.2
B.5	Fan coil units	E.4.3
B.6	Humidifiers	E.5
B.7	Fans	E.6
B.8	Sound attenuators	E.7
B.9	Fire dampers	E.8
B.10	Mechanical dampers	E.9.1
B.10	Manual dampers	E.9.2
B.11	Grilles and diffusors	E.10
B.12	Air handling units	E.11
B.13	Refrigeration packages	E.12
B.14	Constant-volume terminal reheat units	E.13

E.1	HVAC EQUIPMENT LOUVRES DATA SHEET	Page 1 of 1

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.	

1	**Technical Data**			
2	Air flowrate		m³/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	**Materials**			
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	**Notes:**			
37	Applicable standard for performance: AMCA 500-89			
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41				
42				
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44				
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E.2	HVAC EQUIPMENT MOISTURE SEPARATORS AND FILTERS DATA SHEET	Page 1 of 1

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.	

1	**Technical Data**				
2	Outdoor conditions:	Summer:	Temperature	°C	
3			Relative humidity	%	
4		Winter:	Temperature	°C	
5			Relative humidity	%	
6	Unit composition:				Coalescer: ☐ Separator: ☐ Filter: ☐
7					
8	Separation efficiency			%	
9	Filter class				
10	Air flowrate			m^3/s	
11	Face air velocity			m/s	
12	Acceptable salt concentration			10^{-6}	
13	Pressure drop (clean filter)			Pa	
14	Maximum recommended pressure drop			Pa	
15	Filter indicator required			Yes/No	
16	Type of indicator				
17	Unit orientation			V/H	
18	Duct size:		Width	mm	
19			Height	mm	
20	Unit length			mm	
21	Service side (in direction of airflow)			L/R	
22	Water trap required			Yes/No	
23	Height of seal in water trap			mm	
24	Trace heating required			Yes/No	
25	Trace heating cable		Type		
26	Power supply			V	
27	Power consumption			W	
28	Junction box:		Manufacturer		
29			Type		
30	Glands		Type		
31	Mass			kg	
32					
33	**Materials**				
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	**Notes:**	Applicable standards: EN 779			
48					

E.3.1	HVAC EQUIPMENT FLUID HEATING COILS DATA SHEET	Page 1 of 2

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.	

1	**Technical Data**		
2	**General**		
3	Total heating load (design)	kW	
4	Heating medium		
5	**Design**		
6	**Heating medium side**		
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^3	
13	Heating medium flowrate	kg/s	
14	Htg med treatment hypochlorite	10^{-6}	
15	Tube velocity	m/s	
16	Pressure drop	kPa	
17	Working pressure	kPa	
18	Design pressure	kPa	
19	Test pressure(air under water)	kPa	
20	**Airside**		
21	On-coil temperature - min.	°C	
22	Off-coil temperature - max.	°C	
23	Maximum temperature rise	°C	
24	Air volume flowrate	m^3/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	Air flow mode		
30			
31	**Construction**		
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^2	
40	Number of rows		
41	Fin thickness	mm	
42	Fin spacing	mm	
43	Tubes serviceable		
44	Tube diameter	mm	
45	Nozzle orientation (direction A/F)		
46	Nozzle size - flow	mm	
47	Nozzle size - return	mm	
48	Nozzle type/rating		

E.3.1	HVAC EQUIPMENT FLUID HEATING COILS DATA SHEET	Page 2 of 2

Package No.		Doc. No.		Rev.
49	**Construction (continued)**			
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	**Materials**			
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	Electrotinning 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			
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72	**Notes:**			
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E.3.2	HVAC EQUIPMENT ELECTRIC HEATING COILS DATA SHEET	Page 1 of 2

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.	

1	**Technical Data**		
2	**General**		
3	Heating duty (design)	kW	
4	Air flow 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			
17	**Design**		
18	**Airside**		
19	Air volume flowrate	m^3/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	
27			
28	**Elements/Electrical**		
29	Element surface temp - operating	°C	
30	Element surface temp - maximum	°C	
31	Max. temp inside element term box	°C	
32	Absorbed power	kW	
33	Full load current	phase amps	
34			
35	**Protection/Safety control devices**		
36	High airway temperature (TAH)		
37	- TAH required	Yes/No	
38	- TAH trip set point	°C	
39	- TAH type of device		
40	- TAH reset method		
41	- TAH reset location		
42	High element surface temp. (TEH)		
43	- TEH required	Yes/No	
44	- TEH trip set point	°C	
45	- TEH type of device		
46	- TEH reset method		
47	- TEH reset location		
48			

