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Fibre optic fusion splices for
single-mode optical fibre transmission systems;
Common requirements and conformance testing**

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Foreword

This Interim European Telecommunication Standard (I-ETS) has been produced by the Transmission and Multiplexing (TM) Technical Committee of the European Telecommunications Standards Institute (ETSI).

An ETSI standard may be given I-ETS status either because it is regarded as a provisional solution ahead of a more advanced standard, or because it is immature and requires a "trial period". The life of an I-ETS is limited to three years after which it can be converted into an ETS, have its life extended for a further two years, be replaced by a new version, or be withdrawn.

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1 Scope

This Interim European Telecommunication Standard (I-ETS) specifies requirements for fusion splices to be used in single mode optical fibre telecommunications land-based (not submarine) systems. The scope covers the establishment of minimum uniform requirements for the following aspects:

- optical, environmental and mechanical properties;
- test conditions;
- acceptance criteria.

The splices considered are between single fibres, between ribbon fibres and between ribbon and multiple single fibres. The optical fibres which are spliced are intended to conform to EN 188100 [4] and EN 188101 [5].

In order to obtain the required functional behaviour of the fusion splices, it is necessary to follow a number of procedures for fibre preparation, fibre alignment, jointing and protection as described in ITU-T Recommendation L.12 [6].

All the following requirements refer to protected splices measured in a laboratory. The I-ETS is intended to provide criteria for the assessment of splicing equipment and techniques, including the splice protector.

Some users may have additional specific requirements, such as the need to verify performance at lower temperatures. These users should specify splices conforming to the basic ETSI performance standard plus the additional tests or more severe test conditions.

2 Normative references

This I-ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this I-ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

- [1] ISO/IEC 61073-1 Second Edition 1994-07: "Splices for optical fibres and cables - Part 1: Generic specification - Hardware and accessories".
- [2] ETS 300 019: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".
- [3] IEC 68-2-30. "Damp Heat, cyclic (12 + 12 hour cycle)".
- [4] EN 188100: "Sectional Specification: Single-mode (SM) optical fibre".
- [5] EN 188101: "Family Specification: Single-mode dispersion unshifted (B1.1) optical fibre".
- [6] ITU-T Recommendation L.12 (1992): "Optical fibre joints".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this I-ETS the following definition applies:

fusion splice: Fusion spliced fibres protected by a splice protector with fibre tails of 1,5 metres on each side of the splice protector.

3.2 Abbreviations

For the purposes of this I-ETS, the following abbreviation applies:

OTDR Optical Time Domain Reflectometer

4 Tests

All tests called for by this specification shall be carried out in accordance with the prescribed IEC standard tests defined in ISO/IEC 61073-1 [1] and IEC 68-2-30 [3].

All optical tests shall be carried out in both the 1 310 nm window and the 1 550 nm window unless otherwise stated. Light sources with peak wavelengths of 1 310 nm \pm 30 nm and 1 550 nm \pm 30 nm shall be used.

In this I-ETS, a performance requirement stating that there shall be no change in attenuation shall be interpreted as a change of less than \pm 0,05 dB to allow for measurement uncertainties.

A length of 1,5 m on each side of the splice protector shall to be exposed to the test conditions of all optical, mechanical and environmental tests unless otherwise specified in the test details.

4.1 Visual inspection

In accordance with ISO/IEC 61073-1 [1], subclause 4.4.1.

Details:

The splice shall be examined for defects using a magnifying glass giving a magnification of between 3 and 8 times.

Requirements:

The fused region and the stripped fibre on each side of the fused region shall be fully enclosed within the splice protector. The splice protector shall be seen to be gripping the fibre coating at each end of the splice. The fibre shall emerge from the protector without any visible sign of bending or kinking. The splice protector shall show no sign of damage. Heat shrink splice protectors shall have no bulges since these would suggest that air had become trapped during the shrink down process.

4.2 Attenuation

In accordance with ISO/IEC 61073-1 [1] subclause 4.4.4, method 1 or method 2.2.

NOTE: Attenuation is referred to as "insertion loss" in ISO/IEC 61073-1 [1]. The two terms are interchangeable and "attenuation" is used throughout this I-ETS.

