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SERIES L: ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Optical infrastructures – Infrastructure including node elements (except cables)

Performance requirements for passive optical nodes: Sealed Closures for Outdoor Environments

Recommendation ITU-T L.201

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Recommendation ITU-T L.201

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

Summary

Recommendation ITU-T L.201 refers to passive optical nodes in outdoor environments. It deals with the design of the closure housing as well as the fibre organizer or fibre management system, taking into account mechanical and environmental characteristics as well as the characteristics of the optical fibre organizer.

The following new elements have been added in this revision:

– A new clause 6.3 on closure materials with detailed test requirements for UV-light exposure and the fungal resistance of polymer materials and a material test requirement for the ageing of polymer materials by humidity;

– A new clause 6.5 on cable attachment and termination with recommendations for the electrical grounding of the metallic elements of the cables;

– A test programme for the performance evaluation of sealed optical closures in the outdoor ground level (OG) environment.

The following changes were made to harmonize the performance tests with [IEC 61753-1]:

– Sealing tests are done with 20 kPa overpressure for OG and outdoor above ground (OA) closures.

– Pass-fail criteria of pressure loss during test have been added to mechanical sealing tests for OG and OA closures.

– Reduced loads for the cable axial tension test for small diameter cables and microduct tubes.

– Reduced loads for the cable axial compression test for small diameter cables.

– The duration of the cycles in cable torsion and cable bending test have been added.

– The location for impact test has been added for rectangular shaped closures.

– The free fall test has been removed (it has been replaced by a more reproduceable shock test).

– In the assembly and disassembly test the duration is reduced to 5 cycles.

– Resistance to solvents and contaminating fluids: immersion in diesel with duration of 1 h and 24 h drying time and added immersion in petroleum jelly for 5 days has been added. Kerosene immersion has been removed.

– The duration of the change of temperature has been reduced to 12 cycles.

– Water immersion test at 1 m for 7 days for OG closures has been added.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T L.13	1992-07-31		11.1002/1000/1417
2.0	ITU-T L.201/L.13	2003-04-11	6	11.1002/1000/6135
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Keywords

Fibre management system, organizer, outside plant, passive optical nodes, sealed closures.

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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 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 K.11], [ITU-T K.47], [IEC 62368-1] and the ITU-T Manual "Protection of telecommunication lines and equipment against lightning discharges" [b-ITU-T Manual].

This Recommendation provides the means for characterizing and evaluating the performance of optical closures according to the principles of [ITU-T L.200]. This includes both the mechanical integrity and the optical stability of the product, simulating the effect of environmental factors, as well as interventions related to network maintenance. It contains a basic test programme for optical closures which is globally applicable. Additional requirements can be agreed between customer and supplier to reflect local or special conditions. All functions and features that a product may contain should be reflected in the mix of test samples that are subjected to the test programme.

Recommendation ITU-T L.201

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 the mechanical and environmental characteristics of the optical closure;

– Deals with the characteristics of the optical fibre organizers;

– Provides a test programme for the performance evaluation of sealed optical closures in three basic environments: outdoor subterranean or underground (OS), outdoor ground level (OG) and outdoor above ground (OA);

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

– Contains a checklist for a systematic product characterization according to [ITU-T L.200];

– Contains a list of additional requirements to reflect special environments (e.g., tunnels) and 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 G.652] Recommendation ITU-T G.652 (2016), *Characteristics of a Single-Mode Optical Fibre and Cable*.

[ITU-T G.657] Recommendation ITU-T G.657 (2016), *Characteristics of a Bending-Loss Insensitive Single-Mode Optical Fibre and Cable*.

[ITU-T K.11] Recommendation ITU-T K.11 (2009), *Principles of Protection Against Overvoltages and Overcurrents*.

[ITU-T K.47] Recommendation ITU-T K.47 (2012), *Protection of Telecommunication Lines Against Direct Lightning Flashes*.

