TECHNICAL REPORT

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First edition
2000-07

Information technology –

Implementation and operation of customer premises cabling –

Part 2: Planning and installation

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INFORMATION TECHNOLOGY –

IMPLEMENTATION AND OPERATION OF CUSTOMER PREMISES CABLING –

Part 2: Planning and installation

FOREWORD

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

2) In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

3) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC and ISO technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

- type 2, when the subject is still under technical development or where, for any other reason, there is the future but not immediate possibility of an agreement on an International Standard;

- type 3, when the technical committee has collected data of a different kind from that which is normally published as an International Standard, for example ‘state of the art’.

Technical reports of types 1 and 2 are subject to review within three years of publication to decide whether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/IEC 14763-2, which is a technical report of type 3, was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

This document is not to be regarded as an International Standard. Comments on the content of this document should be sent to the IEC Central Office.

INTRODUCTION

This Technical Report is one of two prepared in support of international standard ISO/IEC 11801. The diagram below shows the inter-relationship of the currently developed Technical Reports and other supporting standards.

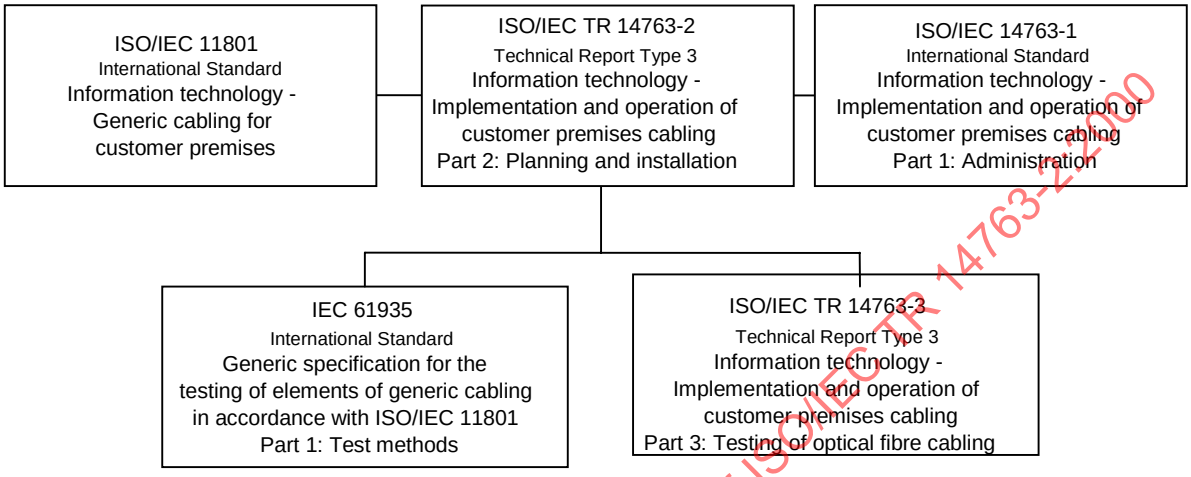

Figure 1 – Document relationships

This document forms Part 2 of ISO/IEC 14763 (Technical Report, type 3) and highlights issues relevant to planning and installing generic cabling which has been designed in accordance with ISO/IEC 11801.

Administration procedures relevant to generic cabling within customer premises are detailed in ISO/IEC 14763-1.

The test procedures to be applied to the cabling, during and after installation, are detailed in ISO/IEC 14763-3 for optical fibre cabling and IEC 61935-1 for balanced copper cabling.

Users of this document should be familiar with ISO/IEC 11801.

Additional information regarding the use of centralised optical fibre cabling is included in annex A.

INFORMATION TECHNOLOGY –
Implementation and operation of customer premises cabling –
Part 2: Planning and installation

1 Scope

This Technical Report specifies requirements and provides general considerations for the planning, specification, quality assurance and installation of new cabling in accordance with ISO/IEC 11801.

2 Reference documents

This document contains dated or undated references to specifications from other publications. These references are quoted at the relevant points in the text and the publications are listed below. In the case of dated references, subsequent changes or revisions to these publications belong to this standard only if they have been incorporated by change or revision. In the case of undated references, the latest edition of the relevant publications is applicable in each case.

