BS EN 50600-2-2:2014

BSI Standards Publication

Information technology - Data centre facilities and infrastructures -

Part 2-2: Power distribution

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee TCT/7, Telecommunications – Installation requirements.

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

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

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2015-01-06
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2015-01-06

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Introduction

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

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

The implementation of data centres varies in terms of:

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

b) security level;

c) physical size;

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

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

This series of European Standards specifies requirements and recommendations to support the various parties involved in the design, planning, procurement, integration, installation, operation and maintenance of facilities and infrastructures within data centres. These parties include:

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

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

3) facility and infrastructure integrators, suppliers of equipment;

4) installers, maintainers.

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

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

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

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

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

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

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

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

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

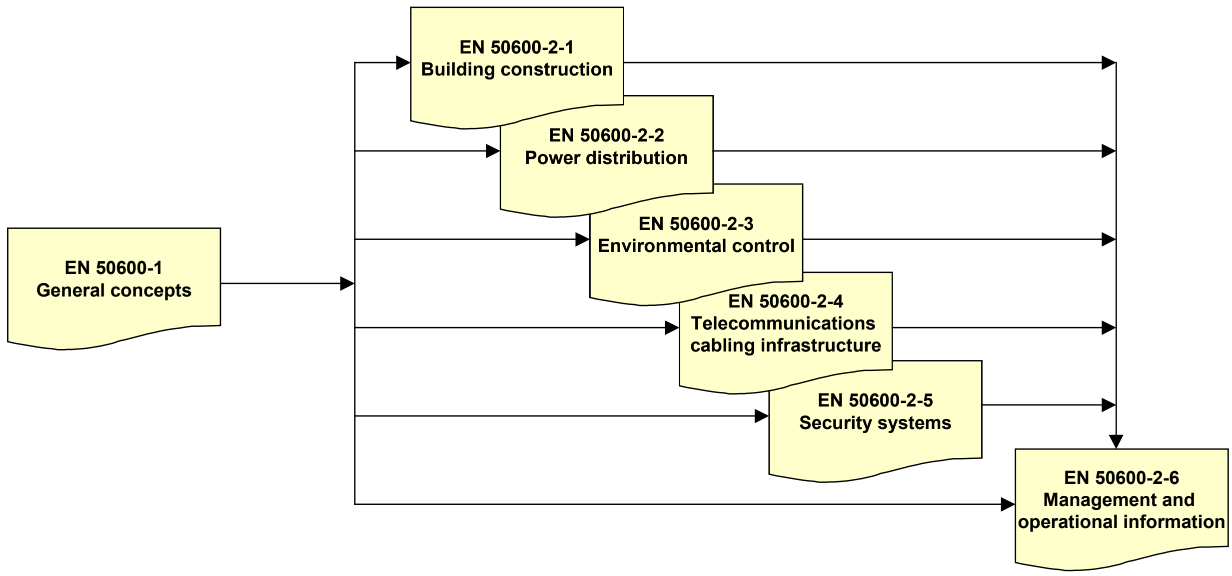

Figure 1 — Schematic relationship between the EN 50600 standards

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

This European Standard addresses facilities and infrastructures for power supplies to, and power distribution within, data centres together with the interfaces for monitoring the performance of those facilities and infrastructures in line with EN 50600-2-6 (in accordance with the requirements of EN 50600-1). The line diagrams used in certain figures are not intended to replace the more familiar electrical circuit diagrams associated with power supply and distribution systems which are included where relevant.

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

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

1 Scope

This European Standard addresses power supplies to, and power distribution within, data centres based upon the criteria and classifications for “availability”, “physical security” and “energy efficiency enablement” within EN 50600-1.

This European Standard specifies requirements and recommendations for the following:

a) power supplies to data centres;

b) power distribution systems within data centres;

c) facilities for both normal and emergency lighting;

d) equipotential bonding and earthing;

e) lightning protection;

f) devices for the measurement of the power consumption characteristics at points along the power distribution system and their integration within management tools.

Safety and electromagnetic compatibility (EMC) requirements are outside the scope of this European Standard and are covered by other standards and regulations. However, information given in this European Standard may be of assistance in meeting these standards and regulations.

Conformance of data centres to the present document is covered in Clause 4.

2 Normative references

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

EN 50160:2010, *Voltage characteristics of electricity supplied by public electricity networks*

EN 50174-2, *Information technology – Cabling installation – Part 2: Installation planning and practices inside buildings*

EN 50174-3, *Information technology – Cabling installation – Part 3: Installation planning and practices outside buildings*

EN 50310, *Application of equipotential bonding and earthing in buildings with information technology equipment*

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 50600-2-3 [1], *Information technology – Data centre facilities and infrastructures – Part 2-3: Environmental control*

[1] Draft for formal vote under preparation.

EN 50600-2-4 [2)], *Information technology – Data centre facilities and infrastructures – Part 2-4: Telecommunications cabling infrastructure*

EN 50600-2-5 [3)], *Information technology – Data centre facilities and infrastructures – Part 2-5: Security systems*

EN 60044-1:1999, *Instrument transformers – Part 1: Current transformers (IEC 60044-1:1996, modified)*

EN 60947 (all parts), *Low-voltage switchgear and controlgear (IEC 60947, all parts)*

EN 61000-2-4:2002, *Electromagnetic compatibility (EMC) – Part 2-4: Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances (IEC 61000-2-4:2002)*

EN 61439 (all parts), *Low-voltage switchgear and controlgear assemblies (IEC 61439, all parts*)

EN 62040 (all parts), *Uninterruptible power systems (UPS) (IEC 62040, all parts)*

EN 62305 (all parts), *Protection against lightning (IEC 62305, all parts)*

EN 62305-4, *Protection against lightning – Part 4: Electrical and electronic systems within structures (IEC 62305-4)*

EN 88528-11, *Reciprocating internal combustion engine driven alternating current generating sets – Part 11: Rotary uninterruptible power systems – Performance requirements and test methods (IEC 88528-11)*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

3.1.1
active power
real power
product of r.m.s. voltage, r.m.s. current and power factor (expressed as W)

3.1.2
additional supply
backup supply
power supply that provides power in the event of failure of primary and/or secondary supply

3.1.3
apparent power
product of r.m.s. voltage and r.m.s current (expressed as VA)

3.1.4
capacitive load
load that is capacitive, so that the alternating current is out of phase with and leads the voltage

3.1.5
catenary
wire hung at a specific tension between supporting structures of power cabling

[2)] Circulated for CENELEC enquiry.

[3)] Draft for CENELEC enquiry under preparation.

3.1.6
diverse route
alternative, separate, pathway intended to provide adequate segregation from another pathway, in order to provide resilient service provision in the event of physical damage to one of the pathways

3.1.7
emergency power off
designated device to provide emergency switching which disconnects power from one or more data centre facilities, infrastructures or spaces

Note 1 to entry: The configuration and function of emergency power off devices may be subject to national or local regulations.

3.1.8
fire compartment
discrete zone designed to contain a fire within that zone

3.1.9
high voltage
voltage whose nominal r.m.s. value is 36 kV < U_n ≤ 150 kV

Note 1 to entry: Because of existing network structures, in some countries the boundary between MV and HV can be different.

[SOURCE: EN 50160:2010, 3.7]

3.1.10
inductive load
load that is inductive, so that the alternating current is out of phase with and lags behind the voltage

3.1.11
information technology equipment
equipment providing data storage, processing and transport services together with equipment dedicated to providing direct connection to core and/or access networks

3.1.12
IT load
electrical consumption of all the information technology equipment measured at its input terminals including all on-board integrated power supplies and cooling fans

3.1.13
load factor
ratio of the average load to the peak load over a period of time

3.1.14
locally protected supply provision
sockets which continue to deliver power to connected equipment for a defined period following failure of power supply and distribution equipment by means of a battery supply or UPS adjacent to, or co-located with, those sockets (e.g. emergency lighting)

3.1.15
low voltage
voltage whose nominal r.m.s. value is U_n ≤ 1 kV

[SOURCE: EN 50160:2010, 3.9]

3.1.16
mechanical cooling load
electrical consumption of all the plant and components used to provide environmental control within the data centre, generally comprising compressors, controls, fans, pumps and humidifiers

3.1.17
medium voltage
voltage whose nominal r.m.s. value is 1 kV < U_n ≤ 36 kV

Note 1 to entry: Because of existing network structures, in some countries the boundary between MV and HV can be different.

