

Australian/New Zealand Standard™

**Information technology—
Implementation and operation of
customer premises cabling**

Part 2: Planning and installation



AS/NZS ISO/IEC 14763.2:2014

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee CT-001, Communications Cabling. It was approved on behalf of the Council of Standards Australia on 3 June 2014 and on behalf of the Council of Standards New Zealand on 20 April 2014.

This Standard was published on 17 June 2014.

The following are represented on Committee CT-001:

Australian Chamber of Commerce and Industry
Australian Industry Group
Australian Information Industry Association
BICSI South Pacific (Australia)
BICSI South Pacific (New Zealand)
Electrical Trades Union
Energy Networks Association
Engineers Australia
National Electrical and Communications Association
Telecommunications Users Association of New Zealand
Telstra Corporation

Additional Interests:

Australian Communications and Media Authority
Communications Alliance
National Broadband Network

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Web Shop at www.saiglobal.com.au or Standards New Zealand web site at www.standards.co.nz and looking up the relevant Standard in the on-line catalogue.

For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of either Standards Australia or Standards New Zealand at the address shown on the back cover.

This Standard was issued in draft form for comment as DR AS/NZS ISO/IEC 14763.2.

Australian/New Zealand Standard™

Information technology— Implementation and operation of customer premises cabling

Part 2: Planning and installation

First published as AS/NZS ISO/IEC 14763.2:2014.

COPYRIGHT

© Standards Australia Limited/Standards New Zealand

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968 (Australia) or the Copyright Act 1994 (New Zealand).

Jointly published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001 and by Standards New Zealand, Private Bag 2439, Wellington 6140.

ISBN 978 1 74342 742 2

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee CT-001, Communications Cabling.

This Standard is identical with, and has been reproduced from ISO/IEC 14763-2:2012, *Information technology—Implementation and operation of customer premises cabling, Part 2: Planning and installation*.

As this Standard is reproduced from an International Standard, the following applies:

- (a) In the source text ‘this part of ISO/IEC 14763’ should read ‘this Australian/New Zealand Standard’.
- (b) A full point substitutes for a comma when referring to a decimal marker.

References to International Standards should be replaced by references to Australian or Australian/New Zealand Standards, as follows:

<i>Reference to International Standard</i>	<i>Australian/New Zealand Standard</i>
IEC	AS/NZS IEC
61935 Specification for the testing of balanced and coaxial information technology cabling	61935 Specification for the testing of balanced and coaxial information technology cabling
61935-1 Part 1: Installed balanced cabling as specified in ISO/IEC 11801 and related standards	61935.1 Part 1: Installed balanced cabling as specified in ISO/IEC 11801 and related standards (IEC 61935-1, Ed.3.0 (2009) MOD)
ISO/IEC	AS/NZS
11801 Information technology—Generic cabling for customer premises	3080 Information technology—Generic cabling for customer premises (ISO/IEC 11801:2011, MOD)
	AS/NZS ISO/IEC
14763 Information technology—Implementation and operation of customer premises cabling	14763 Telecommunications installations—Implementation and operation of customer premises cabling
14763-3 Part 3: Testing of optical fibre cabling	14763.3 Part 3: Testing of optical fibre cabling (ISO/IEC 14763-3:2011, MOD)
24702 Information technology—Generic cabling—Industrial premises	24702 Telecommunications installations—Generic cabling—Industrial premises
24764 Information technology—Generic cabling systems for data centres	24764 Generic cabling systems for data centres

Only normative references that have been adopted as Australian or Australian/New Zealand Standard have been listed.

The term ‘normative’ has been used in this Standard to define the application of the annex to which it applies. A ‘normative’ annex is an integral part of a Standard.

CONTENTS

1	Scope.....	13
2	Normative references	14
3	Terms, definitions and abbreviations	15
3.1	Terms and definitions	15
3.2	Abbreviations	21
3.3	Conventions	22
4	Conformance	22
5	Specification of installations	23
5.1	General	23
5.2	Installation specification	23
5.2.1	Requirements	23
5.2.2	Recommendations	25
5.3	Technical specification	25
5.3.1	General	25
5.3.2	Safety requirements	26
5.3.3	Security requirements.....	26
5.3.4	Performance and configuration – Requirements.....	26
5.3.5	Environmental conditions.....	27
5.4	Scope of work	27
5.4.1	Pre-installation	27
5.4.2	Installation.....	28
5.4.3	Post-installation.....	29
5.5	Quality assurance	29
6	Quality planning	30
6.1	Quality plan	30
6.2	Sampling	31
6.2.1	Balanced cabling	31
6.2.2	Optical fibre cabling.....	33
6.3	Treatment of marginal results	34
6.3.1	Balanced cabling	34
6.3.2	Optical fibre cabling.....	34
6.4	Treatment of non-compliant results	35
6.5	Change control.....	35
7	Installation planning	35
7.1	General	35
7.2	Safety	35
7.2.1	General	35
7.2.2	Mains power cabling.....	35
7.2.3	Optical fibre cabling.....	35
7.3	Environment.....	36
7.4	Points of electrical contact.....	36
7.5	External service provision	36
7.5.1	Requirements	36

