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

Passive node elements for fibre optic networks – General principles and definitions for characterization and performance evaluation

ITU-T Recommendation L.51

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Summary

This Recommendation contains the general principles for generating performance requirements for passive optical nodes. It describes the product and performance parameters necessary to characterize a nodes' capabilities and features. It also summarizes the general requirements that are applicable for all types of passive nodes throughout the entire optical network.

The annex contains a description of the applicable environmental classes, while the appendices contain a description of optical test sample construction, test methods for simulating an intervention at a node and a checklist for facilitating the definition of nodes in optical access networks.

Source

ITU-T Recommendation L.51 was approved by ITU-T Study Group 6 (2001-2004) under the ITU-T Recommendation A.8 procedure on 11 April 2003.

FOREWORD

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Introduction

The quality of an optical network will be determined by the performance of each of its individual components. Nodes in this network are one of the key building blocks of the physical network.

A node occurs at each opening or end of a cable jacket. Examples of nodes are optical distribution frames, joint closures for underground and aerial applications, street cabinets etc. Each node shall be capable of performing its expected function in the network, while exposed to the environment that it is intended to reside in. In order to obtain an end-to-end reliable optical network, it is, therefore, necessary to apply a consistent evaluation methodology for all the different types of nodes.

This Recommendation defines the fundamental parameters that are relevant to describe passive optical node products in a systematically way and it is recommended to be used as a basis for generating performance requirements for passive optical nodes. An additional checklist, reflecting the parameters as defined in this Recommendation, in order to facilitate the characterization of a product and to compile the proper set of performance tests, can be created (see Appendix IV).

ITU-T Recommendation L.51

Passive node elements for fibre optic networks – General principles and definitions for characterization and performance evaluation

1 Scope

This Recommendation applies to passive nodes for optical networks. It contains the general principles, definitions and requirements to generate consistent performance requirements for each different class of node products.

Annex A and Appendices I to III describe a number of topics applicable to all types of optical nodes: environmental classes, optical test sample layout, simulation methods to evaluate optical stability and a list of additional requirements.

Appendix IV contains a summary checklist of the recommended features and functionalities for passive nodes in the optical network.

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 cable*.

– 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*.

– 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 of changes in attenuation and in return loss (multiple paths)*.

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

3 Terms and definitions

This Recommendation defines the following terms:

3.1 node: A node is defined as a point of intervention in the network e.g., at each opening or at the end of a cable jacket.

"Passive" applies to nodes that do not contain active electronics or other devices that dissipate heat.

"Live" applies to a fibre, an optical circuit or a node at the moment that it carries an optical signal.

3.2 handling versus Access: "Handling" means moving a product between its installed location and the workstand. It also includes the manipulation of the attached cables, the addition of cables, opening or closing covers, drawers or doors.

"Access" includes removing cable sheath; manipulation of uncut/looped fibre; manipulation of elements of the organizer system; manipulation of splices, devices and fibre slack, cutting, cleaving and splicing. These manipulations may become very difficult or impossible at extreme temperatures.

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.

3.4 break out device: The term "break out device" applies to the means that are often used to separate or regroup fibres at the end of the cable sheath entering a node.

4 Abbreviations and Acronyms

This Recommendation uses the following abbreviations:

DWDM	Dense Wavelength Division Multiplexing
FO	Fibre Optics
ME	Multiple element storage of fibres (more than 12 fibres stored together on the same storage device) This is also known as "Mass storage"
MSDS	Material Safety Data Sheet
OAN	Optical Access Network
ODF	Optical Distribution Frame
OSP	Outside plant
OTDR	Optical Time Domain Reflectometer
SC	Single Circuit
SE	Single Element
SF	Single Fibre
SR	Single Ribbon
UV	Ultra Violet
WDM	Wavelength Division Multiplexing

5 Performance recommendations for passive optical nodes: general principles

In order to achieve a complete and yet maintainable set of performance recommendations, following principles are to be applied:

5.1 Optical functionality and environmental stability

A network node shall be able to fulfil its function, including reconfigurability, in the network.

This functionality shall be guaranteed in all conditions of the environment, in which the node will reside.

5.2 Consistency for all node types throughout the entire network

The performance or stability of a network is determined by its individual components. In order to obtain an end-to-end reliable network, all different network nodes shall be evaluated using the same methods and metrics.

5.3 Ability to fit all different types of applications

Since it is not practical to generate an individual recommendation for each specific application, the performance recommendation will be conceived as a flexible tool that allows the generation of complete performance requirements for each specific node product, as a function of its functional features. This Recommendation defines the elements by which a product shall be characterized.

Product characterization may be facilitated by a checklist, reflecting all these elements

5.4 Global applicability of the basic environmental classification, with an option to adjust to specific local conditions

For passive optical nodes, five basic environmental classes are defined, thus providing a minimum level of specification. (see Table 1)

Whenever a basic environmental class is not sufficient to describe a specific local condition, additional requirements and/or more extreme environmental test conditions may be agreed between customer and supplier.

Therefore, the performance recommendation shall be a minimum basic specification, to which each node product has to comply.

6 Parameters concerning functionality of an optical node

The test program for an optical node, shall evaluate all of its functions and features. This clause lists the parameters necessary to characterize the optical functionality of a node.