Details:

fibre lengths (L) (for method 1):	L > 4 m, L1 > 2 m, L2 > 2 m;
fibre lengths (L) (for method 2.2):	L1 > 1 km, L2 > 1 km.

Requirements:

The requirements specified in the following table apply to both the 1 310 nm and 1 550 nm windows.

Table 1

Category	Mean attenuation	Maximum attenuation
Single fibres:		
Class I	$\leq 0,10$ dB	$\leq 0,20$ dB
Class II	$\leq 0,20$ dB	$\leq 0,50$ dB
Ribbon and multiple fibres:		
Class III	$\leq 0,20$ dB	$\leq 0,80$ dB

4.3 Return loss

In accordance with ISO/IEC 61073-1 [1], subclause 4.4.5.

Requirements:

allowable return loss: > 60 dB.

Throughout all the environmental and climatic tests, the return loss shall be > 60 dB.

4.4 Vibration (sinusoidal)

In accordance with ISO/IEC 61073-1 [1], subclause 4.5.1.

Details:

frequency range:	10-55 Hz;
endurance duration per axis:	0,5 hour;
number of axes:	three orthogonal;
number of cycle (10-55-10 Hz):	15;
vibration amplitude:	0,75 mm.

Requirements:

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\ 550\ \text{nm} \pm 30\ \text{nm}$ before, during and after the test. The maximum sampling interval during the test shall be 2 ms.

4.5 Pulling (fibre retention)

In accordance with ISO/IEC 61073-1 [1], subclause 4.5.3.

Details:

magnitude and rate of application of the tensile load:	$5\ \text{N} \pm 0,5\ \text{N}$ at a speed of 0,5 N/s;
duration at the maximum load:	60 seconds;
point of application of load:	0,3 m from splice.

Requirements:

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\ 550\ \text{nm} \pm 30\ \text{nm}$ before, during and after the test. During the test the attenuation shall be measured at least once while the load is at the maximum level.

4.6 Cold

In accordance with ISO/IEC 61073-1 [1], subclause 4.5.11.

Details:

temperature:	-25°C;
duration of exposure:	16 hours;
pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	2 hours at normal ambient conditions.

Requirements:

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\ 550\ \text{nm} \pm 30\ \text{nm}$ before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 1 hour.

4.7 Dry heat

In accordance with ISO/IEC 61073-1 [1], subclause 4.5.12.

Details:

temperature:	+70°C;
duration of exposure:	96 hours;
pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	2 hours at normal ambient conditions.

Requirements:

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\ 550\ \text{nm} \pm 30\ \text{nm}$ before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 1 hour.

4.8 Damp heat (steady state)

In accordance with ISO/IEC 61073-1 [1], subclause 4.5.13.

Details:

temperature:	+40°C;
relative humidity:	93 % \pm 2 %;
duration of exposure:	96 hours;
pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	2 hours at normal ambient conditions.

Requirements:

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\ 550\ \text{nm} \pm 30\ \text{nm}$ before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 1 hour.

4.9 Damp heat (cyclic)

This test shall be carried out on splices which are to be used in weather protected environments corresponding to ETS 300 019 [2], classes 3.3, 3.4 or 3.5.

The test should therefore be carried out in accordance with IEC 68-2-30 [3]. Test cycle variant 1 is preferred but this cycle requires special test chambers and variant 2 is acceptable for qualification.

Details:

test cycle	variant 1 or 2;
high temperature:	+55°C;
low temperature:	+25°C;
duration of each cycle:	24 hours;
number of cycles:	6;
pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	16 hours at normal ambient conditions.

Requirements:

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\ 550\ \text{nm} \pm 30\ \text{nm}$ before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 1 hour.

4.10 Change of temperature

In accordance with ISO/IEC 61073-1 [1], subclause 4.5.16.

Details:

high temperature:	+70°C;
low temperature:	-25°C;
temperature rate of change:	1°C/minute;
duration at extreme temperatures:	1 hours;
number of cycles:	12;
pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	2 hours at normal ambient conditions.

Requirements:

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\ 550\ \text{nm} \pm 30\ \text{nm}$ before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 10 minutes.

4.11 Corrosive atmosphere (salt mist)

This test shall be carried out on splices which are to be used in weather protected environments corresponding to ETS 300 019 [2] classes 3.3, 3.4 or 3.5 or in non-weather protected environments corresponding to ETS 300 019 [2] class 4.1.

