

University of Oxford IT Services Infrastructure Installation Specification Strategy

IISS-01-002: Installation and acceptance testing of singlemode optical fibre cabling

1 INTRODUCTION

1.1 Scope

This document specifies the requirements for the:

- installation of singlemode optical fibre cable;
- administration and management of singlemode optical fibre cable into closures;
- jointing of the singlemode optical fibre cable and the treatment of the optical fibres within closures;
- jointing of the singlemode optical fibre cable to pigtailed cable assemblies within closures and the treatment of the optical fibres within closures;
- testing of the installed cabling links.

1.2 Authorisation

Within the terms of this specification, the term “authorisation” refers to written approval obtained from the Network Operations Manager of University of Oxford IT Services.

1.3 Pre-requisites

This specification prefers that the installation and testing of optical fibre cabling is undertaken by a member of the Fibreoptic Industry Association who is also an Accredited Installer under the Accredited Installer Scheme.

All installation activities under the remit of, and associated with, University of Oxford IT Services specifications are required to comply with BS 6701. With regard to the installation, jointing and termination of optical fibre cables the contractors attention is drawn to the requirements of BS 6701.

Installations in accordance with this specification shall meet the specific requirements of clause 5 of the current published edition of BS 6701 and of the BS EN 50174 series of standards. To be specific:

- contractors shall comply with the requirements of clause 5 of the current published edition of BS EN 50174-1 (including all amendments);
- where installing cables within buildings, contractors shall comply with the requirements of clauses 5, 6 and 8 of the current published edition of BS EN 50174-2 (including all amendments);
- where installing cables outside buildings, contractors shall comply with the requirements of clauses 5 and 6 of the current published edition of BS EN 50174-3 (including all amendments).

Where the installation environment or other circumstances are deemed to prevent compliance with the above standards, the proposed deviations shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

Annex A of this document contains an Acceptance of Standards sheet that confirms that the contractor has obtained, read and understood the requirements of the above mentioned standards. This shall be signed by the responsible person within the contractor's organisation before any installation work commences.

1.4 Terms and definitions

This document adopts the terms and definitions of the current published editions of the BS EN 50174 series of standards (including all amendments).

2 OPTICAL FIBRE CABLES AND OPTICAL FIBRE CONNECTING HARDWARE

2.1 Optical fibre cables

2.1.1 General

The cables are free-issued by University of Oxford IT Services and no other cables shall be used unless authorised in advance.

Cables containing between 48 and 144 (inclusive) singlemode optical fibres are typically used within the 'backbone' of the network linking locations within the city of Oxford.

Cables containing 16 singlemode optical fibres are typically used for as 'edge' cables connecting the backbone cabling to buildings.

The specifications of the cables are provided in 2.1.2 to 2.1.5 so that the contractor is aware of the construction and mechanical properties of the cables.

The optical fibre within the cables conforms to ITU-T Recommendation G.652D (more accurately specified in BS EN 60793-2-50:2016 as optical fibre B1.3 – and to be re-designated as optical fibre B-652.D in BS EN 60793-2-50:2019) and has a mode field diameter of $9,2 \pm 0,4 \mu\text{m}$. In order to maintain the joint losses specified in this document it is critical that the optical fibre pigtails (see 2.2) also conform to this specification.

The cabled optical fibre shall meet the requirements of Category OS2 of BS EN 50173-1:2018. With regard to attenuation this requires the following:

- 1310 nm: $\leq 0,4 \text{ dB/km}$;
- 1383 nm: $\leq 0,4 \text{ dB/km}$;
- 1550 nm: $\leq 0,4 \text{ dB/km}$.

NOTE: It is increasing common for cables to contain so-called bend-insensitive optical fibres conforming to ITU-T Recommendation G.657 (more accurately specified in BS EN 60793-2-50:2016 as optical fibre B6.ax – and to be re-designated as optical fibre B-657.Ax in BS EN 60793-2-50:2019). The cables containing such optical fibres also meet the requirements of Category OS1a and OS2 of BS EN 50173-1:2018 but their use, and locations, should be clearly designated and information provided to the Network Operations Manager.

The recommended installation temperature for all the cables specified in this document is -10°C to $+40^\circ\text{C}$.

2.1.2 144-SMOF cables

2.1.2.1 Mechanical performance

The cable consists of 13 elements stranded around a non-metallic central strength member. The elements are a combination of water-blocked loose tubes (each containing 12 optical fibres) and an insulated copper wire, to give the required fibre count. The core is water blocked and wrapped with binders/tapes as required (to aid manufacture). Two ripcords are run in longitudinally (diametrically opposed) over the cable core, together with an overall black sheath.

