



Standard

Fibre Optic Overhead Ground Wire (OPGW) Standard

R1588303

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Authorisations

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Responsibilities

This document is the responsibility of the Asset Strategy Team, Tasmanian Networks Pty Ltd, ABN 24 167 357 299 (hereafter referred to as "TasNetworks").

Please contact the Primary Systems Asset Strategy Leader with any queries or suggestions.

- Implementation All TasNetworks staff and contractors.
- Compliance All group managers.

Minimum requirements

The requirements set out in TasNetworks' documents are minimum requirements that must be complied with by all TasNetworks team members, contractors, and other consultants.

The end user is expected to implement any practices which may not be stated but which can be reasonably regarded as good practices relevant to the objective of this document.

Record of revisions

Version	Section number	Details
1.0	All	Amended to reflect TasNetworks branding and document numbering
2.0	All	Document restructured and updated for changes in standards

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1 General

1.1 Purpose

To define the technical specifications for the supply of Fibre Optic Overhead Ground Wire (OPGW) for installation on extra high voltage power lines, under the responsibility of Tasmanian Networks Pty Ltd (hereafter referred to as 'TasNetworks').

1.2 Scope

This standard applies to all OPGW purchased for installation on extra high voltage transmission lines under the responsibility of TasNetworks.

This standard contains minimum requirements for:

- (a) OPGW design;
- (b) properties of both optical fibres and ground (earth) wire;
- (c) engineering, manufacture, testing at manufacturer's works;
- (d) secure packaging, supply, transportation, and delivery to site; and
- (e) associated documentation.

This standard is to be applied to new OPGW as well as replacement of part or all of existing OPGW.

This standard does not describe OPGW construction or commissioning requirements.

1.3 Objective

Compliance with this standard in the procurement of OPGW by TasNetworks will ensure:

- (a) that the relevant Australian legal requirements are met;
- (b) that the requirements of the Tasmanian Electricity Code and National Electricity Rules are met;
- (c) personnel and public safety;
- (d) the safety of TasNetworks' assets;
- (e) ease of operation and maintenance;
- (f) the reliability and continuity of TasNetworks' electrical transmission network;
- (g) the reliability and continuity of TasNetworks' telecommunications network; and
- (h) the exposure of TasNetworks' business to risk is minimised.

1.4 Certificate of conformance

Before any OPGW is supplied to TasNetworks, a certificate of conformance with this standard must be submitted to TasNetworks. The certificate of conformance (R1108400) must be duly supported with documents, drawings, test results, test reports, test certificates, completed check lists and other documents as applicable. Where TasNetworks has approved deviation to any specific requirements of this standard, proof of all such approvals must be included with the certificate of conformance.

TasNetworks will supply a blank certificate of conformance (R1108400), to be completed by the Contractor and submitted with the tender.

The OPGW will be dispatched from the manufacturer's factory only after receipt and acceptance by TasNetworks of the certificate of conformance. Title for the OPGW will transfer to TasNetworks upon both TasNetworks' acceptance of the certificate of conformance and receipt of the goods. This requirement shall be reflected in the contracting arrangements made between TasNetworks and the supplier, or between TasNetworks and its construction Contractor if that Contractor is purchasing the OPGW on TasNetworks' behalf.

1.5 Precedence

Any apparent conflict between the requirements of this standard and the law, mandatory requirements, industry standards, project specifications, non-statutory standards or guidelines, and any other associated documents should be brought to the immediate attention of TasNetworks for resolution and no action must be taken that might result in a breach of law or mandatory standard. Where there may be a conflict between the requirements of this standard and any:

- (a) law, mandatory requirement or industry standard, then that law or statutory requirements will prevail over this standard;
- (b) non-mandatory standard, or guideline, then this standard will prevail over that standard or guideline; and
- (c) project specification, then the contract documentation will prevail over this standard.

1.6 Deviation

Approval for a deviation to this standard may only be accorded if it does not reduce the quality of workmanship, pose a safety risk to personnel or equipment and does not deviate from the intent of this standard. Deviations if any must be specifically requested and approved in writing by TasNetworks, Network Performance and Strategies Manager.

