Technical Specification

Transport and Main Roads Specifications MRTS234 Communications Cables

March 2020

Queensland Government

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1 Introduction

This Technical Specification defines the design, supply, installation, testing and commissioning, performance, documentation, training and maintenance requirements for telecommunications cables.

Telecommunications cables are used to transmit data, video and voice signals as an integral part of the Principal's telecommunication network that is described more fully in MRTS245 *Principal's Telecommunications Network* and the Contract. This Technical Specification applies to telecommunications cables with metallic cores and / or optical fibre cores.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specification* and MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate. This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

2 Definition of terms

The terms defined in Clause 2 of MRTS01 *Introduction to Technical Specifications* and MRTS20 *General Equipment Requirements* apply to this Technical Specification. Additional terminology relevant under this Technical Specification are defined in Table 2 following.

Table 2 – Definitions

Term	Definition
ACMA	Australian Communications & Media Authority
AFSL	Above Finished Surface Level
AI	Accredited Installer – Refer Section 4.4
APC	Angle Physical Contact Fibre Connector
BFSL	Below Finished Surface Level
CI	Certified Installer – Refer to Section 4.5
Conduit	Parts of a closed wiring system used to enclose cables in an electrical or telecommunications installation, which allows the cables to be drawn in or replaced
CSTA	Corrugated Steel Tape Armoured
CWDM	Coarse Wave Division Multiplexing
dB	Decibel – ratio measurement, (power out/power in)/$\log_{10}$
DC	Direct Current
Drawn cable	Cable that is drawn under tension, rather than blown by compressed air
DSP	Fluke Tester Reference
DTX	Fluke Tester Reference
ELV	Extra Low Voltage maximum 50V AC or 120V ripple free DC
FOBOT	Fibre Optic Break out Termination enclosure
GITC	Government Information Technology Contract
GRP / FRP	Glass Reinforced Plastic / Fibreglass Reinforced Plastic
ICT	Information Communications Technology
IP	Ingress Protection

Term	Definition
JDSU	A registered brand of optical fibre test equipment
KVAC	Kilo Volt Alternating Current
Low Voltage	Exceeding extra Low Voltage but not exceeding 1000V AC or 1500V DC
LSPM	Light Source Power Meter
LSZH	Low Smoke Zero Halogen
MFD	Mode Field Diameter
OFCS	Optical Fibre Communication System
OS2	Optical Single-Mode Grade 2 – classification of optical fibre cable
OTDR	Optical Time Domain Reflectometer
PDF	Portable Document Format
Pit	A wiring enclosure used to provide space for placing and joining cables, pulling cables, performing an operation on cables or for the inclusion of other equipment
RCDD	Registered Communications Distribution Designer
RTPM	Registered Telecommunications Project Manager
SC	Subscriber Connector (Fibre Optics)
SMOF	Single Mode Optical Fibre
TDR	Time Domain Reflectometer
VIP	Video Inspection Probe

3 Reference documents

The requirements of the referenced documents listed in Table 3 of MRTS201 *General Equipment Requirements* and Table 3 following apply to this Technical Specification. Where there are inconsistencies between this Technical Specification and referenced MRTS (including those referenced in MRTS201 *General Equipment Requirements*), the requirements specified in this Technical Specification shall take precedence.

Table 3 – Referenced documents

Reference	Title
ANSI/SCTE 47	*Test method for coaxial cable attenuation*
AS/CA S008	*Requirements for customer cabling products*
AS/CA S009	*Installation requirements for customer cabling (Wiring Rules)*
AS/NZS IEC 60825.1	*Safety of laser products – Equipment classification and requirements*
AS/NZS IEC 60825.14	*Safety of laser products – A user's guide*
AS/NZS IEC 60825.2	*Safety of laser products – Safety of optical fibre communication systems (OFCS)*
AS/NZS IS0/IEC 14763.2	*Telecommunications installations – Implementation and operation of customer premises cabling – Planning and installation*

Reference	Title
AS/NZS ISO/IEC 14763.3:2017	*Telecommunications installations – Implementation and operation of customer premises cabling – Part 3: Acceptance testing for optical fibre cabling*
AS/NZS 1367	*Coaxial cable and optical fibre systems for the radio frequency (RF) distribution of analogue and digital television and sound signals in single and multiple dwelling installations*
AS/NZS 1660.1	*Test methods for electrical cables, cords and conductors – conductors and metallic components*
AS/NZS IEC 61034	*Measurement of smoke density of cables burning under defined conditions*
AS/NZS 1768	*Lightning protection*
AS/NZS 2053.1	*Conduits and fittings for electrical installations – General requirements*
AS/NZS 11801.1	*Information technology - Generic cabling for customer premises General requirements (ISO/IEC 11801-1:2019, MOD)*
AS/NZS 11801.3	*Information technology - Generic cabling for customer premises Industrial premises (ISO/IEC 11801-3:2017, MOD)*
AS/NZS 3000	*Electrical installations (known as the Australian / New Zealand Wiring Rules)*
AS/NZS 11801	*Information technology – Generic cabling for customer premises – Part 1: General requirements*
AS/NZS 3084	*Telecommunications installations – Telecommunications pathways and spaces for commercial buildings*
AS/NZS 3085.1	*Telecommunications installations – Administration of communications cabling systems – Basic requirements*
ISO/IEC 61935.1	*Specification for the testing of balanced and coaxial information technology cabling – Installed balanced cabling as specified in ISO/IEC 11801 and related standards (IEC 61935-1, Ed.3.0 (2009) MOD)*
ISO/IEC 61935.2	*Testing of balanced communication cabling in accordance with ISO/IEC 11801 – Patch cords and work area cords*
IEC 61300-3-35	*Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-35: Examinations and measurements - Visual inspection of fibre optic connectors and fibre-stub transceivers*
AS1049.1	*Telecommunication cables – Insulation sheath and jacket – Materials*
IEC 61196 1	*Coaxial communication cables – Part 1: Generic specification – General, definitions and requirements*
IEC 61196 6	*Coaxial communication cables – Part 6: Sectional specification for CATV drop cables*
ITU T G652	*Characteristics of a single mode optical fibre and cable*
ITU T G657	*Characteristics of a bending loss insensitive single mode optical fibre and cable for the access network*
MRTS01	*Introduction to Technical Specifications*
MRTS201	*General Equipment Requirements*

Reference	Title
MRTS245	*Principal's Telecommunications Network*
MRTS50	*Specific Quality System Requirements*
MRTS91	*Conduits and Pits*
SAA HB243	*Communications cabling manual – Module 1: Australian regulatory arrangements*
TIA/EIA 455 104A	*Fibre Optic Cable Cyclic Flexing Test*