IEC 60793 (all parts), *Optical fibres*

IEC 60794 (all parts), *Optical fibre cables*

IEC 61156 (all parts), *Multicore and symmetrical pair/quad cables for digital communications*

IEC 61935-1,— *Generic cabling systems – Specification for the testing of balanced communication cabling in accordance with ISO/IEC 11801 – Part 1: Installed cabling* [1)]

ISO/IEC 11801, *Information technology – Generic Cabling for Customer Premises*

ISO/IEC 14763-1, *Information technology – Implementation and Operation of Customer Premises Cabling – Part 1: Administration*

ISO/IEC TR 14763-3, *Information technology – Implementation and Operation of Customer Premises Cabling – Part 3: Testing of optical fibre cabling*

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this part of ISO/IEC 14763 the following definitions apply in addition to those of ISO/IEC 11801 and ISO/IEC 14763-1.

3.1.1
balun
a device for transforming an unbalanced voltage to a balanced voltage or vice-versa

3.1.2
bonding
the process of connecting the earthing conductors/contacts on cabling, pathway systems or components to an identified earthing point within the premises as specified in national or local regulations

1) To be published.

NOTE Equipotential bonding is defined as “provision of electric connections between conductive parts, intended to achieve equipotentiality“.

3.1.3
cabinet
an enclosed construction intended for housing telecommunication components and equipment

3.1.4
civil works
activities required to prepare pathways and pathway systems, particularly external to buildings, prior to the installation of cabling

3.1.5
closure
fixture or fitting of either open or closed construction intended to contain connecting hardware

3.1.6
frame
an open construction intended for mounting telecommunications components and equipment

3.1.7
impedance matching device
a device designed to match the impedance of transmission equipment to that of the installed cabling

3.1.8
minimum dynamic bend radius
the minimum allowable radius a cable may be bent during installation

3.1.9
minimum static bend radius
the minimum allowable radius a cable may be bent in its operating position

3.1.10
pathway system
areas or volumes defined by markings or fittings within pathways intended for the containment of installed cables

3.1.11
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)

3.1.12
Stage 2
a possible contractual boundary following the completion of cabling installation at which testing may be appropriate

3.2 Abbreviations

This document uses the abbreviations of ISO/IEC 11801 and ISO/IEC 14763-1.

4 Safety

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

5 Planning

5.1 General

This clause details the recommended approach to be taken during the planning phase, prior to the development of an Installation Specification (see clause 6).

5.2 Distributors, Transition Points and Telecommunications Outlets

5.2.1 General

The functional elements of generic customer premises cabling as defined within ISO/IEC 11801 are the Distributors (Campus, Building and Floor), the Transition Point (optional) and the Telecommunications Outlets together with the cables used to interconnect them (see clause 5 of ISO/IEC 11801).

The requirements for the relative positioning of the Distributors and the Telecommunications Outlets and the performance of the cabling sub-systems are detailed in clauses 6 and 7 of ISO/IEC 11801.

5.2.2 Distributors

5.2.2.1 Environmental protection

Distributors are located within areas designated as Equipment Rooms or Telecommunications Closets. The Equipment Rooms and Telecommunications Closets (and cabinets or other closures within them) should provide physical and environmental protection for the distributors.

This protection may be achieved either by choice of appropriate location or by specific design features and should address the following aspects:

a) temperature;

b) humidity;

c) vibration;

d) exposure to ultraviolet radiation

e) ingress of dust, fluids (including flooding) or other contaminants;

f) chemical attack;

g) physical damage (accidental or malicious);

h) security;

i) presence of hazards;

j) electromagnetic interference.

5.2.2.2 Location

Floor distributors should be located such that the length of the horizontal cabling sub-system does not exceed the limits detailed in ISO/IEC 11801.

Distributors should be positioned with adequate access and should be provided with illumination suitable to allow installation and operation of the equipment and cabling contained therein. The following recommendations are made for all cabinets or frames constituting a distributor:

a) the minimum clearance on all vertical faces where access is required should be 0,9 metres;
b) no connection points should be set at a height greater than 2,5 metres;
c) no connection points should be set at a height less than 0,15 metres.

The design, dimensions and clearances (e.g. sub-floor) of the distributors should:

d) enable compliance with relevant national or local regulations with regard to cable segregation;
e) enable the required cables to be installed whilst maintaining the minimum bend radii specified in clause 8 of ISO/IEC 11801;
f) enable an agreed proportion of additional cables to be subsequently installed whilst maintaining the minimum installation bend radii specified in clause 8 of ISO/IEC 11801;
g) allow appropriate provision for the management of cables and patch cords.

