BS ISO/IEC 14763-2:2019

BSI Standards Publication

Information technology – Implementation and operation of customer premises cabling

Part 2: Planning and installation

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National foreword

This British Standard is the UK implementation of ISO/IEC 14763-2:2019.

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

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Part 2: Planning and installation

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INFORMATION TECHNOLOGY – IMPLEMENTATION AND OPERATION OF CUSTOMER PREMISES CABLING –

Part 2: Planning and installation

FOREWORD

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International Standard ISO/IEC 14763-2 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

This second edition cancels and replaces the first edition published in 2012 and Amendment 1:2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- the inclusion of planning and installation practices to support remote powering over the telecommunications cabling infrastructure;
- the inclusion of planning and installation practices outside buildings.

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The text of this standard is based on the following documents:

FDIS	Report on voting
JTC1-SC25/2909/FDIS	JTC1-SC25/2931/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the ISO/IEC 14763 series, published under the general title *Information technology – Implementation and operation of customer premises cabling*, can be found on the IEC and ISO websites.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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INTRODUCTION

The use of generic information technology (IT) cabling, termed telecommunications cabling throughout this document (in accordance with the ISO/IEC 11801 series), for an increased number of non-IT services is reflected in the predominant use of the term telecommunications in this document.

The importance of services delivered by telecommunications cabling infrastructure is similar to that of utilities such as heating, lighting and electricity supplies. As with those utilities, interruptions to service can have a serious impact. Poor quality of service due to lack of planning, use of inappropriate components, incorrect installation, poor administration or inadequate support can threaten an organization's effectiveness.

There are four phases in the successful implementation of telecommunications cabling:

a) design;

b) specification – the detailed requirement for the cabling, including the planning of its accommodation and associated building services addressing safety and specific environments (e.g. electromagnetic), together with the quality assurance requirements to be applied;

c) installation – in accordance with the requirements of the specification;

d) operation – the management of connectivity and the maintenance of transmission performance during the life of the cabling.

This document supports the specification, implementation and operation of generic telecommunications cabling designed in accordance with the standards and associated documents developed by ISO/IEC JTC 1/SC 25 and addresses the following topics:

- specification depending on the application, environment, building infrastructure and facilities;
- quality assurance;
- installation planning (including pathways and spaces) depending on the application, environment, building infrastructure and facilities, etc.;
- installation practice (including pathways and spaces);
- documentation and administration;
- testing;
- inspection;
- operation;
- maintenance and maintainability (based on any impact from planning and installation);
- repair and repairability (based on any impact from planning and installation).

It does not cover those aspects of installation associated with the transmission of signals in free space between transmitters, receivers or their associated antenna systems (e.g. wireless, radio, microwave or satellite).

The following normative annexes support specific aspects of planning and installation:

- Annex A: Optical fibre polarity;
- Annex B: Common infrastructures within multi-tenant premises.

The requirements and recommendations of Clauses 5 to 14 are premises-independent. The following normative annexes include requirements for generic cabling in accordance with specific International Standards:

- Annex C: Cabling in accordance with ISO/IEC 11801-2;

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- Annex D: Cabling in accordance with ISO/IEC 11801-3;
- Annex E: Cabling in accordance with ISO/IEC 11801-4;
- Annex F: Cabling in accordance with ISO/IEC 11801-5;
- Annex G: Cabling in accordance with ISO/IEC 11801-6.

Annex H provides information on environmental classes for spaces containing telecommunications equipment.

Annex I provides additional information regarding remote powering.

This document sets out the responsibilities of telecommunications cabling installers and premises owners, and is intended to be referenced in relevant contracts. The owners can delegate selected responsibilities to designers, specifiers, operators and maintainers of installed telecommunications cabling.

This document is also relevant to

- architects, building designers and builders,
- main contractors,
- designers, suppliers, installers, inspectors (auditors), building managers, maintainers and owners of telecommunications cabling,
- access providers and service providers,
- end users.

This document is one of a number of documents prepared in support of International Standards and Technical Reports for cabling design produced by ISO/IEC JTC 1/SC 25. Figure 1 shows the inter-relationship between these International Standards and Technical Reports.

Users of this document should be familiar with the applicable cabling design standard.

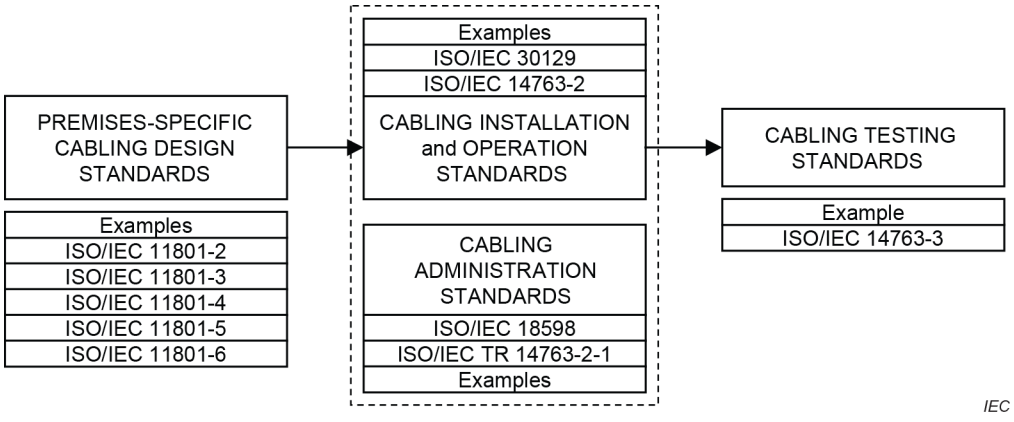

Figure 1 – Schematic relationship between ISO/IEC 14763-2 and other relevant International Standards and Technical Reports

NOTE Telecommunications infrastructure affects raw material consumption. The infrastructure design and installation methods also influence product life and sustainability of electronic equipment life cycling. These aspects of telecommunications infrastructure impact our environment. Since building life cycles are typically planned for decades, technological electronic equipment upgrades are necessary. The telecommunications infrastructure design and installation process magnifies the need for sustainable infrastructures with respect to building life, electronic equipment life cycling and considerations of effects on environmental waste. Telecommunications designers are encouraged to research local building practices for a sustainable environment and conservation of fossil fuels as part of the design process.

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INFORMATION TECHNOLOGY – IMPLEMENTATION AND OPERATION OF CUSTOMER PREMISES CABLING –

Part 2: Planning and installation

1 Scope

This part of ISO/IEC 14763 specifies requirements for the planning, installation and operation of telecommunications cabling and cabling infrastructures including cabling, pathways, spaces and telecommunications bonds (other than that specified in ISO/IEC 30129) in support of generic cabling standards and associated documents.

The following aspects are addressed:

a) specification of the installation;

b) quality assurance;

c) installation planning;

d) installation practice;

e) documentation;

f) administration;

g) testing;

h) inspection;

i) operation;

j) maintenance;

k) repair.

The requirements and recommendations of Clauses 5 to 14 are premises-independent. Annexes C through G contain premises-specific amendments of and additions to these requirements and recommendations.

In addition, this document describes the methodology for the assessment of spaces, pathways, pathway systems and cabling (either installed or planned) in support of remote powering objectives.

This document excludes specific requirements applicable to other cabling systems (e.g. power supply cabling); however, it takes account of the effects other cabling systems may have on the installation of telecommunications cabling (and vice versa) and gives general advice.

This document excludes those aspects of installation associated with the transmission of signals in free space between transmitters, receivers or their associated antenna systems (e.g. wireless, radio, microwave or satellite).

This document is applicable to certain hazardous environments but does not exclude additional requirements which are applicable in particular circumstances (e.g. electricity supply and electrified railways).

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.

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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.

IEC 60364-5-52, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60825-2, *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)*

IEC 61084 (all parts), *Cable trunking systems and cable ducting systems for electrical installations*

IEC 61386 (all parts), *Conduit systems for cable management*

IEC 61537, *Cable management – Cable tray systems and cable ladder systems*

IEC 61784-5 (all parts), *Industrial communication networks – Profiles*

IEC 61918:2018, *Industrial communication networks – Installation of communication networks in industrial premises*

IEC 61935-1, *Specification for the testing of balanced and coaxial information technology cabling – Part 1: Installed balanced cabling as specified in ISO/IEC 11801 and related standards*

IEC 61969-1, *Mechanical structures for electronic equipment – Outdoor enclosures – Part 1: Design guidelines*

IEC 61969-2, *Mechanical structures for electronic equipment – Outdoor enclosures – Part 2: Coordination dimensions*

IEC 62305-4, *Protection against lightning – Electrical and electronic systems within structures*

IEC 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

IEC 62368-3, *Audio/video, information and communication technology equipment – Part 3: Safety aspects for DC power transfer through communication cables and ports*

IEC 62949, *Particular safety requirements for equipment to be connected to information and communication technology networks*

ISO/IEC 11801-1:2017, *Information technology – Generic cabling for customer premises – Part 1: General requirements*

ISO/IEC 11801-2, *Information technology – Generic cabling for customer premises – Part 2: Office premises*

ISO/IEC 11801-3, *Information technology – Generic cabling for customer premises – Part 3: Industrial premises*

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ISO/IEC 11801-4, *Information technology – Generic cabling for customer premises – Part 4: Single-tenant homes*

ISO/IEC 11801-5, *Information technology – Generic cabling for customer premises – Part 5: Data centres*

ISO/IEC 11801-6, *Information technology – Generic cabling for customer premises – Part 6: Distributed building services*

ISO/IEC 14763-3, *Information technology – Implementation and operation of customer premises cabling – Part 3: Testing of optical fibre cabling*

ISO/IEC 18598, *Information technology – Automated infrastructure management (AIM) systems – Requirements, data exchange and applications*

ISO/IEC 20000-1, *Information technology – Service management – Part 1: Service management system requirements*

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 11801-1, ISO/IEC 11801-2, ISO/IEC 11801-3, ISO/IEC 11801-4, ISO/IEC 11801-5, ISO/IEC 11801-6, ISO/IEC 30129 and the following apply.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
acceptance testing
<of installed cabling> contractual test to confirm that the installed cabling satisfies specific aspects of its specification

3.1.2
access provider space
location of access provider transmission and support equipment

3.1.3
anchor wire
tensioned cable designed to add support to structures

3.1.4
automated infrastructure management system
AIM system
integrated hardware and software system that automatically detects the insertion or removal of cords, documents the cabling infrastructure including connected equipment enabling management of the infrastructure and data exchange with other systems

[SOURCE: ISO/IEC 18598:2016, 3.1.3]

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3.1.5
cable bundle
multiple cables maintained in close proximity, generally by fasteners (e.g. cable ties)

3.1.6
cabinet
enclosed construction intended for housing closures and other telecommunications components and equipment

3.1.7
cable management system
system used for the support and/or containment, retention, and protection of all types of cables, information and communication lines, electrical power distribution conductors and their associated accessories

Note 1 to entry: Includes ducts and tubes housing, or intended to house, blown telecommunications cables and/or cable elements.

