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SERIES L: CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Performance requirements for passive optical nodes: Sealed closures for outdoor environments

ITU-T Recommendation L.13

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Performance requirements for passive optical nodes: Sealed closures for outdoor environments

Summary

This Recommendation refers to passive optical nodes in outdoor environments. It deals with the design of the closure housing as well as the fibre organizer taking into account mechanical and environmental characteristics as well as the characteristics of the optical fibre organizer.

The following elements are added for this revision:

– a test plan for the performance evaluation of sealed optical closures in 2 basic environments: underground (OS) or above ground (OA);

– the simulation of the effect of interventions related to network maintenance.

Appendices were added:

– a checklist for a systematic product characterization according to L.51;

– a list of additional requirements to reflect special environments (e.g., tunnels) or local conditions.

Source

ITU-T Recommendation L.13 was approved by ITU-T Study Group 6 (2001-2004) under the ITU-T Recommendation A.8 procedure on 11 April 2003.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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NOTE

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CONTENTS

Introduction

A node occurs at each opening or end of a cable sheath. When an optical node resides in an outdoor environment, it is generally contained in a sealed enclosure. This is commonly also referred to as an optical closure, optical cable joint or optical sheath joint. In this Recommendation the term "optical closure" will be used.

An optical closure comprises a mechanical structure (closure housing) that is attached to the ends of the sheaths joined and a means (organizer) for containing and protecting the fibres and passive optical devices. The optical closure will:

– restore the integrity of the sheath, including mechanical continuity of strength members when required;

– protect the fibres, fibre joints and optical devices from the environment in all types of outdoor plant (aerial, direct buried, in ducts and underwater);

– provide for the organization of the fibre joints, passive devices and the storage of fibre overlength;

– provide electrical bonding and grounding of the metal parts of the sheath and strength members where required. The method of achieving electrical continuity will vary with the type of cable sheath and the type and location of the strength members. Further information is given in ITU-T Recs K.11, K.25 and ITU-T Manual "Protection of telecommunication lines and equipment against lightning discharges".

This Recommendation acknowledges that the cable sheaths used with optical fibre cables are of similar design to those used with copper cables. Thus, the methods used for jointing optical fibre cable sheaths are based on those used in sheath joints for conventional copper cable; reference may be made to the Handbook "Outside plant technologies for public networks" and L-series Recommendations.

Compared to the previous version, this Recommendation provides the means for characterization and evaluation of the performance of optical closures according to the principles of ITU-T Rec. L.51. This includes both mechanical integrity and optical stability of the product, simulating the effect of environmental factors, as well as interventions related to network maintenance. It contains a basic test program for optical closures which is globally applicable. Additional requirements can be agreed upon between customer and supplier to reflect local or special conditions. All functions and features that a product may contain must be reflected in the mix of test samples that are subjected to the test program.

ITU-T Recommendation L.13

Performance requirements for passive optical nodes: Sealed closures for outdoor environments

1 Scope

This Recommendation:

– refers to passive optical nodes in outdoor environments;

– deals with the design of the closure housing as well as the fibre organizer;

– deals with mechanical and environmental characteristics of the optical closure;

– deals with the characteristics of the optical fibre organizers.

Following elements are added for this revision:

– a test plan for the performance evaluation of sealed optical closures in 2 basic environments: underground (OS) or above ground (OA);

– the simulation of the effect of interventions related to network maintenance;

– a checklist for a systematic product characterisation according to ITU-T Rec. L.51;

– a list of additional requirements to reflect special environments (e.g., tunnels) or local conditions.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation G.652 (2003), *Characteristics of a single-mode optical fibre and cable*.

– ITU-T Recommendation K.11 (1993), *Principles of protection against overvoltages and overcurrents*.

– ITU-T Recommendation K.25 (2000), *Protection of optical fibre cables*.

– ITU-T Recommendation L.51 (2003), *Passive node elements for fibre optic networks – General principles and definitions for characterization and performance evaluation*.

– IEC 60068-2-6:1995, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*.

– IEC 60068-2-11:1981, *Environmental testing – Part 2: Tests. Test Ka: Salt mist*.

– IEC 60068-2-14:1984, *Environmental testing – Part 2: Tests. Test N: Change of temperature*.

– IEC 60068-2-17:1994, *Basic environmental testing procedures – Part 2: Tests – Test Q: Sealing*.

– IEC 60068-2-27:1987, *Environmental testing. Part 2: Tests. Test Ea and guidance: Shock.*

– IEC 60529:2001, *Degrees of protection provided by enclosures (IP Code)*.

