เล่ม ๑๑๙ ตอนพิเศษ ๑๐๐ ง ราชกิจจานุเบกษา ๑๔ ตุลาคม ๒๕๔๕

ประกาศกระทรวงอุตสาหกรรม

ฉบับที่ ๓๐๖๑ (พ.ศ. ๒๕๔๕)

ออกตามความในพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม

พ.ศ. ๒๕๑๑

เรื่อง กำหนดมาตรฐานผลิตภัณฑ์อุตสาหกรรม

ใยแก้วนำแสง

เล่ม ๑ - ๕ ข้อกำหนดรายการร่วม : วิธีวัดลักษณะทางสภาวะแวดล้อม

อาศัยอำนาจตามความในมาตรา ๑๕ แห่งพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม พ.ศ. ๒๕๑๑ รัฐมนตรีว่าการกระทรวงอุตสาหกรรมออกประกาศกำหนดมาตรฐานผลิตภัณฑ์อุตสาหกรรม ใยแก้วนำแสง เล่ม ๑ - ๕ ข้อกำหนดรายการร่วม : วิธีวัดลักษณะทางสภาวะแวดล้อม มาตรฐานเลขที่ มอก. ๒๐๔๘ - ๒๕๔๓ ไว้ ดังมีรายการละเอียดต่อท้ายประกาศนี้

ประกาศ ณ วันที่ ๒๘ พฤษภาคม พ.ศ. ๒๕๔๕

สุริยะ จึงรุ่งเรืองกิจ

รัฐมนตรีว่าการกระทรวงอุตสาหกรรม

มอก. 2048-2543
IEC 793-1-5(1995)

มาตรฐานผลิตภัณฑ์อุตสาหกรรม

ใยแก้วนำแสง

เล่ม 1-5 ข้อกำหนดรายการร่วม : วิธีวัดลักษณะทางสภาวะแวดล้อม

มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้กำหนดขึ้นโดยรับ IEC 793-1-5(1995) Optical Fibres - Part 1 : Generic specification - Section 5 : Measuring methods for environmental characteristics มาใช้ในระดับเหมือนกันทุกประการ (identical) โดยใช้ IEC ฉบับภาษาอังกฤษเป็นหลัก

มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้มีจุดมุ่งหมายเพื่อกำหนดลักษณะที่ต้องการที่เป็นเอกภาพสำหรับวิธีวัดลักษณะทางสภาวะแวดล้อมของใยแก้วนำแสงโดยวิธีการวัดเหล่านี้ถูกนำมาใช้สำหรับการตรวจสอบเพื่อวัตถุประสงค์เชิงพาณิชย์ รายละเอียดให้เป็นไปตาม IEC 793-1-5(1995)

INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL FIBRES –

Part 1: Generic specification –
Section 5: Measuring methods for environmental characteristics

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of the IEC on technical matters, prepared by technical committees on which all the National Committees having a special interest therein are represented, express as nearly as possible, an international consensus of opinion on the subjects dealt with.

3) They have the form of recommendations for international use published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.

4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

International Standard IEC 793-1-5 has been prepared by sub-committee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

The fourth edition of IEC 793-1, published in 1992, has been subject to revision. It has been divided into five standards each of which incorporates one section.

The first edition of IEC 793-1-5 cancels and replaces section 5 of IEC 793-1, of which it constitutes a minor revision.

This standard shall be used in conjunction with the following standards:

IEC 793-1-1: 1995, *Optical fibres – Part 1: Generic specification – Section 1: General*

IEC 793-1-2: 1995, *Optical fibres – Part 1: Generic specification – Section 2: Measuring methods for dimensions*

IEC 793-1-3: 1995, *Optical fibres – Part 1: Generic specification – Section 3: Measuring methods for mechanical characteristics*

IEC 793-1-4: 1995, *Optical fibres – Part 1: Generic specification – Section 4: Measuring methods for transmission and optical characteristics*

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

DIS	Report on voting
86A/304/DIS	86A/330/RVD

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

OPTICAL FIBRES –

Part 1: Generic specification –
Section 5: Measuring methods for environmental characteristics

1 Scope and object

This section of IEC 793-1 describes measuring methods which apply to environmental tests of optical fibres. The methods are to be used for inspection of optical fibres for commercial purposes.

