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Information technology - Data centre facilities and infrastructures - Part 99-1: Recommended practices for energy management

Technologies de l¿information - Installation et infrastructures des centres de traitement de données - Partie 99-1: Pratiques recommandées relatives à la gestion énergétique

Informationstechnik - Einrichtungen und Infrastrukturen von Rechenzentren - Teil 99-1: Empfohlene Praktiken für das Energiemanagement

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Documento de trabajo

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Documento de trabajo

Contents Page

Documento de trabajo

European foreword

This document (CLC/TR 50600-99-1:2020) has been prepared by CLC/TC 215 "Electrotechnical aspects of telecommunication equipment" in conjunction with the Directorate-General Joint Research Centre (DG JRC) of the European Commission (EC).

This document supersedes CLC/TR 50600-99-1:2019.

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association.

CLC/TR 50600-99-1:2020 includes the following significant technical changes with respect to CLC/TR 50600-99-1:2019:

— Update to recently agreed energy management practices and align with the 2020 edition of the *EU Code of Conduct for data centres Best Practices* document.

— Environmental Sustainability practices incorporated within the 2019 edition of the *EU Code of Conduct for data centres Best Practices* document have now been re-located to CLC/TR 50600-99-2:2019.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

This document aligns with the Best Practices document of the Code of Conduct for Data Centre Energy Efficiency (CoC) scheme operated by the DG JRC and continues to be prepared by data centre experts from operators, vendors, consultants, academics, professional and national bodies.

The publication of this document is intended to integrate recommended practices of energy management into the EN 50600 series developed by CLC/TC 215.

Regarding the structure of the EN 50600 series, see the Introduction.

Documento de trabajo

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;

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 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, consultants, 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 document, the EN 50600 series will comprise the following standards and documents:

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 supply and 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*

Documento de trabajo

EN 50600-3-1, *Information technology — Data centre facilities and infrastructures — Part 3-1: Management and operational information*

EN 50600-4-1, *Information technology — Data centre facilities and infrastructures — Part 4-1: Overview of and general requirements for key performance indicators*

EN 50600-4-2, *Information technology — Data centre facilities and infrastructures — Part 4-2: Power Usage Effectiveness*

EN 50600-4-3, *Information technology — Data centre facilities and infrastructures — Part 4-3: Renewable Energy Factor*

EN 50600-4-6, *Information technology — Data centre facilities and infrastructures — Part 4-6: Energy Reuse Factor*

EN 50600-4-7, *Information technology — Data centre facilities and infrastructures — Part 4-7: Cooling Efficiency Ratio*

CLC/TR 50600-99-1, *Information technology — Data centre facilities and infrastructures — Part 99-1: Recommended practices for energy management*

CLC/TR 50600-99-2, *Information technology — Data centre facilities and infrastructures — Part 99-2: Recommended practices for environmental sustainability*

CLC/TR 50600-99-3, *Information technology — Data centre facilities and infrastructures — Part 99-3: Guidance to the application of EN 50600 series.*

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

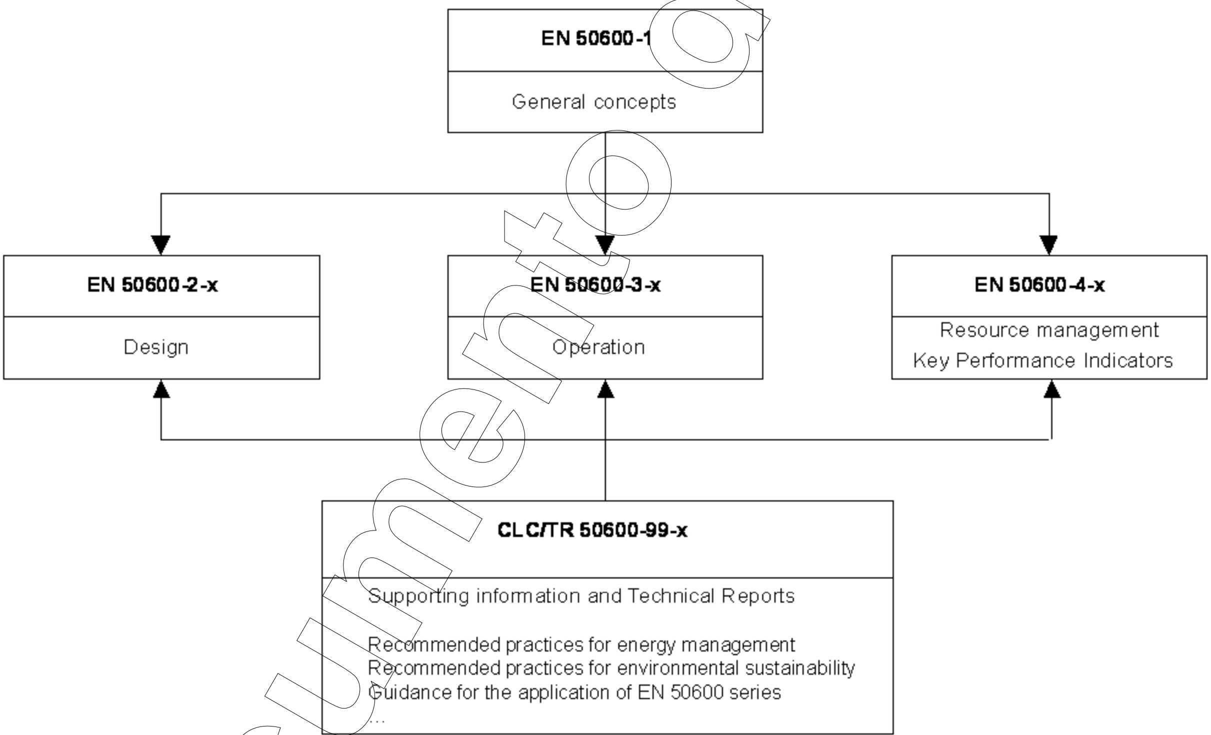

Figure 1 — Schematic relationship between the EN 50600 series of documents

EN 50600-2-X documents 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.

EN 50600-3-X documents specify requirements and recommendations for data centre operations, processes and management.

Documento de trabajo

EN 50600-4-X documents specify requirements and recommendations for key performance indicators (KPIs) used to assess and improve the resource usage efficiency and effectiveness, respectively, of a data centre.

The Directorate-General Joint Research Centre (DG JRC) of the European Commission operates a Code of Conduct for Data Centre Energy Efficiency (CoC) scheme. In support of the scheme, a “best practices” document has been established by DG JRC. To enhance the visibility, these Best Practices have been converted in this document to create recommended Practices for improving the energy management (i.e. reduction of energy consumption and/or increases in energy efficiency) of data centres.

The areas addressed are:

— physical building;

— mechanical and electrical equipment;

— computer room;

— cabinets/racks;

— ICT equipment;

— operating systems;

— virtualization;

— software;

— business practices.

The Practices are separated into Expected Practices as referenced in the CoC (see Clause 5) and other Practices which can be employed as optional or alternative solutions in particular cases (see Clause 6). Practices under consideration for the next or future revision/amendment of this document are included in Clause 7. During the maintenance of this document, the Practices of Clauses 6 and 7 might be augmented and others might migrate into Clause 5.

The Practices listed in Clauses 5, 6 and 7 are referenced as x.yyy where x is the clause number and yyy is a sequential number starting within each (sub-)clause.

Customers or suppliers of information and communication technology (ICT) services might also find it useful to request or provide a list of the Practices of this document that are implemented in a data centre to assist in procurement of services that meet their environmental or sustainability standards.

This document also:

— acts as an education and reference document to assist data centre operators in identifying and implementing measures to improve the energy management of their data centres;

— provides a common terminology and frame of reference for describing an energy management practice, avoiding doubt or confusion over terminology.

Documento de trabajo

1 Scope

This document is a compilation of recommended Practices for improving the energy management (i.e. reduction of energy consumption and/or increases in energy efficiency) of data centres. It is historically aligned with the EU Code of Conduct for Data Centre Energy Efficiency (CoC) scheme operated by the Directorate-General Joint Research Centre (DG JRC) of the European Commission (EC).

It is recognized that the Practices included might not be universally applicable to all scales and business models of data centres or be undertaken by all parties involved in data centre operation, ownership or use.

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.

EN 14511 (all parts), *Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors*

EN 50600-1:2019, *Information technology — Data centre facilities and infrastructures — Part 1: General concepts*

EN 50600 (series), *Information technology — Data centre facilities and infrastructures*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

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

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

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

3.1.1
airflow pathway
route taken by air to reach a specific point

3.1.2
albedo
diffuse reflectivity or reflecting power of a surface

3.1.3
availability
ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided

[SOURCE: EN 50600-1:2019, 3.1.1]

Documento de trabajo

3.1.4
cable management system
system used for the support and/or containment, retention, protection of all types of cables, information and communication lines, electrical power distribution conductors and their associated accessories (includes ducts and tubes housing, or intended to house, blown information technology cables and/or cable elements)

[SOURCE: EN 50174-1:2018, 3.1.9]

3.1.5
co-location data centre
data centre in which multiple customers locate their own network(s), servers and storage equipment

Note 1 to entry: The support infrastructure of the building (such as power distribution and environmental control) is provided as a service by the data centre operator.

[SOURCE: EN 50600-1:2019, 3.1.6]

3.1.6
computer room space
area within the data centre that accommodates the data processing, data storage and telecommunication equipment that provides the primary function of the data centre

[SOURCE: EN 50600-1:2019, 3.1.7]

3.1.7
computer room air conditioning/computer room air handling
CRAC/CRAH
equipment that provides cooling airflow volumes into a computer room as a means of environmental control

Note 1 to entry: Other abbreviations such as CCU, DFU, RACU, UFU are sometimes used to refer to such equipment.

3.1.8
cooling economizer
system to enable the use of cool external condition to provide cooling to internal data centre spaces without the use of mechanical cooling or refrigeration

Note 1 to entry: Also referenced as “free cooling”.

Note 2 to entry: Free cooling / economised cooling designs take advantage of cool ambient conditions to meet part or all of the facilities’ cooling requirements so that the dependency on any form of mechanical cooling including compressors is reduced or even removed entirely, which can result in significant energy reduction.

Note 3 to entry: The opportunities for the utilization of free cooling are increased in cooler and dryer climates and where increased temperature set points are used. Where refrigeration plant can be reduced in size (or eliminated), operating and capital cost are reduced, including that of the required supporting electrical infrastructure.

Note 4 to entry: Free cooling can be retrofitted to some facilities.

Documento de trabajo

3.1.9
data centre
structure, or group of structures, dedicated to the centralized accommodation, interconnection and operation of information technology and network telecommunications equipment providing data storage, processing and transport services together with all the facilities and infrastructures for power distribution and environmental control together with the necessary levels of resilience and security required to provide the desired service availability

Note 1 to entry: A structure can consist of multiple buildings and/or spaces with specific functions to support the primary function.

Note 2 to entry: The boundaries of the structure or space considered the data centre which includes the information and communication technology equipment and supporting environmental controls can be defined within a larger structure or building.

[SOURCE: EN 50600-1:2019, 3.1.9]

3.1.10
direct liquid-cooled ICT equipment
ICT equipment that is cooled by a direct flow of liquid into an equipment cabinet or directly to the ICT equipment chassis to provide cooling rather than the use of moving air

3.1.11
energy efficiency
measure of the work done (as a result of design and/or operational procedures) for a given amount of energy consumed

3.1.12
energy management
combination of reduced energy consumption and increased energy efficiency, re-use of energy and use of renewable energy

Note 1 to entry: See also EN 50600-3-1 for another definition of energy management.