E.3.2	HVAC EQUIPMENT ELECTRIC HEATING COILS DATA SHEET	Page 2 of 2

Package No.		**Doc. No.**	**Rev.**
49	**Design (continued)**		
50	High high element surf temperature (TEHH)		
51	- TEHH required	Yes/No	
52	- TEHH trip set point	°C	
53	- TEHH type of device		
54	- TEHH reset method		
55	- TEHH reset location		
56	Air flow failure protection (AFF)		
57	- AFF required	Yes/No	
58	- AFF type of device		
59	- AFF supplier		
60	Temperature control (TC)		
61	- TC required	Yes/No	
62	- TC design set point	°C	
63	- TC type of device		
64	- TC supplier		
65			
66	**Construction**		
67	Airway/duct size - nom. width	mm	
68	Airway/duct size - nom. height	mm	
69	Coil depth	mm	
70	Overall heater width	mm	
71	Overall heater height	mm	
72	Flange size	mm	
73	Flange drilling detail		
74	Face area of coil	m²	
75	No. of element terminal boxes	No off	
76	Location element terminal boxes		
77	Total number of elements	No off	
78	Element length	mm	
79	Individual element power rating	W	
80	Total element surface area	m²	
81	Element cross section area	mm²	
82	Element bundles removeable	Yes/No	
83	Power cable size/gland entry size		
84	Lifting lugs No off/position		
85	Earthing bosses No off/position		
86	Term. box lifting facility required	Yes/No	
87	Term. box lifting facility type		
88	Term. box/casing air space required	Yes/No	
89	Term. box/casing air space dim.	mm	
90	Casing thermally insulated	Yes/No	
91	Mass - operating	kg	
92			
93	**Materials**		
94	Element material		
95	Sheath material		
96	Sheath finish		
97	Element fill material type		
98	Element fill material density	kg/m^3	
99	Casing material/thickness	mm	
100	Casing finish		
101	Term. box material/thickness	mm	
102	Term. box material finish		
103	Casing thermal insulation material		
104			
105			
106			

E.3.3	HVAC EQUIPMENT UNIT HEATERS DATA SHEET	Page 1 of 2

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.	

1	**General**		
2	Unit description		
3	**Unit Composition**		
4	Component description	Tag No.	Ref. Data Sheet No.
5	Intake louvre		
6	Air heater		
7	Fan		
8	Fan motor		
9	Air discharge damper		
10	Discharge louvre		
11	Control panel		
12			

13	**General**					
14	Heating duty (design)	kW				
15	Heating medium					
16	Air flow mode					
17	Electrical power supply	V/Hz/P·h				
18	Area classification		Hazardous	☐	Nonhazardous	☐
19	Hazardous area certification					
20	Hazardous area gas groups					
21	Hazardous area temp. classification					
22	Electrical enclosures IP rating					
23	Control method					
24	Control panel supplier					
25	Control panel location					
26	Control panel area classification					
27	Control panel tag number					
28						
29	**Design**					
30	**Airside**					
31	Air volume flowrate	m^3/s				
32	On-coil temperature - min.	°C				
33	Off-coil temperature - max.	°C				
34	Maximum temperature rise	°C				
35	Unit heater mounting height	m				
36	Required air throw	m				
37	Air discharge velocity	m/s				
38	Heating coil face velocity	m/s				
39	Unit absorbed power	kW				
40	Heating duty (actual)	kW				
41	Air pressure drop	Pa				
42						

43	**Noise Data** (at rated duty)	Sound power levels SWL in dB (ref. 10^{-12} W)								
44		Octave band centre frequency, Hz								
45		63	125	250	500	1000	2000	4000	8000	dBA
46	Guaranteed data at inlet/outlet									
47	Guaranteed data to surroundings									
48	Max. acceptable to surroundings									

E.3.3	HVAC EQUIPMENT UNIT HEATER DATA SHEET	Page 2 of 2

Package No.		**Doc. No.**		**Rev.**
49	**Construction**			
50	Unit overall dimensions	width	mm	
51		height	mm	
52		length	mm	
53	Air intake dimensions	width	mm	
54		height	mm	
55	Air discharge dimensions	width	mm	
56		height	mm	
57	Casing type			
58				
59	**Materials**			
60	Unit frame and casing material			
61	Base frame material			
62	Electrical cable type			
63	Electrical cable support type			
64	Cable tray material			
65	Pipe connection material			
66	Pipe connection type			
67	Pipe material/thickness			
68				
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79	**Notes:**			
80	1. Component design, construction and materials as individual data sheets.			
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E.4.1	HVAC EQUIPMENT DX COOLING COILS DATA SHEET	Page 1 of 2
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.	

1	**Technical Data**		
2	**General**		
3	Total cooling load (design)	kW	
4	Refrigerant type		
5	**Design**		
6	**Refrigerant Side**		
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	
14	**Thermostatic Expansion Valve (TEV)**		
15	Number of TEVs		
16	Number of solenoid valves		
17	TEVs' superheat settings	kPa	
18	TEVs' spring ranges	kPa	
19	**Capacity control**		
20	No. of cooling stages		
21	Minimum cooling load - % total load		
22	Hot gas injection required		
23	Hot gas header required		
24	**Airside**		
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 flowrate	m^3/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			
38	**Construction**		
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		
45	Section height	mm	
46	Total face area	m^2	
47	Tube surface area	m^2	
48	Number of rows		

E.4.1	HVAC EQUIPMENT DX COOLING COILS DATA SHEET	Page 2 of 2

Package No.		Doc. No.	Rev.
49	**Construction (continued)**		
50	Fin thickness	mm	
51	Fin spacing	mm	
52	Tube bundles removeable		
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	**Materials**		
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		
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94	**Notes:**		
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E.4.2	HVAC EQUIPMENT FLUID COOLING COILS DATA SHEET	Page 1 of 2

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.	