6.1 Node content and interfaces/compatibility

A node may be capable of accommodating different types of cables, fibres and passive devices. These shall be listed and the applicable dimensional limitations shall be defined. All the elements listed shall be present in the test program.

6.1.1 Cable construction

Cable termination and "break out devices" may be different for each different cable type.

Compatibility with different types and dimensions of cables shall be stated by the supplier. Each applicable cable type within minimum to maximum cable dimensions shall be represented in the test program.

6.1.2 Fibre type, fibre coating and ribbon count

For testing purposes, it is recommended to use matched cladding fibre according to ITU-T Rec. G.652 (non-dispersion shifted), or another fibre type as agreed between customer and supplier. Compatibility with different types and designs of fibres shall be stated by the supplier. Each applicable fibre type shall be represented in the test program.

In addition to fibre type, other important fibre-related variants are:

a) *Coating style*
   - Primary Coated (250 µm);
   - Secondary Coated (900 µm) (specify tight/semi-tight);
   - Pigtails/patchcord (specify minimum/maximum diameter);
   - Ribbon coating style.

b) *Ribbon count*
   - 2, 4, 6, 8, 12, 24, other: fibres per ribbon.

Node suppliers shall indicate which variants are supported and supply test data for each.

NOTE – Macrobending sensitivity varies with fibre designs and types. For specific fibre designs and types additional testing should be considered.

6.1.3 Passive optical devices

The passive optical node shall be able to properly store and protect all compatible passive devices without altering their performance characteristics. Examples of passive devices are:

a) Splices and splice protectors;

b) Optical connectors;

c) Other Optical components.

It is recommended that passive optical components, other than connectors or splices, be factory-installed on a prefibred module or tray that is compatible with the rest of the organizer system. Hence, only the inputs and outputs are to be connected to the fibres at the node.

The types of devices that can be stored, either brand and type or dimensional limitations (e.g., minimum and maximum length, diameter, etc.), shall be listed and represented in the test program.

Any effects that are due to the properties of the optical devices themselves, are outside the evaluation of the organizer system itself.

6.1.4 Fibre overlength and uncut fibre

The occurrence of overlength is often inherent to the use of optical fibres.

The fibre organizer system of a node shall provide features and methods to store this fibre overlength in a reliable and consistent way. Fibre overlength is related to:

a) *Splices*

The fibre overlength is typically to be stored on the same organizer element as the splices.

It will permit the removal of the splice to the splicing equipment or tools and back to the splice holder.

The length should be such that it allows at least 3 resplices. If reconfiguration is necessary, the overlength should be sufficient to allow rerouting and storage of a splice in any other splice position in the organizer system.

b) *Uncut fibre at initial installation*

The unused fibres remaining after opening the cable shall not be cut, but shall be stored together or separately. These fibres may be branched at some future time. Therefore, the overlength of the uncut fibres shall be sufficient to meet the splicing requirements of the above paragraph a).

c) *Patchcords and pigtails*

Optical connectors are used at nodes where frequent reconfiguration is expected. Connectors may need to be rerouted to different positions with the same pigtail length. The length of pigtails and patchcords should be such that they can reach all required positions within the organizer system. The organizer system shall provide the means to manage the related overlength in an orderly manner (i.e., controlled bend radius, accessibility).

d) *Unspliced fibre ends*

At some nodes non-live fibre ends need to be stored.

Depending on the future destination, they may be stored in mass, by element, or individually. This can be done in a storage basket, a dedicated storage area for unspliced fibre, or on splice trays.

6.2 Network adaptability

Optical nodes, that are intended as network flexibility points, shall be re-entrable and adaptable or expansible.

The circuits that remain live during such an intervention shall not be disturbed. The test program shall reflect these capabilities.

6.2.1 Optical stability

Two types of optical stability are defined:

a) *Static optical stability*

The static optical stability of a live node at rest can be evaluated by measuring the difference in attenuation of the circuits before and after an exposure (= Residual loss). It includes monitoring (at regular time intervals) during slow variations of environmental parameters (= excursion loss).

b) *Dynamic optical stability*

Dynamic optical stability reflects the behaviour of the optical circuits during an intervention at a node of which at least some of the fibres remain live. It will measure sudden variations (= transient losses) in a circuits' attenuation level during:

i) manipulation of the entire node and its organizer system;

ii) access to adjacent circuits stored in the same network node;

iii) sudden effects induced by the external environment (e.g., vibration, shock).

Recommended limits for transient loss evaluation according to IEC 61300-3-28 are:

$\Delta IL \leq 0.5$ dB (1310/1550 nm) during the test measured in the live circuit (transient loss)

$\Delta IL \leq 1.0$ dB (1625 nm) during the test measured in the live circuit (transient loss).

For optical nodes that are intended to be re-accessible while the network remains live, it is recommended to evaluate for dynamic optical stability.