Mechanical data:

- Tube Diameter (nominal): 1,9 mm
- Cable Diameter (nominal): 13,9 mm
- Cable Weight (nominal): 205 kg/km
- Tensile Strength: 1850 N
- Minimum Bend Diameter: 280 mm (static)
- Crush Resistance: 2000 N/100 mm

2.1.2.2 Fire performance

From 1st July 2017, all cables intended for permanent installation within buildings and other structures are subject to the EU Construction Products Regulation (CPR). Cables that are within scope of the CPR are required to be of a designated EuroClass in relation to their reaction to fire covering flame spread and some or all of the following characterises:

- heat release;
- production of smoke and its transmittance;
- production of flaming droplets;
- production of acid gas.

BS 6701:2016 Amendment 1:2017 requires certain cables inside buildings to meet EuroClass C_{ca}-s1b,d2,a2 of BS EN 13501-6. As a result, cables that do not meet the requirements of BS 6701:2016 Amendment 1:2017 shall not be installed inside buildings and other structures without the express authority of the Network Operations Manager.

NOTE: Cables intended for external installation only (subject to limited installation allowances inside buildings in accordance with BS EN 50174 series standards) may be excluded from a EuroClass specification but are still required to be sheathed using Low Smoke Zero Halogen (LSOH) materials specified in earlier editions of this document and meeting, as a minimum, EuroClass D_{ca}-s1b,d2,a2 of BS EN 13501-6.

2.1.3 72-SMOF cables

See 2.1.2.

2.1.4 48-SMOF cables

See 2.1.2.

2.1.5 16-element cables

2.1.5.1 Mechanical performance

The cable consists of 6 elements stranded around a glass reinforced plastic central strain member. The elements are a combination of water-blocked loose tubes (each containing eight optical fibres) and fillers to give the required fibre count. The cable core is dry water-blocked adopting a combination of water-swellaable tapes and yarns. A polyethylene/aluminium laminate moisture barrier tape is applied longitudinally over the core together with a ripcord, followed by a black sheath.

Mechanical data:

- Tube Diameter (nominal): 2,2 mm
- Cable Diameter (nominal): 11,6 mm
- Cable Weight (nominal): 145 kg/km
- Tensile Strength: 2000 N
- Minimum Bend Diameter: 240 mm (static), 480 mm (dynamic)
- Crush Resistance: 2500 N/100 mm

2.1.5.2 Fire performance

BS 6701:2016 Amendment 1:2017 requires certain cables inside buildings to meet EuroClass C_{ca}-s1b,d2,a2 of BS EN 13501-6. As a result, cables that do not meet the requirements of BS 6701:2016 Amendment 1:2017 shall not be installed inside buildings and other structures without the express authority of the Network Operations Manager.

NOTE: Cables intended for external installation only (subject to limited installation allowances inside buildings in accordance with BS EN 50174 series standards) may be excluded from a EuroClass specification but are still required to be sheathed using Low Smoke Zero Halogen (LSOH) materials specified in earlier editions of this document and meeting, as a minimum, EuroClass D_{ca}-s1b,d2,a2 of BS EN 13501-6.

2.2 Optical fibre pigtails

NOTE: Cables designed to be used in cords do not automatically fall within the scope of the Construction Products Regulation and therefore there is no reference to EuroClass in this clause.

The optical fibre pigtails are terminated with a simplex LC connector in accordance with BS EN 61754-20:2012, Interface 20-1 (simplex LC).

The cabled optical fibre used to produce the pigtails shall meet the requirements of Category OS1a of BS EN 50173-1:2018. With regard to attenuation this requires the following:

- 1310 nm: $\leq 1,0$ dB/km;
- 1383 nm: $\leq 1,0$ dB/km;
- 1550 nm: $\leq 1,0$ dB/km.

The mechanical requirements of singlemode optical fibre pigtails are:

- cable construction: tight buffered optical fibre typically diameter 900 μ m;
 - mode field diameter: $9,2 \pm 0,4$ μ m;
- NOTE: This aspect of the specification is critical for the attainment of the joint losses required by this specification
- length: $1,00 \pm 0,05$ metres.

The optical performance requirements of the cable comprising the singlemode optical fibre pigtails are:

- cabled optical fibre performance: Category OS1a of BS EN 50173-1:2018;
- NOTE: In earlier editions of this document, this designation was OS1 - this does not represent a performance modification.
- termination insertion loss: Grade C of BS EN 50377-7-4:
 - random mated performance: $\geq 97\%$ $\leq 0,5$ dB and a mean of $\leq 0,25$ dB;
 - performance to be measured on double ended assemblies 2 m in length and results recorded before pigtails are created;
 - test cords shall feature optical fibre with the same nominal mode field diameter as the pigtail;
 - termination return loss: $100\% \geq 45$ dB;
 - end-face inspection criteria: in accordance with Table 1 of BS EN 61300-3-35:2014.

