

## 27 ANNEX G – QUALITY PLAN

### 27.1 Testing of Installed Balanced Cabling Using Field Testers

The following requirements apply to testing of installed balanced cabling using an appropriate field tester, primarily for:-

1. conformance to AS/NZS 11801.1 and acceptance of initial installations, and/or
2. AS 11801.2
3. AS 11801.3
4. AS 11801.4
5. AS 11801.5
6. AS 11801.6
7. Maintenance and repair activities.

Link includes a permanent link and consists of a cable and a single (mated) connector at both ends.

The version of any undated referenced standards within this document is that which is current at the date of the project document.

#### 27.1.1 Compatibility

Compatibility of twisted pair cabling components shall be achieved by the utilization of one manufacturer's product backed by a manufacturer's warranty of minimum 20 years.  
Cabling system manufacturer/s shall be Commscope, Molex, Siemon or agreed alternative

#### 27.1.2 Testing Balanced Cabling – General

Standards	AS/NZS 11801.1 and IEC 61935-1
Test Configuration	Link / Permanent Link
Cable Location	Indoor
Balanced Cable Type	UTP, F/UTP or U/STP
Balanced Cabling Class	Minimum Class
AS 11801.2	Class E
AS 11801.3	Class D
AS 11801.4	Class D
AS 11801.5	Class E <sub>A</sub>
AS 11801.6	Class E <sub>A</sub>
Test Methodology	IEC 61935-1
Test Equipment	Meeting IEC 61935-1 and cabling Class
Tester Manufacturer	Fluke
Direction of test	Two directions per cable
Tester Calibration	Equipment 'in calibration' at time of test

#### 27.1.3 Test Equipment

Field Tester(s)	Fluke DSX 5000 or DSX 8000
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#### 27.1.4 Tests to be performed for Twisted Pair links

All Links shall be tested as noted for the following:-

Basic Verification	Test Requirement	Sample Size
Wire Map	Yes	100%
Continuity d.c.	Yes	100%
Signal Conductors	Yes	100%
Screen Conductors, if present	Yes	100%
Short Circuit	Yes	100%
Open Circuit	Yes	100%

Transmission Parameter	Test Requirement	Sample Size
Return Loss	Yes	100%
Insertion Loss	Yes	100%
Pair to Pair NEXT	Yes	100%
PS NEXT	Yes	100%
Pair to Pair ACR-N	Yes	100%
PS ACR-N	Yes	100%
Pair to Pair ACR-F	Yes	100%
PS ACR-F	Yes	100%
Direct Current (d.c.) Loop Resistance	Yes	100%
Propagation Delay	Yes	100%
Delay Skew	Yes	100%

Alien (exogenous) Crosstalk	Test Requirement	Sample Size
Statement of Compliance	Yes	100%
PS ANEXT	Yes	100%
PS ANEXT avg	Yes	100%
PS AACR-F	Yes	100%
PS AACR-F avg	Yes	100%

Additional Test Requirements	Test Requirement	Sample Size
Length	Yes	100%
Direct Current (d.c.) resistance unbalanced with a pair	Yes	100%
Direct Current (d.c.) resistance unbalanced between pairs	Yes	100%

#### 27.1.5 Test Result Analysis

Test results for each cable, in relation to the specified Class/Category, shall be reported as;

1. PASS or
2. Marginal PASS or
3. FAIL or Marginal Fail (FAIL\*)

#### 27.1.6 Handling of Marginal Pass Results

The marginal pass results are deemed not acceptable.

#### 27.1.7 Handling of Fail and Marginal Fail (Fail\*) Results

All Fail and Marginal Fail results are deemed unacceptable.

#### 27.1.8 Non-conforming test to the quality plan

All unacceptable tests shall be repaired and/or replaced and re-tested until such time as they pass all applied tests.

#### 27.1.9 Documentation of Test Results

All test results shall be given in the native format of the tester manufacturer (e.g. Fluke LinkWare), including reader software capable of data analytics, when not publicly available at no charge. PDF, CSV, other Excel forms, Summary Results and Images of results are unacceptable and are deemed to be noncompliant.

The documentation for each parameter shall include;

- a) Test equipment
  1. Type and manufacturer
  2. Serial number and calibration status
  3. Level and software version
- b) Details of cabling interface adaptors (type, reference number, manufacturer)
- c) Details of cabling under test

- d) Date and time of test
- e) Any relevant environmental conditions
- f) Tester operators’ names. Not the tester or installer company name.
- g) Measured result of each parameter
- h) Required result of each parameter for a PASS

**27.1.10 Additional Specified Requirements**

**27.1.10.1 Independent test result verification**

All twisted pair test and optical fibre results shall be independently verified by a NATA inspection body as compliant to the standards and requirements specified within this quality plan.

Any report that achieves a partial compliance or a non-compliance status shall be deemed non-compliant.