3.1.8
cabling component
product associated with the cabling installation including cables, connecting hardware, closures, cabinets, frames, racks and pathway systems together with components used to provide bonds to earthing systems

3.1.9
catenary wire
dedicated wire used in aerial applications to which telecommunications cables are attached

3.1.10
closure
fixture or fitting of either open or closed construction intended to contain connecting hardware

3.1.11
closed pathway system
cable management system which does not allow installation of cables by laying without tensile load

3.1.12
electrostatic discharge
transfer of electric charge between bodies of different electric potential in proximity or through direct contact

[SOURCE: IEC 60050-161:2014,161-01-22]

3.1.13
entrance room
space within, or at the boundary of, a building housing the demarcation point where facilities owned by external access and/or service providers interface with the premises cabling

Note 1 to entry: For generic cabling in accordance with ISO/IEC 11801-5, the demarcation point is the external network interface (ENI) and the data centre cabling at that point is the network access cabling.

3.1.14
extraneous-conductive-part
conductive part not forming part of the electrical installation and liable to introduce an electric potential, generally the electric potential of a local earth

[SOURCE: IEC 60050-826:2004, 826-12-11; IEC 60050-195:1998, 195-06-11]

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3.1.15
frame
open construction, typically self-supporting and floor-mounted, intended for housing closures and other telecommunications equipment

3.1.16
hand hole
point of access to a pathway that is too small for a person to enter to perform work but that allows the routing of cables during the cable installation process such that bending and pulling requirements are met

Note 1 to entry: An example of a hand hole within a building is called a draw-box.

3.1.17
high-voltage
voltage over 1 000 V RMS or 1 500 V DC

3.1.18
home entrance
space at the boundary of a home that can house the interface(s) between the home networks and external networks provided to the home and that demarcate the administration and maintenance of the two networks

3.1.19
hot zone
area around a high-voltage installation (e.g. substation, transformer, pylon) whose earth potential rise in normal operation or when an earth fault occurs is over the limits given in ITU-T K.68 for typical fault situations

3.1.20
identifier
unique item of information to distinguish a specific component of the cabling installation

3.1.21
installer
person installing cabling components

Note 1 to entry: No design functions are assumed.

3.1.22
junction box
space within a home that enables cables to be routed between pathway systems

3.1.23
label
means of clearly marking a specific component of the telecommunications infrastructure with its identifier and (optionally) other information

3.1.24
maintenance hole
<telecommunications> vault or chamber located in the ground or earth as part of an underground conduit system and used to facilitate placing, connectorization, and maintenance of cables as well as the placing of associated equipment, in which it is expected that a person will enter to perform work

3.1.25
metallic telecommunications cable
cable utilizing metallic conductors for signal transmission

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3.1.26
metallic telecommunications cabling
cabling utilizing metallic conductors for signal transmission

3.1.27
minimum bend radius
<installation> minimum radius, as defined by the cable manufacturer, supplier or relevant product standard, to which a cable or cable element is allowed to be subjected during installation

3.1.28
minimum bend radius
<operating static> minimum radius, as defined by the cable manufacturer, supplier or relevant product standard, to which a cable or cable element is allowed to be subjected following installation and when fixed in its final operating position

3.1.29
minimum bend radius
<operating dynamic> minimum radius, as defined by the cable manufacturer, supplier or relevant product standard, to which a cable or cable element is allowed to be subjected under conditions where the cable or cable element is subject to movement during operation

3.1.30
multi-tenant building
building which is designed to accommodate more than one tenant, each of whom has their own tenant entrance facility but who share building entrance facilities (BEF) and associated distribution spaces

3.1.31
non-deformed power supply
power supply that excludes the effects of non-linear loads which generate harmonic currents (e.g. fluorescent lamps, switch mode power supply devices)

3.1.32
open pathway system
pathway system which allows installation of cables by laying without tensile load

3.1.33
openable pathway system
cable management system which restricts access to installed cables but which can be opened to allow installation of cables by laying without tensile load

3.1.34
pathway
<cable route, cable way> defined route for cables between termination points

3.1.35
pathway system
cable management system or other area or volume defined by markings or fittings used to protect and/or support the cabling in order that its desired performance is maintained

3.1.36
power supply cable
cable whose primary purpose is the supply of electrical power

3.1.37
power supply cabling
cabling whose primary purpose is the supply of electrical power

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3.1.38
premises owner
owner of the premises within which cabling is to be installed and who can delegate the responsibilities specified in this document to appointed representatives

Note 1 to entry: Appointed representatives can include designers, specifiers, operators and maintainers of the resulting cabling infrastructures.

3.1.39
primary distribution space
space within a home that houses the home distributor (primary home distributor) of ISO/IEC 11801-4 and associated equipment

3.1.40
protective earth conductor
conductor provided for the purposes of safety, for example protection against electric shock

[SOURCE: IEC 60050-826:2004, 826-13-22; IEC 60050-195:1998, 195-02-09]

3.1.41
rack
open construction, typically wall-mounted, for housing closures and other telecommunications equipment

3.1.42
rack unit
44,45 mm of vertical mounting space in an IEC 60297 series standard cabinet or rack

Note 1 to entry: 44,45 mm = 1,75 in.

3.1.43
record
collection of information about, or related to, a specific element of the telecommunications infrastructure

3.1.44
referenced cabling design document
relevant International Standard or Technical Report for cabling design

Note 1 to entry: Refer to ISO/IEC JTC 1/SC 25 and Figure 1 for a list of relevant standards.

3.1.45
remote powering
supply of power to application-specific equipment via balanced cabling

3.1.46
secondary distribution space
space within a home that houses a secondary home distributor of ISO/IEC 11801-4

3.1.47
segregation
physical separation and/or isolation for the purposes of safety, protection of damage to equipment or the prevention of electromagnetic noise from power supply cabling interfering with circuits operating on telecommunications cabling

3.1.48
service loop
excess length of cable or cable element(s)

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3.1.49
service provider
operator of any service that furnishes telecommunications content (transmissions) delivered over access provider facilities

Note 1 to entry: The access provider and the service provider can be a single entity.

3.1.50
service provider space
location of service provider transmission and support equipment

3.1.51
space
specified volume (e.g. room, maintenance hole or part thereof) housing closures and/or other telecommunications equipment

3.1.52
surge protective device
device intended to protect the electrical apparatus from high transient overvoltages and to limit the duration and frequently the amplitude of the follow-on current

3.1.53
telecommunications equipment
active or passive equipment necessary to deliver a specific application

EXAMPLES hubs, switches, routers, adapters

3.1.54
termination point
connection, free connector or fixed connector (as appropriate) fitted to an installed cable and housed within a closure

3.1.55
tenant entrance facility
facility that provides all necessary mechanical and electrical services for the entry of telecommunications cables into a tenant's space and which may allow for transition from external to internal cable

3.1.56
work order
collection of information which documents the changes requested and the operations to be carried out on the telecommunications infrastructure

3.2 Abbreviated terms

For the purposes of this document, the abbreviated terms given in ISO/IEC 11801-1, ISO/IEC 11801-2, ISO/IEC 11801-3, ISO/IEC 11801-4, ISO/IEC 11801-5, ISO/IEC 11801-6, ISO/IEC 30129 and the following apply.

AIM automated infrastructure management

CATV community antenna television

CAD computer aided design

CER common equipment room

CSA cross-sectional area

CTR common telecommunications room

EMI electromagnetic interference

EMS energy management systems

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ENI	external network interface
HV	high-voltage
HVAC	heating, ventilation and air conditioning
LV	low-voltage
IS	installation specification
MPO	multi-fibre push-on
NVP	nominal velocity of propagation
QP	quality plan
SPD	surge protective device
U	rack unit

3.3 Conventions

Annexes B to G adopt a non-sequential clause numbering structure in order to clarify and directly reference the clauses in the main body that are affected by the text of each annex.