3.1.13
enterprise data centre
data centre that is operated by an enterprise which has the sole purpose of the delivery and management of services to its employees and customers

[SOURCE: EN 50600-1:2019, 3.1.14]

3.1.14
grid
<technology> interconnection of ICT resources in multiple locations to achieve a common objective

3.1.15
hot aisle/cold aisle
<system> construction of cabinets and containment intended to prevent the mixing of ICT equipment intake and exhaust air within computer room space(s)

3.1.16
information and communication technology equipment
ICT equipment
information technology (IT) and network telecommunications (NT) equipment providing data storage, processing and transport services

Note 1 to entry: Representing the “critical load” of the data centre.

3.1.17
insolation
total amount of solar radiation energy received on a given surface area during a given time

Documento de trabajo

3.1.18
make-up air
air introduced into a data centre space to replace air that is exhausted through ventilation or combustion processes

3.1.19
managed service
data centre operated to provide a defined set of services to its clients either proactively or as the managed service provider (not the client) determines that services are needed

3.1.20
rack
open construction, typically self-supporting and floor-mounted, for housing closures and other information technology equipment

[SOURCE: EN 50174-1:2018, 3.1.34]

3.1.21
resilience
ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event

[SOURCE: IEEE Technical Report PES-TR65]

3.1.22
set-point
desired or target value (maximum or minimum) for either temperature or humidity

3.1.23
virtualization
creation of a virtual version of physical ICT equipment or resource to offer a more efficient use of ICT hardware

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply in addition to those of the EN 50600 series.

AC	Alternating current
ASHRAE	Formerly “American Society of Heating, Refrigeration and Air conditioning Engineers”
BIOS	Basic input/output system
BREEAM	Building Research Establishment Environmental Assessment Methodology
CoC	EC DG JRC Code of Conduct for Data Centre Energy Efficiency
CRAC/CRAH	Computer room air conditioning/computer room air handling
DC	Direct current
DCiE	Data centre infrastructure efficiency
DCIM	Data centre infrastructure management
DG JRC	Directorate-General Joint Research Council of the European Commission
DX	Direct expansion
EC	European Commission

Documento de trabajo

ICT	Information and communications technology
IP	Internet protocol
IT	Information technology
ITIL	Information Technology Infrastructure Library
LCA	Life cycle assessment
LEED	Leadership in Energy and Environmental Design
MERV	Minimum Efficiency Reporting Value
NT	Network telecommunications
PDU	Power distribution unit
PSU	Power supply unit
PUE	Power usage effectiveness
REF	Renewable Energy Factor
SERT™	Server Efficiency Rating Tool
SLA	Service level agreement
SMASH	Systems Management Architecture for Server Hardware
SNMP	Simple network management protocol
SPEC	Standard Performance Evaluation Corporation
UPS	Uninterruptible power supply

4 Principles

4.1 General

Clauses 5 to 7 contain the full list of energy management Practices of this document.

Clause 5 contains those Practices that are considered “Expected Practices” of the CoC and which are listed under the following situations (see Table 1 to Table 4):

a) existing data centres (example);

b) ICT equipment (new or replacement);

c) software install or upgrade;

d) new build or refurbishment of data centres.

Clause 6 contains those Practices that are considered as optional or alternative within the CoC scheme (see Table 5 to Table 8).

Under each heading the recommended Practices of Clauses 5 and 6 are based upon the categories described in 4.2 to 4.8.

Each practice has been assigned a qualitative value (1 to 5) to indicate the level of benefit to be expected from its implementation and, therefore, the relative priorities that should be applied to it. A value of 5 indicates the greatest benefit/priority.

Documento de trabajo

These values are not intended to be totalled or aggregated to provide an overall 'operator score' and should not be mistaken as being quantitative. This would require large scale data on the effects of each practice or technology which is not yet available as well as a complex system of scoring representing the combinational increase or reduction of individual practice values within that specific facility.

Practices under consideration for inclusion in either Clauses 5 or 6 for the next or future revision/amendment of this document are included in Clause 7 (see Table 9 to Table 11). These Practices do not have a qualitative value applied to them.

4.2 Data centre utilization, management and planning

It is important to develop a holistic strategy and management approach to the data centre in order to ensure the required availability and effective delivery of economic and environmental benefits. The sub-headings under this category are:

a) General policies:

   These policies apply to all aspects of the data centre and its operation.

b) Resilience level and provisioning:

   Two of the most significant sources of inefficiency in data centres are the over provisioning of space, power or cooling or the facilities being run at less than full capacity. Monolithic, as opposed to modular design of facilities also represents a significant and frequently unnecessary capital expenditure. Further, as the level of resilience of the data centre increases the inefficiencies due to fixed overheads increase and this is compounded by poor utilization.

c) Involvement of organizational groups:

   Ineffective communication between the disciplines working in the data centre is a major driver of inefficiency and can create issues of capacity management and reliability.

4.3 Data centre ICT equipment and services

The ICT equipment creates the demand for power and cooling in the data centre, any reductions in power and cooling used by, or provisioned for, the ICT equipment will have magnified effects at the utility energy supply.

The specifications of ICT equipment operating temperature and humidity ranges in this section do not indicate that the computer room should be immediately operated at the upper bound of these ranges. This is addressed under the category "Data centre cooling". The purpose of the equipment environmental specifications in 4.3 is to ensure that new equipment is capable of operating under the wider ranges of temperature and humidity thus allowing greater flexibility in operating temperature and humidity to the operator.

The sub-headings under this category are:

a) Selection and deployment of new ICT equipment:

   Once ICT equipment is purchased and installed in the data centre it typically spends several years in the data centre consuming power and creating heat. The appropriate selection of hardware and deployment methods can provide significant long term savings.

b) Deployment of new ICT services:

   The service architecture, software and deployment of ICT services have an impact at least as great as that of the ICT equipment.

Documento de trabajo

c) Management of existing ICT equipment and services:

It is common to focus on new services and equipment being installed into the data centre but there are also substantial opportunities to achieve energy and cost reductions from within the existing service and physical estate, for example, by decommissioning hardware no longer in use or implementing energy saving policies.

d) Data management and storage:

Storage is a major growth area in both cost and energy consumption within the data centre. It is generally recognized that a significant proportion of the data stored is unnecessary, duplicated or does not require high performance access.

Some sectors have a particular issue due to very broad and non-specific data retention directives from governments or regulating bodies which can cause large volumes of data to be unnecessarily heavily protected and archived.

4.4 Data centre cooling equipment

A major part of the facility infrastructure is the cooling system.

Cooling of the data centre is frequently the largest energy loss in the facility and as such represents a significant opportunity to reduce energy consumption.

The sub-headings under this category are:

a) Airflow management and design:

The objective of airflow management is to circulate only the amount of air through the data centre that is necessary to remove the heat created by the ICT equipment (i.e. no air circulates unnecessarily).

Poor airflow management often results in attempts to compensate by reducing air supply temperatures or supplying excessive air volumes, which have an energy penalty.

Improving airflow management will deliver more uniform ICT equipment inlet temperatures and are a prerequisite to increasing temperature set-points and reducing airflow volumes which enable reductions in energy consumption without the risk of equipment overheating.

b) Cooling management:

The data centre is not a static system and the cooling systems should be tuned in response to fluctuations in thermal load.

c) Temperature and humidity settings:

Operating overly restricted environmental controls (in particular, excessively cooled computer rooms) results in an energy penalty.

Widening the set-point range for temperature and humidity can reduce energy consumption. When reviewing environmental management issues it is recommended that expert advice should be sought before changing the environmental range for the facility (e.g. before set-points are changed) in order to avoid risks to operational integrity.

d) Selection of cooling system:

The cooling system typically represents a major part of the energy consumed in the data centre in addition to the critical ICT load. This is also the area with the greatest variation in technologies.

Free and economized cooling:

Free or economized cooling designs use cool ambient conditions to meet part or all of the facilities cooling requirements hence compressor work for cooling is reduced or removed, which can result in significant energy reduction. Economized cooling can be retrofitted to some facilities and should be considered in all new builds retrofits and upgrades.

High efficiency cooling system:

When refrigeration is used as part of the cooling system design high efficiency cooling system should be selected. Designs should operate efficiently at system level and employ efficient components. This demands an effective control strategy which optimizes efficient operation, without compromising reliability. Even in designs where the refrigeration is expected to run for very few hours per year the cost savings in infrastructure electrical capacity and utility power availability or peak demand fees justify the selection of high efficiency equipment.

e) Computer Room Air Conditioning/Computer Room Air Handling (CRAC/CRAH) equipment:

These are major components of most cooling systems within the computer room; they are frequently unable to provide efficient operation in older facilities.

f) Reuse of data centre waste heat:

Data centres produce significant quantities of waste heat. Whilst this is typically at a relatively low temperature there are some applications for reuse of this energy which could offer economic and environmental benefit. As ICT equipment utilization is increased through consolidation and virtualization the exhaust temperature is likely to increase which will provide greater opportunity for waste heat to be re-used. Direct liquid-cooled ICT equipment is likely to provide a further improvement in the ability to use waste heat.

4.5 Data centre power equipment

Another major part of the facility infrastructure is the power conditioning and delivery system. This normally includes uninterruptible power supplies (UPS), power distribution units (PDU), cabling and can also include other equipment e.g. backup generators and static switches.

The sub-headings under this category are:

a) Selection and deployment of new power equipment:

Power delivery equipment has a substantial impact upon the efficiency of the data centre and tends to stay in operation for many years once installed. Careful selection of the power equipment at design time can deliver substantial savings through the lifetime of the facility.

b) Management of existing power equipment.

4.6 Other data centre equipment

Data centre spaces contain equipment other than that of 4.3, 4.4 and 4.5. Practices should be employed to minimize energy consumption and/or improve energy efficiency of such equipment and should be optimized based on relevant building standards, such as relevant EU standards, LEED, BREEAM, etc.

The sub-heading under this category is:

a) General Practices:

These general Practices apply to all data centre spaces.

Documento de trabajo

4.7 Data centre building

The location and physical layout of the data centre premises is important to achieving flexibility and efficiency.

The sub-headings under this category are:

a) Building physical layout:

The physical layout of the building can present fundamental constraints on the applicable technologies and achievable efficiencies (e.g. technologies such as fresh air cooling require significant space for equipment and distribution systems that might not be available in an existing building).

b) Building geographic location:

The geographic location for a data centre can impact achievable efficiency, primarily through the influence of external climate.

c) Water sources:

Data centres might use a significant quantity of water to provide environmental control. The type and source of water might affect the energy consumption.

4.8 Data centre monitoring

The development and implementation of a monitoring and reporting strategy is key to managing the efficiency of a data centre.

The sub-headings under this category are:

a) Energy consumption and environmental measurement:

Many data centres currently have little or no monitoring of energy consumption or environmental conditions; some do not have separate utility metering or billing.

The ability to measure energy use and factors impacting energy use is a prerequisite to identifying and justifying improvements. It should also be noted that measurement and reporting of a parameter can also include alarms and exceptions if that parameter passes outside of the acceptable or expected operating range.

b) Energy consumption and environmental data collection and logging:

Once data on energy consumption and environmental (temperature and humidity) conditions is available through the installation of measurement devices it should be collected and logged.

c) Energy consumption and environmental reporting:

Energy consumption and environmental (temperature and humidity) condition data needs to be reported to be of use in managing the energy efficiency of the facility.

d) ICT reporting:

Utilization of the ICT equipment is a key factor in optimizing the energy efficiency of the data centre.