A copy of the NATA Report is to be provided to the Specifier on creation.

**27.1.10.2 Handling of non-specified parameters**

For the following examples, test results containing non-specified or incorrect requirements shall be deemed as acceptable or unacceptable as follows:-

Item	Unacceptable	Acceptable	Conditions
Wrong Test Standard e.g. TIA	✓		
Wrong Cable Type	✓		
Wrong Test Configuration	✓		
Wrong NVP affecting Alien crosstalk test exemption	✓		
Under-length CP Link without Manufacturer substantiation	✓		

**27.1.10.3 Handling of non-compliant NATA reports**

All elements that result in a partial or non-compliant status shall be repaired and/or replaced and retested with the test data resubmitted to the NATA inspection body until a NATA Statement of Compliance and associated report is issued by the NATA inspection Body.

This Quality Plan has been approved by the Specifier.

Representative Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

## 27.2 Optical Fibre Cable Testing Using Light Source and Power Meter (LSPM)

The following requirements apply to testing of installed optical fibre cabling primarily for:-

1. conformance and acceptance of initial installations, and/or
2. acceptance of maintenance and repair activities.

### 27.2.1 Testing – General (Applies to LSPM)

Standards	AS/NZS 11801.1 and AS/NZS 14763.3
Test Configuration	Link (fibre and connectors at both ends)
Optical Fibre Cabling Type	OM3 OM4 OM5 OS1a OS2
Test methodology	AS/NZS 14763.3
Test Equipment	AS/NZS 14763.3
Direction of test	Two directions per core
Wavelength of test	MM 850 nm and 1300 nm SM 1310 nm and 1550 nm
Tester Calibration	Equipment shall be in calibration at time of test

### 27.2.2 Testing – Light Source and Power Meter (LSPM)

Reference Method	One-test-cord method
Test equipment LSPM	Suitable for the type of fibre and connectors being tested
MM Launch conditions	Encircled Flux modal conditions in accordance to AS/NZS 14763.3 Annex A, achieved by:- <ol style="list-style-type: none"> <li>1. Conditioner device in launch test cord, or</li> <li>2. Documented manufacturer's claim, or</li> <li>3. Compliance Statement from manufacturer.</li> </ol>
SM Launch Conditions	<ol style="list-style-type: none"> <li>1. According to AS/NZS 14763-3 Clause 6.5 or</li> <li>2. Documented manufacturer's claim or</li> <li>3. Compliance Statement from manufacturer.</li> </ol>
Recorded Result	Highest loss result

### 27.2.3 Acceptance Requirements for Optical Fibre Link Attenuation

The attenuation acceptance requirements for optical fibre links shall be calculated, based on the optical attenuation allowance for each component and cable utilised for the creation of the link.

**Table 1 - Allowable Budget Attenuation for Components**

Component and Wavelength	Project Attenuation (Loss) Maximum	AS/NZS 11801-1 Attenuation (Loss) Maximum
Mated Ref to Ref Connection MMF at 850 & 1300 nm SMF at 1310 & 1550 nm	As per standard	0.10 dB 0.20 dB
Mated Ref to Non-Ref Connection MMF at 850 & 1300 nm SMF at 1310 & 1550 nm	As per standard	0.50 dB 0.75 dB
Non-Ref to Non-Ref Connection At all wavelengths MMF SMF	As per standard	0.75 dB 0.75 dB
Splice At all wavelength, MMF SMF	As per standard	0.30 dB 0.30 dB

MMF Cable OM3, OM4	at 850 nm at 1300 nm	As per standard	3.50 dB/km 1.50 dB/km
MMF Cable OM5	at 850 nm at 1300 nm	As per standard	3.00 dB/km 1.50 dB/km
SMF Cable	at 1310 & 1550 nm OS1a OS2	As per standard	1.00 dB/km 0.40 dB/km

Ref = Reference Connector

Non-Ref = Non-reference (Random) Connector

#### 27.2.4 Measurement Uncertainty

AS/NZS 14763.3 defines measurement uncertainty for optical fibre testing as follows;

**Table 2 - Measurement Uncertainty Values**

Reference Method	Measurement Uncertainty
1-Test-Cord	SMF ± 0.24 dB MMF ± 0.27 dB when attenuation reading is ≤1.9 dB, and MMF ± (0.14 x attenuation) when attenuation is >1.9 dB

#### 27.2.5 Tests to be Carried Out

#### 27.2.6 Transmission

Basic verification:-

- Polarity

Transmission requirements:-

- Attenuation in dB (Non-Average for LSPM)
- Length in meters
- Propagation delay in nanoseconds

#### 27.2.7 Test Result Analysis

For a PASS, the LSPM test result shall not exceed the Loss Budget, calculated from the sum of all the components under test.

