IEC 60793-1-30

Edition 2.0 2010-05

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**Optical fibres –
Part 1-30: Measurement methods and test procedures – Fibre proof test**

**Fibres optiques –
Partie 1-30: Méthodes de mesure et procédures d'essai – Essais de sélection**



IEC 60793-1-30:2010-05(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

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# OPTICAL FIBRES –

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## FOREWORD

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International Standard IEC 60793-1-30 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

This bilingual version (2017-12) corresponds to the monolingual English version, published in 2010-05.

This second edition cancels and replaces the first edition published in 2001 and constitutes a technical revision.

The main change with respect to the previous edition is an improved description of the procedure.

The text of this standard is based on the following documents:

| CDV | Report on voting |
|---|---|
| 86A/1288/CDV | 86A/1313/RVC |

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 60793-1-3x series, published under the general title *Optical fibres – measurement methods and test procedures*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

# INTRODUCTION

Publications in the IEC 60793-1 series concern measurement methods and test procedures as they apply to optical fibres.

Within the same series, several different areas are grouped, but all numbers possibly not used, as follows:

- parts 1-10 to 1-19: General
- parts 1-20 to 1-29: Measurement methods and test procedures for dimensions
- parts 1-30 to 1-39: Measurement methods and test procedures for mechanical characteristics
- parts 1-40 to 1-49: Measurement methods and test procedures for transmission and optical characteristics
- parts 1-50 to 1-59: Measurement methods and test procedures for environmental characteristics

# OPTICAL FIBRES –

## Part 1-30: Measurement methods and test procedures – Fibre proof test

## 1 Scope

This part of IEC 60793 describes procedures for briefly applying a specified tensile load as a proof test to continuous lengths of optical fibre. The tensile load is applied for as short a time as possible, yet sufficiently long to ensure the glass experiences the proof stress, typically much less than one second.

This method is applicable to types A1, A2, A3 and B optical fibres.

The object of this standard is to establish uniform requirements for the mechanical characteristic fibre proof test.

## 2 Normative references

None.



## 3 Apparatus



### 3.1 General

There are several possible machine designs, all of which perform the basic functions required for measuring fibre proof with the indicated general operating requirements. Care should be used in the design so as to prevent coating damage.

Two machine types are used:

– braked capstan type;

– dead weight type.

Either machine may be used during the fibre-drawing process (on-line for coated fibre only), or as a separate process step (off-line).

NOTE There are dynamics with on-line screening (different from off-line screening) which should be taken into account.

### 3.2 Fibre pay out

Isolate the tensile load variations from the proof test region so as not to cause variations in the proof load. Do not permit the applied proof stress to fluctuate below the value specified in the detail specification.

### 3.3 Proof test region

With the exception of additional bend stress of up to 10 % of the proof stress, apply the proof stress uniformly through the cross-sectional area of the test sample. Ensure that the load-bearing members in this region are rigid (e. g. made of steel or aluminium). During testing, the tension-producing mechanism(s) shall not allow the proof stress to fluctuate below the value specified in the detail specification.

Proof testing requires that a constant stress be applied sequentially along the full length of fibre. A break rate (failures per unit length) is statistically expected. It is carried out during fibre manufacturing, on-line as part of the fibre drawing and coating process, or off-line as part of the testing process.

The stress history of proof test stressing is as follows:

- stress loading from near-zero to the proof test stress during a load time;
- constant proof test stress during a dwell time;
- stress unloading from the proof test stress back down to near-zero during an unload time.

## 3.4 Fibre take-up

Isolate the tensile load variations from the proof test region so as not to cause variations in the proof load. Ensure that the applied proof stress does not fluctuate below the value specified in the detail specification.