– IEC 61300-2-1:2003, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-1: Tests – Vibration (sinusoidal)*.

– IEC 61300-2-4:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-4: Tests – Fibre/cable retention*.

– IEC 61300-2-5:2002, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-5: Tests – Torsion/twist*.

– IEC 61300-2-9:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-9: Tests – Shock*.

– IEC 61300-2-10:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-10: Tests – Crush resistance*.

– IEC 61300-2-12:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-12: Tests – Impact*.

– IEC 61300-2-22:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-22: Tests – Change of temperature*.

– IEC 61300-2-23:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-23: Tests – Sealing for non-pressurized closures of fibre optic devices*.

– IEC 61300-2-26:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-26: Tests – Salt mist*.

– IEC 61300-2-33:1995, *Fibre optic interconnecting devices and passive components – Basic test –and measurement procedures – Part 2-33: Tests – Assembly and disassembly of closures*.

– IEC 61300-2-34:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-34: Tests – Resistance to solvents and contamining fluids*.

– IEC 61300-2-37:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-37: Tests – Cable bending for closures*.

– IEC 61300-2-38:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-38: Tests – Sealing for pressurized closures of fibre optic devices*.

– IEC 61300-3-1:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-1: Examinations and measurements – Visual examination*.

– IEC 61300-3-3:2003, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-3: Examinations and measurements – Active monitoring changes in attenuation and return loss (multiple paths)*.

– IEC 61300-3-28:2002, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-28: Examinations and measurements – Transient loss*.

3 Terms and definitions

This Recommendation defines the following terms:

3.1 optical closure: The term "optical closure" refers to a sealed sheath joint, including the fibre organizer system.

3.2 closure housing: Closure housing only refers to the sealed container or box, not including the organizer system. Its main functions are: sealing to the cables, mechanical attachment of the cable and protection of its content.

3.3 organizer system: In a node, the optical fibres are to be properly managed and guided from where a cable or pigtail enters the node, until it leaves again. The organizer system comprises the whole of means and features that are intended to guide and store fibres and passive devices inside a node, at any location where they are not protected by the cable sheath.

4 Abbreviations and acronyms

For the definitions of terms used in this Recommendation, see ITU-T Rec. L.51.

CM Central strength Member

ME Multiple Element (mass storage)

OA Outdoor Above Ground

OS Outdoor Subterranean or underground

SC Single Circuit

SE Single Element

SF Single Fibre

SR Single Ribbon

5 Design characteristics of optical closures

5.1 General requirements

Each optical closure must comply to the general requirements as listed in clause 8/L.51.

5.2 Design of the closure housing

Closure housing designs employ either cold or hot systems depending on the sealing methods used. Cold processes do not require heat, whereas hot processes do. Mastic, tapes, grommets, o-rings, cured rubber shapes, pastes, potting compounds, rubber gels and (cold) adhesives are cold processes. Thermoshrinkable materials, hotmelts and polyethylene injection welding are the primary hot processes. The heat source may be electrical resistance heating, infrared heating, hot air, or a gas flame. Regardless of which of these processes is used, the following shall be considered:

- the materials used for making the cable joint shall be compatible with each other, with the materials of the sheath and with other materials normally used in the outside plant;
- a design may allow for jointing together two or more cable ends. The cables entering the closure may be of differing sizes and/or types;
- a design should allow for jointing together at least one pair of cables which are not at the end of a cable i.e., without cutting all the fibres between both cable ends (this application is also known as "external node", "midspan closure" or "balloon splice");
- it is desirable that closures can be re-opened when necessary and remade without interruptions to working circuits;
- a single design, which may be used for all of the above applications and in all outdoor environments;

– if a design is limited to certain applications and environments in the network, any limitations shall be clearly indicated to the user; the detailed characterization of features and compatibility of a closure can be done using the checklist in Appendix I;
– if joint sealing encapsulant is used, information is required for adjustments in setting time due to variations in ambient temperature and humidity; the use of encapsulant is not recommended for reentrable closures;
– if a heat source is required to seal the closure and/or closure to the sheath, a suitable heat source (gas flame or electrical power) needs to be available at the jointing points. Consideration shall be given to control of the heat source to protect personnel and prevent damage to the closure or cable;
– all materials that are exposed to the environment must be sufficiently resistant to funghi. Materials that will be exposed to solar radiation must be UV resistant.

5.3 Design of the organizer system

Fibre organizers are an integral part of an optical closure. The organizers are comprised of one or more sheets or trays that have means for routing and holding fibre joints and fibre overlength in an orderly manner, and should minimize fibre strain.