3.1 Regulations, codes, standards – order of precedence

All relevant regulations, codes and standards shall form part of the fibre optic cabling work including, but not limited to, and in order of precedence, the following:

- Telecommunications Act 1997
- Australian Communications and Media Authority (ACMA) requirements:
  - AS/CA S008 *Requirements for authorised cabling products*, and
  - AS/CA S009 *Installation requirements for customer cabling (Wiring rules)*
- AS/NZS 3000 *Wiring Rules*
- Building Code of Australia
- Queensland Workplace Health & Safety Acts and Regulations
- Australian Information and Communications Technology (ICT) cabling and related standards:
  - AS/NZS 11801.1 *Information technology – Generic cabling for customer premises General requirements* (ISO/IEC 11801–1:2019)
  - AS/NZS 11801.3 *Information technology – Generic cabling for customer premises Industrial premises (ISO/IEC 11801–3:2017, MOD)*
  - AS/NZS 3084 *Telecommunications installations – Telecommunications pathways and spaces for commercial buildings*
  - AS/NZS 3085.1 *Telecommunications installations – Administration of communications cabling systems – Part 1: Basic requirements*
  - AS/NZS ISO/IEC 14763.*2 Information technology – Implementation and operation of customer premises cabling Planning and installation*
  - AS/NZS ISO/IEC 14763.3 *Telecommunications installations – Implementation and operation of customer premises cabling – Part 3: Acceptance testing of optical fibre cabling*
  - IEC 61300–3–35 *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3–35: Examinations and measurements – Visual inspection of fibre optic connectors and fibre-stub transceivers*
  - AS/NZS IEC 60825.1 *Safety of laser products – Equipment classification and requirements*
  - AS/NZS IEC 60825.14 *Safety of laser products – A user's guide*
  - AS/NZS IEC 60825.2 *Safety of laser products – Safety of optical fibre communication systems* (OFCS) and

  - HB243 *Communications Cabling Manual – Module 1: Australian regulatory arrangements.*

- cabling systems manufacturer installation requirements, and
- operator certificates, tickets and licences required for the machinery, apparatus, plant, tools, and so on to be used or operated.

Conflicting information shall be governed by reference to the latest editions of the relative documents.

3.2 Quality system requirements

The quality system requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification. Additional quality requirements relevant to this Technical Specification are defined in Table 3.2.

Table 3.2 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
4.4	1. Cable type – optical fibre type shall be optical single mode 2 (OS2) G652.D		
6.2		1. Post-delivery tests – All optical fibre cables shall be tested upon delivery to site prior to installation	
6.4		2. Underground cable installation – Optical fibre cables shall be minimum 500 mm BFSL	
6.5.2		3. Lubricants – only polymer-based lubricants shall be used	
6.5.3		4. Hauling tension – stated hauling tensions shall be adhered to	
6.5.5	2. Identification and marking – optical fibre cables shall be marked and identified as specified		
6.6.1		5. Installation general – Cabling shall be installed as specified	
6.6.3		6. Installation Procedure – Contractor supplied evidence of approved procedures	
6.6.4		7. Conduit Entries – All conduit entries shall be sealed	
6.6.5		8. Identification marking and labelling – Installed cables shall be labelled as specified	

Clause	Hold Point	Witness Point	Milestone
7.3.1	3. Drawn, fibre optic cables – optic fibre cables shall be constructed as specified		
7.4	4. Blown fibre systems – shall be approved by the Administrator prior to installation		
7.5.1	5. Joint enclosures – fibre optic termination enclosures shall be pre-approved by the Administrator prior to installation		
7.5.3		9. Terminations – No section of the fibre cores may be exposed outside the enclosure	
7.5.4		10. Patch panel – shall be mounted as specified	
7.6.4		11. Test result data requirements – LSPM / O TDR / Link Budgets Loss Calculations	
7.6.5		12. Visual inspection of terminated optical fibre – Fibre optic terminations shall be visually inspected with a video inspection probe	
7.6.12	6. Test result acceptance – supplied test results must be approved by the Principal		
8.3.2		13. Minimum bending radius installation requirements	
8.5		14. Testing of twisted pair cables – twisted pair cables shall be tested in accordance with the specified requirements	
9.2	7. Coaxial cable electrical parameters – coaxial cables shall be constructed to meet the requirements of the installation		
9.4		15. Testing of coaxial cables – The Contractor shall supply hard and electronic copies of the test results	

4 General requirements

4.1 Technical requirements

Materials and equipment provided under this Technical Specification shall comply with requirements of AS/CA S008. Materials and equipment installed under this Technical Specification shall comply with the installation requirements of AS/CA S009. All earthing installations and systems shall comply with AS/NZS 3000 and where required AS/CA S009.

4.2 Operational requirements

The performance requirements specified in MRTS201 *General Equipment Requirements* apply to materials and work provided under this Technical Specification.

4.3 Environmental conditions

The environmental conditions specified in MRTS201 *General Equipment Requirements* apply to this Technical Specification. Additional environmental conditions for equipment provided under this Technical Specification are described below:

1. Cables shall be suitable for installation within the intended environment. Cables installed in outdoor conditions shall comply with the requirements of AS/CA S008.
2. Underground conduits and associated infrastructure shall comply with the requirements of MRTS91 *Conduits and Pits*.

4.4 Cable type

All fibre optic cables installed shall be optical single mode 2 (OS2) G652.D (low or zero water peak). Multimode cable shall not be used.

The cable construction type required shall be detailed in the project specific detailed scope of works. **Hold Point 1**

4.5 Cable construction

All communications cabling shall comply with AS/CA S008.

4.5.1 Outdoor construction optic cable

Prior to the finalisation of the network design the designer shall confirm with the regional ITS representative the minimum requirements for cable construction with respect to vermin resistance.

Outdoor construction cable shall be non-metallic construction where the optical fibre cable will be installed in LV electrical conduit systems. Backbone fibre optic cable shall consist of a minimum of 144 cores unless otherwise specified by the respective ITS Regional Representative. All cores of a fibre optic backbone cable shall be terminated at in a node cabinet unless otherwise directed by the respective ITS Regional Representative.

Where dedicated ICT communications pathways are provided consideration shall be given to the installation of corrugated steel tape armoured construction cable.

4.5.1.1 Non-metallic outdoor construction optical fibre cable

Non-metallic outdoor construction fibre optic cable shall have a composite layered construction based on:

a) Nylon outer sheath

b) primary polyethylene outer jacket

c) GRP rod (solid round or flat filament profile) armoured rodent barrier (not applicable to aerial cable) providing 100% coverage to the inner cable construction

d) secondary polyethylene or Nylon™ inner sheath

e) dry water blocking tape or threads surrounding fibre tubes and fillers

f) have solid fillers in lieu of empty tubes

g) maximum of 24 fibres per loose tube

h) Glass Reinforced Plastic / Fibreglass Reinforced Plastic (GRP / FRP) central strength member; and

A GRP rod armoured rodent resistant cable shall be used for projects where rodent protection is an identified risk. The contractor shall refer to the detailed scope of works project documentation for specific details of the optical fibre cable to be installed.