[SOURCE: EN 50160:2010, 3.11]

3.1.18
pathway
defined route for cables between termination points

[SOURCE: EN 50174-1:2009/A1:2011, 3.1.26]

3.1.19
power factor
under periodic conditions, ratio of the absolute value of the active power *P* to the apparent power S: $\lambda = |P|/S$

Note 1 to entry: The ratio of the active (real) power flowing to the load to the apparent power (as a result of the capacitive or inductive nature of the load) and is a dimensionless number between 0 and 1.

[SOURCE: IEC 60050-131:2002, 131-11-46, modified]

3.1.20
protected supply provision
no break protected supply provision
sockets which continue to deliver power to connected equipment for a defined period following failure of power supply and distribution equipment

3.1.21
primary distribution equipment
equipment which is required to manage, control and convert incoming power supplies (primary, secondary and, where appropriate, additional) in a form suitable for distribution by secondary distribution equipment

3.1.22
primary supply
principal power supply that provides power to the data centre under normal operating conditions

3.1.23
resistive load
load in which the alternating current is in phase with the voltage

Note 1 to entry: The total reactance is zero.

3.1.24
secondary distribution equipment
equipment which is required to manage, control and distribute the power provided by the primary distribution equipment to the short-break and unprotected sockets within the data centre and to the tertiary distribution equipment

Note 1 to entry: The power supply may be single-phase AC, three-phase AC or DC. If there is a change from 3-phase to 1-phase supply, this is generally achieved at the secondary distribution equipment that is served directly from the primary distribution equipment.

3.1.25
secondary supply
power supply that provides power to the data centre in conjunction with the primary supply under normal operating conditions

3.1.26
short-break supply provision
back-up supported supply provision
sockets which, upon failure of power supply and distribution equipment, will be provided with power from an additional power supply after a defined period

3.1.27
socket
connection enabling supply of power to attached equipment

Note 1 to entry: This may be a de-mateable or a hardwired connection.

3.1.28
tertiary distribution equipment
power supply equipment, typically accommodated within the cabinets, frames and racks of the data centre spaces, which directly feeds the protected sockets therein

3.1.29
total harmonic current distortion
measurement of the harmonic distortion present on a current level, defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency

3.1.30
total harmonic voltage distortion
measurement of the harmonic distortion present on a voltage level, defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency

3.1.31
unprotected supply provision
sockets which fail to deliver power to connected equipment following failure in power supply and distribution equipment

3.2 Abbreviations

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

AC	Alternating Current
DC, dc	Direct Current
EPO	Emergency Power Off
HV	High Voltage
ITE	Information technology equipment
LV	Low Voltage
MV	Medium Voltage
r.m.s.	root mean square
SPD	Surge Protective Device

THCD	Total Harmonic Current Distortion
THVD	Total Harmonic Voltage Distortion
TVSS	Transient Voltage Surge Suppression
UPS	Uninterruptible Power Supply

4 Conformance

For a data centre to conform to this European Standard:

a) it shall feature a power supply and distribution design solution that meets the required Availability Class of Clause 6 (and is predicted to meet the relevant availability requirements of that clause);

b) the environmental controls applied to the spaces accommodating the power supply and distribution system within the premises and serving the data centre shall be in accordance with EN 50600-2-3;

c) it shall feature an approach to physical security in relation to the power supply and distribution solution that meets the requirements of Clause 7;

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

e) the equipotential bonding system within the data centre shall be in accordance with the local mesh earthing requirements of EN 50310;

f) where lightning protection is required, it shall be in accordance with the EN 62305 series applied with reference to EN 50310;

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

5 Power supply and distribution within data centres

5.1 General

The distribution of electrical power is one of the most important aspects of data centre infrastructure. Disturbances of power supply voltage, current and frequency have a direct effect on the operational safety of the data centre infrastructure and its availability.

The functional elements of power supply to and distribution within data centres are described in Table 1. The requirements and recommendations for the provision of physical security to the spaces accommodating the functional elements are described in Clause 7.

The primary and secondary supplies are typically provided from a transformer which may either be:

a) within the premises containing the data centre (and may be owned by either the utility or the data centre premises owner) or

b) external and owned by the utility (and not considered to be a functional element).

The primary and secondary distribution equipment may also contain transformers.

The supply area is shown schematically in Figure 2 and indicates two implementations. The upper diagram shows the minimum implementation comprising a primary power supply only. The lower diagram includes a secondary supply and also and additionally supply that provides power to relevant equipment in the data centre, if required, following a failure of the primary and/or secondary power supply.

Table 1 — Functional elements of power distribution

Area	Functional element	Typical accommodation (using spaces of EN 50600–1)
Supply	Primary supply Secondary supply	Transformer space
	Supply transfer equipment (where multiple supplies exists)	Electrical space
	Additional supply (e.g. generator, uninterruptible power supplies)	Generator space or electrical space
Distribution	Primary distribution equipment	Electrical distribution space Transformer space (if required)
	Uninterruptible power supplies (UPS)	Electrical space (or computer room space)
	Secondary distribution equipment	Electrical space (but also present in many other areas) Transformer space (if required)
	Tertiary distribution equipment	Computer room spaces or spaces requiring provision of protected supplies

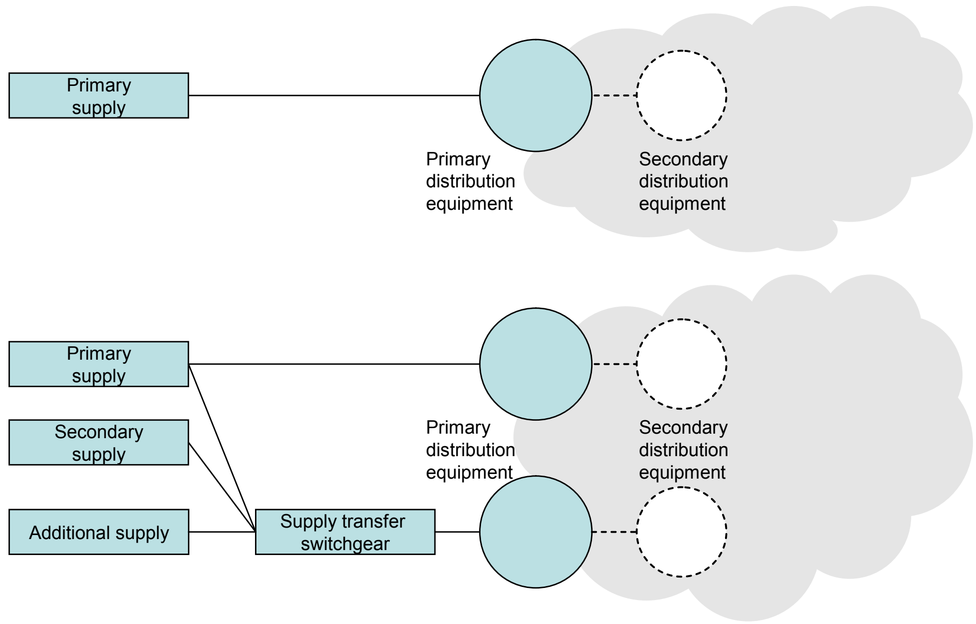

Figure 2 — Power supply functional elements

The primary distribution equipment provides the interface between the supply and distribution areas.

The input to the primary distribution equipment may be LV and/or MV.

The output from the primary distribution equipment may be LV and/or MV depending upon the size of the premises and the input requirements of any UPS or DC supply equipment installed between the primary and secondary distribution equipment.

The input to the secondary distribution equipment may be LV and/or MV.

The distribution area is shown in Figure 3. The power is distributed via one or more instances of secondary distribution equipment. These and subsequent figures adopt a system level approach to the implementation. Examples of specific implementations are shown in Annex A using symbols more familiar to those of the electrical design and installation field.

Within Figure 3 the power is provided to sockets in the distribution area that are categorised as:

1) unprotected sockets - suitable for equipment that is not critical to the function of the data centre (e.g. normal lighting and powering of tools and equipment required for the maintenance of the facility);

2) protected sockets - intended for equipment (e.g. data processing, storage and transport equipment) that is critical to the function of the data centre and which cannot tolerate failure of supply, served by solutions including uninterruptible power supplies (UPS) installed as part of the distribution system;

3) locally protected sockets - intended for equipment (e.g. emergency lighting) served by solutions including uninterruptible power supplies (UPS) or local battery supplies installed at or close to the socket);

4) short-break sockets (available where the primary and/or secondary power supply is augmented with an additional supply) - intended for equipment (e.g. environmental control equipment) that is critical to the function of the data centre but which can tolerate a failure of supply for a short period before the additional supply (e.g. generator) is brought into service.