Distributors should not be installed:

h) in toilet facilities;
i) boiler/plant/machine rooms;
j) in emergency escape ways;
k) in ceiling or sub-floor spaces;
l) in areas subject to flooding;
m) within cabinets or closures containing fire hose reels or other fire-extinguishing equipment.

5.2.3 Telecommunications Outlets

5.2.3.1 Distribution

Each Work Area should be provided with Telecommunications Outlets in accordance with ISO/IEC 11801.

There is no single recommendation for the distribution and density of Telecommunications Outlets within premises. The dimensions of the Work Area and the quantity of Telecommunications Outlets provided are installation-specific (subject to the minimum requirements of ISO/IEC 11801) but the following issues should be considered:

a) local regulations may set minimum figures for the area or volume associated with the space allocated to a person within an office environment;
b) the number of Telecommunications Outlets within each Work Area should reflect the predicted requirements of that Work Area;
c) operational flexibility may be enhanced by the use of additional Telecommunications Outlets.

Subsequent installations of horizontal cabling to provide additional Telecommunications Outlets tend to be both costly and disruptive. It is recommended that:

d) planning decisions should accommodate the diverse telecommunications demands of the occupants;
e) the detailed design and planning of pathways and pathway systems servicing the Work Areas should aim to minimise the cost and disruption of ongoing changes to the cabling system.

5.2.3.2 Location

The planned locations of Telecommunications Outlets should address:

a) access to allow installation and operation (disconnection and reconnection of Work Area Cables);

b) space to house application-specific adapters (such as baluns or impedance matching devices) which should be external to the Telecommunications Outlet, in accordance with ISO/IEC 11801;

c) ingress of dust, fluids (including flooding) or other contaminants;

d) chemical attack;

e) accidental physical damage.

The planned locations of the Telecommunications Outlets and the design of any closures containing the Telecommunications Outlets should enable compliance with relevant national or local regulations with regard to cable segregation.

5.2.4 Transition Points

5.2.4.1 Distribution

A transition point provides for interconnection between horizontal cables extending from building pathways and cables extending into work area spaces; it is not a user interface.

5.2.4.2 Location

A transition point is located between horizontal cables extending from building pathways and cables extending into work area spaces. Transition points should be located in fully accessible, permanent locations such as building columns, and permanent walls. Transition points should not be installed in furniture unless that unit of furniture is permanently secured to the building structure.

The use of suspended ceiling space or access floor space for transition points is acceptable with the following conditions:

a) transition points should not be located in any obstructed area;

b) access to the transition point should not require occupants to relocate;

c) the ceiling or floor tile should be clearly and permanently marked and identified as containing a transition point;

d) the transition point should be administered according to ISO/IEC 14763-1;

e) transition point connecting hardware should be protected from physical abuse and foreign substances by an enclosure that is suitable for the environment;

f) telecommunications equipment should not be directly connected at the transition point.

NOTE When the transition point is located in an air-handling space, additional precautions may be required to ensure that building code requirements are met.

5.2.5 Administration and polarity maintenance for optical fibre cabling

ISO/IEC 11801 recommends that accidental misconnection of different optical fibre types should be prevented by some form of coding e.g. by the use of different colours on the connecting hardware.

ISO/IEC 11801 recommends that polarity should be maintained for duplex communications channels by the use of keyed connecting hardware or the clear identification of the optical fibre interfaces.

5.3 Pathways and pathway systems

5.3.1 Planning approach

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 as follows:

a) the Campus Backbone Cabling Sub-system;
   1. between Building Entrance Facilities;
   2. between Building Entrance Facilities and Distributors;
b) the Building Backbone Cabling Sub-systems;
c) the Horizontal Cabling Sub-systems.

Examples of pathway systems that may be used are shown in Table 1.