Rationale

BS EN 50377-7-4

Connector sets and interconnect components to be used in optical fibre communication systems. Product specifications. LC-PC simplex terminated on IEC 60793-2-50 category B1.1 and B1.3 singlemode fibre with full zirconia ferrule for category C

[BS] EN 50173-1:2018 (which contains all the component requirements for the [BS] EN 50173 series of standards) and ISO/IEC 11801-1 specify the maximum connection insertion loss to be 0,75 dB..

To support this level of performance, standards have been produced for connectors applied to optical fibres of a given type. For example, [BS] EN 50377-7-4 is entitled "LC-PC simplex terminated on IEC 60793-2-50 category B1.1 and B1.3 singlemode fibre with full zirconia ferrule for category C". This standard specifies two grades of random mated insertion loss performance – the first (Grade C), the least demanding, supports the requirements of [BS] EN 50173-1 and ISO/IEC 11801 by requiring that 97 % of all connections $\leq 0,5$ dB with 50 % $\leq 0,25$ dB. A more demanding Grade, B, requires 97 % of all connections $\leq 0,25$ dB with 50 % $\leq 0,12$ dB. [BS] EN 50377-7-4 provides a sound basis for both specifying the procurement of pigtails and cords but also provides a foundation for statistical improvement of test limits for events, links and channels.

However, it should be noted that such performance requires the optical fibres at the connections to be of the same nominal range.

2.3 Bulkhead adaptors

Singlemode bulkhead adaptors shall conform to BS EN 61754-20:2012, Interface 20-5 (duplex LC).

In order to maximise compatibility and insertion loss performance, the bulkhead adaptors shall be from the same manufacturer as the connector plugs used to terminate the optical fibre pigtails of 2.2.

2.4 Closures

2.4.1 External joint closures

External joint closures for installation in chambers shall meet the requirements of, and be selected from the range specified in, BS EN 50411-2-3 (in-line) or BS EN 50411-2-4 (dome).

The preferred external joint closures are the dome type of the following specifications:

- Commscope/TE Connectivity FOSC 400 product range;
- Commscope/TE Connectivity FIST-GCO2-BC6-NN (for 144 optical fibre joints).

Where the installation environment or other circumstances are deemed to prevent the use of these products, the proposed deviation shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

2.4.2 Internal joint closures

Internal joint closures for installation within buildings shall meet the requirements of, and be selected from the range specified in, BS EN 50411-3-1.

Where the installation environment or other circumstances are deemed to prevent compliance with the above standard, the proposed deviation shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

2.4.3 Cable breakout units

Cable breakout units shall be employed to divide the optical fibre within cables of 2.1.2 and 2.1.3 (i.e. containing > 48-SMOF) to serve the panels of 2.4.4 and, where appropriate, the other closures of 2.4.5.

The preferred cable breakout unit is the Commscope/TE Connectivity CBU-4PG7-13/18 which is designed to accommodate the cables of 2.1.2 and 2.1.3. Where the installation environment or other circumstances are deemed to prevent the use of this product, the proposed deviation shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

2.4.4 Panel closures for installation within cabinets, frames or racks

The panels shall be of simple construction (no slide-out or swing-out requirements apply) and be of 1U height suitable for mounting within a 19" cabinet, frame or rack shall be fitted with 24 bulkhead adaptors in accordance with 2.3 together with a simple fibre management system comprising splice holders and optical fibre loop fittings capable of accommodating 48 splices and associated loops of optical fibre.

The panels shall be capable of being fitted with up to three glands to match the tubes of the cable break out units of 2.4.3 or optical fibre cables of 2.1.4 or 2.1.5.

The proposed panels and fittings shall be advised to University of Oxford IT Services and authorisation for their use shall be obtained.

2.4.5 Other closures accommodating terminated optical fibres

These will be specified on a case-by-case basis and their selection, procurement and installation will require pre-authorisation by University of Oxford IT Services.

2.4.6 Fibre management systems

Where not supplied as part of the closure, fibre management systems (i.e. splice trays) shall ensure that the optical fibre accommodated is not subject to bend radii of ≤ 30 mm in accordance with the core network objectives described in BS PD IEC TR 62048.

2.5 Accessories

2.5.1 Labels

The preferred labels to be applied to cables are Critchley 'K' type (black on yellow or black on white print).

