BS EN 50600-2-3:2014





BSI Standards Publication

Information technology — Data centre facilities and infrastructures

Part 2-3: Environmental control

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National foreword

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CENELEC

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Foreword

This document (EN 50600-2-3:2014) has been prepared by CLC/TC 215 “Electrotechnical aspects of telecommunication equipment”.

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2015-09-01
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2017-09-01

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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 economical 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;

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

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 and physical security. Effective management and operational information is required to monitor achievement of the defined needs and objectives.

This series of European Standards 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, facility managers, ICT managers, project managers, main contractors;

2) architects, building designers and builders, system and installation designers;

3) facility and infrastructure integrators, suppliers of equipment;

4) installers, maintainers.

At the time of publication of this European Standard, the EN 50600 series will comprise the following standards:

— EN 50600-1, *Information technology — Data centre facilities and infrastructures — Part 1: General concepts*;

— EN 50600-2-1, *Information technology — Data centre facilities and infrastructures — Part 2-1: Building construction*;

— EN 50600-2-2, *Information technology — Data centre facilities and infrastructures — Part 2-2: Power distribution*;

— EN 50600-2-3, *Information technology — Data centre facilities and infrastructures — Part 2-3: Environmental control*;

— EN 50600-2-4, *Information technology — Data centre facilities and infrastructures — Part 2-4: Telecommunications cabling infrastructure*;

— EN 50600-2-5, *Information technology — Data centre facilities and infrastructures — Part 2-5: Security systems*;

— EN 50600-2-6, *Information technology — Data centre facilities and infrastructures — Part 2-6: Management and operational information*.

The inter-relationship of the standards within the EN 50600 series is shown in Figure 1.

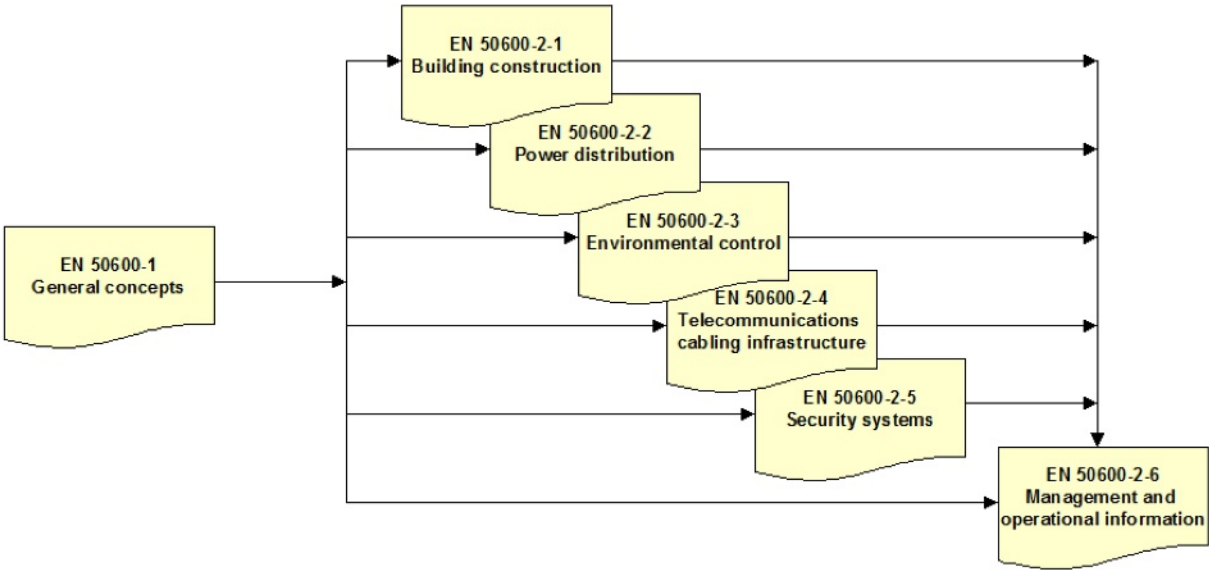

Figure 1 — Schematic relationship between the EN 50600 standards

EN 50600-2-X standards specify requirements and recommendations for particular facilities and infrastructures to support the relevant classification for “availability”, “physical security” and “energy efficiency enablement” selected from EN 50600-1.

This European Standard 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 EN 50600-2-6 (in accordance with the requirements of EN 50600-1).

This series of European Standards does not address the selection of information technology and network telecommunications equipment, software and associated configuration issues.

1 Scope

This European Standard addresses environmental control within data centres based upon the criteria and classifications for “availability”, “security” and “energy efficiency enablement” within EN 50600-1.