6.2.2 Circuit separation

Optical circuits can be physically separated in order to eliminate the risk of inducing transient losses in circuits that do not belong to the same group as the ones that are to be manipulated. The following levels are defined, ranked from the highest to the lowest degree of separation:

a) *Single fibre (SF)*

Fibres and connections can be stored individually. It is possible to handle one individual fibre or connection, without the need to touch or disturb any other fibre in the node.

b) *Single circuit (SC)*

If an optical circuit consists of more than one fibre (e.g., send and receive on two separate fibres) all fibres of the same circuit may be grouped. It will still allow access to an individual fibre circuit without affecting any other circuit in the node.

c) *Single ribbon (SR)*

Individual fibre ribbon storage. During access, all circuits within that same ribbon could be disturbed.

d) *Single element (SE)*

A single element is a group of fibres (excluding ribbonised fibres) as they are combined within the cable. e.g., all the fibres in a same loose buffer tube, all the fibres in the same slot of a slotted core cable. Generally the term single element is typically up to a maximum of twelve fibres.

Fibre separation in larger groups is considered as mass storage.

e) *Multiple element storage (ME or Mass)*

The term multiple element or mass storage applies when more than twelve individual fibres or multiple ribbons are stored together on the same storage device.

The circuit separation levels can be applied to the storage of:

– splices and overlength;
– uncut fibres (loops);
– fibre ends coming from optical devices.

The level of circuit separation will have an impact on the organizer size and complexity. In reality, it is often not necessary to separate all fibres individually or by circuit. It may be sufficient to reserve a limited number of splices or uncut fibres for future access. This will optimize the balance between space usage, first installed cost and network adaptability. For this purpose, the organizer system should allow a flexible mix of fibre separation levels in the same node. A modular organizer design is therefore recommended.

Node suppliers shall indicate which separation levels can be supported and supply test data for each.

6.3 Wavelength

With an increasing need for bandwidth, there is a tendency also to utilize longer wavelengths of light. Therefore, the ability to carry longer wavelengths also relates to the network adaptability and future versatility.

The behaviour of an optical circuit will vary, depending upon the wavelength carried. The sensitivity for losses, due to mechanical stresses or bending in the fibre, increases with longer wavelengths.

This implies that the ability of the network to carry longer wavelengths will depend on the quality of the optical organizer at the nodes. It also means that a product may be considered suitable for all shorter wavelengths, if they have passed the optical evaluation at a longer wavelength (see Note).

NOTE – This is not valid for the evaluation of optical devices, splices and connectors themselves.

7 Environmental conditions for passive optical nodes

In addition to the node's optical functionality in the network, performance requirements and test severity shall also reflect the environmental conditions to which a product is exposed during its lifecycle. A more detailed description of environmental classes can be found in Annex A.

7.1 Installed product

Once installed, optical nodes typically may reside in one of the following basic environments:

Table 1/L.51 – Application environments

Indoor	temperature controlled	IC
	non-temperature controlled	IN
Outdoor	above ground	OA
	at ground level	OG
	under ground (sub-terrain)	OS

The conditions for testing within these environments vary throughout the world.

Typical values, applicable to passive optical nodes, can be found in Annex A.

When a node is exposed to conditions that are more extreme than those defined in these five basic environmental classes, this is to be classified as an "**extreme**" environment (**E**). The differences to the closest basic environmental class shall be specified in the product specification. The severity of the affected tests is to be adjusted accordingly.

7.2 Transport and storage

Prior to installation, and while contained in the original packaging, exposure to the following conditions should not induce damage that will affect the products' functionality:

– storage in indoor, non-temperature controlled locations, e.g., storage in unheated indoor warehouses;

– transport and handling by commercial transport, transport by car, truck, plane, train or boat.

NOTE 1 – Special storage or transport conditions (e.g., outdoor storage) are to be agreed between supplier and customer.

NOTE 2 – Special handling precautions are to be clearly marked on the packaging.

7.3 Installation or intervention

The minimum and maximum temperatures at which an optical node may be installed or re-entered, are not necessarily equal to the maximum temperature excursion of the environment in which it will reside, once installed.

Passive optical nodes should be installable, at least, in the following temperature ranges:

– **handling** of outdoor fibre nodes: between –15 and +45 °C;

– **handling** of indoor fibre nodes: between +5 and +45 °C;

– **accessing** the fibres and the organizer on the other hand is typically done in a more controlled environment.

The installation conditions are to be reflected in the test program by installing the test samples and executing handling tests at the extreme applicable temperatures.

8 General requirements

Each passive fibre node product shall comply to the following general requirements:

8.1 Storage, transport and packaging

– The product, in its original packaging, shall be suitable for normal public or commercial transportation and storage in non-temperature controlled indoor warehouses.

– The components of the kits shall be free of defects that would affect product performance.

– Each product shall be identified to include the following information:

  - supplier's name;
  - product designation, model or type;
  - lot number, batch number, date (at least month and year) of production or serial number;
  - expiry date if the product contains components with a limited shelf life.

8.2 Materials

– All materials that will come in contact with personnel shall meet appropriate health and safety regulations;

– For all materials used, a Material Safety Data Sheet (MSDS) shall be available upon request;

– The effect UV light and fungi on all exposed polymeric materials, shall not affect product performance;
– All metallic parts shall be sufficiently resistant to the corrosive influences they may encounter in normal conditions of the designated environment(s);
– All components shall be resistant to solvents and degreasing agents as recommended in the installation instructions.

Annex A

Environmental classification

For passive optical nodes, a set of five basic different environmental classes covers the majority of the applications around the globe. This annex describes these environmental classes in some more detail.

A.1 Basic environmental classes

IC: Indoor temperature controlled

– inside buildings protected by a roof and walls all around, heating or air-conditioning available;
– contact with chemical and biological contaminants is negligible, e.g., inside central offices, some remote network buildings/houses, residential buildings.

