

Main Roads Technical Standard

MRTS234

Provision of Telecommunications Cables

October 10

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Provision of Telecommunications Cables

1 INTRODUCTION

This standard 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 and the Contract. This standard applies to telecommunications cables with metallic cores and/or optical fibre cores.

This Technical Standard shall be read in conjunction with MRTS01 *Introduction to Technical Standards*, MRTS50 *Specific Quality System Requirements* and other Technical Standards as appropriate.

This Technical Standard forms part of the Transport and Main Roads Specifications and Technical Standards Manual.

2 DEFINITION OF TERMS

The terms defined in Clause 2 of MRTS01 *Introduction to Technical Standards* and MRTS201 apply to this standard. Additional terminology relevant under this standard are defined in Table 2 below.

Table 2 – Definitions

Term	Definition
AFSL	Above finished surface level
BFSL	Below finished surface level
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.
Drawn cable	Cable that is drawn under tension, rather than blown by compressed air
ELV	Extra low voltage maximum 50V AC or 120V ripple free DC
FO	Fibre optic
FOBOT	Fibre optic break out termination enclosure
GRP	Glass reinforced plastic
Low Voltage	Exceeding extra low voltage but not exceeding 1000 V AC or 1500 V DC
LSPM	Light source power meter
OTDR	Optical time domain reflectometer
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.
SMOF	Single mode optical fibre
TDR	Time Domain Reflectometer
DTMR	Department of Transport and Main Roads
VIP	Video Inspection Probe

3 REFERENCE DOCUMENTS

The requirements of the referenced documents listed in Table 3 of MRTS201 and Table 3 below apply to work under this standard. Where there are inconsistencies between this standard and referenced MRTS (including those referenced in MRTS201), the requirements specified in this standard shall take precedence.

Table 3 – Referenced Documents

Document ID	Document Name / Description
MRTS201	General equipment requirements
MRTS91	Ducts and pits
ANSI/SCTE 50	Test procedure for measuring regularity of impedance of coaxial cable
AS/ACIF S008	Requirements for authorised products
AS/ACIF S009	Installation requirements for customer cabling (Wiring Rules).
AS/NZS 1367	Coaxial cable and optical fibre systems for the RF distribution of analogue and digital television and sound signals in single and multiple dwelling installations
AS/NZS 14763.2 (Draft)	Information Technology - Implementation and operation of customer premises cabling - Part 2: Planning and installation
AS/NZS 14763.3	Telecommunications installations - Implementation and operation of customer premises cabling - Testing of optical fibre cabling
AS/NZS 1660	Test methods for electrical cables, cords and conductors
AS/NZS 1768	Lightning protection
AS/NZS 2053.1	Conduits and fittings for electrical installations - General requirements
AS/NZS 24702	Telecommunications installations - Generic cabling - Industrial premises
AS/NZS 3000	Electrical installations (Wiring Rules)
AS/NZS 3080	Telecommunications installations – Integrated telecommunications cabling systems for commercial purposes
AS/NZS 3085.1	Telecommunications installations – Administration of communications cabling systems – Basic requirements
AS/NZS 61935.1	Telecommunications installations – Generic cabling systems – Specification for the testing of balanced communication cabling
AS/NZS 61935.2	Telecommunications installations – Generic cabling systems – Specification for the testing of patch cords in accordance with AS/NZS 3080
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
SAA HB 29	Telecommunications cabling handbook

3.1 Regulations, Codes, Standards – Order of Precedence

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

- Telecommunications Act 1997
- Australian Communications and Media Authority (ACMA) requirements
 - AS/ACIF S008:2006 Requirements for customer cabling products;

- AS/ACIF S009:2006 Installation requirements for customer cabling (Wiring rules);
- AS/NZS 3000:2007 Wiring Rules
- Building Code of Australia:2009
- Queensland Workplace Health & Safety Acts and Regulations
- Australian ICT cabling and related standards
 - AS/NZS 3080:2003 / Amendment 1:2009 Telecommunications installations-Generic cabling for commercial premises
 - AS/NZS 3084:2003 / Amendment 1:2007 Telecommunications installations – Telecommunications pathways and spaces for commercial buildings
 - AS/NZS 3085.1:2004 Telecommunications installations – Administration of communications cabling systems – Part 1: Basic requirements
 - AS/NZS 14763.3:2007 Telecommunications installations – Implementation and operation of customer premises cabling – Part 3: Acceptance testing of optical fibre cabling
 - AS/NZS 2211.1:2004 Safety of LASER products – Part 1: Equipment classification, requirements and user’s guide
 - AS/NZS 2211.2:2006 Safety of laser products - Safety of optical fibre communication systems (OFCS)
 - HB29-2007 Communications Cabling Manual – Module 2: Communications cabling handbook
 - HB243-2007 Communications Cabling Manual – Module 1: Australian regulatory arrangements
- Cabling systems manufacturers installation requirements
- Operator certificates, tickets and licences required for the machinery, apparatus, plant, tools etc to be used or operated