1.7 References

This standard is to be read in conjunction with other standards and documents as applicable. In particular this includes the project specifications and the following:

1.7.1 TasNetworks standards and documents

R1108397	OPGW information to be provided with tender
R248811	OPGW deliverables
R1037048	Transmission line design standard
R1108400	Certificate of conformance

1.7.2 Other standards

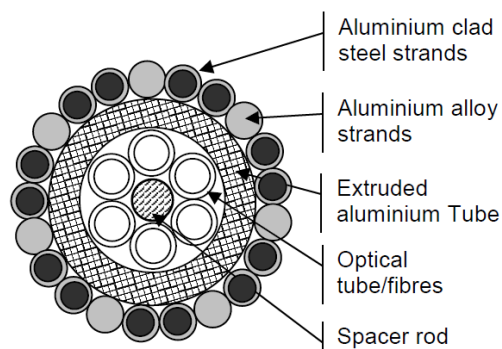
ANSI/EIA 359-A	Standard colours for identification and coding
IEC 60793-1	Optical Fibres – Measurement Methods and Test Procedures
IEC 60793-2	Optical Fibres – Product Specifications
IEC 60794-1-1	Optical Fibre Cables – Generic Specification - General

IEC 60794-1-2	Optical Fibre Cables – Generic Specification – Basic Optical Cable Test Procedures
IEC 60794-4	Optical Fibre Cables – Sectional Specification – Aerial optical cables along electrical power lines
IEC 60794-4-10	Optical Fibre Cables – Aerial optical cables along electrical power lines – Family specification for OPGW (Optical Ground Wires)
IEEE 1138-2009	IEEE Standard for Testing and Performance for Optical Ground Wire (OPGW) for Use on Electric Utility Power Lines
ITU-T G.650.1 :2010	Definitions and test methods for linear, deterministic attributes of single-mode fibre and cable
ITU-T G.650.2 :2008	Definitions and test methods for statistical and non-linear related attributed of single-mode fibre and cables
ITU-T G.652 :2009	Characteristics of a single-mode optical fibre and cable
ITU-T G655	Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable

2 General requirements

The OPGW comprises an inner core containing optical fibres for data transmission, and an outer layer(s) of conductor strands to provide strength and to act as an overhead ground (earth) wire. The typical construction of OPGW used in TasNetworks transmission network is shown in Figure 1 below:

Figure 1 – Typical OPGW construction



General requirements for the OPGW are specified in Table 1. In addition, OPGW construction in the factory must also conform to the following requirements:

- Any material filled in the buffer tube, or alike, must be non-hygroscopic, non-nutritive to fungus, electrically non-conductive and homogenous. The filling must be free from dirt and foreign matter. The filling of the buffer tube in the factory must be performed in such a way that the filling material can be removed at a later date using conventional non-toxic solvents.
- The optical fibres must not adhere to the inside of the buffer tube, or alike, that is used to contain the optical fibres.

Table 1 – General requirements for OPGW

No.	Parameter	Unit	Value
1.	Standard to be complied with as a minimum	-	IEEE 1138-2009
2.	Minimum design technical life of the OPGW	yrs	60
3.	Maximum nominal overall diameter	mm	14.5
4.	Mass	kg/m	< 0.420
5.	Minimum number of fibre cores	No.	48
6.	Modulus of Elasticity Modulus	Gpa	≤ 120
7.	Coefficient of Linear Expansion	/°C	> 15 x 10 ⁻⁶
8.	Minimum bending radius	mm	450
9.	Buffering	-	Loose

2.1 Compatibility

The OPGW design must be mechanically and electrically compatible with the design of the transmission line and comply with the requirements of the Transmission Line Design standard (R1037048).

A check for increased transverse cascade failure risk from augmentation with larger OPGW in an OHEW position should be assessed using ASCE No 74E.

The OPGW must be compatible with readily available fittings for all required applications, including, but not limited to:

- dead-ends;
- suspension clamps;
- vibration dampers;
- down-lead clamps; and
- joint (splice) boxes.

