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Information technology — Data centre facilities and infrastructures —

Part 3:
Power distribution

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

Partie 3: Distribution de puissance

Reference number
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Contents

Page

Foreword

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

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

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

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

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

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

This first edition cancels and replaces the first edition (ISO/IEC TS 22237-3:2018), which has been technically revised.

The main changes are as follows:

— availability requirements have been aligned with ISO/IEC 22237-1 and ISO/IEC 22237-4;

— figures have been updated.

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

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

Introduction

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

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

The implementation of data centres varies in terms of:

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

b) security level;

c) physical size; and

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

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

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

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

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

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

3) suppliers of equipment; and

4) installers, maintainers.

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

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

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

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

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

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

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

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

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

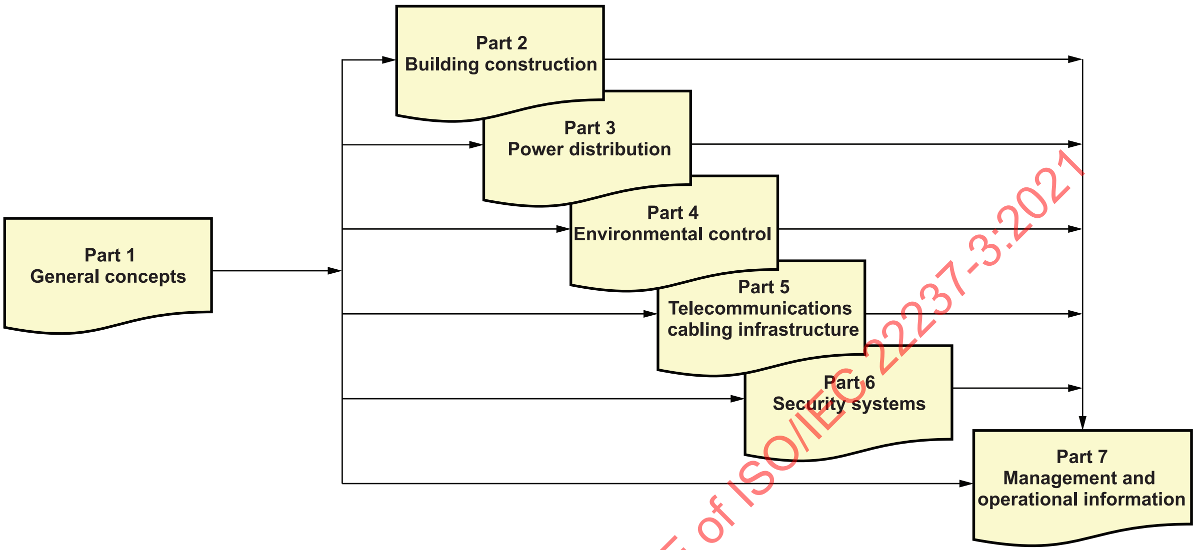


Figure 1 — Schematic relationship between the ISO/IEC 22237 series of documents

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

This document, ISO/IEC 22237-3, 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 ISO/IEC TS 22237-7 (in accordance with the requirements of ISO/IEC 22237-1). 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.

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

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

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

Information technology — Data centre facilities and infrastructures —

Part 3: Power distribution

1 Scope

This document 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 ISO/IEC 22237-1.

This document specifies requirements and recommendations for the following:

a) power supplies to data centres;

b) power distribution systems to all equipment within data centres;

c) telecommunications infrastructure bonding;

d) lightning protection;

e) devices for the measurement of the power consumption and power quality 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 document and are covered by other standards and regulations. However, information given in this document can be of assistance in meeting these standards and regulations.

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

The use of the data centre stored energy or alternate sources to be used by the grid is not in the scope of this document and is for consideration in future specifications.

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 13160 (all parts), *Leak detection systems*

IEC 60076-11, *Power transformers — Part 11: Dry-type transformers*

IEC 60364 (all parts), *Low-voltage electrical installations*

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

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

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

IEC 61557-12, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. — Equipment for testing, measuring or monitoring of protective measures — Part 12: Performance measuring and monitoring devices (PMD)*

IEC 61869-2:2012, *Instrument transformers — Part 2: Additional requirements for current transformers*

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

IEC 62053-21, *Electricity metering equipment (a.c.) — Particular requirements — Part 21: Static meters for active energy (classes 1 and 2)*

IEC 62053-22, *Electricity metering equipment (a.c.) — Particular requirements — Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)*

IEC 62271-200, *High-voltage switchgear and controlgear — Part 200. AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

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

IEC 62586-1, *Power quality measurement in power supply systems — Part 1: Power quality instruments (PQI)*

IEC 62586-2, *Power quality measurement in power supply systems — Part 2: Functional tests and uncertainty requirements*

IEC 62974-1, *Monitoring and measuring systems used for data collection, gathering and analysis — Part 1: Device requirements*

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

IEC/TS 62749, *Assessment of power quality — Characteristics of electricity supplied by public networks*

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

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

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

ISO/IEC 30129, *Information technology — Telecommunications bonding networks for buildings and other structures*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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

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

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

3.1.1
active power
P
under periodic conditions, mean value, taken over one period, *T*, of the instantaneous power, *p*:

$$P = \frac{1}{T}\int_0^T p\mathrm{d}t$$

Note 1 to entry: Under sinusoidal conditions, the active power is the real part of the complex power *S*, thus *P* = Re *S*.

Note 2 to entry: The coherent SI unit for active power is watt, W.

[SOURCE: IEC 60050-131:2002, 131-11-42]

3.1.2
additional supply
power supply that provides power in the event of failure of *primary* (3.1.22) and/or *secondary supply* (3.1.24)

3.1.3
apparent power
product of the r.m.s. voltage *U* between the terminals of a two-terminal element or two-terminal circuit and the r.m.s. electric current *I* in the element or circuit *S* = *UI*

Note 1 to entry: Under sinusoidal conditions, the apparent power is the modulus of the complex power $\underline{S}$, thus $S = |\underline{S}|$.