Unprotected, locally protected and short-break sockets are fed directly by the secondary distribution equipment. The output from the secondary distribution equipment is assumed to be LV. Additional secondary distribution equipment is typically installed where there is a need to change the current capacity of the power supply cabling.

The protected sockets are fed by tertiary distribution equipment which feeds stand-alone and cabinet, frame or rack mounted equipment. The tertiary distribution equipment enables the monitoring of the IT load as described in 8.4.

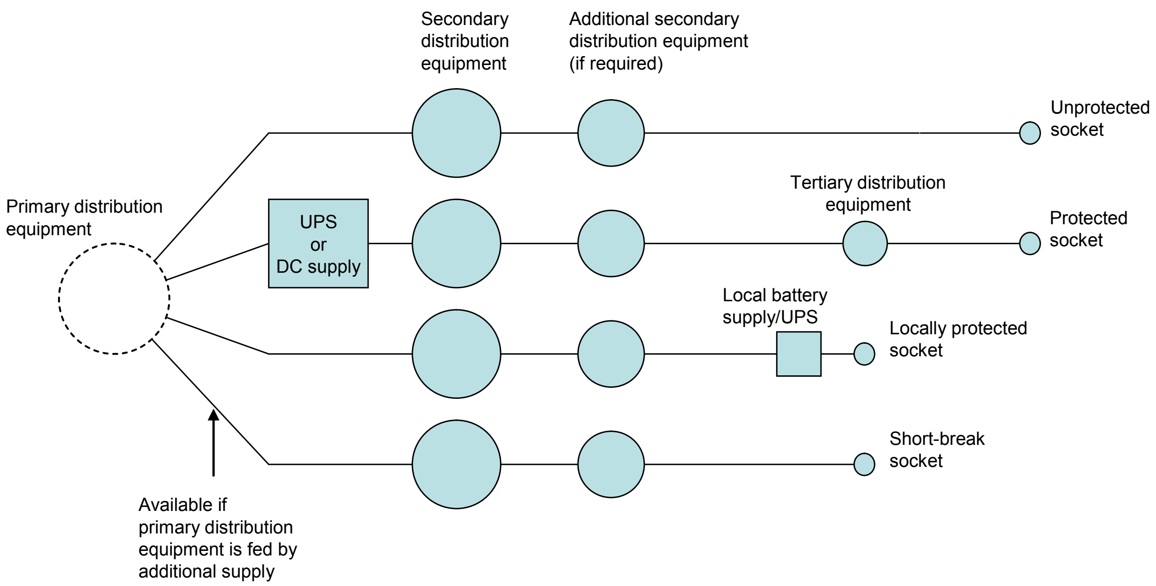

Figure 3 —Secondary and tertiary power distribution systems

5.2 Dimensioning of power distribution systems

In small data centres, the data centre may only contain the functional elements within the distribution area (the primary distribution equipment being elsewhere in the premises and serving the power distribution in the remainder of the premises). In large data centres, primary distribution equipment may be dedicated to the demands of the data centre itself.

The smallest data centres may comprise a single cabinet containing in-cabinet distribution equipment providing protected power supplies to data processing, storage and transport equipment. In such cases the functionality of the secondary distribution equipment may be provided by the in-cabinet distribution equipment. It may not be necessary to provide any unprotected or short-break power supplies within the cabinet.

In the small data centres comprising a limited number of cabinets, frames or racks, the UPS equipment may be installed immediately prior to, or within, the tertiary distribution area.

As data centres grow either physically and/or in terms of their importance to the business they support, the most obvious additional element is the provision of an additional supply as shown in Figure 2 - in the form of a generator that is intended to deliver short-break supply provision for an extended period if the primary and/or secondary supply fails and to enhance the protected supply provision within the data centre.

The use of secondary and additional power supplies and primary distribution equipment in order to enhance levels of availability are addressed in 6.2.6.

6 Availability

6.1 General requirements

The power supply and distribution systems for a data centre comprise a complex sequence of components in a hierarchical structure via a series of serial and parallel subsystems which convert the power from the primary, secondary or additional supplies, maintain and/or improve its quality and availability, and deliver that power to a mix of unprotected and protected end-equipment within the data centre.

The measurement of power supply parameters at the locations described in Clause 8 and the associated monitoring of the those parameters and their trends is also able to indicate conditions where demand may be threatened by the available capacity.

The power supply and distribution systems within the data centre shall be designed and/or selected in order to provide the required availability of power supply to the end-equipment.

The Availability Class of the power supply and distribution systems shall be at least equal to that required by the Availability Class of the overall set of facilities and infrastructures chosen in accordance with EN 50600-1.

Subclause 6.2 defines general requirements and recommendations for the design and selection of the power supply system and in terms of Availability Class.

Subclause 6.3 defines general requirements and recommendations for the design of the power distribution system and in terms of Availability Class.

6.2 Power supply

6.2.1 Capacity planning

6.2.1.1 Sizing

6.2.1.1.1 Requirements

The maximum capacity of the power supply system to the data centre shall be sized to accommodate:

a) the maximum planned IT load and allowance for future growth to allow for technology developments (typically, but not necessarily, based upon the published ‘start up’ power requirements supplied by the equipment manufacturers);

b) the maximum mechanical cooling load (typically based on the highest predicted temperature external to the data centre);

c) the small power, security, lighting and building/energy controls;

d) losses in the power distribution system.

During the planning and dimensioning of the power supply, its associated spaces and the selection of components of the power supply system of the data centre, the following shall also be considered:

e) during construction:

   1) temporary/construction power requirements;

f) during operation:

   1) growth of real power load over time;

   2) predicted variations and periodicity of active power load and power factor;

   3) predicted variations and periodicity of load factor;

g) exceptional conditions (i.e. special and/or unusual loads):

   1) nature of load;

   2) occurrence (i.e. continuous, intermittent, cyclical).

The selection of components of the power distribution system (e.g. transformers and generators) shall allow a scalable solution which takes into account the variability between ‘normal’ demand (when the mechanical cooling system is working at lower ambient temperatures) and the ‘maximum’ demand.

The capacity of any additional supply system shall at least match the capacity planning for the short-break, protected or locally protected sockets as shown in Figure 4.

Where secondary and/or additional supplies are implemented, the balance of the loads shall be considered in the event of failure i.e. is the load to be distributed (evenly or unevenly) on the remaining supplies or is it to be applied, in full, to a single remaining supply.

6.2.1.1.2 Recommendations

The specification of transformers, alternators and controls should take into consideration the presence of capacitive loads and, where legacy loads are anticipated, high harmonic current distortion.

Most modern IT loads are dual-corded. All distribution paths shall be designed to sustain the maximum load should the redundant path fail.

Static transfer switches should only be considered following an extensive design review due to their “single-point-of-failure” nature and the risk of excessive short circuit currents to semiconductor devices. Such a review should also consider IT based solutions. See 6.3.

Consideration should be given to the status of sockets that provide power to any equipment, such as fuel pumps, necessary to maintain the additional supply.

6.2.1.2 Expansion

6.2.1.2.1 Requirements

The selection of components of the power supply system (e.g. transformers and generators) within the premises shall:

a) allow a modular solution which takes into account the initial load and the maximum planned load while maintaining optimum efficiency;

b) take into account any need to maintain data centre operation during the introduction of additional capacity.

6.2.1.2.2 Recommendations

Modularity should be balanced with reliability by ensuring that the component count is not increased to the detriment of reliability or availability.

6.2.1.3 Diversity

6.2.1.3.1 Requirements

The higher Availability Classes of 6.2.6 require the incoming power supply to be duplicated and delivered via diverse routes.

6.2.1.3.2 Recommendations

Where the data centre is provided with multiple power supplies (primary, secondary or additional), the cabling for each power supply between its point of entry to the building accommodating the data centre and its source (e.g. premises entrance or generator space) should be installed in a separate pathway. The location of the pathways and protection applied to them should minimise the risk of concurrent physical damage.

An analysis should be employed to assess the balance of risk between the use of overhead catenary pathways (due to climatic effects such as high wind, snow or icing) and the use of underground pathways which may be at risk of accidental excavation.