	<i>Page</i>
7.5.2 Recommendations	36
7.6 Pathways and pathway systems	36
7.6.1 General	36
7.6.2 Inside buildings	39
7.6.3 Outside buildings	42
7.7 Spaces	46
7.7.1 Requirements	46
7.7.2 Recommendations	48
7.8 Functional elements	50
7.8.1 Requirements	50
7.8.2 Recommendations	51
7.9 Segregation of information technology cabling and mains power cabling	52
7.9.1 General	52
7.9.2 Requirements	53
7.9.3 Recommendations	59
7.10 Cabling – Requirements	59
7.10.1 General	59
7.10.2 Unscreened cabling	59
7.10.3 Screened cabling	60
7.10.4 Optical fibre cabling	60
8 Installation practices	60
8.1 General	60
8.2 Safety	60
8.2.1 General	60
8.2.2 Mains power cabling	60
8.2.3 Functional bonding	60
8.2.4 Optical fibre cabling	60
8.2.5 Guards and signs	61
8.2.6 Enclosed spaces	61
8.2.7 Maintenance holes	61
8.2.8 Closures	61
8.3 Environment	61
8.3.1 Storage	61
8.3.2 Installation – Requirements	61
8.4 Component inspection and testing – Requirements	61
8.5 Pathways	62
8.5.1 Requirements	62
8.5.2 Inside buildings – Requirements	62
8.5.3 Outside buildings	62
8.6 Spaces	63
8.6.1 Requirements	63
8.6.2 Entrance facilities	63
8.6.3 Rooms and enclosures intended to contain distributors	63
8.6.4 Cabinets, frames and racks	63
8.6.5 Closures	63
8.6.6 Outlets	63
8.7 Pathway system installation	63
8.7.1 General	63
8.7.2 Inside buildings	64

8.7.3	Outside buildings	64
8.8	Closure installation	64
8.9	Cable installation	65
8.9.1	Cable installation within pathway systems	65
8.9.2	General	65
8.9.3	Inside buildings	66
8.9.4	Cable installation in maintenance holes	66
8.9.5	Cable installation within closures – Requirements	67
8.10	Jointing and terminating of cables	67
8.10.1	Requirements	67
8.10.2	Balanced cabling	68
8.10.3	Screened balanced cabling	68
8.10.4	Optical fibre cabling	68
8.11	Cords and jumpers	68
8.12	Surge protective devices	68
8.13	Acceptance	68
8.13.1	Inspection	68
8.13.2	Testing	69
9	Documentation and administration	69
9.1	Symbols and preparation of documents	69
9.2	Administration	69
9.2.1	General	69
9.2.2	Administration system	70
9.2.3	Identifiers – Requirements	72
9.2.4	Component labelling	72
9.2.5	Records	75
9.2.6	Cable administration system	79
9.2.7	Reports	82
10	Testing	82
10.1	General	82
10.1.1	Links and permanent links	82
10.1.2	Channels	83
10.1.3	Cabling interface adaptors	84
10.1.4	Calibration	84
10.1.5	Equipment protection	84
10.1.6	Measurement conditions	84
10.2	Test procedures for balanced cabling	85
10.2.1	General	85
10.2.2	Measurement of length-related parameters	85
10.2.3	Treatment of marginal test results	85
10.2.4	Treatment of unacceptable test results	85
10.2.5	Test result format	85
10.2.6	Test result documentation	86
10.3	Test procedures for optical fibre cabling	86
10.3.1	General	86
10.3.2	Treatment of unacceptable test results	86
10.3.3	Test result documentation	87
11	Inspection	87
11.1	General	87

11.2	Inspection Level 1	87
11.3	Inspection Level 2	88
11.4	Inspection Level 3	88
11.5	Inspection documentation – Requirements	88
12	Operation	89
12.1	Standard operating procedure	89
12.1.1	Requirements	89
12.1.2	Recommendations	89
12.2	Cords and jumpers	89
12.3	Optical fibre adaptors	89
13	Maintenance	89
13.1	Approaches to maintenance	89
13.1.1	General	89
13.1.2	Requirements	90
13.2	Maintenance procedures	90
13.2.1	Requirements	90
13.2.2	Recommendations	90
14	Repair	91
	Annex A (normative) Optical fibre polarity maintenance: connecting hardware for multiple optical fibres	92
	Annex B (normative) Common infrastructures within multi-tenant premises	101
	Annex C (normative) Cabling in accordance with ISO/IEC 11801	109
	Annex D (normative) Cabling in accordance with ISO/IEC 15018	116
	Annex E (normative) Cabling in accordance with ISO/IEC 24764	122
	Annex F (normative) Cabling in accordance with ISO/IEC 24702	135
	Annex G (normative) Cabling in accordance with ISO/IEC TR 24704	138
	Bibliography	139
	Figure 1 – Schematic relationship between ISO/IEC 14763-2 and other relevant standards	12
	Figure 2 – Quality assurance schematic	23
	Figure 3 – Example of conformant and non-conformant bend radius management	40
	Figure 4 – Example of use of curved corners in pathway systems	42
	Figure 5 – Example of cabling installations outside buildings	43
	Figure 6 – Dimensions of rooms intended to contain distributors	50
	Figure 7 – Process of determining cable separation	54
	Figure 8 – Flowchart for cable separation calculation	57
	Figure 9 – Separation of mains power and information technology cables without dividers	58
	Figure 10 – Separation of mains power and information technology cables with dividers	58
	Figure 11 – Examples of cord and jumper labelling	74
	Figure 12 – Cable administration database and possible linkages	80
	Figure 13 – Basic cabling administration	80
	Figure 14 – Examples of cabling permanent links	83
	Figure 15 – Reference planes for link and channels (point-to-point)	83
	Figure 16 – Example of a cabling channel	84