## 3.5 Load and unload

The load and unload regions occur on both sides of the proof test region. Tension in the fibre ramps up from being under constant low tension, in the pay-out region, to the full load in the proof test region. Tension in the fibre then ramps down, from the proof test region, to a constant low tension in the take-up region. The unload zone is the arc formed by the two tangent points in the guide where the fibre finally leaves the loading area. (For example, unloading across 90° of a 150 mm diameter wheel at a speed of about 12 m/s yields an unloading time of about 10 ms.) Control the unload time to some maximum, agreed between user and manufacturer. Accomplish ramping up and ramping down as quickly as possible.



## 3.6 Minimum bending radii

All radii over which the test sample passes need to be of sufficient size so that the maximum stress and time at that stress shall not significantly degrade the strength of the sample.

## 3.7 Typical equipment design

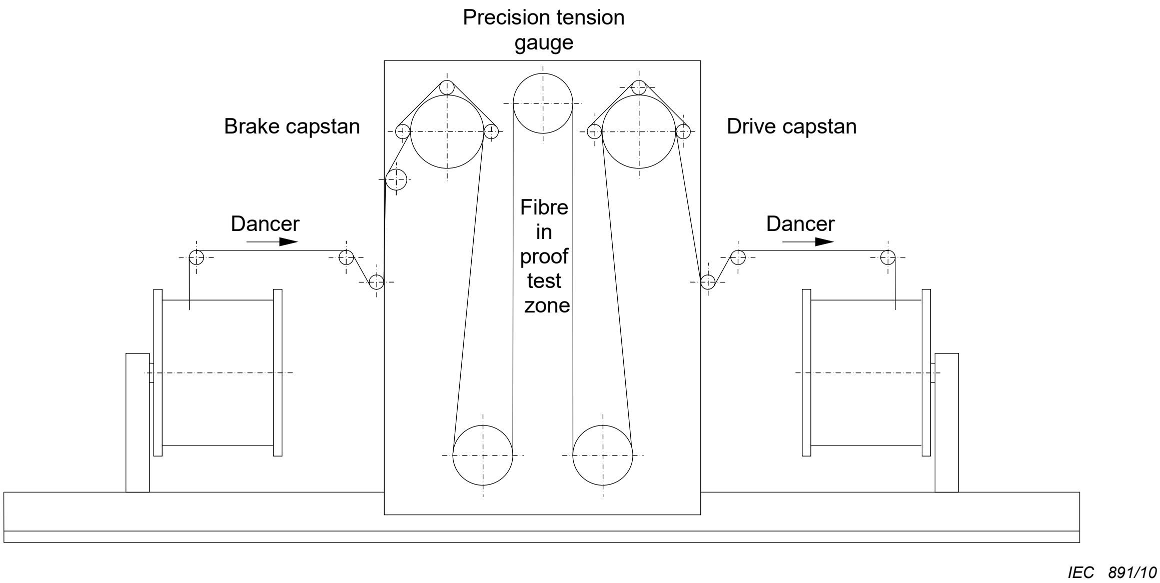
### 3.7.1 Introduction

The following examples illustrate some typical designs. Other designs may be used, provided the operating requirements in 3.2 to 3.6 are met.

### 3.7.2 Braked capstan type

A specific apparatus illustrating these requirements is shown in Figure 1. The fibre is paid out with constant low tension. The rewinding after the proof test is also done with constant tension. The levels of the pay-off and take-up tensions are adjustable. The proof test load is applied to the fibre between the brake and drive capstans by creating a speed difference between the capstans. Two belts are used to prevent slippage at the capstans. One design can be that the high precision tension gauge measures the load on the fibre and controls the speed difference to achieve the required proof test load. The load level and operating speed of the equipment can be independently set. Another design can be that the difference in speeds between the two capstans is set and controlled directly according to the desired fibre elongation (strain), without tension measurements.

NOTE The relationship between stress and strain can be found in IEC/TR 62048 (see Bibliography).