In accordance with ISO/IEC 61073-1 [1], subclause 4.5.17.

Details:

Atmosphere:	salt solution 5 % NaCl, pH 6,5 to 7,2;
Temperature:	+35°C;
Duration of test:	96 hours;
Pre-conditioning procedure:	2 hours at normal ambient conditions;
Recovery procedure:	2 hours at normal ambient conditions.

Requirements:

The attenuation shall be measured at $1\ 550\ \text{nm} \pm 30\ \text{nm}$ before and after the test at normal ambient conditions. On completion of the test there shall be no difference between the initial and final attenuation.

4.12 Industrial atmosphere

This test shall be carried out on splices which are to be used in weather protected environments corresponding to ETS 300 019 [2] classes 3.3, 3.4 or 3.5 or in non-weather protected environments corresponding to ETS 300 019 [2] class 4.1.

In accordance with ISO/IEC 61073-1 [1], subclause 4.5.19.

Details:

Atmosphere:	sulphur dioxide (SO ₂) 25 ppm;
Temperature:	+25°C;
Relative humidity	75 %;
Duration of test:	96 hours;
Pre-conditioning procedure:	2 hours at normal ambient conditions;
Recovery procedure:	2 hours at normal ambient conditions.

Requirements:

The attenuation shall be measured at 1 550 nm ± 30 nm before and after the test at normal ambient conditions. On completion of the test there shall be no difference between the initial and final attenuation.

4.13 Condensation

This test shall be carried out on splices which are to be used in non-weather protected environments corresponding to ETS 300 019 [2], class 4.1.

In accordance with ISO/IEC 61073-1 [1], subclause 4.5.15.

Details:

pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	2 hours at normal ambient conditions.

Requirements:

During the test the attenuation shall be within ± 0,10 dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at 1 550 nm ± 30 nm before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 10 minutes.

4.14 Water immersion

This test shall be carried out on splices which are to be used in weather protected environments corresponding to ETS 300 019 [2], classes 3.3, 3.4 or 3.5 or in non-weather protected environments corresponding to ETS 300 019 [2], class 4.1.

At present there are several different user requirements. ETSI is attempting to harmonize these requirements. Until this is achieved, water immersion testing should be carried out in accordance with specific user test methods and requirements.

5 Acceptance criteria

Fusion splicing machines used to produce splices conforming to the performance requirements of this I-ETS are required to demonstrate conformance by means of the following qualification procedure. The splice definition given in section 3.1 of this I-ETS shall apply to the test samples.

5.1 Attenuation

A minimum of 100 splices shall be made using randomly oriented fibre conforming to the standards quoted in the introduction of this I-ETS. The attenuation requirements are applicable to both the 1 310 nm and 1 550 nm windows. The following table shows the acceptance limits for the mean and maximum attenuation values.

Table 2

Category	Mean attenuation	Maximum attenuation	Notes
Single fibres:			
Class I	≤ 0,10 dB	≤ 0,20 dB (≥ 99 % of splices)	Core concentricity error of the fibre used for qualification shall be ≥ 0,4 µm and ≤ 1,0 µm to provide effective testing of the alignment system.
Class II	≤ 0,20 dB	≤ 0,50 dB (≥ 95 % of splices)	
Ribbon and multiple fibres:			
Class III	≤ 0,20 dB	≤ 0,80 dB (≥ 95 % of splices)	

5.2 Other optical, environmental and mechanical requirements

A minimum sample size of 4 shall be subjected to each test. Any parallel or serial grouping of tests can be used, provided that each test or serial group of tests is preceded by visual inspection and followed by the change of temperature test.

5.3 Pass/fail criteria

To satisfy the qualification approval requirements of this I-ETS performance specification there shall be no failures of any in the sample groups for any test parameter. If a failure does occur this shall be investigated and the cause of failure identified and corrected. The test which is affected shall then be repeated using the minimum sample size stated in this I-ETS.

A fully documented test report and supporting data shall be prepared and shall be available for inspection. Failures and the corrective action taken to eliminate failures shall be documented and evidence shall be presented to show that the corrective action will have no detrimental effect on the performance in any of the other tests. Design changes, as opposed to improvements in quality control, will usually be deemed to necessitate a repeat of the full qualification programme.

History

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