[ITU-T L.200] Recommendation ITU-T L.200/L.51 (2003), *Passive Node Elements for Fibre Optic Networks – General Principles and Definitions for Characterization and Performance Evaluation*.

[IEC 60068-2-10] IEC 60068-2-10 (2005), *Environmental testing – Part 2: Tests - Test J and guidance: Mould growth.*

[IEC 60529] IEC 60529 (2013), *Degrees of protection provided by enclosures (IP Code)*.

[IEC 61300-2-1] IEC 61300-2-1 (2009), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-1: Tests – Vibration (sinusoidal).*

[IEC 61300-2-4] IEC 61300-2-4 (2019), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-4: Tests – Fibre/cable retention*.

[IEC 61300-2-5] IEC 61300-2-5 (2009), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-5: Tests – Torsion*.

[IEC 61300-2-9] IEC 61300-2-9 (2017), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-9: Tests – Shock*.

[IEC 61300-2-10] IEC 61300-2-10 (2021), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-10: Tests – Crush resistance*.

[IEC 61300-2-11] IEC 61300-2-11 (2012), *Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-11: Tests – Axial compression.*

[IEC 61300-2-12] IEC 61300-2-12 (2009), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-12: Tests – Impact*.

[IEC 61300-2-19] IEC 61300-2-19 (2012), *Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-19: Tests - Damp heat (steady state).*

[IEC 61300-2-22] IEC 61300-2-22 (2007), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-22: Tests – Change of temperature*.

[IEC 61300-2-23] IEC 61300-2-23 (2010), *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] IEC 61300-2-26 (2007), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-26: Tests – Salt mist*.

[IEC 61300-2-33] IEC 61300-2-33 (2012), *Fibre optic interconnecting devices and passive components – Basic test –and measurement procedures – Part 2-33: Tests – Assembly and disassembly of fibre optic mechanical splices, fibre management systems and closures*.

[IEC 61300-2-34] IEC 61300-2-34 (2009), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-34: Tests – Resistance to solvents and contaminating fluids of interconnecting components and closures*.

[IEC 61300-2-37] IEC 61300-2-37 (2016), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-37: Tests – Cable bending for closures*.

[IEC 61300-2-38] IEC 61300-2-38 (2006), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-38: Tests – Sealing for pressurized fibre optic closures*.

[IEC 61300-3-1] IEC 61300-3-1 (2005), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-1: Examinations and measurements – Visual examination*.

[IEC 61300-3-3] IEC 61300-3-3 (2009), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-3: Examinations and measurements – Active monitoring of changes in attenuation and return loss (multiple paths)*.

[IEC 61300-3-28] IEC 61300-3-28 (2012), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-28: Examinations and measurements – Transient loss*.

[IEC 61753-1] IEC 61753-1 (2018), *Fibre optic interconnecting devices and passive components - Performance standard - Part 1: General and guidance*.

[IEC 61756-1] IEC 61756-1 (2019), *Fibre optic interconnecting devices and passive components – Interface standard for fibre management systems – Part 1: General and guidance.*

[IEC 62368-1] IEC 62368-1 (2018), *Audio/video, information and communication technology equipment – Part 1: Safety requirements.*

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 closure housing: Closure housing refers only to the sealed container or box and does not include the organizer system. Its main functions are: providing sealing to the cables, mechanical attachment of the cable and protecting its content.

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

3.2.3 optical fibre organizer (fibre management 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 all the 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 L.200].

ME Multiple Element (mass storage)

OA Outdoor Above Ground

OG Outdoor Ground level

OPGW Optical Power Ground Wire

OS Outdoor Subterranean or underground

SC Single Circuit

SE Single Element

SF Single Fibre

SR Single Ribbon

5 Conventions

None.

6 Design characteristics of optical closures

6.1 General requirements

Each optical closure must comply to the general requirements as listed in clause 8 of [ITU-T L.200].

6.2 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 should be considered:

– The materials used for making the cable joint should be compatible with each other, with the materials of the sheath and with other materials and solvents 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 should 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 re-enterable 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 should be given to the control of the heat source to protect personnel and prevent damage to the closure or cable.