Documento de trabajo

5 Expected Practices

5.1 Existing data centres

Table 1

Index	Task set	Description	Value
UTILIZATION, MANAGEMENT AND PLANNING: Involvement of organizational groups			
5.1.1	Group involvement	Establish a group containing representatives from all disciplines (software, ICT equipment, mechanical, electrical and procurement) for the approval of any significant decision to ensure that the impacts of the decision have been properly understood and an effective solution reached. *NOTE For example, this could include the definition of standard ICT equipment lists by considering the mechanical and electrical implications of different types of hardware. This group could be seen as the functional equivalent of a change board.*	5
UTILIZATION, MANAGEMENT AND PLANNING: General policies			
5.1.2	Energy Management	Implement a plan for energy management in accordance with emerging EU guidelines and internationally standardized methodologies. Consider appointing a cross functional Energy Manager to take responsibility for this initiative. *NOTE EN ISO 50001 is an example of a standardized methodology.*	3
5.1.3	Asset management	Implement asset management for all ICT, mechanical and electrical equipment assets in accordance with internationally standardized methodologies. *NOTE 1 Understanding the numbers, types and purposes of the assets deployed in a data centre underpins effective energy management.* *NOTE 2 EN ISO 55000 is an example of a standardized methodology.*	3
5.1.4	Monitor and manage air quality	Ensure that air quality is monitored and managed to ensure that critical equipment is not damaged by particulates or corrosive elements which might impact both IT equipment and cooling equipment in terms of performance, energy efficiency and reliability. This should inform the choice of filters used and the planned replacement schedule as well as the frequency of routine technical cleaning programme (including underfloor and ceiling void areas if applicable). Filter choices should be informed by ISO 16890-1. *NOTE The ASHRAE white paper '2011 Gaseous and Particulate Contamination Guidelines for Data Centers' recommends that data centre air quality is monitored and cleaned according to EN ISO 14644-1:2015, Class 8. This can be achieved by routine technical cleaning and simple filtration using the following guidelines.* Airborne Contaminants including gaseous contaminants should be managed according to ANSI/ISA 71.04–2013.	2

Documento de trabajo

Index	Task set	Description	Value
5.1.5	Consider technical areas of data centres as industrial space	Consider the computer room, electrical and mechanical spaces to be industrial spaces enabling the environmental conditions in those spaces to comply with local statutory requirement and law (Health and Safety, etc.) rather than be designed for human comfort. The computer room, electrical and mechanical spaces should be designed, built and operated with the single primary objective of delivering high availability ICT services reliably and efficiently rather than for seated human comfort. As such these spaces might only require the control of make-up air volumes and environmental conditions to pressurize the spaces in order avoid ingress of particles and contaminants. These areas should not contain desks or workstations. *NOTE This is not intended to reduce or impose conditions on dedicated office spaces within the data centre building.*	3
5.1.6	Site documentation	Ensure that high quality, accurate O&M manuals, As-Built records, commissioning records, schematics and single lines diagrams are available in order to enable all installed infrastructure and equipment to be maintained as originally designed and operated at optimum levels of efficiency. Accurate documentation and records are essential to the correct operation and use of energy efficiency functions built-In by equipment manufacturers. Updates should be made whenever any settings are changed or equipment is added, replaced or modified. Effective commissioning and delivery of detailed and accurate documentation should be a key part of any project handover.	3
5.1.7	Training and development	Ensure the Data Centre Manager and any appointed Energy Manager has relevant and appropriate training to fulfil an energy efficiency role and have an in-depth appreciation of Best Practices (such as this Code of Conduct). Ensure that both ICT and Facilities personnel are aware of Data Centre energy efficiency Best Practises (such as this Code of Conduct) in order to support organisational strategies to reduce IT energy usage. Remove silos and promote a minimum level of common understanding relating to data centre Operations and Management. An overall training methodology should be defined and delivered to all relevant personnel in order to improve individual personal development and develop suitably qualified and experienced data centre personnel. *NOTE Properly trained and qualified personnel are essential to efficient data centre operation.*	3
ICT EQUIPMENT AND SERVICES: Management of existing ICT equipment and services			
5.1.8	Audit existing physical estate and services	Audit the existing physical estate to establish what ICT equipment is in place and what service(s) it delivers. Consider the implementation of an ITIL type Configuration Management Database and Service Catalogue in accordance with the ISO/IEC 20000 series.	5
5.1.9	Decommission and remove unused equipment	Decommission and remove any ICT equipment supporting unused services. Installed hardware should be regularly examined to ensure that it is still required and continues to support active services. In particular decommission and remove test and development platforms once no longer needed.	5

Documento de trabajo

Index	Task set	Description	Value
5.1.10	Audit of existing ICT environmental requirements	Identify the allowable intake temperature and humidity ranges for existing installed ICT equipment. Identify ICT equipment with restrictive intake temperature ranges so that it can be either: — marked for replacement as soon as is practicable with equipment capable of a wider intake range or — moved and dealt with as per Practices “Equipment segregation” Practice 5.1.15 and 5.2.18 as well as “Separate environmental zones” Practices 5.4.11 and 5.4.12. The specification of wider operating humidity and temperature ranges for the computer room should be performed in conjunction with changes in ICT equipment procurement policy. Over time, ICT equipment with narrow environmental operating ranges should be replaced.	4
ICT EQUIPMENT AND SERVICES: Data management and storage			
5.1.11	Data management policy	Develop a data management policy to define what data should be kept, for how long and at what level of protection taking care to understand the impact of any data retention requirements. Implement the policy by communication and enforcement by those responsible.	3
DATA CENTRE COOLING: Airflow management and design			
5.1.12	Cabinet/rack airflow management – Blanking Plates	Install blanking plates in locations within cabinets/racks where there is no equipment. *NOTE This helps to minimize the waste heat from one device contaminating the intake air of another device (re-circulation) which reduces cooling efficiency.*	4
5.1.13	Raised floor airflow management	Review placement and opening percentages of vented tiles to ensure appropriate airflow volume to ICT equipment and to reduce bypass air flow. Close unnecessary apertures in floors where the sub-floor space acts as an airflow pathway. Maintain unbroken rows of cabinets/racks to prevent re-circulated air and reinforce Hot / Cold aisle design with empty but fully blanked cabinets (or solid doors) rather than leaving gaps in aisles. *NOTE Unbroken rows are necessary in hot/cold aisle environments where any opening between the aisles will degrade the separation of hot and cold air. This can be achieved by filling any gaps with fully blanked cabinets/racks.*	3
5.1.14	Raised floor airflow management – Obstructions	Review the placement and level of obstruction created by cabling, cable management systems and other structures in the airflow pathways. Ensure that the under floor airflow pathways are as free of obstructions as possible. Consider the use of overhead cable management systems which might substantially reduce the level of obstruction. *NOTE Obstructions reduce airflow creating turbulence, increasing the resistance and increasing the energy required to deliver the required airflow. Obstructions can increase velocities, causing negative pressure.*	3

Documento de trabajo

Index	Task set	Description	Value
5.1.15	Equipment segregation	Install groups of ICT, mechanical and electrical equipment with substantially different environmental requirements and/or equipment airflow direction in separate areas which have independent environmental controls. *NOTE This prevents cooling system settings being constrained by the equipment with the most restrictive environmental range or poor airflow control which might compromise overall energy efficiency.*	3
DATA CENTRE COOLING: Cooling management			
5.1.16	Review of cooling capacity before ICT equipment changes	Review the availability of cooling and means of delivery before any changes to ICT equipment in order to optimize the use of cooling resources. *NOTE This includes consideration of both the cooling system equipment and the placement and airflow capacity of vented tiles.*	2
5.1.17	Define and review cooling strategy	Review, on a periodic basis, the consistency of deployment of ICT equipment with respect to the cooling design and identify appropriate changes.	2
5.1.18	Effective regular maintenance of cooling system	Employ regular maintenance of the cooling system in order to preserve or achieve a “like new condition”. *NOTE 1 This is essential to maintain the designed cooling efficiency of the data centre. Examples include belt tension, condenser coil fouling (water or air side), evaporator fouling, etc.* *NOTE 2 This includes regular filter changes to maintain air quality and reduce friction losses along with the routine monitoring of air quality and a regular technical cleaning regime (including underfloor areas if applicable).*	2
DATA CENTRE COOLING: Temperature and humidity settings			
5.1.19	Review and if practical raise ICT equipment intake air temperature	Review and, if practical (see NOTE 1), increase the ICT equipment intake temperature to within the range of 10 °C to 35 °C (see NOTE 2) in order to reduce energy consumption by reducing or eliminating unnecessary cooling (see paragraph below between NOTES 2 and 3). *NOTE 1 Where computer rooms contain ICT equipment with legacy environmental ranges as defined in Practice 5.2.2, the maximum temperature for these facilities will be restricted by this equipment until segregation can be achieved as described in Practices 5.1.15, 5.2.18, 5.4.11 and 5.4.12.* *NOTE 2 This conforms to the allowable range of ASHRAE Class A2 (see Annex A).* Some, particularly older, ICT equipment can exhibit significant increases in fan power consumption as intake temperature is increased. It should be confirmed that ICT equipment will not consume more energy than is saved in the cooling system. *NOTE 3 Additional Practices for airflow management as defined in 5.1, 5.2, 5.4 and 6.1 might need to be implemented at the same time to ensure successful operations.*	4

Documento de trabajo

Index	Task set	Description	Value
5.1.20	Review and if practical widen the working humidity range	Review and, if practical (see NOTE 1), reduce the lower relative humidity set-point of the computer room space(s) to –12°C DP and 8 % rh (see NOTE 2) to reduce the demand for humidification. Review and, if practical, increase the upper relative humidity set-point of the computer room space(s) to 27°C DP and 80 % rh – see NOTE 2 — to decrease the dehumidification loads within the facility (see paragraph below between NOTES 2 and 3). *NOTE 1 Where computer rooms contain ICT equipment with legacy environmental ranges as defined in Practice 5.2.2, the maximum temperature for these facilities will be restricted by this equipment until segregation can be achieved as described in Practices 5.1.15, 5.2.18, 5.4.11 and 5.4.12.* *NOTE 2 This conforms to the allowable range of ASHRAE Class A2 (see Annex A).* Unnecessary humidifier loads generated by chilled water or evaporator temperatures below the computer room air dew point causing dehumidification should be eliminated through adjustment of the lower humidity set-point. *NOTE 3 Controlling humidity within a wider range of humidity ratio or relative humidity can reduce humidification and dehumidification loads and therefore energy consumption.*	4
5.1.21	Review and if practical raise chilled water temperature	Review and if practical increase the chilled water temperature set-points to maximize the use of free cooling and reduce compressor energy consumption. Set points should be raised together with supply air flow set points to avoid reducing capacity. Review and if beneficial increase the chilled water temperature difference to reduce the water flow and thereby to reduce pump energy consumption. Where a DX system is used, review the evaporator temperatures. *NOTE Electronic Expansion Valves (EEVs) allow better control and permit higher evaporator temperatures than Thermostatic Expansion Valves (TEVs).*	4
DATA CENTRE COOLING: Selection of cooling system: High efficiency cooling system			
5.1.22	Cooling system operating temperatures	Evaluate the opportunity to optimize the refrigeration cycle set-points of mechanical refrigeration systems to minimize compressor energy consumption.	3
OTHER DATA CENTRE EQUIPMENT: General Practices			
5.1.23	Turn off lights	Turn off lighting (preferably automatically) whenever areas of the building are unoccupied.	1
DATA CENTRE MONITORING: Energy consumption and environmental measurement			
5.1.24	Incoming energy consumption metering	Install metering equipment capable of measuring the total energy consumption of the spaces which comprise the data centre including all ICT, mechanical and electrical equipment.	4
5.1.25	ICT energy consumption metering	Install metering equipment capable of measuring the total energy consumed by ICT equipment within the computer room space(s) to support the reporting of data as described in Practices 5.1.28 and 5.1.29. *NOTE This includes all power feeds i.e. where non-UPS protected power is delivered to the ICT equipment.*	4