Note 2 to entry: The coherent SI unit for apparent power is voltampere, VA.

[SOURCE: IEC 60050-131:2002, 131-11-41]

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

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

3.1.7
dual-corded equipment
equipment served by multiple power supply input interfaces

3.1.8
emergency power off
EPO
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 can be subject to national or local regulations.

3.1.9
fire compartment
discrete zone designed to contain a fire within that zone

3.1.10
high voltage
HV
voltage whose nominal r.m.s. value is 35 kV < U_N ≤ 230 kV

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

3.1.11
inductive load
load that is inductive, so that the alternating current is out of phase with and lags behind the voltage

3.1.12
IT load
electrical consumption of all the information technology equipment, providing data storage, processing and transport services, measured at its input terminals including all on-board integrated power supplies and cooling fans

3.1.13
load factor
ratio, expressed as a numerical value or as a percentage, of the consumption within a specified period (year, month, day, etc.), to the consumption that would result from continuous use of the maximum or other specified demand occurring within the same period

Note 1 to entry: This term should not be used without specifying the demand and the period to which it relates.

Note 2 to entry: The load factor for a given demand is also equal to the ratio of the utilization time to the time in hours within the same period.

[SOURCE: IEC 60050-691:1973, 691-10-02]

3.1.14
locally protected socket
sockets (3.1.26) 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
LV
voltage whose nominal r.m.s. value is U_N ≤ 1 kV

3.1.16
Main-Tie-Tie-Main
electrical connection between two power supply or power distribution circuits which allows current to flow in either direction and containing two circuit breakers enabling maintenance while one of the circuits is active

3.1.17
medium voltage
MV
voltage whose nominal r.m.s. value is 1 kV < U_N ≤ 35 kV

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

3.1.18
pathway
<cable route, cable way> defined route for cables between termination points

[SOURCE: ISO/IEC 14763-2:2019, 3.1.34]

3.1.19
power factor
λ
under periodic conditions, ratio of the absolute value of the *active power* (3.1.1), *P*, to the *apparent power* (3.1.3), *S*: $\lambda = |P|/S$

Note 1 to entry: This is 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 — new Note 1 to entry added.]

3.1.20
protected socket
socket (3.1.26) which continues 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)* (3.1.22, 3.1.24, 3.1.2) in a form suitable for distribution by *secondary distribution equipment* (3.1.23)

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

3.1.23
secondary distribution equipment
equipment which is required to manage, control and distribute the power provided by the *primary distribution equipment* (3.1.21) to the *short-break*, *protected* and *unprotected sockets* (3.1.25, 3.1.20, 3.1.30) within the data centre and to the *tertiary distribution equipment* (3.1.27)

Note 1 to entry: The power supply can 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.

3.1.24
secondary supply
power supply independent from, and that is continuously available to be used to provide power to the data centre following the disruption of, the primary power supply

Note 1 to entry: A second feed to a separate transformer from the same grid is not a secondary supply.

3.1.25
short-break socket
sockets (3.1.26) which, upon failure of power supply and distribution equipment, will be provided with power from an *additional supply* (3.1.2) after a defined period

3.1.26
socket
connection enabling the supply of power to attached equipment

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

3.1.27
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* (3.1.20) therein

3.1.28
total harmonic distortion of current
THD_i
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

3.1.29
total harmonic distortion of voltage
THD_u
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

3.1.30
unprotected socket
sockets (3.1.26) which fail to deliver power to connected equipment following failure in power supply or distribution equipment

3.2 Abbreviated terms

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

AC	alternating current
DC	direct current
EPO	emergency power off
HV	high voltage
KPI	key performance indicator
LV	low voltage
MV	medium voltage
PMD	power metering and monitoring device
PSU	power supply unit
r.m.s.	root mean square
SPD	surge protective device
THD_i	total harmonic distortion of current
THD_u	total harmonic distortion of voltage

3.3 Symbols

λ	power factor
P	real or active power
$\underline{S}$	complex power
S	apparent power, the magnitude, or modulus, of complex power
T	one time period

U root mean square (r.m.s.) voltage

I root mean square (r.m.s.) current

4 Conformance

For a data centre to conform to this document:

a) it shall feature a power supply and distribution design solution that meets both the general requirements and the required Availability Class of Clause 6;

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 ISO/IEC 22237-4;

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 telecommunications bonding system within the computer room and telecommunications spaces of the data centre shall be in accordance with the local mesh bonding requirements of ISO/IEC 30129;

f) where lightning protection is required, it shall be in accordance with the IEC 62305 series applied with reference to ISO/IEC 30129;

g) the design of low voltage (LV) power supply and distribution installations shall be in accordance with the IEC 60364 series;

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

The Availability Class of the power distribution infrastructure is based on the required Availability Class of the data centre. The power supply infrastructure shall be of the same or higher Availability Class.

5 Power supply and distribution within data centres

5.1 Functional elements

5.1.1 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 and distribution to the data centre are described as:

— sources: e.g. primary, secondary or additional supplies;

— devices: e.g. supply transfer switchgear;

— paths: pathways, spaces and cabling.

Typical sources and devices 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.

Implementations need not include all of the elements listed in Table 1. Also, the types of equipment comprising certain functional elements can exist in both the area of supply and distribution.