IN: Indoor non-temperature controlled

– inside buildings protected by a roof and walls all around, no heating or air-conditioning available;
– contact with chemical and biological contaminants is negligible, e.g., cable vaults, basements, remote network buildings/houses, inside garages, warehouses, homes.

OA: Outdoor above ground

– all outdoor non-sheltered locations, above ground level;
– no other sources of heat or extreme temperatures than the surrounding air or solar radiation;
– exposed to contaminants and dust that may occur in the atmosphere in rural, city or industrial areas, e.g., wall mounted, pole mounted, strand mounted nodes.

OG: Outdoor ground level

– outdoor, standing on the ground, perhaps with a base that resides partially below the ground; this class may also apply to outdoor wall mounted products which are close to ground level;
– exposed to contaminants and dust that may occur in the atmosphere in rural, city or industrial areas.

The base of the product may be permanently in contact with soil, biological and chemical contaminants that occur at or just below ground or street-level, e.g., along roads, pavements and railroads.

OS: Outdoor underground (sub-terrain)

– outdoor below ground level;

– exposed to soil or water-borne contaminants, including organic and inorganic agents related to the presence of roads and traffic, e.g., in manholes, handholes or direct buried.

A.2 Special conditions

Extreme

- any environment for which at least one of the environmental parameters exceeds the boundaries of the five basic environmental classes as specified above: e.g., more extreme temperature excursions;
- exact test settings are to be agreed between supplier and customer.

Additional requirements

- In specific cases, extra constraints may be required on top of the conditions of one of the basic environmental classes (e.g., bullet resistance, accidental flooding, etc.). This is not included under the term "extreme" conditions. For these occasions, additional requirements or tests can be added on top of the test program of the basic environmental class.
- See also Appendix III for information on potential additional requirements.

Table A.1/L.51 – Summary of typical parameters for the basic environmental classes

	Indoor		**Outdoor**		
	IC	**IN**	**OA**	**OG**	**OS**
Exposure ↓	**Temp controlled**	**Temp non-controlled**	**Above ground**	**Ground level**	**Underground**
Temp Min (°C)	+5	–10	–40	–40	–30
Temp Max (°C)	+40	+60	+65	+65	+60
Solar Radiation	No		Yes	Yes	No
Relative Humidity (max) (%)	**93%** (decreasing once above 30° C)		**100%** (occasional/permanent exposure to water possible)		
Precipitation	No		Rain, Snow, etc.	Rain, Snow, etc.	N.A.
Submersion	No (Note 2)		No	No (Note 2)	Yes
Vibration (m/s^2)	10-55 Hz 1 m/s^2 (~0.1 g) (whole system) 5 m/s^2 (~0.5 g) (components)		5-500 Hz 10 m/s^2 (~1 g) (due to e.g., traffic, wind, etc.)		
Chemical	Negligible (Note 1)		Atmospheric	Atmospheric + Soil (base only)	Soil/waterborne
Biological	Negligible		Atmospheric	Atmospheric + Soil (base only)	Soil/waterborne

NOTE 1 – In areas where corrosive atmospheres can be expected (marine and coastal areas, industrial areas, urban pollution), increased corrosion protection may be requested as an additional requirement.

NOTE 2 – If accidental flooding may occur, e.g., in vaults or basements, this is to be added as a conditional requirement. This will also correspond to a higher IP rating according to IEC 60529.

Appendix I

Construction of optical test samples

Each optical sample will contain one or more optical circuits. For each variant of cable construction and ribbon count, a separate optical circuit or sample is to be built and tested. This appendix describes the generic layout of optical samples, which is applicable for all types of passive optical nodes.

I.1 Single fibre splice/connector storage

Rationale

This sample set-up represents a node element containing single fibre splices or connectors. Cables or pigtails will be terminated as required by the installation instructions.

It allows the evaluation of the entire organizer system, including effects at the cable termination and fibre break out.

Description

The sample is prepared as shown in Figure I.1.