Table 1 – Examples of Pathway Systems

Location	Pathway Systems	Features
Indoor	Trunking/ conduit	Enclosed containment systems normally used in open office areas. Single or multiple cable designs. Available in metallic or non-metallic form.
	Tray	Open containment systems designed to house large number of cables and normally used in floor/ceiling spaces or in restricted access areas (e.g. basements, plant rooms, telecommunications spaces etc.). Tray provides continuous support for the contained cable when used in horizontal pathways. Typically available in metallic form.
	Basket	Similar to tray but contains supporting bars rather than continuous support. Normally used in horizontal pathways. Typically available in metallic form.
	Ladder	Similar to tray but contains supporting bars rather than continuous support. Normally used in vertical pathways. Typically available in metallic form.
	Duct	Enclosed containment systems designed to house a large number of cables and normally used in floor/ceiling spaces or in restricted access areas (e.g. basements, plant rooms, telecommunications spaces etc.). Available in metallic or non-metallic form.
	Designated routes	Pathways defined by markings or some other designation.
Indoor/outdoor	Catenary	A suspended strength member to which single or multiple cables may be attached in order 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.
Outdoor	Duct	Enclosed containment systems designed to house single or multiple cables between buildings, maintenance holes and drawpits. The use of ducts enables subsequent removal and addition of cables. Typically available in non-metallic form.
	Direct Burial	Open trench routes into which specially-designed cables are installed and then back-filled.
NOTE Where conducting pathway systems are used, the electrical continuity of the installed sections should be maintained and bonded to earth in accordance with relevant national or local regulations.		

5.3.2 Environment

The installation and operating environments within the pathways or created by the type of pathway systems used should be compatible with both the cabling and the proposed methods of installation.

Common factors to be considered are:

a) temperature;

b) humidity;

c) vibration;

d) exposure to UV;

e) chemical attack;

f) accidental physical damage;

g) security;

h) presence of hazards;

i) electromagnetic interference;

j) rodent damage.

NOTE 1 Certain environments may place restrictions on the use of fusion splicing of optical fibres (which generally use an open electric arc).

NOTE 2 Requirements for levels of toxic or corrosive gas emission, smoke generation and flame propagation of the installed cabling during combustion should be determined and may be subject to national or local regulation.

The pathways and pathway systems should be selected following consideration of:

k) the method of attaching the selected pathway systems;

l) the loading of the pathway systems both by the weight of the proposed quantities of cable and the proposed methods of cable installation.

Where possible incompatibility exists then alternative routes, pathway systems or components with enhanced environmental (or other) characteristics should be considered. Failure of alternative routes to comply with the length requirements of clause 6 of ISO/IEC 11801:1995 may necessitate the establishment of additional distributors or the use of alternative cable types or media.

5.3.3 Dimensions

The points of cable entry to the pathways should be located to provide space for any equipment required for installation (including cable drums and drum stands) and should enable installation of the cables whilst maintaining the minimum installation bend radii specified in clause 8 of ISO/IEC 11801.

The dimensions and types of pathways and pathway systems selected should:

a) enable compliance with relevant national or local regulations with regard to cable segregation;

b) enable the initial quantity of cables to be installed whilst maintaining the minimum bend radii and not exceeding the cable pull strength specified in clause 8 of ISO/IEC 11801;

c) enable an agreed proportion of additional cables to be subsequently installed whilst maintaining the minimum installation bend radii and not exceeding the cable pull strength specified in clause 8 of ISO/IEC 11801.

The pathways constructed using tray should:

d) provide an agreed minimum clearance from the surface to which it attaches;

e) provide an agreed minimum working space above the tray to enable access during cable installation;

f) use pre-formed bends, compatible with the pathway, to perform changes in direction.

5.4 Earthing and bonding

ISO/IEC 11801 contains requirements for the earthing and bonding of generic cabling components. The provision of appropriate earthing and bonding points should be considered during the planning phase.

6 Installation specification

6.1 General

An Installation Specification should be produced by, or on behalf of, the user and should be agreed with the installer prior to the commencement of the installation. This clause details aspects which should be covered within the Installation Specification.

6.2 Operational requirements

The Installation Specification should contain specifications relating to operational requirements. In order to meet overall telecommunications requirements, it is recommended that the following aspects be addressed.

Topology: detailing the locations of the distributors, Transition Points, Telecommunications Outlets, pathways and pathway systems together with the number of cables required within each pathway.

Hazards: providing relevant information and drawings clearly identifying the boundaries of hazardous or potentially hazardous areas within the proposed pathways and installation zones together with the classification of those areas.

Environment: the installation environment within the pathways should be defined stating any conditions which may assist in the choice of cabling components or may affect the cabling both during and following installation (see clause 5).

6.3 Technical specification

The Installation Specification should contain a technical specification which details the performance requirements for the cabling and associated components. The Technical Specification forms a basis against which the performance of installed cabling together with all cabling components and installation techniques used are assessed.