4 Conformance

For planning and installation of cabling and cabling infrastructures to conform to this document,

a) the requirements of the applicable generic cabling design standards shall be applied,

b) the specification of the installation shall meet the requirements of Clause 5,

c) the quality planning of the installation shall meet the requirements of Clause 6,

d) the planning of the installation shall meet the requirements of Clause 7,

e) the installation practices shall meet the requirements of Clause 8,

f) the documentation and administration of the installation shall meet the requirements of Clause 9,

g) the testing and inspection of the installation shall meet the requirements of Clauses 10 and 11, respectively,

h) the operation of the installation shall meet the requirements of Clause 12,

i) the maintenance and repair shall meet the requirements of Clauses 13 and 14, respectively,

j) the additional requirements of the applicable premises-specific annex shall be met,

k) telecommunications bonding networks shall conform to ISO/IEC 30129,

l) where a lightning protection system is required, it shall conform to the "integrated lightning protection system" according to IEC 62305-4,

m) other lightning protection systems, including the "isolated lightning protection system" according to IEC 62305-3, are allowed provided that specific restrictions are applied both to the implementation of the telecommunications cabling as agreed between the planners of the lightning protection system and the telecommunications cabling,

n) local regulations shall be met.

5 Specification of installations

5.1 General

Clause 5 in conjunction with Clause 6 describes the key aspects of installation quality assurance as shown in Figure 2.

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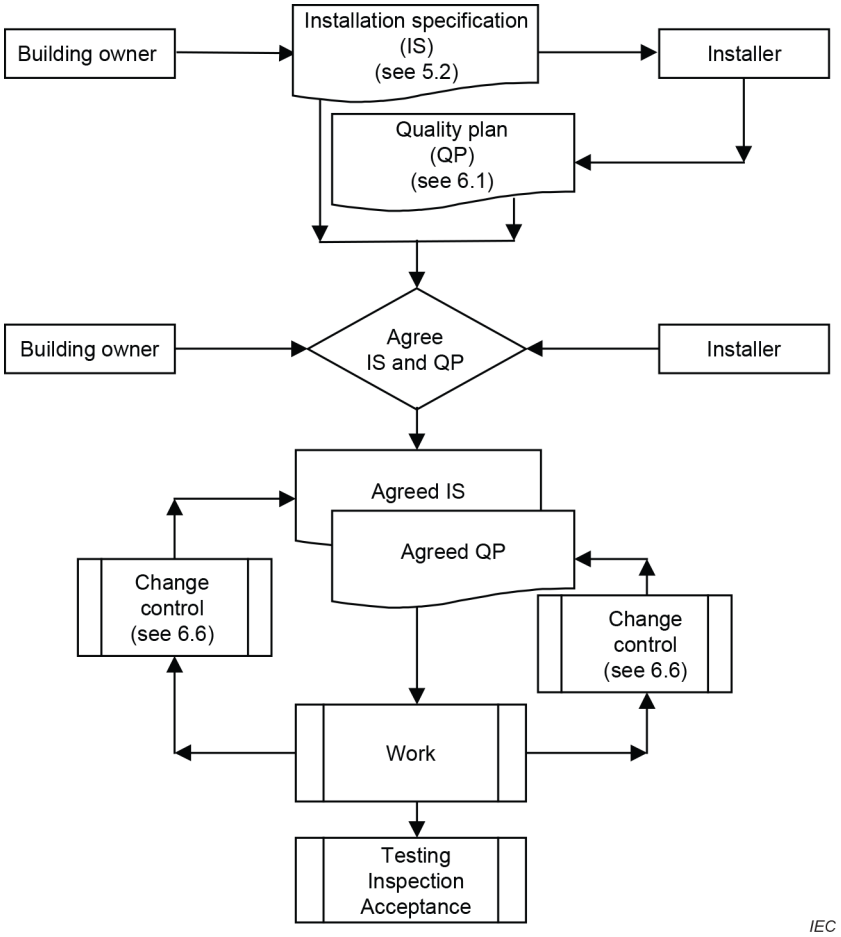

Figure 2 – Quality assurance schematic

5.2 Installation specification

5.2.1 Requirements

5.2.1.1 General

An installation specification shall be produced by, or on behalf of, the premises owner, in accordance with the requirements of 5.2. The installation specification shall be agreed with the installer prior to the commencement of the installation.

The installation specification shall comprise

- the technical specification (see 5.3),
- the scope of work (see 5.4),
- quality assurance (see 5.5).

5.2.1.2 Other infrastructures

The installation specification shall detail how the following have been taken into account:

- other building services such as power supply distribution, earthing and bonding systems;
- building management systems including security and access control;
- circuits for smoke/fire detection and associated controls;
- heating, ventilation and air conditioning (HVAC) infrastructures;
- industrial machinery (e.g. automation islands as described in Annex D);

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- piping systems (water supply and waste, fire suppression, compressed air, machine lubricating oil, hydraulic fluids, dry material and high temperature exhaust ports);
- other relevant infrastructures.

The installation specification shall explicitly state where any of the above do not apply.

5.2.1.3 Legislation, regulations and statements of compliance

Applicable legislation, regulations and statements of compliance shall be detailed, including

- building regulations relating to the installation,
- specific site regulations,
- safe working practices,
- external service protection,
- contractors' authorization,
- accreditation of installer personnel.

The installation specification shall explicitly state where any of the above do not apply.

5.2.1.4 Site contacts

The installation specification shall detail the site contacts with responsibilities for

- operational requirements,
- site information (including access and applicable restrictions, knowledge of relevant hazardous areas),
- technical requirements,
- documentation of existing cabling, if relevant,
- compatibility of existing telecommunications cabling components,
- items to be issued to the telecommunications cabling installer by, or on behalf of, the premises owner,
- storage of materials,
- removal, disposal and/or recycling of excess and waste material,
- occupational health and safety,
- installation of cabling by a third party,
- main contractor and/or sub-contractors,
- transfer of responsibility and/or property.

5.2.2 Recommendations

The installation specification should reflect predictable expansion to the cabling system, whether from the need to support additional users or increases in quantity or type of applications, with reference to

- pathways and pathway systems,
- cabinets, frames and racks,
- termination points,
- the power supply system.

The quantity and location of termination points should reflect the predicted requirements over the intended life of telecommunications cabling.

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The installation specification should contain the elements of the telecommunications strategy that include details of

- the application(s) to be supported by the installed cabling highlighting, where relevant, current and future requirements,
- external service provision and its interface(s) to the telecommunications cabling (see Clause 7),
- resilience planning,
- security requirements and/or access restrictions.

5.3 Technical specification

5.3.1 General

5.3.1.1 Requirements

The technical specification shall contain details of, and the performance requirements for, the cabling and associated components. The technical specification forms the basis of assessment of the performance of installed cabling together with all cabling components and installation techniques used.

The technical specification shall cover both new installations and extensions of existing installations.

The technical specification shall detail the location of, and requirements for, any relevant external network interfaces (ENIs) (see Clause 7).

The technical specification shall define the

- level of administration system to be applied to the cabling infrastructure (see Clause 9),
- range of documentation to be supplied by the installer including any requirements to link records to each other and to other building services records,
- format of the documentation (see Clause 9),
- labelling to be undertaken by the installer (see Clause 9),
- specification of labels (as a minimum, meeting the requirements of Clause 7),
- requirements for acceptance testing (see Clause 10),
- requirements for inspection (see Clause 11),
- requirements for the treatment of parts of the installation that do not comply with the requirements for inspection and acceptance testing,
- the format of test result and inspection documentation (see Clauses 10 and 11) which shall contain the pass/fail results of the acceptance tests, where required, and any actions taken to repair or correct installation failures.

5.3.1.2 Recommendations

The technical specification should detail the requirements for the

- physical and operational lifetime of the cabling installation,
- provision of facilities necessary to support the installation of additional termination points over the intended operational life of the installed cabling.

5.3.2 Notification of hazards

The technical specification shall

- identify and classify any hazards within the pathways and at termination points,

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NOTE The hazard classification of areas containing, or intended to contain, optical fibre telecommunications equipment and optical fibre telecommunications cabling is described in IEC 60825-2 and is used to define appropriate installation and labelling practices.

- detail the boundaries of areas containing hazards, or potentially hazardous areas.

5.3.3 Security requirements

The technical specification shall detail measures required to prevent unauthorized access to pathways, pathway systems, closures, cabinets, frames, racks and cords.

5.3.4 Performance and configuration – Requirements

The technical specification shall detail the required transmission performance of the cabling to be installed

- when subject to the defined operational environment (see 5.3.5),
- in conjunction with existing cabling.

The environmental compatibility shall be achieved by selection of appropriate components and/or by mitigation techniques that modify the environment to which the component is subjected including

- isolation from the defined environment (by means of protection and/or segregation),
- separation from the defined environment.

The technical specification shall detail any remote powering objectives using equipment in accordance with IEC 62368-3.

Failure to specify remote powering objectives indicates that either there are none or that they only apply to cabling which has been designed to support remote powering without the need to apply specific planning or installation practices and have no impact on other cabling in shared pathways and spaces.

For balanced cabling in accordance with the ISO/IEC 11801 series, remote powering equipment shall not supply more than 500 mA per conductor (i.e. i_c ≤ 500 mA) and the installations shall be designated in one of the following Categories:

- Category RP1: attachment of the remote powering equipment at a distributor is controlled such that the average current for all conductors served by the distributor ($i_{\text{c-average}}$) is no greater than 212 mA.

  Category RP1 installations avoid planning and installation practices but do require documentation and administrative controls during both the attachment of remote powering equipment and any subsequent extensions of the cabling (see 9.2.2.4.1). An additional complexity is that $i_{\text{c-average}}$ is not just a simple average. Instead, $i_{\text{c-average}}$ (A) is calculated as

$$i_{\text{c-average}} = \sqrt{\frac{\sum_{n=1}^{N} i_{c_n}^2}{N}} \tag{1}$$

where

n is the index of conductors (including those that carry no current);

N is the total number of conductors (including those that carry no current);

i_{c_n} is the current in conductor with index n (A).