Where the installation environment or other circumstances are deemed to prevent the use of these products, the proposed deviations shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

2.5.2 Singlemode optical fibre fusion splice protectors

Singlemode optical fibre fusion splice protectors shall meet the requirements of, and be selected from the range, specified in BS EN 50411-3-3.

3 PATHWAYS AND SPACES

3.1 Pathways and accessories

3.1.1 Pathways

In general the cables are installed in pre-laid 4 inch diameter BT PVC ducts.

In certain areas cables may be routed on tray in areas such as tunnels or in heating ducts.

The routing schedule defining the pathways to be used for a particular installation phase shall be provided by University of Oxford IT Services. Any proposed deviations shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

Where ducts contain other cables, the installer shall determine the viability of installing the additional cable(s) of this specification and any risk of damage to both the new and legacy cables together with any need for additional installation materials (lubricants) or modified techniques. Following agreement of the proposed approach, between the installer and University of Oxford IT Services, any resulting damage is considered to be a joint responsibility.

NOTE: Failure to undertake a risk assessment and subsequent acceptance by University of Oxford IT Services places the liability for any damage on the installer.

3.1.2 Draw ropes

Draw ropes shall be of BT specification 6mm polypropylene rope (blue).

3.2 Gas blocking at building entrance facilities

The preferred method is the Rayflate Duct Sealing System (RDSS) manufactured by Raychem. The gas seals shall be installed using both the gas and inflation equipment supplied for use with the RDSS and in accordance with the supplier's instructions.

Where the installation environment or other circumstances are deemed to prevent the use of this method, the proposed deviation shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

3.3 Spaces

3.3.1 Chambers

The chambers are pre-installed and meet BT footway and carriageway specification. This specification and construction of chambers is outside the scope of this specification.

The routing schedule defining the pathways to be used for a particular installation phase shall be provided by University of Oxford IT Services. Any proposed deviations shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

3.3.2 Cabinets, frames or racks

The mounting schedule for panels, defining the location of the cabinet, frame or rack and the location of the panels with them, for a particular installation phase shall be provided by University of Oxford IT Services. Any proposed deviations shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

4 EQUIPMENT

4.1 Fusion splicing equipment

Fusion splicing equipment (splicing apparatus and cleaving tools etc.) shall be capable of delivering the insertion loss specified in 5.3 for joints between cables of 2.1 and between those cables and the optical fibre pigtails of 2.2. The equipment shall be maintained and serviced in accordance with suppliers instructions.

4.2 Light source - power meter (LSPM) equipment

LSPM equipment (also known as insertion loss measurement (ILM)) used shall be in accordance with the requirements of BS EN 61280-4-2.

The LC connectors on the test cords shall be from the same manufacturer and to the same termination specification as the connector plugs used to terminate the optical fibre pigtails of 2.2. Test cords are not required to be terminated with reference terminations.

4.3 Optical time domain reflectometer (OTDR) equipment

Equipment used shall be in accordance with the requirements of BS EN 61280-4-2.

The LC connectors on the test cords shall be from the same manufacturer and to the same termination specification as the connector plugs used to terminate the optical fibre pigtails of 2.2. Test cords are not required to be terminated with reference terminations.

5 INSTALLATION

5.1 General

5.1.1 Free- issue items

Cable will be free-issued to contractors from stock held by University of Oxford IT Services and is generally stored on drums capable of accommodating 2 km of the appropriate cable.

Contractors shall be responsible for collecting and returning the cable drums as required from/to the designated cable store.

Contractors shall be determining and recording lengths of cables on drums before taking them from and returning them to the designated cable store.

For short length runs, space will be available at the cable store to fleet out the required length for loading onto smaller drums or coiling.

5.1.2 Scope of work

5.1.3 Working practices

All work outside buildings is required to be undertaken in accordance with the relevant aspects of the Code of Practice associated with the New Roads and Street Works Act.

5.1.4 Induction

All contractor staff working in the duct network will be required to attend an induction from the University Ductwork Supervisor which addresses safe working practices, risk management and to have their personal certification verified (see 5.1.5).

5.1.5 Required personal certification

In accordance with the New Roads and Street Works Act, University of Oxford IT Services requires that a qualified NRSWA Streetworks Supervisor is present during installation works and that any excavation or re-instatement work is undertaken by qualified NRSWA Streetworks Operatives.

All contractor staff involved in the installation of optical fibre cables shall carry CSCS certification appropriate to the tasks to be undertaken.

5.1.6 Installation standards

The contractor is responsible for providing all guarding, signage and keys for chamber lifting during the installation of fibre.