1	**Technical Data**		
2	**General**		
3	Total cooling load (design)	kW	
4	Cooling medium		
5	**Design**		
6	**Cooling Medium Side**		
7	Flow temperature	°C	
8	Return temperature	°C	
9	Cooling medium flowrate	kg/s	
10	Specific heat capacity	kJ/kg·°C	
11	Specific weight (density)	kg/m^3	
12	Cooling medium filtration	µm	
13	Clg med treatment hypochlorite	10^{-6}	
14	Tube velocity	m/s	
15	Pressure drop	kPa	
16	Working pressure	kPa	
17	Design pressure	kPa	
18	Test pressure(air under water)	kPa	
19	**Airside**		
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 flowrate	m^3/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		
33			
34	**Construction**		
35	Airway/duct size - nom. width	mm	
36	Airway/duct size - nom. height	mm	
37	Coil casing depth	mm	
38	Flange size	mm	
39	Flange drilling detail		
40	Number of sections		
41	Section height	mm	
42	Total face area	m^2	
43	Element surface area	m^2	
44	Number of rows		
45	Fin thickness	mm	
46	Fin spacing	mm	
47	Tubes serviceable		
48	Tube diameter	mm	

E.4.2	HVAC EQUIPMENT FLUID COOLING COILS DATA SHEET	Page 2 of 2
Package No.	**Doc. No.**	**Rev.**

49	**Construction (continued)**		
50	Nozzle orientation (direction A/F)		
51	Nozzle size - flow	mm	
52	Nozzle size - return	mm	
53	Nozzle type/rating		
54	Header size	mm	
55	Air vent size	mm	
56	Eliminators required		
57	Drip pan required		
58	Manometric trap required		
59	Drain size/type/rating		
60	Manometric trap seal depth	mm	
61	Trap refill point required		
62	Mass - dry	kg	
63	Mass - wet (operating)	kg	
64			
65	**Materials**		
66	Tube material/thickness	mm	
67	Tube finish		
68	Header material/thickness	mm	
69	Header finish		
70	Fins material/thickness	mm	
71	Fins finish		
72	Electrotinning thickness	mm	
73	Casing material/thickness	mm	
74	Casing finish		
75	Drip pan material/thickness	mm	
76	Drip pan finish		
77	Trap material/finish		
78	Tube nozzles material/finish		
79	Drain nozzle material/finish		
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86	**Notes:**		
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E.4.3	HVAC EQUIPMENT FAN COIL UNITS DATA SHEET	Page 1 of 2

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.	

1	**General**		
2	Unit description		
3	Ref D&ID No.		
4	**Unit Composition**		
5	Componenent description	Tag No.	Ref. Data Sheet No.
6	Fan		
7	Fan motor		
8	Filter		
9	Compressor/compressor motor		
10	Condenser		
11	Evaporator/cooling coil		
12	Control panel		

13	**Technical Data**					
14	**General**					
15	Total cooling load (design)	kW				
16	Cooling medium					
17	Condenser type		Air-cooled	☐	Water-cooled	☐
18	Condenser location		Local	☐	Remote	☐
19	Electrical power supply	V/Hz/P·h				
20	Area classification		Hazardous	☐	Nonhazardous	☐
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						
31	**Design**					
32	**Airside**					
33	Air volume flowrate	m^3/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	**Noise Data** (at rated duty)	Sound power levels SWL in dB (ref. 10^{-12} W)								
43		Octave band centre frequency, Hz								
44		63	125	250	500	1000	2000	4000	8000	dBA
45	Guaranteed data at inlet/outlet									
46	Guaranteed data to surroundings									
47	Max. acceptable to surroundings									

E.4.3	HVAC EQUIPMENT FAN COIL UNITS DATA SHEET			Page 2 of 2
Package No.	**Doc. No.**			**Rev.**
48	**Construction**			
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	**Materials**			
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				
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77				
78	**Notes:**			
79	1. Component design, construction and materials as individual data sheets.			
80				
81				
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E.5	HVAC EQUIPMENT HUMIDIFIER DATA SHEET	Page 1 of 1

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.	

1	**Technical Data**			
2				
3	**Airside:**			
4	Air flowrate		m^3/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				
17	**Water side:**			
18	Type/quality/making process			
19	Water:	pH value		
20		Conductivity		
21	Nominal flowrate		l/s	
22	Maximum flowrate		l/s	
23	Working pressure		kPa	
24	Dosing recommended			
25				
26	**Heater element/Electrical**			
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				
33	**Protection/Safety control devices**			
34	High airway humidity control required		Yes/No	
35	Humidistat	Type		
36		Setpoint	% 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				
45	**Notes**			
46				
47				
48				

E.6	HVAC EQUIPMENT FANS DATA SHEET	Page 1 of 2

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.	

1	**Technical Data**						
2	Fan type	Axial flow fan:		Centrifugal fan:		Mixed flow fan:	
3							
4	Fan installation	H/V					
5	Volume flowrate	m^3/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							
15	**Construction**						
16	Motor tag No.						
17	Motor data sheet 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 x 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 trak	Yes/No					
32	Inspection door	Yes/No					
33	Inspection door size (W x H)	mm					
34	Casing drain size	mm					
35	Earthing boss	Yes/No					
36	Drive arrangement		Direct drive:		Belt drive:		
37							
38	Direct drive details:		Coupling:		Impeller on motorshaft:		
39	Coupling type						
40	Coupling material						
41	Coupling manufacturer						
42	Belt drive details:						
43	No. of belts						
44	Belttype						
45							