This European Standard specifies requirements and recommendations for the following:

a) temperature control,

b) fluid movement control,

c) relative humidity control,

d) particulate control,

e) vibration,

f) floor layout and equipment locations,

g) energy saving practices,

h) physical security of environmental control systems.

For issues related to electromagnetic environment, see EN 50600-2-5.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50600-1, *Information technology — Data centre facilities and infrastructures — Part 1: General concepts*

EN 50600-2-5[1)], *Information technology — Data centre facilities and infrastructures — Part 2-5: Security systems*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions in EN 50600-1 and the following apply.

3.1.1
adiabatic cooling
adiabatic cooling is a cooling system that is using the evaporative cooling principle to reduce the air temperature

3.1.2
absolute humidity
quantity of water vapour in a given volume of air, expressed by mass

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1) Circulated for CENELEC enquiry.

3.1.3
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: EN 50600-2-1:2014, 3.1.1]

3.1.4
comfort environmental controls
controls which produce an environment which is appropriate for the effective performance of personnel in a given space

3.1.5
dew point
temperature at which the water vapour in a gas begins to deposit as a liquid or ice, under standardized conditions

[SOURCE: IEC 60050-212:2010, 212-18-11]

3.1.6
exhaust air temperature
the temperature of the air leaving the data centre building or the temperature of the air leaving the heat load

3.1.7
fresh air cooling
cooling system that uses the external air to cool the data centre either directly or indirectly

3.1.8
heat load
thermal power that is produced

3.1.9
information technology equipment
equipment providing data storage, processing and transport services together with equipment dedicated to providing direct connection to core and/or access networks

3.1.10
outdoor air temperature
temperature of the air measured outside of the data centre building

3.1.11
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]

3.1.12
return air temperature
temperature of the air re-entering the environmental control system e.g. the air handling unit

3.1.13
supply air temperature
temperature of the air entering the IT equipment

3.1.14
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 may include partial treatment such as heating, relative humidity control, filtering or purification, and, in some cases, evaporative cooling.

3.2 Abbreviations

For the purposes of this document, the abbreviations given in EN 50600-1 and the following apply.

UPS	Uninterruptible Power Supply
CRAC	Computer Room Air Conditioning (Unit)
IT	Information Technology
ITE	Information Technology Equipment

4 Conformance

For a data centre to conform to this European Standard:

a) it shall feature an environmental control solution that meets the requirements of Clauses 4 and 5;

b) it shall feature an approach to physical security in relation to the environmental control solution that meets the requirements of Clause 6;

c) it shall feature an energy efficiency enablement solution that meets the requirements of the relevant Granularity Level of Clause 7;

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

5 Environmental control within data centres

5.1 General

5.1.1 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 primary and secondary elements.

Primary elements relate to the mechanical generation of temperature controlled fluids. Secondary elements relate to the distribution of fluids generated by the primary elements. See Table 1 for examples of these elements.

Some environmental systems combine the function of primary and secondary elements.

Table 1 — Examples of Primary and Secondary Functional Elements

Area	Fluid	Functional Element(s)
Primary	Water	Water supply grid, chiller, pump(s)
	Air	Outside air intake, filter, heat exchanger
Secondary	Water	Pump(s), valve(s), pipe system, liquid cooled enclosures
	Air	Duct system, computer room air conditioning unit

It should be noted that a Class 1 environmental control system does not necessarily contain any of these elements.

5.1.2 Requirements

The approach taken for the design of the environmental control system shall take into account available technology, physical security and data centre availability.

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.

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 filtration shall be considered.

In all spaces where there is 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 see EN 50600-2-5.

5.1.3 Recommendations

Opportunities for reductions in energy consumption exist where wider tolerances of temperature and relative humidity can be tolerated in defined data centre spaces. It is recommended to use cooling units with integrated vibration decoupling for all rotating parts (e.g. fan, compressor) or low vibration parts. If the cooling units or other external components with rotating parts are not equipped with integrated vibration decoupling the whole unit should be decoupled.

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 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 heating shall be provided for alternators and switchgear.

Temperature and the presence of particulates (smoke, carbon monoxide and fuel) shall be monitored. See EN 50600-2-5 for further information regarding monitoring of smoke.

Heater elements in the generator engine may provide sufficient heat for this space, where this is not possible thermostatically controlled heaters shall be applied.

5.2.4.2 Fuel storage systems

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

The fuel storage systems shall be monitored for leakage.

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.

5.2.5 Transformer space(s)

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 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.