The object of this section is to establish uniform requirements for environmental characteristics of optical fibres.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this section of IEC 793-1. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this section of IEC 793-1 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 68-2-10: 1988, *Basic environmental testing procedures – Part 2: Tests – Test J and guidance: Mould growth*

IEC 68-2-14: 1984, *Basic environmental testing procedures – Part 2: Tests – Test N: Change of temperature*

3 Tests of environmental characteristics

The ability of an optical fibre to meet environmental requirements shall be verified by subjecting samples to tests selected from table 1. The tests or combinations of tests applied, the relevant conditions, the number of samples and acceptance criteria, for example those concerning mechanical and transmission characteristics, shall be as indicated in the detail specification.

Table 1 – Environmental characteristics

Test method	Test	Characteristics covered by the test method
IEC 793-1-D1	Temperature cycling	Climatic performance
IEC 793-1-D2	Contamination (under consideration)	Chemical resistance
Test J of IEC 68-2-10	Mould growth	Biological resistance
IEC 793-1-D3	Nuclear radiation	Nuclear radiation resistance

4 Operational definitions

Under consideration.

5 Method IEC 793-1-D1 – Temperature cycling

5.1 *Object*

This measuring method applies to optical fibres which are tested by temperature cycling in order to determine the stability behaviour of the attenuation of a fibre submitted to temperature changes, which may occur during storage, transportation and usage.

Test conditions for temperature dependent measurements shall simulate the worst conditions.

5.2 *Sample preparation*

The sample will be a factory length or a sample of sufficient length as indicated in the detail specification but the sample should be of an appropriate length to achieve the desired accuracy.

NOTE – For example, it is recommended that the minimum length of fibre submitted to the test should be not less than 1 000 m for A1 fibre and 2 000 m for B fibre.

In order to gain reproducible values the fibre sample shall be brought into the climatic chamber as a loose coil or on a reel.

The result of the test could be influenced by the bending radius of the fibre. With this respect, sample conditioning should be realized as close as possible to normal usage conditions. In case of testing on a reel, the fibre shall be wound up in such a way that all the changes of fibre characteristics (attenuation, length, etc.) which could occur in normal usage conditions are not altered.

Potential problems are due to an actual difference on expansion coefficients between test sample and holder (reel, basket, plate, etc.) that can induce during thermal cycles significant effect on the test result if "no effect" conditions are not completely fulfilled.

Parameters of influence are mainly: details of conditioning, type and material(s) of the holder, diameter of the sample coil or reel, etc.

General recommendations are as the following:

- The winding diameter shall be large enough to keep the ability of fibre to accommodate differential expansion and contraction.
- A winding diameter substantially greater than the value selected for fibre delivery may be necessary.
- Any risk of fibre expansion (or contraction) limitation created by conditioning shall be suppressed. In particular, special care should be taken to avoid remaining tension on the fibre during the test, for example a tight winding on a reel is not recommended as it can limit fibre contraction at low temperature. On the other hand, a tight multilayer winding can limit expansion at high temperature.

- Use of loose winding is recommended such as large diameter coils, bufferized reels with a soft layer or zero tension facility device, etc.

The test is commonly destructive due to the difficulty to rewind properly the fibre sample after the test.

5.3 *Apparatus*

a) An appropriate attenuation measuring set for determination of attenuation change shall be used. See clauses 4 to 9 of IEC 793-1-4.

b) Climatic chamber

The size of the climatic chamber shall be suitable to accommodate the sample, and its temperature shall be controllable to remain within ±3 K of the specified testing temperature.

One example of a suitable chamber is given in clause 2 (test Nb) of IEC 68-2-14.

5.4 *Procedure*

a) Initial measurement

The sample shall be visually inspected and a basic value for attenuation determined at ambient temperature. Preconditioning conditions have to be agreed between manufacturer and customer.

b) Conditioning

1) The sample, while being at the ambient temperature shall be introduced into the test chamber, the latter also being at that temperature. Preconditions have to be agreed between supplier and customer.

2) The temperature in the chamber shall then be lowered to the appropriate low temperature T_A at the appropriate rate of cooling.

3) After temperature stability in the chamber has been reached, the sample shall be exposed to the low temperature condition for the appropriate period t_1.