Conflicting information shall be governed by reference to the latest editions of the relative documents. All conflicts shall be resolved with the Administrator.

3.2 Quality System Requirements

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

Table 3.2 – Hold Points and Witness Points

Clause	Hold Point	Witness Point
4.4	1. Cable type - optical fibre type shall be OS2	
6.2		1. Post delivery tests – Optical fibre cables shall be tested on the drum prior to hauling
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.

Clause	Hold Point	Witness Point
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 procedures shall be approved
6.6.4		7. The contractor shall supply 5 spare cable bushings of each type used in the conduit seal device to enable future cabling installations through the installed duct plug
6.6.5		8. Identification marking and labelling – Installed cables shall be labelled as specified
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 – optical fibre terminations shall meet the requirements of the specification
7.5.4		10. Patch panel – shall be pre approved by the Administrator
7.6.4		11. Visual inspection of terminated optical fibre – fibre optic terminations shall be visually inspected with a video inspection probe
7.6.5		12. Test result data requirements – test results shall meet the requirements of the specification
7.6.11	6. Test result acceptance – supplied test results shall be reviewed against the specified requirements	
8.3		13. Twisted pair installation requirements – the specified requirements for twisted pair cable installation shall be adhered to

Clause	Hold Point	Witness Point
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 – coaxial cables shall be tested as specified

4 GENERAL REQUIREMENTS

4.1 Technical Requirements

Materials and equipment provided under this standard shall comply with requirements of AS/ACIF S008. Materials and equipment installed under this standard shall comply with requirements of AS/ACIF S009.

Specific installation requirements shall meet the electrical requirements of AS/NZS 3000

4.2 Operational Requirements

The operational requirements specified in MRTS201 apply to materials and work provided under this standard.

4.3 Environmental Conditions

The environmental conditions specified in MRTS201 apply to work under this standard. Additional environmental conditions for equipment provided under this standard are described below.

Cables shall be suitable for installation within the environment intended. Cables installed in outdoor conditions shall be suitable for the purpose and comply with the requirements of AS/ACIF S008.

Underground conduits and associated infrastructure shall be provided in accordance with MRTS91.

4.4 Cable Type

All installed fibre optic cable shall be optical single mode 2 (OS2) G652.d (low or zero water peak).

Hold Point 1

4.5 Cable Construction

All AS/ACIF S008 compliant outdoor cable shall be constructed as follows:

- a) Sacrificial primary Polyethylene (PE) outer jacket;
- b) Secondary Nylon™ jacket (Bonded to PE);
- c) Polyurethane (PE) inner sheath (under secondary Nylon™ jacket);
- d) No metal shall be used in construction of the fibre optic cable;
- e) Water blocking tape surrounding fibre tubes and fillers;
- f) Have solid PE fillers;
- g) Maximum of 12 Fibres per tube; and
- h) GRP central strength member.

GRP armoured construction cable shall be specified on a project specific basis where rodent protection is an identified risk mitigation strategy (for example, open cable trays).

Tight buffered construction cables shall not be installed in an outdoor environment.

5 INSTALLATION METHODS

5.1 Aerial

Aerial supported or self-supporting fibre optic cables shall not be installed without prior approval in writing from the Administrator.

Where aerial fibre optic cabling is approved, the cable and installation practices shall comply with the requirements of AS/ACIF S008 and AS/ACIF S009. Approval in writing from the Administrator shall be sought prior to the commencement of the installation.

5.2 Underground

Fibre optic cables installed underground shall be enclosed in a suitable complaint conduit system meeting the requirements of MRTS91.

Direct buried fibre optic cables shall only be installed if approved by the Administrator in writing.