E.6	HVAC EQUIPMENT FANS DATA SHEET	Page 2 of 2
Package No.	**Doc. No.**	**Rev.**

46	Inlet guide vanes	Yes/No				
47	Inlet guide vanes details:					
48	Guide vanes operation		Automatic:		Manual:	
49	Actuator type					
50	Solenoid valve type					
51	Limit switch type					
52	Vibration RMS velocity	mm/s				
53	Vibration Monitoring	Yes/No				
54	Manufacturer					
55	Anti-vibration mounting details:					
56	Type					
57	Manufacturer					
58	Rating	%				
59						
60	**Materials**					
61	Casing Material					
62	Thickness	mm				
63	Impeller material					
64	Impeller shaft material					
65	Base frame material					
66	Drive guard/lining material					
67	Inlet guard material					
68	Discharge guard material					
69	Inlet cone material					
70						

71	**Noise Data** (at rated duty)	Sound power levels SWL in dB (ref. 10^{-12} W)								
72		Octave band centre frequency, Hz								
73	Type of data	#	125	250	500	1000	2000	4000	8000	dBA
74	Guaranteed data to surroundings									
75	Guaranteed data to duct									
76	Max. acceptable to surroundings									
77	Max. acceptable to duct									

78	
79	**Notes:**
80	Applicable standard for capacity: ANSI/AMCA 210, alternatively ISO 5801
81	Applicable standard for sound: AMCA 300, alternatively ISO 3744 and ISO 9614
82	
83	
84	**Fan handling:**
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E.7	HVAC EQUIPMENT SOUND ATTENUATORS DATA SHEET	Page 1 of 1

Package No.	**Doc. No.**		**Rev.**
Supplier:	Enquiry No.:	Quote No.:	Purchase order No.:

Tag No. / **Location**	**System No.** / **Air flowrate** m^3/s	**Air velocity** m/s / **Pressure drop** Pa	**Model** / **Duct-class**	**Manu-facturer** / **Connection type**	**Duct connection** W × H, (Diameter) mm / **Unit size** W × H, (Diameter) mm	**Unit mass** kg	**Key:**	63	125	250	500	1000	2000	4000	8000	dB A	D & ID Reference No. / Notes
							1										
							2										
							3										
							1										
							2										
							3										
							1										
							2										
							3										
							1										
							2										
							3										
							1										
							2										
							3										
							1										
							2										
							3										
							1										
							2										
							3										

Key:
1. Required sound attenuation (insertion loss) in dB.
2. Actual sound attenuation (insertion loss) in dB.
3. Self-generated SWL in dB at actual flow. (ref. 10^{-12} W)

OCTAVE BAND CENTRE FREQUENCY, Hz

Applicable standards: For noise measurements reference is made to :
ISO 7235, *Acoustics — Measurement procedures for ducted silencers — Insertion loss, flow noise and total pressure loss*.

E.8	HVAC EQUIPMENT FIRE DAMPERS DATA SHEET	Page 1 of 2
Package No.	**Doc. No.**	**Rev.**

Supplier	______________	Enquiry No.	______________
Manufacturer	______________	Quote No.	______________
Model	______________	Purchase order No.	______________
Serial No.	______________	Job No.	______________

1	**Technical Data**			
2	Certificate No.			
3	Certifying authority			
4	Actuation (fail-safe)			Pneumatic: ☐ Electric: ☐
5	Actuator	Type:		
6		Ref. data sheet No.:		
7	Fusible link/bulb	Type		
8	Release temperature		°C	
9	Instrument air pressure	Max./Min.	bar g	
10	Power supply		V/Hz/P·h	
11	Quick-release valve	Type		
12		Manufacturer		
13	Pneumatic fittings	Type		
14	Tube connection size		mm	
15	Solenoid valve	Type		
16		Ref. Data Sheet No.:		
17	Limit switch	Type		
18		Ref. Data Sheet No.:		
19	Non-return valve	Type		
20		Manufacturer		
21	Junction box	Type		
22		Manufacturer		
23	Open/closed indicator		Yes/No	
24	Protection cover on linkage/levers		Yes/No	
25	Manual opening/locking arm		Yes/No	
26	Flange standard			
27				
28	**Materials**			
29	Casing	Material		
30		Thickness	mm	
31	Blade	Material		
32		Thickness	mm	
33	Shaft	Material		
34		Thickness	mm	
35	Linkage	Material		
36		Thickness	mm	
37	Bearing	Type		
38		Material		
39	Insulation	Material, A-60: H-0:	H-60:	H-120:
40				
41	**Notes:**	Schedule abbreviations:	Shaft position:	H: Horizontal
42				V: Vertical
43			Actuator position:	L: Left side
44				R: Right side
45				T: Top
46				B: Bottom
47				(All seen in direction of air flow)
48				

E.8	HVAC EQUIPMENT FIRE DAMPERS DATA SHEET	Page 2 of 2

Package No.					Doc. No.								Rev.	
Tag No.	**HVAC system No.**	**Fire-rating**	**Location**	**Air flow-rate** m³/s	**Pressure drop** Pa	**Actuator position** L/R/T/B	**No.of limit switches**	**Duct connection** W × H (diameter) mm	**Overall length** mm	**Shaft position** H/V	**Mass** kg	**Supplier reference drawing**	D&ID reference	Comments

E.9.1	HVAC EQUIPMENT MECHANICAL DAMPERS DATA SHEET	Page 1 of 2

Package No.	**Doc. No.**	**Rev.**

Supplier ______________________ Enquiry No. ______________
Quote No. ______________________ Purchase order No. ______________
Job No. ______________