4) The temperature in the chamber shall then be raised to the appropriate high temperature T_B at the appropriate rate of heating.

5) After temperature stability in the chamber has been reached, the sample shall be exposed to the high temperature condition for the appropriate period t_1.

6) The temperature in the chamber shall then be lowered to the value of the ambient temperature at the appropriate rate of cooling.

7) This procedure constitutes one cycle (see figure 1).

8) The sample shall be subjected to two cycles, unless otherwise required in the relevant detail specification.

9) The detail specification shall state:

i) the change of attenuation and inspection checks, during conditioning;

ii) the period(s) after which they are to be carried out.

10) Before removal from the chamber, the sample under test shall have reached temperature stability at the ambient temperature.

11) The value of T_A and T_B and t_1 shall be specified in the detail specification.

The rate of cooling (or heating) shall be specified in the detail specification. Care should be taken in order that the temperature of fibre does not significantly differ from the specified temperature of the climatic chamber at the end of the cooling (or heating) phases.

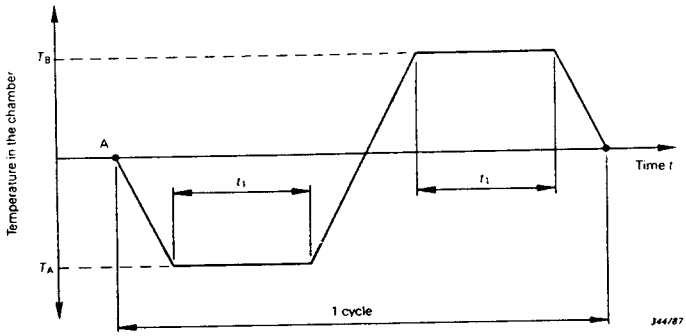

Figure 1 – Temperature in the chamber

c) Recovery

1) If the ambient temperature is not the standard atmospheric condition to be used for testing after removal from the chamber, the sample shall be allowed to attain temperature stability at this latter condition.

2) The detail specification may call for a specific recovery period for a given type of sample.

5.5 *Results*

a) Final measurements:

The samples shall be visually inspected and optically and mechanically checked, as required in the detail specification.

b) The following data shall be presented with the results:

- diameter of the sample coil or reel;
- details of winding:
  - coil, reel, other (to be stated in case of bufferized reel, the type of buffering used);
  - single or multilayer;
  - open winding or basket weave;
  - winding tension and zero tension facility device if any;
  - type and materials of the holder;
  - position of the sample (vertical/horizontal).

– fibre length under test;

– end preparation;

– test set data including type of measurement equipment and launching conditions;

– severity of test (number of cycles, temperature cycle diagram). Temperatures and times shall be recorded;

– if humidity is controlled or uncontrolled. If the humidity level is controlled, the humidity levels at each temperature extreme should be reported;

– change of attenuation at a specified wavelength as a function of temperature cycling including indication of accuracy.

6 Method IEC 793-1-D2 – Contamination

Under consideration.

7 Method IEC 793-1-D3 – Nuclear radiation

Procedure for measuring gamma irradiation effects in optical fibres and optical cables.

7.1 *Scope*

This test procedure outlines a method for measuring the steady state response of optical fibres and optical cables exposed to gamma radiation. It can be employed to determine the level of radiation induced attenuation produced in single-mode or multimode optical fibres, in either cabled or uncabled form, due to exposure to gamma radiation. This test is not a material test for the non-optical material components of a fibre optic cable. If degradation of cable materials exposed to irradiation is to be studied, other test methods will be required.

7.1.1 *Background*

The attenuation of cabled and uncabled optical fibres generally increases when exposed to gamma radiation. This is primarily due to the trapping of radiolytic electrons and holes at defect sites in the glass (i.e. the formation of color centers). This test procedure focuses on two regimes of interest: the low dose rate regime suitable for estimating the effect of environmental background radiation, and the high dose rate regime suitable for estimating the effect of adverse nuclear environments. The testing of the effects of environmental background radiation is achieved with an attenuation measurement approach similar to method C1A of IEC 793-1-4. The effects of adverse nuclear environments are tested by monitoring the power before, during and after exposure of the test sample to gamma radiation. The depopulation of color centers by light (photobleaching) or by heat causes recovery (lessening of radiation induced attenuation). Recovery may occur over a wide range of time scales ranging from 10^{-2} s to 10^{4} s. This complicates the characterization of radiation induced attenuation since the attenuation depends on many variables including the temperature of the test environment, the configuration of the sample, the total dose and the dose rate applied to the sample and the light level used to measure it.

