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ISO/IEC 22237-4

First edition
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Information technology — Data centre facilities and infrastructures —

Part 4: **Environmental control**

Technologie de l'information — Installation et infrastructures de centres de traitement de données —

Partie 4: Contrôle environnemental

Reference number
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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

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

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

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

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

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 39, *Sustainability, IT & Data Centres*.

This first edition cancels and replaces the first edition (ISO/IEC TS 22237-4:2018), which has been technically revised.

The main changes are as follows:

— availability requirements have been aligned with ISO/IEC 22237-1 and ISO/IEC 22237-3;

— figures have been updated.

A list of all parts in the ISO/IEC 22237 series can be found on the ISO and IEC websites.

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

Introduction

The unrestricted access to internet-based information demanded by the information society has led to an exponential growth of both internet traffic and the volume of stored/retrieved data. Data centres are housing and supporting the information technology and network telecommunications equipment for data processing, data storage and data transport. They are required both by network operators (delivering those services to customer premises) and by enterprises within those customer premises.

Data centres need to provide modular, scalable and flexible facilities and infrastructures to easily accommodate the rapidly changing requirements of the market. In addition, energy consumption of data centres has become critical, both from an environmental point of view (reduction of carbon footprint), and with respect to economic considerations (cost of energy) for the data centre operator.

The implementation of data centres varies in terms of:

a) purpose (enterprise, co-location, co-hosting or network operator facilities);

b) security level;

c) physical size; and

d) accommodation (mobile, temporary and permanent constructions).

NOTE Cloud services can be provided by all data centre types mentioned.

The needs of data centres also vary in terms of availability of service, the provision of security and the objectives for energy efficiency. These needs and objectives influence the design of data centres in terms of building construction, power distribution, environmental control, telecommunications cabling and physical security. Effective management and operational information are required to monitor achievement of the defined needs and objectives.

The ISO/IEC 22237 series specifies requirements and recommendations to support the various parties involved in the design, planning, procurement, integration, installation, operation and maintenance of facilities and infrastructures within data centres. These parties include:

1) owners, operators, facility managers, ICT managers, project managers, main contractors;

2) consultants, architects, building designers and builders, system and installation designers, auditors and commissioning agents;

3) suppliers of equipment; and

4) installers, maintainers.

At the time of publication of this document, the ISO/IEC 22237 series comprises the following documents:

— ISO/IEC 22237-1, *Information technology — Data centre facilities and infrastructures — Part 1: General concepts*;

— ISO/IEC TS 22237-2, *Information technology — Data centre facilities and infrastructures — Part 2: Building construction*;

— ISO/IEC 22237-3, *Information technology — Data centre facilities and infrastructures — Part 3: Power distribution*;

— ISO/IEC 22237-4 (this document), *Information technology — Data centre facilities and infrastructures — Part 4: Environmental control*;

— ISO/IEC TS 22237-5, *Information technology — Data centre facilities and infrastructures — Part 5: Telecommunications cabling infrastructure*;

— ISO/IEC TS 22237-6, *Information technology — Data centre facilities and infrastructures — Part 6: Security systems*;

— ISO/IEC TS 22237-7, *Information technology — Data centre facilities and infrastructures — Part 7: Management and operational information*.

The inter-relationship of the specifications within the ISO/IEC 22237 series is shown in Figure 1.

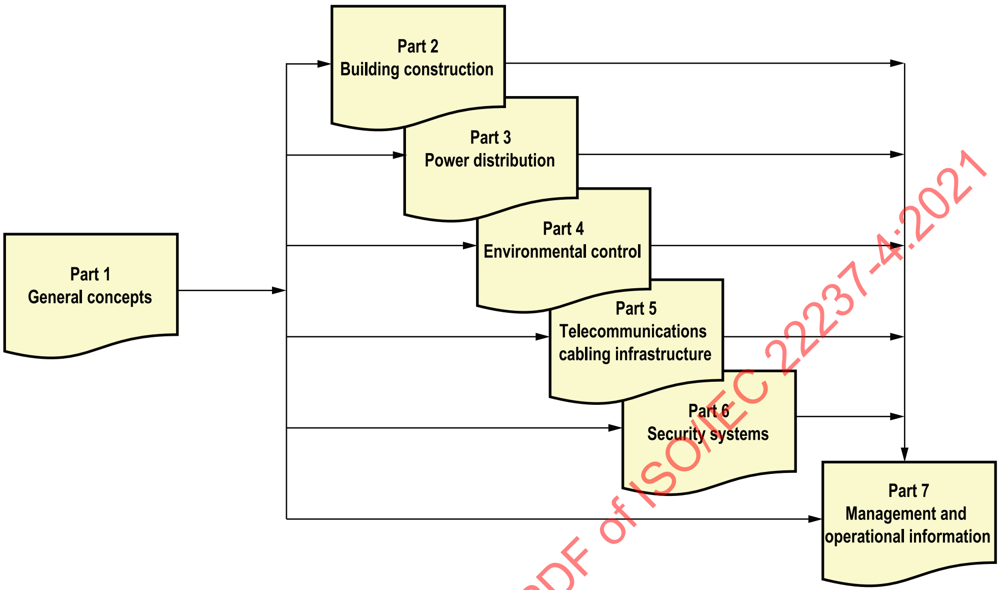

Figure 1 — Schematic relationship between the ISO/IEC 22237 series of documents

ISO/IEC TS 22237-2 to ISO/IEC TS 22237-6 specify requirements and recommendations for particular facilities and infrastructures to support the relevant classification for “availability”, “physical security” and “energy efficiency enablement” selected from ISO/IEC 22237-1.

This document, ISO/IEC 22237-4, addresses the environmental control facilities and infrastructure within data centres together with the interfaces for monitoring the performance of those facilities and infrastructures in line with ISO/IEC TS 22237-7 (in accordance with the requirements of ISO/IEC 22237-1).

ISO/IEC TS 22237-7 addresses the operational and management information (in accordance with the requirements of ISO/IEC 22237-1).

This document is intended for use by and collaboration between architects, building designers and builders, and system and installation designers.

The ISO/IEC 22237 series does not address the selection of information technology and network telecommunications equipment, software and associated configuration issues.

Information technology — Data centre facilities and infrastructures —

Part 4: Environmental control

1 Scope

This document addresses environmental control within data centres based upon the criteria and classifications for “availability”, “security” and “energy efficiency enablement” within ISO/IEC 22237-1.

This document specifies requirements and recommendations for the following:

a) temperature control;

b) fluid movement control;

c) relative humidity control;

d) particulate control;

e) vibration;

f) physical security of environmental control systems.