Fibre pay-off region – Stage 1: Constant pay-off

Proof testing region – Stage 2: Proof testing with master and braking capstan and precision tension gauge

Fibre take-up region – Stage 3: Constant tension take-up spooling

**Figure 1 – Braked capstan type**



### 3.7.3 Dead weight type

Another specific apparatus illustrating these requirements is shown in Figure 2.



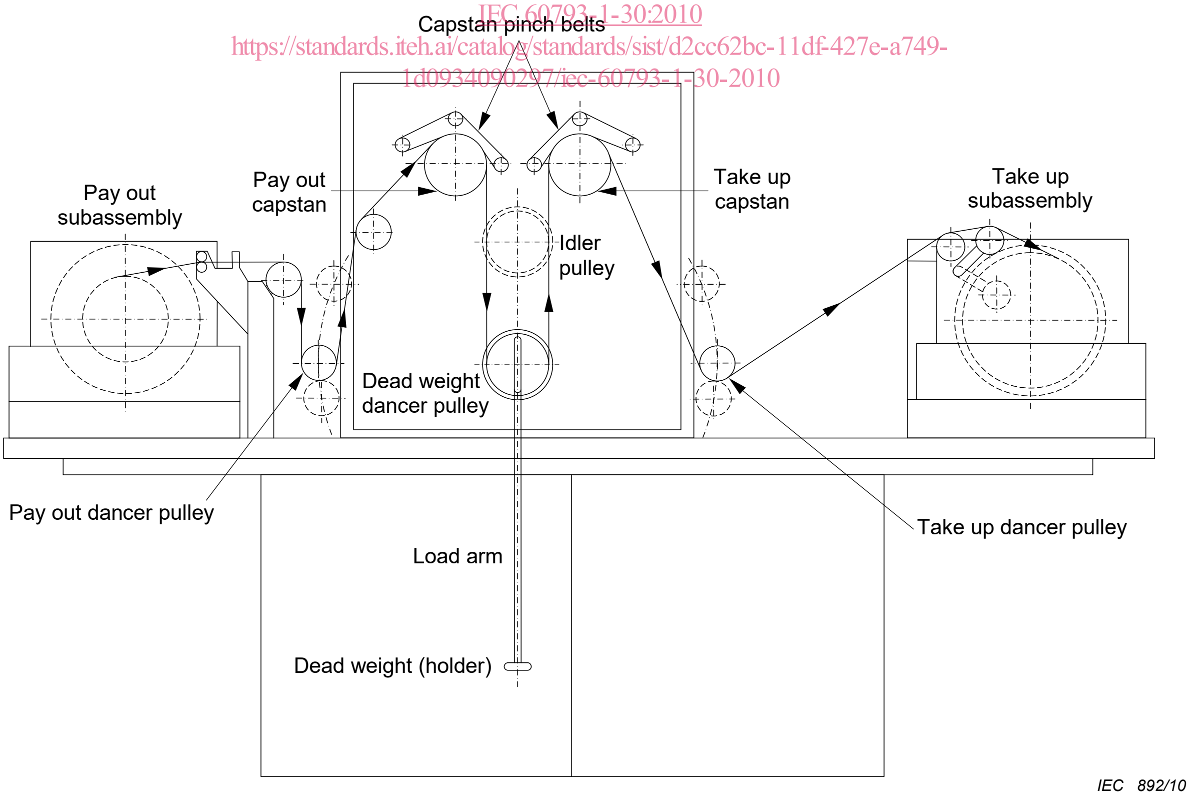



**Figure 2 – Dead weight type**

This sub-assembly pays out fibre from a reel under constant low tension. The pay-out sub-assembly has various guide rollers and pulleys, plus a motorised traversing mechanism.

The pay-out dancer pulley keeps the sample under just enough tension to run straight and true to the proof test region, with minimum tension fluctuations. The pay-out capstan is the start of the proof test region. This capstan is driven and synchronized with the take-up capstan.

Two belts are required to hold the fibre sample firmly against the pay-out and take-up capstans so that there is no slippage at the entrance to, and exit from, the proof test region.