Table 1 — Typical functional elements of power supply and distribution

Area	Functional element	Typical accommodation (using spaces defined in ISO/IEC 22237-1)
Supply	Primary supply Secondary supply	Transformer space
	Supply transfer equipment (where multiple supplies exists)	Electrical space
	Additional supply (e.g. generator, uninterruptible power system [UPS])	Generator space or electrical space
Distribution	Primary distribution equipment	Electrical distribution space Transformer space (if required)
	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

5.1.2 Power supply to the data centre

The power supply schematic of Figure 2 indicates two implementations. The upper diagram shows the minimum implementation comprising a single source (primary power supply) only. The lower diagram shows multiple sources and includes a secondary supply as well as an additional supply that provides power to relevant equipment in the data centre.

The primary and secondary supplies are typically provided from transformers which can be within the premises containing the data centre (and can be owned by either the utility or the data centre premises owner) or external and owned by the utility (and not considered to be a functional element of the data centre).

An additional supply is one of the possible functional elements for supplying the data centre with power. The additional supply will provide energy in case the primary and secondary supplies are not available. Therefore, parameters such as the sizing, the basic design as well as the availability of the overall power supply concept have to be precisely planned.

While the additional supply is typically a locally managed supply, it can be provided by a separate utility supply provided that it is protected from failures in the primary or secondary supplies. In such cases, the concept of short-break (see 5.1.3) is not relevant. If the additional supply is a locally managed supply, with no connection to the utility, it shall be designed to be able to replace the power supply(ies) in case of their failure.

The primary distribution equipment can also contain transformers.

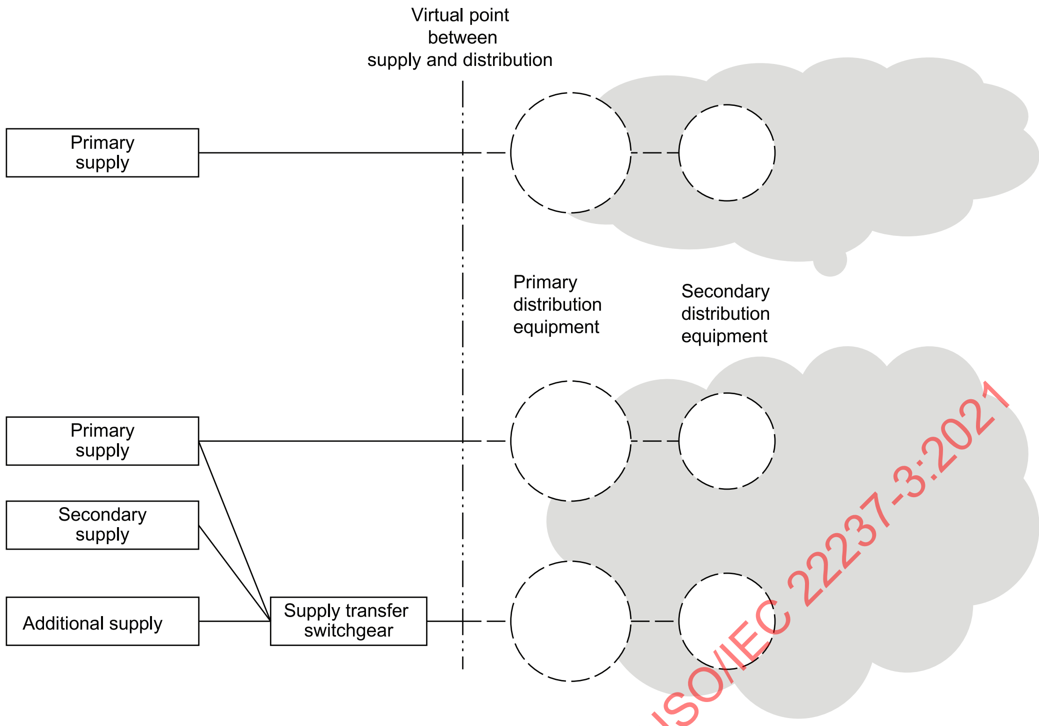


Figure 2 — Power supply functional elements

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

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

The output from the primary distribution equipment can 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.

5.1.3 Power distribution within the data centre

The functional elements of the power distribution within the data centre are described as:

— devices: e.g. primary, secondary and tertiary distribution equipment, UPS;

— paths: pathways, spaces and cabling that connects the devices.

The distribution system 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.

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

Equipment within the power distribution system may also contain transformers.

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

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

2) protected sockets: intended for equipment that is critical to the function of the data centre (e.g. information technology and network telecommunications equipment, certain elements of the environmental control and security systems) and which cannot tolerate failure of supply, served by solutions including UPS installed as part of the distribution system;

3) locally protected sockets: intended for equipment (e.g. emergency lighting) served by solutions including 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 and certain lighting systems) that is critical to the function of the data centre but which can tolerate a failure of supply for a defined period before the additional supply (e.g. generator) is brought into service.

The output from the secondary distribution equipment is typically LV. Additional secondary distribution equipment is typically installed where there is a need to change the current capacity of the power supply cabling.