##### 27.2.7.1 Handling of Apparent Gains

Apparent Gains up to the measurement uncertainty defined in AS/NZS14763.3 are deemed conditionally compliant.

Apparent gains over the measurement uncertainty are deemed unacceptable.

##### 27.2.7.2 Handling of Marginal Pass Results

The marginal pass results are deemed acceptable.

##### 27.2.7.3 Handling of Fail and Marginal Fail (Fail\*) Results

Fail results are deemed unacceptable.

Marginal Fail results are deemed unacceptable.

All unacceptable tests shall be repaired and/or replaced and re-tested until such time as they pass all applied tests, or the attached network equipment works.

#### 27.2.8 Documentation of Test Results

All optical fibre test results for each tested core of an optical fibre cable shall include as a minimum;

- Optical fibre type
- Cable ID (Identification)
- Core ID (Identification)
- Interface connector type at both ends of the link
- Splices associated with interface connectors
- MPO/MTP cassette associated with the interface connector
- Embedded MPO/MTP cassette (not associated with interface connectors)
- Embedded splices (not associated with interface connectors)
- Embedded connectors (not associated with interface connectors)

Test Results

- Attenuation Loss      dB
- Length                    m
- Propagation Delay    ns    (length x 5 ns)

**27.2.9 Additional Specified Requirements**

**27.2.9.1 Visual Inspection of fibre end-faces**

When testing for transmission requirements, visual inspection of each fibre end-face shall be conducted in accordance with AS/NZS 14763.3 Annex B.

**27.2.9.2 Independent test result verification**

All twisted pair test and optical fibre results shall be independently verified by a NATA inspection body as compliant to the standards and requirements specified within this quality plan.

Any report that achieves a partial compliance or a non-compliance status shall be deemed non-compliant.

A copy of the NATA Report is to be provided to the Specifier on creation.

**27.2.9.3 Handling of non-compliant NATA reports**

All elements that result in a partial or non-compliant status shall be repaired and/or replaced and retested with the test data resubmitted to the NATA inspection body until a NATA Statement of Compliance and associated report is issued by the NATA inspection Body.

This Quality Plan has been approved by the Specifier.

Representative Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

### 27.3 Optical Fibre Cable Testing Using OTDR

The following requirements apply to testing of installed optical fibre cabling using an Optical Time Domain Reflectometer, primarily for:-

1. conformance and acceptance of initial installations, and/or
2. acceptance of maintenance and repair activities.

#### 27.3.1 Testing – General (Applies to LSPM)

Standards	AS/NZS 11801.1 and AS/NZS 14763.3
Test Configuration	Link (fibre and connectors at both ends)
Optical Fibre Cabling Type	Multimode and Singlemode
Test methodology	AS/NZS 14763.3
Test Equipment	AS/NZS 14763.3
Direction of test	Two directions per core
Wavelength of test	MM 850 nm and 1300 nm SM 1310 nm and 1550 nm
Tester Calibration	Equipment shall be in calibration at time of test

#### 27.3.2 Testing – Optical Time Domain Reflectometer (OTDR)

Range	Longer than (cable + launch & tail test cords), But no more than 3 times longer
Pulse Width	5 nanoseconds (nS) preferred But not exceeding 40 nS
Index of Refraction	Values in cable specification sheet
Averaging Time	Not less than 15 seconds (S) Not less than 30 seconds (S)
Event Threshold	0.10 dB Events reported at 0.10 – 0.20 dB are deemed conditionally compliant (acceptable)
MM Launch conditions	Encircled Flux modal conditions according to AS/NZS 14763.3 Annex A, is achieved by:- - Conditioner device in launch test cord, or - Documented manufacturer's claim, or - Compliance Statement from manufacturer.
SM Launch Conditions	According to AS/NZS 14763-3 Clause 6.5, is by: - Documented manufacturer's claim or - Compliance Statement from manufacturer
Test Cord Verification	Both Launch and Tail test cords with interfacing reference connectors:- - do not need verification before each test - shall be verified each time tester is started - shall be verified for new/changed test cords - verification test cord results shall be reported in test result documentation
Launch Cord	At least 100 m
Tail Cord	At least 100 m
Recorded Attenuation Result	Average from bi-directional testing
Recorded ORL Result	Lowest value, closest to zero, (not averaged)

#### 27.3.3 Acceptance Requirements for Optical Fibre Link Attenuation

The attenuation acceptance requirements for optical fibre links shall be calculated, based on Table 1, for the optical loss/attention allowance for each component and cable utilised for the creation of the link.