7.1.2 *Caution*

Strict regulations and suitable protective facilities shall be adopted in the laboratory for this test. Carefully selected trained personnel shall be used to perform this test. It can be extremely hazardous to test personnel if it is improperly performed or without qualified conditions.

7.2 *Test equipment (see figures 2 and 3)*

7.2.1 *Radiation source*

7.2.1.1 *Testing of environmental background radiation*

A ^{60}Co or equivalent ionizing source shall be used to deliver gamma radiation at a low dose rate of ≤20 rad/h (see figure 2).

7.2.1.2 *Testing of adverse nuclear environments*

A ^{60}Co or equivalent ionizing source(s) shall be used to deliver gamma radiation at a desired dose rate ranging from 5 rad/s to 250 rad/s (see figure 3).

7.2.2 *Light source*

A light source such as a tungsten-halogen lamp or set of lasers or LEDs shall be used to produce radiant energy at wavelengths of 850 nm, 1 300 nm and 1 550 nm or at wavelengths as specified in the detail specification. The light source shall be stable in intensity over a time period sufficient to perform the measurement. The power coupled from the source into the test sample shall be ≤30 dBm (1,0 μW) or as specified in the detail specification. The light source shall be modulated with a pulsed signal at a 50 % duty cycle.

NOTE – If a source that couples more than 1,0 μW is used, photobleaching may occur.

7.2.3 *Optical filters/monochromators*

Unless otherwise specified, wavelengths of 850 nm ± 20 nm, 1 300 nm ± 20 nm, and 1 550 nm ± 20 nm shall be obtained by filtering the light source with a set of optical filters or a monochromator. The 3 dB optical bandwidth of the filters shall be less than or equal to 25 nm.

7.2.4 *Cladding mode stripper*

When necessary, a device that extracts cladding modes shall be employed at the input end and output end of the test sample. If the fibre coating materials are designed to strip cladding modes, a cladding mode stripper is not required.

7.2.5 *Fibre support and positioning apparatus*

A means of stably supporting the input end of the test sample such as a vacuum chuck, shall be arranged. This support shall be mounted on a positioning device so that the end of the test sample can be repeatedly positioned in the input beam.

7.2.6 *Optical splitter* (see figure 3)

An optical splitter shall divert a small portion of the input light to a reference detector. The reference path shall be used to monitor system fluctuations for the duration of the test.

7.2.7 *Input launch simulator*

7.2.7.1 *Category A1 fibres (graded index multimode fibre)*

An equilibrium mode simulator shall be used to attenuate higher order propagation modes and to establish a steady-state mode condition near the input end of the fibre. Refer to method C1A of IEC 793-1-4 for instructions on how to established proper launch conditions for Category A1 graded index multimode fibres.

7.2.7.2 *Category B fibres (single-mode fibre)*

An optical lens system or fibre pigtail may be employed to excite the test fibre. The power coupled into the test sample shall be stable for the duration of the test. If an optical lens system is used, a method of making the positioning of the fibre less sensitive is to overfill the fibre end spatially and angularly. If a pigtail is used, it may be necessary to use index matching material to eliminate interference effects. A high order mode filter shall be employed to remove high order propagating modes in the wavelength range greater than or equal to the cut-off wavelength of the test fibre. The test condition specified in method C7A of IEC 793-1-4 satisfies this requirement.

7.2.7.3 *Categories A2.1 and A2.2 (quasi-step and step index fibres)*

Launch conditions shall be created as specified in the detail specification.

7.2.8 *Detector – signal detection electronics*

An optical detector which is linear and stable over the range of intensities that are encountered shall be used. A typical system might include a photovoltaic mode photodiode amplified by a current input preamplifier, with synchronous detection by a lock-up amplifier.

7.2.9 *Optical power meter*

A suitable optical power meter shall be used to determine that the power coupled from the optical source into the test sample is less than or equal to 1,0 µW or the level specified in the detail specification.