5.3 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/ACIF S008. The conduit shall be coloured white and labelled communications in accordance with the requirements of AS/ACIF S008. Where fibre optic cables are installed in an area accessible to the public the conduit shall be metallic construction to a height of 2400 mm 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.

6 INSTALLATION REQUIREMENTS

The installation requirements specified in MRTS201 apply to work under this standard. Additional installation requirements for equipment provided under this standard are described below.

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 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 Administrator.

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 Administrator. **Witness Point**

6.3 Underground Cable Installation

AS/ACIF 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.
- 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 mm, a Katimex Part#107183, or approved equivalent, line swivel shall be used at the point of attachment to all cables.

6.4 Underground Conduit Pathways

Underground conduit pathways shall be compliant to the requirements of AS/ACIF S009 and MRTS91. The minimum depth of cover for a telecommunications conduit shall be 500 mm BFSL. **Witness Point**

6.5 Cable Hauling Practices

6.5.1 Conduits

Ensure that all conduits are clean and free of debris.

6.5.2 Lubricants

Apply a suitable polymer based cable lubricant. Petroleum or wax based lubricant shall not be used.

Witness Point

6.5.3 Hauling Tension

The maximum hauling tension to be applied to fibre optic cables shall be:

- a) Tight buffered construction – 220N/22 kg or the cable manufacturer's maximum, whichever is the lesser value; and
- b) Loose tube construction – 2750N/275 kg or the cable manufacturer's maximum, whichever is the lesser value.

The installer shall use a mechanical hauling device for all cable installations exceeding 500m. The mechanical hauling device shall have an adjustable tension setting suitable for the cable being installed.

Witness Point

6.5.4 Minimum Bend Radius

The following minimum bend radii shall be applied to the installation of fibre optic cable under this specification:

- a) Tight buffered construction – 20 times the outside diameter of the cable during hauling. When secured in a static environment, the bend radius shall be no less than 10 times the outside diameter.
- b) Loose tube construction – 30 times the outside diameter of the cable during hauling. When secured in a static environment, the bend radius shall be no less than 20 times the outside diameter.

6.5.5 Identification and Marking

Unless otherwise specified, the cable sheath shall be marked indelibly 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 embossed on the outer sheath at regular intervals not exceeding 1 m:

- (i) manufacturer's name or identifying initials;
- (ii) year of manufacture;
- (iii) type of cable;
- (iv) metre markings; and
- (v) 'Department of Transport and Main Roads'.

6.5.6 Storage

The Contractor shall take all reasonable care when storing metallic communications cable, FO cable, FO 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 side. All drums shall be transported upright to prevent compression damage.

Cables or cable drums shall not be stored directly on the ground.

Cables, FO duct and accessories shall be protected from damage and solar radiation.

6.6 Installation

6.6.1 General

Witness Point

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 FO ducts shall be replaced as the cables and/or ducts are installed.

Conduits shall not be filled beyond 60% capacity.

Unless otherwise specified, a minimum of 6 metres of slack cable shall be coiled in each pit adjacent to connecting equipment or joints.

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

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 Administrator 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.

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

6.6.3 Installation Procedure

The Contractor shall prepare and submit to the Administrator an installation procedure for each type of cable. The installation procedures shall be included in the Contractor's construction plan. **Witness Point**

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

- a) FO 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 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 TYCO 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. On completion of the installation, the contractor shall supply 5 spare cable

bushings of each type used in the conduit seal device to enable future cabling installations through the installed duct plug. **Witness Point**

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. 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 DTMR nominated cable identifier and the source/destination information. The label shall be the functional equivalent of a TNA Industries CMA86 label. The information shall be permanently embossed/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.

All termination enclosures shall be uniquely labelled as per the DTMR 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. **Witness Point**

7 FIBRE OPTIC CABLE

7.1 Reliability and Life Cycle

Unless otherwise specified, the design service life of cables shall be 25 years in the environmental conditions specified above. All cables shall have a layer to protect against damage by vermin. The minimum vermin protection shall be sacrificial Polyethylene (PE) jacket. Metallic vermin protection shall not be used.

7.2 General

In addition to the general requirements described above, the following requirements apply to FO cables unless specified in the project documentation.

Maximum optical attenuation of all FO cables shall be in accordance with Section 9.4.2.1 of AS 3080.

The minimum optical performance requirements for FO 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 Polyethylene (PE) jacket (blue) 0.45 nom. wall +/- 0.1 mm.