1	**Technical Data**					
2	Actuation			Pneumatic:		Electric:
3						
4				Shut-off	Pressure relief	Modulating
5	Damper manufacturer					
6	Model					
7	Actuator	Type:				
8		Ref. Data Sheet No.:				
9	Instrument air pressure		bar g			
10	Pneumatic fittings	Type:				
11	Tube connection size		mm			
12	Quick-release valve	Type:				
13		Manufacturer				
14	Power supply		V/Hz/P·h			
15	Solenoid valve	Type:				
16		Ref. Data Sheet No.:				
17	Limit switch	Type:				
18		Ref. Data Sheet No.:				
19	Non-return valve	Type:				
20		Manufacturer				
21	Junction box	Type:				
22		Manufacturer				
23	Open/closed indicator		Yes/No			
24	Protection cover on linkage/levers		Yes/No			
25	Manual opening/locking arm		Yes/No			
26	Flange standard					
27						
28	**Materials**					
29	Casing	Material				
30		Thickness	mm			
31	Blade	Material				
32		Thickness	mm			
33	Shaft	Material				
34		Thickness	mm			
35	Linkage	Material				
36		Thickness	mm			
37	Bearing	Type				
38		Material				
39						

40	**Notes:**	Schedule abbreviations:	Damper type:	S:	Shut-off damper
41				P	Pressure relief damper
42				M:	Mudulating damper
43			Shaft position:	H:	Horizontal
44				V:	Vertical
45			Actuator position:	L:	Left side
46				R:	Right side
47				T:	Top
48				B:	Bottom
49					(All seen in direction of air flow)
50		Applicable standard: EN 1751			

E.9.1	HVAC EQUIPMENT MECHANICAL DAMPERS DATA SHEET	Page 2 of 2

Package No.					**Doc. No.**							**Rev.**	
Tag No.	**HVAC system No.**	**Location**	**Damper type** S/P/M	**Air flow rate** m^3/s	**Pressure drop** Pa	**No. of limit switches**	**Duct connection** W × H (diameter) mm	**Overall length** mm	**Actuator position** L/R/T/B	**Shaft pos.** H/V	**Mass** kg	**Supplier reference drawing**	D&ID reference	Comments

E.9.2	HVAC EQUIPMENT MANUAL DAMPERS DATA SHEET	Page 1 of 2
Package No.	**Doc. No.**	**Rev.**

Supplier	______________________	Enquiry No.	________
		Quote No.	________
		Purchase order No.	________
		Job No.	________

1	**Technical Data**							
2								
3	Damper type			Non-return	Balancing	Pressure relief	Shut-off
4							
5	Damper manufacturer						
6	Open/closed indicator		Yes/No				
7	Flange standard						
8							
9							
10	**Materials**						
11	Casing	Material					
12		Thickness	mm				
13	Blade	Material					
14		Thickness	mm				
15	Shaft	Material					
16		Thickness	mm				
17	Linkage	Material					
18		Thickness	mm				
19	Bearing	Type					
20		Material					
21							
22							
23							
24							
25							
26	**Notes:**	Schedule abbreviations:	Damper type:	N:	Non-return damper		
27				B:	Balancing damper		
28				P	Pressure relief damper		
29				S:	Shut-off damper		
30			Shaft position:	H:	Horizontal		
31				V:	Vertical		
32							
33		Applicable standard: EN 1751					
34							
35							
36							
37							
38							
39							
40							
41							
42							
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44							
45							
46							
47							

E.9.2	HVAC EQUIPMENT MANUAL DAMPERS DATA SHEET	Page 2 of 2
Package No.	Doc. No.	Rev.

Tag No.	HVAC system No.	Location	Damper type N/B/P/S	Damper model	Air flow rate m^3/s	Pressure drop Pa	Duct connection W × H (diameter) mm	Duct connection type	Overall length mm	Shaft pos. H/V	Mass kg	Supplier reference drawing	D&ID reference	Comments

E.10	HVAC EQUIPMENT GRILLES AND DIFFUSORS DATA SHEET	Page 1 of 1

Package No.	**Doc. No.**		**Rev.**
Supplier:	Enquiry No.	Quote No.	Purchase order No.

Tag No.	Location	Air flowrate m^3/s	Manufacturer	Duct connection size W × H (diameter) mm	Material	Colour	Key: 1. Self generated SWL at actual flow 2. Static insertion loss SWL Sound power levels in dB (ref. 10^{-12} W)										D & ID Reference No.
	System No.	Pressure drop Pa	Unit type	Diffusor/grille size W × H (diameter) mm	Material thickness mm	Unit mass kg	OCTAVE BAND CENTRE FREQUENCY, Hz										Notes
								63	125	250	500	1000	2000	4000	8000	dB A	
							1										
							2										
							1										
							2										
							1										
							2										
							1										
							2										
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							1										
							2										
							1										
							2										
							1										
							2										

E.11	HVAC EQUIPMENT AIR HANDLING UNITS DATA SHEET	Page 1 of 2

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. ______________________

1	**Unit Composition**		
2	Ref. D&ID No. :		
3	Description	Tag No.	Ref. data sheet No.
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			