Figure A.1 – Duplex connecting hardware plug	93
Figure A.2 – Duplex connecting adapter	93
Figure A.3 – Duplex patch cord	93
Figure A.4 – Views of crossover patch cords	94
Figure A.5 – Optical fibre sequences and adapter orientation in patch panel for the symmetrical position method	95
Figure A.6 – Optical fibre sequences and adapter orientation in patch panel for the reverse-pair position method	95
Figure A.7 – Array connector cable or patch cord (key-up to key-up)	97
Figure A.8 – Array adapter with aligned keyways	97
Figure A.9 – Transition assembly	98
Figure A.10 – Connectivity method for duplex signals	99
Figure A.11 – Connectivity method for parallel optics channels	100
Figure B.1 – Example of common pathways and spaces in a multi-tenant building	102
Figure B.2 – Example of a campus entrance facility	104
Figure B.3 – Example 1: Common equipment room	106
Figure B.4 – Example 1: Common telecommunications room	107
Figure B.5 – Example 2: Common telecommunications room	107
Figure C.1 – Connection of functional elements providing redundancy	110
Figure E.1 – Connection of functional elements providing redundancy	123
Figure E.2 – Example of layered cable trays with smaller width upper trays	126
Figure E.3 – Example of uncovered (accessible) row of floor tiles to provide access to lower tray	127
Figure E.4 – Dimensions of rooms intended to contain distributors	129
Figure E.5 – Example of "hot" aisles, "cold" aisles and cable pathway locations	131
Table 1 – Installed balanced cabling test parameters	31
Table 2 – Minimum sample sizes for alien (exogenous) crosstalk testing	33
Table 3 – Installed optical fibre cabling test parameters	33
Table 4 – Examples of pathway systems	37
Table 5 – Stacking height for non-continuous and interval support pathway systems	41
Table 6 – Design and planning of pathways outside buildings	43
Table 7 – Separation recommendations between metallic information technology cabling and specific EMI sources	53
Table 8 – Classification of information technology cables	55
Table 9 – Minimum separation S	55
Table 10 – Power cabling factor P	56
Table 11 – Level of installation complexity	70
Table 12 – Level of operational complexity	70
Table 13 – Minimum requirements of administration systems	71
Table 14 – Minimum requirements of operational administration systems	72
Table 15 – Labelling requirements	73
Table 16 – Labelling recommendations (additional)	74
Table 17 – Infrastructure records for spaces, cabinets, racks, frames and closures	76

Table 18 – Infrastructure records for cables and termination points	77
Table 19 – Infrastructure records	78
Table 20 – Infrastructure records for pathways and premises.....	79
Table 21 – Recommendations of installation administration systems.....	81
Table 22 – Recommendations of operational administration systems	81
Table A.1 – Optical fibre colour code scheme of IEC 60794-2	92
Table B.1 – Summary of common spaces used to service a multi-tenant building.....	102
Table D.1 – Minimum requirements for dimensions of primary distribution spaces	118
Table D.2 – Requirements for dimensions of secondary distribution spaces.....	119
Table D.3 – Minimum dimensions of spaces allocated to junction boxes	120
Table D.4 – Recommendations for dimensions of primary distribution spaces	120
Table D.5 – Recommendations for dimensions of secondary distribution spaces.....	121
Table E.1 – Environmental requirements for data centres	124
Table F.1 – Risk elements for consideration in determining an appropriate maintenance approach.....	137

INTRODUCTION

The importance of services delivered by information technology 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 organisation's effectiveness.

There are four phases in the successful implementation of information technology 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 International Standard supports the specification, implementation and operation of generic information technology 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, etc.,
- 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 the main body of this standard are premises-independent. The following normative Annexes include requirements for generic cabling in accordance with specific standards

- Annex C: Cabling in accordance with ISO/IEC 11801,
- Annex D: Cabling in accordance with ISO/IEC 15018,
- Annex E: Cabling in accordance with ISO/IEC 24764,
- Annex F: Cabling in accordance with ISO/IEC 24702,

- Annex G: Cabling in accordance with ISO/IEC TR 24704.

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

This standard is also relevant to

- architects, building designers and builders,
- main contractors,
- designers, suppliers, installers, inspectors (auditors), building managers, maintainers and owners of information technology cabling,
- public network providers and local service providers,
- end users.

This International Standard 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 standards and technical reports.

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

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.