5.2 Cable installation

5.2.1 General

Continuous cable pulls shall be used whenever possible, avoiding splice points.

All conduits and ducts shall maintain a draw rope after installing a cable. If during the installation a draw rope is damaged or removed, it shall be replaced by the contractor.

Cable pulling shall be done by hand, except when tension meters, tension-controlled, or breakaway swivels are employed. Any mechanical means shall be "fused" at a level no greater than the tensile strength of the cable (see 2.1).

When pulling optical fibre cables into conduits and ducts or installing fibre cables on cable trays:

- the strength member(s) of the cable shall bear all or nearly all of the pulling force;
- cable sheath shall not be subjected to tensile loads other than those associated with cable laying and drawing through short enclosed routes (less than 5 m);
- optical fibre cables shall not be pulled by applying tension directly to the optical fibres (pulling the optical fibres).

5.2.2 External cable installation

A suitable pulling eye, or equivalent, shall be attached to the cable strength member of each cable being installed. Where necessary, cable lubricant may be used subject to the agreement of procedures in accordance with 3.1.1.

Cables are to be marked by a yellow insulation tape wrap at the ingress to every chamber. The cables shall also be marked with an Optical Fibre Hazard label in accordance with FIA TSD-2000-5-1. The appropriate level of Hazard shall be advised by University of Oxford IT Services.

Optical fibre cables shall be labelled at points of ingress and egress to spaces (chambers and other structures) using products meeting the requirements of 2.5.1. At entry points to directly accessible pathways (such as open tray) and along the route within such pathways the cables shall be labelled at separations not exceeding 10 m using products meeting the requirements of 2.5.1.

When pulls are accomplished in two or more stages, and spare cable must be unreeled at intermediate locations, it shall be configured in large figure-eights - maintaining the minimum bend radius of the cable and subject to appropriate temporary guarding and signage.

Within each chamber (whether or not it contains an external joint closure), the lengths of accessible cable within the chamber shall be confirmed by the Network Operations Manager in advance of any installation taking place. .

Where chambers are large enough to support service loops without static bend radius requirements being compromised service loops of 3-4 m length shall be accommodated at approximately 250 m intervals.

The labelling schedule to be used for a particular installation phase shall be provided by University of Oxford IT Services. Any proposed deviations shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

When underground conduit or ducts containing optical cables enter a building or other structure, entry shall be sealed using solutions meeting the requirements of 3.2 to prevent the entry/exit of gases into/from the structure.

5.2.3 Internal cable installation

Internal runs of fibre cable shall be installed in tray, trunking or basket.

Where directly accessible, the optical fibre cables shall be strapped down at interval not exceeding 3 m. The cables shall also be marked on a similar interval with an Optical Fibre Hazard label in accordance with FIA TSD-2000-5-1. The appropriate level of Hazard shall be advised by University of Oxford IT Services.

In addition to the general requirements for cable dressing within BS EN 50174-2, any straps or supports attached to or placed around optical fibre cables shall be tight enough to prevent rotation or axial movement of the cable but shall not deform the cable sheath. Cable ties shall have the free tab cut off to prevent over tightening in the future.

NOTE: When optical cables are squeezed out of shape, unacceptable forces are placed on the fibres, which frequently result in micro bends, micro cracking, or even broken fibres. Where possible, rounded or padded supports shall be used.

A minimum of 3 m of cable shall be left coiled and secured within or immediately adjacent to any jointing or termination point for any future service or maintenance.

The labelling schedule to be used for a particular installation phase shall be provided by University of Oxford IT Services. Optical fibre cables shall be labelled using products meeting the requirements of 2.5.1. In general:

- optical fibre cables routed in directly accessible pathways (such as open tray) shall be labelled at separations not exceeding 3 m;
- optical fibre cables shall be labelled on ingress and egress to and from building structures.

Any proposed deviations shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

5.3 Jointing

5.3.1 Splice performance

Fusion splice joints between;

- optical fibres in two cables shall exhibit an insertion loss $\leq 0,1\text{dB}$ at 1310 nm. This is required to be verified by OTDR testing in accordance with clause 6 - the interim indications of splice insertion loss provided by the splicing equipment shall not be used as a confirmation of this value.
- optical fibres in a cable and a pigtail shall exhibit an insertion loss $\leq 0,1\text{dB}$ at 1310 nm. However, this is difficult (if not impossible) to verify separately from the insertion loss of the connection of the pigtail. A limit of 0,6 dB is applied to the combined loss of the fusion splice and the connection.