The entrance of each power supply to the building containing the data centres should be:

a) physically segregated to provide a barrier in accordance with national or local regulations;

b) sufficiently contained to survive a explosion in one transformer housing.

6.2.2 Availability of the utility supply

6.2.2.1 Requirements

The primary and secondary (if present) power supply shall be in accordance with EN 50160.

The primary and secondary (if present) power supplies for a data centre are typically the utility. The reliability of these supplies shall be assessed during the design process and the design of any additional supplies shall reflect the predicted availability of the primary/secondary supplies.

Using historical availability records where available, the additional supply providing the emergency generation system shall be designed following consideration of:

a) capacity;

b) period of use (intermittent or continuous);

c) load profile (continuous or variable).

Depending on the outcome of this assessment it may be desirable to reverse the roles of primary and additional supplies i.e. a generator may provide the primary supply backed up by the network operator's power supply.

Additional power supplies shall be matched to the power distribution system and their function, including replenishment of any fuel, shall be covered by a service level agreement which takes into account the capacity of any on-site storage facilities.

The timescales for maintenance and repair within the service level agreements relating to any additional power supply(s) shall be shorter than the operating period supported by their fuel storage capacities.

The control systems for additional power supplies shall remain functional if primary or secondary power supplies are disrupted.

6.2.2.2 Recommendations

A local primary power supply (e.g. power station or hydro-plant) should be considered as a primary supply if:

a) the availability of the grid connection is considered inadequate

b) the power quality of the grid supply is considered inadequate.

If a local power supply is used as a primary supply, the impact of any periodic shut-downs should be considered and secondary and additional supplies should be continuously rated for long term full-load operation.

Where the additional supply providing the emergency generation system is continuously rated for long-term full-load operation, the primary supply should be the utility.

6.2.3 Power quality

6.2.3.1 Requirements

The power quality shall be in accordance with EN 50160.

6.2.3.2 Recommendations

Power supplies at AC 400 V are typically shared by several consumers who act in combination to define, and typically reduce, the lower power quality. Where concerns exist, consideration should be given to the monitoring of power quality parameters.

In order to achieve the higher levels of power quality, a data centre should:

a) be connected to the network operator’s supply at the highest possible voltage level;

b) share a sub-station with as few other consumers as is possible;

c) not be located near to large consumers of electrical power, such as metals manufacturing and processing, or large electrical machines and electronic drives, such as gas compression facilities.

6.2.4 Load presented to the utility supply

6.2.4.1 Requirements

The loads, power factors and harmonics presented to the supply(s) shall remain within the boundaries of any contract of supply and/or be compatible with any local generated and additional supplies.

6.2.4.2 Recommendations

The following aspects should be taken into account when planning the capacity of the supply with respect to the load;

a) Critical loads*:*

   1) the input power factor and harmonic current spectrum of the chosen UPS (as indicated in Figure 2 and Figure 3, UPS or DC supplies are required in order to ensure adequate power quality to protected sockets feeding the IT, and other critical loads - as a result the load presented to the utility is dominated by the power input stage of the chosen UPS);

   2) the input power factor and harmonic current spectrum of the critical load when the UPS is in bypass or other off-line mode.

b) Non-critical loads*:* the input power factor and harmonic current spectrum of the loads fed by unprotected, short-break and locally protected sockets such as cooling system compressors, pumps and fans - especially if variable speed drives are used.

6.2.5 Equipment

6.2.5.1 Transformers

6.2.5.1.1 Requirements

Where the primary and/or secondary power supply to the premises accommodating the data centre is HV or MV, any transformers shall be selected to:

a) provide peak load while running at peak design ambient temperature for the location with any de-rating for harmonic load currents from UPS or variable speed drives within the facility;

b) stay within their design operating temperature range at peak load.

6.2.5.1.2 Recommendations

Dry type transformers in accordance with EN 60076-11 should be used.

6.2.5.2 Supply transfer switchgear

6.2.5.2.1 General

Supply transfer switchgear for data-centre facilities is normally automated with mains-failure monitoring.

6.2.5.2.2 Requirements

If no supply synchronisation is present, transitions shall be open transition with a delay to prevent a risk of damage to equipment and/or allow for any inductive load decay.

6.2.5.2.3 Recommendations

None.

6.2.5.3 Uninterruptible power supplies (UPS)

6.2.5.3.1 Requirements

The following scenarios shall be considered when designing the power supply system associated with UPS equipment:

a) normal operation on UPS fed by utility or by additional supply;

b) load on UPS bypass fed by utility or by additional supply.

The power quality supplied by static UPS equipment shall be in accordance with the appropriate Class of EN 62040 series. The power quality supplied by dynamic UPS equipment shall be in accordance with the appropriate Class of EN 88528-11.

In the absence of alternative requirements being specified by the suppliers of equipment to be connected to protected sockets, the power quality between the UPS and the protected sockets shall be in accordance with EN 61000-2-4:2002, Class 1.

6.2.5.3.2 Recommendations

UPS equipment should be selected to operate in normal mode from the anticipated power quality of the supply and yet supply the protected sockets with conditioned power.

UPS inputs, outputs and bypass(es) should be fitted with surge protection devices (SPDs), e.g. all-mode Transient Voltage Surge Suppression (TVSS). For rotary UPS, such devices should also be fitted at the load connection side.

6.2.6 Availability Class design options

6.2.6.1 General

All infrastructures in the data centre utilise the concept of 'N' when planning the load and the redundancy, e.g. N, N +1, 2 N or 2(N +1), etc where N is seldom equal to 1. To maximise the utilisation of capital plant, and so minimise energy standing losses, the designer shall take into account the increased redundancy for running at partial load when choosing how to specify the configuration of 'N'

Four design options, of increasing Availability Class are specified for the power supply and power distribution systems:

a) Class 1: Single path (no resilience) - a single path system without resilience is suitable where it is acceptable that a single fault in an element in the path will result in loss of functional capability and where maintenance (routine preventative or unplanned repair) requires the load to be shut-down.

b) Class 2: Single path (resilience provided by redundancy of components) - a single path system with resilience is suitable where it is required that a single fault in the in the path will not result in loss of supply because sufficient redundant components in each sub-assembly are included and where routine planned maintenance does not require the load to be shut-down. Major faults may result in unplanned load shutdown and some maintenance routines (for example annual or bi-annual integrity checks for safety) may require planned load shutdown.

c) Class 3: Multi-path resilience and concurrent repair/operate solution - an active/passive multi-path system with resilience is suitable where it is required that a single fault in the path will not result in loss of supply because sufficient redundant components in each sub-assembly are included and where routine planned maintenance does not require the load to be shut-down. Major faults may result in unplanned load shutdown but all maintenance routines (for example annual or biannual integrity checks for safety) will not require planned load shutdown by use of the passive path. The passive path serves to act as the concurrent maintenance enabler as well as reducing to the minimum the recovery of service time after a major fault. The designer should aim to have the least number of common-point-of-failure possible between the active and passive paths, including segregated routing and physical compartmentalisation.

d) Class 4: Multi-path resilience, concurrent repair/operate, and fault tolerant solution **-** An active/active multi-path system is suitable where it is required that no single fault in either path will result in loss of supply and where planned maintenance does not require the load to be shut-down. A major fault in one path will not result in unplanned load shutdown and all maintenance routines (for example annual or biannual integrity checks for safety) will not require planned load shutdown by use of the other active path. Each path serves to act as the concurrent maintenance enabler as well as avoiding any recovery of service time after a major fault. The designer should aim to have no common-point-of-failure between the two paths, including segregated routing, physical compartmentalisation and fire-rated enclosures. Each path does not require N+1 redundancy unless the client specifies that during maintenance or repair (planned or unplanned) where one path is removed from service the remaining path has to retain a higher degree of resilience than N. This is most valid when a scalable solution in each path results in N where N is multi-module and higher than 3 (for example). It is assumed in this standard that during system maintenance or repair, unless specified by the client, a degraded level of resilience is permitted.

6.2.6.2 Class 1: Single path (no resilience) solutions

Figure 4 shows an example of a basic single path design solution in which a single radial is provided from a MV/LV transformer (e.g. AC 400 V). The transformer may be either external to the premises containing the data centre and owned by the utility or within the premises i.e. a functional element of the power supply system of the data centre in which case it may be owned by either the utility, the premises owner or a third party.