All GRP rod armoured rodent resistant cable not already tested shall be submitted to an independent rodent accredited testing facility at no cost to the Department of Transport and Main Roads. Any subsequent test report shall be submitted to the Principal for approval. Such testing shall be conducted at an independent test centre utilising local rodent, in particular the Australian Black Bush Rat (Rattus rattus).

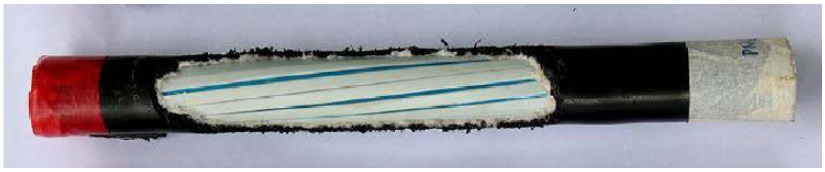
The current accepted testing centre is:

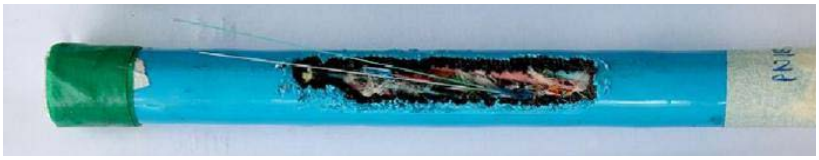
University of Queensland,
School of Agriculture and Food Sciences,
Faculty of Science, Gatton QLD 4343

Test reports from the Department of Natural Resources are also acceptable.

Test reports shall include a description of each sample including part numbers. The report results shall directly reference the sample and related description and part number.

The minimum acceptable test outcome shall be no physical impact below the level of the GRP rod armour layer.





To maximise the life of communications cable such as optic fibre, the department needs to ensure that the cables are adequately protected against rodents. The image above is of a cable that was significantly damaged by rodents, which was not of an armoured cable type. The exposed inner sheaths and the lighter coloured bundles of 12 core optic fibre are visible through the penetration.

Therefore, the department needs to specify armoured rodent protection on fibre optic cables to prevent this type of damage in the future and extend the life of a fibre cable installation and reduce maintenance costs (and associated operational downtime) to repair damaged cable.

4.5.1.2 Metallic armoured outdoor construction optical fibre cable

Metallic armoured outdoor construction fibre optic cable shall have a composite layered construction based on:

a) Outer Nylon sacrificial jacket

b) primary polyethylene outer jacket

c) Corrugated Steel Tape (CSTA) armoured rodent barrier (not applicable to aerial cable)

d) secondary polyethylene or Nylon™ inner sheath

e) a glass reinforced polymer central strength member

f) have solid fillers in lieu of empty tubes

g) maximum of 24 fibres per loose tube

h) a water blocked inner core

4.5.2 Indoor construction fibre optic cable

Indoor construction fibre optic cable shall be constructed as follows:

a) low smoke zero halogen outer sheath

b) aramid yarn strength member

c) glass polymer central strength member/optional flexible central strength member

d) 900µm tight buffered cores

Indoor grade cable shall only be installed in compliant indoor pathways and shall not be exposed to the elements or moisture rich environment.

5 Installation methods

5.1 Underground

Fibre optic cables installed underground shall be enclosed in a suitable compliant conduit system meeting the requirements of MRTS91 *Conduits and Pits*. All communications conduits shall be white in colour. The fibre optic cable shall be installed in the communications conduits, unless prior written permission is granted by the department for installation in electrical conduits.

The department prefers to install fibre optic cable within dedicated white communications conduits. AS/CA S009 allows for the installation of optic fibre cable within electrical conduits. However, the department seeks to further reduce the risk of any accidental exposure of departmental communications maintenance personnel to electrical hazards.

5.2 Surface

Fibre optic cables installed onto the surface of a structure shall be enclosed in a PVC or metallic conduit meeting the requirements of AS/CA S008. The conduit shall be coloured white and labelled Communications in accordance with the requirements of AS/CA S008. Where fibre optic cables are installed in an area accessible to the public the conduit shall be metallic in construction to a height of 2400 mm Above Finished Surface Level (AFSL) or be enclosed in a hat section of 1.6 mm thick hot dip galvanised sheet metal.

No fibre optic cable shall be installed on a surface without an approved enclosure.

Optic fibre cable installed within communications cable risers affixed to Intelligent Transport Systems (ITS) gantries, structures and other applications as approved by the Principal shall be military specification compliant with particular reference to general cable durability and flexibility under TIA/EIA 455 104A and bending radius (refer to Clause 6.5.4). The Departmental project representative shall be consulted for further direction should this requirement not be satisfied.

In some situations, the department needs to install fibre optic cables with bends which are tighter than what can be provided for by standard commercial cables. Tactical field construction cables are able to meet this requirement apart from being generally much more rugged and durable.

5.3 Longitudinal barriers

ICT cabling shall not be installed within longitudinal barriers without prior approval of the regional ITS manager. Refer to MRTS200 *General Requirements for Intelligent Transport Systems Infrastructure* for additional information.

6 Installation requirements

The installation requirements specified in MRTS201 *General Equipment Requirements* apply to this Technical Specification. Additional installation requirements for equipment provided under this Technical Specification are described in the following sections.

6.1 Pre-delivery tests

All fibre optic cables shall be tested on the drum prior to delivery to site. Testing shall consist of an OTDR trace on one core of each filled tube in one direction at one wavelength (1310 or 1550 nm). Any tested cable showing any anomalies on any core shall be rejected. Traces shall be stored, and an electronic copy submitted to the Principal.

In some instances, SMOF cables may need to be used for accepting additional disparate services. This may involve the use of CWDM to effectively increase the fibre core count and hence useable capacity. In these cases, the wavelength of 1383 nm is to be included in the testing of the cable.

6.2 Post-delivery tests

Upon delivery to site and prior to physical installation, all fibre optic cables shall be tested. Testing shall consist of an OTDR trace on all cores in one direction at one wavelength. Tested cable showing any anomalies on any core shall be rejected. Traces shall be stored, and an electronic copy submitted to the Principal. **Witness Point 1**

6.3 Underground cable installation

AS/CA S008 outdoor rated fibre optic cables shall be installed into underground conduits using the following methodologies for each cable type. A minimum 6 mm polypropylene draw rope shall be used to haul all fibre optic cables:

- loose tube construction – Attach a Katimex Part# 108170, or approved equivalent, cable grip stocking to the cable, and
- after completion of cable hauling and prior to commencement of fibre termination, the first 5.0 m of cable shall be removed.