7.2.10 *Radiation dosimeter*

Thermoluminescent LiF or CaF crystal detectors (TLDs) shall be used to measure the total radiation dose received by the specimen fibre.

7.2.11 *Temperature controlled container*

Unless otherwise specified, the temperature controlled container shall have the capability of maintaining the specified temperatures to within ±2 °C.

7.2.12 *Test reel*

The test reel shall not act as a shield or sink for the radiation used in this test.

7.3 *Test sample*

7.3.1 *Specimens*

7.3.1.1 *Fibre specimen*

The test specimen shall be a representative sample of the fibre specified in the detail specification.

7.3.1.2 *Cable specimen*

The test specimen shall be a representative sample of the cable described in the detail specification and shall contain at least one of the specified fibres.

7.3.2 *Specimen for environmental background radiation test*

Unless otherwise specified in the detail specification, the length of the test sample shall be 3 000 m ± 30 m. (Where reactor constraints dictate smaller lengths, the length of the test sample may be 1 100 m ± 20 m.) A minimum length at the ends of the test sample (typically ≤5 m) shall reside outside of the test chamber and be used to connect the optical source to the detector. The irradiated length of the test sample shall be reported.

7.3.3 *Specimen for testing adverse nuclear environments*

Unless otherwise specified in the detail specification, the length of the test sample shall be 250 m ± 2,5 m. (When test conditions require a high total dose and dose rate, per table 2, a shorter test sample length may be necessary.) A minimum length at the ends of the test sample (typically ≤5 m) shall remain outside of the test chamber and be used to connect the optical source to the detector. The irradiated length of the test sample shall be reported.

7.3.4 *Test reel*

The test sample shall be spooled onto a reel with a drum diameter that is specified in the detail specification. Allowance shall be made for the unspooling of a measured length of the test sample from each end of the reel to allow for attachment to the optical measurement equipment. An alternative deployment method allows the fibre to be loosely wound in coil of specified diameter.

7.3.5 *Ambient light shielding*

The test sample shall be shielded from ambient light to prevent external photobleaching.

7.4 *Test procedure*

7.4.1 *Calibration of radiation source*

Calibration of the radiation source for dose uniformity and level shall be made prior to the test sample being set up in the chamber. Four TLDs shall be placed in the area of exposure and the center of the TLDs shall be placed where the axis of the test reel will be placed. (Four TLDs are used to get a representative average value.) A dose equal to or greater than the actual test dose shall be used to calibrate the system. To maintain the highest possible accuracy in measuring the test dose, the TLDs shall not be used more than once.

7.4.2 *Fibre end preparation*

The test sample shall be prepared such that its endfaces are smooth and perpendicular to the fibre axis.

7.4.3 *Environmental background radiation test*

The procedures for measuring the attenuation of the test sample before and after exposure to the gamma radiation source are described below.

7.4.3.1 The reel of fibre or cable to be tested shall be placed in the test set-up in accordance with figure 2.

7.4.3.2 The input end of the fibre shall be placed in a positioning device and aligned. The output end shall be positioned so that all light exiting the fibre impinges on the active surface of the detector.

7.4.3.3 The test sample shall be preconditioned in the temperature chamber at 25 °C ± 5 °C for 1 h prior to testing, or at the test temperature for a preconditioned time as specified in the detail specification.

7.4.3.4 An attenuation measurement of the test sample shall be performed, at the specified test wavelengths, in accordance with method C1A of IEC 793-1-4. The attenuation A_1, of the fibre prior to exposure to the gamma radiation source shall be recorded.

7.4.3.5 The power at the input end of the test sample (point A in figure 2) shall be measured with a calibrated power meter. If necessary, the source level shall be adjusted so that the power at point A is less than 1,0 μW or as specified in the detail specification.

7.4.3.6 The test sample ends shall be prepared in accordance with 7.4.2 and aligned in the test set in accordance with 7.4.3.2.

7.4.3.7 With the radiation source off, the input end of the test sample shall be positioned to obtain maximum optical power at the detector. Once set, the input launch conditions shall not be changed during the gamma irradiation portion of the test.

7.4.3.8 Prior to irradiation, the output power shall be measured at all test wavelengths at the specified test temperature.

7.4.3.9 A chart recorder or suitable continuous measurement device shall be connected to the detection system so that a continuous power measurement can be made. The measurement equipment shall be set up such that the detection signal does not exceed the limits of the equipment.