It should include the following aspects.

Cabling performance: in accordance with ISO/IEC 11801.

Cable(s): physical parameters and environmental parameters together with requirements of ISO/IEC 11801.

Connecting hardware: physical parameters together with requirements of ISO/IEC 11801.

Closure(s): physical and environmental parameters.

Acceptance criteria: in accordance with manufacturer's specification and meeting the minimum requirements of ISO/IEC 11801.

Identification scheme: in accordance with ISO/IEC 14763-1.

Labelling requirements: in accordance with ISO/IEC 14763-1.

6.4 Scope of work

The Installation Specification should include a Scope of Work. The Scope of Work should define the installation tasks required (see Table 2) and any other requirements.

It is the responsibility of the user to ensure that all information relating to existing cabling is accurate. If doubt exists the installer should be instructed to survey the existing cabling and verify the information. If records relating to existing pathways, spaces or cabling are found to be inaccurate, they should be updated accordingly.

Table 2 – The Scope of Work

Installation phase	Detail required
Pre-installation	• civil works detailing any building work required for each pathway • pathway systems • areas requiring further evaluation, calculation and/or verification • Bill of Materials (BOM) detailing exact quantities of all cabling components, installation accessories and other materials • cabling component acceptance criteria

Installation	• installation programme
	• labour and access restrictions
	• contract responsibilities and interfaces including the clear statement of responsibilities for the connection of the generic cabling systems to public networks (national or local regulations may be applicable);
	• cable installation schedule
	• connectivity schedule
	  • pin-out specification
	  • duplex fibre connection scheme
	• bonding schedule (in accordance with manufacturers recommendations which should comply with national or local regulations)
	• installed cabling (Stage 1) acceptance criteria
	• final cabling (Stage 2) acceptance criteria
	• cabling administration
	• documentation

Post-installation	• reinstatement • spare materials and components • spare installation and test equipment • training • repair and maintenance

6.5 Contract terms and conditions

Contract Terms and Conditions should be specified and the Installation Specification should refer to any specific operational or technical limitations which may affect the Contract.

6.6 Changes and variations

All modifications, changes and variations to the Installation Specification should be clearly documented to enable traceability.

7 Quality plan

7.1 General

A Quality Plan is a detailed proposal covering the procedures to be adopted to ensure compliance with the Installation Specification.

The Quality Plan should be produced by, or on behalf of, the installer and should be agreed with the user prior to the commencement of the installation.

The Quality Plan should clearly state the measures to be taken to demonstrate compliance with:

a) the recommendations of this document;

b) the requirements of ISO/IEC 11801 and ISO/IEC 14763-1;

c) the Installation Specification.

The Quality Plan should also reflect the scope of the Installation Specification and clearly identify any measures to be adopted to transfer responsibility for the installed cabling to the premises owner or occupant.

7.2 Cabling component acceptance tests

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

The Quality Plan should specify procedures to be adopted to ensure compatibility between all components to be used during the installation. Table 3 details the issues to be considered.

Table 3 – Cabling Component Acceptance

Key elements required in the Quality Plan	
Inspection	**Test**
• inspection methods • cable [a] • connecting hardware [b] • closures [c] • acceptance criteria • inspection schedule • sampling level • documentation	• test methods • cable [d] • connecting hardware [e, f] • exceptions • acceptance criteria • correction factors • test schedule • sampling level • documentation

[a] Inspection of cable may be undertaken without removal from its means of transport or storage. The inspection should include cable construction, the quantity and identification of cable elements, cable diameter, condition of external sheath, marking and identification.

[b] The inspection should include the design and type of connecting hardware and its mechanical compatibility with the cables.

[c] An external inspection should include dimensions, materials, mounting facilities, environmental sealing, the quantity and dimensions of access openings, the quantity and fit of glands and seals together with the appropriate labelling and identification. An internal inspection should include strain relief fittings, cable management and earthing and/or bonding fittings.

[d] Evidence of conformance of cables to the appropriate specification should be provided by the cable manufacturer. Where additional testing is required this should be in accordance with IEC 61156 (copper), IEC 60793 (optical fibre) or IEC 60794 (optical fibre cable).

[e] Evidence of conformance of connecting hardware to the appropriate specification should be provided by the connecting hardware manufacturer. Testing of balanced copper patch cords and equipment cables is limited to continuity and pin-out conformance testing pending availability of performance test specifications.