6.3 Closure materials

All materials that are likely to come in contact with personnel should meet appropriate local health and safety regulations. Closure materials should be compatible with each other and with the materials of the cables and/or microducts. All components of the closure should be resistant to solvents and degreasing agents that are typically used to clean and degrease fibres and cables.

The materials used in the closures should remain functional when exposed to outside plant environments:

– All polymer materials should be sufficiently resistant to fungi. The fungal resistance test is done according to [IEC 60068-2-10] variant 1, severity 1. The effect of fungal growth should be determined by measuring a suitable property (e.g., tensile strength and elongation at yield) both before and after the exposure of the material slabs. The average change in the mechanical characteristics of the tested material slabs should be less than 20%.

– The polymer materials that will be exposed to solar radiation should be UV resistant. The UV test is done according to [b-ISO 4892-3], lamp type 1A (UVA-340), cycle 1, duration 2160 h. The effect of UV light should be determined by measuring a suitable property (e.g., tensile strength and elongation at yield) both before and after the exposure of the material slabs. The average change in the mechanical characteristics of the tested material slabs should be less than 20%.

– All polymer materials should be resistant to high humidity. A damp heat (steady state) test according to [IEC 61300-2-19] should be done at a high temperature and high humidity as long as no phase transitions in the material occur. The following conditions and durations could be used:

  – +75°C/95%RH for 2 000 h;
  – +85°C/95%RH for 1 000 h;
  – +95°C/95%RH for 500 h.

  Higher test temperatures with shorter test duration are allowed when no phase transition occurs in the material. The ageing effect of humidity should be determined by measuring a suitable property (e.g., tensile strength and elongation at yield) both before and after the exposure of the material slabs. The average change in the mechanical characteristics of the tested material slabs should be less than 20%.

– All metal parts should be resistant to corrosive effects. The effects of corrosion are tested on the complete closure or on representative test samples according to the salt fog test method described in clause B.1.10. No signs of beginning corrosion should be visible. A colour change caused by passivation is allowed.

6.4 Design of the optical fibre organizer (fibre management 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 routeing 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 L.200].

6.4.1 Characteristics of the optical fibre organizer (fibre management system)

The function of an optical fibre organizer is:

– To provide means for routeing, 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 L.200]; 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 should not be less than the recommended radius for the application specified by [IEC 61756-1] or [b-ITU-T G Sup59];

– To provide easy identification and access to any stored fibre joint for remaking the joint;

– To separate fibre 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 L.200]: single circuit (SC), single element (SE), single fibre (SF), single ribbon (SR), multiple element (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 should be compatible with the other materials in the cable joint and the degreasing agents as recommended in the installation instructions.

6.4.2 Configurations of the optical fibre organizers (fibre management systems)

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 prevent optical losses or interruption of traffic due to organizer manipulations.

6.5 Cable attachment and termination

The following characteristics for cable attachment and termination should be considered:

– Allowing attachment of all cables entering the closure. The cables may be of different sizes and/or types.
– When applicable, providing a good bonding and grounding of metallic elements of cables. The method of achieving electrical continuity can vary with the type of cable sheath and the type and location of the strength members. Further information is given in [ITU-T K.11], [ITU-T K.47] and [IEC 62368-1].
– The addition or removal of cables should not result in interruption of service on other cables.

7 Performance evaluation test programme

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

– A basic test programme for the applicable environment (see Annexes A and B);
– A number of additional requirements according to local standards when necessary (see [ITU-T L.200] 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 are executed according to IEC 61300-2 test methods where available.

The performance test programme of a passive optical closure should:

– 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 at temperatures between −5°C and +45°C;
– Simulate closure and cable handling at temperatures between −15°C and +45°C;
– Evaluate all available features of the product.

When an optical closure is suitable for all environments, OA, OG and OS, it should pass whichever conditions of the three environments that are the most severe. 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 clause 6.2.1 in [ITU-T L.200]); for products that may be subject to an intervention while the network remains live, dynamic optical stability is recommended.