2 Normative references

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

ISO 14644-8, *Cleanrooms and associated controlled environments — Part 8: Classification of air cleanliness by chemical concentration (ACC)*

ISO 16890-1, *Air filters for general ventilation — Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM)*

ISO/IEC 22237-1, *Information technology — Data centre facilities and infrastructures — Part 1: General concepts*

ISO/IEC 22237-3, *Information technology — Data centre facilities and infrastructures — Part 3: Power distribution*

ISO/IEC/TS 22237-6, *Information technology — Data centre facilities and infrastructures — Part 6: Security systems*

IEC 61439-1, *Low-voltage switchgear and controlgear assemblies — Part 1: General rules*

IEC 62040-3, *Uninterruptible power systems (UPS) — Part 3: Method of specifying the performance and test requirements*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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

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

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

3.1.1
access floor
system consisting of completely removable and interchangeable floor panels that are supported on adjustable pedestals connected by stringers to allow the area beneath the floor to be used by building services

Note 1 to entry: Also known as raised floor.

[SOURCE: ISO/IEC TS 22237-2:2018, 3.1.1 – modified: added note 1 to entry]

3.1.2
comfort environmental control
control which produces an environment which is appropriate for the effective performance of personnel in a given space

3.1.3
dew point
temperature at which the water vapour in a gas begins to deposit as a liquid or ice, under standardized conditions

3.1.4
direct fresh air cooling
cooling system that uses the external air that can be filtered to cool the IT equipment in the data centre

3.1.5
diesel rotary uninterruptible power system
DRUPS
system where the output waveform is produced by a rotating machine that is mechanically connected to a flywheel stored energy source, and the flywheel stored energy source is coupled to a backup engine with an electro-magnetic clutch

3.1.6
inlet air temperature
temperature of the (cold) air entering the rack or IT equipment

3.1.7
relative humidity
ratio, expressed as a percentage, of the vapour pressure of water vapour in moist air to the saturation vapour pressure with respect to water or ice at the same temperature

[SOURCE: IEC 60050-705:1995, 705-05-09]

3.1.8
return air temperature
temperature of the (warm) air re-entering the environmental control system, e.g. the air handling unit

3.1.9
rotary uninterruptible power system
rotary UPS
system where the output waveform is produced by a rotating machine, using either batteries or flywheel as stored energy source

3.1.10
static uninterruptible power system
static UPS
system where the output waveform is produced by electronic circuits, using either batteries or flywheel as stored energy source

3.1.11
supply air temperature
temperature of the (cold) air leaving the environmental control system e.g. the air handling unit

3.1.12
ventilation
supply of air motion in a space by circulation or by moving air through the space

Note 1 to entry: Ventilation can be produced by any combination of natural or mechanical supply and exhaust.

Note 2 to entry: Such systems can include partial treatment such as heating, *relative humidity* (3.1.7) control, filtering or purification, and, in some cases, evaporative cooling.

3.2 Abbreviated terms

For the purposes of this document, the abbreviated terms given in ISO/IEC 22237-1 and the following apply.

AHU	air handling unit
DX	direct expansion cooling unit
IT	information technology
ICT	information and communication technology

4 Conformance

For a data centre to conform to this document:

a) it shall feature an environmental control solution that meets the requirements of Clauses 5 and 6;

b) it shall feature an approach to physical security in relation to the environmental control solution that meets the requirements of Clause 7;

c) it shall feature an energy efficiency enablement solution that meets the requirements of the relevant Granularity Level of Clause 8;

d) local regulations, including safety, shall be met.

The required Class of the Environmental Control system of a data centre is based on the required Availability Class of the data centre.

5 Environmental control within data centres

5.1 General

5.1.1 Design input

Power supply, distribution and environmental control are important primary facilities and infrastructures of a data centre and have inter-related design aspects:

a) power supplied to IT equipment which is converted to heat output;

b) power supplied to the environmental control system to remove the heat output.

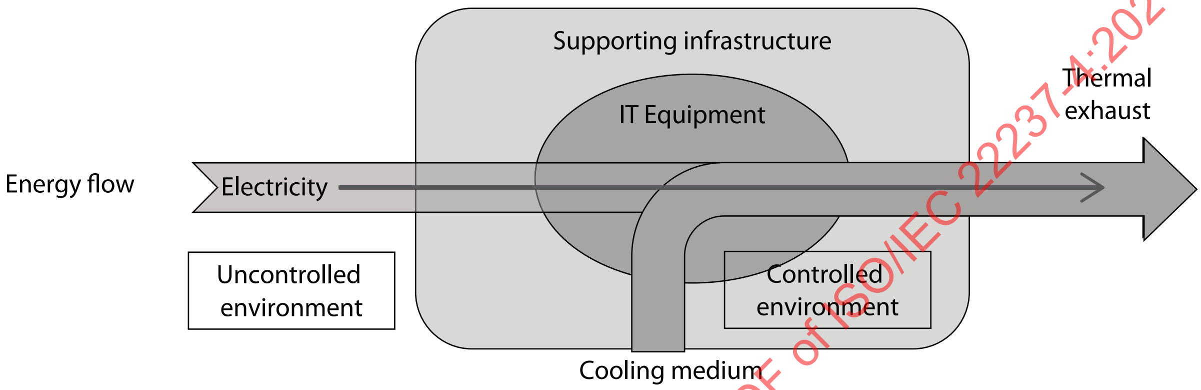

Figure 2 — Logical representation of environmental control of data centre spaces

5.1.2 Functional elements

The environmental control system is one of the most important parts of the data centre infrastructure. Excessive variations of temperature or relative humidity can directly affect the functional capability of the data centre and its infrastructures.

The functional elements of the environmental control system are divided into supply and distribution elements. The division of environmental control systems into supply and distribution reflects energy efficiency where data centres use multiple cooling sources in various combinations (e.g. cold water from public grids, non-dedicated central cooling plants, geothermal systems, rivers, and compressor systems).

Supply elements relate to the generation of temperature-controlled fluids. Distribution elements relate to the distribution of fluids generated by the supply elements. Distribution elements are differentiated in devices (units) and paths. See Table 1 for examples of these elements.

It should be noted that for environmental control systems the electrical energy flow is into the system and the thermal flow is from within the controlled environment outwards to the uncontrolled environment (exhausted from the building).

Some environmental systems combine the function of supply and distribution elements.

Table 1 — Examples of supply and distribution elements

Area	Fluid	Functional element(s)	
		Device/Functional element	**Path/Functional element**
Supply	Water/Refrigerant	External water supply, chiller, pump(s), condensing unit	Pipe system

Table 1 *(continued)*

Area	Fluid	Functional element(s)	
		Device/Functional element	**Path/Functional element**
	Air	Outside air intake, filter(s), heat exchanger	Duct/Plenum system
Distribution	Water/Refrigerant	Pump(s), heat exchanger	Pipe system
	Air	CRAC, CRAH, louvres, AHU	Duct/Plenum system

5.1.3 Requirements

The approach taken for the design of the environmental control system shall take into account available technology, physical security, data centre availability, maintenance and future extension (continuity of service).