14	**Technical Data**								
15	Main data								
16	Air flowrate (at density 1,2 kg/m^3)		m^3/s						
17	Required static pressure increase (excl. unit)		Pa						
18	Total pressure drop over unit		Pa						
19				Summer			Winter		
20	Air inlet conditions		°C/%RH						
21	Air outlet conditions		°C/%RH						
22	Inspection side (seen in direction of air flow)		L/R						
23	Fan motor location			Internal:		External:			
24	Casing construction			Bolted:		Cleated:		Welded:	
25	Section joints gasket		Type						
26	Lifting pad eyes		Yes/No						
27	Perforated inner skin		Yes/No						
28	Earthing boss		Yes/No						
29	Max. allowed air leakage								
30	Flange standard								
31	Unit mass	Dry	kg						
32		Operational	kg						
33									
34	**Materials**								
35	Unit frame and casing material								
36	Base frame material								
37	Material thickness outer skin		mm						
38	Material thickness inner skin		mm						
39	Insulation thickness		mm						
40	Insulation density		kg/m^3						
41	Max. design pressure over/under		Pa						

42	**Noise Data** (at rated duty)	Sound power levels SWL in dB (ref. 10^{-12} W)								
43		octave band centre frequency, Hz								
44		63	125	250	500	1000	2000	4000	8000	dBA
45	Guaranteed data to AHU outlet									
46	Guaranteed data to AHU inlet									
47	Guaranteed data to surroundings									
48	Max. acceptable to surroundings									
49	Max. acceptable to AHU outlet									

E.11	HVAC EQUIPMENT AIR HANDLING UNITS DATA SHEET	Page 2 of 2
Package No.	**Doc. No.**	**Rev.**

50	**Air handling unit sketch:**							
51								
52								
53								
54								
55								
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82								
83								
84								
85								
86								
87								
88								
89								
90								
91	A	mm	F	mm	K	mm		
92	B	mm	G	mm	L	mm		
93	C	mm	H	mm	M	mm		
94	D	mm	I	mm	N	mm		
95	E	mm	J	mm	O	mm		
96								
97								
98	**Note 1:** Applicable standards for performance: prEN 1886, prEN 13053 and prEN 308							
99	**Note 2:** For component design, construction and materials as individual data sheets.							
100								
101								
102								
103								
104								
105								
106								
107								
108								

E.12	HVAC EQUIPMENT REFRIGERATION PACKAGE DATA SHEET	Page 1 of 3

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. ______

1	**Unit Composition**									
2	Ref. D&ID No. :									
3	Unit description:									
4										
5										
6										
7	Component description			Tag No.						
8										
9										
10										
11										
12										
13										
14										
15										
16	**Technical Data for complete Unit**									
17	Main data									
18	Cooling dapacity (total/sensible)		kW							
19	Air flowrate		m^3/s							
20	Air inlet conditions		°C / %RH							
21	Air outlet conditions		°C / %RH							
22	Available fan static pressure (excl. unit)		Pa							
23	Chilled water flowrate		l/s							
24	Chilled water temperature	Supply	°C							
25		Return	°C							
26	Refrigerant		Type							
27	Condenser water flowrate		l/s							
28	Evaporating temperature		°C							
29	Condensing temperature		°C							
30	Total power consumption		kW							
31	Power supply		V/Hz/P·h							
32	Control voltage		V							
33	Overall size (W x L x H)		mm							
34	Service space required		mm							
35	Mass	Dry	kg							
36		Operating	kg							
37	Casing material									
38	Casing insulation material/thickness		mm							
39										
40	**Noise Data** (at rated duty)	Sound power levels SWL in dB (ref. 10^{-12} W)								
41		octave band centre frequency, Hz								
42		63	125	250	500	1000	2000	4000	8000	dBA
43	Max. acceptable to surroundings									
44	Guaranteed data to surroundings									
45	**Notes:**									
46										
47										
48										
49										

E.12	HVAC EQUIPMENT REFRIGERATION PACKAGE DATA SHEET	Page 2 of 3
Package No.	**Doc. No.**	**Rev.**

50	**Component Technical Description**		
51	Filter	No off	
52	Type		
53	Filter class (EN 779)		
54	Filter size (W x H)	mm	
55	Filter frame material		
56	Compressor	No off	
57	Type		
58	Manufacturer		
59	Speed	r/min	
60	Displacement	m^3/h	
61	Capacity control		
62	Crankcase heater (or pump down function)		
63	Oil Crankcase Type		
64	Oil charge	l	
65	Motor		
66	Power consumption	kW	
67	Starting current	A	
68	Running current	A	
69			
70	**Evaporator/Cooling coil**	DX-Coil:	Water Coil:
71	No. of coils		
72	Casing material		
73	Casing material thickness	mm	
74	Tube material		
75	Fin material		
76	Drip tray material		
77	Water inlet temperature	°C	
78	Water outlet temperature	°C	
79	Water flowrate	l/s	
80	Pressure drop (water side)	kPa	
81	Evaporating temperature	°C	
82	*For free-standing evaporator/cooling coil;*		
83	Pipe connection sizes Liquid line	mm	
84	Suction line	mm	
85	Water supply	mm	
86	Water return	mm	
87	Drain	mm	
88	Fan No. of fans		
89	Total air flowrate	m^3/s	
90	Power consumption	kW	
91	Controls Valve	Type	
92	Valve actuator		
93	Valve size	mm	
94	Mass	kg	

95	**Noise Data** (at rated duty)	Sound power levels SWL in dB (ref. 10^{-12} W)								
96	for a free-standing unit	octave band centre frequency, Hz								
97		63	125	250	500	1000	2000	4000	8000	dBA
98	Max. acceptable to surroundings									
99	Guaranteed data to surroundings									

100	**Notes:**
101	
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E.12	HVAC EQUIPMENT REFRIGERATION PACKAGE DATA SHEET	Page 3 of 3
Package No.	**Doc. No.**	**Rev.**