The maximum ambient temperature shall not exceed the maximum temperature specified by the equipment manufacturer 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 35 °C.

Filtration against dust shall be provided, if required, in accordance with the instructions of the supplier of the equipment to be accommodated.

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

Anti-condensation heating shall be provided for switchgear.

Temperature and the presence of smoke particulates shall be monitored. See EN 50600-2-5 for further information regarding monitoring of smoke.

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.

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 heating shall be provided.

Temperature controlled air extraction shall be provided, where the facility's redundancy so requires ventilation shall be by redundant fans each rated to the maximum load expected. Temperature and relative humidity shall be monitored.

5.2.7 Telecommunication spaces(s)

Temperature and relative humidity shall be maintained in accordance with the instructions of the supplier of the equipment to be accommodated. Where this is not known in advance temperature shall be maintained between 10 °C and 30 °C with relative humidity maintained between 20 % and 70 %.

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 resilient environmental control system (for examples see 6.2.5.3).

5.2.8 Main Distributor spaces(s)

If external to computer room space the requirements of 5.2.7 shall be applied; if contained within the computer room space then 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.

An analysis examining the balance between tight environmental controls versus high performance energy saving controls 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.

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

a) operating temperature;

b) relative humidity;

c) air quality:

1) particulate content;

2) bacterial content;

3) gaseous contaminants.

The designer of the environmental control system shall assess the impact of the failure of the system on the data centre infrastructure.

5.2.10 Electrical space(s)

See 5.2.15, if the electrical space contains UPS equipment.

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.

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 heating shall be provided.

Temperature and relative humidity shall be monitored.

5.2.11 Mechanical space(s)

Temperature and relative humidity shall be monitored.

If the mechanical space accommodates electrical equipment then the requirements of 5.2.10 apply.

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 shall be applied (temperature and relative humidity); temperature and relative humidity shall be monitored.

5.2.15 Accommodation of UPS equipment

5.2.15.1 Static 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.

Closed loop monitoring for temperature and relative humidity shall be provided.

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

5.2.15.2 Diesel rotary UPS

The environmental controls required for the accommodation of diesel rotary UPS are as stated in 5.2.4.

5.2.15.3 Batteries

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

Ventilation shall be provided to avoid hydrogen accumulation. Where mechanical extraction is used the fans shall be redundant and fed from separate secondary power supply points.

It is recommended that Hydrogen monitoring is provided.

See EN 50272-2 for further information.

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 EN 50600-1.

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

6.2 Design options by space

6.2.1 General

All systems in data centres utilize the concept of '*N*' when planning the load and the redundancy, e.g. *N*, *N*+1, 2*N* or 2(*N*+1), etc. where *N* is seldom equal to 1. To maximize the utilization of capital plant, and so 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 of '*N*'.

Four design options, of increasing availability are specified:

It should be noted that Class 1 as defined by EN 50600-1 has no meaning within this standard and no specific requirements exist.

a) Class 2: Single path (no resilience) - a single path system without resilience is suitable where it is acceptable that a single fault in an element in the path will result in loss of functional capability and where maintenance requires the load to be shut-down.

b) Class 3: Single path (resilience provided by redundancy of components) - a single path system with resilience is suitable where it is required that a single fault in the path will not result in loss of functional capability because sufficient redundant components in each sub-assembly are included and where routine planned maintenance does not require the load to be shut-down. Major faults may result in unplanned load shutdown and some maintenance routines may require planned load shutdown.

c) Class 4: Multi-path resilience and concurrent repair/operate solution - an active/passive multi-path system with resilience is suitable where it is required that a single fault in the path will not result in loss of functional capability because sufficient redundant components in each sub-assembly are included and where routine planned maintenance does not require the load to be shut-down. Major faults may result in unplanned load shutdown but maintenance routines will not require planned load shutdown. The passive path serves to act as the concurrent maintenance enabler as well as reducing to the minimum the recovery of service time (minimising the mean downtime) after a major fault. The designer should aim to have the least number of common-points-of-failure possible between the active and passive paths, including segregated routing and physical compartmentalisation.

d) Enhanced Class 4: Multi-path resilience, concurrent repair/operate, and fault tolerant solution - an active/active multi-path system is suitable where it is required that no single fault in any path will result in loss of functional capability and where planned maintenance does not require the load to be shut-down. A major fault in one path will not result in unplanned load shutdown and no maintenance routines will require planned load shutdown by use of the other active path. Each path serves to act as the concurrent maintenance enabler as well as avoiding any recovery of service time (mean downtime of zero) after a major fault. The designer should aim to have no common-point-of-failure between the two paths, including segregated routing, physical compartmentalisation and fire-rated enclosures. Each path does not require N+1 redundancy unless the client specifies that during maintenance or repair (planned or unplanned) where one path is removed from service the remaining path has to retain a higher degree of resilience than N. This is most valid when each path is modular and contains more than three elements. It is assumed in this standard that during system maintenance or repair, unless specified by the client, a degraded level of resilience is permitted.