Physical data centre location and external conditions (minimum, median and maximum external temperature and humidity rate) have to be taken into account for the selection of the functional elements.

The design of the environmental control system and the selection and installation of functional elements shall take into consideration the effect of vibration on the data centre spaces.

The design of the environmental control system and the selection and installation of functional elements shall take into consideration the effect of friction and/or obstruction in the pathways for temperature-controlled fluids. Operational controls shall be provided to ensure no degradation of fluid flow due to changes in the pathways (see ISO/IEC TS 22237-7).

During the design phase, the requirement for the number of air changes per unit time and air pressure shall be established.

In all data centre spaces, the requirements for air quality shall be considered.

In all spaces with a risk of damage to static-sensitive equipment from electro-static discharge, the relative humidity shall be maintained in accordance with the instructions of the supplier of the equipment to be accommodated. Where no information exists or where the equipment manufacturer is not specified, a minimum dew point of 5,5 °C shall be maintained.

Where direct fresh air cooling solutions are chosen, the requirements analysis and the resulting methodology of monitoring and control is of prime importance. In these circumstances, particular consideration shall be given to the control of contaminants.

For guidance on the ventilation requirements of activated gaseous suppression systems that have been discharged, see ISO/IEC TS 22237-6.

An overview of the requirements on environmental conditions is given in Annex A.

5.1.4 Recommendations

Opportunities for reductions in energy consumption exist where wider tolerances of temperature and relative humidity can be accepted in defined data centre spaces (see CLC/TR 50600-99-1).

Measurements are requested at various points in the text to provide insight, the ability to analyse and ultimately to improve energy efficiency.

Devices of the environmental control system with integrated vibration decoupling for all rotating parts (e.g. fan, compressor) or low vibration parts should be selected.

Where devices of the environmental control system or other external devices with rotating parts are not equipped with integrated vibration decoupling, the whole unit should be decoupled.

Where the design of the cooling system relies on the use of “F-gaseous” coolants, the long-term availability of such coolants and the subsequent effect on the cooling system efficiency should be considered.

5.2 Environmental control of data centre spaces

5.2.1 Building entrance facilities

No specific requirements.

5.2.2 Personnel entrance(s)

Comfort environmental controls shall be applied to this space.

5.2.3 Docking/loading bay(s)

No specific requirements.

5.2.4 Generator space(s) including fuel storage

5.2.4.1 Generator and DRUPS spaces

Temperature shall be maintained in accordance with the instructions of the supplier of the equipment to be accommodated. Where no information exists or where the equipment manufacturer is not specified, the temperature shall be maintained above 0 °C and should be above 10 °C.

Adequate ventilation shall be provided for combustion and for radiator cooling.

Where the manufacturer is not known at the time of design, the maximum temperature shall be 35 °C.

Anti-condensation measures shall be taken for generator and switchgear.

5.2.4.2 Fuel systems

The fuel system shall be protected against sub-zero ambient temperatures to avoid fuel solidification.

NOTE The availability of generators can be adversely affected by cold (< 10 °C) or poor-quality fuel and can be improved through the installation of crankcase heaters, or by installing the generators in a conditioned, purpose-built space within the data centre facility.

5.2.5 Transformer space(s)

The temperature shall be maintained in accordance with the instructions of the supplier of the equipment to be accommodated unless the system has been de-rated for operation at higher ambient temperatures. Where the manufacturer is not known at the time of design, the maximum temperature shall be in accordance with IEC 61439-1.

Where necessary, filtration against particulate contamination shall be provided to prevent build-up of dust in accordance with the instructions of the supplier of the equipment to be accommodated. Measures shall be provided to allow inspection and cleaning of the transformer and the transformer space(s).

Forced air cooling of the transformer should be considered at the design phase where this would represent an improvement in transformer efficiency.

Anti-condensation measures shall be taken for switchgear.

5.2.6 Electrical distribution space(s)

Temperature shall be maintained in accordance with the instructions of the supplier of the equipment to be accommodated. Where no information exists or where the equipment manufacturer is not specified, the temperature shall be maintained above 0 °C and should be above 10 °C.

Where practicable, natural ventilation shall be provided.

The maximum ambient temperature shall not exceed the maximum temperature specified by the supplier of the equipment to be accommodated unless the system has been de-rated for operation at higher ambient temperatures. Where the manufacturer is not known at the time of design the maximum temperature shall be 40 °C.

Anti-condensation measures shall be taken.

If required, temperature-controlled air extraction shall be provided.

5.2.7 Telecommunication spaces(s)

Temperature and relative humidity shall be maintained in accordance with the requirements of 5.2.9.

Temperature and relative humidity shall be monitored.

Where the data centre is supported by a single telecommunications space, or by multiple, non-resilient telecommunications spaces, the space(s) shall have a single path environmental control system (for examples see 6.2.2.2 and 6.2.2.3).

5.2.8 Main distributor spaces(s)

The requirements of 5.2.9 shall be applied.

5.2.9 Computer room space(s) and associated testing space(s)

The computer room space is the most important space from an environmental control perspective. The designer of the environmental control system shall assess the impact of the failure of the system on the data centre infrastructure.

Outside air shall be filtered according to ISO 16890-1, with the Class depending on the local air quality, and minimum filter Class M5.

An analysis examining the balance between energy management and environmental control parameters with reference to the type of IT equipment to be accommodated shall be performed by the owner of the data centre. The results of this analysis shall be compared with the business model for the data centre. CLC/TR 50600-99-1 provides further information to assist with this analysis.

Environmental controls shall be applied that maintain the following parameters within limits defined by the requirements of the analysis described above:

a) supply air temperature;

b) supply air relative humidity;

c) air quality:

   1) particulate content;

   2) gaseous contaminants.

For the classification of air cleanness by chemical concentration (ACC), ISO 14644-8 shall be applied. Gaseous contaminants should be measured periodically or monitored continuously regarding ANSI/ISA-71-04-2013. Where no information exists or where the equipment manufacturer is not specified, a minimum class G1 should be maintained. Visual inspection of hardware within the space should be performed as part of the maintenance routines to mitigate the potential risk of damage due to corrosion. Additional information as to the nature and concentration of contaminants can be obtained by laboratory analysis of collected dust from the data centre and/or specimens collected using carbon adhesive tabs.

The supply air temperature shall be monitored with temperature sensors in the supply path near the IT equipment. The number of sensors shall be chosen so as to provide a representative average supply air temperature and shall be in accordance with 8.2. In areas of high thermal load additional temperature sensors can be necessary to detect hot spots.