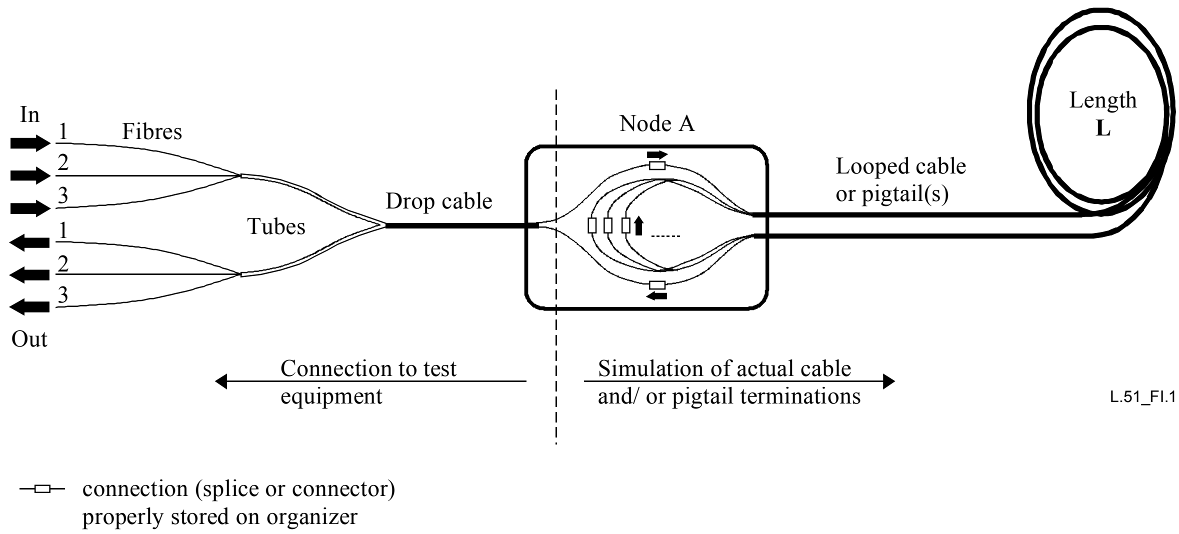

Figure I.1/L.51 – Storage of single fibre splices or connectors

Both extremities of a looped cable (or pigtails if applicable for the product) are terminated at the node. The length L of the looped cable or pigtails should be chosen in such a way that it is longer than the "dead zone" of an OTDR. This will allow the location off the potential causes of optical losses and differentiate if a change in signal is induced by the organizer system or by an optical component. The required length depends on the selected pulse width and dynamic range of the OTDR. Typically, a length of 10 to 25 m outside the node is applied for this purpose. If later in the test cycle, a second node is to be installed (see clause I.2) , this length should be at least double, plus the required length for the window cut.

In the node, the fibres of one cable extremity are connected to the fibres of the other cable extremity in such a way that light will sequentially flow 10 times through the selected fibres in the loop. (e.g., connect 1 to 2, 2 to 3, ..., 8 to 9). The first and last fibre of this series will be connected to the "in" and "out" of the test equipment.

Connections shall be made using good-quality fusion splices or connectors. The connections shall be stored on the organizer as described in the installation instructions. All relevant fibre separation levels (e.g., SC, SE, MASS) are to be represented in the sample (preferably in separate circuits).

The fibres of a drop cable are spliced to the above mentioned circuit to make external connections to a light source and an optical power meter. If the node is designed to have pigtail entries or exits, pigtails can be applied as the drop to the test equipment. This can be useful for the optical evaluation of the pigtail termination hardware.

All circuits of the test sample are connected to the test equipment as described in IEC 61300-3-3 The equipment should not be disconnected during the execution of a test.

I.2 Storage of uncut fibres; addition of a drop cable

Rationale

This sample set-up represents a node element containing uncut (express) fibres. This test set-up allows to examine of the effect of removing the cable jacket, inserting and storing the uncut fibre in the enclosure of the node. It also simulates the effect of adding a drop cable on the live circuits.

Description

Prepare a sample as shown in Figure I.1. Choose the length L (e.g., 25 to 50 m) so that L' remains long enough for OTDR testing.

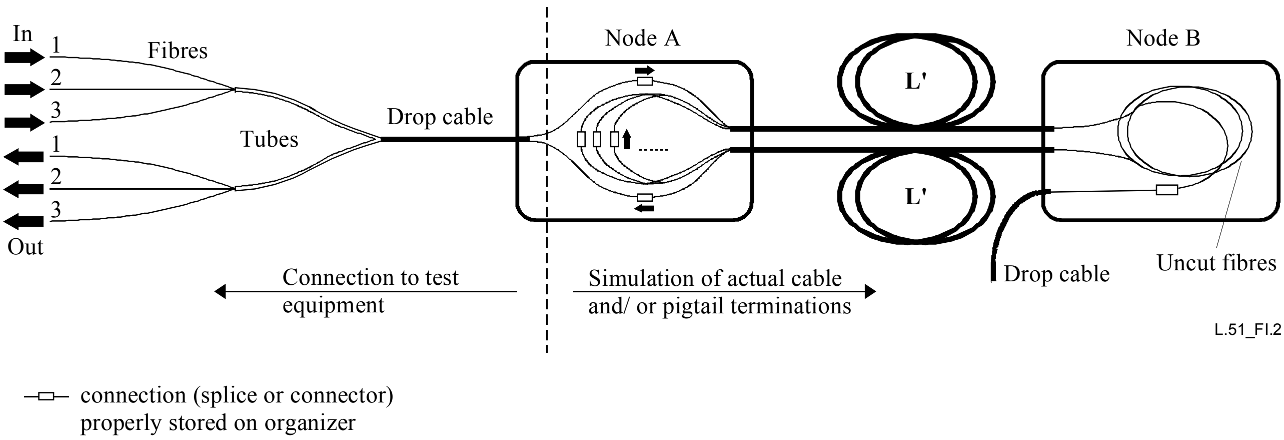

Figure I.2/L.51 – Storage of uncut single fibre loops

In the middle of the looped cable, the jacket will be removed over a distance as described in the installation instructions (= window cut). Then the bundle of uncut fibres will be inserted and stored inside node B (see Figure I.2).

If uncut fibre can be stored in different separation levels (e.g., mass, SE, SC/SF), each of these options is to be executed preferably as a separate circuit. For mass storage, one complete cable element will be made live amongst the non-live fibre loops. For the storage of uncut fibres by single elements or single circuits/fibres, it may be necessary to remove the tube that contains the fibre without cutting or damaging the fibre (e.g., by "shaving").