Documento de trabajo

Index	Task set	Description	Value
5.1.26	Room level monitoring of supply air temperature and humidity	Install monitoring equipment at room level capable of indicating the supply air temperature and humidity for the ICT equipment.	2
5.1.27	CRAC/CRAH unit level metering of supply or return air temperature	Collect data from CRAC/CRAH units on supply and return (dependent upon operating mode) air temperature.	3
DATA CENTRE MONITORING: Energy consumption and environmental collection and logging			
5.1.28	Periodic manual readings	Undertake manual measurements at regular intervals (ideally at peak load) and record the following: — energy consumption; — temperature and humidity (dry bulb temperature, relative humidity and dew point temperature). *NOTE Automated readings (see 5.1.29 and 6.1.20) are considered to be a replacement for this Practice.*	3
5.1.29	Automated daily readings	Implement automated daily readings of energy usage and environmental conditions. *NOTE This enables more effective management of energy use and supersedes periodic manual readings Practice 5.1.28.*	4
DATA CENTRE MONITORING: Energy use and environmental reporting			
5.1.30	Written Report	Report periodically, as a minimum (via written or automated means), the following: — energy consumption; — Power Usage Effectiveness (PUE) in accordance with EN 50600-4-2 or Data Centre Infrastructure Efficiency (DCIE) – see NOTE; — environmental ranges. *NOTE DCIE is the inverse of PUE expressed as a percentage.*	4

Documento de trabajo

5.2 ICT equipment (new or replacement)

Table 2

Index	Task set	Description	Value
ICT EQUIPMENT AND SERVICES: Selection and deployment of new ICT equipment			
5.2.1	ICT equipment selection criteria – Power	Include energy efficiency performance as a high priority criterion when choosing new ICT equipment. The power consumption of the device in normal operating circumstances should be considered in addition to peak performance per Watt. *NOTE Consider EnergyStar, SERT™1, SPECpower or metrics more closely aligned to the target environment.* Maintenance costs, serviceability and reliability should also be considered in the decision making process.	5
5.2.2	New ICT equipment selection criteria – Restricted operating temperature and humidity range	Purchase ICT equipment which operates within the temperature and humidity range defined in Practice 5.2.3. Where this is not possible, purchase ICT equipment which operates within the intake temperature range 15°C to 32°C and –12°C DP and 8 % rh to 27°C DP and 80 % rh – see NOTE. *NOTE This conforms to the allowable range of ASHRAE Class A1 (see Annex A).* ICT equipment with differing environmental requirements should be segregated within the computer room in order to minimize the size of the space requiring tighter environmental control. See Practices 5.1.15, 5.2.18, 5.4.11 and 5.4.12.	4
5.2.3	New ICT equipment selection criteria – Expected operating temperature and humidity range	Buy ICT equipment which operates within the temperature and humidity range defined in Practices 5.1.19 and 5.1.20 respectively. Procurement specifications should demand data from vendors regarding operating conditions for any model or range which restricts warranty to less than continuous operation within these temperature and humidity ranges. NOTE 1 This conforms to the allowable range of ASHRAE Class A1 (see Annex A). NOTE 2 Where ICT equipment types cannot be procured to meet this specification refer to the following for exclusions and mitigation measures: Practices 5.1.15, 5.2.18, 5.4.11 and 5.4.12. Directly liquid cooled ICT devices are addressed in Practices 6.2.3 and 6.4.10.	5
5.2.4	Select ICT equipment suitable for the data centre power density and cooling delivery capabilities	Observe the “per cabinet/rack” or “per square metre” power and cooling capacity limits of the computer room space(s). Exceeding these limits might create cooling and airflow management problems reducing the overall capacity and efficiency of the data centre. Power and cooling should be considered as capacity constraints in addition to physical space.	3

1 SERT™ is the trademark of a product supplied by the Standard Performance Evaluation Corporation (SPEC). This information is given for the convenience of users of this document and does not constitute an endorsement by CENELEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Documento de trabajo

Index	Task set	Description	Value
5.2.5	ICT equipment power usage against inlet temperature	Select ICT equipment which performs the required task with the lowest power consumption in the expected environmental conditions. A number of metric or benchmarks exist including: — EnergyStar specifications for servers; — EnergyStar specifications for storage; — Linpack; — SERT[TM1]; — SPECpower. Procurement specifications should demand data from vendors showing the total system power for a range of temperatures covering the full allowable inlet temperature range for the equipment at 100 % load. Data should reference the benchmark(s) used and show data for 5°C or smaller steps of inlet temperature. Consideration should be given to a review of data showing total system power covering the full allowable inlet temperature range under 0 % and 50 % load on the selected benchmark. *NOTE This Practice is intended to encourage manufacturers to produce ICT equipment which operates efficiently in higher temperatures.*	5
5.2.6	Select equipment suitable for the data centre airflow direction	Select ICT equipment whose airflow direction matches the airflow design for the area in which it is to be operated. This is commonly front to rear or front to top. If the ICT equipment has a different airflow direction to the design of the area into which it is installed (such as right to left when the cabinet/rack is intended to be front to back), air diversion plates/ducts should be installed to change the airflow to match the design of the area. *NOTE ICT equipment with conflicting airflow direction will compromise the airflow management of the data centre and therefore restrict the ability to increase temperature set-points. It is possible to mitigate this issue by segregating such equipment according to Practices 5.1.15, 5.2.18, 5.4.11 and 5.4.12.*	4
5.2.7	Enable power management features	Enable power management features on ICT equipment as it is deployed. This includes BIOS, operating system and driver settings. Ensure that this policy is documented in the ICT equipment deployment process.	5
5.2.8	Provision only to the actual ICT power usage required	Provision power and cooling only to the planned power draw of the IT equipment as-configured (based on the components actually installed), rather than the Power Supply Unit (PSU) size or nameplate rating. *NOTE 1 This avoids over-sizing the power and cooling infrastructure resulting in unnecessary energy consumption and higher capital costs.* *NOTE 2 This can require changes to the provisioning if the IT equipment performance is increased or upgraded.*	3

Documento de trabajo

Index	Task set	Description	Value
5.2.9	EnergyStar compliant ICT equipment	Use the EnergyStar labelling programmes as a guide to selecting the most efficient ICT equipment where they are available for the class of equipment being reviewed. These include: — EnergyStar specifications for servers; — EnergyStar specifications for storage equipment. Those able to determine the in-use energy efficiency of ICT equipment through more advanced or effective analysis should do so.	4
5.2.10	Energy and temperature reporting hardware	Select ICT equipment that is capable of reporting energy consumption and inlet temperature. Where applicable, industry standard reporting approaches should be used e.g. IPMI, DMTF Redfish and SMASH. ICT equipment should have an IP interface and support one of the following: 1. SNMP polling of inlet temperature and energy consumption; Event-based SNMP traps and SNMP configuration are not required; 2. IPMI/Redfish polling of inlet temperature and energy consumption; 3. An interface protocol which enables the operators' existing monitoring platform to retrieve inlet temperature and energy consumption. *NOTE The intent of this Practice is to ensure that over time the operator will gain comprehensive monitoring of temperature and energy consumption in the computer room space(s).*	3
5.2.11	Select free standing equipment suitable for the data centre – Airflow direction	Restrict the use of free standing ICT equipment or ICT equipment supplied in custom enclosures to areas where the airflow direction of the enclosures matches the airflow design in the area. This is commonly front to rear or front to top. Specifically the equipment should match the hot/cold aisle layout or containment scheme implemented in the facility. *NOTE Any equipment and enclosures with conflicting airflow direction will compromise the airflow management of the data centre and therefore restrict the ability to increase temperature set-points. It is possible to mitigate this issue by segregating such equipment according to Practices 5.1.15, 5.2.18, 5.4.11 and 5.4.12.*	4
5.2.12	AC/DC Converter efficiency	Select ICT equipment containing high efficiency AC/DC power converters. These should be rated at 90 % power efficiency or better across the range of expected loads.	3
ICT EQUIPMENT AND SERVICES: Deployment of new IT services			
5.2.13	Deployment of grid and virtualization technologies	Deploy grid and virtualization technologies wherever possible to maximize the use of shared platforms. Obtain senior management approval prior to implementing any new ICT service that requires dedicated ICT equipment and which will not run on a resource sharing platform.	5
5.2.14	Reduce ICT equipment resilience level	Restrict the deployment of redundant ICT equipment to the situations where the business need demands additional resilience. Redundant ICT equipment should only be implemented following a risk analysis to determine the business need for additional resilience i.e. where the risk and impact of loss of ICT services outweighs the potential savings in energy consumption and justifies the additional capital cost. Ensure that the IT hardware resilience level is agreed by the application owners.	4

Documento de trabajo

Index	Task set	Description	Value
5.2.15	Reduce hot/cold standby equipment	Restrict the deployment of standby ICT equipment to the situations where the business need demands additional resilience i.e. where the risk and impact of loss of ICT services on the business outweighs the potential savings in energy consumption and justifies the additional capital cost. “Cold standby” (switched “off”) ICT equipment should be deployed in preference to “hot standby” (switched “on”) ICT equipment provided that it can still meet the business requirements of the organization.	4
DATA CENTRE COOLING: Airflow management and design			
5.2.16	Hot/cold aisle deployment	Align ICT equipment in the computer room space(s) in a hot/cold aisle configuration. *NOTE A hot aisle/cold aisle concept aligns ICT equipment airflow. Cold air is fed into the cold aisle between cabinets/racks. The ICT equipment draws in air from this cold aisle for cooling and exhausts hot air into the hot aisle. The separation of the hot and cold air improves the efficiency of the heat exchange in the ICT equipment and in the CRAC/CRAH which in turn reduces the energy consumed by the cooling system.*	5
5.2.17	Provide adequate perforated area on cabinet doors	Install cabinets with either no doors (if security requirements are not compromised) or doors with at least 66 % perforated area where a hot/cold aisle configuration is implemented. Use solid doors only where the cooling system is specifically designed to incorporate them e.g. chimney cabinets which funnel hot air to an overhead plenum or water cooled cabinets with a heat exchanger inside the cabinet which circulate air within the cabinet. EN 50174-2 recommends a minimum of 66 % perforated area. 80 % is considered ideal by other experts in this field.	3
5.2.18	Equipment segregation	Deploy groups of ICT equipment with substantially different environmental requirements and / or equipment airflow direction in separate areas. The environment and airflow should then be controlled separately to match the ICT equipment requirements in each area. *NOTE If this practice is not followed it can result in the need to constrain the environmental conditions unnecessarily resulting in higher energy consumption e.g. if the temperature is kept low to meet the needs of legacy ICT equipment the power consumed by the cooling system might be higher than if it is allowed to rise to a temperature acceptable to newer ICT equipment. In addition mixing ICT equipment with different airflows might cause wide variations in temperature in the computer room space(s) reducing the ability to raise the temperature and making the cooling process less efficient.*	3

5.3 Software install or upgrade

Table 3

Index	Task set	Description	Value
ICT EQUIPMENT AND SERVICES: Deployment of new IT services			
5.3.1	Select efficient software	Select software which uses the least energy to perform the required task whilst ensuring it meets the organizational needs. *NOTE Forecasting and measurement tools and methods are still being developed to provide metrics for software energy efficiency. However, approximations can be used such as the power consumption of the ICT equipment whilst the software is running. This is an extension of existing capacity planning and benchmarking processes.*	5

Index	Task set	Description	Value
5.3.2	Develop efficient software	Make energy performance optimization a high priority in the development process and develop software which uses the least energy to perform the required task whilst ensuring it meets the organizational needs. *NOTE Forecasting and measurement tools and methods are still being developed to provide metrics for software energy efficiency. However, approximations can be used such as the power consumption of the ICT equipment whilst the software is running. This is an extension of existing capacity planning and benchmarking processes.*	5