[f] Testing of optical fibre patch cords and equipment cables is detailed in ISO/IEC 14763-3.

Where testing of components is a requirement, the Quality Plan should detail the quantity of tests (e.g. sampling level) together with the type of test to be applied. The test type, methods and equipment should be selected from those detailed in ISO/IEC 11801.

7.3 Pre-installation cabling acceptance (Stage 1) tests

The Quality Plan should specify the procedures to be adopted to ensure that the installed cable will comply with the requirements of the Installation Specification. The key elements are contained in Table 4.

Where Stage 1 testing is a requirement, the Quality Plan should detail the quantity of tests (e.g. sampling level) together with the type of test to be applied. The test type, methods and equipment should be selected from those detailed in ISO/IEC 11801.

7.4 Post-installation cabling acceptance (Stage 2) tests

The Quality Plan should specify the procedures to be adopted to ensure that the installed and terminated cabling complies with the requirements of the Installation Specification. The key elements are contained in Table 4.

Where Stage 2 testing is a requirement, the Quality Plan should detail the quantity of tests (sampling level) together with the type of test to be applied. The test type, methods and equipment should be selected from those detailed in ISO/IEC 14763-3 and IEC 61935-1.

Table 4 – Stage 1 and 2 Cabling Acceptance

Key elements required in the Quality Plan
• test type and test methods • optical fibre cabling: see ISO/IEC 14763-3 • balanced copper cabling: see IEC 61935-1 • exceptions • acceptance criteria • correction factors • test schedule • sampling level documentation

7.5 Test equipment

The Quality Plan should specify:

a) the types of test equipment;

b) the accuracy of measurement equipment (including test cords);

c) the calibration status of the equipment (with reference to appropriate standards);

7.6 Documentation

The Quality Plan should describe the format of the documentation to be provided for the installation in accordance with clause 10.

8 Cable and closure selection

8.1 General

ISO/IEC 11801 specifies performance requirements for the cables to be used within generic customer premises cabling. The suitability of particular cable constructions should be determined based on a thorough understanding of the installation and operating environments. This clause gives advice on cable materials and design to ensure compatibility with installation and operating environments.

The purpose of a closure is to provide safe storage and access to individual cables and/or cable elements enabling splicing and termination of cables and to enable earthing of relevant metallic components with the cables. This clause details the requirements for closure design and materials to ensure compatibility with installation and operating environments.

8.2 Operating environment

8.2.1 Cables

Cables are constructed to provide protection from a wide range of physical, climatic and chemical environments, as identified in Table 5.

Where the construction of outdoor cable is not compatible with the requirements of the internal premises environment, a transition to suitable internal cables is necessary.

Table 5 – Types of Cable Construction

Characteristic	Types of construction
Mechanical Damage and Rodent Damage Resistance	Metal tapes and wires can offer some resistance to external crushing and piercing forces and protection against rodent damage. These materials are generally applied directly under the outer sheath
UV Exposure Resistance	A UV resistant or stabilised sheathing material should be used for outdoor applications in which the cable is to be subjected to UV radiation.
Moisture Resistance	Polyethylene is generally used for external applications in conjunction with internal moisture barriers for improved performance. The moisture barriers which may be used include metallic and non-metallic materials to prevent radial ingress of moisture into the cable together with filling compounds or other water blocking materials to prevent axial migration of moisture along the cable.
Burning properties	There is a variety of materials that can be used to minimise the propagation of fire and the harmful and/or damaging effect of smoke and fumes (see notes 1 and 2).
Hydrocarbon Resistance	In many situations, adequate resistance is provided by additional coatings applied to standard outdoor cables with polyethylene sheaths. In the most severe conditions, an effective barrier against hydro-carbon attack is a lead inner sheath with a polyethylene outer sheath (see note 1).
NOTE 1 National and/or local regulations may apply to the selection of these materials. NOTE 2 The burning properties of a cable depend upon all the materials used within the construction including sheathing materials, insulation materials and filling compounds. Manufacturer's information should be sought where necessary.	

8.2.2 Closures

Enclosure materials and sealing properties should reflect the relevant environmental conditions of the proposed locations. Any points of entry to the closures may affect the sealing properties. The choice of glands and seals should ensure that the overall requirement is maintained.

Suitable fittings should be provided to allow the closure or any metallic member of the cables to be bonded to earth for both safety (in accordance with relevant national or local regulations) and functional purposes as defined in the Installation Specification.