5.3.2 Optical fibre identification

The optical fibre identification system to be applied is shown in

5.3.3 External joint closures

The jointing schedule defining the optical fibres to be jointed for a particular installation phase shall be provided by OUIITS. Any proposed deviations shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

The outer sheath of the cable(s) shall be stripped back by at least 1m (or greater if specified by the supplier of the closure for the arrangement of optical fibres within its fibre management system).

Optical fibre cables shall be securely installed into enclosures using the appropriate size of cable gland for the cable.

All waste optical fibre shall be removed from the closure before final assembly into as-built condition.

The external joint closure shall be assembled in accordance with the supplier's instructions.

Table 1. It should be noted that this is not the colour sequence of Annex of BS EN 50174-1 or that promoted on the cable data sheet provided by Prysmian.

5.3.4 External joint closures

The jointing schedule defining the optical fibres to be jointed for a particular installation phase shall be provided by OUIITS. Any proposed deviations shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

The outer sheath of the cable(s) shall be stripped back by at least 1m (or greater if specified by the supplier of the closure for the arrangement of optical fibres within its fibre management system).

Optical fibre cables shall be securely installed into enclosures using the appropriate size of cable gland for the cable.

All waste optical fibre shall be removed from the closure before final assembly into as-built condition.

The external joint closure shall be assembled in accordance with the supplier's instructions.

Table 1 - Optical fibre designation

Designation	Tubes of 8 (16-SMOF cables)	Tubes of 12 (48-, 72- and 144-SMOF cables)
1	Blue	Blue
2	Orange	Orange
3	Green	Green
4	Red	Red
5	Slate	Slate
6	Yellow	Yellow
7	Brown	Brown
8	Violet	Violet
9		Pink
10		Turquoise
11		Black
12		White

5.3.5 Internal joint closures

The jointing schedule defining the optical fibres to be jointed for a particular installation phase shall be provided by University of Oxford IT Services. Any proposed deviations shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

The outer sheath of the cable(s) shall be stripped back by at least 1m (or greater if specified by the supplier of the closure for the arrangement of optical fibres within its fibre management system).

Optical fibre cables shall be securely installed into enclosures using the appropriate size of gland for the cable.

All waste optical fibre shall be removed from the closure before final assembly into as-built condition.

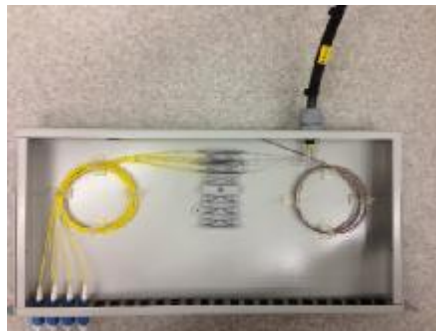
The internal joint closure shall be assembled in accordance with the supplier's instructions.

5.3.6 Panels and other closures accommodating terminated optical fibres

The jointing schedule defining the optical fibres to be jointed for a particular installation phase shall be provided by University of Oxford IT Services. Any proposed deviations shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

The outer sheath of the cable(s) shall be stripped back by at least 1m (or greater if specified by the supplier of the closure for the arrangement of optical fibres within its fibre management system).

Optical fibre cables shall be securely installed into enclosures using the appropriate size of gland for the cable.



All optical fibre not contained within fibre management systems shall be laid neatly into loops of radius ≥ 100 mm. This includes all optical fibres not initially intended for termination or jointing.

The management of the optical fibres within panels and other closures shall adopt the generic format shown above. The layout of the optical fibre loops and the associated splice holders for each cable shall enable easy access in cases of subsequent jointing activity. All joints shall be protected by splice protection sleeves and retained in splice holders and any un-jointed optical fibre shall be placed on top of the group associated with the cable.

All waste optical fibre shall be removed from the panels and closures before final assembly into as-built condition.

5.4 Working practices

In addition to the general requirements of BS 6701 and other standards listed in 1.3, BS 6701 also draw attention to the requirements of certain safe practice regulations including the Confined Spaces Regulations and the Control of Substances Hazardous to Health Regulations.

Safe working practices in relation to optical fibre hazards are specified in BS EN 60825-2 and are further explained in Fibreoptic Industry Association documents TSD-2000-5 series documents. The requirements and recommendations of these documents form the requirements of this specification.

The following additional issues are highlighted here which address work areas where optical fibre is cut, prepared or cleaved or otherwise resulting in the possible presence of small pieces of exposed primary coated or uncoated optical fibre (optical fibre waste).

Work areas:

- shall be clean, organized and well lit;
- shall be repeatedly and consistently cleared of optical fibre waste;
- shall be equipped with a sealable container for optical fibre waste which shall be handled and disposed of in accordance with the instructions provided in FIA-TSD-2000-5-3.