The dancer pulley may consist of two pulleys, one behind the other on a common shaft. (The second pulley is optional, however.) The fibre is fed first to the rear pulley, then back up to the idler pulley, back down to the front dancer pulley and up to the take-up capstan.

The load arm is attached to both the shaft of the dead weight dancer pulley and to the dead weight itself. The load arm is adjustable to zero balance. It is pivoted and actuates a sensor which signals the drive capstan either to increase or decrease speed, depending on the position of the load arm. Since both drives are controlled from a common reference, load arm movement is negligible because the arm seeks a neutral position when the machine is at any operating speed.

There is a thin plate at the bottom of the load arm. Weights are added to the plate to produce the required actual proof load.

The idler pulley, which is optional, provides increased gauge length of the fibre under test. No idler pulley is required if there is only one dancer pulley.



The take-up capstan is at the end of the proof test region. This is driven and synchronized with the pay-out capstan so that tension fluctuations are minimized.



The take-up dancer pulley produces the desired winding tension of the fibre on the take-up reel. (The winding tension is low in comparison to the proof test and is not part of the detail specification requirement.)

The take-up sub-assembly takes up the fibre on a reel for final shipping or for further processing. It has various guide rollers and pulleys to ensure even lay-down of the fibre, at the desired tension level, so that the fibre remains on the reel without cascading.

## 4 Sample preparation

Use the entire length of optical fibre as the test specimen, minus short sections, typically 25 m to 50 m at the ends (end allowance length). This allowance is required for a period of acceleration during which the unloading time exceeds the maximum.

## 5 Procedure

The test specimen is fed into the machine according to the operating instructions for the machine.

The tension load on the machine is set according to the requirements in the detail specification.

The procedure allows easy detection of any failure in the fibre by the operator, if or when it occurs.

The test specimen is run through the proof test machine.

## 6 Calculations – Compensation for load-sharing by coating

Calculate the fraction, $F$, of the tension carried by the protective coating as follows:

$$F = \frac{E_2(D_2^2 - D_1^2) + E_1(D_1^2 - D_g^2)}{[E_2(D_2^2 - D_1^2) + E_1(D_1^2 - D_g^2)] + E_g D_g^2}$$

where

$E_g$ is Young's modulus of the glass fibre in Pa;

$E_2$ is Young's modulus of the second coating layer in Pa;

$E_1$ is Young's modulus of the first coating layer in Pa;

$D_g$ is the nominal diameter of the glass fibre in μm;

$D_2$ is the nominal diameter of the second coating layer in μm;

$D_1$ is the nominal diameter of the first coating layer in μm.

Use values for $E_2$ and $E_1$ that are consistent with the operating temperature, humidity and strain rate. A worst case over-estimate of the coating contribution can be made by replacing the modulus of the inner primary coating by the larger modulus of the outer primary coating. In this way, the diameter and modulus of the inner primary coating need not be known.

Calculate the corrected proof test tension, $T_a$ (N), to be applied to the coated fibre as follows:



$$T_a = \frac{(0{,}0008)\, D_g^2 \sigma_p}{(1 - F)}$$



where

$D_g$ is the nominal diameter of the glass fibre in μm;

$\sigma_p$ is the proof stress in GPa;

$F$ is the fraction of the load carried by the coating.

The coefficient 0,0008 is a rounded number of $\pi/4 \times 10^{-3}$.

NOTE In case of strain controlled braked capstan proof test machines, this compensation is not applicable.

## 7 Results

### 7.1 Test requirement

All fibre shall pass the proof test machine. Some surviving sections may be shorter than the other.

If a fibre fails, evidence of failure shall be readily apparent. Fibre failure may show up as a complete separation, a gross stretching of the coating material in the failure area, an automatic shutdown of the machine, etc. This requirement is especially important for fibres having a coating material that carries a substantial portion of the applied tensile load, or having a large failure elongation.