Closures used in outdoor applications should also provide retention and a positive stop for the cable members used to prevent buckling which may occur due to shrinkage at low temperatures.

All pre-installed optical fibre adaptors and connectors should be fitted with suitable protective caps to prevent their contamination.

8.3 Installation environment

8.3.1 Cables

The construction of the cable should be compatible with the installation techniques to be used. This may dictate the use of strength members and/or armouring.

Where the cable contains metallic members (other than the conductors within metallic cables), provision should be made for the bonding to earth of such members in accordance with appropriate regulations (see 7.2.2).

8.3.2 Closures

The design of the closure and/or its immediate surroundings should allow for storage of service loops of cable.

The closure should provide cable and cable element management ensuring protection of connecting hardware, cable strain relief and maintenance of sufficient bend radii as recommended by the cable manufacturer.

9 Installation practices

9.1 General

This clause details the practices which should be adopted for the installation of cables, connecting hardware and closures.

9.2 Pre-installation procedures

The Installer should:

a) establish that the pathways specified in the Installation Specification are accessible and available in accordance with the installation programme;

b) establish that the environmental conditions within the pathways and the installation methods to be used are suitable for the cable to be installed;

c) establish the accessibility and availability of those locations at which drums (or equivalent) are to be positioned during the installation programme and ensure that all necessary installation accessories are available;

d) confirm proposed locations of closures and establish their accessibility and availability;

e) ensure that all necessary guards, protective structures and warning signs are used to protect both the cable and all personnel as required by national or local regulations;

f) ensure that working areas such as tunnels, maintenance holes, drawpits, cable chambers and any other unventilated structures are tested for asphyxiating and explosive gases;

g) pre-rope pathways as required.

9.3 Pathways

For the direct burial of cable:

a) ground analysis should be performed when considering underground, tunnel or direct buried pathways;

b) a sufficient depth of ground cover should be provided in accordance with appropriate regulations;

c) the cable should be suitably protected, generally by armouring;

d) means to identify the presence of buried cables (e.g., a warning tape buried between the cable and the surface) should be provided to prevent inadvertent damage during excavation.

For pathways crossing beneath roadways or railway lines:

e) ducts should be used;

f) a sufficient depth of ground cover should be provided in accordance with appropriate regulations.

For aerial or catenary mounted cables:

g) fittings and accessories should be used in accordance with the cable manufacturer's instructions;

h) existing catenary wires should be checked for the proposed loading without excessive sagging and additional fastenings and fixings provided where necessary; alternatively the catenary may have to be replaced;

i) bonding to earth (in accordance with appropriate regulations) should be undertaken within building entrance facilities and along the route. In the vicinity of voltage inducing plant, bonding to earth should be undertaken at each electrical power transformer location.

9.4 Pathway systems

The following practices should be adopted during the installation of pathway systems:

a) all pathway systems should be installed using the appropriate fastenings and fixings;

b) no bolts, sharp objects or edges should be allowed on cable bearing surfaces;

c) joints should be butted and present a smooth surface for the installation;

d) underground ducts should be of a non-porous material and have smooth internal walls;

e) sections of duct should be jointed to prevent ingress of foreign materials;

f) building entry points, and where specified, ceiling/floor joints, should be sealed to prevent the ingress of gases or liquids;

g) the design of duct, conduit and trunking should allow installation and removal of the cable without risk of damage to other cables.

9.5 Component acceptance and storage

Cabling components should be inspected and tested in accordance with the Quality Plan upon receipt.

Cabling components should be handled and stored in accordance with manufacturer's instructions.

9.6 Cable installation

Installation of cable should be undertaken in accordance with the installation programme specified in the Installation Specification. A usage log may be established to enable traceability.

During cable installation, appropriate techniques should be adopted in order to:

a) prevent cable kinking, ravelling or twisting;

b) prevent excessive abrasion or crushing of the cable;

c) ensure that the maximum installation and installed tensile load limits (as specified in ISO/IEC 11801 and also available from the cable supplier) are not exceeded;

   i) a constant tension and smooth pulling action is recommended;

   ii) if necessary, a load gauge may be applied to the cable during installation;

   NOTE The installation tensile limit (also known as the short term tensile limit) and the installed tensile limit (also known as the long term tensile limit) may be different.

d) ensure that the minimum bend radii requirements (as specified in ISO/IEC 11801 and also available from the cable supplier) during installation (also known as under tension or loaded) and after installation (also known as unloaded) are met.