Where air containments are used, it is recommended that the supply air temperature be monitored by temperature sensors in the containment. The number of sensors shall be chosen so as to provide a representative average supply air temperature.

The relative humidity of supply air shall be monitored in the supply path. The number of sensors shall be chosen so as to provide a representative average value.

A combined sensor for temperature and relative humidity is allowed. Depending on the availability class, redundant temperature and humidity sensors shall be installed.

It is recommended to install a dew point sensor where relative humidity is measured, or to calculate a dew point from temperature and relative humidity data.

5.2.10 Electrical space(s)

If the electrical space contains UPS equipment, see 5.2.15.

Anti-condensation measures shall be taken.

Where practicable, natural ventilation shall be provided.

The maximum ambient temperature shall not exceed the maximum temperature specified by the supplier of the equipment to be accommodated unless the system has been de-rated for operation at higher ambient temperatures. Where the manufacturer is not known at the time of design, the maximum temperature shall be in accordance with IEC 61439-1.

Temperature and relative humidity should be monitored.

5.2.11 Mechanical space(s)

If the mechanical space accommodates electrical equipment, then the requirements of 5.2.10 apply. Otherwise, temperature and humidity shall be maintained in accordance with the instructions of the supplier of the equipment to be accommodated.

5.2.12 Control room space(s)

Comfort environmental controls shall be applied to this space.

5.2.13 Office space(s)

Comfort environmental controls shall be applied to this space.

5.2.14 Storage and holding space(s)

Basic environmental controls should be applied (temperature and relative humidity); temperature should be monitored. Measures addressing gaseous contaminants (see 5.2.9) should be considered.

5.2.15 Accommodation of UPS equipment

5.2.15.1 Static UPS and rotary UPS

Temperature shall be maintained in accordance with the instructions of the supplier of the equipment to be accommodated. Where no information exists or where the UPS equipment is not specified, the temperature shall be maintained between 15 °C and 35 °C (non-condensing). Where storage batteries are included in the UPS space, the requirements of 5.2.15.3 shall be applied.

Air-conditioning, rated for the maximum heat output of the UPS system, shall be provided if the external ambient conditions preclude the use of filtered fresh air.

Monitoring for temperature shall be provided.

Waste heat should be used to pre-heat the standby generator plant of the UPS system where possible.

5.2.15.2 DRUPS

The environmental controls required for the accommodation of Diesel Rotary UPS are stated in 5.2.4.1.

5.2.15.3 Batteries

Where batteries are located away from the UPS equipment that they serve, the temperature shall be controlled in accordance with the manufacturer's instructions to maintain planned battery lifetime. Where no information exists or where the equipment is not specified the temperature shall be maintained at (20 ± 2) °C.

If required, a resilient fresh air ventilation shall be provided to avoid hydrogen accumulation.

It is recommended that hydrogen monitoring be provided.

See EN 50272-2 for further information on safety requirements for secondary batteries.

6 Availability

6.1 General

The environmental control system shall be designed to support the Availability Class chosen following the risk assessment undertaken in accordance with the availability classification defined in ISO/IEC 22237-1.

This document defines four Classes of Environmental Control Systems of increasing availability (Class 1, Class 2, Class 3 and Class 4).

6.2 Availability Class design options

6.2.1 General

To maximize the utilization of capital plant, and to minimize energy standing losses, the designer shall take into account the increased redundancy for running at partial load when choosing how to specify the configuration.

In systems with multiple paths it is permissible to utilize different technologies for each path.

For examples of current "Best Practice" for environmental control, see CLC/TR 50600-99-1.

Scalable design options are not available for rooms other than those described in 6.2.2 and 6.2.3.

Four design options, of increasing Availability Class, are specified:

A Class 1 solution (single path) is appropriate where the outcome of the risk assessment deems it acceptable that:

— a single fault in a functional element can result in loss of functional capability;

— planned maintenance can require the load to be shut down.

A Class 2 solution (single path with redundancy) is appropriate where the outcome of the risk assessment deems it necessary that:

— a single fault in a device shall not result in loss of functional capability of that path (via redundant devices);

— routine planned maintenance of a redundant device shall not require the load to be shut down.

NOTE Failure of the path can result in unplanned load shutdown and routine maintenance of non-redundant devices can require planned load shutdown.

A Class 3 solution (multiple paths providing a concurrent repair/operate solution) is appropriate where the outcome of the risk assessment deems it necessary that:

— a fault of a functional element shall not result in loss of functional capability;

— although a failure of a path can result in unplanned load shutdown, maintenance routines shall not require planned load shutdown as the passive path serves to act as the concurrent maintenance enabler as well as reducing the recovery of service time (minimizing the mean downtime) after the failure of a path;

— planned maintenance shall not require the load to be shut down.

All paths shall be designed to sustain the maximum load.

A Class 4 solution (fault-tolerant solution except during maintenance) is appropriate where the outcome of the risk assessment deems it necessary that:

— a fault of a functional element shall not result in loss of functional capability;

— for power supply and distribution: any single event impacting a functional element shall not result in load shutdown;

— for environmental control: a failure of one path shall not result in unplanned load shutdown;

— planned maintenance shall not require the load to be shut down.

All paths shall be designed to sustain the maximum load.

6.2.2 Computer room and telecom space(s)

6.2.2.1 General

The designer of systems which require an additional primary supply (e.g. water) shall consider that the continuity of the primary supply has to meet the requirements of the chosen availability class.

Environmental control systems shall be able to restart automatically after disruption to their power supply. The designer of the system shall consider the effect of power supply disruption and the duration of the restart time following power supply disruption on the environmental conditions within the controlled space. The designer shall also consider delayed operation time in the design of the environmental control system, e.g. sizing of buffer tanks.

When environmental control systems are connected to a UPS, the UPS should be separated from the UPS for the IT equipment.

It should be noted that the examples given in the following subclauses are non-exclusive.

6.2.2.2 Class 1 — Supply: Single path system

6.2.2.2.1 General

Figure 3 shows a Class 1 cooling supply system with a single supply sub-system and a single path to the distribution sub-system. Examples of a Class 1 cooling supply sub-system are:

a) a single compressor-based chiller and a pump;

b) an inlet fan and a cooling coil.

6.2.2.2.2 Power supply

The environmental control system shall be fed from a power supply system that meets at least the requirements of ISO/IEC 22237-3, Class 1.

6.2.2.2.3 Power distribution

The designer of the system shall determine the power connection requirements (e.g. unprotected or protected) of control and other functional elements of the environmental control system along with any required management routines such that the design objectives of 6.2.2.1 are met.