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- Category RP2: attachment of the remote powering equipment at a distributor is controlled such that the average current for all conductors served by the distributor ($i_{c\text{-average}}$) is restricted to a specified value between 212 mA and 500 mA;

  Category RP2 installations require planning and installation practices (see Clauses 7 and 8) together with documentation and administrative controls during both the attachment of remote powering equipment and any subsequent extensions of the cabling (see 9.2.2.4.1). An additional complexity is that $i_{c\text{-average}}$ is not just a simple average as described for Category RP1 installations.

- Category RP3: attachment of the remote powering equipment at a distributor is unrestricted subject to the limit of i_c ≤ 500 mA.

  Category RP3 installations require planning and installation practices (see Clauses 7 and 8) together with documentation and administrative controls during subsequent extensions of the cabling (see 9.2.2.4.1).

These Categories are summarized in Table 1.

Table 1 – Remote powering cabling installation Categories and controls

Category	$i_{c\text{-average}}$	i_c	Controls required during	
			Attachment of remote powering equipment	Planning of subsequent cabling installation
RP1	≤ 212 mA	≤ 500 mA	Yes	Yes
RP2	> 212 mA < 500 mA	≤ 500 mA	Yes	Yes
RP3	-	≤ 500 mA	No	Yes

A consistent Category should be applied to all distributors at which remote powering is applied.

Where the installation specification describes an extension to existing cabling, the Category of the existing installation shall be specified.

Values for i_c and $i_{c\text{-average}}$ for remote powering applications of IEEE 802.3 are shown in Figure 3.

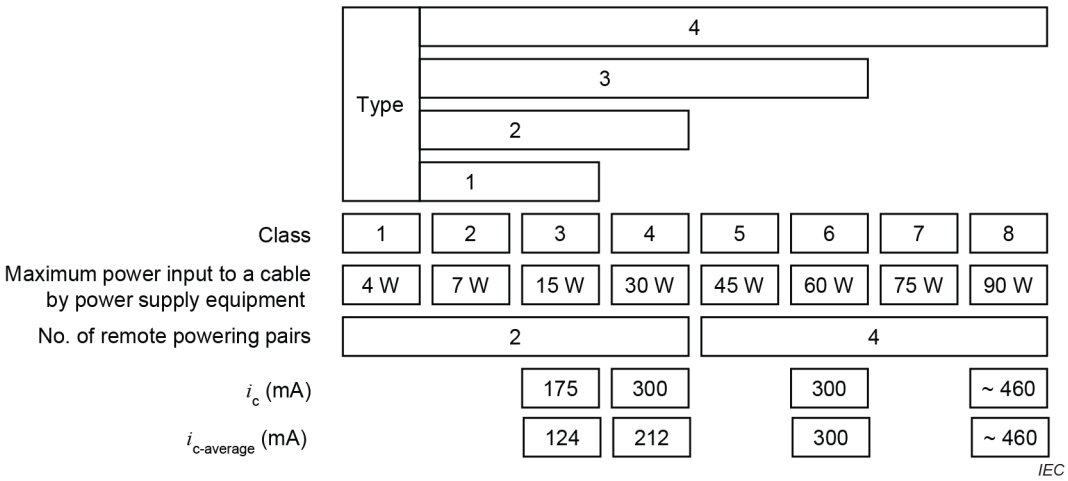

Figure 3 – Conductor current for IEEE 802.3 remote powering applications

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Installations of Category RP2 represent an engineered solution and require the application of Clause I.3.

For installation of cabling in accordance with ISO/IEC 11801-2, ISO/IEC 11801-3, ISO/IEC 11801-4 and ISO/IEC 11801-6, the planning, installation and administration requirements of Category RP3 shall be applied.

The capacity of the power supply or supplies to spaces from which remote powering is distributed shall be consistent with the stated objectives and power dissipated from the cabling should be included in the heat load calculation of the environmental control system of the building.

The technical specification shall detail the

- locations where less than the available number of cable elements are terminated at a termination point or joint,
- pin-pair assignment for balanced cable elements at interfaces to the installed cabling,

  Annex A provides information about possible connections between the wires and the pins of telecommunications outlets within generic cabling systems in accordance with the referenced cabling design document. The same set of pin-pair combination should be used throughout the whole cabling installation.
- positioning of optical fibres at interfaces to the installed cabling.

  NOTE Annex A contains requirements and recommendations for the maintenance of polarity within cabling terminated with connecting hardware housing multiple optical fibres.

When two cabling links of different specifications, but which are physically similar, are used in the same installation (for example, different performance Categories and cables with different nominal impedance), special precautions are required to ensure that they are properly identified.

The technical specification shall contain the requirements for

- the pathways, pathway systems, spaces, cabinets, frames, racks, closures, cables, termination points and cords (see Clause 7),
- differentiation of pathway systems and cables associated with cabling subsystems installed to provide enhanced reliability within the infrastructure (e.g. tie cabling),
- the bonding of the cabling components to the protective and functional earthing systems (see IEC 60364 series and ISO/IEC 30129).

Spaces, pathways and/or the pathway systems within the pathways shall be able to accommodate components and where necessary provide adequate ventilation, in order that any stated remote powering objectives neither compromise the transmission requirements of the installation specification or the warranty conditions of the components. Information on assessment methods is provided in 7.14.

5.3.5 Environmental conditions

5.3.5.1 Requirements

The technical specification shall detail the intended installation and operational environmental conditions. The MICE classification system of ISO/IEC 11801-1 (and described in ISO/IEC TR 29106) shall be used where the intended installation and operational environmental conditions lie within the boundaries defined by $M_3I_3C_3E_3$. In addition, the following environmental conditions shall be taken into account:

- biological attack (e.g. mould or fungal growth);
- physical damage (accidental or malicious) including damage caused by animals

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- presence, or potential presence, of hazards (such as contaminating, toxic or explosive materials);
- the movement of air (e.g. caused by fans, heating and ventilation systems);
- meteorological effects (e.g. wind);
- impact of natural events, e.g. lightning strike, earthquake.

A number of standards exist for the classification of environments relevant to telecommunications components and equipment. Reference should be made to the IEC 60721 series.

5.3.5.2 Recommendations

The technical specification should include a risk assessment including abnormal environmental conditions (temperature changes, flooding) which should result in a risk management plan that can have an effect on the requirements for component performance or mitigation.

5.4 Scope of work

5.4.1 Pre-installation

5.4.1.1 Requirements

The scope of work shall detail requirements for

- any building work required on each pathway,
- pathway preparation and the installation of pathway systems,
- accommodation of the terminating devices for external (outdoor) and internal (indoor) cables at building entrance facilities,
- the quantities of cabling components and installation accessories,
- the bonding of pathway systems,
- additional surveys to be undertaken to supplement information in the scope of work.

The scope of work shall define

- the responsibilities for the identification, design and completion of the works involved,
- the responsibilities for obtaining all necessary clearances and permits,
- requirements for site-specific safety inductions and training requirement,
- the location of storage facilities for cabling components and installation accessories,
- a system for the disposal of waste components and/or installation materials.

5.4.1.2 Recommendations

The scope of work should contain

- site plans that are marked up to show the works required,
- details of the facilities (such as telephone and accommodation) to be used by the installer,
- details of the processes operating on the premises, for the duration of the installation, for the delivery of, storage of, access to and removal of, materials.

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5.4.2 Installation

5.4.2.1 Requirements

The scope of work shall detail locations of

- spaces,
- pathways,
- cabinets, frames and racks,
- closures,
- termination points,
- connection to bonding systems and protective earthing systems.

The scope of work shall detail requirements for

- warning signs and equipment to ensure safe working,
- the pathway systems to be used in each pathway,
- the cables to be installed in each pathway,
- jointing and/or termination at each termination point,
- the bonding of cabling components,
- marking and labelling the cabling components,
- the quantity and type(s) of inspection and testing to be applied to the cabling installation.

The scope of work shall define an installation programme detailing key dates including

- requirements for progress meetings,
- attendance at contract inspection points,
- final installation date,
- the date that the installation documentation is to be supplied,
- the date that the installation is to be brought into service,
- hand-over date(s).

The scope of work shall detail

- items to be provided by the telecommunications cabling installer,
- items to be issued to the telecommunications cabling installer by, or on behalf of the premises owner,
- other works with potential to affect the programme,
- access limitations together with restrictions on personnel movement, vetting and clearance levels,
- the responsibilities for the identification, design and completion of the works involved,
- the responsibilities for obtaining all necessary clearances and permits,
- applicable fire precautions and escape routes,
- site access and security arrangements.

5.4.2.2 Recommendations

The scope of work should contain

- site plans that are marked up to show the works required,
- details of the facilities (such as telephone and accommodation) to be used by the installer,

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- details of a system of materials control.

During the development of the scope of work, testing should be considered

- where application-specific cabling is to be used to support a more demanding application,
- where extending or modifying an undocumented installation.

5.4.3 Post-installation

5.4.3.1 Requirements

The scope of work shall detail requirements for reinstatement and shall define

- the responsibilities for the identification, design and completion of the works involved,
- the responsibilities for obtaining all necessary clearances and permits (where not covered by those obtained in 5.4.2.1),
- a maintenance and control procedure for the final cabling documentation.

5.4.3.2 Recommendations

The scope of work should detail requirements for

- operational training including safety,
- maintenance training for the premises owner and/or the designated cabling maintainer,
- fault analysis training,
- repair and maintenance contracts,
- spares, e.g. cable, cords, closures, connecting hardware, tools, test equipment and test leads.

5.5 Quality assurance

The installation specification shall

- contain a list of the items to be addressed in the quality plan applicable to the installation as defined by, or on behalf of, the premises owner,
- identify the responsibilities for any additional tasks necessary to allow agreement of the quality plan (see Clause 6).