Organizer compatibility and features can be listed by using the checklist in Appendix I. The desired optical stability type can be selected according to ITU-T Rec. L.51.

5.3.1 Characteristics of fibre organizers

The function of an optical fibre organizer is:

– to provide means for routing, storing and protecting fibre joints or other passive devices in a predetermined order, from one cable sheath end to another;
– to separate circuits up to a certain level as defined in ITU-T Rec. L.51; the number of fibre joints in one organizer may vary according to the size and shape of the fibre joint and the number of fibres in a cable subunit;
– to ensure that the fibre bend radius shall not be less than 30 mm in general applications. For special applications a minimum bend radius of 20 mm can be agreed between customer and supplier (see Note in 5.3.2);
– to provide easy identification and access to any stored fibre joint for rejointing;
– to separate fibres circuits up to the appropriate separation level; this will limit the risk of interruption of traffic to those fibres that belong to the same group of circuits (see ITU-T Rec. L.51: SC, SE, SF, SR, ME);
– to provide a means for storing the fibre overlength required for jointing and for possible rejointing in the future.

The materials used for making the organizer shall be compatible with the other materials in the cable joint and the degreasing agents as recommended in the installation instructions.

5.3.2 Configurations of optical fibre organizers

The trays or sheets of an organizer may be configured in one of the following ways:

– lateral sliding from a frame – similar to removing a book from a shelf;
– rotation about a hinge – similar to turning a page in a book;
– lifting from a stack – similar to lifting a book from a stack; or
– unrolling – similar to locating a page on a scroll.

All movements of the organizer parts should proceed in a predetermined way in order to eliminate optical losses or interruption of traffic due to organizer manipulations.

NOTE – In order to maintain mechanical reliability and minimize losses in the network, the cumulative length of fibre, exposed to this smaller bend radius should be limited to less than 2 m per fibre link.

6 Performance evaluation test program

The complete test program for a passive optical closure consists of:

– a basic test program for the applicable environment (see Annexes A and B);

– a number of additional requirements according to local standards when necessary (see ITU-T Rec. L.51 and the checklist in Appendix I).

For specific products, alternative test conditions to those given in Annex B may be agreed between customer and supplier.

Tests shall be executed according to IEC 61300-2 test methods where available.

The performance test program of a passive optical closure shall:

– evaluate the product for two groups of criteria: mechanical integrity and optical stability (see annex A);

– simulate the effects of exposure to:

  • the environment in which it will be installed;

  • an intervention at the node;

– simulate installation conditions;

– evaluate all available features of the product.

When an optical closure is suitable for both environments OA and OS, it shall pass the most severe conditions of either environment. As an alternative, the tests that are different for each of these environments may be duplicated at both settings.

Two types of optical stability can be selected (see 6.2.1/L.51); for products that may be subject to an intervention, while the network remains live, dynamic optical stability is recommended.

7 Sample preparation

A representative number of test samples is to be prepared, taking into account the following parameters:

– all product features and compatibility (checklist see Appendix I);

– applicable sizes of cables;

– mechanical test samples shall be installed at –15° C, room temperature and +45° C;

– for mechanical evaluation, a fresh sample should be prepared for each different test; if a failure occurs when consecutive testing is applied on the same sample, the last test may be repeated on a fresh sample.

Appendix I/L.51 illustrates how optical samples can be prepared; due to their complexity, consecutive testing on the same sample is most practical.

Annex A

Performance evaluation criteria

A.1 Mechanical and tightness evaluation

The performance evaluation criteria shall be assured during or after tests in Annex B.

A.1.1 Pressure loss during the test

International standard:	IEC 61300-2-38 Method B.
Conditions:	Internal pressure: (40 ± 2) kPa; (see Note b4, Annex B); Temperature: at test temperature; Elapsed time: <12 hrs.
Requirement:	Difference in pressure before and after the test ≤ 2 kPa at the same atmospheric conditions.

A.1.2 Tightness

International standard:	IEC 61300-2-38 Method A; IEC 60068-2-17 Test Qc.
Conditions:	Internal pressure: (40 ± 2) kPa; (see Note b4, Annex B); Test temperature: (23 ± 3)° C; Test time: 15 minutes; Depth: Just below water surface.
Requirement:	No bubbles indicating a leakage shall be observed during the test.

A.1.3 Visual appearance

International standard:	IEC 61300-3-1.
Conditions:	Examination of product with the unaided naked eye.
Requirement:	No defects which would affect product performance.