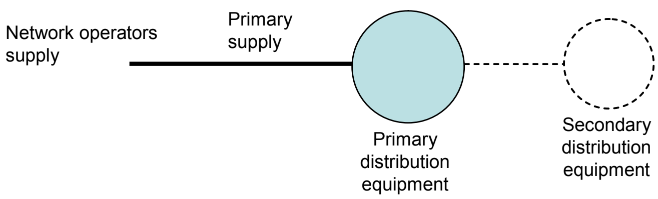

Figure 4 — Example of single path solution for power supply

The pathway within the premises carrying the power supply should be underground unless the risk from accidental excavation is considered higher than the threat from atmospheric disturbance or deliberate or accidental physical damage.

6.2.6.3 Class 2: Single path (resilience provided by redundancy of components) solutions

Figure 5 shows the implementation of Figure 4 (see 6.2.6.2) augmented by an appropriate additional supply, dedicated to the needs of the data centre, which provides resilience by means of redundancy of components.

The transformer may be either external to the premises containing the data centre and owned by the utility or within the premises, i.e. a functional element of the power supply system of the data centre in which case it may be owned by either the utility, the premises owner or a third party.

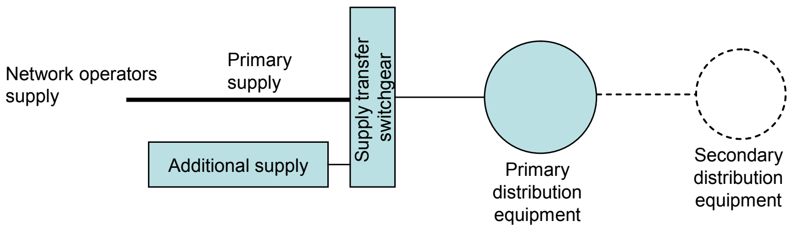

Figure 5 — Example of "single path resilient" solution for power supply

The pathways within the premises carrying the primary, secondary and additional supplies should be:

a) located underground unless the risk from accidental excavation is considered higher than the threat from atmospheric disturbance or deliberate or accidental physical damage;

b) physically separated, between the boundary of the premises and the point of enty into buildings containing the relevant data centre spaces, by at least 20 m to ensure that a single incident will not cause damage to both entrance pathways;

c) accommodated within separate fire compartments within any buildings containing the spaces served.

6.2.6.4 Class 3: Multi-path resilience and concurrent repair/operate solutions

Figure 6 shows an example of a design solution providing multi-path resilience with concurrent repair/operate features. An N +1 array of MV/LV transformers (either external or internal to the premises) is fed by a MV ring to provide diverse routing of supply. Any transformer should be housed in separate fire compartments.

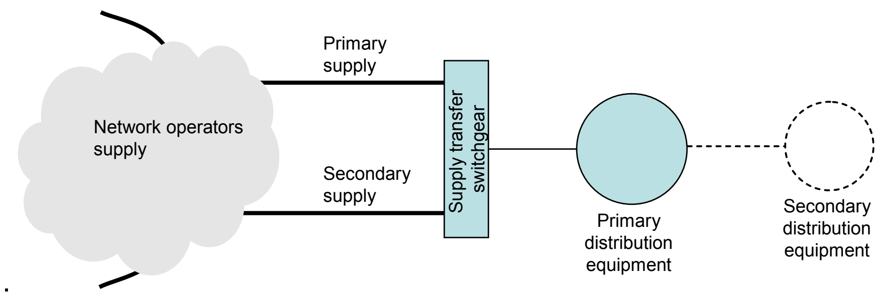

Figure 6 — Example of "multi-path resilience with concurrent repair/operate" solution for power supply

The implementation of an appropriate additional supply produces an enhanced design solution (see 6.2.6.3).

The pathways within the premises carrying the primary, secondary and additional supplies should be:

a) located underground unless the risk from accidental excavation is considered higher than the threat from atmospheric disturbance or deliberate or accidental physical damage;

b) physically separated, between the boundary of the premises and the point of entry into buildings containing the relevant data centre spaces, by at least 20 m to ensure that a single incident will not cause damage to both entrance pathways;

c) accommodated within separate fire compartments within any buildings containing the spaces served.

6.2.6.5 Class 4: Fault tolerant solutions

Figure 7 shows an example of a fault tolerant design solution in which two separate and diversely routed MV supplies from two physically diverse transformers (external or internal to the premises), each one of which is fed via a ring, not a radial. Each transformer shall be housed in separate fire compartments.

In such a configuration, each feed shall:

a) be rated for the maximum load of the entire facility;

b) be live;

c) normally share the connected load equally.

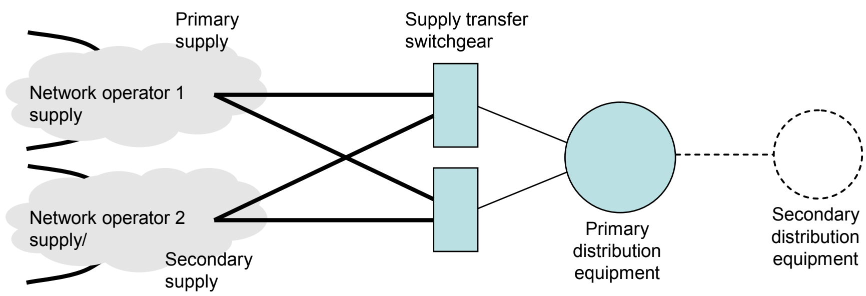

Figure 7 — Example of fault tolerant design solution for power supply

The pathways within the premises carrying the primary, secondary and additional supplies shall be:

d) located underground unless the risk from accidental excavation is considered higher than the threat from atmospheric disturbance or deliberate or accidental physical damage;

e) physically separated, between the boundary of the premises and the point of enty into buildings containing the relevant data centre spaces, by at least 20 m to ensure that a single incident will not cause damage to both entrance pathways;

f) accommodated within separate fire compartments within any buildings containing the spaces served.

The dual supply from the supply transfer switchgear shall be diverse routed, accommodated within separate fire compartments and shall feed separate switchgear within the primary distribution equipment.

6.3 Power distribution

6.3.1 Capacity planning

6.3.1.1 Sizing

6.3.1.1.1 Requirements

The maximum capacity of the power distribution system and the associated spaces of the data centre shall be sized to accommodate:

a) the maximum planned IT load and allowance for future growth to allow for technology developments (typically, but not necessarily, based upon the published “start up” power requirements supplied by the equipment manufacturers);

b) the maximum mechanical cooling load (typically based on the highest predicted temperature external to the data centre);

c) the small power, security, lightning and building/energy controls;

d) losses in the power distribution system.

During the planning and dimensioning of the power distribution system and the selection of components of the power distribution system of the data centre, the following shall also be considered:

e) during construction:

   1) temporary/construction power requirements;

f) during operation:

   1) growth of real power load over time;

   2) predicted variations and periodicity of load factor;

g) exceptional conditions (i.e. special and/or unusual loads):

   1) nature of load

   2) occurrence (i.e. continuous, intermittent, cyclical).

The selection of components of the power distribution system shall allow a scalable solution which takes into account the variability between “normal” demand (when the mechanical cooling system is working at lower ambient temperatures) and the “maximum” demand.

UPS equipment shall be selected to operate at the anticipated load taking into account the expected power factors of the load.

NOTE Typically, IT equipment exhibits capacitive loads with power factors close to 1,0 whereas the output of UPS are typically inductive with power factors of low as 0,8.

6.3.1.1.2 Recommendations

None.

6.3.1.2 Expansion

6.3.1.2.1 Requirements

The selection of components of the power distribution system (e.g. UPS) on the premises accommodating the data centre (e.g. transformers and generators) shall:

a) allow a modular which takes into account the initial IT load and the maximum planned load and maintains optimised efficiency;

b) take into account any need to maintain data centre operation during the introduction of additional capacity.

6.3.1.2.2 Recommendations

UPS systems should be loaded to optimise their efficiency in accordance with manufacturer's instructions. Modularity should be balanced with reliability by ensuring that the component count is not increased to the detriment of reliability or availability.

It should be possible to implement the desired stages of expansion without shutting down the critical load down or requiring live-working.

6.3.2 Power quality

6.3.2.1 Requirements

In all cases, the design of the power distribution systems and the selection of its components shall take into account the expected power quality of the relevant supply by considering:

a) the active power load;

b) the apparent power load;

c) the requirements for power quality within the data centre;

d) short term inrush current components.