Technicians in work areas:

- shall use double-sided tape, or some other effective means, for picking up optical fibre waste;
- shall be not bring or consume food or drink into work areas;
- shall not smoke;
- shall thoroughly wash their hands immediately when leaving the work area;
- shall check their clothing, and pat themselves with clean tape to remove any optical fibre waste.

6 TESTING OF OPTICAL FIBRE CABLING

6.1 Witness testing

The testing schedule defining the optical fibres to be tested for a particular installation phase shall be provided by University of Oxford IT Services. Any proposed deviations shall be advised to University of Oxford IT Services and authorisation for such deviations shall be obtained.

No tests shall be carried out until the equipment and test methods to be used have been demonstrated to, and authorised by, University of Oxford IT Services staff.

LSPM testing shall only be employed when the lengths of the installed link is too short for the effective use of the OTDR testing solution. The length at which this occurs is dependent on the OTDR equipment to be used and shall be agreed, and authorised by, University of Oxford IT Services staff.

6.2 Inspection of optical fibre end-faces (installed and test cords) before connections are made

In order to prevent damage to the end-faces of optical fibre pigtails, optical fibre end-faces shall be inspected for loose contamination which shall be removed prior to any connection being established. Inspection equipment is specified in EN 61300-3-35 and cleaning procedures, where necessary, as specified in IEC/TR 62627-01.

6.3 Test methods

6.3.1 LSPM (ILM)

The 1-cord reference method of BS EN 61280-4-2 shall be used. Test cords shall be identified and their location in the test configuration recorded such that the test can be repeated accurately if necessary.

Each link shall be tested in both directions at 1310 nm. Both test results shall be recorded.

The test limit for a terminated link of length L (m) containing S interim splices (not including pigtail splices) shall be:

$$\text{Allowed loss @ 1310 nm} = 0.001 \times 0,4 \times L + 0,1 \times S + 1,2 + 0,5 \text{ dB}$$

This limit takes into account measurement error and no results exceeding the limit will be accepted.

6.3.2 OTDR

6.3.2.1 General

The capability of an OTDR to provide useful results depends on the length of the installed cable and the options within the OTDR to be compatible with that length.

Singlemode optical OTDR have minimum effective measurement lengths and shall only be used if the lengths to be measured are viable.

588 **6.3.2.2 Terminated optical fibre**

589 The OTDR method of BS EN 61280-4-2 shall be used.

590 NOTE: This is method 2 of BS EN 61280-4-2:1999 and will be Annex D of BS EN 61280-4-2:2014.

591

592 The testing of a terminated link (i.e. terminated at both ends) shall be undertaken with a launch cord and a tail cord. Bi-
593 directional results at 1310 nm are required. Both test results shall be recorded.

594

595 The OTDR trace shall show a consistent loss of no greater than 0,4 dB/km.

596

597 There shall be no other discontinuities within the trace than those associated with the known locations of optical fibre joints as
598 defined in the jointing schedule for that particular phase of the installation. The average loss of each joint (mean of bi-
599 directional results) shall not exceed 0,1 dB.

600

601 The test limit for a terminated link of length L (m) containing S interim splices (not including pigtail splices) shall be:

602

603
$$\text{Allowed loss (@ 1310 nm)} = 0.001 \times 0,4 \times L + 0,1 \times S + 1,2 \text{ dB}$$

604

605 NOTE: The 0,5 dB allowance for measurement error required by the LSPM method of 6.3.1 is not necessary.

606

607

608

7 INSPECTION OF FIBRE INSTALLATION

609 Following testing, each optical fibre interface (LC port) shall be re-inspected against the requirements of Table 1 of BS EN
610 61300-3-35:2014.

611

612 The end-face image shall be recorded by a CCD camera based microscope and the image recorded as part of the
613 documentation of the system.

614

615

616

8 DOCUMENTATION

617 Documentation required for each cable includes:

618

- 619 • unique University reference number of route (comprising one of more cable reference IDs);
- 620 • end point locations of cable(s);
- 621 • route of cable, including University chamber numbers passed through;
- 622 • any through splice point locations on cable route;
- 623 • cable size (number of optical fibres);
- 624 • link length;
- 625 • end-face inspection images;
- 626 • end-to-end OTDR testing of through spliced links, where appropriate;
- 627 • end-to-end ILM testing using appropriate source and meter equipment.