6.2.2 Spaces excluded from the availability classification

The following spaces are not subject to a classification for the design of environmental control systems in relation to availability:

a) building entrances facilities,

b) personnel entrances,

c) docking/loading bays,

d) generator space (s),

e) transformer space,

f) electrical distribution space(s),

g) telecommunications space(s),

h) electrical space(s),

i) mechanical space(s),

j) control room space(s),

k) office space(s),

l) storage and holding space(s).

6.2.3 Main Distributor space(s)

If external to computer room space there are no scalable design options for this space. If contained within the Computer Room space the requirements of 6.2.4 shall be applied.

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

6.2.4.1 General

The computer room space is the most important space from an environmental control perspective.

6.2.4.2 Class 2: Single path (no resilience)

An example of a chilled water cooling system would comprise a single (or N) compressor based chiller, single primary pump and single (or N) air-conditioning modules in the critical space - all being fed from a single path electrical power system that need not include redundancy.

An example of a fresh-air cooling system with adiabatic cooling would comprise a single (or N) inlet fan, single (or N) supplementary cooling coil, single (or N) adiabatic cooling spray system and, where required, powered louvres - all being fed from a single path electrical power system that need not include redundancy. The supplementary cooling coils would feed N heat rejection systems.

6.2.4.3 Class 3: Single path (resilience provided by redundancy of components)

An example of a chilled water cooling system would comprise a redundant (N+1) compressor based chiller system, redundant (N+1) primary pumps and redundant (N+1) air-conditioning modules in the critical space - all being fed from a single path electrical power system that includes N+1 redundancy in key components. Some passive and inherently reliable sub-systems (e.g. the chilled water piping) would not have redundancy built-in and a failure in such an element would be considered major and would usually result in a loss of cooling.

An example of a fresh-air cooling system with adiabatic cooling would comprise a redundant array (N+1) of inlet fans, a redundant array (N+1) of supplementary cooling coils, single (or N) adiabatic cooling spray system and, where required, powered louvres - all being fed from a single path electrical power system that includes N+1 redundancy in key components.

Where water is used for humidification or adiabatic cooling then a redundant source, or on-site storage of sufficient volume to meet the clients' resilience requirements, shall be included in the design. All pumps and water treatment plant (where required) shall have N+1 redundancy in key components.

6.2.4.4 Class 4: Multi-path resilience and concurrent repair/operate solution

An example of a chilled water cooling system would comprise a redundant (N+1) compressor based chiller system, dual (N+1) primary pumps and redundant (N+1) air-conditioning modules in the critical space - all being fed from a single path electrical power system that includes N+1 redundancy in key components but also has a passive delivery path (with automatic or manual changeover switches). All passive sub-systems (e.g. the chilled water piping) shall also have in-built path redundancy where a failure in such an element would usually result in a loss of cooling albeit with a rapid (manual) substitution of the active path with the passive path.

An example of a fresh-air cooling system with adiabatic cooling would comprise a redundant array (N+1) of inlet fans, a redundant array (N+1) of supplementary cooling coils, a redundant array (N+1) of adiabatic cooling spray systems and, where required, powered louvres - all being fed from a single path electrical power system that includes N+1 redundancy in key components but also has a passive delivery path (with automatic or manual changeover switches). Heat transfer from the supplementary cooling coils to the external heat rejection system shall have N+1 redundant topology. If the heat rejection path is common then a passive path shall be provided.

Where water is used for humidification or adiabatic cooling then a redundant source, or on-site storage of sufficient volume to meet the clients' resilience requirements, shall be included in the design. All pumps and water treatment plant (where required) shall have N+1 redundancy in key components and a passive path for delivery of water with manual intervention.

The environmental control system shall be designed such that loss of functional capability is limited to 10 min in any one operating year.

6.2.4.5 Enhanced Class 4: Multi-path resilience, concurrent repair/operate, and fault tolerant solution

An example of an active/active (2N) chilled water cooling system would comprise two segregated and entirely separate (N) compressor based chiller systems, each with (N) primary pumps, separate (N) piping systems and non-redundant (N) air-conditioning modules in the critical space - each system fed from its own single path electrical power system that may or may not include N+1 redundancy in key components.