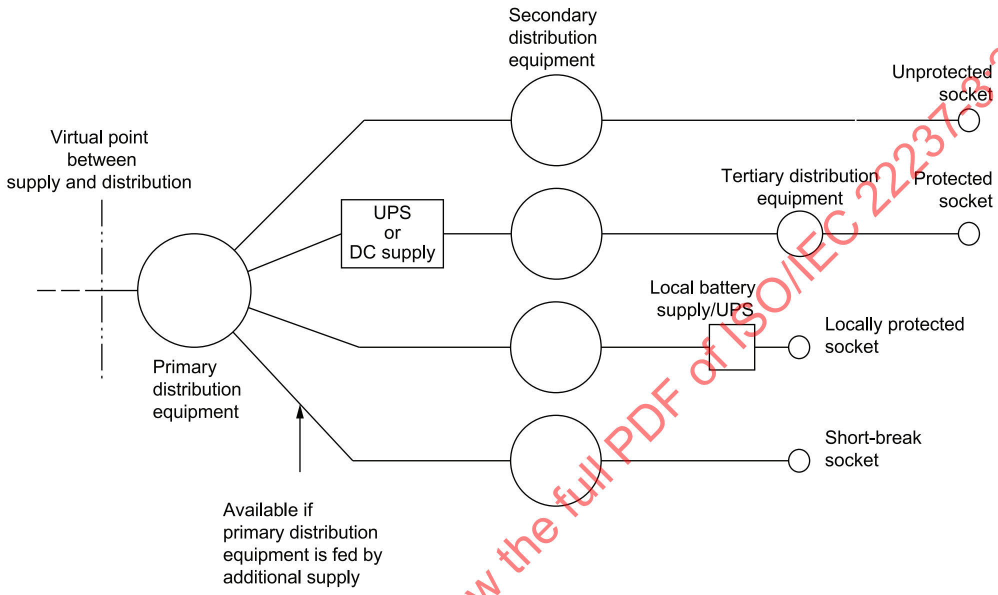


Figure 3 — Types of sockets served by the power distribution system

5.2 Dimensioning of power distribution systems

In small data centres, the data centre might 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 can be dedicated to the demands of the data centre itself.

The smallest data centres can 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 is provided by the in-cabinet distribution equipment. It is not necessary to provide any unprotected or short-break sockets within the cabinet.

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

As shown in Figure 2, a generator is included as an additional power supply. This is intended to deliver short-break power supply and protected supply for an extended period in case of failures of the primary and secondary power supply of the data centre.

The use of secondary power supplies and additional 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 functional elements in a hierarchical structure. A series of serial and parallel systems convert the power from the primary, secondary or additional supplies and, maintaining and/or improving its quality and availability, deliver that power to a mix of end-equipment within the data centre.

The measurement of power supply parameters at the locations described in Clause 8 and the associated monitoring of those parameters and their trends also enable the indication of conditions where demand is 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 ISO/IEC 22237-1.

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 (typically, but not necessarily, based upon the published ‘start up’ power requirements supplied by the equipment manufacturers) taking into account allowance for future growth and technology developments (including increased power density of the IT equipment);

b) the maximum load associated with the environmental control systems serving the data centre spaces taking into account:

   1) the predicted external ambient temperature and humidity conditions,

   2) the Availability Class of the environmental control systems;

c) additional loads including, but not restricted to, security, lighting and building/energy controls, standby consumption for generators and rotary UPS and also battery recharging following a battery discharge;

d) losses in the power distribution system.

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

1) during construction: temporary/construction power requirements;

2) during operation:
   i) initial load (“day one“ of operation),
   ii) growth of active power load over time,
   iii) predicted variations and periodicity of active power load and power factor,
   iv) predicted variations and periodicity of load factor;
3) during inspection (e.g. performance verification, load bank testing etc.) and maintenance of components of the power supply system that are under control of the premises owner;
4) exceptional conditions (i.e. special and/or unusual loads):
   i) nature of load,
   ii) occurrence (i.e. continuous, intermittent, cyclical).

The selection of the functional elements of the power supply system shall provide a solution which takes into account the variability between ‘normal’ demand and the ‘maximum’ demand.

The additional supply shall be dimensioned in such a way that it operates reliably under the anticipated load, taking into account the anticipated power factors of the load. It is therefore necessary to check whether the power load of the data centre is in the capacitive or inductive range. Other possible operating conditions also have to be taken into consideration.

The capacity of any additional supply system shall at least match the capacity planning for the short-break, protected and locally protected sockets as shown in Figure 3.

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. Performance of partially loaded additional supplies (e.g. generators) shall be considered when making such a choice.

Most IT loads are dual-corded.

6.2.1.1.2 Recommendations

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

Static transfer switches should only be considered following an extensive design review. 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 the functional elements of the power distribution system shall:

a) provide a 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 installation of additional capacity.

6.2.1.2.2 Recommendations

Modularity and scalability should be balanced by the number of devices necessary to fulfil availability objectives.

6.2.1.3 Diversity

6.2.1.3.1 Requirements

Availability Classes 3 and 4 state requirements and recommendations concerning the duplication and diverse routeing of the incoming power supplies.

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.

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 can be at risk of accidental excavation.

Underground pathways should be used where possible unless the risk of accidental excavation is considered unacceptable.

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) provided with a barrier to prevent ingress of rodents and other animals that can damage the power supply cabling within the building,

c) sufficiently contained to survive an explosion in one transformer housing.

6.2.2 Availability of the utility supply

6.2.2.1 Requirements

The primary and secondary (where provided by a utility) power supply shall be in accordance with IEC/TS 62749.

The reliability (i.e. continuity of supply) 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, 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 can be desirable to reverse the roles of primary and additional supplies i.e. where a generator provides the primary supply backed up by the utility power supply.

The design of additional supplies shall be matched to the power distribution system. The support infrastructure for the additional supplies (including capacity of fuel storage capacities) shall be appropriate to the planned service level agreement for replenishment, maintenance and repair of those support infrastructures.

The control systems for additional supplies shall remain functional following failure of primary or secondary power supplies.

6.2.2.2 Recommendations

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

a) the availability of the grid connection is considered inadequate; and/or

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. Secondary and additional supplies should be continuously rated for long term full-load operation.

6.2.3 Power quality

6.2.3.1 Requirements

The power quality of primary and secondary supplies shall be in accordance with IEC/TS 62749.

The power quality of the additional, non-utility supplies shall be in accordance with IEC 61000-2-4, Class 2.