Finally a non-live drop cable will be installed at node B. The fibres of the drop cable are to be stored on the organizer system. In case of SC/SF or SE storage of uncut fibre, they are to be mixed randomly between the uncut fibres.

I.3 Ribbon splice/connector storage

Rationale

This test set up is similar to clause I.1 except for the fact that it applies to ribbonised fibres instead of single fibres.

Description

The sample is prepared according to Figure I.3.

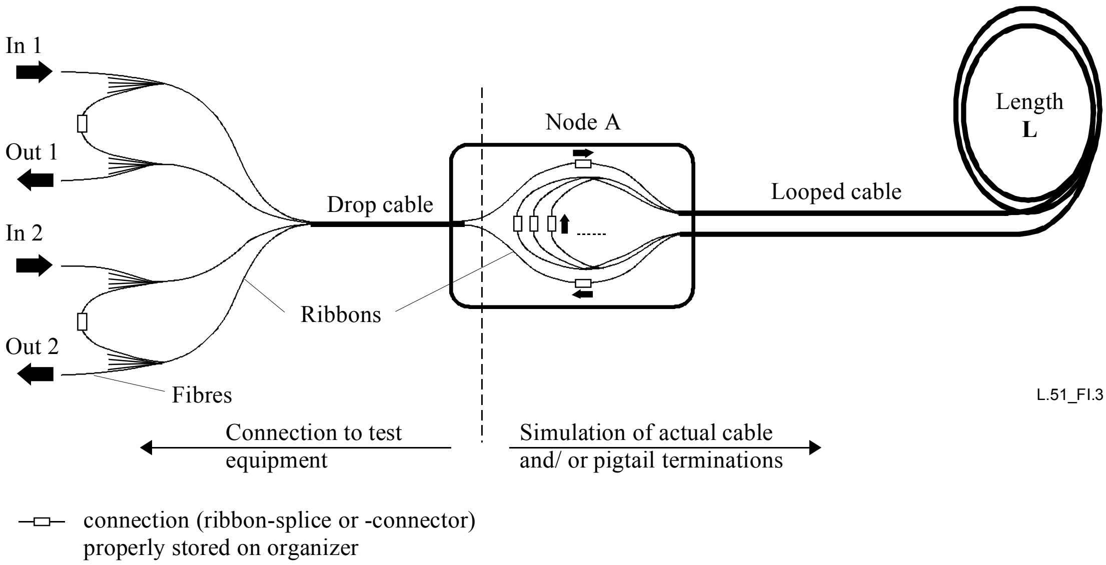

Figure I.3/L.51 – Storage of ribbon splices or connectors

Both extremities of a looped ribbon cable (or ribbon pigtails if applicable for the product) are terminated at the node. The length L of the looped cable or pigtails is to be chosen as described in clause I.1.

In the node, the ribbons are spliced to the ribbons at the other cable end in such a way that light will sequentially flow through four ribbons. Connections shall be made using good-quality fusion splices or connectors. The connections shall be stored on the organizer as described in the installation instructions. All relevant fibre separation levels (e.g., SR, MASS) are to be represented in the sample (preferably in separate circuits). The fibres of a drop cable are spliced to the above-mentioned circuit to make external connections to a light source and an optical power meter. For this purpose, any suitable type of cable or pigtails may be used since the termination of the drop to the test equipment is not the subject of the evaluation test.

Only the outer fibres of a ribbon are to be made live since they have the highest exposure to external loads and deformations (e.g., for a 12-fibre ribbon , fibres 1 and 12 of the ribbon will be live). For each circuit, these fibres are interconnected at the equipment side. This is done in such a way that the optical signal flows sequentially through the four ribbons of the circuit (the signal will also pass through a series of 10 splices as in clause I.1).

All circuits of the test sample are connected to the test equipment as described in IEC 61300-3-3. The equipment should not be disconnected during the execution of a test.

I.4 Storage of uncut ribbons; addition of a drop cable

Rationale

This test set up is similar to clause I.2 except for the fact that it applies to ribbonised fibre instead of single fibres.

Description

Prepare a sample as shown in Figure I.3. Choose the length L so that L' remains long enough for OTDR testing (e.g., 25 to 50 m).