The following scenarios shall be considered when designing the power distribution system associated with UPS equipment:

1) normal operation on UPS fed by utility or by additional supply;

2) load on UPS bypass fed by utility or by additional supply.

Considerations of power quality in relation to UPS shall be in accordance with 6.2.5.3.

The components of the power distribution system shall be selected to meet the demands for selectivity and short-circuit performance in all relevant operational modes.

6.3.2.2 Recommendations

None.

6.3.3 Equipment

6.3.3.1 UPS

6.3.3.1.1 Requirements

See 6.3.3.1.1.

6.3.3.1.2 Recommendations

See 6.2.5.3.2.

6.3.3.2 Switchgear

6.3.3.2.1 Requirements

Low voltage switchgear and control gear shall be in accordance with the EN 60947 series.

Low voltage switchgear and control gear assemblies shall be in accordance with the EN 61439 series.

6.3.3.2.2 Recommendations

None.

6.3.4 Availability Class design options

6.3.4.1 Implementation

6.3.4.1.1 General

6.3.4.2 to 6.3.4.5 specifically address the implementations which affect the availability of the protected socket infrastructure.

The term ‘UPS or DC supply’ shown in Figure 8, Figure 9, Figure 10 and Figure 11 is used to include both non-redundant and redundant systems to meet the reliability requirements of the design.

6.3.4.1.2 Requirements

The supply at protected sockets shall not be negatively affected by any load steps resulting from switching operations or faults.

The choice of components and systems as well as their quality shall be taken into consideration by the planning. Recommendations or installation rules of the suppliers or manufacturers shall be considered during the planning process.

Where power distribution systems incorporate multiple paths, a failure of components in one path shall not negatively affect the provision of power in any other path.

6.3.4.1.3 Recommendations

None.

6.3.4.2 Class 1: Single path (no resilience) solutions

Figure 8 shows an example of a single path design solution.

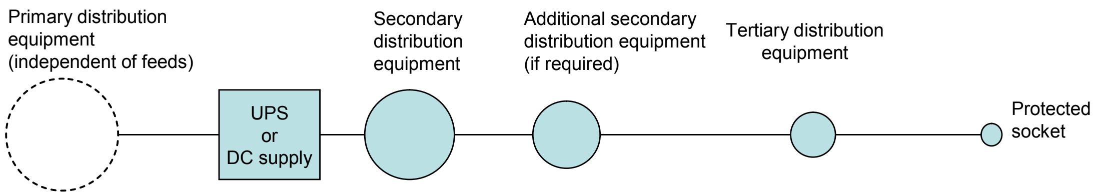

Figure 8 — Example of single path solution for power distribution

The UPS or dc supply shall be designed and installed to provide power for a period adequate to ensure that data are not lost following supply failure.

6.3.4.3 Class 2: Single path (resilience provided by redundancy of components) solutions

Figure 9 shows examples of single path design solutions providing resilience by means of redundancy of components.

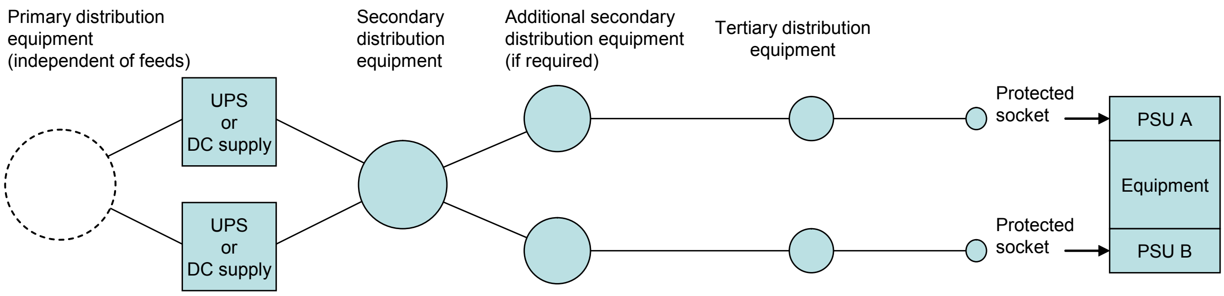

Figure 9 — Example of "single path resilient" solution for power distribution

The UPS or dc supply shall be designed and installed to provide power for a period following supply failure adequate to allow controlled shut-down of equipment connected to the protected sockets or establishment of alternate supply.

6.3.4.4 Class 3: Multi-path resilience and concurrent repair/operate solutions

Figure 10 shows an example of a design solution providing multi-path resilience with concurrent repair/operate features.

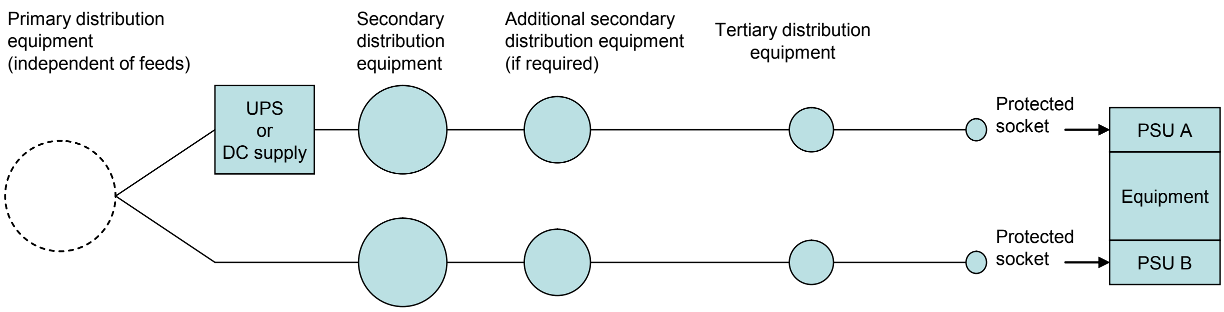

Figure 10 — Example of "multi-path resilience with concurrent repair/operate" solution for power distribution

The UPS or dc supply shall be designed and installed to provide power for a period following supply failure adequate to allow establishment of alternate supply.

6.3.4.5 Class 4: Fault tolerant solutions

Figure 11 shows an example of a fault tolerant design solution. Each path shall be equipped with UPS equipment that is separated physically and housed in separate fire compartments.

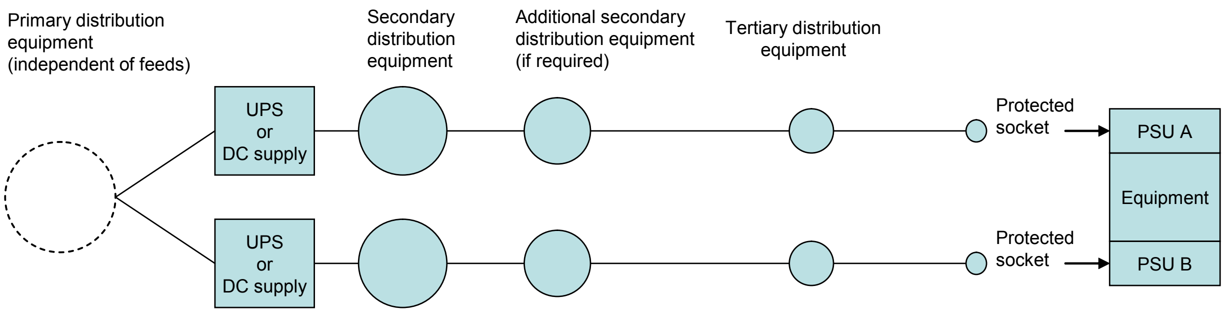

Figure 11 — Example of fault tolerant design solution for power distribution

The UPS or dc supply shall be designed and installed to provide power for a period following supply failure adequate to allow establishment of alternate supply.

6.4 Incorporation of LVDC distribution

The feasibility of LVDC distribution (in the range DC 380 V to DC 600 V) is under consideration by IEC/TC 64. This standard will reflect any developments in due course.

6.5 Additional considerations

6.5.1 Lightning and surge protection

The measures applied shall be in accordance with EN 62305 series applied with reference to EN 50310, EN 50174-2 and EN 50174-3.

The power distribution system and the connected equipment shall be protected by surge protective devices according to EN 62305-4.