A.2 Optical evaluation

NOTE a1 – All optical losses indicated are referenced to the initial optical signal at the start of the test.

NOTE a2 – An "incoming fibre" is defined as a part of an optical circuit containing the fibre entering the product, spliced to a fibre leaving the product. One optical circuit can contain many "incoming fibres". Light will sequentially flow through all the "incoming fibres".

NOTE a3 – Fibre type used for single mode: G.652 Matched cladding.

A.2.1 Change in insertion loss (static optical stability)

International standard:	IEC 61300-3-3 Method 1.
Conditions:	Source wavelength: 1310, 1550 or 1625 nm (select the highest applicable wavelength).
Requirement:	$\Delta IL \leq 0.2$ dB (1310/1550 nm) per incoming fibre during the test (excursion loss); $\Delta IL \leq 0.5$ dB (1625 nm) per incoming fibre during the test (excursion loss); $\Delta IL \leq 0.1$ dB (1310/1550/1625 nm) per incoming fibre after the test (residual loss).

A.2.2 Transient loss (dynamic optical stability)

International standard: IEC 61300-3-28.

Conditions: Source wavelength: 1310, 1550 or 1625 nm (select the highest applicable wavelength) Unpolarized; Detector bandwidth: (0-1500) Hz.

Requirement: $\Delta IL \leq 0.5$ dB (1310/1550 nm) during the test measured in the life circuit (transient loss);
$\Delta IL \leq 1.0$ dB (1625 nm) during the test measured in the life circuit (transient loss);
$\Delta IL \leq 0.1$ dB (1310/1550/1625 nm) after the test in the life circuit (residual loss).

Annex B

Performance test program for underground closures (OS) and above ground closure (OA)

For this annex consider the following notes:

NOTE b1 – D is the cable outer diameter in mm.

NOTE b2 – All testing is at room temperature unless otherwise stated.

NOTE b3 – Test settings are applicable for both environments OA and OS unless specifically marked otherwise.

NOTE b4 – For products used in pressurized networks, all testing should be executed at 98 ± 9.8 kPa instead of 40 kPa.

NOTE b5 – For in-line closures that are installed without cable slack, higher axial tensile loads may be necessary.

NOTE b6 – For cables with a very rigid construction (e.g., slotted core cables, armoured cables), the clamping distance may need to be increased to 1000 mm.

NOTE b7 – Temperature ranges for aircycling are typical values. Adaptations to specific local conditions can be agreed between customer and supplier.

NOTE b8 – The need for static or dynamic optical stability is to be agreed between customer and supplier. The appropriate performance criteria are to be selected accordingly in the test program of B.2.

B.1 Mechanical evaluation

B.1.1 Cable axial tension

International standard: IEC 61300-2-4

Conditions: Load per cable: D/45 mm × 1000 N (maximum 1000 N) (Note b5);
Test pressure: (OS) (40 ± 2) kPa (Note b4);
(OA) 0 kPa;
Test time: 1 hr per cable.

Performance criteria: Tightness; (OS) Pressure loss during test; Displacement ≤ 3 mm; Visual appearance.

B.1.2 Cable flexure

International standard: IEC 61300-2-37.

Conditions: Force: 30° bending or max. 500 N;
Force application: 400 mm from end of the seal (Note b6);
Test pressure: (OS) (40 ± 2) kPa (Note b4);
(OA) 0 kPa;
Test temperatures: (–15 ± 2)° C and (+45 ± 2)° C;
Number of cycles: 5 per cable.

Performance criteria: Tightness; (OS) Pressure loss during test; Visual appearance.

B.1.3 Cable torsion

International standard: IEC 61300-2-5.

Conditions: Torque: maximum rotation 90°/maximum 50 Nm;
Torque application: 400 mm from end of the seal (Note b6);
Test pressure: (OS) (40 ± 2) kPa (Note b4);
(OA) 0 kPa;
Test temperatures: (–15 ± 2)° C and (+45 ± 2)° C;
Number of cycles: 5 per cable.

Performance criteria: Tightness; (OS) Pressure loss during test; Visual appearance.

B.1.4 Impact

International standard: IEC 61300-2-12 Method B.

Conditions: Impact tool: Steel ball;Weight: 1 kg;
Drop height: (OS) 2 m;
(OA) 1 m;
Test pressure: (OS) (40 ± 2) kPa (Note b4);
(OA) 0 kPa;
Test temperatures: (–15 ± 2)° C and (+45 ± 2)º C;
Location: at the centre of the closure at 0°, 90º, 180º, 270º around the longitudinal axis;
Number of impacts: 1 per location.