6 Quality planning

6.1 Quality plan

A quality plan addressing the requirement of the installation specification shall be produced by, or on behalf of, the installer in accordance with the requirements of this document. The quality plan shall be agreed with the premises owner prior to the commencement of the installation and shall address the requirements of 6.1 independent of the provision of the materials or facilities involved.

For installations of cabling in accordance with ISO/IEC 11801-4 in single homes, quality plans are not required but can be requested.

The quality plan describes methods and procedures as detailed below and does not replace the need for the installer to assess, against the requirements of this document, the pathways and spaces (and any other relevant facilities and infrastructures) provided by the premises owner.

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The quality plan shall clearly state the measures and procedures to be adopted to demonstrate compliance with

- the requirements of this document,
- the requirements of the referenced cabling design document,
- the installation specification.

The quality plan shall detail the procedures

- for the transfer of responsibilities between the installer, premises owner and, where relevant, other contractors,
- for the acceptance of cabling components and the cabling installation (including verification of physical, mechanical, optical and/or electrical specifications based on the manufacturers' or suppliers' specifications and relevant standards),
- to be adopted to assess compatibility between cabling components to be used during the installation,
- to be adopted to assess compatibility with any existing installed cabling,
- to assess any stated objectives for remote powering for compatibility with the intended operating environment (information on assessment methods is provided in 7.14),
- to address the impact of potential component incompatibilities,
- to ensure the selection of appropriate cords to extend the fixed portion of the cabling to create channels.

Where, at any point during the installation process, inspection and/or testing of cabling components or installed cabling is specified in the installation specification, or by local regulations, the quality plan shall detail the

- inspection and test equipment,
- the calibration status of the inspection and test equipment,
- sampling plans (see 6.2),
- measurement procedures (see Clause 10),
- treatment of results which are non-compliant or marginal (i.e. within the specified measurement accuracy of the test system), see 6.4.

The quality plan shall detail the competency of personnel to undertake the installation in accordance with the installation specification.

Where sampling plans are applied, the quality plan shall detail the procedures (for example, extension of sampling procedures) to be adopted if sample testing identifies results which are non-compliant or marginal (i.e. within the specified measurement accuracy of the test system), see 6.4.

6.2 Specification of cabling components

Specifications for the cabling components to be used shall be obtained from manufacturers or suppliers including

a) environmental requirements (storage, installation and operation),

b) cord, cable and cable element minimum bend radii (installation, operating static and, if relevant, operating dynamic),

c) cord and cable maximum tensile load,

d) cord and cable crush resistance.

Instructions for the storage, installation and operation of the cabling components shall be obtained from manufacturers or suppliers including

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1) pathways and pathway systems,
2) installation tools and installation equipment,
3) termination of cables to connecting hardware.

6.3 Sampling

6.3.1 Balanced cabling

6.3.1.1 General

Table 2 shows three groups of balanced cabling transmission parameters (basic verification, internal transmission and alien (exogenous) crosstalk) using the parameters that define the Classes of links and channels within the referenced cabling design standards. Subclauses 6.3.1.2, 6.3.1.3 and 6.3.1.4 specify requirements and recommendations for the testing of these parameter groups. The test procedures and equipment for balanced cabling links and channels are specified in Clause 10.

Requirements are defined for other transmission parameters but are considered to be met by design.

It is recommended that installation specifications require the acceptance testing of permanent links since permanent link requirements incorporate an adequate margin to support the expected variability of the cords used to create channels.

NOTE A conformant channel containing a permanent link does not ensure that other channels created from that permanent link will themselves be conformant to channel requirements.

6.3.1.2 Permanent link testing

Independent of the requirements of the installation specification, basic verification parameters of Table 2 shall be tested using a sample level of 100 %.

Where the installation specification requires acceptance testing of internal transmission parameters of Table 2 against the permanent link requirements of Classes D, E, E_A, F, F_A, I or II, the sample level applied should be 100 %. If the test equipment is able to measure additional parameters in conjunction with the specified internal parameters of Table 2 then the sample should be 100 %.

Where the installation specification requires acceptance testing of alien (exogenous) transmission parameters of Table 2 against the permanent link requirements of Classes E_A or F_A, the minimum sample level applied should be in accordance with 6.3.1.4.

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Table 2 – Installed balanced cabling test parameters

Parameter group	Transmission parameter
Basic verification	Wire-map
	Continuity: direct current (DC) – Signal conductors – Screen conductors (if present) [a] – Short circuits – Open circuits
Internal transmission	Return loss
	Insertion loss [b]
	Pair-to-pair NEXT
	PS NEXT
	Pair-to-pair ACR-N
	PS ACR-N
	Pair-to-pair ACR-F
	PS ACR-F
	DC loop resistance [b]
	DC resistance unbalance within a pair
	DC resistance unbalance between pairs
	Propagation delay [b]
	Delay skew [b]
Alien (exogenous) crosstalk	PS ANEXT
	PS $ANEXT_{avg}$
	PS AACR-F
	PS $AACR\text{-}F_{avg}$

NOTE Link or channel length can also be of interest, but is not a pass/fail criterion.

[a] It shall be ensured that continuity is provided by the cabling components and not by alternative connections such as protective earth conductors.

[b] The margin between the measured value of a permanent link and the channel requirement should be reported where possible.

6.3.1.3 Channel testing

Channel tests can be used to determine performance where the installation specification requires

a) one or more cords to be added to each end of a permanent link of a given Class to create a channel of the same or lower Class,

b) permanent links of a given Class to be interconnected and one or more cords are added to each end to create a channel of a lower Class,

c) any cords attached to a permanent link of a given Class (or within a channel of a given Class) to be changed,

d) cabling implementations for which there are no permanent link limits (where standards do not contain requirements or where the installation specification contains channel requirements different from those specified in the referenced cabling design standards),

e) lengths and configurations of cabling that lie outside the reference implementations of the referenced cabling design standards.

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In cases a), b), and c), where the installation specification requires acceptance testing of internal transmission parameters of Table 2 against the permanent link requirements of Classes D, E, E_A, F or F_A, the sample level applied should be 100 %. A lower sample level can be applied to channel testing provided that the associated risk of undiagnosed faults is recognized in the quality plan.

In cases d) and e), where the installation specification requires acceptance testing of internal transmission parameters of Table 2 against the requirements of channel Classes D, E, E_A, F or F_A, the sample level applied should be 100 %.

Where the installation specification requires acceptance testing of alien (exogenous) transmission parameters of Table 2 against the requirements of a specific channel Class, the minimum sample level applied should be in accordance with 6.3.1.4.

6.3.1.4 Alien (exogenous) crosstalk testing

Where the installation specification requires acceptance testing of alien (exogenous) crosstalk transmission parameters of Table 2 of installed permanent links or channels against the requirements of permanent link or channel Classes E_A or F_A of ISO/IEC 11801-1:2017, the minimum sample of disturbed permanent links or channels to be tested should be in accordance with Table 3.

Table 3 – Minimum sample sizes for alien (exogenous) crosstalk testing

Total no. of links/channels N	Sample size
3 to 150	3 or ROUNDUP(0,1 × N) (whichever is the greater)
151 to 3 200	33 [a]
3 201 to 35 000	126 [a]
35 001 to 150 000	201 [a]
150 001 to 500 000	315 [a]
[a] Equivalent to acceptance quality level (AQL) of 0,4 %, normal inspection, general inspection level I as defined in the ISO 2859 series for populations of up to 500 000 links.	

The sample quantity shall be subject to the selection criteria as specified in IEC 61935-1.

IEC 61935-1 contains an option to reduce the quantity of tests provided that evidence exists to indicate that measured performance exhibits adequate margin against the specified limit.

6.3.2 Optical fibre cabling

6.3.2.1 General

Table 4 shows three groups of optical fibre cabling transmission parameters (basic verification, basic test group and extended test group) using the parameters that define the links and channels within the referenced cabling design standards. Subclauses 6.3.2.2 and 6.3.2.3 specify requirements and recommendations for the testing of these parameter groups. The test procedures and equipment for optical fibre cabling links and channels are specified in Clause 10.

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Table 4 – Installed optical fibre cabling test parameters

Parameter group	Transmission parameter
Basic verification	Polarity
Basic test group	Attenuation
	Propagation delay [a]
	Length [b, c]
Extended test group	Interface connector attenuation
	Interface connection return loss
	Embedded connecting hardware attenuation
	Embedded connecting hardware return loss
[a] Propagation delay is not a pass/fail criterion. [b] Length is not a pass/fail criterion. [c] Length may be determined by sheath marking or physical measurement.	

6.3.2.2 Permanent link testing

Where the permanent link contains non-fixed cabling (e.g. CP cable in ISO/IEC 11801-2 and LDP cable in ISO/IEC 11801-5), any result is only applicable to the specific configuration under test.

Independent of the requirements of the installation specification, basic verification parameters of Table 4 shall be tested using a sample level of 100 %.

Where the installation specification requires acceptance testing of transmission parameters of Table 4 against the requirements of a specific permanent link Class and

- where testing of optical fibre cabling attenuation is undertaken with equipment that also automatically tests verification parameters, a sample level of 100 % should be used,
- provided that polarity has been confirmed, testing of length/propagation delay can be restricted to a sample level within a given cable containing a number of permanent links or within a number of cables running in common pathways.
- where testing of propagation delay/length is undertaken with equipment that also automatically tests verification parameters, a sample level of 100 % should be used (propagation delay testing is only necessary where latency requirements are specified).

Testing of multimode optical fibre may be limited to 850 nm, unless otherwise specified.

6.3.2.3 Channel testing

Channel tests can be used to determine performance where the installation specification requires

a) one or more cords to be added to each end of a permanent link to create a channel,

b) permanent links to be interconnected and one or more cords are added to each end to create a channel,

c) any cords attached to a permanent link (or within a channel) to be changed,

d) cabling implementations for which there are no permanent link limits (where standards do not contain requirements or where the installation specification contains channel requirements different to those specified in the referenced cabling design standards).