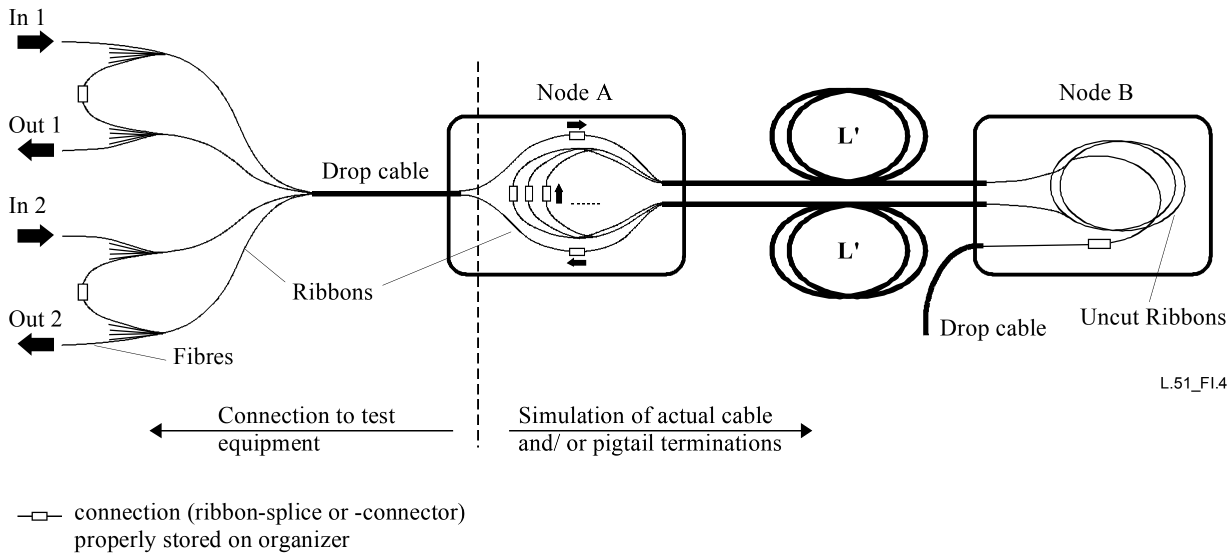

Figure I.4/L.51 – Storage of uncut ribbon loops

In the middle of the looped cable, the jacket will be removed over a distance as described in the installation instructions (= window cut). After that, the bundle of uncut ribbons will be inserted and stored inside node B.

If uncut ribbon can be stored in different separation levels (e.g., mass, SR), each of the options is to be executed as a separate circuit. For mass storage, one complete cable element will be made live amongst the non-live ribbon loops. For the storage of single uncut ribbons, it may be necessary to remove the tube that contains the ribbons without cutting or damaging the fibres (e.g., by "shaving").

Finally, a non-live drop cable will be installed at node B. The ribbons of the drop cable are to be stored on the organizer system. In case of SR storage of uncut fibre, they are to be mixed randomly between the uncut ribbons.

Appendix II

Intervention at a live node: test methods

When installed in the network, a node may be subjected to a number of manipulations related to interventions for network maintenance. This appendix describes how to simulate the effect of these manipulations for the evaluation of the optical stability of a node:

Node and cable handling

- removing a node from its installed location to an appropriate working location;
- handling of a cable that is attached to a node.

Re-entry/access after initial installation

- opening and closing of drawers and doors, or removing and reinstalling the cover of an enclosure;
- gaining access to previously installed fibres in an organizer system.

Adding cables

- termination and connection of additional cables;
- routing the fibres to the required position and connecting them.

Internal reconfiguration of connections and fibres

- break a splice and connect to another fibre end;
- disconnect a connector and mate with another connector;
- cut one or more uncut fibres and connect to another fibre end;
- adding organizer elements/devices and connecting the fibres.

Unless specified otherwise, these tests should be executed at room temperature.

Samples will be evaluated:

– Visually: No defects that would affect the functionality of the product are allowed.

– Optically:
  - Static: residual loss, excursion loss;
  - Dynamic: transient loss, residual loss.

II.1 Opening and closing covers or drawers to gain access to the organizer system

Applicable for: products that generate relative movements of the fibres or the organizer system during opening or closing.

Sample construction: Prepare a representative optical sample according to clauses I.1 or I.3.

Description: Remove the cover or open the drawer up to its ultimate position, close again.

Severity Parameter: Number of cycles.

II.2 Movements of organizer elements to gain access to the actual fibre circuits

Applicable for: products that generate relative movements of the organizer elements while gaining access to the fibres and connections (e.g., hinging, pivoting, sliding, removal of trays, baskets, or other organizer components).

Sample construction: Prepare a representative optical sample according to clauses I.1 or I.3.

Description: Move the organizer element between its 2 extreme positions.

Severity Parameter: Number of cycles.

II.3 Addition and connection of extra cables

Applicable for: products that can accept extra cables or pigtails after initial installation.

Sample construction: Prepare a representative optical sample according to clauses I.1 or I.3.

Description: Prepare a suitable cable or pigtail.

Insert the cable and terminate it at the node according to the installation instructions.

Route the fibres and store on the organizer elements, adjacent to those that contain the live fibres or ribbons.

The drop cable itself should not be connected to the live circuits.

II.4 Rearranging connections (splices)

Applicable for: products that can accept extra cables or pigtails after initial installation.

Sample construction: Prepare a representative optical sample according to clauses I.1 or I.3.

Make a mix of organizer elements (e.g., trays, cassettes) containing live circuits next to organizer elements containing non-live fibres and connections.

Description: Select an organizer element with a non-live connection.

Break the splice and remove 1 fibre end from the organizer.

Reroute the fibre (or ribbon) to another non-live organizer element and connect again.

Repeat this test for each applicable variant (fibre grouping, fibre coating, fibre separation level, etc.).

II.5 Rearranging connectors, jumpers or pigtails

Applicable for: products that can contain connectors, pigtails or jumpers.

Sample construction: Prepare a representative optical sample according to clauses I.1 or I.3.

Description: Select a non-live connector.

Demate the connector.

Reroute the pigtail or jumper to another position at the node (on the same, or if possible, to another organizer element).

Mate with the non-live connector at the other position.

Repeat this test for each variant (within the same organizer element, to another organizer element, etc.).