   NOTE Where this is not possible, any non-compliance should be agreed between the installer and the user.

e) the minimum bending radius inside optical fibre connecting hardware such as tele-communication outlets and within closures should be as specified by the manufacturer of the optical fibre cable.

Where cable is to be pulled within shared pathways:

e) the concurrent installation of draw ropes is not recommended;

f) precautions should be taken in order to prevent damage to existing cables or structures;

g) to avoid damage to new or existing cables, use extra care when pulling a cable or cables into an occupied pathway.

Appropriate regulations concerning the installation of telecommunications cabling in the vicinity of mains electricity cabling should be complied with.

A minimum agreed length of cable should be provided at each closure position to enable subsequent access to the closure and to ensure sufficient length for cable management, termination, acceptance testing and also to reduce the impact of any damage to the end of the cable.

Where cables contain liquid or gel filling materials it is advisable to use protective caps (or equivalent) over exposed ends of the cable. This is particularly important where there may be considerable delays between installation of the cable and final termination.

9.7 Protection of installed cables

Following the installation of cable within pathways:

a) where possible, cables should be anchored at the start and finish of a bend to ensure that the minimum bend radius of the cable is maintained;

b) on cables which are not continuously supported, the maximum distance between support points should not exceed 500 mm (horizontal) and 500 mm (vertical);

c) cable ties, where used, should not be overtightened; it is preferred to use many loose ties on small bundles of cables;

d) where relevant, earthing of cable components should be undertaken in accordance with the requirements of the Installation Specification.

9.8 Installation of closures

Closures should be fixed or mounted in position using the recommended fittings. The closure should be bonded to earth in accordance with the requirements of the Installation Specification.

9.9 Pre-installation cabling acceptance (Stage 1) tests

Stage 1 testing should be undertaken as specified within the Quality Plan.

9.10 Termination, jointing and installation of cable within closures

9.10.1 General

Termination and splicing of cables should be undertaken in accordance with the connectivity schedule and installation programme provided in the Installation Specification.

Fittings within closures should be used to provide support, maintaining the minimum bend radii requirements of the cable manufacturer and strain relief for the cable and to prevent kinking at the point of entry into the closure.

Where relevant, cable components should be bonded to earth in accordance with the Installation Specification.

9.10.2 Copper Cabling

The amount of sheath removed from the cable and the untwisted length of the cable elements immediately in the vicinity of the termination should be kept to a minimum as detailed in ISO/IEC 11801.

Where shielded/screened cabling is terminated, the closure and/or the connector should be designed to adequately terminate the type of the shield/screen within the cable (see ISO/IEC 11801 for transfer impedance requirements).

9.10.3 Optical Fibre Cabling

Unmated optical fibre adaptors and connectors should be fitted with protective caps.

9.11 Administration

Labels and identifiers should be fitted to cables, connecting hardware and closures in accordance with the Installation Specification.

9.12 Post-installation cabling acceptance (Stage 2) inspection and tests

Where possible, visual inspection should be undertaken to ensure that the requirements of this clause and the Quality Plan have been complied with. Where agreed in the Quality Plan, this inspection may be undertaken by a third party.

Inspection and testing should be undertaken as detailed in the Quality Plan following final assembly and fitting of the closures as specified within the Installation Specification.

NOTE Screened/shielded cabling systems should be correctly bonded in accordance with manufacturer instructions prior to testing.

9.13 Further work

Where installed cables pass through fire barriers, the barrier should be re-established in accordance with relevant requirements.

10 Documentation

10.1 Installation documentation

This covers all technical and contractual issues relating to the installation undertaken and should include:

a) the Installation Specification;
b) the Quality Plan;
c) changes and variations;
d) support information including:
   i) component specifications and drawings;
   ii) component acceptance test and component supply log documentation;
   iii) pre-installation cabling acceptance (Stage 1) test documentation.

10.2 Cabling documentation

This covers the location, interconnections and performance of the installed cabling and should include:

a) site plan (as built);
b) component usage log, if used;
c) interconnection information;
d) post-installation cabling acceptance (Stage 2) test documentation.

The documentation format may be schematic or report based (or a combination of the two) and should be designed to support the changes made to the cabling throughout its operational life (see ISO/IEC 14763-1).