Where channel tests are undertaken, the actual cords used to create the channel shall be used and installed in the as-built configuration. In all cases, the sampling recommendations of 6.3.2 apply.

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Testing of multimode optical fibre may be limited to 850 nm, unless otherwise specified.

6.4 Treatment of marginal results

6.4.1 Balanced cabling

6.4.1.1 General

IEC 61935-1 requires that test results of individual parameters be marked with an asterisk if the difference between the measured result and the test limit is less than the specified measurement accuracy.

The measurement accuracy is generally dependent on the field tester test limit, the nature of the test adapters, and actual link properties and is dependent on the frequency at which the minimum test margin occurs.

6.4.1.2 Requirements

The quality plan shall include guidelines on how marginal test results are handled.

As examples, the quality plan can state that

- marginal pass results shall be accepted but marginal fail results shall not be accepted,
- marginal results shall not be accepted,

NOTE This implies that the performance of the installed cabling has sufficient margin to accommodate the measurement accuracy of the tester to be used and that the tester measurement accuracy to be used is known.

- marginal results shall be accepted.

To minimize marginal test results, the quality plan shall specify the properties of the field tester that is used for testing. Field test equipment with better accuracy than the minimum specified in IEC 61935-1 for a given cabling performance and frequency range should be used.

6.4.2 Optical fibre cabling

ISO/IEC 14763-3 does not require that test results of individual parameters be marked with an asterisk if the difference between the measured result and the test limit is less than the specified measurement accuracy.

6.5 Treatment of non-compliant results

The quality plan shall detail the procedures to be applied where it has been impossible to obtain a compliant result. Examples of such procedures include labelling the cabling appropriately and highlighting its status and the impact of the non-compliance in the installation documentation. See 10.2.4 and 10.3.2 for further information.

6.6 Change control

All modifications, changes and variations to the installation specification and quality plan should be clearly documented to enable traceability.

7 Installation planning

7.1 General

Clause 7 details requirements and recommendations for planning of installations. It covers

- pathways and spaces,
- functional elements of the referenced cabling design standards,

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- segregation from power supply cabling,
- support for installation practices (e.g. bend radius, pulling load).

Relevant telecommunication services to be included when the installation is planned include

- voice,
- data,
- video,
- fire, security and access control systems,
- other building signalling systems (e.g. HVAC, EMS),
- machine control,
- remote power delivery.

7.2 Safety

7.2.1 General

The specification of safety requirements is beyond the scope of this document. It is referred to those safety standards and regulations applicable at the location of the installation.

7.2.2 Low voltage power supply cabling

The proper implementation of the requirements of this document assumes that electrical installations, bonding networks and protective measures against overvoltages are undertaken in accordance with the IEC 60364 series and/or local regulations, as appropriate.

In addition, installation and mitigation guidelines for electrical installations (including earthing) to ensure electromagnetic compatibility can be found in IEC TR 61000-5-2.

7.2.3 Telecommunications cables fire performance

Telecommunications cables inside buildings that do not comply with the national or local fire regulations or the minimum recommended performance requirements of IEC 60332-1-2 shall be installed within a cable management system that meets the requirements of a fire barrier in accordance with local fire regulations.

7.2.4 Optical fibre cabling

The hazard classification of areas containing optical fibre telecommunications equipment and optical fibre telecommunications cabling shall be undertaken in accordance with IEC 60825-2.

7.2.5 Transmission and terminal equipment

Telecommunications cabling shall be connected to equipment that complies with IEC 62368-1 or IEC 62949. Where equipment circuits provide direct current (DC) power transfer over the information technology cabling, the equipment shall comply with IEC 62368-3.

7.3 Environment

The MICE concept according to ISO/IEC 11801-1 shall be used to describe the environment where the cabling or parts of the cabling will be located.

Where necessary, product and supporting systems shall be selected to provide sufficient protection from the environment to enable the cabling to meet the required transmission performance.

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7.4 Points of electrical contact

The long-term stability of electrical connections including bonds between sections, or parts of pathway systems and to earthing systems depends on the galvanic coupling of the materials used. Where risk of galvanic corrosion exists, relevant specialists shall be consulted and any measures taken shall be documented for future use.

7.5 External service provision

7.5.1 Requirements

Information shall be obtained from, and agreement reached with, the access provider(s) and service provider(s) with respect to

a) the precise physical location of the ENI(s),

b) the quantity and capacity of the components that provide the ENI(s),

c) the identification and numbering of individual circuits at each ENI,

d) any additional options required,

e) the responsibility of the technical and operational maintenance of the boundary of the external service provision,

f) the liaison arrangements for the access providers(s) and service provider(s) and the premises owner or an appointed representative,

g) the procedures to be followed by the premises owner or an appointed representative in reporting and reacting to faults in the external service provision,

h) arrangements for access to the premises,

i) technical requirements for equipment supplied by the access providers(s) and service provider(s).

7.5.2 Recommendations

Access providers(s) and service provider(s) should be advised of the foreseeable service requirements.

7.6 Pathways and pathway systems

7.6.1 General

7.6.1.1 Pathway system types

Examples of pathway systems that can be used are shown in Table 5.

NOTE If a pathway system, cable management system or a compartment of a cable management system is selected to support a specific cabling technology, it might not be suitable for the subsequent installation of other cabling technologies.

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Table 5 – Examples of pathway systems

Pathway systems	Features
Cable trunking systems	Enclosed containment systems – consisting of a base and access cover, providing an enclosure for cables or insulated conductors and possible electrical and or communications accessories Openable pathway system Single or multiple compartment forms. Available in metallic or non-metallic form.
Cable tray systems	Open containment systems, consisting of a base and side members, intended to house cables and to provide support for the contained cable when used in horizontal pathways. Open pathway system Cable tray systems are mainly used in floor/ceiling spaces or in restricted access areas (e.g. above suspended ceiling, basements, plant rooms, telecommunications spaces). Available in metallic or non-metallic form.
Wire mesh cable tray system (basket)	A form of cable tray system where the cable tray consists of a mesh of wires. Open pathway system Typically available in metallic form.
Cable ladder systems	Open containment systems, consisting of side members, fixed to each other by means of rungs, intended to house cables and to provide support for the contained cable when used in horizontal pathways. Open pathway system Cable ladder systems are mainly used in horizontal and vertical pathways. Available in metallic and non-metallic form.
Conduit systems	Enclosed containment systems of circular cross-section, providing an enclosure for cables or insulated conductors. Closed pathway system Available in metallic or non-metallic form.
Cable ducting systems	Enclosed containment systems of non-circular cross-section, providing an enclosure for cables or insulated conductors and possibly electrical and or communication accessories. Closed pathway system Available in metallic or non-metallic form.
Interval support	Open support system. Designed to support small to medium number of cables and normally used above suspended ceiling or below raised floors. Available in a range of forms (e.g. hooks and fasteners) and materials (metallic or non-metallic).
Designated routes	Pathways defined by markings or some other designation, normally used in floor spaces or within hollow walls or other building structures.
Catenary	A suspended strength member to which single or multiple cables can be attached to span an open space. Available in metallic or non-metallic form. In some cases the cable is designed as a catenary cable and contains an integral catenary strength member.

7.6.1.2 Requirements

7.6.1.2.1 Pathway and pathway system selection

Pathways shall be planned to accommodate maximum distance restrictions for balanced, coaxial and optical fibre applications by means of the appropriate placement of spaces accommodating transmission and terminal equipment and the provision of suitably direct routes between them.

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Where multiple phases of cable installation are anticipated, pathway systems shall be designed (by means of physical dimensions or by internal partitioning) to provide any required segregation to meet operational objectives (e.g. removal, re-installation).

Access to pathways and pathway systems containing the cabling infrastructures serving multiple premises (enterprises, tenants) shall be restricted as specified in Annex B.

Pathway systems shall be selected in accordance with the installation requirements of the telecommunications cabling manufacturer or supplier.

Pathways and the pathway systems within the pathways shall be able to accommodate components and where necessary provide adequate ventilation, in order that any stated remote powering objectives neither compromise the transmission requirements of the installation specification or the warranty conditions of the components. Information on assessment methods is provided in 7.14.

Elements of other supply systems such as water, heating, HVAC or sprinklers shall not be used as pathways or support for pathway systems due to the potential environmental impact on the cabling components and the risk that cable support will disappear following changes made to the supporting system.

NOTE An exception to this is where the telecommunications cabling directly serves a device of the supply system (e.g. water meter).

The grids of suspended ceilings shall not be used as support for pathway systems but can be used as pathways for individual cables serving devices within the suspended ceiling.

The location or construction of pathways within, and pathway systems installed in, escape routes shall prevent the installed cables becoming an obstacle in the event of fire during the periods of evacuation and fire-fighting activity.

The inside of the pathway systems shall

- have smooth surfaces and be free of burrs, sharp edges or projections that can damage cable insulation,
- be free of localized pressure points that can degrade the transmission performance of the installed system.

Abrasive supports (e.g. threaded rod) installed within the cable fill area shall have that portion within the pathway system protected with a smooth, non-scratching covering so that cable can be pulled without physical damage.

Cable management systems of the types listed below shall comply with the relevant International Standards:

- conduit systems: IEC 61386 series;
- cable trunking systems and cable ducting systems: IEC 61084 series;
- cable tray systems and cable ladder systems: IEC 61537.

The external surfaces of existing piping systems shall not be used for the installation of pathway systems or the direct attachment of cables.

Segregation between power supply cabling and metallic telecommunications cabling shall be in accordance with 7.9.