For all fibre optic cable installations exceeding 500 m, a Katimex Part# 107183, or approved equivalent, line swivel shall be used at the point of attachment to all cables.

6.3.1 Tunnels

In addition to the general requirements of Clause 5.5, all new cables installed within new tunnels shall be LSZH type outer jacket to minimise smoke toxicity in the event of a tunnel fire.

For existing tunnels, all new cables shall be of the LSZH type outer jacket.

A non-metallic armoured construction cable shall be used where rodent protection is an identified risk within the tunnels (refer Clause 5.5).

The LSZH cable shall be tested to and comply with AS/ANZ IEC 61034 with particular reference to smoke emission characteristics of the cable.

The department wants to ensure that any new cables installed within tunnels are LSZH type. These cables have a LSZH jacket which emit reduced smoke and no halogen when burnt. Many departmental tunnels are used as emergency egress during a tunnel fire and minimising the potential smoke toxicity contributing factors where possible during design will help maximise safety outcomes.

6.4 Underground conduit pathways

Underground conduit pathways shall comply with the requirements of AS / CA S009 and MRTS91 *Conduits and Pits*. The minimum depth of cover for a telecommunications conduit shall be 500 mm Below Finished Surface Level (BFSL). **Witness Point 2**

6.5 Cable hauling practices

6.5.1 Conduits

As required by MRTS91 *Conduits and Pits*:

a) Ensure that all conduits are clean and free of debris.

b) Ensure all conduit ends are de-burred and free of sharp edges.

6.5.2 Lubricants

Apply a suitable polymer-based cable lubricant. Petroleum or wax-based lubricant shall not be used. **Witness Point 3**

6.5.3 Hauling tension

The maximum hauling tension to be applied to fibre optic cables shall be as per the cable manufacturer's installation instructions.

The installer shall use a mechanical hauling device for all cable installations exceeding 500 m. The mechanical hauling device shall have an adjustable tension setting suitable for the cable being installed. A suitable swivel shall be used when hauling cables in excess of 500 m. **Witness Point 4**

6.5.4 Minimum bend radius

The minimum bend radius to be applied to fibre optic cables shall be as per the cable manufacturer's installation instructions.

6.5.5 Identification and marking

Unless otherwise specified, the cable sheath shall be marked in a contrasting colour with sequential metre markings at one metre intervals. The metre markings need not start at zero. The starting and finishing metre markings shall be recorded on the drum flange. **Hold Point 2**

The following information shall be printed or stamped on the outer sheath at regular intervals not exceeding 1 m:

- manufacturer's name or identifying initials
- year of manufacture
- type of cable
- number of cores (for optic fibre)
- type of fibre cable (for example, SMOF G652.d)
- metre markings, and
- 'Department of Transport and Main Roads'.

Better identification of cables will allow site inspectors to readily discern the nature of cable configurations in existing installations through cable labelling.

6.5.6 Storage

The Contractor shall take all reasonable care when storing metallic communications cable, fibre optic cable, fibre optic duct and accessories. These shall be stored in a safe, dry and secure location until required. Fibre optic cable drums shall not be transported on their flat sides. All drums shall be transported upright to prevent compression damage.

Cables or cable drums shall not be stored directly on the ground. Cables, fibre optic duct and accessories shall be protected from damage and solar radiation.

6.6 Installation

6.6.1 General

Cables shall be bundled and drawn in together using cable lubricant as required. Cables shall lie loose in the conduit and be free from residual tension, kinks or twists. Where two or more cables share a duct, they shall be installed such that:

- they are not wrapped about each other, and
- any single cable can be withdrawn without disturbing the other cable(s).

Draw ropes used to draw in cables and / or fibre optic ducts shall be replaced as the cables and / or ducts are installed.

Conduits shall not be filled beyond 60 per cent capacity.

Additional lengths of neatly coiled cable slack shall be provisioned under the following conditions:

- pits adjacent to connecting equipment or joints – 10 metres
- at the nearest pit to every 200 metres – 10 metres
- at all pits comprising a road crossing – 20 metres

New pits shall be suitably sized to accommodate the required slack cable. Existing pit(s) that have insufficient spare capacity to support the required cable slack lengths shall be immediately reported to the Principal for a determination on whether a cable slack requirement can be waived at that particular pit(s).

Sufficient cable slack provisions allow the department to future proof for the purpose of enhancements requiring connection to previous cabling installations at the areas listed. If sufficient cable slack is not available, complete new sections of cable are required to be drawn and this is costly as joints will introduce losses and, as the number increases, will degrade the reliability of the communications.

Should the installed cable bending radius prevent installation of the required slack provisions under this clause, written approval to waive or to provide further direction from the Administrator shall be sought as soon as the project becomes aware of the non-compliance.

Ends of cables that are not immediately terminated shall be sealed to prevent ingress of moisture and other foreign material. Ends of conduits and fibre optics ducts shall be sealed in accordance with MRTS91 *Conduits and Pits*. The Contractor shall rectify and / or replace any seals on cables, fibre optic ducts, and / or conduits that are disturbed or damaged, including cable that remain uninstalled on its drum. **Witness Point 5**

The Contractor shall replace any damaged materials.

6.6.2 Cable joints

Cables shall be ordered in appropriate lengths to minimise the number of joints. A jointing plan shall be prepared and presented to the Principal for approval prior to the purchase of any fibre optic cable.

All cable joints shall be enclosed in a protective housing to avoid damage and prevent the ingress of moisture and other foreign materials. The housing shall ensure that no stress is imparted to the joint and any exposed cable cores. The joint enclosure shall be rated to IP68.

Fibre optic joints shall be located in maintenance accessible locations. The location must have provision for access for a service vehicle and associated parking bay, accessible 24/7 without the requirement for traffic control.

All cable entries to the joint housing shall be sealed to prevent the ingress of moisture and other foreign materials.

For fibre optic cable, mechanical splices shall not be used.

6.6.3 Installation procedure

The Contractor shall prepare and submit to the Principal an installation procedure for each type of cable. The installation procedures shall be included in the Contractor's construction plan. Where new cable is replacing older or previously installed cable, the recovery and removal of the older or previously installed cable and associated joints will form part of the contractors work unless otherwise specified. **Witness Point 6**

The installation procedures shall include but not be limited to detailing the materials and methods to be used for:

a) fibre optic duct (where used)

b) de-watering conduits if required

c) draw rope replacement in conduits

d) storage of materials on and off site

e) cable installation

f) cable joints

g) cable terminations

h) disposal of excess materials

i) product identification and traceability

j) inspection and test plans, and

k) confirmation that the conduit is able to accommodate the cables.