Performance criteria: Tightness; (OS) Pressure loss during test; Visual appearance.

B.1.5 Static load (crush test) (OS only)

International standard: IEC 61300-2-10.

Conditions: Load: 1000 N; Application surface 25 cm^2;
Test pressure: (40 ± 2) kPa (Note b4);
Test temperatures: (–15 ± 2)° C and (+45 ± 2)° C;
Location: at the centre of the closure at 0° and 90° around the longitudinal axis;
Duration: 10 minutes.

Performance criteria: Tightness; Pressure loss during test; Visual appearance.

B.1.6 Vibration (mechanical)

International standard: IEC 61300-2-1; IEC 60068-2-6 Test Fc.

Conditions: Frequency: 10 Hz; Cycle: Sinusoidal; Amplitude: at least 3mm (= 6 mm peak-to-peak);
Test pressure: (OS) (40 ± 2) kPa regulated;
(OA) 0 kPa;
Cable clamping: 500 mm from end of the seal;
Duration: at least 1.000.000 cycles ~28 hrs.

Performance criteria: Tightness; Visual appearance.

B.1.7 Waterhead (OS only)

International standard: IEC 61300-2-23 Method 2.

Conditions: Water column height: 5 m (or an equivalent external water pressure of 50 kPa);
Wetting agent: none;
Test pressure: 0 kPa;
Duration: 7 days.

Performance criteria: Visual Appearance: No water ingress.

B.1.8 Resistance to aggressive media

International standard: IEC 61300-2-34.

Conditions: Submersion in: (OA) (OS) HCl at pH 2;
(OA) (OS) NaOH at pH 12;
(OS) Kerosene (lamp oil): ISO 1998/I 1.005;
(OS) Petroleum jelly;
(OS) Diesel fuel for cars: EN 590;
Test pressure: (OS) (40 ± 2) kPa (Note b4);
(OA) 0 kPa;
Drying time at 70° C: none;
Duration: 5 days.

Performance criteria: Tightness; Visual appearance.

B.1.9 Resistance to detergents (stress cracking) (OS only)

International standard: IEC 61300-2-34.

Conditions: Submersion in 10% detergent solution at 50° C (e.g., Igépal);
Test pressure: (40 ± 2) kPa (Note b4);
Drying time at 70° C: none;
Duration: 5 days.

Performance criteria: Tightness; Visual appearance: No visible cracking.

B.1.10 Resistance to corrosion (salt fog)

International standard: IEC 61300-2-26; IEC 60068-2-11 Test Ka.

Conditions: Exposure to a salt mist of 5% NaCl in water;
Test pressure: 0 kPa;
Test temperature: (+35 ± 2)° C;
Duration: 5 days.

Performance criteria: Tightness; Visual appearance: No evidence of corrosion.

B.1.11 Temperature cycling (OS)

International standard:	IEC 61300-2-22; IEC 60068-2-14 Test Nb.
Conditions:	Lowest/Highest temperature: (–30/+60 ± 2)° C; Humidity: uncontrolled (Note b7); Dwell time: 4 hrs; Transition time: 2 hrs; Internal pressure: (40 ± 2) kPa regulated (Note b4); Number of cycles: 20.
Performance criteria:	Tightness; Visual appearance.

B.1.12 Temperature cycling (OA)

International standard:	IEC 61300-2-22; IEC 60068-2-14 Test Nb.
Conditions:	Lowest/highest temperature: (–40/+65 ± 2)° C; Humidity: uncontrolled (Note b7); Dwell time: 4 hrs; Transition time: 2 hrs; Internal pressure: (0 ± 2) kPa regulated; Number of cycles: 20.
Performance criteria:	Tightness; Visual appearance.

B.1.13 Re-entries

International standard:	IEC 61300-2-33.
Conditions:	Aging between each re-entry: at least one thermal cycle (see B1.11 (OS) and B1.12 (OA)); Number of re-entries: 10.
Performance criteria:	Tightness.

B.1.14 Central strength member protrusion

International standard:	Not available; Clamp the strength member (CM) into the CM fixation means as per installation instruction; use a suitable fixture that permits the load to remain properly aligned to the axis of the CM.
Conditions:	Load: 450 N axial push on the CM; Duration: 30 minutes.
Performance criteria:	The central strength member should not move inwards more than 5 mm.

B.1.15 Free drop

International standard:	IEC 61300-2-12 method A.
Conditions:	Severity: drop height 75 cm; Test temperatures: (–15 ± 2)° C and (+45 ± 2)° C; Number of drops: 1.
Performance criteria:	Tightness.