Separation of cable bundles within pathways (and pathway systems) shall be adequate to support any remote powering objectives defined in the installation specification. Subclause 7.14 provides details of appropriate assessments.

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Where separation between different cabling systems is required, this shall be maintained by physical barriers to prevent unintended change during installation or extensions to the installation.

Where separation between different cabling systems is required, it shall be maintained by physical separation to prevent accidental damage during installation or extensions to the installation.

7.6.1.2.2 Pathway and pathway system capacity planning

Within pathway systems, the usable cross-sectional area is determined as follows:

a) for open or openable pathway systems and cable management systems (e.g. tray or basket), cables are not installed above the sidewalls;

b) bends in the pathway systems can restrict the usable cross-sectional area dependent upon the specified bend radii of the cable to be installed;

c) for pathway systems to which cables are to be attached or supported (e.g. messenger/catenary wires or designated routes), the cross-sectional area is the minimum available area surrounding the pathway system.

NOTE For pathway systems containing cables of a common diameter, the cross-sectional area can be considered to be the number of cables.

During initial planning, the cross-sectional area of the cables shall not exceed 40 % of the cross-sectional area of the pathway system at its most restrictive point.

7.6.1.3 Recommendations

7.6.1.3.1 Pathway and pathway system selection

For access providers. a minimum of two entrance pathways for access providers should be provided, both of which should be

- located underground (aerial entrance pathways are not recommended because of their vulnerability due to physical exposure),
- physically separated, between the boundary of the premises and the point of entry into the building, by at least 20 m to ensure that a single incident will not cause damage to both entrance pathways.

The number of pathway systems required within each of the building entrance pathways depends on the number of access providers and the number and type of cables that the access providers will install. The entrance pathway systems should have adequate capacity to handle growth and additional access providers.

For generic cabling, it is recommended that the planning of pathways and the selection of pathway systems is undertaken using a structured approach and addressing each cabling sub-system in turn.

Additional pathway systems to support future installations should be considered where the cost of subsequent installation can be reduced.

Any maintenance holes, hand holes and closures within the pathways in unsecured areas should be protected against unauthorized access.

Pathway systems should be selected to ensure that water or other contaminant liquids cannot collect. The use of hidden pathways (such as within plastered wall surfaces) is not recommended but, if used, cabling should have either vertical or horizontal orientation.

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7.6.1.3.2 Pathway and pathway system capacity planning

Pathway systems should be planned for the maximum predicted deployment of cabling. This can be achieved either by deploying sufficient pathway systems at the time of installation or by planning and reserving space for sufficient additional pathway systems.

Open or openable pathway systems should provide adequate capacity to allow subsequent installation of additional telecommunications cables whilst maintaining minimum bend radii (see 7.6.2.1.2) and segregation from power supply cabling (see 7.9).

7.6.2 Inside buildings

7.6.2.1 Requirements

7.6.2.1.1 Loading and protection

Co-ordination of cabling pathway and space design in conjunction with architects and other engineers is critical.

If the pathway systems are to be supported from overhead structures, the overhead structure shall have a hanging capacity of 1,2 kPa (minimum) in addition to that required to support any other infrastructures. This requirement shall be communicated to, and coordinated with, the structural engineer.

If the pathway systems are to be supported by access floor systems, the weight of fully loaded pathway systems shall be evaluated and co-ordinated with the access floor system designer.

Pathway systems shall be installed to provide adequate protection to the installed cabling where cabling can be damaged or have its transmission properties adversely affected.

The use of hidden pathways within plastered wall surfaces requires the use of appropriately specified cables and is not recommended from a maintenance perspective.

In fixed installations where impact to the installed cabling can occur (specifically including all cabling within 50 mm above floor level) protection shall be afforded by one or more of the following:

- the mechanical characteristics of the pathway system;
- the location selected;
- the provision of additional local or general mechanical protection.

The selection of pathway systems shall enable the installation of fire barriers, if required.

Sufficient space shall be allocated to hand holes and the storage of cable loops (service loops) in accordance with manufacturer's instructions (see 7.6.2.1.2 in relation to minimum bend radius).

Where used, cable bundles shall not contain more than 24 cables.

Grouping of cables (by bundling or other means) and the separation of such groups shall take into account the remote powering objectives of the installation specification (see 5.3.4). Information on assessment methods is provided in 7.14.

Where multiple cables are run in a fixed physical relationship, cables with appropriate performance shall be selected to prevent any impact on transmission performance.

NOTE For example, applications dependent on PS AACR-F can be affected in cables of differing lengths in close proximity.

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7.6.2.1.2 Minimum bend radii

The pathway system shall ensure that cable is able to be installed and, where appropriate, fixed in accordance with the applicable minimum bend radius (installation, operating static and operating dynamic) by using identifiable techniques. These requirements apply in all places where cables change direction and apply in three dimensions. Examples of such techniques are pre-fabricated curved corners and radius limiters as shown in Figure 4.

The techniques employed shall

- be designed to maintain the relevant minimum bend radius of the cable(s) to be installed,

  Where either multiple cable types are involved or cables have multiple bend radius specifications (e.g. cable bundles, so-called shotgun cables or cables with dedicated/catenary wires attached), the largest minimum bend radius shall apply.
- not introduce deformation of the cable sheath,
- not apply compressive loads exceeding that specified for the cable.

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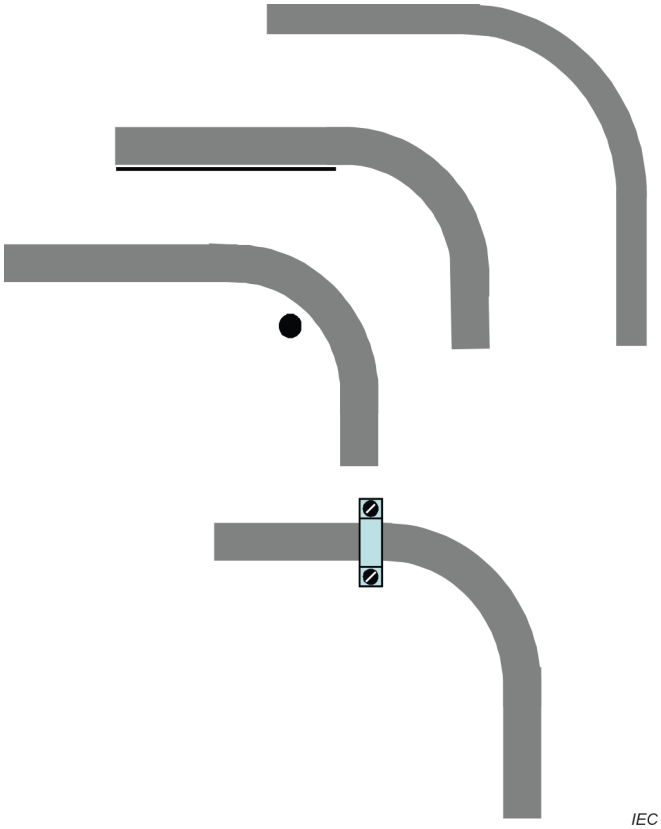

Figure 4a – Examples of non-conformant bend limiting techniques

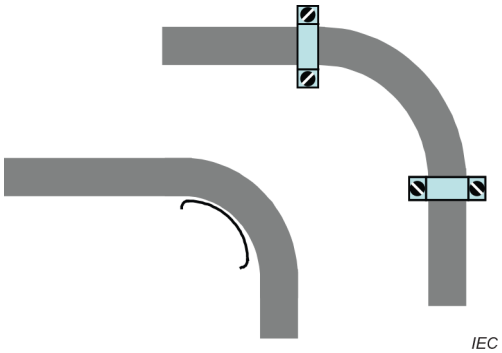

Figure 4b – Examples of conformant bend limiting techniques

Figure 4 – Examples of conformant and non-conformant bend radius management

Minimum bend radius is determined by manufacturer's instructions.

If instructions do not exist, the minimum bend radius shall be the greater of either 50 mm or

- four times the cable diameter for 4-pair balanced cables,
- eight times the cable diameter for other metallic cables,
- 10 times the cable diameter for optical fibre cables,
- 10 times the cable diameter for coaxial cables.

NOTE 1 Pathway systems that do not allow such an approach can restrict the type and use of cables installed in the pathways and cable management systems selected.

NOTE 2 Specific cable constructions, e.g. armoured cables, can require greater bend radii than those specified above.

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7.6.2.1.3 Maximum stacking height

The maximum stacking height in pathway systems is determined by manufacturers' instructions for the cable with the lowest crush resistance to be installed within the pathway system. If instructions do not exist, the following shall apply:

- for continuous pathway systems (e.g. cable trays), the stacking height shall not exceed 150 mm;
- for non-continuous pathway systems (e.g. wire mesh cable tray, cable ladder) and interval support pathway systems (e.g. hooks), the maximum stacking height shall be calculated according to Table 6.

Table 6 – Stacking height for non-continuous and interval support pathway systems

Distance between supports l (mm)	Formula	Maximum stacking height h (mm)
0	$h = \frac{150}{1+0{,}002\times l}$	150
100		125
150		115
250		100
500		75
750		60
1 000		50
1 500		37,5
NOTE The requirement for h is based on cables with a crush resistance of at least 5 000 N/m.		

7.6.2.1.4 Conduit

Unless appropriately specified cables and/or installation techniques are to be used

- the maximum distance between pulling points shall be 50 m where conduits are installed without bends,
- the maximum distance between pulling points shall be 30 m where conduits are installed with up to two 90° bends.

Where a conduit contains bends

- the conduit shall not be subject to cumulative changes in direction of more than 180° between pulling points (e.g. outlets, telecommunications rooms, or pull boxes),
- the conduit shall not contain more than two bends of up to 90° each between pulling points.