6.6.4 Conduit entries to enclosures and facilities

All telecommunications conduits entering a structure or roadside enclosure shall be sealed, conduits containing cabling shall be effectively sealed with a multi-port sealing device (Quadplex™ Duct Plug) or approved equal.

Spare entry points in the conduit seal shall be sealed with equivalent blanking plugs matching the sealing device. **Witness Point 7**

6.6.5 Identification labelling and marking

All cables shall be tagged permanently at both ends with sufficient information to identify the cable uniquely and describe the termination point of the opposite end of the cable in accordance with the requirements of the detailed design drawings. Identification methods shall be in accordance with AS 3085.1.

All installed fibre optic cables shall be labelled at each accessible location (termination enclosure / pit) with a durable label detailing the Departmental nominated cable identifier and the source / destination information. The label shall be the functional equivalent of a TNA Industries TNA-CM86 label printed / embossed to order.

The information shall be permanently printed / etched onto the surface of the label. For underground installations, a label shall be placed on the cable at each point of entry / exit. The label at these locations shall logically indicate the source of the cable in each direction as per the detailed design drawings.

All FOBOT and joint enclosures shall be uniquely labelled as per the departmental labelling standard for the project. All terminated cores shall be uniquely labelled/numbered. All unterminated cores within a tube shall be identified by tube number and core colour on the 'as built' documentation. All unused tubes containing spare fibre cores shall be labelled with the source / destination information and cable ID.

Transport and Main Roads reserves the right to engage an independent ICT cabling inspector to review the entire installation of elements thereof. **Witness Point 8**

7 Fibre optic cable

7.1 Reliability and life cycle

The design service life of cables shall be 25 years in the installation environment.

7.2 General

In addition to the requirements stated above, the following requirements apply to fibre optic cables unless specified in the project documentation.

Maximum optical attenuation of all fibre optic cables shall be in accordance with Section 9.5.2.1 of AS/NZS 11801.1.

The minimum optical performance requirements for fibre optic cables are listed in Table 7.3.1(a).

7.3 Drawn, fibre optic cables

7.3.1 General

SMOF cables shall be provided with a primary sacrificial Nylon™ jacket (blue) of 0.45 mm nominal Wall thickness +/- 0.1 mm.

The secondary sheath shall be polyethylene 1.2 mm nominal Wall ± 0.1 mm.

The minimum physical performance requirements for fibre optic cables are listed in Table 7.3.1(a). **Hold Point 3**

Table 7.3.1(a) – Minimum optical requirements

Parameter	Single Mode Optical Fibre Cable (SMOF)			
	1310 nm	**1383 nm**	**1550 nm**	**1625 nm**
Maximum attenuation (dB / km)	0.35	0.35	0.21	0.24
Chromatic dispersion coefficient	≤ 3.5ps/nm/ km	–	≤ 19ps/nm/ km	≤ 22ps/nm/ km
Modal bandwidth	–	–	–	–
Mode Field Diameter (MFD)	9.2 ± 0.4 microns	–	10.4 ± 0.5 microns	–

Table 7.3.1(b) – Minimum physical requirements

Parameter	SMOF
Rated tensile strength	1.5 KN (minimum)
Maximum crush resistance	2.0kN / 100 mm (minimum)
Cladding non circularity	≤ 2.0%
Minimum bend radius • (No load) • (Full load)	≥ 10 x cable diameter ≥ 20 x cable diameter
Operating temperature	- 10°C to +70°C
Fibre identification	Colour coded
Water blocking (within tubes):	Thixotropic gel
Water blocking (within cable):	Dry block or thixotropic gel

7.3.2 Drawn, Single Mode Optical Fibre cable

SMOF cables shall comply with AS/NZS 11801.1 including tests defined in the relevant Annexures.

7.4 Blown fibre systems

Unless otherwise specified, blown fibre systems shall not be installed without prior written approval from the Principal. **Hold Point 4**

7.5 Fibre optic cable joints, splices, terminations, patch panels and patch leads

7.5.1 Joint enclosures

All fibre optic cables shall be terminated within a suitable approved enclosure. All termination enclosures shall be approved by the Principal prior to implementation. **Hold Point 5**

All fibre optic termination enclosures shall match those detailed in the project detailed design. As a minimum, all fibre optic termination enclosures shall have the following features:

Underground joint enclosures shall be suitable for the initial cables installed plus two future cables and be minimum IP68 rated. Sufficient trays to splice every core shall be provided in the joint enclosure. Where cores are not terminated in the joint, they shall be prepared and laid up in the spare trays ready for future splicing.

- Fibre tubes (containing 12 cores) not required to be spliced in a joint shall be expressed through the joint. The expressed tubes shall be suitable stored within the joint such that the tubes remain secure when the joint is opened
- Underground joint enclosures shall be the functional equivalent of the following:
  - Commscope FIST-GC02-XXY-NV where a small strand count spur cable is required to be spliced into a main trunk cable of up to 144 cores
  - Commscope FIST-GC02-XXYY-NV where multiple high strand count cables are spliced to each other and / or multiple small strand count spur cables. This enclosure shall only be used where there are greater than four cables entering an enclosure
- A pressure test valve shall be included in the dome of the enclosure
- Mechanical cable restraint at the cable point of entry supporting the cable not more than 300 mm from the exposed cores / tubes
- Internal mechanical restraint for the central strength member
- Splice cassette with a minimum capacity of 12 heat shrink splice protection sleeves – the splice cassette will be suitably sized to prevent macro bending of the terminated cores.

7.5.1.1 Mini DIN rail mount termination enclosure

- Wall mount / DIN rail mount enclosures shall have capacity for a minimum of 12 SC / APC simplex couplers – the enclosures shall have sufficient space to store a minimum of 3.0 m of stripped tight buffered cores of loose tube
- SC simplex couplers shall have an integral spring activated dust cover / shutter
- Unused openings in the enclosure shall be sealed with blanking plugs
- Mini DIN rail mounted enclosures shall be the functional equivalent of the following:
  - AFL – FDE-12-SCA-1-S

7.5.1.2 19” rack mount enclosures

- 19–inch 1RU rack mount enclosures shall have capacity for a minimum of 24 SC / APC simplex couplers – rack mountable enclosures shall have sufficient space to store a minimum of 3.0 m of stripped tight buffered cores or loose tube
- SC simplex couplers shall have an integral spring activated dust cover / shutter

- Unused openings in the enclosure shall be sealed with blanking plugs
- larger rack mounted enclosures shall have the capacity specified in the tender documentation
- 19–inch rack mount enclosures shall be the functional equivalent of the following:
  - AFL RC–1CI1TE–BA–2S for up to 24 terminated fibre strands
  - AFL RBA–2CI2TE–BB–4S–Z for up to 48 terminated fibre strands
  - AFL RAL–12JQ–BF–12S–Z for larger fibre strand counts

Termination enclosures shall have sufficient space to allow the fibre cores free and unstressed entry to the splice cassette and to the coupler. Macro bending of the fibre cores is not acceptable.