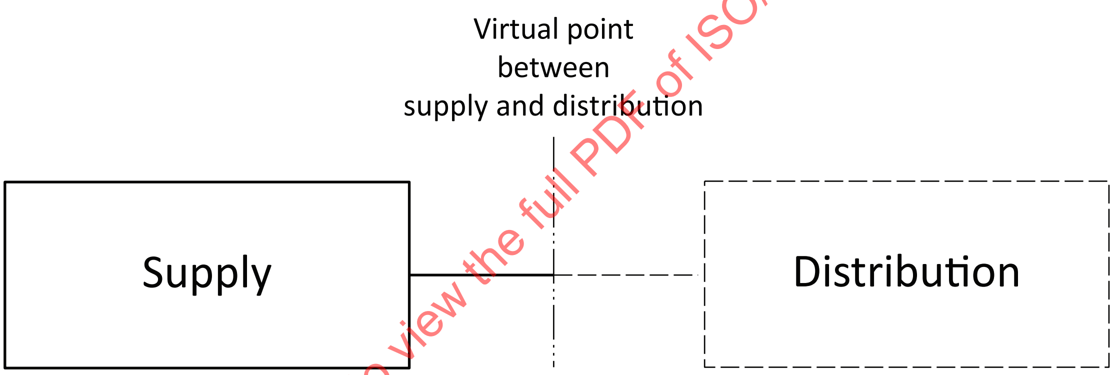

Figure 3 — Class 1 cooling supply sub-system

6.2.2.3 Class 1 — Distribution: single path system

6.2.2.3.1 General

Figure 4 shows a Class 1 cooling system with a single distribution sub-system and a single path from the supply sub-system. An example of a Class 1 cooling distribution sub-system is:

— a single air-conditioning module.

6.2.2.3.2 Power supply

The environmental control system shall be fed from a power supply system that meets at least the requirements of ISO/IEC 22237-3, Class 1.

6.2.2.3.3 Power distribution

The designer of the system shall determine the power connection requirements (e.g. unprotected or protected) of control and other functional elements of the environmental control system along with any required management routines such that the design objectives of 6.2.2.1 are met.

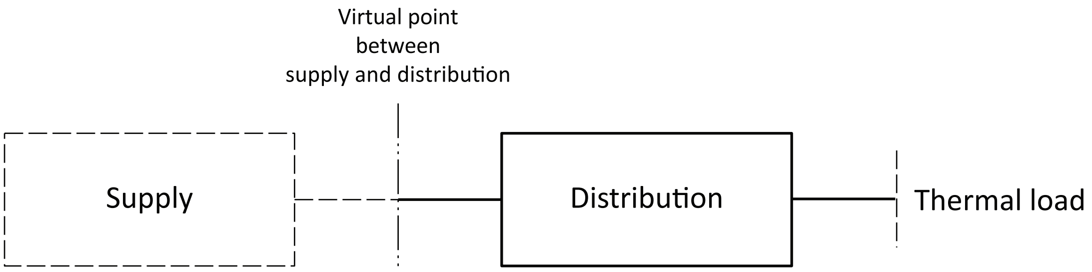

Figure 4 — Class 1 cooling distribution sub-system

6.2.2.4 Class 2 — Supply: single path system

6.2.2.4.1 General

Figure 5 shows a Class 2 cooling system with redundant supply sub-system and a single path to the distribution sub-system. Examples of a Class 2 supply sub-system are:

a) a redundant compressor-based chiller array and pumps;

b) a redundant array of inlet fans and cooling coils.

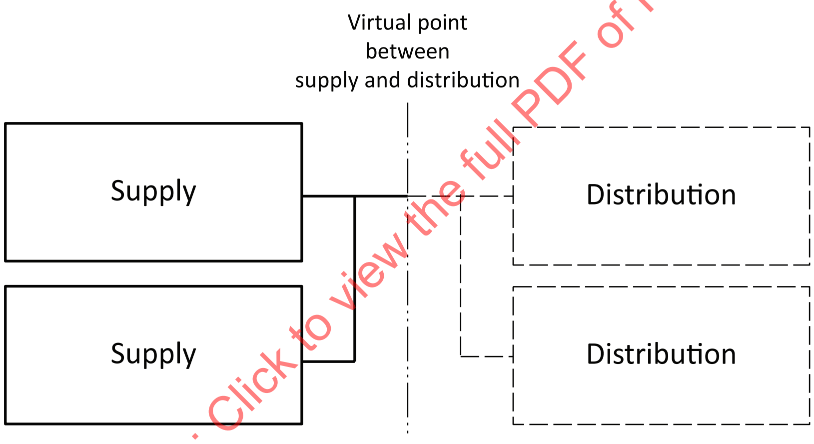

Figure 5 — Class 2 cooling supply sub-system

6.2.2.4.2 Power supply

The environmental control system shall be fed from a power supply system that meets at least the requirements of ISO/IEC 22237-3, Class 2.

6.2.2.4.3 Power distribution

The designer of the system shall determine the power connection requirements (e.g. unprotected, protected or short-break) of control and other functional elements of the environmental control system such that the design objectives of 6.2.2.1 are met.

6.2.2.5 Class 2 — Distribution: single path system

6.2.2.5.1 General

Figure 6 shows a Class 2 cooling system with redundant distribution devices and a single path from the supply sub-system. An example of a Class 2 cooling distribution sub-systems is:

— a redundant air-conditioning module.

6.2.2.5.2 Power supply

The environmental control system shall be fed from a power supply system that meets at least the requirements of ISO/IEC 22237-3, Class 2.

6.2.2.5.3 Power distribution

The designer of the system shall determine the power connection requirements (e.g. unprotected, protected or short-break) of control and other functional elements of the environmental control system such that the design objectives of 6.2.2.1 are met.

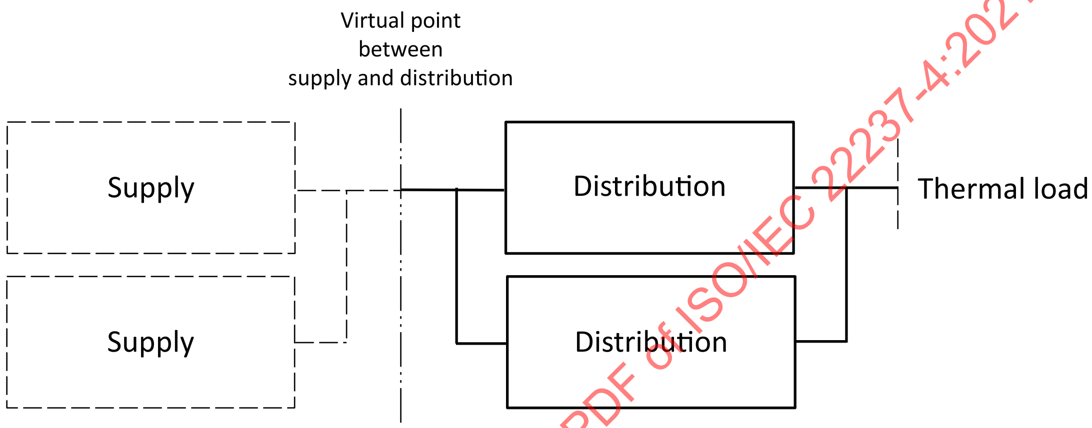

Figure 6 — Class 2 cooling distribution sub-system

6.2.2.6 Class 3 — Supply: multi-path resilience and concurrent repair/operate solution

6.2.2.6.1 General

Figure 7 shows a Class 3 cooling system with redundant supply sub-system and a redundant path to the distribution sub-system. Examples of a Class 3 supply sub-system are:

a) a redundant compressor-based chiller array and redundant pumps;

b) a redundant array of inlet fans and cooling coils.