#### 27.3.4 Measurement Uncertainty

Measurement Uncertainty is:-

- Stated in tester documentation by the tester manufacturer, or
- Contained within the test data

**Table 1 - Allowable Budget Loss/Attenuation for Components**

Component and Wavelength	Project Attenuation (Loss) Maximum	AS/NZS 11801-1 Attenuation (Loss) Maximum
Mated Ref to Ref Connection MMF at 850 & 1300 nm SMF at 1310 & 1550 nm	As per standard	0.10 dB 0.20 dB
Mated Ref to Non-Ref Connection MMF at 850 & 1300 nm SMF at 1310 & 1550 nm	As per standard	0.50 dB 0.75 dB
Non-Ref to Non-Ref Connection At all wavelengths	MMF SMF	As per standard 0.75 dB 0.75 dB
Splice At all wavelength,	MMF SMF	As per standard 0.30 dB 0.30 dB
Connector with splice at tester interface MMF SMF	As per Manufacturer Specification	0.80 dB 1.05 dB
Connector with splice embedded in link MMF SMF	As per Manufacturer Specification	1.05 dB 1.05 dB
MPO/MTP Cassette at tester interface MMF SMF	As per Manufacturer Specification	1.25 dB 1.50 dB
MPO/MTP Cassette embedded in link MMF SMF	As per Manufacturer Specification	1.50 dB 1.50 dB
MMF Cable OM3, OM4 at 850 nm at 1300 nm	As per standard	3.50 dB/km 1.50 dB/km
MMF Cable OM5 at 850 nm at 1300 nm	As per standard	3.00 dB/km 1.50 dB/km
SMF Cable at 1310 & 1550 nm OS1a OS2	As per standard	1.00 dB/km 0.40 dB/km

Ref = Reference Connector

Non-Ref = Non-reference (Random) Connector

Component	Project Return Loss	AS/NZS 11801-1 Return Loss
Connector ORL (Optical Return Loss) { = minus Reflectance}	Mated MM Mated SM Mated SM	(Further from Zero is better) PC 20 dB PC 35 dB APC 60 dB

**27.3.5 Tests to be Carried Out**

The following elements of the extended test group are to be tested and against the standards and specific requirements of this quality plan.

Extended Test Group		
Test	Additional Project Requirements	AS/NSZ
Permanent Link Attenuation		14763.3 ✓
Channel Attenuation		✓
Permanent Link Propagation Delay		✓



Channel Propagation Delay		✓
Optical Fibre Length	No more than 10 metre variation to LSPM results	✓
Optical Fibre Attenuation		✓
Local and remote interface connector attenuation		✓
Local and remote interface connector return Loss		✓
Embedded connecting hardware attenuation		✓
Embedded connecting hardware return loss		✓
Continuity		✓
Maintenance of Polarity		✓

### 27.3.6 Test Result Analysis

For a PASS, the OTDR test results shall:

1. clearly show the launch and tail cords on the traces for all fibres in the cable, and
2. not exceed the Loss Budget for device.

#### 27.3.6.1 Handling of Apparent Gains after Averaging

Apparent gains over 0.09 dB are deemed unacceptable.

#### 27.3.6.2 Handling of Marginal Pass Results

Marginal pass results are acceptable.

#### 27.3.6.3 Handling of Fail and Marginal Fail (Fail\*) Results

All Fail and Marginal Fail results are unacceptable.

#### 27.3.6.4 Handling of Unacceptable Results or Activities

All unacceptable results and/or activities shall be repaired and/or replaced and/or re-tested until such time as they achieve acceptance.

### 27.3.7 Documentation of Test Results

All optical fibre test results for each tested core of an optical fibre cable shall include as a minimum;

- Optical fibre type
- Cable ID (Identification)
- Core ID (Identification)
- Interface connector type at both ends of the link
- Splices associated with interface connectors
- MPO/MTP cassette associated with the interface connector
- Embedded MPO/MTP cassette (not associated with interface connectors)
- Embedded splices (not associated with interface connectors)
- Embedded connectors (not associated with interface connectors)
- Test Results
  - Attenuation Loss          dB
  - Link Length                m
  - Propagation Delay        ns      (length x 5 ns)
  - ORL Optical Return Loss
  - Length to embedded events and event type

### 27.3.8 Additional Specified Requirements

#### 27.3.8.1 Visual inspection of fibre end-faces

When testing for transmission requirements, visual inspection of each fibre end-face shall be conducted in accordance with AS/NZS 14763.3 Annex B.

#### 27.3.8.2 Independent test result verification

All optical fibre results shall be independently verified by a NATA inspection body as compliant to the standards and requirements specified within this quality plan.

Any report that achieves a partial compliance or a non-compliance status shall be deemed non-compliant.

A copy of the NATA Report is to be provided to the Specifier on creation.

**27.3.8.3 Handling of non-compliant NATA reports**

All elements that result in a partial or non-compliant status shall be repaired and/or replaced and retested with the test data resubmitted to the NATA inspection body until a NATA Statement of Compliance and associated report is issued by the NATA inspection Body.

This Quality Plan has been approved by the Specifier.

Representative Name:

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Signature:

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Date:

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