108	**Condenser:**							
109	Condenser type	Air-cooled:		Water-cooled:		Seawater-cooled:		
110	Condenser location	Integrated in unit:		Free-standing:				
111	No. of coils							
112	Casing material	(Free-standing unit)						
113	Casing material thickness	(Free-standing unit)	mm					
114	Tube material							
115	Fin material							
116	Shell material:	Refrigerant side						
117		Water side						
118	Design pressure:	Refrigerant side	bar					
119		Water side	bar					
120	Pressure drop	Air side	Pa					
121		Water side	kPa					
122	Water supply temperature		°C					
123	*For free-standing condenser:*							
124	Pipe connection sizes	Liquid line	mm					
125		Hot gas line	mm					
126		Water supply	mm					
127		Water return	mm					
128	Fan	No. of fans						
129		Total air flowrate	m^3/s					
130		Power consumption	kW					
131	Controls	Valve type						
132		Valve actuator						
133		Valve size	mm					
134	Mass		kg					
135	Overall size (W x L x H)		mm					

136	**Noise Data** (at rated duty)	Sound power levels SWL in dB (ref. 10^{-12} W)								
137	for a free-standing unit	octave band centre frequency, Hz								
138		63	125	250	500	1000	2000	4000	8000	dBA
139	Max. acceptable to surroundings									
140	Guaranteed data to surroundings									

141	**Notes:**
142	Applicable standard: ISO 5149
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E.13	HVAC EQUIPMENT CONSTANT VOLUME UNITS DATA SHEET	Page 1 of 1
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.	

1	**Unit Composition**		
2	Component description	Tag No.	Ref. Data Sheet No.
3	Control valve		
4	Attenuator		
5	Heater		
6	Cooling coil		
7			

8	**General**					
9	Control valve type		Manual		Mechanical	
10	Duct configuration		Single		Dual	
11	Heating or cooling		Heating		Cooling	
12	Heating/cooling duty (design)	kW				
13	Heating/cooling medium					
14	Electrical power supply	V/Hz/P·h				
15	Area classification		Hazardous		Nonhazardous	
16	Hazardous area certification					
17	Hazardous area gas groups					
18	Hazardous area temp. classification					
19						
20	**Design**					
21	**Airside**					
22	Air volume flowrate	m^3/s				
23	Entering air temperature	db/wb °C	Summer		Winter	
24	Leaving air temeprature	db/wb °C	Summer		Winter	
25	Maximum temperature rise/drop	°C				
26	System operating pressure	Pa				
27	Air pressure drop	Pa				
28	Heating/cooling duty (actual)	kW				
29						

30	**Noise Data** (at rated duty)	Sound power levels SWL in dB (ref. 10^{-12} W)								
31		octave band centre frequency, Hz								
32		63	125	250	500	1000	2000	4000	8000	dBA
33	Noise data at unit inlet									
34	Room noise limit									
35	Guaranteed data to room									

36	**Construction**		
37	Unit overall length	mm	
38	Duct connection size	mm	
39	Duct discharge size	mm	
40			
41	**Materials**		
42	**Control valve**		
43	Casing material/thickness	mm	
44	Blade material/thickness	mm	
45			
46			
47	**NOTE** Component design, construction and materials as individual data sheets.		
48			
49			

Annex F
(informative)

Flange standard

Table F.1 — Standard data for circular flanges

<table>
<tr><th>Nominal duct size (ØD)
mm</th><th>Bolt circle (ØE)
mm</th><th>Flange (flat bar)
mm</th><th>Bolt hole size
mm</th><th>Bolt size</th><th>No. of bolts</th></tr>
<tr><td>100</td><td>145</td><td rowspan="7">40 × 4</td><td rowspan="7">10</td><td rowspan="7">M8</td><td rowspan="3">4</td></tr>
<tr><td>125</td><td>170</td></tr>
<tr><td>160</td><td>205</td></tr>
<tr><td>200</td><td>245</td><td rowspan="4">8</td></tr>
<tr><td>250</td><td>295</td></tr>
<tr><td>315</td><td>360</td></tr>
<tr><td>355</td><td>400</td></tr>
<tr><td>400</td><td>459</td><td rowspan="9">50 × 5</td><td rowspan="9">12</td><td rowspan="9">M10</td><td rowspan="3">12</td></tr>
<tr><td>450</td><td>509</td></tr>
<tr><td>500</td><td>599</td></tr>
<tr><td>560</td><td>619</td><td rowspan="3">16</td></tr>
<tr><td>630</td><td>689</td></tr>
<tr><td>710</td><td>769</td></tr>
<tr><td>800</td><td>859</td><td rowspan="4">24</td></tr>
<tr><td>900</td><td>959</td></tr>
<tr><td>1 000</td><td>1 059</td></tr>
<tr><td>1 120</td><td>1 209</td><td rowspan="3">80 × 8</td><td rowspan="3">14</td><td rowspan="3">M12</td></tr>
<tr><td>1 250</td><td>1 339</td><td rowspan="2">32</td></tr>
<tr><td>1 400</td><td>1 489</td></tr>
</table>