B.2 Optical evaluation

Construction of optical samples according to Annex A/L.51.

B.2.1 Cable flexure

International standard:	IEC 61300-2-37.
Conditions:	Force: 30° bending or max. 500 N; Force application: 400 mm from end of the seal (Note b6); Test temperatures: (–15 ± 2)° C and (+45 ± 2)° C; Number of cycles: 5 per cable.
Performance criteria: (Note b8)	Static: Change in insertion loss (residual loss); Dynamic: Transient loss.

B.2.2 Cable torsion

International standard:	IEC 61300-2-5.
Conditions:	Torque: Maximum rotation 90°/maximum 50 Nm; Torque application: 400 mm from end of the seal (Note b6); Test temperatures: (–15 ± 2)° C and (+45 ± 2)° C; Number of cycles: 5 per cable.
Performance criteria: (Note b8)	Static: Change in insertion loss (residual loss); Dynamic: Transient loss.

B.2.3 Intervention at a node

International standard:	IEC 61300-2-33.
Conditions:	Execute all manipulations that will normally occur for this product during an intervention after initial installation. A List of typical manipulations can be found in Appendix II/L.51.
Performance criteria: (Note b8)	Static: Change of insertion loss (residual loss); Dynamic: Transient loss.

B.2.4 Vibration

International standard:	IEC 61300-2-1; IEC 60068-2-6 Test Fc.
Conditions:	Sweep range: (5-500) Hz sinusoidal at 1 octave/minute; Crossover frequency: 9 Hz; – amplitude below 9 Hz: 3.5 mm; – acceleration above 9 Hz: 10 m/s^2 (~1 g); Direction: 3 mutually perpendicular axes; Duration: 10 cycles/axis.
Performance criteria: (Note b8)	Visual appearance. Static: Change in insertion loss (residual loss); Dynamic: Transient loss.

B.2.5 Shock

International standard:	IEC 61300-2-9; IEC 60068-2-27 Test Ea.
Conditions:	Wave form: Half sine; Duration: 11 milliseconds; Acceleration: 150 m/s^2 (~15g); Direction: 3 mutually perpendicular axes; Number of shocks: 3 up and 3 down per axis.

Performance criteria: (Note b8)	Visual appearance; Static: Change in insertion loss (residual loss); Dynamic: Transient loss.

B.2.6 Temperature cycling (OS)

International standard:	IEC 61300-2-22; IEC 60068-2-14 Test Nb.
Conditions:	Lowest/highest temperature: (–30/+60 ± 2)° C; Humidity: uncontrolled (Note b7); Dwell time: 4 hrs; Transition time: 2 hrs; Number of cycles: 20.
Performance criteria: (Note b8)	Visual appearance; Static/dynamic: Change in insertion loss (excursion loss).

B.2.7 Temperature cycling (OA)

International standard:	IEC 61300-2-22; IEC 60068-2-14 Test Nb.
Conditions:	Lowest/highest temperature: (–40/+65 ± 2)° C; Humidity: uncontrolled (Note b7); Dwell time: 4 hrs; Transition time: 2 hrs; Number of cycles: 20.
Performance criteria: (Note b8)	Visual appearance; Static/dynamic: Change in insertion loss (excursion loss).

Appendix I

Product characterization checklist

This checklist facilitates the systematic characterization of the features and capabilities of an optical closure. It reflects the parameters that are described in ITU-T Rec. L.51. It may be useful for preparation of the products' testprogram as well as product description for tenders and purchasing specifications, comparison of different or competitive products and creation of commercial information and ordering guides.

NOTE – For outdoor enclosures in general, IP protection classes are defined in IEC 60529. Optical closures that pass the tightness evaluation and the submersion test as described in Annexes A and B, can be considered to inherently meet the IP68 requirement.

Product name: .....

Application Environment(s) (see 7.1/L.51)

☐ OA Outdoor above ground
☐ OS Outdoor underground (subterranean)
☐ E Extreme (describe differences versus a basic environmental class)

Optical functionality & compatibility (see clause 6/L.51)

– ***optical stability level****:*

☐ Static

☐ Dynamic (transient free)

– ***wavelength*** (see 6.3/L.51)

☐ 1310 nm
☐ 1550 nm
☐ 1625 nm
☐ Other: …….....

– ***cable construction*** (see 6.1.1/L.51)

☐ Loose buffer tube
☐ Micro-sheath
☐ Central core
☐ Slotted core
☐ Blown fibre
☐ Break out cable
☐ Interfacility cable
☐ Optical Power Ground Wire (OPGW) cable
☐ Other: .....