3 Optical fibres

3.1 Characteristics

The optical characteristics of a **non-zero dispersion-shifted single-mode optical fibre and cable** are detailed within Recommendation ITU-T G.655. Specifically, TasNetworks requires that optical fibre characteristics be compliant with the attributes defined within category G.655.E. The only exception to these requirements is with respect to the optical fibre attenuation coefficient, where TasNetworks requires a more onerous maximum attenuation coefficient than that described within ITU-T G.652.E. In particular, the optical fibre must have an attenuation coefficient of:

1. no more than 0.35 dB/km at 1310 nm;
2. no more than 0.22 dB/km at 1550 nm; and
3. no more than 0.25 dB/km at 1625 nm.

Protective coating of the optical fibre must be easily strippable by means of a mechanical stripping tool without damaging the optical fibre. The use of chemicals must not be required for this purpose.

3.2 Optical fibre core grouping and colour code

Optical fibres must be marked by a coloured coating with different colours according to ANSI/EIA 359-A. The colour coding system must not cause optical fibres to stick together.

3.2.1 Core grouping

Optical fibre cores must be bundled in groups of no more than 12 fibres in each group. The number of optical fibres in each group must be equal.

Where the optical fibres are bundled in groups, each bundle must be distinguishable by a coloured yarn, coloured tube or ring mark/s. The colour code for the yarn or tube must be the same as that for the optical fibres as stated above.

If ring marks are used to mark bundled groups, then the following methodology shall be followed:

- Group 1: without ring
- Group 2: with 1 ring
- Group 3: with 2 rings
- Group 4: with 3 rings, etc.

The optical fibre, yarn and tube colours and ring marks must be stable during temperature cycling and must not be subject to fading or smearing either onto each other or into the gel filling material.

The original colour coding system must be discernible throughout the design life of the OPGW.

4 Ground wire

In addition to the general requirements specified elsewhere in this standard, the ground wire must conform to the requirements listed in Table 2.

Table 2 – Requirements for ground wire

No.	Parameter	Unit	Value
1.	DC resistance at 20°C	Ω/km	< 0.35
2.	Operating temperature range	°C	-40 to +70
3.	Installation temperature range	°C	-25 to +60
4.	Minimum breaking load	kN	49
5.	Minimum strand diameter	mm	3.0
6.	Lay direction of outer most layer	-	Right hand lay
7.	Minimum short circuit capacity (I ² t)	kA ² s	100

5 Testing

All components of the OPGW must be tested in accordance with relevant applicable Australian and International standards. Where tests are optional in the standards, it will be considered that these tests are required by TasNetworks, unless otherwise agreed in writing by TasNetworks.

Tests must be conducted to determine mechanical, thermal and electrical characteristics of the OPGW. All tests as prescribed by the relevant IEEE and IEC standards must be conducted unless otherwise specifically approved by TasNetworks in writing.

All test reports must be forwarded to TasNetworks within 14 days of the test for approval and acceptance. The tests will only be considered as complete after approval and acceptance of the test results is provided by TasNetworks in writing.

5.1 Type tests

Type tests are intended to prove the soundness of design of the systems and their suitability for operation under the conditions detailed in the PPR-Technical Specification. Type tests must be carried out before the delivery of the OPGW. A certified test report, detailing the results of such tests along with the procedures followed, must be provided to TasNetworks. These tests must have been applied to a system of identical design to that offered, or to a system with a similar design which does not materially alter the properties to be checked by the type test.

Where such tests have already been performed, a copy of the type test reports must be provided with the tender.

As a minimum, the type tests listed in Table 3 must be conducted on the batch of OPGW manufactured for TasNetworks.

TasNetworks will not accept any OPGW that fails any of these tests. The type tests listed must be conducted in accordance with IEEE 1138-2009.