An example of a fresh-air cooling system with adiabatic cooling would comprise two cooling systems each with a non-redundant array (N) of inlet fans, an array (N) of supplementary cooling coils, an array (N) of adiabatic cooling spray systems and, where required, powered louvres - each system being fed from its own single path electrical power system that may or may not include N+1 redundancy in key components. Heat transfer from the supplementary cooling coils to the external heat rejection system need only have N redundant topology. The heat rejection path shall not be common.

Where water is used for humidification or adiabatic cooling then two separate and redundant sources, or dual on-site storage of sufficient volume to meet the clients' resilience requirements, shall be included in the design. If there is only one primary source of water then dual storage systems shall be included with as much water capacity as needed to match the on-site autonomy of diesel fuel provision for the emergency electrical generators. All pumps, piping system and water treatment plant (where required) shall have 2N redundancy, each system fed by separate power systems.

6.2.5 UPS space

6.2.5.1 General

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

For rotary UPS the requirements of 5.2.15 shall apply.

6.2.5.2 Class 2: Single path (no resilience)

The UPS space shall be ventilated/cooled by a single air-conditioning terminal or fresh-air fan that is rated to supply the cooling capacity equal to the maximum possible power losses in the UPS and not exceed the peak temperature supported by the chosen UPS, usually in the order of 40°C. A single failure in the cooling plant exposes the UPS to over-temperature and shut-down/bypass with associated risk to the critical load.

6.2.5.3 Class 3: Single path (resilience provided by redundancy of components)

The UPS space shall be ventilated/cooled by an N+1 redundant air-conditioning terminal array or fresh-air fans that are rated at N to supply the cooling capacity equal to the maximum possible power losses in the UPS and not exceed the peak temperature supported by the chosen UPS. A single failure in the cooling plant components shall not expose the UPS to over-temperature and shut-down/bypass with associated risk to the critical load.

6.2.5.4 Class 4: Multi-path resilience and concurrent repair/operate solution

The UPS space shall be ventilated/cooled by two separate air-conditioning terminal array's or fresh-air fan arrays that are each rated to supply the cooling capacity equal to the maximum possible power losses in the

UPS and not exceed the peak temperature required by the chosen UPS. A complete failure in the cooling plant of one path shall not expose the UPS to over-temperature and shut-down/bypass with associated risk to the critical load. The two systems shall not share a common power system.

6.2.5.5 Enhanced Class 4: Multi-path resilience, concurrent repair/operate, and fault tolerant solution

Not applicable.

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 consideration shall be given to the number of CRACs and the fan speed at which each CRAC is operated.

The design of the system shall accommodate a situation where all CRACs run at minimum fan speed. Where capacity allows consideration shall be given to switching a proportion of CRACs to standby mode, ready to start up upon failure of a running CRAC.

7 Physical security

7.1 General

Based on the security classification defined following the risk assessment undertaken in accordance with EN 50600-1, EN 50600-2-3 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 Access

All controls and equipment comprising the environmental control system shall be in areas of Protection Class 3 or above as specified in EN 50600-2-5.

Where pathways are routed in areas of a lower Protection Class they shall be monitored for unauthorized access. See EN 50600-2-4.

8 Energy efficiency enablement

8.1 General

Based on the energy efficiency enablement granularity level defined following the risk assessment undertaken in accordance with EN 50600-1, 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. 8.9 summarizes these requirements by granularity level.

8.2 Measurement of temperature

8.2.1 External temperature

In all cases external temperature shall be measured and monitored. An external temperature sensor should 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 Class 2 and above the feedback from the external temperature sensor shall be automatic.

A single sensor is required for Level 2 and 3.

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

8.2.2 Computer room temperature

8.2.2.1 Temperature measurement

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. Temperature sensors should not be placed in areas of high turbulence and should be so placed as to establish thermal gradient.

The requirements analysis shall determine which of the following air temperatures shall be measured:

a) supply air temperature;

b) return air temperature;

c) cold aisle temperature (where used);

d) hot aisle temperature (where used).

8.2.2.2 Supply air temperature

The supply air temperature is the temperature at the intake to the IT equipment.

Level 1:

Supply air temperature shall be measured with a single sensor placed in proximity to the IT equipment.

Where used, cold aisle temperature shall be measured at a single location per aisle.

Level 2:

Supply air temperature shall be measured at two points.

Cold aisle temperature shall be measured at every five cabinets or racks in every aisle.

Level 3:

Supply air temperature shall be measured by one sensor per equipment cabinet or rack located in accordance with the cooling method chosen.