8 Sample preparation

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

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

– Applicable sizes of cables;

– Sealing test samples should be installed at −5°C, room temperature and +45°C;

– For sealing 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;

– For the optical performance evaluation, the closure should be installed with sufficient long cables of the relevant fibre type for which the organizer system is designed.

Appendix I in [ITU-T L.200] illustrates how optical samples can be prepared. Due to their complexity, consecutive testing on the same sample is the most practical approach.

Annex A

Performance evaluation criteria

(This annex forms an integral part of this Recommendation.)

A.1 Sealing evaluation

It should be ensured that the performance evaluation criteria are met 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: (OS) (40 ± 2) kPa; (see Note b4, Annex B); (OG and OA) (20 ±2) kPa; Temperature: at test temperature; Measurement before and after the test should be done within 12 h.
Requirement:	Difference in pressure before and after the test ≤ 2 kPa measured under the same atmospheric test conditions.

A.1.2 Tightness after test

International standard:	[IEC 61300-2-38] Method A.
Conditions:	Internal pressure: (OS) (40 ± 2) kPa; (see Note b4, Annex B); (OG and OA) (20 ± 2) kPa; Test temperature: (+23 ± 5)°C; Test time: 15 minutes; Depth: Just below water surface.
Requirement:	No bubbles indicating a leakage should be observed during the test.

A.1.3 Visual appearance

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

A.2 Optical performance 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 – In general the fibre type used for building the test samples is ITU-T G.652.D fibre with nominal mode field diameter between 9.0 µm and 9.2 µm. When closures are qualified with these ITU-T G.652.D fibres, they are automatically qualified for use with other ITU-T G.652.D and ITU-T G.657 fibres. If the organizer system is designed for bending-loss insensitive single-mode fibres [ITU-T G.657], the relevant fibre type needs to be used in the optical test sample.

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

International standard:	[IEC 61300-3-3] Method 1.
Conditions:	Source wavelength: 1 310 nm, 1 550 nm or 1625 nm (select the highest applicable wavelength).
Requirement:	$\Delta IL \leq 0.2$ dB (1 310 nm/1 550 nm) per incoming fibre during the test (excursion loss); $\Delta IL \leq 0.5$ dB (1 625 nm) per incoming fibre during the test (excursion loss); $\Delta IL \leq 0.1$ dB (1 310 nm/1 550 nm/1 625 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: 1 310 nm, 1 550 nm or 1 625 nm (select the highest applicable wavelength) unpolarized;
Requirement:	$\Delta IL \leq 0.5$ dB (1 310 nm/1 550 nm) during the test measured in the live circuit (transient loss); $\Delta IL \leq 1.0$ dB (1 625 nm) during the test measured in the live circuit (transient loss); $\Delta IL \leq 0.1$ dB (1 310 nm/1 550 nm/1 625 nm) after the test in the live circuit (residual loss).

Annex B

Performance test programme for outdoor subterranean or underground (OS) closures, ground level (OG) closures and above ground (OA) closures

(This annex forms an integral part of this Recommendation.)

For this annex consider the following notes:

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

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

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

NOTE b4 – For OS 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 1 000 mm.

NOTE b7 – Temperature ranges for change of temperature tests 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. When no degradation in transmission is allowed during handling or reconfiguration of the closure, the dynamic optical stability criterion is used. The appropriate performance criteria are to be selected accordingly in the test programme of B.2.