628

629

630

9 OTHER DOCUMENTS IN THIS SERIES

631 IISS-00-001: Infrastructure Installation Specification Strategy: Overview

632 IISS-00-002: Infrastructure Installation Specification Strategy: Distributed building services

633 IISS-01-001: Assessment of balanced cabling test results

634

635

636 ISP-00-001: Infrastructure Specification Project: Overview

637 *ISP-00-002: Access to University of Oxford IT Services facilities (later)*

638 ISP-01-001: University of Oxford IT Services Entrance Facilities - Product and design specification

639 ISP-01-002: University of Oxford IT Services Entrance Facilities - Accommodation requirements

640 ISP-02-001: University of Oxford IT Services Intermediate cabling (INTI-ENTI) - Product and design specification

641 ISP-02-002: University of Oxford IT Services Intermediate cabling (INTI-ENTI) - Accommodation requirements
642 ISP-03-001: Distribution cabling - Recommendations: Overview
643 ISP-03-002: Direct-connect cabling - Recommendations: Telecommunications infrastructure
644 ISP-03-003: Distribution cabling - Recommendations: IT infrastructure
645 ISP-03-004: Distribution cabling - Recommendations: Distributed building services infrastructure
646
647

648 **NORMATIVE REFERENCES**

649

BS 6701:2016 + Amendment 1:2017 BS EN 13501-6	Telecommunications equipment and telecommunications cabling – Specification for installation, operation and maintenance Fire classification of construction products and building elements. Classification using data from reaction to fire tests on electric cables
BS EN 50174-1:2018	Information technology - Cabling installation - Installation specification and quality assurance
BS EN 50174-2:2018	Information technology - Cabling installation - Planning and Installation practices inside buildings
BS EN 50174-3:2013 + Amendment 1:2017	Information technology - Cabling installation - Planning and Installation practices outside buildings
BS EN 50173-1:2018	Information technology - Generic cabling systems - General requirements
BS EN 61300-3-35	Fibre optic interconnecting devices and passive components. Basic test and measurement procedures. Examinations and measurements. Fibre optic connector endface visual and automated inspection
FIA-TSD-2000-5-1	Optical Power: Safety Levels
FIA-TSD-2000-5-2	Optical Fibre: Handling of Processing Chemicals
FIA-TSD-2000-5-3	Optical Fibre: Disposal of Waste

650

651

652 **BIBLIOGRAPHY**

653

BS EN 61754-20	Fibre optic interconnecting devices and passive components. Fibre optic connector interfaces. Type LC connector family
BS EN 50411-2-3	Fibre organisers and closures to be used in optical fibre communication systems. Product specifications. Sealed inline fibre splice closures Type 1, for category S & A
BS EN 50411-2-4	Fibre organisers and closures to be used in optical fibre communication systems. Product specifications. Sealed dome fibre splice closures Type 1, for category S & A
BS EN 50411-3-1	Fibre organisers and closures to be used in optical fibre communication systems. Product specifications. Fibre management system, splice wall box, for category C & G
BS EN 50411-3-3	Fibre organisers and closures to be used in optical fibre communication systems. Product specifications. Singlemode optical fibre fusion splice protectors
BS EN 61280-4-2	Fibre-optic communication subsystem test procedures - Part 4-2: Installed cable plant - Single-mode attenuation and optical return loss measurement
BS EN 60825-2	Safety of laser products. Safety of optical fibre communication systems (OFCS)
BS PD IEC TR 62048	Optical fibres - Reliability -Power law theory

654

655

656

657

ANNEX A

658

ACCEPTANCE OF STANDARDS

659

660 This specification requires that the contractor's nominated and responsible employee detailed below has obtained, read and
661 understood the requirements of the installation quality assurance and practice standards detailed in this specification and to
662 which compliance is required by this specification.

663

664

The current status of the standards is listed below and is linked to the date and issue version of this specification.

665

Document	Title	Current edition	Next edition
BS 6701	<i>Telecommunications equipment and telecommunications cabling – Specification for installation, operation and maintenance</i>	2016 + Amendment 1:2017	Not known
BS EN 50174-1	<i>Information technology - Cabling installation - Installation specification and quality assurance</i>	2018	Not known
BS EN 50174-2	<i>Information technology - Cabling installation - Planning and Installation practices inside buildings</i>	2018	Not known
BS EN 50174-3	<i>Information technology - Cabling installation - Planning and Installation practices outside buildings</i>	2013 +A1: 2017	Not known
BS EN 61300-3-35	<i>Fibre optic interconnecting devices and passive components. Basic test and measurement procedures. Examinations and measurements. Fibre optic connector endface visual and automated inspection</i>	2015	
BS EN 61280-4-2	<i>Fibre-optic communication subsystem test procedures - Part 4-2: Installed cable plant - Single-mode attenuation and optical return loss measurement</i>	2014	

666

Contractor organisation

Contractor nominated person

Signature

Date

667