Two sensors per equipment cabinet or rack located at the front 1/3 of the way from the top and 1/3 up from the base are recommended.

8.2.2.3 Return air temperature

Level 1:

Return air temperature shall be measured with a single sensor placed in proximity to the intake of the cooling equipment. Where there are multiple systems, e.g. CRAC units, the temperature shall be measured at each unit.

Where used, hot aisle temperature shall be measured at a single location per aisle.

Level 2:

Return air temperature shall be measured with a single sensor placed in proximity to the intake of the cooling equipment and a sensor at the rear of one cabinet or rack. Where there are multiple systems, e.g. CRAC units, the temperature shall be measured at each unit.

Where used, hot aisle temperature shall be measured at every five cabinets or racks in every aisle.

Level 3:

Return air temperature shall be measured with a single sensor placed in proximity to the intake of the cooling equipment and at one sensor per equipment cabinet or rack located in accordance with the cooling method chosen.

Two sensors per equipment cabinet or rack located at the rear 1/3 of the way from the top and 1/3 up from the base are recommended.

8.2.2.4 Cold aisle temperature

The cold aisle temperature is the temperature of the supply air in the cold aisle. This temperature shall be measured in order to regulate the cold aisle.

8.2.2.5 Hot aisle temperature

The hot aisle temperature is the exhaust temperature in the hot aisle. The temperature can either be measured directly at each hot aisle or centrally at the air conditioning components.

Level 1:

Where used, hot aisle temperature shall be measured at a single location per aisle.

Level 2:

Where used, hot aisle temperature shall be measured at every five racks in every aisle.

Level 3:

Hot aisle temperature shall be measured at one sensor per equipment rack, located in accordance with the cooling method chosen. Two sensors per equipment rack, located at the rear 1/3 of the way from the top and 1/3 up from the base are recommended.

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 Levels 2 and 3.

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

8.3.2 Computer room relative humidity

Level 1:

Computer room relative humidity shall be measured at the same locations as for supply air temperature.

A combined sensor for temperature and relative humidity is recommended.

Level 2:

Computer room relative humidity shall be measured at the same locations as for supply air temperature.

A combined sensor for temperature and relative humidity is recommended.

Level 3:

As per Level 2.

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.

8.4 Measurement of air pressure

Where an access floor is installed, the design of the environmental control system shall consider the requirements for the maintenance of static pressure under the access floor. The requirements for airflow at all points across the access floor shall be determined.

If one part of the cooling concept is the securing of a constant pressure under the access floor through fan speed control of the CRAC unit fans, the differential pressure between the room and the access floor shall be measured. The associated sensors shall be positioned in locations where reasonable values can be obtained and shall ensure that all areas of the access floor are monitored.

8.5 Coolant flow rates

Where the design of the environmental control system relies on the movement of fluids, coolant flow meters shall be installed.

It is recommended that coolant mass flow is measured in order to use the data for monitoring and thus improve the operation of the system.

The location of these sensors shall be determined in accordance with the design requirements of the system.

8.6 Heat removal

The design of the environmental control system shall determine the requirement to measure or calculate the heat removed in order to use the data for monitoring and optimization of the cooling units.

Additionally the design shall determine the requirement to quantify total energy use of the cooling system.

8.7 Outside air

Where outside air is drawn into the data centre space(s) for environmental control purposes, sensors for temperature and relative humidity shall be placed at the air inlet.

Note that air quality would also be measured at this point in support of contamination protection (see 5.2.9).

8.8 Provision of alarms

Provision of alarms should consist of two upper and two lower set points against any environmental parameter to provide warning and critical alarms.

8.9 Measurement requirements by Granularity Level

Table 2 summarizes the measurement requirements of Clause 8 by Granularity Level.

Table 2 — Measurement requirements by Granularity Level

Requirement	Granularity Level		
	Level 1	**Level 2**	**Level 3**
Supply Air Temperature	Single sensor in proximity to IT equipment One sensor per cold aisle	Two sensors in proximity to IT equipment One sensor every 5 cabinets or racks in a cold aisle	One sensor per cabinet or rack
Return Air Temperature	Single sensor in proximity to intake of cooling equipment or One sensor per hot aisle	One sensor in proximity to intake of cooling equipment and a single sensor at rear of one cabinet or rack or One sensor every 5 cabinets or racks in a hot aisle	One sensor in proximity to intake of cooling equipment and a single sensor at rear of each cabinet or rack
Relative humidity	As supply air temperature	As supply air temperature	As supply air temperature
External relative humidity and temperature	One sensor	Two sensors	Two sensors
Air Pressure	As required	As required	As required
Coolant Flow	As required	As required	As required
Heat Removal	As required	As required	As required
Outside Air	As required	As required	As required