Where monitoring is required, instruments shall be in accordance with one of the following:

a) Class S of IEC 62586-1 and IEC 62586-2; or

b) power metering and monitoring devices (PMD) of Type III of IEC 61557-12 (Class 0,2 or 0,5) and current transformers of the same class in accordance with IEC 61869-2.

NOTE 1 Type III PMDs allow advanced power monitoring/network performance.

NOTE 2 Type III PMDs in accordance with IEC 61557-12 can also be used in power stations or substations if they are designed for EMC environments G or EMC environments H according to IEC 62586-1, respectively.

Where power quality is to be monitored, logged and analysed (including warnings of events), products used for data collection, gathering and analysis shall be in accordance with IEC 62974-1.

6.2.3.2 Recommendations

LV power supplies are typically shared by several consumers who act in combination to define, and typically reduce, the power quality. Where concerns exist, an analysis of availability and power quality should be obtained and consideration should be given to the monitoring of power quality parameters.

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

a) be connected to the utility supply at the highest possible voltage level,

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

c) not be located near to large consumers of electrical power, such as metals manufacturing and processing facilities, 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,

      NOTE 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 another 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 without any de-rating for harmonic load currents from UPS (including when under maintenance) or variable speed drives within the facility; and

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

The design of transformers and their housings shall take into account the risk and impact of fire.

The design of transformer housing shall prevent ingress of rodents and other animals that can damage the transformer.

Dry-type transformers shall conform to IEC 60076-11.

Where under control of the data centre premises owner, each transformer space shall be housed within a fire compartment.

6.2.5.1.2 Recommendations

Oil-cooled transformers should only be used where appropriate mitigation of fire risk is employed (e.g. by the use of incombustible oil).

Dry type transformers should conform to IEC/TS 60076-20:2017, Table 10, Level 2.

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

LV switchgear and control gear shall be in accordance with the IEC 60947 series.

LV switchgear and control gear assemblies shall be in accordance with the IEC 61439 series.

HV and MV supply transfer switchgear and control gear shall be in accordance with IEC 62271-200.

If no supply synchronization is present (see 6.2.5.3.1), transitions shall be open 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

HV and MV supply transfer switchgear should be in accordance with Category LSC2 of EN 62271-200.

A maintenance-free design should be employed to prevent a shut-down for maintenance on the switchgear.

6.2.5.3 Additional supplies

6.2.5.3.1 Requirements

The selection of continuous rating specification shall be based on an analysis of reliability of the primary/secondary supplies.

Where the additional supply comprises generators powered by diesel fuels, the following shall be provided:

a) locally protected sockets for the system controller(s);

b) the provision of facilities to allow a load test (e.g. operation parallel to the utility or a load bank).

Where the additional supply comprises generators powered by diesel fuels, the following shall be considered in the design of the system to meet the required availability requirements:

1) continuous pre-heating of the diesel engines;

2) monitoring of leakage from fuel storage systems in accordance with the EN 13160 series;

3) redundant starter systems, each consisting of a starter motor and a second independent starting medium;

4) redundant system controllers;

5) monitoring system for the lubricating oil level and a device for refilling the lubricating oil (including during operation);

6) the provision of facilities to allow a load test (e.g. operation parallel to the utility or a load bank);

7) the need for synchronization between the additional, primary and secondary supplies.

6.2.5.3.2 Recommendations

None.

6.2.5.4 Uninterruptible power systems (UPS)

6.2.5.4.1 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 the IEC 62040 series. The power quality supplied by dynamic UPS equipment shall be in accordance with the appropriate Class of IEC 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 IEC 61000-2-4, Class 1.

Where power quality is to be monitored, logged and analysed (including warnings of events), products used for data collection, gathering and analysis shall be in accordance with IEC 62974-1.

6.2.5.4.2 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 SPDs.

UPS battery strings are not recommended to be located within the computer room. However, if the battery strings are located in the computer room they shall be installed in a manufacturer's approved cabinet. Batteries should be located in a separate fire compartment which is large enough to accommodate the predicted quantity of batteries.

6.2.6 Availability Class design options

6.2.6.1 General

Four design options of increasing Availability Class are specified for the power supply infrastructures.

a) Class 1: Single path to primary distribution equipment and with a single source (see 6.2.6.2).

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

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

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

   In the event of failure of the single source or path, unprotected and short break sockets (see Figure 3) have no supply.

b) Class 2: Single path to primary distribution equipment and with a redundant source (see 6.2.6.3).

   A Class 2 solution is appropriate where the outcome of the risk assessment deems it necessary that:

   — a single fault in a source shall not result in loss of functional capability of the path,

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

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

Where the second source is in the form of an additional supply under local control, the correct capacity specification is critical for the services to be maintained.

However, the single path between the supply transfer switchgear and the primary distribution equipment represents a single point of failure. In the event of failure of that path, unprotected and short break sockets have no supply.

c) Class 3: Multiple paths to primary distribution equipment and with redundant sources (see 6.2.6.4).

A Class 3 solution is appropriate where the outcome of the risk assessment deems it necessary that:

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

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

The provision of an additional path between the supply transfer switchgear and the primary distribution equipment addresses the risk of path failure of Class 2.

However, the failure of a source or path while the other source or path is under maintenance represents a risk. Under such circumstances, unprotected and short break sockets have no supply.

d) Class 4: Multiple paths to primary distribution equipment and with multiple sources (see 6.2.6.5).

A Class 4 solution is appropriate where the outcome of the risk assessment deems it necessary that:

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

— any single event impacting a functional element shall not result in load shut-down,

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

Supply is maintained in the event of any single failure of source or path while another source or path is under maintenance.

For all Classes, the reliability (i.e. continuity of supply) of all supply solutions can be improved by the use of ring loop connection to any primary or secondary supply.

The correct capacity specification of equipment within the power distribution infrastructure (see 6.3.4) is critical for the required level of service for protected and locally protected sockets.