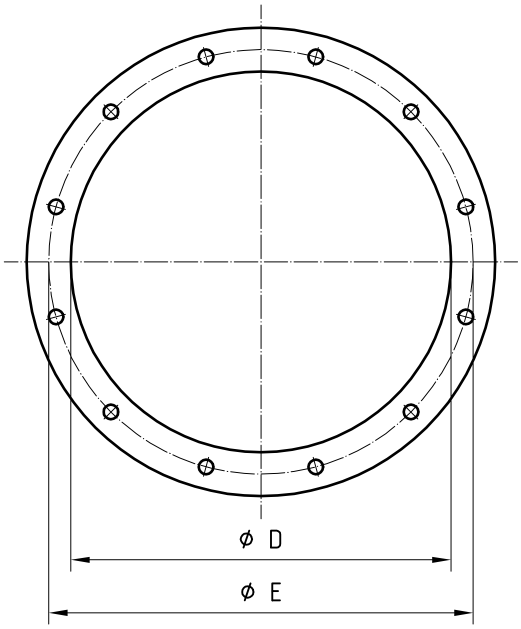
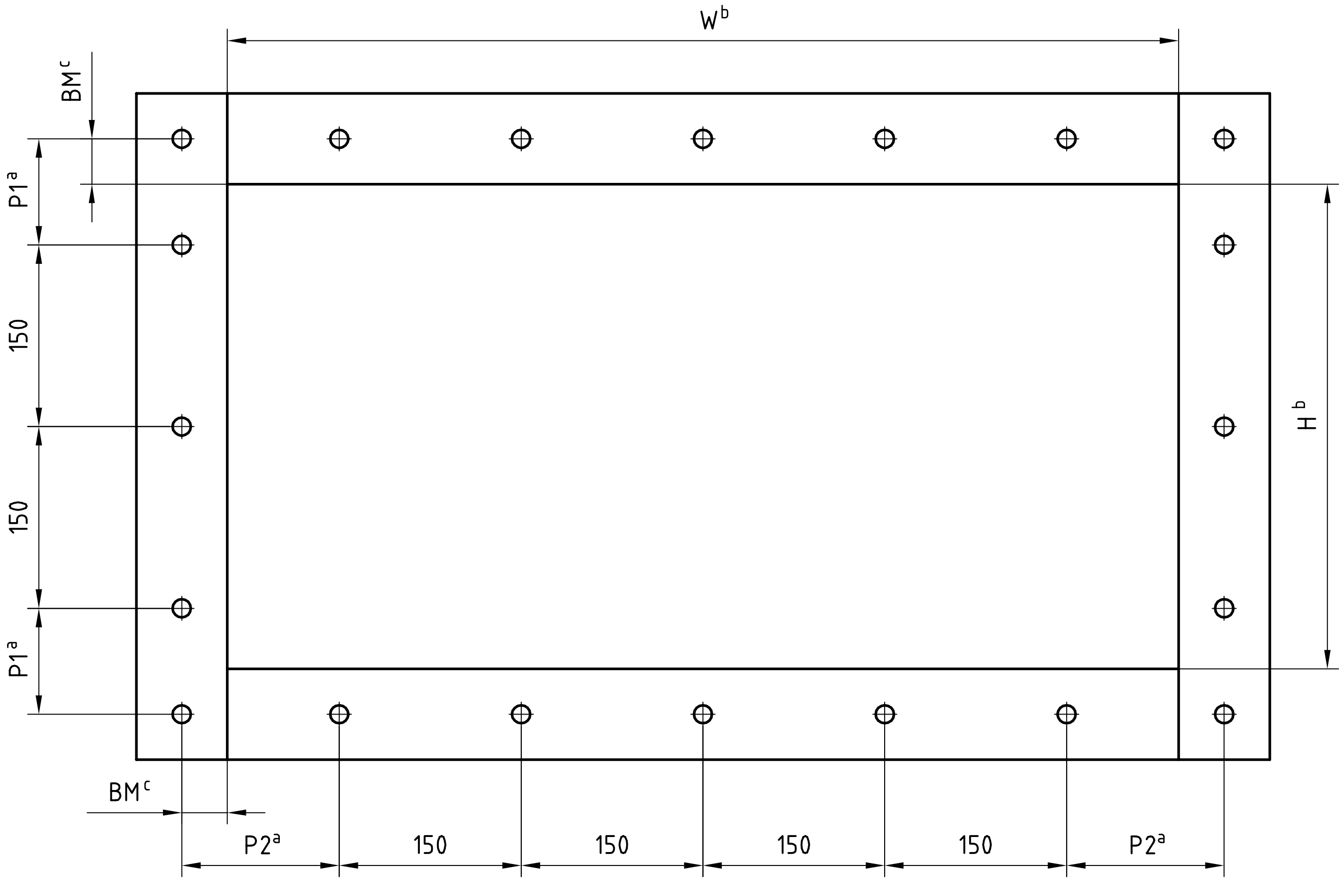


Figure F.1 — Circular flanges

Table F.2 — Standard data for rectangular flanges

Nominal duct longest side mm	**Back mark** mm	**Flat bar or angle iron** mm	**Bolt hole size** mm	**Bolt size**
Duct side ⩽ 350	20	40 × 4 40 × 40 × 4	10	M8
350 < duct side ⩽ 1000	30	50 × 5 50 × 50 × 5	12	M10
1000 < duct side	40	80 × 8 80 × 80 × 8	14	M12

Dimensions in millimetres



Flanges shall be continuously welded on both sides.

Flanges shall be made from the same material as the duct.

a 5 mm < P1 and P2 <150 mm

b W × H = nominal duct size (internal)

c Back mark BM is the distance from the inside duct to centreline hole

Figure F.2 — Rectangular flanges

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