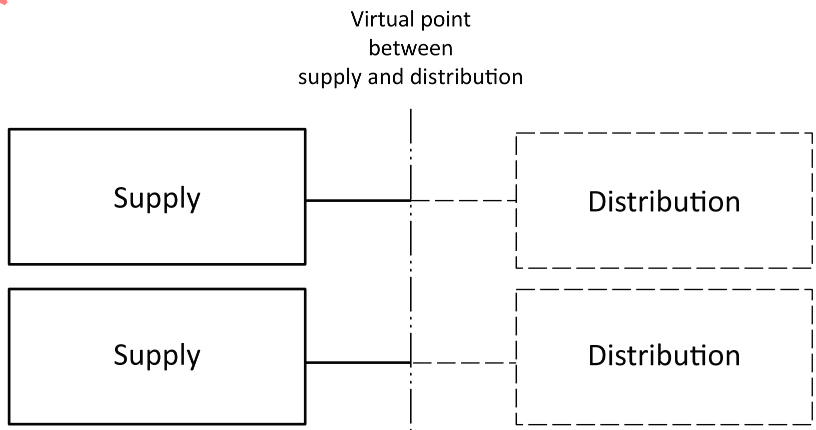

Figure 7 — Class 3 cooling supply sub-system

A passive delivery path (with automatic or manual changeover switches) shall be provided. All passive sub-systems (e.g. the chilled water piping) shall also have in-built path redundancy where a failure in such an element can result in a loss of cooling albeit with a rapid (manual) substitution of the active path with the passive path.

6.2.2.6.2 Power supply

The environmental control system shall be fed from a power supply system that meets at least the requirements of ISO/IEC 22237-3, Class 3.

6.2.2.6.3 Power distribution

The designer of the system shall determine the power connection requirements (e.g. unprotected, protected or short-break) of control and other functional elements of the environmental control system such that the design objectives of 6.2.2.1 are met.

6.2.2.7 Class 3 — Distribution: multi-path resilience and concurrent repair/operate solution

6.2.2.7.1 General

Figure 8 shows a Class 3 cooling system with redundant distribution devices and a redundant path from the supply sub-system. An example of a Class 3 cooling distribution sub-system is:

— a redundant air-conditioning module.

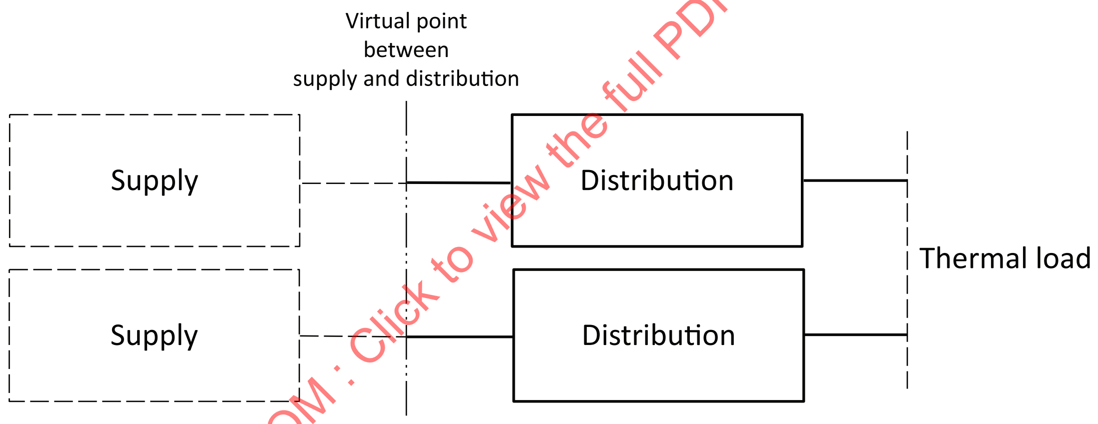

Figure 8 — Class 3 cooling distribution sub-system

A passive delivery path (with automatic or manual changeover switches) shall be provided. All passive sub-systems (e.g. the chilled water piping) shall also have in-built path redundancy where a failure in such an element can result in a loss of cooling albeit with a rapid (manual) substitution of the active path with the passive path, e.g. closed circular pipeline including a sufficient number of shut-off valves.

6.2.2.7.2 Power supply

The environmental control system shall be fed from a power supply system that meets at least the requirements of ISO/IEC 22237-3, Class 3.

6.2.2.7.3 Power distribution

The designer of the system shall determine the power connection requirements (e.g. unprotected, protected or short-break) of control and other functional elements of the environmental control system such that the design objectives of 6.2.2.1 are met.

6.2.2.8 Class 4 — Supply: multi-path resilience, concurrent repair/operate, and fault tolerant solution

6.2.2.8.1 General

Figure 9 shows a Class 4 active/active cooling supply sub-system. It comprises two segregated, compartmentalized and entirely separate supply sub-systems including separated paths. Examples of a Class 4 supply sub-system are:

a) redundant compressor-based chiller arrays and pumps;

b) redundant arrays of inlet fans and cooling coils.