B.1 Sealing evaluation

B.1.1 Cable axial tension

International standard:	[IEC 61300-2-4]
Conditions:	Load per cable (N): 20 × D (mm)with maximum of 1 000 N for cables with diameter D > 7 mm (Note b1 and b5); 10 × D for cables with diameter D ≤ 7 mm; 10 N for tubes and cables without strength member; Load application: 400 mm from the end of the seal; Test pressure: (OS) (40 ± 2) kPa (Note b4); (OG and OA) (20 ± 2) kPa; Test temperatures: (−15 ± 2)°C and (+45 ± 2)°C; Test time: 1 h per cable.
Performance criteria:	Tightness after test; Pressure loss during test; 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); (OG and OA) (20 ± 2) kPa; Test temperatures: (−15 ± 2)°C and (+45 ± 2)°C; Number of cycles: 5 per cable.
Performance criteria:	Tightness after test; 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 the end of the seal (Note b6); Test overpressure: (OS) (40 ± 2) kPa (Note b4); (OG and OA) (20 ± 2) kPa; Test temperatures: (−15 ± 2)°C and (+45 ± 2)°C; Number of cycles: 5 per cable.
Performance criteria:	Tightness after test; 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; (OG and OA) 1 m; Test overpressure: (OS) (40 ± 2) kPa (Note b4); (OG and OA) (20 ± 2) kPa; Test temperatures: (−15 ± 2)°C and (+45 ± 2)°C; Location: at the centre of the closure at 0°, 90°, 180°, 270° around the longitudinal axis. For rectangular shaped closures the impact location should be at the centre of the largest flat surface; Number of impacts: 1 per location.
Performance criteria:	Tightness after test; Pressure loss during test; Visual appearance.

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

International standard:	[IEC 61300-2-10]
Conditions:	Load: 1 000 N; Application with circular surface of 25 cm^2; Test overpressure: (OS) (40 ± 2) kPa (Note b4); (OG) (20 ± 2) kPa; 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 after test; Pressure loss during test; Visual appearance.

B.1.6 Vibration (sealing)

International standard:	[IEC 61300-2-1]
Conditions:	Frequency: 10 Hz; Cycle: Sinusoidal; Amplitude: at least 3 mm (= 6 mm peak-to-peak); Test overpressure: (OS) (40 ± 2) kPa regulated; (OG and OA) (20 ± 2) kPa regulated; Cable clamping: 500 mm from end of the seal; Duration: at least 1 000 000 cycles ~28 h.
Performance criteria:	Tightness after test; Visual appearance.

B.1.7 Waterhead (OS and OG only)

International standard:	[IEC 61300-2-23]
Conditions:	Water column height: (OS) 5 m (or an equivalent external water pressure of 50 kPa); (OG) 1 m (or an equivalent external water pressure of 10 kPa); Wetting agent: none; Test pressure: 0 kPa overpressure, sealed off at room temperature; 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, OG and OS) HCl at pH 2; (OA, OG and OS) NaOH at pH 12; (OG and OS) Petroleum jelly; (OG and OS) Diesel fuel for cars: [b-EN 590]; Test pressure: (OS) (40 ± 2) kPa (Note b4); (OA and OG) (20 ± 2) kPa; Duration: 1 h for diesel, 5 days for other detergents. Drying time: 24 h for diesel at room temperature, none for other detergents;
Performance criteria:	Tightness after test; Visual appearance.

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

International standard:	[IEC 61300-2-34]
Conditions:	Submersion in 10% Nonyl Phenol Ethoxylate solution at 50°C; Test pressure: (OS) (40 ± 2) kPa (Note b4); (OA and OG) (20 ± 2) kPa; Drying time: none; Duration: 5 days.
Performance criteria:	Tightness after test; Visual appearance: No visible cracking.

B.1.10 Resistance to corrosion (salt fog)

International standard:	[IEC 61300-2-26]
Conditions:	Exposure to a salt mist of 5% NaCl in water; pH between 6.5 and 7.2 Test overpressure: 0 kPa overpressure, sealed off at room temperature; Test temperature: (+35 ± 2)°C; Duration: 5 days.
Performance criteria:	Tightness after test; Visual appearance: No signs or evidence of corrosion. A colour change caused by passivation is allowed.