7.5.2 Splices

All fibre optic cores shall be fusion spliced, the splicer shall be suitable for the purpose intended. Mechanical splices shall not be used. The insertion loss of each splice in the fibre optic cable shall not exceed 0.1 dB.

Pigtails for fibre core terminations shall be colour coded as per AS/CA S009 Table B7 below:

Table B7 (from AS/CA S009) – Optical fibre colour code

Core number	Core colour
1	Blue
2	Orange
3	Green
4	Brown
5	Grey
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Pink
12	Aqua

The above colour code shall be applied to both optical fibre strands and tubes. Where the strand / tube count exceeds 12 an identifiable trace colour shall be applied to the element.

Pigtails shall be manufactured from bend insensitive strand type compliant to ITU T G657.A2.

Pigtails connector end faces shall be cleaned prior to insertion into the coupler.

7.5.3 Terminations

All optical fibre cores shall be spliced with matching pigtails on a 19-inch rack mounted, enclosed fibre splice panel. The fly leads shall terminate in a 19-inch rack mounted SC / APC patch panel or other approved enclosure suitable to the terminating environment. No section of the fibre cores may be exposed outside the enclosure. **Witness Point 9**

The insertion loss of each mated pair of connectors shall not exceed 0.5 dB and return loss less than 60.0 db. FOBOT faceplates are to be angled to eliminate the potential for patch lead boots to be pressed against a closed cabinet door. Mandatory installation of cable management panels is required above/below FOBOT's.

All unused or dark Fibre Optic Breakout Termination enclosure (FOBOT) sockets shall be fitted with termination plugs. Sufficient termination plugs shall be left within the FOBOT for all used connections.

Any unused cables shall be labelled and terminated.

7.5.4 Patch panel

The patch panel shall utilise standard square connector / angled polished connector (SC / APC) type connectors. The fibre splice panel and patch panel shall be mounted within a communications field cabinet that complies with MRTS201 *General Equipment Requirements*, or a suitable indoor enclosure.

Unused ports in the patch panel shall be capped to prevent the ingress of moisture and other foreign material. Fibre optic couplers / thru adaptors shall be mounted with all keyways oriented to the bottom to prevent an accumulation of dust in the keyway.

Rack mounted fibre optic termination enclosures shall have integral horizontal and vertical cable management to assist in reducing stress on the patch leads.

Witness Point 10

7.5.5 Patch leads

Equipment shall be connected to the patch panel via flexible and resilient optic fibre patch leads designed for such purpose.

Patch leads shall match the type of optic fibre core, patch panel connectors (SC / APC type) and equipment connectors (SC / APC type) and be of sufficient length to avoid tension on installed patch leads while minimising insertion losses.

All fibre optic patch leads shall be of the bend insensitive type compliant to ITU T G657.A2.

Project specific documentation may specify duplex LC connectors for the equipment end, refer to the directions of the Administrator.

> Fibre optic patch leads are a key component of communications and often are subjected to tight bends over the course of regular maintenance activities. The bend insensitive patch cable type is expected to increase physical routing flexibility for installers.

Patch leads shall have a minimum jacket diameter of 2.0 mm and be yellow in colour.

7.6 Testing and commissioning of installed Single Mode Optical Fibre cabling

7.6.1 Minimum requirements

The Contractor shall carry out all tests that can be applied to fibre optic cable installations as defined in AS/NZS 11801.1:2019.

Insertion loss measurements shall be made over all complete links in both directions at 1310 nm and 1550 nm for SMOF cables. Where CWDM is a requirement of the SMOF design, the wavelength of 1383 nm shall also be included in the Insertion loss measurements.

The Contractor shall supply electronic copies in native format and *.pdf of the OTDR trace for each fibre core as well as tabulated results. The contractor shall provide a copy of the OTDR viewing software to the department.

The Contractor shall provide optical loss budget calculations and result summaries for all cables installed as per Appendix A of this Technical Specification.

7.6.2 Testing standards

Test equipment and testing procedures shall comply with AS/NZS ISO/IEC 14763.3.

Test limit data and link/loss budget calculations shall be derived from the following:

1. core attenuation as per AS/NZS 11801.1:2019 for OS2 Class optical fibre
2. splice loss as per Clause 7.5.2 of MRTS234 *Communications Cables*
3. connector losses as per Clause 7.5.3 of MRTS234 *Communications Cables*.

A maximum link / loss calculation shall be made for each installed link as detailed in Appendix A *'Fibre budget loss calculation and result summary'*.

7.6.3 Test configuration

Newly installed fibres shall be tested as permanent links as defined by AS/NZS 11801.

7.6.4 Test result data requirements

The following shall be provided to the department for each fibre cabling installation:

- Light Source Power Meter (LSPM). Test result data shall be provided in the native format supplied by the test equipment manufacturer (for example, Fluke Networks Linkware). Test results shall not be accepted in any text-based format. LSPM calculations performed on OTDR trace data are not acceptable.
- Optical Time Domain Reflectometer (OTDR). All traces shall be provided in the OTDR's native format and a portable document format (PDF) printout of each trace. Where specific viewing software is required to view and analyse the trace data the Contractor shall provide a copy of the specific software with the trace data.
- Completed budget loss calculation and result summary sheet (refer Appendix A of this Technical Specification).

Detailed test results shall be provided for all cores as part of 'As Constructed' documentation. If fibre is to be used prior to 'As Constructed', documentation being available, a summary report for all cores showing a pass is required before any core is patched into service. **Witness Point 11**

7.6.5 Visual inspection of terminated optical fibre

Fibre terminations shall be confirmed clean by visual inspection using appropriate magnifying equipment in accordance with AS/NZS 14763.3 Annex B (normative) Section B.2 prior to tests being conducted. A Video Inspection Probe (VIP) shall be utilised for the inspection. The VIP shall be capable of storing the captured image. The captured images shall be provided to the department with the handover documentation. **Witness Point 12**

Contaminating particles on the end faces shall be removed using suitable cleaning equipment in accordance with the manufacturer's instructions. The connector shall comply with ISO/IEC 14763 3:2006 and IEC 61300–3–35 SM APC for low reflectance connectors and be tested using equipment which provides a PASS / FAIL indication on the image. Any connectors failing this test shall be replaced.