– ***fibre type, fibre grouping, fibre coating*** (see 6.1.2/L.51)

☐ Multi mode
☐ Single mode

☐ Single fibre
☐ Ribbon 4
☐ R8
☐ R12
☐ R24
☐ other: ….....

☐ Primary coated (~250 µm)
☐ Secondary coated (~900 µm)

– ***passive devices*** (see 6.1.3/L.51):

☐ Splice type: ☐ Fusion
☐ Mechanical (brand/type): .....

☐ Splice protector type:
☐ Heatshrink (min/max dimensions): .....
☐ Mechanical (brand/type) :.....

☐ Connectors: specify brand/type: .....

☐ Branching devices: (describe type, split ratio etc.): .....……
Delivered as preassembled/prefibred modules ☐ yes ☐ no

☐ Other passive devices: (describe) .....
Delivered as preassembled/prefibred modules ☐ yes ☐ no

– ***fibre storage and separation level*** (see 6.2.2/L.51)

	Circuit separation level				
	ME	**SE**	**SR**	**SC**	**SF**
☐ Uncut fibre (looped fibre)	☐	☐	☐	☐	☐
☐ Splices	☐	☐	☐	☐	☐
☐ Passive optical components	☐	☐	☐	☐	☐
☐ Other:	☐	☐	☐	☐	☐

Additional or special requirements and features

– ***storage/transport conditions*** (see 7.2/L.51)

☐ Normal: public transport – indoor storage
☐ Special handling/transport: .....
☐ Special storage: .....

– ***additional (conditional) requirements*** (see Appendix III/L.51):

☐ Bullet/shotgun proof according to: .....
☐ Earthquake resistance according to: .....
☐ Freeze-thaw resistance according to: .....
☐ Fire-related performance according to: .....
  ☐ Fire Retardancy according to: .....
  ☐ Halogen free according to: .....
  ☐ Low smoke emission according to: .....
☐ Electrical grounding and shield continuity according to: .....
  ☐ Current surge according to: .....
  ☐ Insulation resistance according to: .....
  ☐ Contact resistance according to: .....
☐ Rodent resistance according to: .....
☐ Termite resistance according to: .....
☐ Steam resistance according to: .....
☐ Cable blocking according to: .....
☐ Other: ..... according to: .....

Appendix II

Ukrainian experience

II.1 Introduction

This appendix represents the experience of Ukraine for closure performance tests for the Ukrainian State Committee of Communication and Informatization.

II.2 Dimension and optical characteristics

II.2.1 Visual inspection

International standard: IEC 61073-1; IEC 61300-3-1.

Conditions: Examination of product with naked eye.

Acceptance criteria: No defects which will adversely affect performance.

II.2.2 Dimension

International standard: None.

Conditions: Accordance to the technical specification drawing for the product.

Acceptance criteria: Full compliance to the specification drawing.

II.2.3 Bend Radius of optical fibres on the cassette

International standard: IEC 61300-3-3 Method 1.

Conditions: Min. bend radius 30 mm;
Wavelength:
Single mode: $\lambda = 1550 \pm 30$ nm; $\lambda = 1310 \pm 30$ nm;
Multi mode: $\lambda = 1300 \pm 30$ nm; $\lambda = 850 \pm 30$ nm.

Acceptance criteria: The change in insertion loss after storing a fibre on a storage cassette should be less than 0.05 dB (residual loss).

II.3 Environmental characteristics

II.3.1 Temperature cycling

International standard: IEC 61300-2-22; IEC 60068-2-14 Test Nb.

Conditions: Lowest temperature: –40 ± 2° C;
Highest temperature: +60 ± 2° C;
Dwell time: 2.5 hours;
Transition time: 1 hour;
Pressure: at least 40 kPa;
Number of cycles: 20.

Acceptance criteria: Tightness. Visual.

Max increase of attenuation <0.1 dB.

II.3.2 Temperature heat durability

International standard: IEC 61300-2-18; IEC 60068-2-2.

Conditions: Temperature: 60 ± 3° C;
Pressure: at least 40 kPa;
Test time: 7 days.

Acceptance criteria: Tightness. Visual.

II.3.3 Temperature cold durability

International standard: IEC 61300-2-17; IEC 60068-2-1.

Conditions: Temperature: –30 ± 3° C;
Pressure: at least 40 kPa;
Test time: 10 days.

Acceptance criteria: Tightness. Visual.

II.3.4 Resistance to aggressive media

International standard: IEC 61300-2-34.