The application of a power supply solution of a given Class does not place requirements on the Class of the power distribution solution.

6.2.6.2 Class 1: Single source solution

6.2.6.2.1 General

Figure 4 shows a generic implementation of Class 1 supply solution.

An example of a basic single source design solution is a single radial provided from a MV/LV transformer (e.g. 400 V AC).

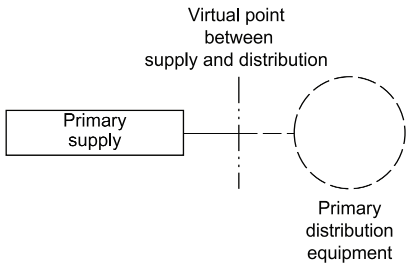


Figure 4 — Example of single path to primary distribution equipment with a single source (Class 1)

Transformers can be:

a) external to the premises containing the data centre and owned by the utility;

b) within the premises, i.e. a functional element of the power supply system of the data centre, owned by either the utility, the premises owner or a third party.

6.2.6.2.2 Requirements

None.

6.2.6.2.3 Recommendations

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: Redundant source (single path to primary distribution equipment) solutions

6.2.6.3.1 General

Figure 5 shows the implementation of Figure 4 (see 6.2.6.2) augmented by a second source. This source is an additional supply, dedicated to the needs of the data centre.

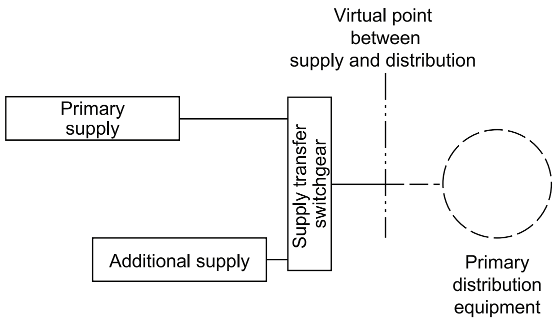


Figure 5 — Example of single path to primary distribution equipment with a redundant source (Class 2)

Transformers can be:

a) external to the premises containing the data centre and owned by the utility;

b) within the premises, i.e. a functional element of the power supply system of the data centre, owned by either the utility, the premises owner or a third party.

6.2.6.3.2 Requirements

Where under control of the premises owner, the location of the pathways and the protection applied to them shall minimize the risk of concurrent physical damage.

6.2.6.3.3 Recommendations

Where under control of the premises owner, the pathways within the premises carrying the source 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 or structures containing the primary distribution equipment, by at least 20 m to ensure that a single incident will not cause damage to both paths and entrance facilities;

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

A feed should be installed to enable a temporary, redundant, additional supply to be employed during periods when the other is under planned maintenance.

6.2.6.4 Class 3: Redundant source (multiple paths to primary distribution equipment) solutions

6.2.6.4.1 General

Figure 6 shows the implementation of Figure 5 (see 6.2.6.3) augmented by a second path to the primary distribution equipment.

If the supply transfer switchgears are interconnected, then a Main-Tie-Tie-Main configuration shall be employed and:

a) both breakers shall be normally open;

b) for manual operation, the breakers shall be lockable to prevent accidental operation;

c) no automatic procedure shall be applied unless appropriate mitigation of risk is employed;

d) detailed operating instructions shall be provided.

Transformers can be:

1) external to the premises containing the data centre and owned by the utility;

2) within the premises, i.e. a functional element of the power supply system of the data centre, owned by either the utility, the premises owner or a third party.

6.2.6.4.2 Requirements

Each path shall feed a separate switchgear within the primary distribution equipment.

In such a configuration, the primary and secondary supplies shall:

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

2) be live.

If two primary supplies are used as indicated in Figure 6 a), a second additional supply shall be installed. Failure to do so renders the additional supply a single point of failure in the event of disruption of the primary supply.

Where under control of the premises owner, the location of the pathways and the protection applied to them shall minimize the risk of concurrent physical damage.

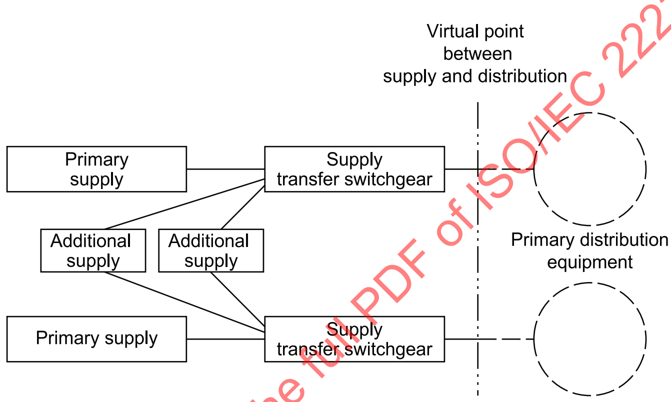
6.2.6.4.3 Recommendations

Where under control of the premises owner, the pathways within the premises carrying the source should be:

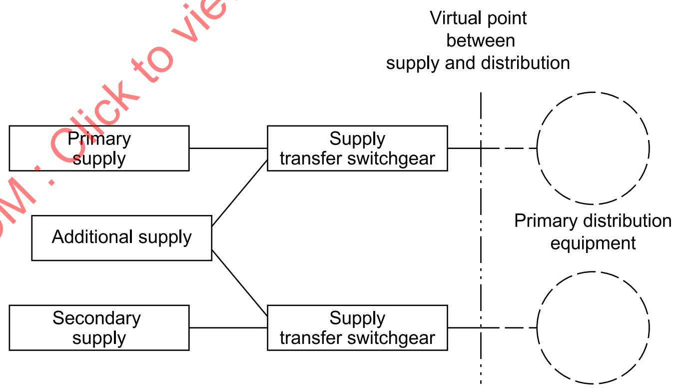
a) located underground, unless the risk from accidental excavation is considered higher than the threat from atmospheric disturbance or deliberate or accidental physical damage;

b) physically separated, between the boundary of the premises and the point of entry into buildings or structures containing the primary distribution equipment, by at least 20 m to ensure that a single incident will not cause damage to both paths and entrance facilities;