Annex A
(normative)

Distribution methodologies for temperature-controlled air in computer room space

A.1 Cabinet or rack air flow management

Recirculation of cooling air inside the cabinet or rack can lead to active equipment overheating. Air will always take the path of least resistance. To avoid overheating of the active equipment and to increase the efficiency of the cooling system, blanking panels are required to fill gaps in cabinet or racks where active equipment has been removed or is not installed. Hot exhaust air from the active equipment would otherwise circulate through the gap back to the air inlet of the active equipment or cold air will pass through the cabinet or rack without cooling the active equipment (bypass).

A.2 Access floor air flow management

A.2.1 General

If a data centre comprises an access floor system, the cooled air is brought to the cabinet or racks/active equipment through the access floor and perforated access floor tiles. If the perforated floor tiles are placed haphazardly, a mixing of different temperature profiles is possible and this leads to very inefficient operation of cooling equipment.

A.2.2 Access floor height

The height of the access floor has a major influence on the efficiency of the air circulation. Usually the access floor contains cabling, piping and is designated as the “supply air duct” for the cold air. A certain obstruction free area is necessary for a proper supply of cold air to any area of the room. The correct sizing of the access floor height helps to maintain the correct pressure under the floor, to avoid velocity pressure effects and to maintain a uniform air distribution across the floor plate. That means, if pipe work, cabling or any other obstructions are placed under the floor, the total height of the access floor shall be increased accordingly. Also, any fixtures (like beams, pillars, etc.) should be avoided. Table A.1 provides the required height of unobstructed space under the floor as a “free height of access floor”. Generally, it depends on the room size, the heat density, the total amount of air and the cooling solution chosen.

Table A.1 — Minimum free height of access floor

Room size	Free height of access floor (5 kW to 10 kW heat load per cabinet or rack)
50 m^2 to 500 m^2	500 mm to 700 mm
500 m^2 to 1 000 m^2	800 mm
1 000 m^2 to 2 000 m^2	1 000 mm
> 2 000 m^2	> 1 500 mm

A.2.3 Perforated floor tiles – Quantity, Placement, Opening factor

In general, perforated floor tiles shall only be placed at positions where cold air is required to cool the IT equipment. Perforated floor tiles shall not be placed in areas with high air velocity (e.g. close to CRAC units) to avoid room air being drawn into the access floor due to possible underpressure caused by high air velocity. The position and the quantity of perforated access floor tiles have to be in line with the design and the actual/required total air flow.

Example: An access floor tile has a specific characteristic - that means a certain air flow across the tile creates a certain pressure drop. If the total design airflow of the IT equipment is e.g. 50 000 m^3/h and a perforated floor tile with an air flow of 500 m^3/h with a pressure drop of 20 Pa is chosen, a total number of 100 perforated floor tiles has to be installed. If the real airflow requirement is lower for whatever reason, e.g. 30 000 m^3/h, it has to be ensured that the chosen access floor tile is operated at its specific characteristic. That means the total number of perforated tiles has to be reduced to 60. If the original quantity of 100 remains at the reduced airflow, the static pressure under the access floor will also be reduced (according to perforated tile curve) and this can lead to an uneven air distribution and eventually lack of cooling in some areas.

A.2.4 Use of perforated floor tiles with dampers

The use of perforated floor tiles with dampers has two major advantages:

No replacement of solid tiles in case of a change of IT equipment with different air flow requirements. The number of perforated floor tiles remains unchanged during the lifetime of a data centre but all of them need to be adjusted to the required air flow.

It is possible to operate with different adjustments according to the actual needs of the IT equipment and therefore to vary the amount of air in different areas of the data centre.

A.3 Hot aisles/cold aisles

A.3.1 General

The computer room is equipped with cabinet or racks placed in pairs of opposing rows with the front of each row facing each other, called an aisle configuration. The aisles (alleys/passages) are designated as cold aisle which have floor mounted air distribution grilles to provide cold air in front of the cabinet or rack. The hot aisle is normally not equipped with floor mounted perforated tiles. This concept helps to reach a certain level of separation between cold supply air and warm/hot return air. The temperature difference between these two air flows is increased and the performance (and efficiency) of the cooling equipment is improved.