5.4 New build or refurbishment of data centres

Table 4

Index	Task set	Description	Value
UTILIZATION, MANAGEMENT AND PLANNING: General policies			
5.4.1	Mechanical and electrical equipment environmental operating ranges	Select and deploy mechanical and electrical equipment which does not itself require cooling in normal operation (the exception to this being UPS batteries). *NOTE UPS batteries require to be kept at lower temperatures to preserve performance and reliability and to maximize operational lifetime.*	4
UTILIZATION, MANAGEMENT AND PLANNING: Resilience level and provisioning			
5.4.2	Build resilience according to business requirements	Determine the level of physical infrastructure resilience and therefore service availability based on a business and risk analysis conducted in accordance with EN 50600-1. *NOTE Multi-path infrastructures are frequently unnecessary and inappropriate. If only a single level of resilience is available in the data centre an increased resilience or availability for critical services can be obtained by splitting the ICT platform across multiple sites and making applications resilient to the loss of an individual site.*	3
5.4.3	Consider multiple levels of resilience	Consider building a data centre to provide different levels of power and cooling resilience to different spaces or areas within spaces to accommodate differing business needs. *NOTE Many co-location providers deliver this, for example single power supplies or optional ‘grey’ power feeds without UPS or generator back-up.*	3
5.4.4	Limit provisioning of power and cooling to a maximum of 18 months of computer room growth capacity	Eliminate the provisioning of excess power and cooling capacity in the data centre. *NOTE 1 Failure to do so can incur substantial capital and operational costs and is typically unnecessary. Designing a data centre for modular (scalable) expansion and then building out this capacity in a rolling programme of deployments is more efficient.* *NOTE 2 This also allows the technology ‘generation’ of the ICT equipment and supporting mechanical and electrical infrastructure to be matched, improving both efficiency and the ability to respond more effectively to changing business requirements.*	3
5.4.5	Design infrastructure to maximize part load efficiency	Design the data centre to maximize the energy efficiency of the facility under partial fill / partial load and variable IT electrical and cooling loads. This is in addition to initial modular provisioning described in Practice 5.4.4 and should take into account the response of the infrastructure to dynamic loads e.g. appropriately controlled variable frequency (or speed) drive for pumps, fans and compressors.	3

Documento de trabajo

Index	Task set	Description	Value
DATA CENTRE COOLING: Airflow management and design			
5.4.6	Implement hot/cold aisle alignment	Ensure that ICT equipment shares an airflow direction, within the cabinet and in adjacent cabinets. Reinforce Hot / Cold aisle design with empty but fully blanked cabinets (or solid doors) rather than leaving gaps in aisles.	5
5.4.7	Contained hot or cold air	Utilize floor layout and equipment deployment design concepts whose basic intent is to contain and separate the cold air from the heated return air in the computer room. *NOTE 1 Examples of these concepts include:* — *hot aisle containment;* — *cold aisle containment;* — *contained cabinet supply,* — *contained room return;* — *contained room supply,* — *contained cabinet return, (incl. cabinet chimneys);* — *contained supply, contained return.* *NOTE 2 Failure to contain airflow results in both a reduction in achievable cooling efficiency and an increase in risk. Changes in ICT equipment and management tools mean that the airflow and heat output of ICT equipment might vary rapidly due to power management and workload re-allocation. This might result in rapid changes to computer room airflow pattern and ICT equipment intake temperature which cannot be easily predicted or prevented.*	5
5.4.8	Contained hot or cold air – Retrofit	When planning to implement 5.4.7, (containment to separate hot and cold air), consider the implications of these techniques for fire suppression and detection systems. *NOTE Where hot/cold aisle separation is already in use but there is no containment of hot or cold air it is possible to retrofit to provide basic separation for example using curtains or other methods.*	4
5.4.9	Cabinet/rack airflow management	Install aperture brushes (draught excluders) or cover plates and panels to minimize all air leakage in each cabinet/rack and across raised floor areas when a raised floor is used as a cooling air supply plenum. *NOTE 1 This includes floor openings at the base of the cabinet/rack and gaps at the sides, top and bottom of the rack between equipment or mounting rails and the perimeter of the cabinet.* *NOTE 2 This is in addition to Practice 5.1.12.*	3
5.4.10	Provide adequate free area on cabinet doors	Replace solid doors (where doors are necessary and cooling airflow is necessary), with perforated doors to ensure adequate cooling airflow to ICT equipment. *NOTE Solid doors will impede cooling airflow and promote recirculation within what becomes an enclosed cabinet preventing effective cooling and heat removal.*	3

Documento de trabajo

Index	Task set	Description	Value
5.4.11	Separate environmental zones	Provide separate areas for ICT equipment which: a) is compliant with the extended range of Practice 5.2.3; b) requires more restrictive temperature or humidity control as described in Practice 5.2.2. Examples are equipment which requires tighter environmental controls to; — maintain battery capacity and lifetime such as UPS; — meet archival criteria such as tape; — meet long warranty durations (10+ years). These areas should have separate environmental controls and might use separate cooling systems to facilitate optimization of the cooling efficiency of each zone. The objective of this Practice is to avoid the need to set the computer room cooling system for the equipment with the most restrictive environmental range and therefore compromising overall energy efficiency.	4
5.4.12	Separate environmental zones – Co-location or Managed Service Provider	Design computer rooms to enable discrete areas with additional “close control” cooling equipment which can be offered to customers with extremely tight environmental control requirements. This allows a tighter SLA to be offered without compromising overall energy efficiency. *NOTE The discrete areas can be differentially priced to include the capital and operational (metered), cost overhead of supporting a less energy efficient legacy environment as an incentive for customers to install ICT equipment in more efficient areas and consider the options for more energy efficient delivery of ICT services.*	4
5.4.13	Control of supplied air flow volume minimizing over pressure	Minimize air re-circulation. Minimize air oversupply. Ensure that there is a slightly positive pressure (≤5 Pa) in the cold air stream with respect to the hot air stream. *NOTE Cooling unit fans can be operated to ensure a slight oversupply of air compared to ICT equipment flow demand to minimize recirculation whilst avoiding oversupply of air volume which can result in bypass and fan energy wastage. This principle is applicable to open and contained systems but particularly applicable to contained air systems.*	3
DATA CENTRE COOLING: Cooling management			
5.4.14	Shut down unnecessary cooling equipment	Shut down unused, non-variable equipment where appropriate. If the facility is not yet fully populated or space has been cleared through consolidation, non-variable equipment such as fixed speed fan CRAC/CRAH units should be turned off in the empty areas. This should not be applied in cases where operating more equipment at lower load is more efficient, e.g. variable speed drive CRAC/CRAH units.	3
5.4.15	Review CRAC/CRAH settings	Optimize the temperature and relative humidity settings of CRAC/CRAH units in occupied areas. For example, many CRAC/CRAH units now have the option to connect their controls and run together when installed in the same area to avoid units working against each other. Care should be taken to understand and avoid any potential new failure modes or single points of failure that might be introduced. Practice 5.4.26 should take precedence. Humidity should not be controlled locally at the CRAC/CRAH unit if the option exists to control centrally.	3

Documento de trabajo

Index	Task set	Description	Value
DATA CENTRE COOLING: Selection of cooling system: High efficiency cooling system			
5.4.16	Select chillers with high Coefficient of Performance or Energy Efficiency Ratio	Select chillers based upon their predicted or specified Coefficient of Performance (CoP) or Energy Efficiency Ratio (EER) in accordance with the EN 14511 series throughout their likely working range. This is a key decision factor during procurement when mechanical refrigeration is to be installed.	3
5.4.17	Efficient part load operation	Design the cooling system infrastructure to maximize its efficiency under partial load conditions. *NOTE For example, exploit the heat exchange area, reduce fan energy consumption, sequence chillers and operate cooling towers with shared load.*	3
5.4.18	Variable speed drives for compressors, pumps and fans	Utilize variable speed (or frequency) controls to optimize energy consumption during changing load conditions. Consider new or retrofit of electrically commutated motors which are significantly more energy efficient than traditional AC motors across a wide range of speeds. In addition to installing variable speed drives it is critical to include the ability to properly control the speed according to demand. It is of limited value to install drives which are manually set at a constant speed or have limited control adjustment.	2
5.4.19	Select systems which facilitate the use of “Free Cooling”	Select cooling designs and solutions which facilitate the use of as much “Free Cooling” as possible based on site constraints, local climatic or regulatory conditions that might be applicable. *NOTE In some data centres it might be possible to use air-side economizers. In some data centres it is possible to use direct or indirect air side free cooling. Others might not have sufficient available space and could require a chilled liquid cooling system to allow the effective use of economised cooling.*	5
5.4.20	Do not share data centre chilled water system with comfort cooling	Segregate chilled water systems which are principally designed to provide an appropriate environment for equipment from those designed to provide human comfort. *NOTE The temperature necessary to achieve comfort cooling is substantially below that for cooling of other spaces in the data centre and will compromise the efficiency of the data centre cooling system.* Where human comfort is necessary the use of heat pumps to provide either cooling or heating should be considered.	4
5.4.21	Do not allow non-ICT equipment to dictate cooling system set-points	Ensure that cooling system set-points are defined by ICT equipment requirements. Segregate electrical and mechanical equipment requiring more restrictive temperature or humidity control ranges from ICT equipment.	4
5.4.22	Chilled water pump control strategy	Review chilled water systems configured with dual pumps (one active, one standby) for options to improve energy efficiency during operation. *NOTE This can be achieved by using the pump manufacturers’ graphs of energy consumption vs. pump speed, to optimize the configuration of the pumps. Two pumps in parallel running at reduced speed can be substantially more efficient than a single pump running at a higher speed.*	1
5.4.23	Free Cooling installation	Investigate the installation of free cooling in all new builds and retrofits or upgrades of cooling systems.	5

Document de travail

Index	Task set	Description	Value
DATA CENTRE COOLING: CRAC/CRAH equipment			
5.4.24	Variable Speed Fans	Consider installing variable speed fans which are particularly effective where one or more of the following conditions apply: — a high level of redundancy in the cooling system; — low utilization of the facility; — highly variable ICT equipment load. *NOTE 1 These fans might be controlled by factors such as the supply or return air temperature or the chilled air plenum pressure.* Consider upgrading or replacing any fixed speed fans within CRAC/CRAH units with variable speed fans which might substantially reduce the energy consumption. *NOTE 2 CRAC/CRAH units with fixed speed compressors have minimum flow requirements which constrain the minimum operating load and therefore minimum air flow.*	4
5.4.25	Control on CRAC/CRAH unit supply air temperature	Control CRAC/CRAH units based on cold air supply temperature only to ensure an even supply air temperature independent of the load. *NOTE Historically many CRAC/CRAH units were controlled on return temperature which is no longer an appropriate practice.*	3
5.4.26	Do not control humidity at CRAC/CRAH unit	Centralize humidity control at the supply air handling unit. Controlling the humidity of the make-up air at the supply air handling unit provides better control and allows use of adiabatic humidification (with lower energy consumption) and potential additional opportunities for some free cooling. Do not install humidity control at the CRAC/CRAH unit on re-circulating air. Select new CRAC/CRAH units which are not equipped with humidity control capability, or reheat capability, to reduce both capital and on-going maintenance costs. *NOTE The chilled water loop or direct expansion evaporator temperatures are generally too high to provide de-humidification.* Practice 5.4.26 should take precedence. Humidity should not be controlled locally at the CRAC/CRAH unit if the option exists to control centrally.	4
5.4.27	Cooling unit sizing and selection	Select appropriately sized cooling units. Air volumes required by ICT equipment not only depend on the ICT load (kW) but also on the difference between the intake and exhaust temperatures of the ICT equipment, which will also vary with utilization. These factors should be considered together with predicted utilization and bypass to size the cooling units design flow rates. As the difference between the intake and exhaust temperatures of the ICT equipment for a given load condition is inversely proportional to airflow, any overestimate will result in undersized CRAC/CRAH air volumes and potential air management problems. Conversely any underestimation will result in excessive CRAC/CRAH air volumes, which will make part load operation inefficient and air bypass more likely.	4