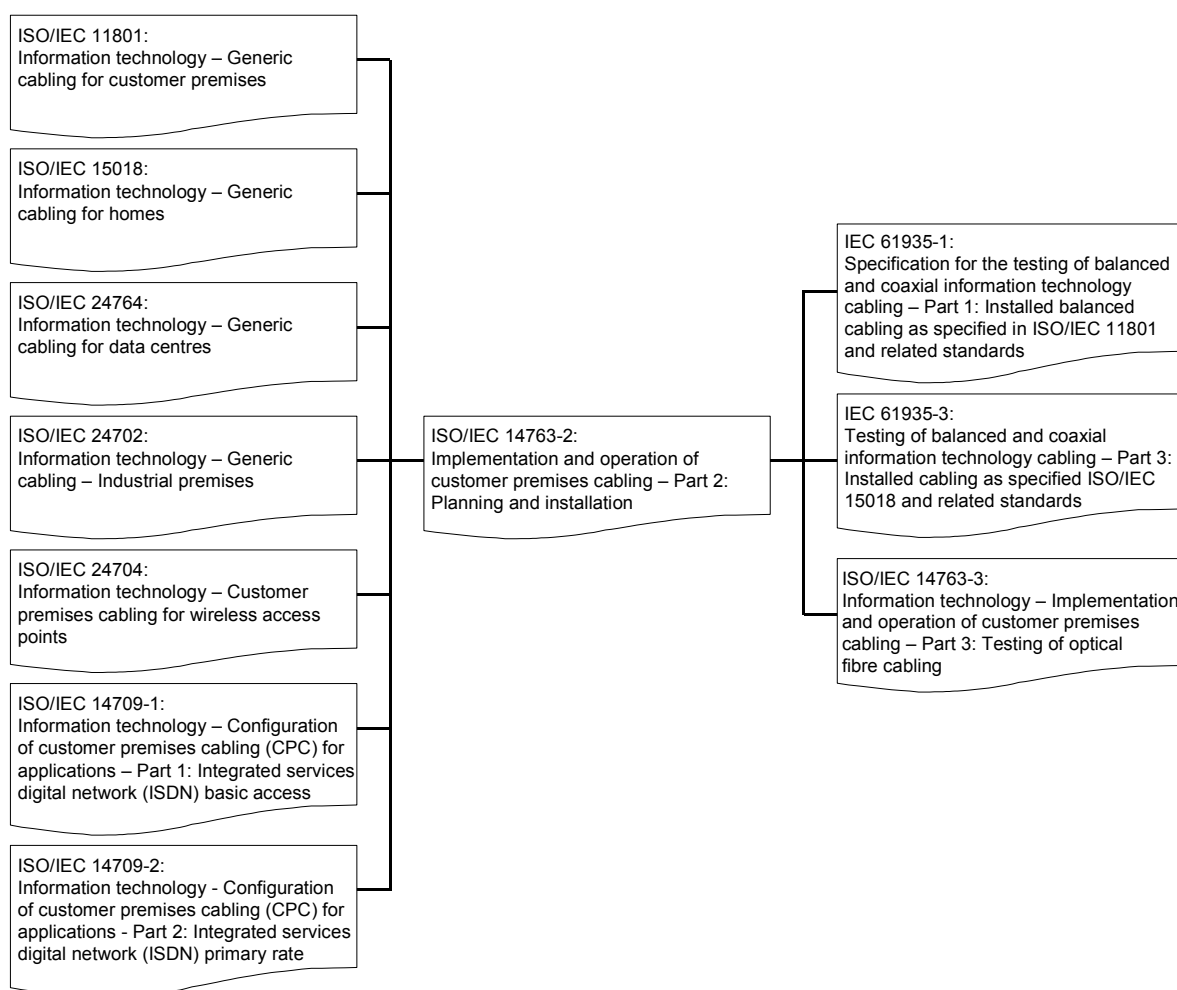


Figure 1 – Schematic relationship between ISO/IEC 14763-2 and other relevant standards

NOTES

AUSTRALIAN/NEW ZEALAND STANDARD

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 cabling and cabling infrastructures (including cabling, pathways, spaces, earthing and bonding) in support of generic cabling standards and associated documents.

The following aspects are addressed

- specification of the installation,
- quality assurance,
- installation planning,
- installation practice,
- documentation,
- administration,
- testing,
- inspection,
- operation,
- maintenance,
- repair.

The requirements of Clauses 5 to 14 of this standard are premises-independent and may be amended by the requirements of premises-specific Annexes.

This part of ISO/IEC 14763 excludes

- specific requirements applicable to other cabling systems (e.g. mains power cabling); however, it takes account of the effects other cabling systems may have on the installation of information technology cabling (and vice versa) and gives general advice,
- 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 standard 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 (electrical safety and protection, optical power, fire, etc.) and electromagnetic compatibility (EMC) requirements are outside the scope of this international standard and are covered by other standards and regulations. However, information given in this international standard may be of assistance in meeting these standards and regulations.

2 Normative references

The following referenced documents are indispensable for the application 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 – Chapter 52: Wiring systems*

IEC 60794-2, *Optical fibre cables – Part 2: Indoor cables – Sectional specification*

IEC 61082-1, *Preparation of documents used in electrotechnology – Part 1: Rules*

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

IEC 61156-5 (all parts), *Multicore and symmetrical pair/quad cables for digital communications – Part 5: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Horizontal floor wiring*

IEC 61156-6 (all parts), *Multicore and symmetrical pair/quad cables for digital communications – Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Work area wiring*

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 61918:2010, *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 61935-3, *Testing of balanced and coaxial information technology cabling – Part 3: Installed cabling as specified in ISO/IEC 15018*

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: Sectional specification – Coordination dimensions for cases and cabinets*

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

ISO/IEC 11801:2002, *Information technology – Generic cabling for customer premises*
Amendment 1 (2008)
Amendment 2 (2010)

ISO/IEC 14709-1, *Information technology – Configuration of Customer Premises Cabling (CPC) for applications – Part 1: Integrated Services Digital Network (ISDN) basic access*

ISO/IEC 14709-2, Information technology – Configuration of Customer Premises Cabling (CPC) for applications – Part 2: Integrated services Digital Network (ISDN) primary rate

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

ISO/IEC 15018:2004, Information technology – Generic cabling for homes
Amendment 1 (2009)

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

ISO/IEC 24702:2006, Information technology – Generic cabling – Industrial premises
Amendment 1 (2009)

ISO/IEC TR 24704:2004, Information technology – Customer premises cabling for wireless access points

ISO/IEC 24764:2010, Information technology – Generic cabling systems for data centres

ISO/IEC TR 29106, Information technology – Generic cabling – Introduction to the MICE environmental classification

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document the following definitions apply in addition to those of the applicable referenced cabling design standard.

3.1.1

acceptance test (of installed cabling)

contractual test to confirm that the installed cabling satisfies specific aspects of its specification

[IEC 60050-151:2001, 151-16-23 modified]

3.1.2

anchoring guy wire

tensioned cable designed to add support to structures

3.1.3

balun

device for transforming an unbalanced voltage to a balanced voltage or vice-versa

3.1.4

bonding network

BN

set of interconnected conductive structures that provides electromagnetic protection for electronic systems and personnel at frequencies from direct current (DC) to low radio frequency (RF)

3.1.5

(cable) bundle

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

3.1.6**building entrance facility**

facility that provides all necessary mechanical and electrical services for the entry of telecommunications cables into a building and which may allow for transition from external to internal cable

3.1.7**cabinet**

enclosed construction intended for housing closures and other information technology components and equipment

3.1.8**cable management system**

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

NOTE Includes ducts and tubes housing, or intended to house, blown information technology cables and/or cable elements.

3.1.9**cabling component**

any product associated with the cabling installation including cables, connecting hardware, closures, cabinets, frames, racks and pathway systems together with components used to provide earth connections for the cabling installation

3.1.10**catenary wire**

dedicated wire used in aerial applications to which information technology cables are attached

3.1.11**closure**

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

3.1.12**civil works**

activities required to prepare pathways and pathway systems, particularly external to buildings, prior to the installation of cabling

3.1.13**common bonding network****CBN**

principal means for effective bonding and earthing inside a building with information technology equipment

NOTE It is the set of metallic components that are intentionally or incidentally interconnected to form the principal bonding network in a building. These components include: structural steel or reinforcing rods, metallic plumbing, alternating current (AC) power conduit, protective conductors, cable racks and bonding conductors. The CBN is connected to the earthing network.