A.3.2 Handling of unused/unwanted openings

Unused or unwanted openings in an access floor concept lead to air flow leakages and therefore inefficient air circulation. On the one hand cooled air can circulate back to the cooling equipment without taking a sufficient amount of heat from the IT-equipment (short circuit air) and fan power is wasted. On the other hand a certain overpressure under the access floor is required to realize an even air distribution throughout the whole computer room and to make sure that each perforated floor tile gets the correct amount of air. This means that all openings in the access floor have to be closed and/or sealed. Within cabinets openings should be no larger than necessary and should use gaskets, brushes, or other methods for sealing.

A.3.3 Containment systems

A.3.3.1 General

The object of all of the philosophies mentioned below is the full separation of supply and return air. This separation leads to a higher temperature difference between hot return and cold supply air, thus increasing the efficiency of the cooling equipment and therefore the efficiency of the data centre in general.

A.3.3.2 Cold aisle containment

The cabinet or racks are placed in rows front to front. The cold aisle in between the cabinet or racks will be covered on the top and at the end of the rows. A full separation between supply and return air is achieved. Cold air will be either supplied through the access floor or through row cooling units into the contained cold aisle. Hot return air leaves the cabinet or racks into the room and is then fed back to the cooling equipment. The room itself will be at a high temperature level.

A.3.3.3 Hot aisle containment

The cabinet or racks are positioned in rows back to back. The hot aisle between the cabinet or racks will be covered on the top and the end of the rows. Therefore, a full separation between return and supply air is achieved. The hot return air out of the hot aisle will be supplied to the cooling equipment either via a duct system or to integrated cooling units in the cabinet or rack row. Cold supply air then will be supplied into the room and therefore the room itself will be at low temperature level.

A.3.3.4 Contained cabinet or rack supply, room return

Cold supply air enters the cabinet or rack through the access floor directly to a contained area at the front of the cabinet or rack. Hot return air leaves the cabinet or rack directly into the room. A full separation between supply and return is achieved, and the room itself is at a high temperature level.

A.3.3.5 Room supply, contained cabinet or rack return

Cold supply air enters the cabinet or rack through the room. Hot return air leaves the cabinet or rack through a duct and suspended ceiling back to the cooling unit. A full separation between supply and return is achieved, and the room itself is at a low temperature level.

A.3.3.6 Contained cabinet or rack supply and return

Cold supply air enters the cabinet or rack through the access floor directly to a contained area at the front of the cabinet or rack. Hot return air leaves the cabinet or rack through a duct and a suspended ceiling back to the cooling equipment. A full separation between supply and return is achieved, and the room itself is at average temperature level.

A.3.3.7 Rear door cooling

A heat exchanger and fans are integrated in the rear door of the cabinet. Hot air from the back of the IT equipment is cooled as it passes through the door back to the room. A full separation between supply and return is achieved, the room is at low temperature level.

A.3.3.8 Closed loop cabinet or rack

The cabinet or rack doors are closed and a heat exchanger and fans are integrated in the cabinet or rack, the whole cooling circuit is completely independent from the room. The cold supply air is brought directly in front of the active equipment and the hot return air is taken from the back of the cabinet or rack to the heat exchanger. The room itself is at average temperature level.

Annex B
(informative)

Control system concepts

B.1 General

The control systems are used to regulate and control the building management systems of the data centre. The control modules are usually incorporated directly into the systems and/or are grouped together in one place as external regulators. The concept of redundancy shall also take into account the control system.

B.2 Control of exhaust temperature (return air)

A fixed default air temperature is set for the control of the exhaust air temperature. The air conditioning varies the supply air temperature by variably adjusting the flow rate of the cooling agent. The supply air temperature to the computer room spaces is not constant using this control concept.

B.3 Control of supply temperature (supply air)

A fixed default air temperature is set for the control of the supply air temperature. This technique varies the flow rate of the supply air. Yet the exhaust air temperature cannot be regulated, which may lead to an overheating of the IT spaces in some scenarios.

B.4 Combination of control of supply and exhaust temperature

The advantages of each of the above regulation concepts are combined by this concept in order to eliminate their detrimental effects. The aim is to maintain a stable supply temperature and to keep the exhaust air temperature as constant as possible. The flow rate of the cooling agent and the flow rate of the air are adjusted accordingly. In order to prevent the formation of hot spots, the differential pressure between the hot and cold aisles can be evaluated and included in the control of the airflows.

B.5 Supply air relative humidity

The relative humidity in the computer room space is always measured in the supply air and is then regulated to obtain a defined relative humidity value at the IT components.

B.6 Proportion of outside air

Control of the proportion of the outside air drawn into the environmental control system for the computer room space is performed by the air handling system. Sensors provide information related to the temperature, relative humidity and air quality allowing a use/not use decision to be made. The air exchange rate is adjusted accordingly.

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