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



a) Power supply implemented with two primary supplies



b) Power supply implemented with a primary and secondary supply

Figure 6 — Example of multiple path to primary distribution equipment with a redundant source (Class 3)

6.2.6.5 Class 4: Multiple source (multiple path to primary distribution equipment) solutions

6.2.6.5.1 General

Figure 7 shows an example of a multiple source, redundant path solution which is fault tolerant and in which two separate sources (primary and/or secondary supplies) are each supported by an additional supply.

If the supply transfer switchgears are interconnected, then a Main-Tie-Tie-Main configuration shall be employed and:

a) both breakers shall be normally open;

b) for manual operation, the breakers shall be lockable to prevent accidental operation;

c) no automatic procedure shall be applied unless appropriate mitigation of risk is employed;

d) detailed operating instructions shall be provided.

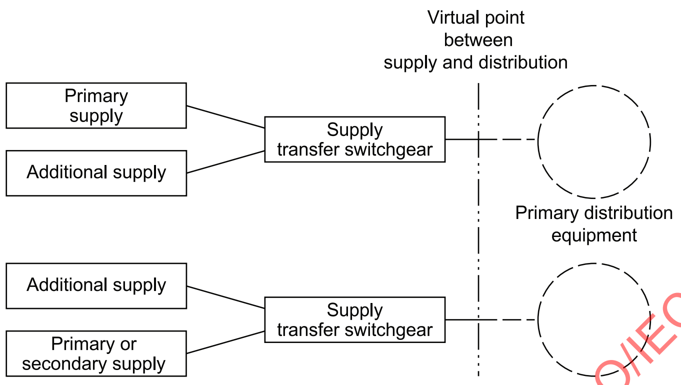


Figure 7 — Example of a multiple path to primary distribution equipment with multiple sources (Class 4)

Transformers can be:

a) external to the premises containing the data centre and owned by the utility;

b) within the premises, i.e. a functional element of the power supply system of the data centre, owned by either the utility, the premises owner or a third party.

6.2.6.5.2 Requirements

Each path shall feed a separate switchgear within the primary distribution equipment.

In such a configuration, the primary, or the primary and secondary, supplies shall:

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

b) be live.

Where under control of the premises owner, the pathways within the premises carrying the primary, secondary and additional supplies shall be:

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

2) physically separated, between the boundary of the premises and the point of entry into buildings or structures containing the primary distribution equipment to ensure that a single incident will not cause damage to both paths and entrance facilities;

3) accommodated within separate fire compartments within any buildings or structures containing the spaces served.

6.2.6.5.3 Recommendations

Where under control of the premises owner, the pathways within the premises carrying the primary, secondary and additional supplies should be physically separated, between the boundary of the premises and the point of entry into buildings or structures containing the primary distribution equipment, by at least 20 m.

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 (typically, but not necessarily, based upon the published 'start-up' power requirements supplied by the equipment manufacturers) taking into account allowance for future growth and technology developments (including increased power density of the IT equipment);

   NOTE Technology developments include technology refresh requirements.

b) the maximum load associated with the environmental control systems serving the data centre spaces taking into account:

   1) the predicted external ambient temperature and humidity conditions,

   2) the Availability Class of the environmental control systems;

c) additional loads including, but not restricted to, security, lighting and building/energy controls and also UPS battery recharging following a battery discharge;

d) losses in the power distribution system.

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

1) during construction: temporary/construction power requirements;

2) during operation:

   i) initial load ("day one" of operation),

   ii) growth of active power load over time,

   iii) temporary additional loads (taking in account both the load and duration) occurring during technology refresh phases,

   iv) predicted variations and periodicity of load factor;

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

   i) nature of load,

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

The selection of the functional elements of the power distribution system shall provide a solution which takes into account the variability between "normal" demand and the "maximum" demand.

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

6.3.1.1.2 Recommendations

None.

6.3.1.2 Expansion

6.3.1.2.1 Requirements

The selection of the functional elements on the premises accommodating the data centre shall:

a) provide a solution which takes into account the initial IT load and the maximum planned load and maintains optimized efficiency;

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

6.3.1.2.2 Recommendations

According to the source paths (single or multiple) UPS systems should be selected and installed to allow their operation at optimum efficiency in accordance with manufacturer's instructions. Modularity and scalability should be balanced by the number of devices necessary to fulfil availability objectives.

It should be possible to implement the desired stages of expansion without shutting down the critical load 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 functional elements shall take into account the anticipated 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 6.2.5.4. In the absence of alternative requirements being specified by the suppliers of equipment to be connected, the power quality shall be in accordance with IEC 61000-2-4, Class 1.

The functional elements of the power distribution system shall be selected to meet the demands for selectivity and short-circuit performance in all relevant operational modes and during all phases of scalable deployment.

6.3.2.2 Recommendations

None.

6.3.3 Equipment

6.3.3.1 UPS

6.3.3.1.1 Requirements

See 6.2.5.4.1.

6.3.3.1.2 Recommendations

See 6.2.5.4.2.

6.3.3.2 Switchgear

6.3.3.2.1 Requirements

LV switchgear and control gear shall be in accordance with the IEC 60947 series

LV switchgear and control gear assemblies shall be in accordance with the IEC 61439 series.

HV and MV switchgear shall be in accordance with IEC 62271-200.