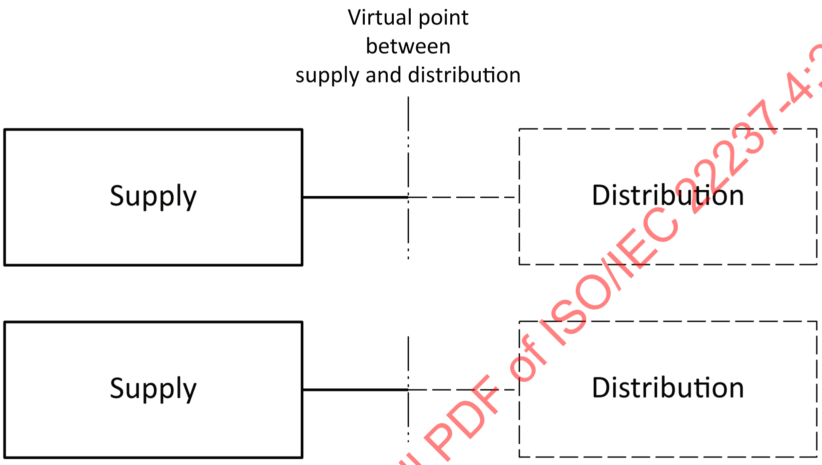

Figure 9 — Class 4 cooling supply sub-system

6.2.2.8.2 Power supply

The environmental control system shall be fed from a power supply system that meets at least the requirements of ISO/IEC 22237-3, Class 2.

6.2.2.8.3 Power distribution

The designer of the system shall determine the power connection requirements (e.g. unprotected, protected or short-break) of control and other functional elements of the environmental control system such that the design objectives of 6.2.2.1 are met.

6.2.2.9 Class 4 — Distribution: multi-path resilience, concurrent repair/operate, and fault tolerant solution

6.2.2.9.1 General

Figure 10 shows a Class 4 active/active cooling distribution sub-system. It comprises two segregated, compartmentalized and entirely separate distribution sub-systems including separated paths. Examples of a Class 4 cooling distribution sub-systems are:

a) redundant air-conditioning modules;

b) redundant air-conditioning modules and adiabatic spray modules with optional powered louvres.

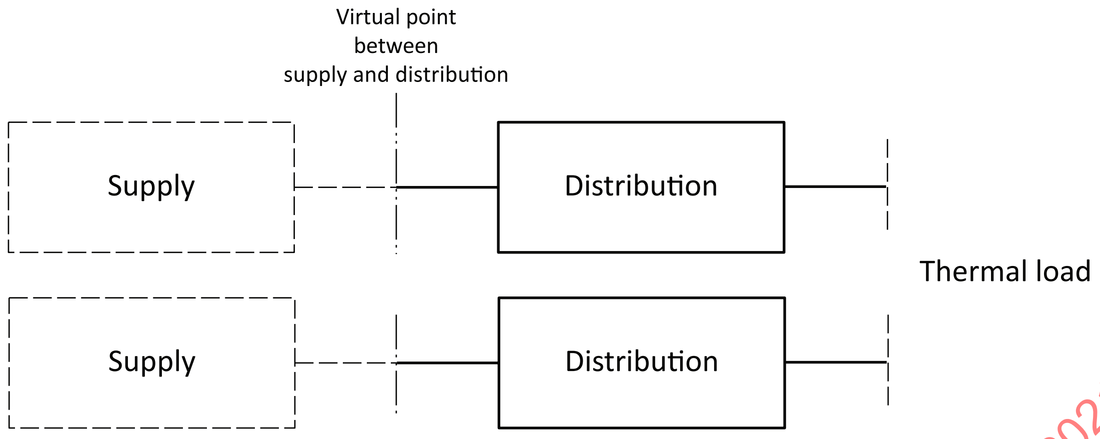

Figure 10 — Class 4 cooling distribution sub-system – segregated

In the example in Figure 10, both distribution sub-systems shall have their own air-conditioning module arrays, with each array sized to meet the thermal load.

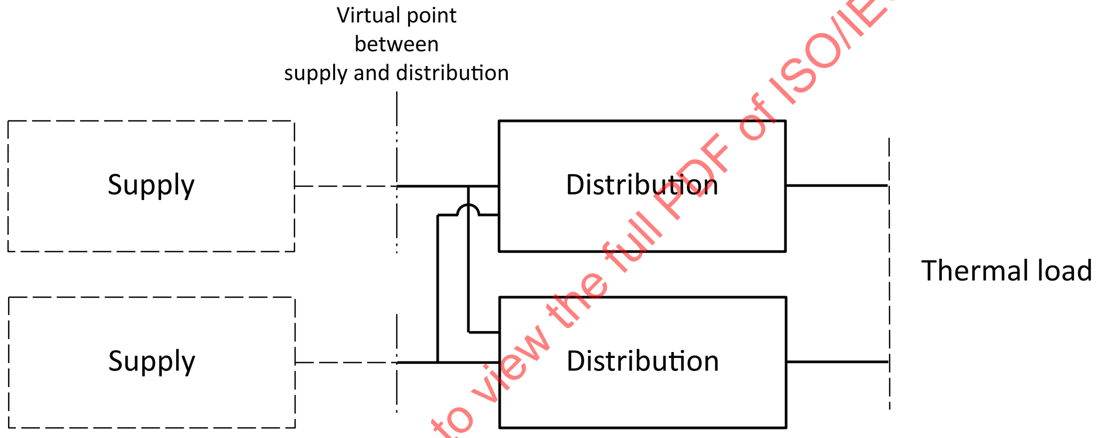

Figure 11 — Class 4 cooling distribution sub-system – shared redundant

Figure 11 shows an example of a Class 4 shared redundant cooling distribution sub-system. It comprises a shared redundant sub-system within the distribution. The air-conditioning modules are configured in a single array with redundancy. All air-conditioning modules shall be connected to both supply sources with the ability to select the preferred supply with automatic changeover switches. The quantity of air-conditioning modules required for a shared redundant cooling system is typically less than the quantity of air-conditioning modules required for an active/active cooling system.

Another example of a Class 4 shared redundant cooling distribution sub-system is a single array with redundancy and redundant supply of different technology (e.g. chiller and DX).

6.2.2.9.2 Power supply

Each environmental control system for an active/active distribution sub-system shall be fed from a power supply system that meets at least the requirements of ISO/IEC 22237-3, Class 2.

In a shared redundant distribution sub-system, all shared redundant elements shall be fed from both power supply systems that meet at least the requirements of ISO/IEC 22237-3, Class 2 (with automatic changeover switches).

6.2.2.9.3 Power distribution

The designer of the system shall determine the power connection requirements (e.g. unprotected, protected or short-break) of control and other functional elements of the environmental control system such that the design objectives of 6.2.2.1 are met.

6.2.3 UPS space

6.2.3.1 General

The requirements of this clause apply where the UPS equipment is not accommodated in the computer room space.

6.2.3.2 Class 1: single path (no resilience)

The UPS space shall be cooled by a supply and distribution system of Class 1 or better that is rated to supply a cooling capacity equal to the maximum possible power losses in the UPS and not exceed the temperature supported by the chosen UPS. If no vendor data exists, IEC 62040-3 shall be applied. A single failure in the cooling plant exposes the UPS to over-temperature and shutdown/bypass with associated risk to the critical load.