Table 3 – Type tests to be conducted on OPGW

Sr. No	Parameter	Reference Clause IEEE 1138
1.	Water ingress test	4.1.1.1
2.	Seepage of flooding compound test	4.1.1.2
3.	Short circuit test	4.1.1.3
4.	Aeolian vibration simulation test	4.1.1.4
5.	Strain margin test	4.1.1.10
6	Stress-strain test	4.1.1.11

5.2 Factory acceptance tests

Procedures for factory acceptance tests with supporting documentation must be submitted to TasNetworks for approval and acceptance. Factory acceptance tests will not be conducted unless the factory acceptance test procedures have been accepted and approved by TasNetworks.

Factory acceptance tests must be carried out on an OPGW sample in the presence of a TasNetworks representative. Factory acceptance testing must be performed at the manufacturer's premises prior to delivery.

As a minimum, this will include optical time-domain reflectometer (OTDR) tests on all fibre cores at 1310 nm, 1550 nm and 1625 nm (one direction only). Each OTDR trace must cover the full length of the OPGW supplied and confirm the maximum attenuation detailed in section 3.1.

5.3 Handover tests

Handover tests must be performed prior to the receipt of the OPGW by TasNetworks to prove that the OPGW has not been damaged during delivery, transportation and unloading. Handover tests will be performed by a TasNetworks' appointed contractor in the presence of TasNetworks. As a minimum, this will include optical time-domain reflectometer (OTDR) tests on all fibre cores at 1310 nm, 1550 nm and 1625 nm (one direction only), unless otherwise directed by TasNetworks. The delivery of the OPGW will only be accepted by TasNetworks if the handover test results are in line with factor acceptance test results.

5.4 Maintenance and routine test plans

A recommended routine test plan must be submitted to TasNetworks as a part of final documentation with OPGW delivery.

All procedures and task guides for the product supplied must be provided.

6 Packaging

TasNetworks has the following packaging requirements:

- OPGW cables must be supplied on drums.
- Each length of OPGW cable must be wound on a separate drum.
- The diameter of the drum barrel must be large enough to prevent damage to the cable during reeling or un-reeling. In no event must the diameter of the barrel be smaller than 40 times the outer diameter of the cable.
- The cable drum must be durable and constructed so as to prevent damage to the cables during shipment and handling.
- Wooden lagging or other suitable means of protection must be applied to the drum to prevent damage to the OPGW cables during shipment and storage.
- Nails and staples used in the construction of the drum must not be placed in a position where they could damage the OPGW cables during shipment, handling, reeling or unreeling.
- The drums will be non-returnable.
- Cable drum material must be certified free of insect infestation.
- The centre-hole diameter of the drum must be 128 mm as a minimum.
- For test purposes a length of at least 4 m of the inner cable end must be accessible without removing wooden lagging. This length must be securely fastened and protected during shipment and handling.
- The cable ends must be sealed using shrinking caps and fastened tightly. A protective wrap must be applied over the outer layer of the cable on each reel. The wrap must be weather resistant and must not be removed until the cable is installed. The fibre tubes/groups must be protected from all environment (condition i.e water ingress).

6.1 Marking plate

Marking plates must be provided with information marked indelibly and legibly.

The plates must be of a non-corrosive material and information must be inscribed with black letters on white background.

Marking plates containing the following information must be securely attached to the outer side on each drum flange (not to the inner side):

- (i) Type and size of cable.
- (ii) Cable length in metres.
- (iii) Gross weight in kilograms.
- (iv) Reel number.
- (v) Measured attenuation coefficients and other technical parameters of the cable.
- (vi) Manufactures name.
- (vii) Year of manufacture.
- (viii) Name of Customer "Tasmanian Networks Pty Ltd".
- (ix) Project name and number with reference Contract Number.
- (x) Arrow showing roll/unwinding direction.

7 Shipping and storage

During transport and storage the OPGW must not be exposed to ambient temperatures outside the range of -40°C to +70°C.

It is also a requirement that OPGW cable drums be stored in an upright position (ie. not laid on their side) to prevent damage to OPGW fibres.

During transport, each OPGW cable drum shall be placed on its flanges and tied down to at least two anchor points.

8 Deliverables

Requirements for project deliverables are outlined in document "OPGW deliverables" (R248811).