7.6.6 Light source power meter testing requirements

The following presents the minimum testing requirements for fibre optic installations at departmental sites:

- the LSPM shall be configurable with test equipment interfaces that match the termination connectors of the completed installation
- where the LSPM test equipment interface matches the installed connector interface the calibration method shall be AS/NZS/ISO/IEC 14763.3 1 jumper method as detailed in Figure 10 of the Standard
- where the LSPM test equipment interface does not match the installed connector interface the calibration method shall be AS/NZS/ISO/IEC 14763.3 3 jumper method as detailed in Figure 9 of the Standard
- all test leads shall be certified reference leads with losses equal to those detailed in AS/NZS/ISO/IEC 14763.3 Clause 6.3.2, Table 3 – manufacturer loss results for all reference lead shall be provided to the department with the LSPM results
- test shall be performed in both directions at both operating wavelengths, and
- test results submitted with positive gain results shall not be accepted.

7.6.7 LSPM test result data requirements

The following information, as a minimum, shall be recorded for each core tested:

- project name
- site ID
- name of tester operator
- fibre ID shall match the label on the FOBOT
- fibre core being tested
- reference method
- calibration date, and
- reference date / time.

7.6.8 Optical Time Domain Reflectometer testing requirements

The following present the minimum testing requirements for fibre optic installations at departmental sites:

- As a minimum, the OTDR shall be a functional equivalent to the JDSU MTS 6000. The OTDR shall be suitable for the length of cable under test.
- Traces shall be performed with both launch and tail leads. Traces shall be performed in both directions and both wavelengths under this methodology.
- Launch and tail leads for single mode installations shall be minimum 500 m in length.
- For testing of completed installations, it is acceptable for the OTDR to be utilised in 'auto' mode with the event table function enabled.

  Where the installed link is less than 250 m in length the pulse width shall be reduced to ensure that the trace is clear and that all elements of the completed installation are identifiable.
- All OTDR traces shall be averaged for a minimum of 30s for lengths up to 1000 m, lengths greater than 1000 m shall be averaged for a minimum of 60s.
- Markers shall be placed at the base of the peak indicating the start of the link under test and the peak indicating the end of the link under test (that is, between the launch / tail leads) to define the segment under test to ensure length is as accurate as possible.
- The event parameters of the OTDR shall be set to reflect the acceptable splice / connector losses detailed in in this Specification.
- Only the final traces are required to be supplied to the Principal.
- A two-point measurement of the link under test exclusive of 'dead zones' shall be made on the link under test to ensure that the installed cable has an attenuation value consistent with the manufacturer's loss / km values contained within the product data sheet.
- Propagation delay shall be reported for all cores tested, and
- Optical return loss shall be measured in accordance with Clause 10.4 of AS/NZS 14763.3.

7.6.9 Optical Time Domain Reflectometer test result data requirements

The following information, as a minimum, shall be recorded for each core tested:

- project name
- date and time of test
- name of tester operator
- fibre ID shall match the label on the FOBOT
- core number
- length of fibre being tested (as identified between the markers)
- loss across the entire length (as identified between the markers), and
- loss across individual events along the fibre path.

7.6.10 Test instrument requirements

All test equipment utilised on departmental projects shall comply with the following requirements:

- comply with AS/NZS ISO/IEC 14763.3
- calibrated within the last 12 months – a copy of the calibration certificate shall be provided to the department on request
- operated by a person appropriately trained and accredited by the test equipment manufacturer – a copy of the accreditation certificate shall be provided to the department on request
- setup using the manufacturer's setup procedure prior to testing being performed – a copy of the set-up procedure shall be provided to the department on request, and
- equipped with test leads suitable for the fibre being tested.

7.6.11 Underground joint enclosure pressure test

All fibre optic underground joint enclosures shall be pressure tested in accordance with the manufacturer's installation instructions.

Testing compliance shall be noted on the project sign-off information.

7.6.12 Test result acceptance

The Contractor shall provide detailed budget loss calculations and result summary to the Principal for acceptance. **Hold Point 6**

A pass result in the budget loss calculation and result summary sheet indicates:

- test equipment is within 12 months of its calibration date
- the operator is trained and accredited to operate the test instruments
- the test leads are correctly referenced
- for LSPM, the measured loss over the length of the fibre is less than the budget loss calculation for the entire length, and
- for OTDR, the loss across each individual component does not exceed the budget loss for that component.

Note: A 'pass' on the LSPM can be negated by a 'fail' on the OTDR. If a reported event on the OTDR exceeds the limits allowed in AS/NZS 11801.1 for that type of event, the tested core will be deemed to have failed.

8 Twisted pair cables

8.1 General

In addition to the requirements stated above, the following requirements apply to twisted pair cables.

The appropriate cable shall be selected to suit the application.

All installed cable shall have a minimum of two twisted pairs.

Twisted pair communication cables shall be suitable for operation in the proximity of low voltage cables. Their material, construction and installation shall comply with AS/NZS 3000.

8.2 Twisted pair electrical parameters

Twisted pair communication cables shall comply with AS/NZS 11801.1:2019, including all parameters for metallic cables defined in the relevant Annexes A, B and C.

8.3 Installation requirements

8.3.1 Hauling tension

The maximum hauling tension to be applied to twisted pair cables shall be:

a) twisted pair cables – 110N / 11 kg or the cable manufacturer's maximum whichever is the greater value.

8.3.2 Minimum bend radius

The following minimum bend radii shall be applied to the installation of twisted pair cables cable under this Technical Specification:

a) Unshielded twisted pair cables – 50 mm radius during hauling. When secured in a static environment the bend radius shall be no less than 25 mm radius, and

b) Shielded twisted pair cables – 60 mm radius during hauling. When secured in a static environment the bend radius shall be no less than 40 mm radius.

Witness Point 13

8.4 Terminations and patch leads

8.4.1 Joints

Twisted pair cables shall be installed in a single length, mid span joints shall not be used without prior written approval of the Principal.

8.4.2 Terminations

All conductors shall be terminated at both ends with an 8P8C modular connector on a 19–inch rack mounted, terminal panel. The insertion loss of each termination or intermediate joint shall not exceed the requirements of AS/NZS 11801.1 for the relevant category of product installed.

The termination panel and / or terminal block shall be mounted within a field cabinet that complies with MRTS201 *General Equipment Requirements*, or a suitable indoor enclosure. The patch panel shall be sealed to prevent the ingress of moisture and other foreign material.

All twisted pair service cables shall be fitted with over voltage protection modules suitable for the Class and performance of the link. OVP modules shall be fitted to both terminated ends.