The secondary sheath shall be Nylon™ (blue) 1.2 nom. wall ± 0.1 mm.

The minimum physical performance requirements for FO cables are listed in Table 7.3.1-A. **Hold Point 3**

Table 7.3.1-A – Minimum Optical Requirements

Parameter	SMOF	
	1310 nm	1550 nm
Maximum mean attenuation (dB/km)	0.35	0.21
Chromatic dispersion coefficient	≤ 3.5ps/nm /km	≤ 19ps/nm /km
Modal bandwidth	–	–
Minimum optical fibre core diameter	9 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 <ul style="list-style-type: none"> • (No load) • (Full load) 	≥ 10x cable diameter ≥ 20x 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 (SMOF) Cable

SMOF cables shall comply with AS 3080, and in particular Clause 9.4.4, including tests defined in Annex B Clause B.2.3 (a) and (b).

7.4 Blown Fibre Systems

Unless otherwise specified, blown fibre systems shall not be installed without prior written approval from the Administrator. **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 Administrator prior to implementation. **Hold Point 5**

As a minimum, all fibre optic termination enclosures shall have the following features:-

- 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.
- Wall mount/DIN rail mount enclosures shall have capacity for a minimum of 12 SC/APC couplers. The enclosures shall have sufficient space to store a minimum of 3.0 m of stripped tight buffered cores of loose tube.
- 19" 1RU rack mount enclosures shall have capacity for a minimum of 24 SC/APC couplers. Rack mountable enclosures shall have sufficient space to store a minimum of 3.0 m of stripped tight buffered cores of loose tube.
- Larger rack mounted enclosures shall have the capacity specified in the tender documentation.
- Underground joint enclosures shall be suitable for the cable size installed and be minimum IP68 rated.

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 FO cable shall not exceed 0.1 dB.

Pigtails for fibre core terminations shall be colour coded as per AS/ACIF S009:2006 Table B7:

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

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 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**

The insertion loss of each mated pair of connectors shall not exceed 0.5 dB, and return loss less than 60.0 dB

Any unused cables shall be labelled and terminated.

7.5.4 Patch Panel

Witness Point

The patch panel shall utilise standard SC/APC type connectors. The fibre-splice panel and patch panel shall be mounted within a telecommunications field cabinet that complies with MRTS201, 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.

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-type) and be of sufficient length to avoid tension on installed patch leads while minimising insertion losses. Project specific documentation may specify duplex LC connectors for the equipment end; refer to the directions of the Administrator.

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

7.6 Testing and Commissioning of Installed SMOF Cabling

7.6.1 Minimum Requirements

The Contractor shall carry out all tests that can be applied to FO cable installations as defined in Annex B of AS 3080. These shall include, but not be limited by, Clauses B.2.2, B.2.3, B.2.3 (a) and (b), B.4.3, B.4.4 and Table B1 of AS 3080.

Insertion loss measurements shall be made over all complete links in both directions at 1310 nm and 1550 nm for SMOF cables.

The Contractor shall supply hard and electronic copies 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 DTMR.

The contractor shall provide optical loss budget calculations and result summaries for all cables installed as per Appendix Two.

7.6.2 Standards

Test equipment and testing procedures shall comply with AS/NZS ISO/IEC 14763.3:2007.

Test limit data and link/loss budget calculations shall be derived from AS/NZS 3080:2003/Amendment 1:2009.

A maximum link/loss calculation shall be made for each installed link as detailed in Appendix Two: "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 3080:2003/Amendment 1:2009.

7.6.4 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 DTMR with the handover documentation. **Witness Point**

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 be tested using FiberChek2 software or approved equivalent. Any connectors exhibiting scratches or pitting within the core area of the connector face shall be replaced.

7.6.5 Test Result Data Requirements

The following shall be provided to DTMR 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 (e.g. 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 Two)

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**

7.6.6 Light Source Power Meter Testing Requirements

The following presents the minimum testing requirements for fibre optic installations at DTMR 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 14763.3:2007 1-jumper method as detailed in Figure 10 of that standard.
- Where the LSPM test equipment interface does not match the installed connector interface the calibration method shall be AS/NZS/ISO/IEC 14763.3:2007 3-jumper method as detailed in Figure 9 of that standard.