3.1.14**earth electrode**

conductive part, which may be embedded in the soil or in a specific conductive medium, e.g. concrete or coke, in electric contact with the Earth

[IEC 60050-826:2004, 826-13-05; IEC 60050-195:1998, 195-02-01]

3.1.15**earthing conductor**

conductor which provides a conductive path, or part of the conductive path, between a given point in a system or in an installation or in equipment and an earth electrode or an earth-electrode network

[IEC 60050-826:2004, 826-13-12; IEC 60050-195:1998, 195-02-03 modified]

3.1.16**electrostatic discharge****ESD**

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

[IEC 60050-161:1990, 161-01-22]

3.1.17**electromagnetic disturbance**

any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

NOTE An electromagnetic disturbance may be an electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

[IEC 60050-161:1990, 161-01-05]

3.1.18**equipotential bonding**

provision of electric connections between conductive parts, intended to achieve equipotentiality

[IEC 60050-826:2004, 826-13-19; IEC 60050-195:1998, 195-01-10]

3.1.19**frame (rack)**

open construction intended for housing closures and other information technology equipment

3.1.20**functional earthing conductor**

conductors that are only used for functional earthing (not protection)

3.1.21**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 (an example of a hand-hole within a building is called a draw-box)

3.1.22**high-voltage**

voltage over 1 000 V r.m.s. or 1 500 V DC

3.1.23**home entrance**

space at the boundary of a home that may 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

3.1.24**identifier**

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

3.1.25**impedance matching device**

device designed to match the impedance of transmission equipment to that of the installed cabling

3.1.26**information technology (telecommunications)**

branch of technology concerned with the transmission, emission and reception of signs, signals, writing, images and sounds; that is, information of any nature by cable, radio, optical or other electromagnetic systems

3.1.27**information technology equipment**

active or passive equipment necessary to deliver a specific application (e.g. hubs, switches, routers, adapters)

3.1.28**installer**

person installing cabling components – no design functions are assumed

3.1.29**isolated bonding network****IBN**

bonding network that has a single point of connection to either the common bonding network or another isolated bonding network

NOTE All isolated bonding networks considered here will have a connection to earth through the single point of connection.

3.1.30**junction box**

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

3.1.31**label**

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

3.1.32**local distribution space**

space within a home that houses the area connection point of ISO/IEC 15018

3.1.33**main earthing terminal**

terminal or busbar that is part of the earthing arrangement of an installation and enabling the electric connection of a number of conductors for earthing purposes

3.1.34**maintenance hole (telecommunications)**

vault/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

3.1.35**meshed bonding network**

bonding network in which all associated equipment cabinets, frames and racks are bonded together as well as at multiple points to the CBN

NOTE Consequently, the meshed BN augments the CBN.

3.1.36**met by design**

requirement which may be met by calculation and selection of appropriate materials and installation techniques, where either there is no test method specified that allows verification or there is no requirement for verification by testing

3.1.37**metallic information technology cable (cabling)**

cables (cabling) utilising metallic conductors for signal transmission

3.1.38**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

3.1.39**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 fixed in its final operating position

3.1.40**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

3.1.41**non-deformed mains power supply**

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

3.1.42**parallel earthing conductor****PEC**

earthing conductor that is parallel to the mains power cable or information technology cable

3.1.43**pathway (cable route, cable way)**

defined route for cables between termination points

3.1.44**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

3.1.45**PEN conductor**

conductor combining the functions of both a protective earthing conductor and a neutral conductor

[IEC 60050-826:2004, 826-13-25; IEC 60050-195:1998, 195-02-12]

3.1.46**premises owner**

owner of the premises within which cabling is to be installed and who may delegate the responsibilities specified in this standard to appointed representatives such as designers, specifiers, operators and maintainers of the resulting cabling infrastructures

3.1.47**primary distribution space**

space within a home that houses the home distributor (primary home distributor) of ISO/IEC 15018 and associated equipment

3.1.48**protective (earth) conductor****PE**

conductor provided for purposes of safety, for example protection against electric shock

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

3.1.49**rack**

see frame

3.1.50**rack unit**

44,45 mm (1.75 inches) of vertical mounting space in an IEC 60297 series standard cabinet or rack

3.1.51**record**

collection of information about, or related to, a specific element of the information technology infrastructure

3.1.52**referenced cabling design document**

relevant international standard or technical report for cabling design

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

3.1.53**secondary distribution space**

space within a home that houses a secondary home distributor of ISO/IEC 15018

3.1.54**segregation**

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

3.1.55**service loop**

excess length of cable or cable element(s)

3.1.56**surge protective device**

device intended to protect the electrical apparatus from high transient over-voltages and to limit the duration and frequently the amplitude of the follow-on current

NOTE The device contains at least one non-linear component.

3.1.57**space**

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

3.1.58**Stage 1**

a possible contractual boundary following the installation of cable but prior to its termination at which testing may be appropriate (certain systems allow the installation of pre-terminated cables which may be subject to Stage 1 testing)

3.1.59**Stage 2**

a possible contractual boundary following the completion of cabling installation at which testing may be appropriate

3.1.60**telecommunications**

see "information technology"

NOTE The term telecommunications has no legal meaning when used in this standard.

3.1.61**termination point**

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

3.1.62**wall section**

fixed-size section of a wall used to mount telecommunications equipment or termination hardware

3.1.63**work order**

collection of information which documents the changes requested and the operations to be carried out on the information technology infrastructure

3.2 Abbreviations

For the purposes of this document the following abbreviations apply.