Any unused cables shall be left unterminated but sealed at both ends to prevent ingress of moisture and other foreign material.

8.4.3 Patch leads

Patch leads shall match the category type, use connectors compatible with the cable terminations and be of sufficient length to avoid tension on installed patch leads.

All CAT5/6 patch leads shall be uniquely labelled at both ends as per the detailed design drawings

All twisted–pair patch leads used for Ethernet communications shall be coloured as shown in Table 8.4.3.

Table 8.4.3 – Ethernet patch leads

Link type	Colour
Standard, straight through patch	Blue
Cross over cables (TIA-568A to TIA-568B terminated)	Red
Communications uplinks (such as from switch to point of access	Yellow
Critical communications links (such as switch to server, or switch to switch)	Green

8.5 Testing of twisted pair cables

All twisted pair links shall be tested as per the performance requirements of AS/NZS 11801.1 for the class of permanent link installed. **Witness Point 14**

8.5.1 Test configuration

Newly installed cables shall be tested as permanent links as defined by AS/NZS 11801.1.

Testing shall be carried out with a verified Level IV or Level V cable analyser capable of providing Time Domain Reflectometer (TDR) results for all terminated copper pairs.

Acceptable equipment includes Fluke Networks, DSX5000, DSX8000, Psieber Wire Expert 4500 and JDSU Certifier 40G.

Test results shall be provided for all installed links in native electronic format for the tester used. Test results shall not be provided in plain text format, pdf or hard copy.

9 Coaxial cable

9.1 General

In addition to the requirements stated above, the following requirements apply to coaxial cables.

Coaxial communication cables shall be suitable for operation in the proximity of low voltage cables.

Their material, construction and installation shall comply with AS/NZS 3000, IEC 61196 1 and IEC 61196 6.

9.2 Coaxial cable electrical parameters

The appropriate coaxial communication cable shall be selected to suit the application including at least 10 per cent spare in the loss budget. **Hold Point 7**

A 75 Ω cable shall be used for video applications, and a 50 Ω cable shall be used for data and applications using radio frequencies.

Coaxial communications cable shall withstand without breakdown:

- spark test of 6 KVAC in accordance with the spark test specified in AS/NZS 1660 Part 3, and
- withstand test of 2 KVAC for one minute in accordance with the withstand test as specified in AS/NZS 1660.

9.3 Installation

9.3.1 Installation procedure

Telecommunications cabling shall be installed in wiring enclosures in accordance with AS/CA S009 and AS/NZS 3000, by a Registered Cabler, with competencies for the work undertaken, authorised under the *Commonwealth Telecommunications Act* 1997 to perform cabling work for telecommunications.

Installation of coaxial telecommunication cables shall comply with AS/NZS 1367. Coaxial cables installed with Low Voltage cabling within the same enclosure shall meet the insulation requirements of AS/NZS 3000 Clauses 1.10.4 and 3.9.9.3.

The cable manufacturer's installation instructions regarding hauling tension and bend radius shall be adhered to. In general, the minimum bend radius of any coaxial cable shall not be less than 10 times the outside diameter of the cable sheath.

9.3.2 Joints and terminations

Unless otherwise specified, joints are not permitted in coaxial cables.

Cable ends shall be prepared for termination to industry standards and to suit cable types. Terminations shall be made in accordance with manufacturers' instructions.

9.4 Testing of coaxial cables

All testing of coaxial cables to determine signal attenuation electrical parameters and verify the loss budget for the particular installation shall be carried out using test methods as specified in ANSI/SCTE 47.

Verification of coaxial cable DC resistance parameters shall be by manufacturer's data sheet or a calibrated digital resistance meter. Alternatively, the installation Contractor may test the cable with an industry standard cable analyser (Fluke Networks DSP or DTX with coaxial adaptor or approved equivalent) and record the information in the analyser database software for submission to the department.

The Contractor shall supply hard and electronic copies of the TDR trace of each cable as well as tabulated results. **Witness Point 15**

10 Documentation

The documentation requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

In addition, the following shall be included:

- locations of joints, inline joint enclosures, spare cable coils and service vehicle parking locations
- schematic drawings for cable usage, including individual optical fibre cores, twisted pairs and coaxial cables
- schematic drawings for usage of fibre optic duct
- a fully updated communication patch record book (including fibre and copper) shall be installed within each ITS field cabinet or communications room which houses a patch rack (including a FOBOT, copper patch panel)

- a complete master patching record both in a softcopy and hardcopy format – the software copy shall be presented in an editable format (such as in Excel™ spreadsheet)
- all OTDR and LSPM test results for all installed fibre both in a softcopy and hardcopy format – the softcopy shall be able to be viewed with a PC, any viewing software shall be provided to the Principal
- all copper testing results both in softcopy and hardcopy formats – the software copy shall be presented in an editable format (such as in Excel™ spreadsheet)
- copies of all fibre optic test certifications; and
- any other documentation requested under this Technical Specification.

11 Warranty Certification

The completed installation shall be covered by a manufacturer warranty certification for a period of not less than 25 years covering all parts and labour including but not limited to:

a) Cable

b) Terminations

c) Termination enclosures / patch panels

d) Couplers / through adaptors

e) Equipment cables

12 Training

The training requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

13 Maintenance

The maintenance requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

14 Handover

The handover requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

Appendix A – Departmental fibre budget loss calculation and result summary

Fibre name (primary label*)		Fibre description (secondary label*)	
Fibre type	Single Mode	Fibre manufacture and part no.	
Installed by		Installation date	
'A' end location		'B' end location	
'A' end FOBOT make and model		'B' end FOBOT make and model	
'A' end FOBOT ID		'B' end FOBOT ID	
'A' end termination type		'B' end termination type	

Budget loss calculation (and other test information)

Length		Loss per km	
		@1310 nm	
		@1550 nm	
No. of connectors		Number of splices	
Budget loss 1310 nm		Budget loss 1550 nm	
LSPM reference method		Manufacturer's propagation delay	
OTDR launch lead length ‘A’		OTDR launch lead length 'B'	

Results summary

'A' end port no	Pigtail buffer colour	Core number	Core colour	'B' end port no	LSPM loss 1310 nm		LSPM loss 1550 nm		Pass / fail LSPM	Pass / fail OTDR	OTDR propagation delay in ns / m	OTDR anomalies (dB Loss) (if any)
					A-B	B-A	A-B	B-A				
		1	Blue									
		2	Orange									
		3	Green									
		4	Brown									
		5	Grey									
		6	White									
		7	Red									
		8	Black									
		9	Yellow									
		10	Violet									
		11	Pink									
		12	Aqua									