Conditions: Test temperature: 23 ± 3° C;
Pressure: 40 ± 2 kPa;
Test media: pH2 solution of hydrochloric acid, pH12 solution of sodium hydroxide, Diesel fuel, Gasoline, 10% Igepal CO-630;
Test time: 10 days.

Acceptance criteria: Tightness. Visual.

II.3.5 Corrosive atmosphere

International standard: IEC 60068-2-11 test Ka; IEC 61300-2-26.

Conditions: Salt fog spray (5% NaCl);
Temperature: 35 ± 3° C;
Pressure: 40 ± 2 kPa;
Test time: 10 days.

Acceptance criteria: Tightness. Visual: no evidence of corrosion.

II.3.6 Water penetration

International standard: IEC 61300-2-32.

Conditions: Temperature: 23 ± 3° C;
Depth: 1 m;
Test time: 7 days.

Acceptance criteria: No water ingress.

II.3.7 Freeze/Thaw

International standard: None.

Conditions: Lowest temperature: –35 ± 2° C;
Highest temperature: 60 ± 2° C;
Depth: min 25 mm from top part of closure;
Dwell time on the lowest temperature: 10 hours;
Dwell time on the highest temperature: 5 hours;
Thaw time: 1 hour;
Freeze time: 0.5 hour;
Middle temperature during 1 h: 0° C;
Next freeze time: 0.5 hour;
Pressure: 40 ± 2 kPa;
Number of cycles: 10.

Acceptance criteria: Tightness. Visual.

II.4 Mechanical characteristics

II.4.1 Axial tension

International standard: IEC 61300-2-4.

Conditions: Test temperature: 23 ± 3° C;
Pressure: at least 40 kPa;
Load: 450 N;
Test time: 30 min per cable.

Acceptance criteria: Tightness. No residual cable movement.

II.4.2 Vibration

International standard:	IEC 60068-2-6 test Fc; IEC 61300-2-1.
Conditions:	Test temperature: 23 ± 3° C; Vibration: 10-55 Hz, sinusoidal; Amplitude: 0.75 mm; Pressure: 40 ± 2 kPa; Test time: 2 h along each of three axes; λ = 1550 nm; Min 8 fibres per test circuit.
Acceptance criteria:	Tightness. Visual. Max increase of attenuation after test <0.1 dB.

II.4.3 Torsion strength

International standard:	IEC 60068-2-17; IEC 61300-2-5.
Conditions:	Test temperature: 23 ± 3° C; Pressure: 40 ± 2 kPa; Load: 50 N × m or 90^{o} during 5 min in each direction; Clamping distance: 10 × D_{cab} from outlet of cable; Number of cycles: 2 per cable.
Acceptance criteria:	Tightness. No residual movement of cable.

II.4.4 Bending strength

International standard:	IEC 61300-2-37.
Conditions:	Test temperature: 23 ± 3° C; Pressure: 40 ± 2 kPa; Load: 500 N or 30^{o}; Clamping distance: 10 × D_{cab} from outlet of cable; Number of cycles: 5.
Acceptance criteria:	Tightness. No movement of cable.

II.4.5 Impact

International standard:	IEC 61300-2-12 Method B.
Conditions:	Test temperature: –15 ± 3° C (condition for min 4 h); Pressure: 40 ± 2 kPa; Impact tool: steel ball; Height: 1 m; Weight: 1 kg; Site of impact: in the middle of the closure; Number of impacts: 1.
Acceptance criteria:	Tightness. Visual.

II.4.6 Static load

International standard:	IEC 61300-2-10.
Conditions:	Test temperature: –15 ± 3° C; Pressure: 40 ± 2 kPa; Load: 1000 N/25 cm^2 area; Test time: 10 min.
Acceptance criteria:	Tightness. Visual.

II.4.7 Drop

International standard:	IEC 61300-2-12 method A.
Conditions:	Test temperature: 23 ± 3° C; Height: 2 m; Number of drops: 1.
Acceptance criteria:	Tightness. Visual.

II.4.8 Ultraviolet resistance

International standard:	IEC 61300-2-30; ISO 4892-3.
Conditions:	Temperature: UV at 60° C during 4 h and dark at 50° C during 4 h; Test time: 1000 h; Ultraviolet light source with a peak emission at 313 nm; Number of samples: 10.
Acceptance criteria:	The change in tensile strength shall not exceed 20%.

II.5 Field condition tests

II.5.1 Re-entry

International standard:	IEC 61300-2-33.
Conditions:	1 re-entry and re-close over 1 month in real field conditions.
Acceptance criteria:	Tightness.

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