AC	alternating current
BEF	building entrance facility
BN	bonding network
CATV	community antenna television
CAD	computer aided design
CBN	common bonding network
CER	common equipment room
CSA	cross-sectional area
CTR	common telecommunications room
DC	direct current
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EMS	energy management systems
ENI	external network interface
EQP	equipment
ESD	electrostatic discharge
IBN	isolated bonding network
HV	high-voltage
HVAC	heating, ventilation and air conditioning

IDC	Insulation displacement connection
ISDN	integrated services digital network
LV	low-voltage
MESH-BN	mesh bonding network
MET	main earthing terminal
NVP	nominal velocity of propagation
PE	protective (earth) conductor
PEC	parallel earthing conductor
PEN	conductor combining the functions of both a protective conductor and a neutral conductor
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 International Standard

- 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) where a lightning protection system is required, it shall conform to the "integrated lightning protection system" according to IEC 62305-4,
- l) 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 information technology cabling as agreed between the planners of the lightning protection system and the information technology cabling,
- m) local regulations, including safety, shall be met.

5 Specification of installations

5.1 General

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

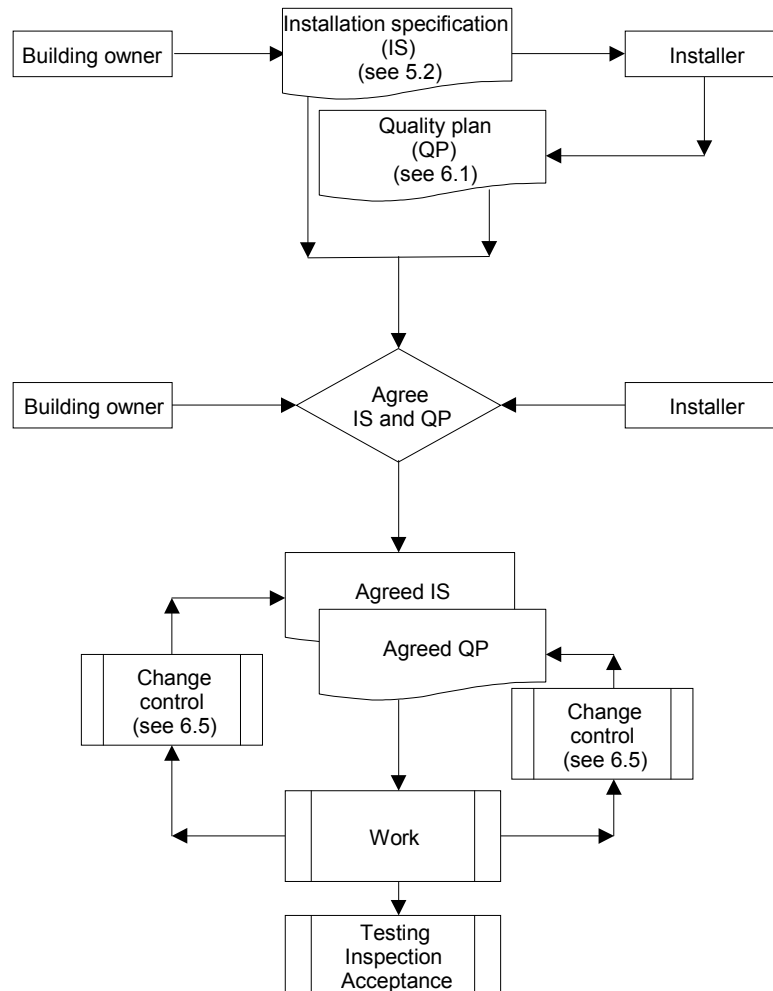


Figure 2 – Quality assurance schematic

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 this clause. 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 has been taken into account

- other building services such as mains power distribution and earthing systems,
- building management systems including security, access control, etc.,
- 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 F),
- 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 information technology cabling components,
- items to be issued to the information technology 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 mains power supply system.

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

The installation specification should contain the elements of the information technology 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 information technology cabling (see Clause 7),
- resilience planning,
- security requirements/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 Safety requirements

The technical specification shall

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

NOTE The hazard classification of areas containing, or intended to contain, optical fibre information technology equipment and optical fibre information technology 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 unauthorised 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/segregation),
- separation from the defined environment.

The technical specification shall detail any mitigation products or techniques necessary to allow the components selected to be installed and operate as specified when subjected to the defined environmental conditions.

The technical specification shall detail the

- pin-pair assignment for balanced cable elements at interfaces to the installed cabling,

NOTE 1 Annex A provides information about possible connections between the wires and the pins of information technology 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 2 Annex A contains requirements and recommendations for the maintenance of polarity within cabling terminated with connecting hardware housing multiple optical fibres.

The technical specification shall contain the requirements for

- the pathways, pathways systems, cabinets, frames, racks, closures, cables, termination points and cords (see Clause 7),
- the functional earthing and equipotential bonding of cabling components and accessories.

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 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;
- 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.

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

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 may 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 protective earthing, functional earthing and equipotential 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.

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,
- relevant earthing points.

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 protective earthing, functional earthing and equipotential 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 information technology cabling installer,
- items to be issued to the information technology 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,
- 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).

NOTE For installations of cabling in accordance with ISO/IEC 15018 in single homes, quality plans are not required but may be requested.

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 standard. The quality plan shall be agreed with the premises owner prior to the commencement of the installation.

NOTE For installations of cabling in accordance with ISO/IEC 15018 in single homes, quality plans are not required but may be requested.

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

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

The quality plan shall detail the procedures

- a) for the transfer of responsibilities between the installer, premises owner and, where relevant, other contractors,
- b) 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),

NOTE Cabling components to be installed may be supplied by the installer or by, or on behalf of, the premises owner.

- c) to be adopted to assess compatibility between cabling components to be used during the installation,
- d) to be adopted to assess compatibility with any existing installed cabling,
- e) to address the impact of potential component incompatibilities,
- f) 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 6.2.

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 6.2.

6.2 Sampling

6.2.1 Balanced cabling

6.2.1.1 General

Table 1 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. This subclause specifies 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.