Documento de trabajo

Index	Task set	Description	Value
DATA CENTRE POWER EQUIPMENT: Selection and deployment of new power equipment			
5.4.28	Modular UPS deployment	Specify and deploy modular (scalable) UPS systems. *NOTE Physical infrastructure such as switches, transformers and cabling can be designed and installed to meet the maximum electrical load of the facility but the sources of inefficiency (such as UPS units and batteries) are installed, as required, in modular units. This substantially reduces both the capital cost and the fixed overhead losses of these systems. In low power environments these might be frames with plug in modules whilst in larger installations these are more likely to be entire UPS units.*	3
5.4.29	High efficiency UPS	Select high efficiency UPS systems. *NOTE These can be of any technology including chemical battery, compressed gas or stored inertia to meet both site limitations and business expectations.* This Practice should be implemented with reference to the EN 62040 series for UPS systems.	3
5.4.30	Use efficient UPS operating modes	Deploy UPS units in their most efficient operating modes where appropriate. Use of alternative UPS technologies such as rotary or direct current systems can be considered. The comparison and evaluation of the technologies shall be based on latest and non-biased information about available products in the market. Some UPS systems can have technologies allowing energy optimization at partial load levels and these shall be taken into account as appropriate for the application. This might also be particularly relevant for any UPS system feeding mechanical loads e.g. CRAC/CRAH fans.	2
5.4.31	EU Code of Conduct Compliant UPS	Install static UPS systems that are compliant with the EU Code of Conduct on Energy Efficiency and Quality of AC Uninterruptible Power Systems. A UPS conforming to this Code of Conduct should be able to perform as rated when operating within a temperature range of 0°C to 40°C and a relative humidity range of 20 % to 80 %. Rotary UPS systems are not included in the EU Code of Conduct for UPS, but this does not in any way suggest that rotary UPS should not be used, rather that rotary technology is not currently covered by the EU Code of Conduct on Energy Efficiency and Quality of AC Uninterruptible Power Systems. Reference can be made to the US EPA’s Energy Star specifications for Uninterruptible Power Supplies.	2
5.4.32	Elimination of Isolation Transformers	Eliminate isolation transformers from distribution to ICT equipment. *NOTE These are not typically required in Europe and introduce unnecessary additional transformer losses. In many cases these have been introduced based on historic US designs not modified for European operation.*	3
5.4.33	Efficient part load operation	Ensure that all electrical infrastructure remains energy efficient under variable ICT electrical loads as described in Practice 5.4.5.	3
OTHER DATA CENTRE EQUIPMENT: General Practices			
5.4.34	Low energy lighting	Deploy low energy lighting systems in the data centre spaces. *NOTE LED lighting systems are an example.*	1

Document de travail

Index	Task set	Description	Value
5.4.35	Pale coloured fixtures and fittings	Use pale/light colours on walls, floors fixtures and fittings including cabinets, etc. to reduce the amount of lighting required to illuminate a computer room and therefore the energy consumed for lighting. *NOTE This will also ensure good levels of visibility both throughout the hall and within cabinets.*	1
5.4.36	Energy and temperature reporting hardware	Select mechanical and electrical equipment with local metering/monitoring of energy usage and/or temperature as appropriate. Capabilities should allow for reporting cumulative periodic energy consumption (kWh), in addition to instantaneous power usage (kW). Temperature reporting should allow for visibility of temperature trends over a period of time as well as instantaneous temperature readings. To assist in the implementation of temperature and energy monitoring across a broad range of data centre infrastructure all monitoring devices installed should be able to use existing networks and operate on an Open Protocol basis. This interface protocol should enable all operators' existing monitoring platform to be able to retrieve data from the installed meters without the purchase of additional licenses from the equipment vendor. *NOTE The intent of this Practice is to provide energy and environmental monitoring of the data centre throughout the entire infrastructure with increasing levels of granularity.*	3
DATA CENTRE BUILDING: Building physical layout			
5.4.37	Locate mechanical and electrical equipment outside the cooled area	Locate mechanical and electrical equipment (e.g. UPS units) which generates heat outside the cooled data centre spaces to reduce the loading on the data centre cooling system.	2
5.4.38	Select or create a building with sufficient 'slab to slab' separation / ceiling height	Ensure sufficient ceiling height to enable the use of efficient air cooling technologies such as raised floor, suspended ceiling, aisle containment or ducts in the data centre when air movement is used to cool the ICT equipment.	3
5.4.39	Facilitate the use of "Free Cooling"	Ensure that the physical layout of the building does not obstruct or restrict the use of "Free Cooling" (either air-side or water-side), or other equipment with an economization / free cooling mode.	3
5.4.40	Location and orientation of mechanical and electrical equipment	Locate cooling equipment, particularly dry or adiabatic coolers, in an area with free air movement. This equipment should ideally be located in a position on the site where the waste heat does not affect other buildings and create further demand for air conditioning.	2
5.4.41	Minimize direct solar heating	Minimize solar heating (insolation), of the cooled areas of the data centre by: — providing shade or increasing the albedo (reflectivity) of the building through the use of light coloured roof and wall surfaces; — avoiding the use of external windows in data centre spaces. *NOTE 1 Failure to protect against solar heating (insolation) will result in additional cooling requirements.* *NOTE 2 Shade can be constructed or provided by utilizing natural features including "green roof" systems.* *NOTE 3 Effective insulation can be provided by using suitable wall and roof coverings.*	2

Index	Task set	Description	Value
DATA CENTRE MONITORING: Energy consumption and environmental measurement			
5.4.42	Distribution board level metering of energy consumption of mechanical and electrical equipment	Improve visibility and granularity of data centre infrastructure energy consumption.	3
DATA CENTRE MONITORING: Energy consumption and environmental collection and logging			
5.4.43	Collecting achieved “Free Cooling” / economized cooling hours	Implement collection and logging of full free cooling, partial free cooling and full refrigerant and compressor based cooling hours throughout the year. *NOTE The intent of this Practice is to record the amount of time and energy spent running on mechanical refrigerant and compressor based cooling versus the use of free cooling in order to reduce the amount of time spent on mechanical cooling during the year.* The site design, cooling system operational set-points and ICT equipment environmental control ranges should allow the data centre to operate without refrigeration for a significant part of the year with no refrigeration for the ICT equipment cooling load as evaluated against a typical meteorological year for the site.	4
DATA CENTRE MONITORING: Energy consumption and environmental reporting			
5.4.44	Reporting achieved “Free Cooling” / economized cooling hours	Implement reporting of full free cooling, partial free cooling and full refrigerant and compressor based cooling hours throughout the year. The site design, cooling system operational set-points and ICT equipment environmental control ranges should allow the data centre to operate without refrigeration for a significant part of the year with no refrigeration for the ICT equipment cooling load as evaluated against a typical meteorological year for the site. *NOTE The intent of this Practice is to report the amount of time and energy spent running on mechanical refrigerant and compressor based cooling versus the use of free cooling in order to reduce the amount of time spent on mechanical cooling during the year.*	4

5.5 Reserved for future new expected practices from 2020 onwards

For further study.

Documento de trabajo

6 Optional and alternative Practices

6.1 Existing data centres

Table 5

Index	Task set	Description	Value
UTILIZATION, MANAGEMENT AND PLANNING: General policies			
6.1.1	Service Charging Models	Employ charging models and tariffs that encourage the use of best Practices and improve energy efficiency in co-location and managed service environments. Ensure that the true cost of data centre services are understood and fully reported in enterprise environments.	3
6.1.2	Powering of devices via the ICT cabling	Monitor and report on usage / energy consumption by devices power by ICT cabling. Cabling in accordance with EN 50173 series (and international equivalents) is increasingly being used to deliver power to devices both inside and outside the data centre. The advantage of this technology is that the same cable can be used for both network connectivity and power. Examples of this include telephony (voice) handsets, cameras, a variety of different environmental sensors even LED lights and lighting control. *NOTE The risk here is that this power is being taken directly from network switches, which constitute "ICT Load". This needs to be considered when looking at energy usage calculations such as DCiE or PUE which might well give false indications if devices are being powered via ICT communications cabling and usage is not being taken in to account.* *This is particularly true if power is being delivered outside the data centre as might be the case with IP Telephony, network switches in the data centre potentially supplying handsets in nearby office spaces. Monitor and report on usage / energy consumption by devices powered by ICT cabling.*	1
6.1.3	Impact of mobile / shifting workloads	Consider the type of workload(s) that will be supported both during the design and operation of data centres. *NOTE Traditionally steady workload levels in data centres have resulted in relatively constant power draws however developments in applications and software is resulting in increasingly fluctuating workloads and even the ability to migrate workloads seamlessly between sites. This not only potentially changes the required equipment resilience and reliability levels at a particular site; it also changes the way that the installed power and cooling infrastructure needs to be managed from both a capacity and energy efficiency perspective.*	2
UTILIZATION, MANAGEMENT AND PLANNING: Resilience level and provisioning			
6.1.4	Design appropriate resilience level	Define the required level of service resilience and availability expected to meet business demands. Utilize appropriate levels of resilience at the data centre, ICT equipment, software and network levels to achieve the required levels. *NOTE High resilience at the physical level is rarely an effective overall solution.*	4

Documento de trabajo

Index	Task set	Description	Value
ICT EQUIPMENT AND SERVICES: Data management and storage			
6.1.5	Separate user logical data storage areas by retention and protection policy	Implement a policy defining storage areas by retention policy and level of data protection. Provide multiple data storage areas which are clearly identified by their retention policy and level of data protection. Store data in an area which matches the required levels of protection and retention. Automate the application of these policies where practicable. *NOTE This is particularly valuable where strong retention requirements exist as it allows data subject to those requirements to be separated at source presenting substantial opportunities for cost and energy savings.*	3
6.1.6	Separate physical data storage areas by protection and performance requirements	Define the required combinations of data storage performance, capacity and resilience. Create a tiered storage environment utilizing multiple media types delivering the required combinations. Implement clear guidelines on usage of storage tiers with defined SLAs for performance and availability. Consider a tiered charging model based on usage at each performance level.	4
6.1.7	Select low power storage devices	Select storage hardware based on an evaluation of the energy efficiency in terms of the service delivered per Watt. *NOTE A recognized metric is the Energy Star specifications for storage.* Evaluate the “in-use power draw” and the “peak power” of the storage device(s) as configured. Energy efficiency of storage devices can be deployment specific and should include the achieved performance and storage volume per Watt as well as additional factors where appropriate, such as the achieved levels of data protection, performance availability and recovery capability required to meet the business service level requirements defined in the data management policy.	4
6.1.8	Reduce total data volume	Implement an effective data identification and management policy to reduce the total volume of data stored. Consider implementing ‘clean up days’ where unnecessary data are deleted from storage.	4
6.1.9	Reduce total storage volume	Apply the data management policy to reduce the number of logical and physical copies of data. Implement storage subsystem space-saving features. Implement storage subsystem “thin provisioning” features where possible. *NOTE Logical and physical copies of data are often referred to as “mirrors”. Storage space-saving features include techniques such as space efficient snapshots / copies or compression.*	4
DATA CENTRE COOLING: Airflow management and design			
6.1.10	Return plenum	Consider the use of a return plenum(s) to return heated air from the ICT equipment directly to the air conditioning units.	3