B.1.11 Change of temperature (OS)

International standard:	[IEC 61300-2-22]
Conditions:	Lowest/Highest temperature: (−30/+60 ± 2)°C; Humidity: uncontrolled (Note b7); Dwell time: 4 h; Transition time: 2 h; Internal overpressure: (40 ± 2) kPa regulated (Note b4); Number of cycles: 12.
Performance criteria:	Tightness; Visual appearance.

B.1.12 Change of temperature (OA and OG)

International standard:	[IEC 61300-2-22]
Conditions:	Lowest/highest temperature: (−40/+65 ± 2)°C; Humidity: uncontrolled (Note b7); Dwell time: 4 h; Transition time: 2 h; Internal overpressure: (20 ± 2) kPa regulated; Number of cycles: 12.
Performance criteria:	Tightness; Visual appearance.

B.1.13 Re-entries

International standard:	[IEC 61300-2-33]
Conditions:	Ageing between each re-entry: at least one thermal cycle (see clauses B1.11 (OS) and B1.12 (OA and OG)); Number of re-entries: 5.
Performance criteria:	Tightness after test and after each re-entry.

B.1.14 Cable axial compression

International standard:	[IEC 61300-2-11]
Conditions:	Load per cable (N): Note b1 10 N for D < 3mm 20 N for 3 mm ≤ D < 6 mm 50 N for 6 mm ≤ D < 10 mm 100 N for 10 mm ≤ D < 20 mm 200 N for D ≥ 20 mm 10 N for tubes and cables without strength member; Load application: At maximum twice the cable diameter measured from end of seal. Duration: 30 minutes per cable.
Performance criteria:	The cable should not move inwards more than 5 mm.

B.2 Optical performance evaluation

Construction of optical samples according to Annex A of [ITU-T L.200].

B.2.1 Cable axial tension

International standard:	[IEC 61300-2-4]
Conditions:	Load per cable (N): 20 × D (mm) (maximum 1 000 N) for cables with diameter > 7 mm (Note b1 and b5); 10 × D (mm) for cables with diameter ≤ 7 mm; 10 N for tubes and cables without strength member; Load application: 400 mm from end of the seal; Test pressure: (OS) (40 ± 2) kPa (Note b4); (OG and OA) (20 ± 2) kPa; Test temperatures: (+23 ± 5)°C; Test time: 1 h per cable.
Performance criteria:	Static: Change in attenuation (change in insertion loss) − residual loss; Dynamic: Transient loss.

B.2.2 Cable flexure

International standard:	[IEC 61300-2-37]
Conditions:	Bending angle: −30° and +30° bending, maximum force 500 N; Force application: 400 mm from end of the seal (Note b6); Duration at extreme position: 5 minutes Test temperature: (+23 ± 5)°C; Number of cycles: 5 per cable.
Performance criteria: (Note b8)	Static: Change in attenuation (change in insertion loss) − residual loss; Dynamic: Transient loss.

B.2.3 Cable torsion

International standard:	[IEC 61300-2-5]
Conditions:	Torsion angle: Rotation +90° and −90°, maximum torque 50 Nm; Torque application: 400 mm from end of the seal (Note b6); Test temperature: (+23 ± 5)°C; Number of cycles: 5 per cable.
Performance criteria: (Note b8)	Static: Change in attenuation (change in insertion loss) − residual loss; Dynamic: Transient loss.

B.2.4 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 of [ITU-T L.200].
Performance criteria: (Note b8)	Static: Change of attenuation (change in insertion loss) − residual loss; Dynamic: Transient loss.

B.2.5 Vibration (optical)

International standard:	[IEC 61300-2-1]
Conditions:	Sweep range: (5-500-50) 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; Test temperature: (+23 ± 5)°C.
Performance criteria: (Note b8)	Visual appearance. Static: Change in attenuation (change in insertion loss) − residual loss; Dynamic: Transient loss.

B.2.6 Shock

International standard:	[IEC 61300-2-9]
Conditions:	Wave form: Half sine; Duration: 11 milliseconds; Acceleration: 150 m/s^2 (~15 g); Direction: 3 mutually perpendicular axes; Number of shocks: 3 up and 3 down per axis; Test temperature: (+23 ± 5)°C.
Performance criteria: (Note b8)	Visual appearance; Static: Change in attenuation (change in insertion loss) − residual loss; Dynamic: Transient loss.