Table 1 – Installed balanced cabling test parameters

Parameter group	Transmission parameter
Basic verification	Wire-map
	Continuity (d.c.)
	– Signal conductors
	– Screen conductors (if present) ^a
	– Short circuits
Internal transmission	– Open circuits
	Return loss
	Insertion loss
	Pair-to-pair NEXT
	PS NEXT
	Pair-to-pair ACR-N
	PS ACR-N
	Pair-to-pair ACR-F
	PS ACR-F
	Direct current (d.c.) loop resistance
	Propagation delay
	Delay skew
Alien (exogenous) crosstalk	PS ANEXT
	PS ANEXT _{avg}
	PS AACR-F
	PS AACR-F _{avg}
^a It shall be ensured that continuity be provided by the cabling components and not by alternative connections such as protective earth conductors.	
NOTE Link or channel length may also be of interest, but is not a pass/fail criterion.	

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.

6.2.1.2 Permanent link testing

Independent of the requirements of the installation specification, basic verification parameters of Table 1 shall be tested using a sample level of 100 %.

Where the installation specification requires acceptance testing of internal transmission parameters of Table 1 against the permanent link requirements of 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 1 against the permanent link requirements of Classes E_A, F or F_A the minimum sample level applied should be in accordance with 6.2.1.4.

6.2.1.3 Channel testing

In all cases, independent of the requirements of the installation specification, basic verification parameters should be tested using a sample level of 100 %.

Channel tests may 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.

In cases a), b), and c), where the installation specification requires acceptance testing of internal transmission parameters of Table 1 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 may be applied to channel testing provided that the associated risk of undiagnosed faults is recognised in the Quality Plan.

In cases d) and e), where the installation specification requires acceptance testing of internal transmission parameters of Table 1 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 1 against the requirements of a specific channel Class the minimum sample level applied should be in accordance with 6.2.1.4.

6.2.1.4 Alien (exogenous) crosstalk testing

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

Table 2 – Minimum sample sizes for alien (exogenous) crosstalk testing

Total no. of links/channels N	Sample size
3 to 150	3 or $0,1 \times N$ (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 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.

6.2.2 Optical fibre cabling

6.2.2.1 General

Table 3 shows two groups of optical fibre cabling transmission parameters (basic verification and transmission) using the parameters that define the Classes of links and channels within the referenced cabling design standards. This subclause specifies 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.

Table 3 – Installed optical fibre cabling test parameters

Parameter group	Transmission parameter
Basic verification	Polarity
Transmission	Attenuation
	Length (propagation delay)

6.2.2.2 Permanent link testing

Where the permanent link contains non-fixed cabling (e.g. CP cord in ISO/IEC 11801 and LDP cord in ISO/IEC 24764) any result is only applicable to the specific configuration under test.

Independent of the requirements of the installation specification, basic verification parameters of Table 3 shall be tested using a sample level of 100 %.

Where the installation specification requires acceptance testing of transmission parameters of Table 3 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,
- where testing of propagation delay/length 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 may 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.

6.2.2.3 Channel testing

Channel tests may 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 longer 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 longer 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 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 6.2.2 apply.

6.3 Treatment of marginal results

6.3.1 Balanced cabling

6.3.1.1 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.

6.3.1.2 Requirements

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

As examples, the quality plan may 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: meaning that the fail limit is less stringent, as compared to the required limit, by the uncertainty of the field tester.

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.

6.3.2 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.

6.4 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.

6.5 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

This clause details requirements and recommendations for planning of installations. It covers

- pathways and spaces,
- functional elements of the referenced cabling design standards,
- segregation from mains power cabling,
- support for installation practices (e.g. bend radius, pulling load).

Cabling for all relevant telecommunication services shall be considered when the installation is planned including

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

7.2 Safety

7.2.1 General

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

7.2.2 Mains power cabling

The proper implementation of the requirements of this standard assume that electrical installations, bonding networks and protective measures against overvoltages are undertaken in accordance with the local regulations, as appropriate.

NOTE The IEC 60364 series may contain appropriate information.

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

7.2.3 Optical fibre cabling

The hazard classification of areas containing optical fibre information technology equipment and optical fibre information technology cabling shall be undertaken in accordance with IEC 60825-2 to define appropriate installation and labelling practices.

7.3 Environment

The MICE concept according to ISO/IEC TR 29106 shall be used to describe the environment where the cabling or parts of the cabling will be located.

Product and/or supporting systems shall be selected, where appropriate, to provide sufficient protection from the environment to enable the cabling to meet the required transmission performance.

7.4 Points of electrical contact

The long term stability of electrical connections including earth connections and connections between sections, or parts of pathway 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 external 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 external 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 external service provider(s).

7.5.2 Recommendations

External 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 may be used are shown in Table 4.

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 may not be suitable for the subsequent installation of other cabling technologies.

Table 4 – 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. 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. 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 etc.). 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. 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. 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. 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. Available in metallic or non-metallic form.
Interval support	Open support system installed with appropriate spacing. 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 may 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 Pathway systems – Requirements

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

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 and the risk that cable support will disappear by change to the supporting system.

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 localised pressure points that may 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.

Where pathway systems take the form of non-enclosed cable management systems to which cables are to be attached or supported by (e.g. dedicated/catenary wires or designated routes) then the cross-sectional area shall be considered to be the minimum available area surrounding the pathway system.

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

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

7.6.1.3 Recommendations

7.6.1.3.1 Pathway and pathway system selection

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. For example, for cabling in accordance with ISO/IEC 11801

- a) the campus backbone cabling sub-system,
 - 1) between building entrance facilities (BEFs),
 - 2) between BEFs and distributors,
- b) the building backbone cabling sub-systems,
- c) the horizontal cabling sub-systems.

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.

7.6.1.3.2 Pathway and pathway system capacity planning

It is recommended to plan the pathway systems 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.

The planning of pathway systems should provide adequate capacity to allow subsequent installation of an additional 40 % of telecommunications cables whilst maintaining minimum bend radii and segregation from mains power cabling (see 7.8).

7.6.2 Inside buildings

7.6.2.1 Requirements

7.6.2.1.1 Pathway systems

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.

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.

Appropriate 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).