Documento de trabajo

Index	Task set	Description	Value
6.1.11	Raised floor or suspended ceiling height	Implement techniques to minimize losses associated with the movement of air. *NOTE It is common to use the voids in the raised floor, suspended ceiling or both in a data centre to feed cold air to equipment or remove hot air from equipment. Where this technique is applied, increasing the size of the spaces can reduce the fan losses associated with moving air.*	3
DATA CENTRE COOLING: Cooling management			
6.1.12	Scalable or modular installation and use of cooling equipment	Design the cooling system to maximize the part load efficiency as described in Practices 5.4.5 and 5.4.17. Install the cooling system in a modular arrangement allowing unnecessary equipment to be shut down. Review configuration at each cooling load change.	3
6.1.13	Dynamic control of building cooling	Consider implementing control systems that optimize the cooling system in real time in accordance with an agreed strategy. *NOTE It is possible to implement control systems that take many factors including cooling load, computer room air temperature and external air temperature into account to optimize the cooling system, (e.g. chilled water loop temperature) in real time.*	3
DATA CENTRE POWER EQUIPMENT: Management of existing power equipment			
6.1.14	Reduce engine-generator heater temperature set-point	Consider lowering the engine heater set-point of generators. Block heaters for the standby generators should be controlled to only operate when the temperature conditions warrant it. Manufacturers should be consulted to determine risk/reliability implications.	2
6.1.15	Power Factor Correction	Monitor the power factor of power supplied to the ICT, mechanical and electrical equipment within the data centre. Consider the use of power factor correction where appropriate. *NOTE 1 Poor power factor management can lead to higher cable losses and also introduce significant risk to the continuity of power supply. Low cost power supplies often have very poor power factors with little or no correction. These can build up to introduce electrical inefficiency and risk.* *NOTE 2 Poor power factor can result in penalties and extra charges imposed by the grid provider.*	2
DATA CENTRE Monitoring: Energy consumption and environmental measurement			
6.1.16	Cabinet/rack level metering of ICT energy consumption	Measure ICT power consumption at cabinet/rack level. Consider "per-port" monitoring using individual power strips. *NOTE EN 50600-2-2 provides guidance on monitoring power consumption at differing levels of granularity.*	3
6.1.17	Row or cabinet/rack level metering of temperature	Measure temperature at row or cabinet/rack level. *NOTE Measurement of air supply temperature in existing hot/cold aisle environments to assist in recognizing and dealing with airflow management issues and both over-cooling and under-cooling of ICT equipment. This is applicable in both contained and non-contained aisles. EN 50600-2-3 provides guidance on monitoring temperature at differing levels of granularity.*	3

Documento de trabajo

Index	Task set	Description	Value
6.1.18	ICT Device level metering of temperature	Measure intake and/or exhaust temperature at ICT equipment level. Improve granularity and reduce metering cost by using built in ICT equipment level metering of intake and / or exhaust air temperature as well as key internal component temperatures. *NOTE Most new servers provide this feature as part of the basic chipset functionality.*	4
6.1.19	ICT Device level metering of energy consumption	Measure power consumption at device level. Improve granularity and reduce metering cost by using built in ICT equipment level metering of energy consumption. *NOTE Most new servers provide this feature as part of the basic chipset functionality.*	4
DATA CENTRE MONITORING: Energy consumption and environmental collection and logging			
6.1.20	Automated hourly readings	Implement automated hourly readings of ICT energy consumption. *NOTE This enables effective assessment of how ICT energy use varies with ICT workload and supersedes periodic manual readings Practice 5.1.28 and automated daily readings Practice 5.1.29.*	4
DATA CENTRE MONITORING: Energy consumption and environmental reporting			
6.1.21	Energy and environmental reporting console	Provide an automated energy and environmental reporting console. Report PUE (according to EN 50600-4-2) or DCIE. See NOTE in Practices 5.1.29 and 6.1.20 with regard to method of reporting. *NOTE This allows mechanical and electrical staff to monitor the energy use and efficiency of the facility and provides enhanced capability. This supersedes the "Written Report" in Practice 5.1.28.*	4
6.1.22	Create an integrated ICT, mechanical and electrical equipment energy and environmental reporting console	Provide an integrated energy and environmental reporting capability in the main ICT reporting console. Report PUE (according to EN 50600-4-2) or DCIE and relate to ICT workload. See NOTE in Practices 5.1.29 and 6.1.20 with regard to method of reporting. *NOTE This allows integrated management of energy use and comparison of ICT workload with energy use. It supersedes Written Report and Energy and environmental reporting console. This reporting can be enhanced by the integration of effective physical and logical asset and configuration data.*	4
DATA CENTRE MONITORING: ICT reporting			
6.1.23	Server utilization	Log and report processor utilization. *NOTE This can be for the overall data centre or grouped by service/location ICT server estate. Whilst effective metrics and reporting mechanisms are still under development a basic level of reporting can be highly informative and should consider energy efficiency.*	3
6.1.24	Network utilization	Log and report network capacity and utilization. *NOTE This can be the proportion of the overall or grouped by service/location network capacity utilized. Whilst effective metrics and reporting mechanisms are still under development a basic level of reporting can be highly informative and should consider energy consumption.*	3

Documento de trabajo

Index	Task set	Description	Value
6.1.25	Storage utilization	Log and report storage capacity and utilization. This can be the proportion of the overall or grouped by service / location storage capacity and performance utilized. Whilst effective metrics and reporting mechanisms are still under development a basic level of reporting can be highly informative. The meaning of utilization can vary depending on what is considered available capacity (e.g. ports, raw vs. usable data storage) and what is considered used (e.g. allocation versus active usage). Ensure the definition used in these reports is clear and consistent. Mixed incentives are possible through the use of technologies such as de-duplication.	3
6.1.26	Business relevant dashboard	Define and report upon appropriate and relevant business specific metrics relating to data centre services. Consider representing these metrics on a dashboard to accurately reflect, highlight, manage and ideally reduce the overall energy usage required to deliver the ICT services defined by specific business requirements. *NOTE 1 This goes beyond Practice 6.1.22 and the metrics chosen as relevant will vary between different businesses.* Consider reporting aggregated data relevant to specific internal business needs. *NOTE 2 This Practice will remain optional while effective open metrics and reporting mechanisms remain under development.*	3

6.2 ICT equipment (new or replacement)

Table 6

Index	Task set	Description	Value
ICT EQUIPMENT AND SERVICES: Selection and deployment of new ICT equipment			
6.2.1	New ICT equipment – Extended operating temperature and humidity range	Include the operating temperature and humidity ranges at the air intake of new equipment as high priority decision factors in the tender process. Consider equipment which operates under a wider range of intake temperature and humidity than described in Practices 5.1.19 and 5.1.20 - such ranges include: — intake temperature 5°C to 45°C and –12°C DP and 8 % rh to 27°C DP and 90 % rh – see NOTE 1; — ETSI EN 300 019-1-3, Class 3.1 (see Annex A). *NOTE 1 This conforms to the allowable range of ASHRAE Class A4 (see Annex A).* *NOTE 2 These extended ranges potentially reduce or eliminate the capital cost of providing mechanical cooling capability.*	3
6.2.2	Control of equipment energy use	Select ICT equipment which provides mechanisms to allow the external control of its energy use. *NOTE An example of this would be the ability to externally restrict a server's maximum energy use or trigger the shutdown of components, entire systems or sub-systems.*	5

Documento de trabajo

Index	Task set	Description	Value
6.2.3	Operating temperature range – Direct liquid cooled ICT equipment	Operate direct liquid cooled devices with supply coolant liquid temperatures sufficient to meet manufacturers’ minimum cooling requirements thus avoiding equipment damage or warranty violations. Direct liquid cooling is addressed in Practice 6.4.10. *NOTE 1 Heat removal is provided by liquid direct to ICT equipment internal components such as heat sinks. The space in which such equipment is installed does not have to be subject to the environmental requirements described in Practices 5.1.19 or 5.1.20. Direct liquid cooling media operate at higher temperatures than traditional air based heat transfer systems. This results in a greater opportunity for compressor-less cooling and the reuse of heat.* *Direct liquid cooling can offer advantages in very high density applications such as High Performance Computing, and might demonstrate some energy efficiency advantages.* *NOTE 2 ASHRAE offers guidelines for the use of liquid cooling in data centres. These are contained in the publication ‘Liquid Cooling Guidelines for Datacom Equipment Centers, Second Edition’.*	4
ICT EQUIPMENT AND SERVICES: Management of existing ICT equipment and services			
6.2.4	Virtualize and archive legacy services	Virtualize and then archive disk images of servers or services that are not used on a regular basis, but cannot be decommissioned for compliance or other reasons, to media with lower energy consumption. *NOTE These services can then be brought online when genuinely required.*	5
6.2.5	Consolidation of existing services	Consolidate, through the use of resource sharing technologies, existing services that do not achieve high utilization of their hardware. *NOTE This applies to servers, storage and networking devices.*	5
6.2.6	Decommission low business value services	Identify services that have low business value or criticality and do not justify the financial or environmental overhead associated with continued operation. Decommission, archive or remove such services to locations offering lower energy consumption.	4
6.2.7	Shut down and consider removal of idle equipment	Shut down or put into a low power ‘sleep’ state servers, networking and storage equipment that is idle for significant time periods and cannot be virtualized. Consider complete removal of such ICT equipment. It will be necessary to validate the ability of legacy applications and hardware to survive these state changes without loss of function or reliability.	4
6.2.8	Control of system energy use	Consider the use of resource management systems capable of analysing and optimizing where, when and how ICT workloads are executed and their consequent energy use. *NOTE This can include technologies that allow remote deployment or delayed execution of jobs or the movement of jobs within the infrastructure to enable shutdown of components, entire systems or sub-systems. The desired outcome is to provide the ability to limit localized heat output or constrain system energy consumption to a fixed limit, at a data centre, row, cabinet/rack or other sub-data centre level.*	4

6.3 Software install or upgrade

Table 7

Index	Task set	Description	Value
ICT EQUIPMENT AND SERVICES: Deployment of new IT services			
6.3.1	Incentives to develop efficient software	Include the energy consumption required to operate software in the bonus/penalty clauses of the contract when outsourcing software development. Whilst forecasting and measurement tools and methods are still being developed, approximations can be used such as the (under load) energy consumption of the ICT equipment required to meet performance and availability targets. This is an extension of existing capacity planning and benchmarking processes. Performance optimization should not be seen as a low impact area to reduce the project budget.	5
6.3.2	Eliminate traditional 2N hardware clusters	Determine the business impact of short service incidents for each deployed service. Replace traditional active / passive server hardware clusters with fast recovery approaches such as restarting virtual machines elsewhere. *NOTE This does not refer to grid or High Performance Computing clusters.*	4
6.3.3	IT equipment utilization	Set minimum or average targets for the utilization of IT equipment (servers, networking, storage). *NOTE This presents substantial uncertainty when considered without the load to power profiles of the equipment, with cloud and mobile services and the increasing ability to relocate the IT compute function dynamically to an alternate location and better serve customers and optimize costs, this becomes more complex and would require substantial work to usefully determine.*	4

6.4 New build or refurbishment of data centres

Table 8

Index	Task set	Description	Value
DATA CENTRE COOLING: Temperature and humidity settings			
6.4.1	Expanded ICT equipment inlet environmental conditions (temperature and humidity)	Where appropriate and effective, computer room space(s) should be designed and operated to provide: — intake temperature 10°C - 40°C; — humidity, –12°C DP and 8 % rh to 27°C DP and 85 % rh. *NOTE 1 This conforms to the allowable range of ASHRAE Class A3 (see Annex A).* and under exceptional conditions up to +45°C as described in ETSI EN 300 019-1-3, Class 3.1 (see Annex A). *NOTE 2 Using the full range up to 40°C or 45°C will allow for the complete elimination of refrigeration in most climates allowing the operator to eliminate the capital and maintenance cost of the cooling systems.*	5
DATA CENTRE COOLING: Selection of cooling system: Free and economized cooling			
6.4.2	Installation of "Free Cooling"	Consider the installation of free cooling in all new builds and retrofits or upgrades of cooling systems.	5