Repeat for all different connector types that require a different manipulation for mating/demating.

II.6 Addition and connection of extra organizer elements

Applicable for: products that can receive extra organizer elements after initial installation (e.g., extra organizer trays or cassettes, modules containing multiple trays, prepackaged passive devices, etc.).

This test may typically be combined with the manipulations of clauses II.2, II.3 and II.4.

Sample construction: Prepare a representative optical sample according to clauses I.1 or I.3.

Ensure that there is space left to install extra organizer elements.

Description: Add an organizer element as described in the installation instructions.

Repeat this test for each type of organizer element that can be added.

II.7 Installing a node product over a piece of uncut cable slack

Applicable for: products that can contain uncut fibre loops (stored all together or separated onto different organizer elements (SE- SF- SR- SC).

Sample construction: Prepare a representative optical sample according to clauses I.1 or I.3.

Description: Remove the cable sheath of the looped cable.

Insert the uncut fibre into node B as per clauses I.2 or I.4.

Roll up the cable loops and store according to the installation instruction.

If uncut, fibre can be stored by element or as individual circuits, fibres or ribbons;

Select a non-live uncut fibre element (e.g., a loose tube).

If necessary, remove tubes or other features that keep the fibres grouped, without breaking the fibres.

Store the uncut fibres or ribbons by element, circuit or individually on the proper organizer elements. Repeat this test for each applicable cable construction type.

II.8 Unrolling, cutting and restorage of uncut fibre

Applicable for: products that contain uncut fibre loops that are intended to be accessible after initial installation.

Sample construction: Continue with the sample as installed in clause II.7.

Description: Remove the uncut fibre from its stored position.

Cut one non-live cable element and store the fibres on the organizer.

Store the remaining uncut fibre loops again in their proper position.

If uncut, fibre can be stored by element or as individual circuits, fibres or ribbons.

Select a non-live uncut fibre.

Cut it in the middle.

Connect the fibre end to another fibre end (on the same or another organizer element as applicable for the design). Repeat this test for each applicable variant (fibre grouping, fibre coating, fibre separation level, cable construction, etc.).

Appendix III

Additional requirements

Additional (conditional) requirements

Additional requirements (also referred to as "conditional requirements") relate to specific local conditions or practices.

This appendix contains a non-exclusive list of potential additional requirements. References to the applicable test methods are not included since they are often subject to regional standards. When claiming conformance to one the conditional requirements, the standard according to which the product has been approved, shall be clearly mentioned.

– Marine/corrosive indoor environments;
– Accidental flooding above ground;
– Bullet/shotgun proof;
– Earthquake resistance;
– Freeze-thaw resistance;

– Fire-related performance:
  - Fire retardancy;
  - Halogen free;
  - Low smoke emission;
– Electrical grounding and shield continuity:
  - Current surge;
  - Insulation resistance;
– Rodent resistance;
– Termite resistance;
– Steam resistance;
– Cable blocking.

Appendix IV

Product characterization checklist

This checklist facilitates the systematic characterization of the features and capabilities of an optical node. It reflects the parameters that are described in this Recommendation. It may be useful for several purposes such as product description for tenders and purchasing specifications, comparison of different or competitive products, preparation of product test programs and the creation of commercial information and ordering guides.

Product type:
☐ Optical distribution frame(ODF),
☐ Wall mounted Box,
☐ Cabinet,
☐ Pedestal,
☐ Sealed Closure
☐ Other: ....

Application Environment(s) (see 7.1)

☐ IC Indoor temperature controlled
☐ IN Indoor non-temperature controlled
☐ OA Outdoor above ground
☐ OG Outdoor at ground level
☐ OS Outdoor under ground (sub-terrain)
☐ E Extreme (describe difference to one of the basic environmental classes)

Optical functionality & compatibility (see clause 6)

– ***optical stability level***

☐ Static
☐ Dynamic (transient free)

– ***wavelength*** (see 6.3)

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

– ***cable construction*** (see 6.1.1)

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

– ***fibre type, fibre grouping, fibre coating*** (see 6.1.2)

☐ multi mode
☐ single mode
☐ Single fibre
☐ Ribbon 4
☐ R 8
☐ R12
☐ R24
☐ other: ….......................
☐ Primary coated (~250 µm)
☐ secondary (~900 µm)

– ***passive devices*** (see 6.1.3)

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

☐ Splice protector type:

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

☐ Connectors:

☐ SC/PC	☐ SC/APC
☐ FC/PC	☐ FC/APC
☐ SC/PC-FC/PC	
☐ E2000	☐ E2000/HRL
☐ DIN/PC	☐ DIN/APC
☐ ST (multimode)	☐ ST (single mode)
☐ NPX	
☐ MTRJ	
☐ MU	
☐ LC	
☐ F3000	

☐ other: ....
(for mini connectors: specify simplex/duplex, brand/type)

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

☐ Other passive devices: (describe) ....
Delivered as Preassembled/prefibreed modules ☐ yes ☐ no

– ***fibre storage and separation level*** (see 6.2.2)

	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)

☐ normal: public transport – indoor storage
☐ special handling/transport: ....
☐ special storage: ....

– ***additional (conditional) requirements*** (see Appendix III):

☐ Marine/corrosive indoor environments according to: ....
☐ Accidental flooding above ground according to: ....
☐ 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: ....

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