- All test leads shall be certified reference leads with losses equal to those detailed in AS/NZS/ISO/IEC 14763.3:2007 Clause 6.3.2 Table 3. Manufacturer loss results for all reference lead shall be provided to DTMR with the LSPM results.
- Test shall be performed in both directions.
- 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
- Reference date/time

7.6.8 OTDR Testing Requirements

The following present the minimum testing requirements for fibre optic installations at DTMR 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 can be performed in one direction 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.
- 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 (i.e. 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 AS/NZS 3080:2003 / Amendment 1:2009.
- Only the final traces are required to be supplied to the Administrator.
- 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.
- Optical return loss shall be measured in accordance with AS/NZS 14763.3 Clause 10.4.

7.6.9 OTDR 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)
- Loss across individual events along the fibre path

7.6.10 Test Instrument Requirements

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

- comply with AS/NZS ISO/IEC 14763.3:2007
- calibrated within the last 12 months. A copy of the calibration certificate shall be provided to DTMR 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 DTMR on request.
- set up using the manufacturer's setup procedure prior to testing being performed. A copy of the set up procedure shall be provided to DTMR on request.
- equipped with test leads suitable for the fibre being tested.

7.6.11 Test Result Acceptance

The Contractor shall provide detailed budget loss calculations and result summary to the Administrator 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 and
- The operator is trained and accredited to operate the test instruments and
- 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.
- 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 3080:2003/Amendment 1:2009 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 general requirements described 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 2 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 3000.

8.2 Twisted Pair Electrical Parameters

Twisted pair communication cables shall comply with AS 3080, including all parameters for metallic cables defined in Annexes A, B and C thereof relevant to the application.

8.3 Installation Requirements

Witness Point

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 lesser value.

8.3.2 Minimum Bend Radius

The following minimum bend radii shall be applied to the installation of fibre optic cable under this specification:-

- a) Unshielded twisted pair cables – 4 times the outside diameter of the cable during hauling. When secured in a static environment the bend radius shall be no less than 10 times the outside diameter.
- b) Shielded twisted pair cables – 8 times the outside diameter of the cable during hauling. When secured in a static environment the bend radius shall be no less than 20 times the outside diameter.

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 Administrator.

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 3080 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, or a suitable indoor enclosure. The patch panel shall be sealed to prevent the ingress of moisture and other foreign material.

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 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	Red
Communications uplinks (such as from switch to POA)	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 3080:2003 including Addendum 2:2009 for the class of permanent link installed. **Witness Point**

8.5.1 Test Configuration

Newly installed fibres shall be tested as permanent links as defined by AS/NZS 3080:2003 / Amendment 1:2009.

Testing shall be carried out with a verified Level III or Level IV cable analyser capable of providing TDR results for all terminated copper pairs.

Acceptable equipment includes Fluke Networks DSP 4300, DTX 1200, DTX 1800, Wirescope 350 and Wirescope Pro.

Test results shall be provided for all installed links in native electronic format for the tester used. (i.e. *.lkw or *.mdb) Test results shall not be provided in plain text format or hard copy.

9 CO-AXIAL CABLE

9.1 General

In addition to the general requirements described above, the following requirements apply to co-axial cables.

Co-axial 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 Co-axial Cable Electrical Parameters

The appropriate co-axial communication cable shall be selected to suit the application including at least 10% 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.

Co-axial communications cable shall withstand without breakdown:

- spark test of 6kVAC in accordance with the spark test specified in AS 1660 Part 3; and
- withstand test of 2kVAC for 1 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/ACIF S009 and AS/NZS 3000, by an ACMA registered cabler authorised under the Commonwealth Telecommunications Act to perform cabling work for telecommunications.

Installation of coaxial telecommunication cables shall comply with AS/NZS 1367. Coaxial cables installed with LV 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 manufacturer's instructions.

9.4 Testing of Coaxial Cables

All testing of co-axial 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 50.

Verification of co-axial 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**

10 DOCUMENTATION

The documentation requirements defined in MRTS201 apply to work under this standard.

In addition, as a minimum, the following shall be included:

- locations of joints and inline joining enclosures;
- schematic drawings for cable usage, including individual optical fibre cores, twisted pairs and co-axial cables; and
- schematic drawings for usage of FO duct and associated micro-tubes.

11 TRAINING

The training requirements defined in MRTS201 apply to work under this standard.

12 MAINTENANCE

The maintenance requirements defined in MRTS201 apply to work under this standard.

13 HANDOVER

The handover requirements defined in MRTS201 apply to work under this standard.