6.5.2 Segregation of power distribution cabling and information technology cabling

The requirements and recommendations for the segregation of LV power distribution cabling and information technology cabling are provided in EN 50174-2 for the planner and installer of the information technology cabling.

6.6 Emergency Power Off

6.6.1 Requirements

Data centres, including those employing UPS systems, shall incorporate an emergency power off (EPO) switch if required by national or local regulations.

Where an EPO switch is required, it shall be protected to prevent unintentional operation and to discourage non-emergency use. The minimum protection shall be a cover that shall be lifted before the EPO switch can be operated.

6.6.2 Recommendations

The use of EPO switches should be avoided.

7 Physical security

7.1 General

The hierarchical nature of a power distribution system provides increasing security risks as one moves from the end-equipment via the power distribution area towards the primary (or additional) supplies.

Availability of the power distribution system is therefore dependent on the access controls and protection against internal environmental events applied to the functional elements and the interconnecting pathways (see EN 50600-2-5).

Protection against external events is addressed in EN 50600-2-1.

7.2 Access

7.2.1 Power supply

Access to the power supply systems shall be limited.

All equipment comprising the power supply system shall be in areas of Protection Class 3 or above as specified in EN 50600-2-5.

Where pathways within premises are routed in areas of a lower Protection Class they shall be monitored for unauthorised access.

7.2.2 Power distribution

Access to the power distribution systems shall be limited.

All equipment comprising the power distribution system shall be in areas of Protection Class 3 or above as specified in EN 50600-2-5.

Where pathways are routed in areas of a lower Protection Class they shall be monitored for unauthorised access.

7.2.3 Attachment of unauthorised end-equipment

The measurement of power supply characteristics at the locations described in Clause 8 and the associated monitoring of the values measured and their trends is also able to indicate conditions where availability of supply is under threat from unauthorised attachment of loads.

7.2.4 Cabling infrastructure to support access control

See EN 50600-2-4.

7.3 Internal environmental events

7.3.1 Power supply

Each transformer space shall be housed within a fire compartment.

7.3.2 Power distribution

7.3.2.1 Requirements

The functional elements of each path within the multipath implementations of 6.3.3.4 and 6.3.3.5 shall be separated both spatially and physically to minimise the risk of damage from one path to the other.

The electrical distribution and electrical spaces of each path within the multipath implementations of 6.3.3.4 and 6.3.3.5 shall be housed to minimise the risk of damage from one path to the other.

7.3.2.2 Recommendations

In addition to the requirements of 7.3.2.1, the electrical distribution and electrical spaces of each path within the multipath implementations of 6.3.3.4 and 6.3.3.5 should be housed within a fire compartment.

7.4 External environmental events

See EN 50600-2-1.

8 Energy efficiency enablement and power distribution

8.1 General

The hierarchical nature of a power supply and distribution systems provides a number of key locations indicated by the red arrows in Figure 12 at which to introduce instrumentation that is able to measure the power supply characteristics. The locations where measurement is relevant are defined by the Granularity Level adopted for the data centre to support the energy efficiency enablement objectives of EN 50600-1.

As indicated in Figure 12:

a) Granularity Level 1 provides measurement of power supply characteristics of the primary, secondary and additional supplies (as appropriate).

b) Granularity Level 2 provides measurement of power supply characteristics at appropriate intermediate points between the primary distribution equipment and the final secondary distribution equipment; measurements shall be made at the outputs of the secondary distribution equipment that are the most remote from the primary distribution equipment. Other outputs of the secondary distribution equipment as indicated in Figure 12 may be measured as required.

c) Granularity Level 3 provides measurement of power supply characteristics to the sockets.

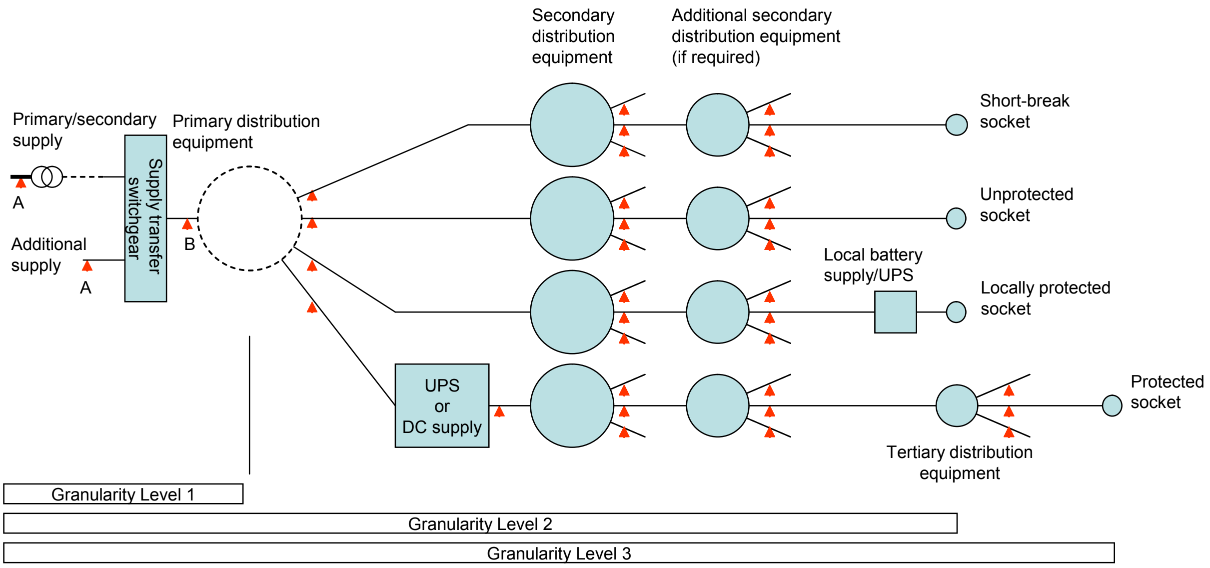

Figure 12 — Possible measurement points

Where a data centre is accommodated within a multi-purpose building, the tertiary distribution equipment should be fed from a dedicated feed from the primary distribution equipment. Where secondary and additional supplies are implemented then the supply transfer switchgear should also be dedicated to the data centre. This will enable segregated energy monitoring for the connected equipment.

8.2 Granularity Level 1

8.2.1 Requirements

The distribution equipment shall be selected to enable measurement of voltage, current, power factor and energy use on all phases present and also on the neutral conductor. The equipment used shall have the following accuracies for the parameters measured:

a) for billing purposes: Class 0,2 (±0,2 %) of EN 60044-1:1999;

b) for non-billing purposes: Class 1 (±1 %) of EN 60044-1:1999.

In addition kVA and kWh shall be monitored.

NOTE An allowance for other loads (non-protected) may have to be estimated.

8.2.2 Recommendations

Where possible, the measurements should be made at the input to the primary and/or secondary supply transformers and, where relevant, the output of the additional supply (indicated as point A in Figure 12). This will provide the optimum information in relation to energy efficiency objectives. Measurement at point B in Figure 12 represents a useful but non-ideal condition.

The added value delivered by measuring total harmonic current distortion (THCD) and total harmonic voltage distortion (THVD) should be considered.

8.3 Granularity Level 2

8.3.1 Requirements

The distribution equipment shall be selected to enable measurement of output voltage, current, power factor and energy use on all phases present and also on the neutral conductor. The equipment used shall have the following accuracies for the parameters measured:

a) for billing purposes: Class 0,2 (± 0,2 %) of EN 60044-1:1999;

b) for non-billing purposes: Class 1 (± 1 %) of EN 60044-1:1999.

In addition, kVA and kWh shall be monitored.

8.3.2 Recommendations

The added value delivered by measuring total harmonic current distortion (THCD) and total harmonic voltage distortion (THVD) should be considered.

8.4 Granularity Level 3

8.4.1 Requirements

Complexity Level 3 shall be applied where environmental control systems are integrated within cabinets containing protected sockets in order to separately measure the IT load.

The distribution equipment shall be selected to enable measurement of output voltage, current and power factor on all phases present and also on the neutral conductor. The equipment used shall have the following accuracies for the parameters measured:

a) for billing purposes: Class 0,2 (± 0,2 %) of EN 60044-1:1999;

b) for non-billing purposes: Class 1 (± 1 %) of EN 60044-1:1999.

In addition, kVA and kWh shall be monitored.

8.4.2 Recommendations

The added value delivered by measuring total harmonic current distortion (THCD) and total harmonic voltage distortion (THVD) should be considered.