6.2.3.3 Class 2: single path (resilience provided by redundancy of devices)

The UPS space shall be cooled by a supply and distribution system of Class 2 or better that is rated to supply a cooling capacity equal to the maximum possible power losses in the UPS and not exceed the temperature supported by the chosen UPS. If no vendor data exists, IEC 62040-3 shall be applied. A single failure in a device does not expose the UPS to over-temperature and shutdown/bypass with associated risk to the critical load.

6.2.3.4 Class 3: multi-path resilience and concurrent repair/operate solution

In case one UPS room is planned, the UPS space shall be cooled by a supply and distribution system of Class 3 or better that is rated to supply a cooling capacity equal to the maximum possible power losses in the UPS and not exceed the temperature supported by the chosen UPS. If no vendor data exists, IEC 62040-3 shall be applied. A single failure in the cooling system shall not expose the UPS to over-temperature and shutdown/bypass with associated risk to the critical load.

In case two separate and redundant UPS rooms are used, the Availability Class 1 or better shall be chosen for the cooling system of each room and the cooling system shall be connected to the same primary power distribution system as the UPS it is supporting.

6.2.3.5 Class 4: multi-path resilience, concurrent repair/operate, and fault tolerant solution

There is no “Class 4 UPS room”, as in a Class 4 system, UPSs will be in two separate rooms, each with a Class 1 environmental control system or better which are supported by two individual Class 2 electrical power supply systems. For the power distribution, the designer of the system shall determine the power connection requirements (e.g. unprotected, protected or short-break) of control and other functional elements of the environmental control systems such that the design objectives of 6.2.2.1 are met.

6.3 Environmental control system capacity planning with respect to expansion

During the design phase the use of modular solutions providing capacity for the expected load with respect to time shall be considered.

6.4 Environmental control system capacity planning with respect to resilience

Where resilience is provided by multiple CRACs or CRAHs, consideration shall be given to the number of units and the fan speed at which each unit is operated.

The design of the system shall accommodate an operating point where all CRACs or CRAHs run at minimum fan speed.

The control system shall be set up in such a way that it conforms with the separation and redundancy equal to the classes for supply and distribution elements. All devices in the system shall operate on a standalone basis, no central control is required. A central control system can be used for monitoring and manual adjustment. If the central control system fails, the components of the system will operate in a fail-safe mode so that the operation of the data centre is not disrupted. For Classes 3 and 4, this can also be achieved with a redundant control system.

7 Physical security

7.1 General

Based on the security classification following the risk assessment undertaken in accordance with ISO/IEC 22237-1, this document (ISO/IEC 22237-4) provides requirements and recommendations (with optional implementations as required) in relation to the following aspects with the design, planning and installation of the environmental control facilities and infrastructures.

7.2 Protection against unauthorized access

All controls and equipment comprising the environmental control system shall be in areas of Protection Class 3 or above as specified in ISO/IEC TS 22237-6.

Where pathways are routed in areas of a lower Protection Class they shall be monitored for unauthorized access. See ISO/IEC TS 22237-6.

8 Energy efficiency enablement

8.1 General

Based on the energy efficiency enablement granularity level defined in accordance with ISO/IEC 22237-1, this clause provides requirements and recommendations (with optional implementations as required) in relation to the following aspects with the design, planning and installation of the environmental control facilities and infrastructures. 8.2 and 8.3 define requirements and recommendations for measurement by parameter.

8.2 Measurement of temperature

8.2.1 External temperature

In all cases, external temperature shall be measured and monitored. An external temperature sensor shall be used, located away from any building exhausts and from direct sunlight. The output from this sensor shall be fed into the control system for the data centre. For data centres of Availability Class 2 and above, the feedback from the external temperature sensor shall be automatic.

A single sensor is required for Level 1.

For Level 2 and above, an additional sensor should be employed to provide resilience. See Table 2.

8.2.2 Computer room temperature

Computer room temperature shall be monitored. In an air-cooled environment, air temperature varies by location. Where liquid-cooled enclosures are used, the temperature of the liquid coolant shall be monitored. Where liquid-cooled IT equipment is used, the temperature of the liquid coolant shall be monitored. Temperature sensors should not be placed in areas of high turbulence and should be so placed as to establish thermal gradient.

The purpose of a data centre cooling system is to deliver the correct volume of air within the accepted environmental conditions to the inlet of the IT equipment. Temperature sensors located as close to the IT equipment air intakes as possible (e.g. attached to rails/inside rack door) will help to determine how effectively this is achieved. Where sufficient air volume is delivered and the hot and cold airstreams are effectively segregated, the measurement of temperature in the cold aisle outside of the rack provides a suitable proxy location. The number of sensors and placement of sensors should give a representative picture of the computer room. It can be desirable to install more than one sensor per rack to understand any deficiencies in cold air delivery (particularly in non-contained systems), for example in front of a live device at one third and two thirds of the rack height.

To understand and optimize the airflow demand from the IT equipment and load on the cooling units, it is useful to know the delta T across both. The cooling units usually report supply and return temperature. Where they do not, additional sensors can be installed to provide this information. The return temperature can vary across the return intake of the cooling unit. As the return temperature can vary across the return intake of the cooling unit, an average of three readings is recommended.

The IT equipment outlet temperature will vary according to device type and workload. To measure IT equipment delta T, additional sensors would be required at the IT equipment outlet. Similarly to the IT equipment air inlet sensors, this needs to be as close to the equipment outlet as possible. Any sensors used for this purpose should be paired with an IT equipment inlet air sensor. An average delta T can then be calculated across the IT devices where the inlet and outlet temperatures are measured.

An alternative to installing permanent sensors is to undertake a periodic survey of temperatures.

Table 2 — Measurement requirements by Granularity Level

Requirement	Granularity Level		
	Level 1	Level 2	Level 3
Inlet air temperature	Single sensor in proximity to IT equipment One sensor per cold aisle	One sensor per cold aisle One sensor every 5 cabinets or racks in a cold aisle	One sensor per 10 cabinets or racks (5 on each side of the aisle)
Return air temperature	Single sensor in proximity to intake of return air to the cooling equipment	One sensor at the air intake per CRAH	One sensor at the air intake per CRAH

If no air containments are used, the number of sensors can be increased.

8.3 Measurement of relative humidity

8.3.1 External relative humidity

In all cases, external relative humidity shall be measured and monitored. An external relative humidity sensor should be used, located away from any building exhausts and from direct sunlight. The relative humidity sensor should be co-located with the temperature sensor (see 8.2.1). The output from this sensor shall be fed into the control system for the data centre. For data centres of Class 2 and above, the feedback from the external relative humidity sensor shall be automatic.

A single sensor is required for Level 1.

For Level 2 and above, an additional, combined relative humidity and temperature sensor should be employed to provide resilience.