Bends within conduits shall be accessible and able to act as pulling points unless no additional cables are to be installed within the conduit, following the initial installation of cable, unless

- cables are to be removed before any additional installation takes place,
- the conduit contains sub-ducts to allow additional cables to be installed.

The inside radius of a bend in conduit shall be at least six times the internal conduit diameter. Bends in the conduit shall not contain any kinks or other discontinuities that can have a detrimental effect on the cable sheath during cable pulling operations.

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The cross-sectional area of the planned/installed cables shall not exceed 40 % of the conduit cross-sectional area.

7.6.2.1.5 Pathway systems under access floors

There shall be adequate space between the top of open cable management systems (e.g. cable tray, wire mesh cable tray) and the access floor tiles to allow the cables to enter/exit the pathway systems without risk of damage and in accordance with the applicable minimum bend radius (installation, operating static and operating dynamic).

Where cable management systems are vertically stacked and run in parallel to provide additional capacity, at least 200 mm vertical separation shall be provided between each layer to provide adequate access to lower layers for addition and removal of cables.

7.6.2.1.6 Non-continuous support for cables

The distance between supporting elements of the pathway system shall not exceed 1 500 mm.

7.6.2.2 Recommendations

7.6.2.2.1 Pathway system co-ordination

Within equipment rooms, the location of aisles separating rows of cabinets, frames or racks should be co-ordinated with lighting and fire protection plans:

- lighting should be placed above aisles and not above cabinets, frames, racks and overhead pathways;
- pathways should not be located where they interfere with proper operation of fire suppression systems such as water distribution from sprinkler heads.

Pathways should not block airflow to or from air conditioning equipment.

Pathways should not restrict access to components of other infrastructures that require periodic maintenance (e.g. valves, electrical receptacles and smoke detectors). Underfloor pathways should not be located above such equipment unless there is an uncovered (accessible) row of tiles adjacent to these pathways.

If the pathway systems are to be supported from overhead structures, the overhead structure should have a hanging capacity of 2,4 kPa (minimum) in addition to that required to support any other infrastructures. Any resulting requirement shall be communicated to, and coordinated with, the structural engineer.

7.6.2.2.2 Cable protection

The use of curved corners (pre-fabricated or manufactured on site) should be considered to maintain cable bend radii and avoid over-filling around bends (see Figure 5).

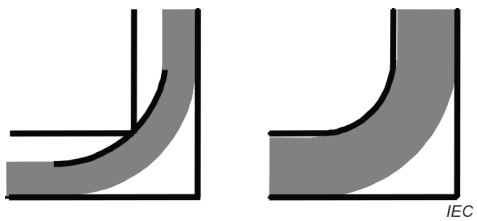

Figure 5 – Example of use of curved corners in pathway systems

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7.6.2.2.3 Conduit

Conduits (or ducts) protruding through a floor should be terminated at least 50 mm above the finished floor surface.

NOTE This protrusion aids in preventing poured concrete from entering the pathway during construction and protects cabling and fire-stop materials from water and other liquid spills.

7.6.2.2.4 Pathway systems under access floors

Where cable management systems are vertically stacked and run in parallel to provide additional capacity,

- access to lower layers should be provided by either using narrower cable management systems for upper layers (as shown in Figure 6) or by providing an uncovered (accessible) row of adjacent tiles (as shown in Figure 7),
- at least 300 mm vertical separation should be provided between each layer to provide adequate access to lower layers for addition and removal of cables.

7.6.2.2.5 Overhead pathway systems

Overhead cable pathways can alleviate the need for access floors that do not employ floor-standing systems that are cabled from below. Overhead cable management systems can be stacked to provide additional capacity.

Cable management systems should be suspended from overhead structures where increased operational flexibility is required to

- support the use of cabinets, frames and racks of various heights,
- add or remove cabinets, frames and racks.

Increased operational flexibility can also be achieved by using freestanding structures with integrated pathways provided that they are designed to accommodate the installation and removal of the desired sizes of cabinets, frames or racks.

Cable management systems can be attached to the tops of cabinets, frames and racks where they are of uniform height.

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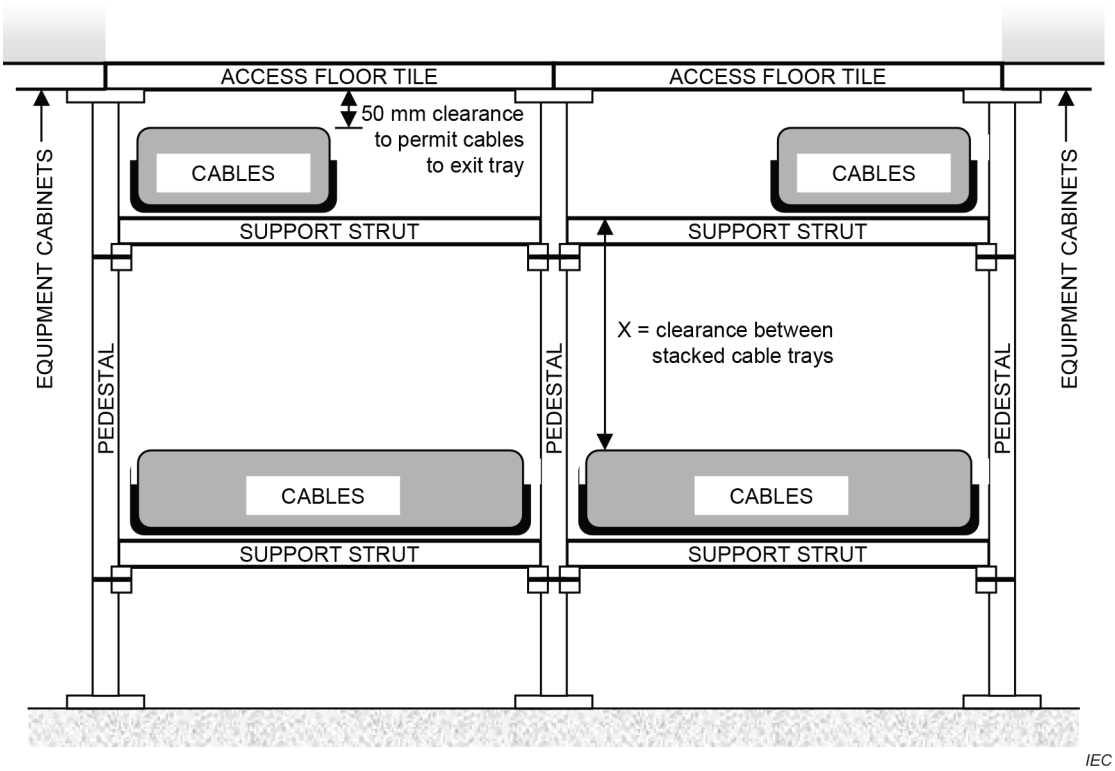

Figure 6 – Example of layered cable trays with smaller width upper trays

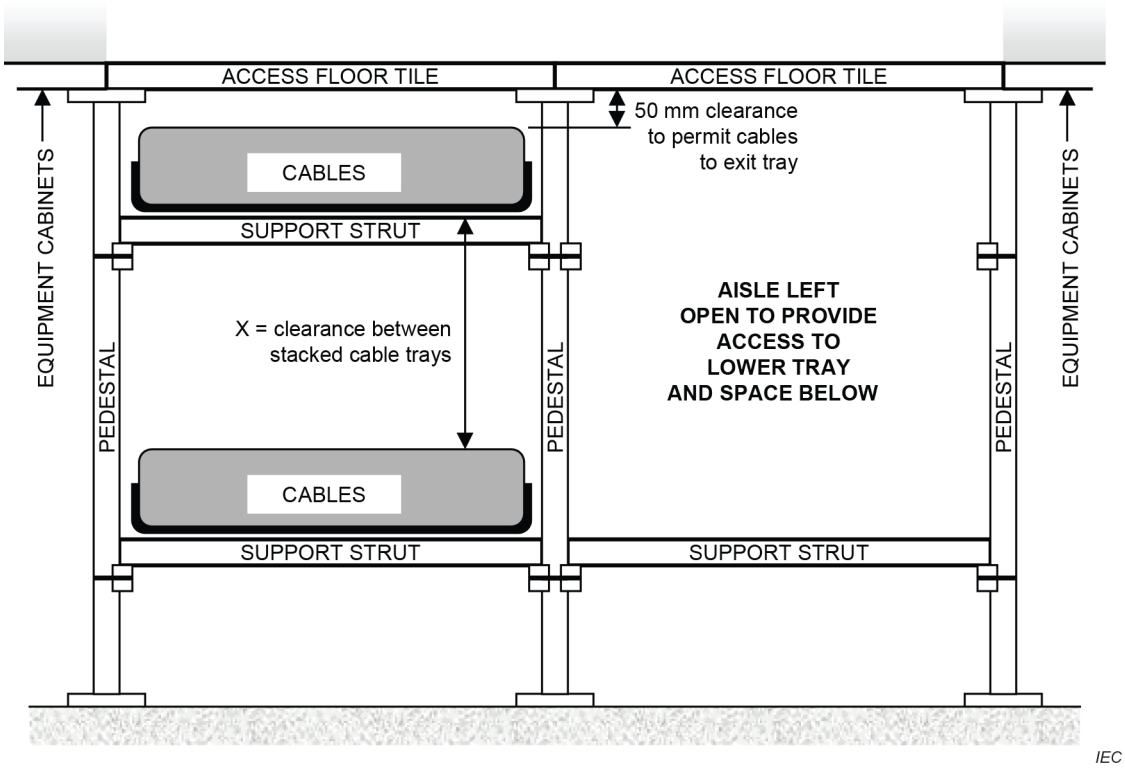

Figure 7 – Example of uncovered (accessible) row of floor tiles to provide access to lower tray

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