Document Preview

Index	Task set	Description	Value
6.4.3	Direct air “Free Cooling”	Cooling of the data centre by using external air. Mix exhaust air with incoming air during periods of low external temperature to ensure compliance with specified supply air temperature and environmental ranges. Special attention should be focused on external air quality monitoring and filtration in accordance with EN ISO 14644-1:2015, Class 8 and reference to EN ISO 16890-1 to determine filter efficiency. In many cases full mechanical cooling / refrigeration capacity is required as a backup to allow operation during periods of high airborne pollutant (e.g. external fires). Additional backup mechanical cooling might also be considered to ensure cooling at extreme ambient temperature and humidity conditions or for system redundancy. This design tends to have the lowest temperature difference between external temperature and ICT equipment supply air. The ICT equipment is likely to be exposed to a large humidity range to allow direct air free cooling / economization to work effectively. The achievable free cooling hours are directly constrained by the chosen upper humidity limit. The design dew point shall ensure that condensation will not take place on components already within or brought in to the data centre.	5
6.4.4	Indirect air free cooling	Cooling using an air-to-air heat exchanger. This can be combined with an adiabatic function. *NOTE Re-circulated air within the facility is passed through an air-to-air heat exchanger. A variation of this is a thermal wheel, quasi-indirect free cooling system.* *This design tends to have a low temperature, circa 3°C, difference between external temperature and ICT equipment supply air.* *The operating ICT equipment humidity range can be well controlled at negligible energy cost in this type of design.* Filtration should be applied in accordance with EN ISO 14644-1:2015 Class 8 and reference to EN ISO 16890-1 to determine filter efficiency.	5
6.4.5	Indirect water free cooling with CRAH and dry cooler or cooling tower	Cooling using a water circuit and removal of heat by a free cooling coil. This can be achieved by dry coolers with or without adiabatic assistance. *NOTE 1 This design tends to have a higher temperature difference between external temperature and ICT equipment supply air, circa 6°C as compared to Practice 6.4.4.* Where the environmental needs of the data centre space(s) are not compatible with the external ambient conditions, consideration should be given to mechanical cooling with chiller or direct expansion units. *NOTE 2 The operating ICT equipment humidity range can be well controlled at negligible energy cost.*	5

Documento de trabajo

Index	Task set	Description	Value
6.4.6	Indirect water free cooling with CRAC with integrated free cooling coil	Cooling using chilled water cooled by cooling towers or dry coolers. Dry coolers can also have an adiabatic function. *NOTE 1 Chilled water is supplied to the free cooling coil of the CRAC when its temperature is low enough to provide full compressor-free, or partial, free cooling. In addition chilled water is supplied to the plate condenser of the CRAC´s closed direct expansion circuit when compressor operation is needed to provide sufficient cooling.* *This design tends to have a higher temperature difference between external temperature and ICT equipment supply air, circa 6°C. This might restrict the hours of compressor-free cooling available.* *Partial free cooling (Mix mode) starts a few degrees below the return air temperature of the CRAC.* *NOTE 2 The operating ICT equipment humidity range can be well controlled at negligible energy cost in this type of design.*	4
6.4.7	Indirect water free cooling with CRAH and free cooling chiller	Cooling using chilled water produced by the free cooling chiller either through the free cooling coils in the chiller, if external temperatures are low, or with compressors at higher external temperatures. *NOTE 1 This chilled water is supplied to the CRAH in the data centre. This design tends to have a higher temperature difference between external temperature and ICT equipment supply air, circa 6°C. This might restrict the hours of compressor-free cooling available and increasing energy overhead.* *Partial free cooling (Mix mode) starts a few degrees below the return air temperature of the CRAH.* *NOTE 2 The operating ICT equipment humidity range can be well controlled at negligible energy cost in this type of design.*	3
6.4.8	Indirect water free cooling with condenser water cooling chilled water	Cooling using chilled water cooled via a plate heat exchanger to the condenser water circuit passing through dry/adiabatic coolers/cooling towers. *NOTE This design usually has a highest difference between the external temperature and ICT equipment supply air due to the additional heat exchange process, circa 8°C.*	3
6.4.9	Alternative cooling sources	Evaluate of alternative forms of cooling where available, practical to utilize and offer genuine energy efficiency. *NOTE These might include ground source cooling from rivers, lakes, seawater, ponds, etc.*	1
DATA CENTRE COOLING: Selection of cooling system: Direct liquid cooling			
6.4.10	Direct liquid cooling of ICT devices	In place of air cooling it is possible to directly liquid cool part or all of some ICT devices. *NOTE 1 This can provide a more efficient thermal circuit and allow the coolant liquid system temperature to be substantially higher, further driving efficiency, allowing for increased or exclusive use of compressor free cooling or heat re use.* *This Practice applies to devices which deliver cooling liquid directly to the heat removal system of the components such as water cooled heat sinks or heat pipes and not the delivery of cooling liquid to an internal mechanical refrigeration equipment or in-chassis air cooling systems.* *NOTE 2 ASHRAE offers guidelines for the use of liquid cooling in data centres. These are contained in the publication 'Liquid Cooling Guidelines for Datacom Equipment Centers, Second Edition'.*	4

Index	Task set	Description	Value
DATA CENTRE COOLING: CRAC/CRAH equipment			
6.4.11	Run variable speed CRAC/CRAH units in parallel	Consider operating CRAC/CRAH units with variable speed fans in parallel to reduce the electrical power necessary to achieve the required air movement. Electrical power is not linear with air flow. Care should be taken to understand any new failure modes or single points of failure that might be introduced by any additional control system.	4
6.4.12	Sequencing of CRAC/CRAH units	Consider turning entire CRAC/CRAH units on and off where variable speed fans are not included to manage the overall airflow volumes. *NOTE This can be effective where there is a high level of redundancy in the cooling system, low utilization of the facility or highly variable ICT electrical load.*	2
DATA CENTRE COOLING: Reuse of data centre waste heat			
6.4.13	Waste heat re-use	Consider the re-use of waste heat that would normally be rejected from the data centre site. *NOTE This does not reduce the energy consumed by the data centre itself or reduce PUE however it does offset the total energy overhead by potentially reducing energy use elsewhere.*	3
6.4.14	Heat pump assisted waste heat re-use	Consider, where the data centre heat is too low to reuse, the use of additional heat pumps to raise the temperature to a useful point for office heating or hot water supply within the data centre building. *NOTE This can supply office, district and other heating.*	2
6.4.15	Use computer room waste heat to warm office, generator and fuel storage areas	Reduce or eliminate the electrical preheat loads for generators and fuel storage by using warm exhaust air from the data centre to maintain temperature in the areas housing generators, fuel storage tanks. *NOTE This can potentially be applied to office areas within the data centre building too as highlighted in 6.4.14*	1
6.4.16	Energy reuse metrics and reporting	Consider referencing the Energy Reuse Factor (ERF) as defined by EN 50600-4-6 and ISO/IEC 30134-6, respectively. These standards should be used for reporting the use of waste heat.	1
DATA CENTRE BUILDING: Building geographical location			
6.4.17	Locate the Data Centre where waste heat can be reused	Locate the data centre where there are opportunities available for the reuse of waste heat. *NOTE Heat recovery can be used to heat adjacent office or industrial space, hydroponic farming and swimming pools resulting in a significant overall net energy saving.*	2
6.4.18	Locate the Data Centre in an area of low ambient temperature	Locate the data centre in areas of low ambient external temperature in order to maximize the potential of free and economized cooling technologies. *NOTE 1 Most temperate climates including much of Northern, Western and Central Europe present significant opportunity for economized cooling and zero refrigeration.* *NOTE 2 The opportunities for the utilization of free cooling are further enhanced where increased temperature set-points are used.* *NOTE 3 Where refrigeration equipment can be reduced in size (or eliminated), operating and capital cost are reduced, including that of supporting electrical infrastructure.*	3

Documento de trabajo

Index	Task set	Description	Value
6.4.19	Avoid locating the data centre in high ambient humidity areas	Locate the data centre in areas of low external humidity in order to maximize the potential of free and economized cooling technologies. *NOTE 1 Many economizer technologies (such as evaporative cooling) are less effective in locations with high humidity.* *NOTE 2 The opportunities for the utilization of free cooling are further enhanced where increased humidity set-points can be used.*	1
6.4.20	Locate near a source of free cooling	Locate the data centre near a source of free ground source cooling such as a river or lake etc. NOTE Local environmental regulation could apply.	1
6.4.21	Co-locate with power source	Locate the data centre close to power generating equipment as this can reduce transmission losses.	1

6.5 Reserved for future new optional and alternative practices from 2020 onwards

For further study.

7 Practices under consideration

7.1 Practices expected to be included in Clause 5 in due course

7.1.1 Existing data centres

For further study.

7.1.2 ICT equipment (new or replacement)

For further study.

7.1.3 Software install or upgrade

For further study.

7.1.4 New build or refurbishment of data centres (any data centre built or undergoing a significant refit of the mechanical and electrical equipment from 2015 onwards)

Table 9

Index	Task set	Description	Year
7.1.4	'Capture Ready' Infrastructure	Consider installing 'Capture Ready' Infrastructure to take advantage of, and distribute, available waste heat during new build and retrofit projects.	2021

Documento de trabajo

7.2 Practices expected to be included in Clause 6 in due course

7.2.1 Existing data centres

Table 10

Index	Task set	Description	Year
7.2.1.1	Network Energy Use	When purchasing new cloud services or assessing a cloud strategy, assess the impact on network equipment usage and the potential increase or decrease in energy consumption with the aim of being able to inform purchasing decisions. The minimum scope should include inside the data centre only. The ambition is to include overall energy consumption and energy efficiency including that related to multiple site operation and the network energy use between those sites	To be decided
7.2.1.2	Smart Grid	Continue to evaluate the use of energy storage and usage to support Smart Grid. A Smart Grid is a solution that employs a broad range of information technology resources, allowing for a potential reduction in electricity waste and energy costs.	To be decided

7.2.2 ICT equipment (new or replacement)

For further study.

7.2.3 Software install or upgrade

Table 11

Index	Task set	Description	Year
7.2.3	Further development of software efficiency definitions	Research and development is required in the area of defining, measuring, comparing and communicating software energy efficiency. Suggested examples of this are; — software could be made resilient to delays associated with bringing off-line resources online such as the delay of drive spin, which would not violate the service level requirements; — software should not gratuitously poll or carry out other unnecessary background “housekeeping” that prevents equipment from entering lower-power states, this includes monitoring software and agents. This is a specialist area which is being examined in detailed by projects specializing in this field. A watching brief will be maintained and links established to any ongoing projects on the development of metrics and standards in this area, which this document can subsequently reference once published and use to underpin the expectations detailed in Practices 5.3.1 and 5.3.2	To be decided

7.2.4 New build or refurbishment of data centres

For further study.

Documento de trabajo

Annex A
(informative)

Environmental classifications

A.1 ASHRAE classifications

Table A.1 contains an excerpt from the ASHRAE classification system in their publication “Thermal Guidelines for Data Processing Environments”. The content of Table A.1 is limited and is for information only. It is recommended that the complete guidelines document is consulted to understand the wider implications of the application of the Classes.

Table A.1 — Equipment environmental specifications

Class	Dry-bulb temperature °C	Humidity range	Maximum Dew Point (DP) °C
Recommended			
A1 — A4	18°C to 27°C	–9°C DP to 15°C DP and 60 % rh	17
Allowable			
A1	15°C to 32°C	–12°C DP and 8 % rh to 27°C DP and 80 % rh	17
A2	10°C to 35°C	–12°C DP and 8 % rh to 27°C DP and 80 % rh	21
A3	5°C to 40°C	–12°C DP and 8 % rh to 27°C DP and 85 % rh	24
A4	5°C to 45°C	–12°C DP and 8 % rh to 27°C DP and 90 % rh	24
Maximum Elevation 3 050 m Max rate of change (5°C/h storage) 20 °C/h other (Max 5°C in any 15 min period of time.)			

A.2 ETSI EN 300 019-1-3 classifications

Table A.2 contains an excerpt from ETSI EN 300 019-1-3. The content of Table A.2 is limited and is for information only. It is recommended that the standard is consulted to understand the wider implications of the application of the Class.

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Table A.2 — Equipment environmental specifications

Class	Dry-bulb temperature °C	Humidity range %
Continuous operation	10 to 35	10 to 80
Class 3.1 (≤10 % of operational hours)	5 to 10 35 to 40	5 to 10 80 to 85
Class 3.1e (≤1 % of operational hours)	−5 to 5 40 to 45	5 to 10 85 to 90

Documento de trabajo

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