6.3.3.2.2 Recommendations

HV and MV switchgear should be in accordance with Category LSC2 of IEC 62271-200.

A maintenance-free design should be employed to prevent a shut-down for maintenance on the switchgear.

6.3.4 Availability Class design options

6.3.4.1 General

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

The choice of devices and 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 functional elements in one path shall not negatively affect the provision of power in any other path.

Four design options of increasing Availability Class are specified for the power distribution infrastructures:

a) Class 1: Single path solution (see 6.3.4.2).

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

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

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

   Protected sockets are fed via a single path. An individual locally-protected socket reduces the risks associated with path failure, however with the increase in the number of elements with a local battery supply/UPS the overall number of failures within the data centre can increase.

Class 1 infrastructures are only appropriate for data centres which do not rely on unprotected or short-break sockets.

b) Class 2: Single path solution with redundancy (see 6.3.4.3).

A Class 2 solution is appropriate where the outcome of the risk assessment deems it necessary that:

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

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

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

A failure of the path will result in the failure of supply. An individual locally-protected socket reduces the risks associated with path failure. However, with the increase in the quantity of elements with a local battery supply/UPS the overall number of failures within the data centre can increase.

c) Class 3: Multiple paths providing a concurrent repair/operate solution (see 6.3.4.4).

A Class 3 solution is appropriate where the outcome of the risk assessment deems it necessary that:

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

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

All paths shall be designed to sustain the maximum load.

For dual-corded equipment, only one path provides a protected socket and the other path provides a short-break socket. Supply is not maintained in the event of failure of a device or path while another path is under maintenance.

It is not uncommon for Class 3 data centres to be designed with a Class 4 power distribution topology with respect to UPS configuration, resulting in both power distribution paths containing a UPS and both sockets being protected sockets. However, the overall classification of a data centre with such a configuration is still Class 3.

d) Class 4: Multiple paths providing a fault tolerant solution except during maintenance (see 6.3.4.5).

A Class 4 solution is appropriate where the outcome of the risk assessment deems it necessary that:

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

— any single event impacting a functional element shall not result in load shut-down;

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

All paths shall be designed to sustain the maximum load.

For dual-corded equipment, protected sockets are provided with two separate paths. Supply is not maintained in the event of failure of a device or path while another path is under maintenance.

6.3.4.2 Class 1: Single path solutions

6.3.4.2.1 General

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

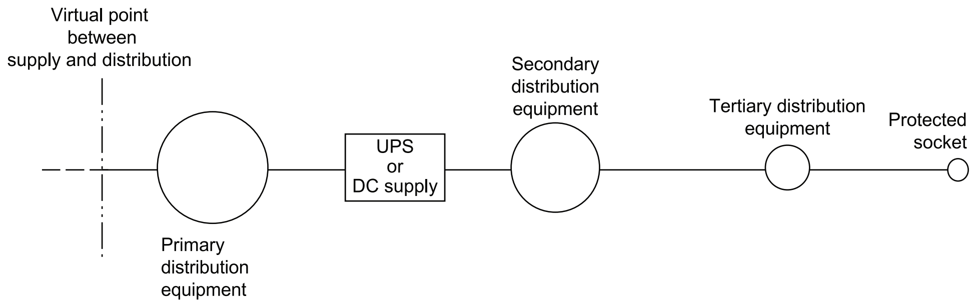


Figure 8 — Example of single path power distribution system (Class 1)

6.3.4.2.2 Requirements

The UPS or DC power supply shall be designed and installed to provide an adequate supply to allow a controlled shut-down to limit potential damage, caused by an interruption of supply from the primary distribution equipment, to a level consistent with the business impact analysis of ISO/IEC 22237-1.

6.3.4.2.3 Recommendations

It is recommended to provide a Main-Tie-Tie-Main bypass in conjunction with the UPS equipment. The bypass should be not located into the same fire compartment as the UPS equipment.

6.3.4.3 Class 2: Single path with redundancy solutions

6.3.4.3.1 General

Figure 9 shows examples of single path design solutions enhanced by means of redundant devices.

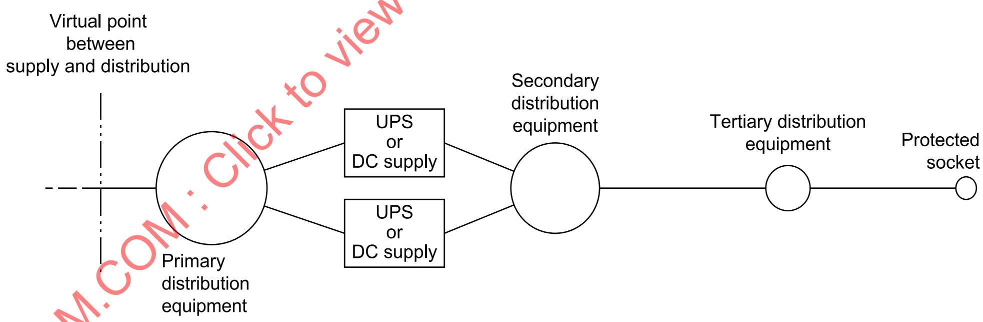


Figure 9 — Example of single path power distribution system with redundancy (Class 2)

6.3.4.3.2 Requirements

The UPS or DC power supply shall be designed and installed to provide an adequate supply to limit potential damage, following an interruption of supply from the primary distribution equipment and before the provision of an alternative supply, to a level consistent with the business impact analysis of ISO/IEC 22237-1.

6.3.4.3.3 Recommendations

It is recommended to provide a Main-Tie-Tie-Main bypass in conjunction with the UPS equipment. The bypass should be not located into the same fire compartment as the UPS equipment.

The primary distribution, secondary distribution and UPS (or DC supply) equipment should be accommodated in separate fire compartments.