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 three dimensions. Examples of such techniques are pre-fabricated curved corners and radius limiters as shown in Figure 3.

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. 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.

Minimum bend radius is determined by manufacturers instructions. If instructions do not exist the following shall apply

- the minimum bend radius for balanced cables containing up to 4-pairs shall be 50 mm,
- the minimum bend radius for optical fibre cables in accordance with IEC 60794-2-21 and containing up to four optical fibres shall be 50 mm,
- the minimum bend radius for other optical fibre cables shall be 10 times the cable diameter and shall not be less than 30 mm,
- the minimum bend radius for coaxial cables shall be 10 times the cable diameter,
- the minimum bend radius for other metallic telecommunications cables shall be 8 times the cable diameter.

NOTE 1 Pathway systems that do not allow such an approach may 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, may require greater bend radii than those specified above.

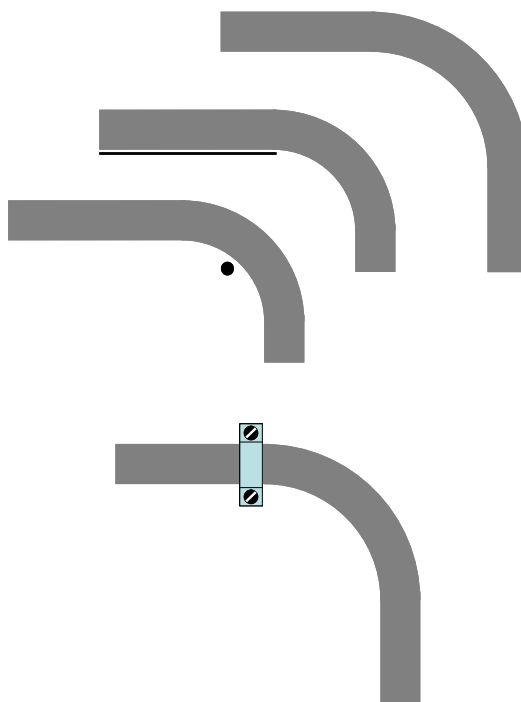


Figure 3a – Examples of non-conformant bend limiting techniques

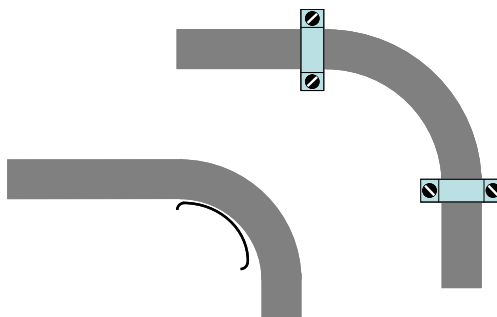


Figure 3b – Examples of conformant bend limiting techniques

Figure 3 – Example of conformant and non-conformant bend radius management

7.6.2.1.3 Maximum stacking height

The maximum stacking height in pathway systems is determined by manufacturers' instructions. 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 5.

Table 5 – Stacking height for non-continuous and interval support pathway systems

Distance between support distance l in mm	Formula	Maximum stacking height height h in mm
0	$h = 150 / (-l * 0,0007 + 1)$	150
100		140
150		136
250		128
500		111
750		98
1 000		88
1 500		73

7.6.2.1.4 Conduit

Where conduits are installed without bends, the maximum distance between pulling points shall be 100 m unless appropriately specified cables and/or installation techniques are to be used.

Where a conduit contains bends

- the conduit shall not be subject to cumulative changes in direction of more than 180° between pulling points,
- the conduit shall not contain more than two bends of up to 90° each between pulling points (e.g. outlets, telecommunications rooms, or pull boxes),
- the maximum distance between pulling points shall be 15 m.

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 6 times the internal conduit diameter. Bends in the conduit shall not contain any kinks or other discontinuities that may have a detrimental effect on the cable sheath during cable pulling operations.

Conduits should be considered as “full” when the cross-sectional area of the planned/installed cables reaches 40 % of the conduit cross-sectional area.

7.6.2.1.5 Non-continuous support for cables

The maximum distance allowed between supporting elements of the pathway system is 1 500 mm.

7.6.2.2 Recommendations**7.6.2.2.1 Pathway system capacity planning**

Where bundles of cables are to be used, they should not contain more than 24 cables to reduce risk of stress and compression at bends.

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 4).

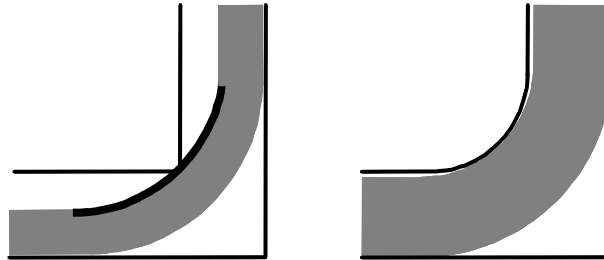


Figure 4 – Example of use of curved corners in pathway systems

7.6.2.2.3 Conduit

Where conduits are installed without bends, the maximum distance between pulling points should be 50 m unless appropriately specified cables and/or installation techniques are to be used.

Conduits (or ductings) 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.

7.6.3 Outside buildings

7.6.3.1 General

In installations outside buildings, such as those shown in the example of Figure 5, it is commonly required to consider other factors (visible and hidden) which might have an environmental impact on the information technology cabling. These include

- high voltage underground cables or overhead lines (electromagnetic impact),
- steam pipes (temperature impact),
- flooding (ingress impact),
- chemical contamination (liquid, gas),
- roads or railroad tracks (mechanical impact).

Where possible, the installation of information technology cabling in such areas affected by these factors should be avoided. However, where national or local regulations allow, mitigation may be applied by selecting appropriate components, pathways, and/or spaces.

Pathways between buildings may use a variety of underground and aerial pathway systems and may use spaces and structures (e.g. hand holes, maintenance holes and telecommunications cabinets) that are constructed to assist cabling installation and to house closures.