8.5 Cabling infrastructure to support energy efficiency enablement

See EN 50600-2-4.

Annex A
(informative)

Example implementations of power distribution

A.1 Symbology

Under consideration.

A.2 Example implementations

A.2.1 Class 1 power distribution

See Figure A.1.

A.2.2 Class 2 power distribution

As Figure A.1 with redundant components or systems present in the power distribution path.

A.2.3 Class 3 power distribution

See Figure A.2

A.2.4 Class 4 power distribution

As Figure A.2 with redundant components or systems present in the each power distribution path.

Redundant (multi-path) power systems shall be constructed independently, physically and in terms of fire protection. Multiple feeds within a redundant power path shall be constructed in accordance with HD 60364-4-444.

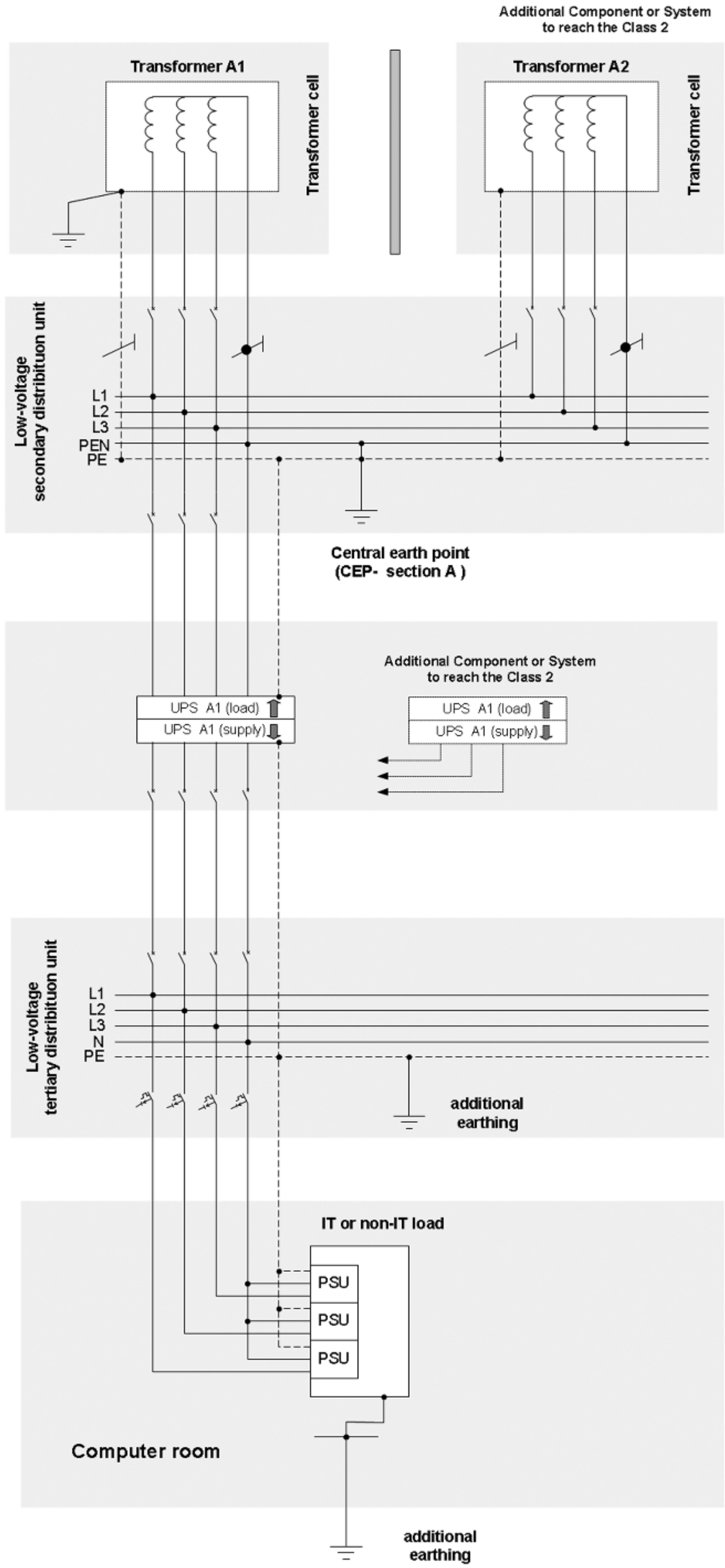

Figure A.1 — Example for a Class 1/Class 2 power distribution

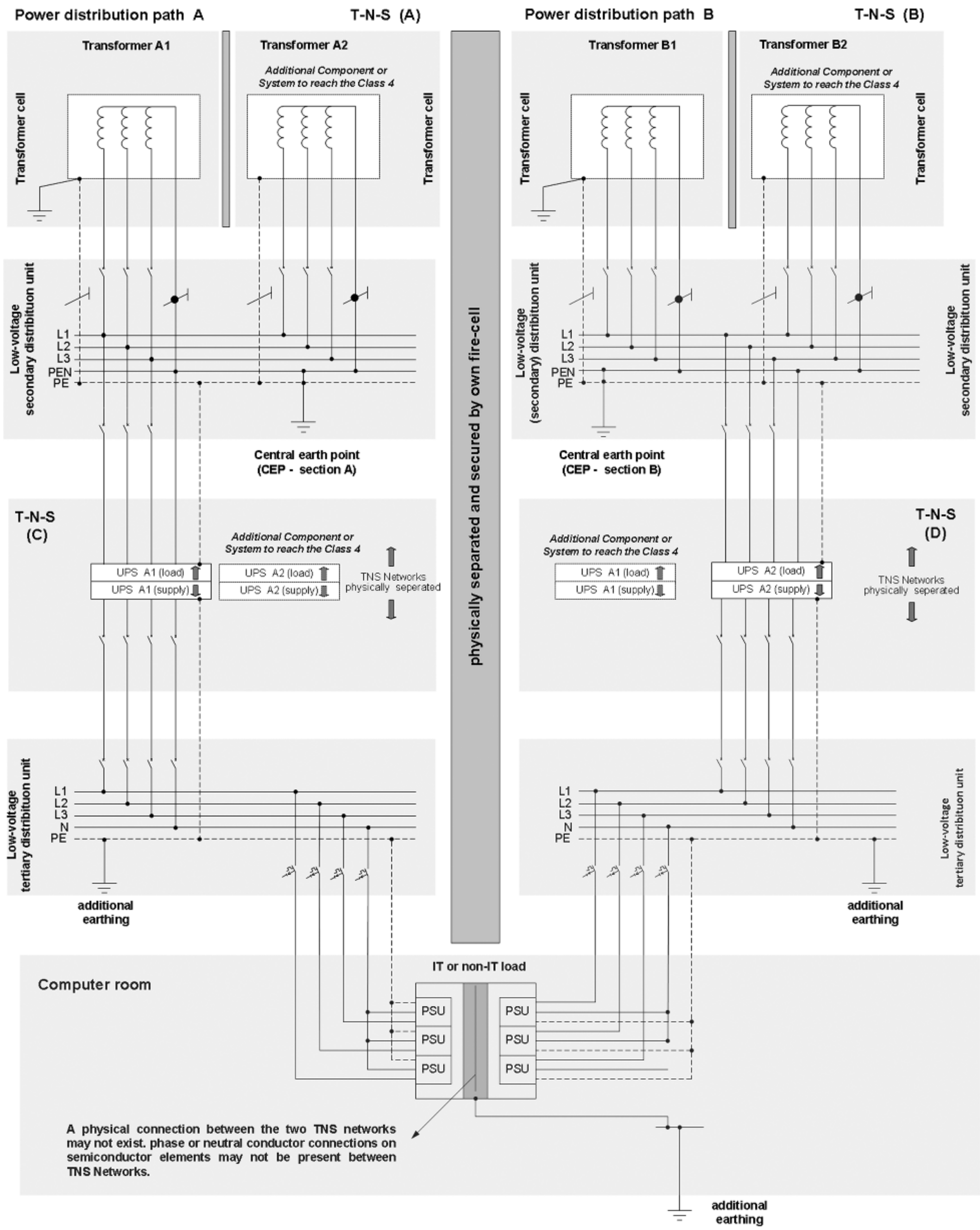

Figure A.2 — Example for a Class 3/Class 4 power distribution

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[4] Draft for CENELEC enquiry in preparation.

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