B.2.7 Change of temperature (OS)

International standard:	[IEC 61300-2-22]
Conditions:	Lowest/highest temperature: (−30/+60 ± 2)°C; Humidity: uncontrolled (Note b7); Dwell time: 4 h; Transition: 1°C /minute; Number of cycles: 12.
Performance criteria: (Note b8)	Visual appearance; Static/dynamic: Change in attenuation (change in insertion loss) - excursion loss and residual loss.

B.2.8 Change of temperature (OA and OG)

International standard:	[IEC 61300-2-22]
Conditions:	Lowest/highest temperature: (−40/+65 ± 2)°C; Humidity: uncontrolled (Note b7); Dwell time: 4 h; Transition: 1°C /minute; Number of cycles: 12.
Performance criteria: (Note b8)	Visual appearance; Static/dynamic: Change in attenuation (change in insertion loss) −excursion loss and residual loss.

Appendix I

Product characterization checklist

(This appendix does not form an integral part of this Recommendation.)

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 L.200]. It may be useful for preparation of the products' test programme as well as product description for tenders and purchasing specifications, the comparison of different or competitive products and the 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 clause 7.1 in [ITU-T L.200])

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

Optical functionality & compatibility (see clause 6 in [ITU-T L.200])

– ***Optical stability level****:*

- ☐ Static
- ☐ Dynamic (transient-free)

– ***Wavelength*** (see clause 6.3 in [ITU-T L.200])

- ☐ 1 310 nm
- ☐ 1 550 nm
- ☐ 1 625 nm
- ☐ Other: …….....

– ***Cable construction*** (see clause 6.1.1 in [ITU-T L.200])

- ☐ Loose buffer tube
- ☐ Microsheath
- ☐ 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 clause 6.1.2 in [ITU-T L.200])

☐ Multimode
☐ Single mode

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

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

– ***Passive devices*** (see clause 6.1.3 in [ITU-T L.200]):

☐ 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 clause 6.2.2 in [ITU-T L.200])

	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 clause 7.2 in [ITU-T L.200])

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

– ***Additional (conditional) requirements*** (see Appendix III in [ITU-T L.200]):

- ☐ Bullet 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

(This appendix does not form an integral part of this Recommendation.)

II.1 Introduction

This appendix represents the experience of Ukraine in closure performance tests for the Ukrainian conformity assessment system according to national regulations

II.2 Dimension and optical characteristics

II.2.1 Visual inspection

International standard: [b-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 with 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: $\lambda = 1\,550 \pm 30$ nm; $\lambda = 1\,310 \pm 30$ nm;
Multimode: $\lambda = 1\,300 \pm 30$ 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; [b-IEC 60068-2-14] Test Nb.

Conditions: Lowest temperature: −40 ± 2°C;
Highest temperature: +60 ± 2°C;
Dwell time: 2.5 h;
Transition time: 1 h;
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: [b-IEC 61300-2-18]; [b-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: [b-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: pH 2 solution of hydrochloric acid, pH 12 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: [b-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: [b-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 h;
Dwell time on the highest temperature: 5 h;
Thaw time: 1 h;
Freeze time: 0.5 h;
Middle temperature during 1 h: 0 °C;

Next freeze time: 0.5 h;
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 = 1 550 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: [b-IEC 60068-2-17]; IEC 61300-2-5.

Conditions: Test temperature: 23 ± 3°C;
Pressure: 40 ± 2 kPa;
Load: 50 N × m or 90° 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°;
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: 1 000 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:	[b-ISO 4892-3].
Conditions:	Temperature: UV at 60°C during 4 h and dark at 50°C during 4 h; Test time: 1 000 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 reclose over 1 month in real field conditions.
Acceptance criteria:	Tightness.

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