7.4.3.10 Environmental background radiation effects, due to exposure to gamma radiation, shall be determined by subjecting the test sample to dose rates of ≤20 rad/h. The test sample shall be exposed to a minimum total dose of at least 100 rad.

7.4.3.11 The output power from the sample shall be recorded for the duration of the gamma irradiation cycle.

7.4.3.12 Upon completion, and within 2 h of the irradiation process, an attenuation measurement of the test sample shall be performed in accordance with 7.4.3.4. The attenuation A_2 of the test sample after exposure to the gamma radiation source shall be recorded.

7.4.3.13 Repeat steps 7.4.3.1 through 7.4.3.12 for the required test temperatures and wavelengths. It will be necessary to use a new non-irradiated specimen for each temperature required.

7.4.4 *Adverse nuc'ear environment test*

The procedures for measuring the power propagating in the test sample before, during and after exposure to the gamma radiation source are described below.

7.4.4.1 The ends of a short length of test sample (1 m to 2 m) shall be prepared according to 7.4.2.

7.4.4.2 The input end of the short test length shall be placed in the positioning device and aligned in the test set (figure 3) to obtain maximum optical power as measured with a calibrated power meter. If necessary, the source level shall be adjusted, using neutral density filters, to obtain an optical power level at the output of the short length of test sample that is less than 1,0 µW or as specified in the detail specification.

NOTE – If a source that couples more than 1,0 µW is used, photobleaching may occur.

7.4.4.3 The test sample reel shall be placed in the test set-up in accordance with figure 3.

7.4.4.4 The input end of the test sample shall be placed in a positioning device and aligned. The output end shall be positioned so that all light exiting the test sample impinges on the active surface of the detector.

7.4.4.5 The test sample shall be preconditioned in the temperature chamber at 25 °C ± 5 °C for 1 h prior to testing, or at the test temperature for a pre-conditioning time as specified in the detail specification.

7.4.4.6 With the radiation source off, the input end of the test sample shall be positioned to obtain maximum optical power at the detector. Once set, the input launch conditions shall not be changed during the gamma irradiation portion of the test.

7.4.4.7 Prior to irradiation, the output power shall be measured at all test wavelengths at the specified test temperature. The power from the reference detector shall also be measured at this time.

7.4.4.8 A chart recorder or suitable continuous measurement device shall be connected to the detection system so that a continuous power measurement can be made. The measurement equipment shall be set up such that the detection signal does not exceed the limits of the equipment.

7.4.4.9 Adverse effects due to exposure to gamma radiation shall be determined by subjecting the test sample to at least one of the dose rates and total dose level combinations specified in table 2 or as specified in the detail specification.

Table 2 – Total dose/dose rate combinations

Total dose rad (Sievert)	Dose rate rads/s
3 000	5
10 000	50
100 000	200
1 000 000	200

Dose rate levels are only approximate levels since the radiation source characteristics change. A variation in dose rate as high as ±50 % can be expected between sources. The time required to turn the radiation source on or off shall be ≤10 % of the total exposure time.

7.4.4.10 The output power from the test sample shall be recorded for the duration of the gamma irradiation cycle. The power shall also be recorded for at least 15 min after completion of the irradiation process or as specified in the detail specification. The power level of the reference detector shall also be recorded during the recovery time after completion of the irradiation process.

7.4.4.11 Repeat steps 7.4.4.2 through 7.4.4.10 for the required test temperatures and wavelengths. It will be necessary to use a new non-irradiated specimen for each temperature required.

7.5 *Calculations*

7.5.1 *The change in optical attenuation ΔA (Environmental background radiation test)*

$$\Delta A = A_2 - A_1 \quad \text{dB}$$

where

A_1 is the attenuation of the test sample prior to exposure to gamma radiation;

A_2 is the attenuation of the test sample after exposure to gamma radiation.

7.5.2 The change in optical transmittance A shall be calculated for each wavelength by using the following formula (testing of adverse nuclear environment):

$$A_0 = -10 \log (P_0/P_B) \quad \text{dB}$$

$$A_{15} = -10 \log (P_{15}/P_B) \quad \text{dB}$$

where

P_0 is the power output of the test sample within 1 s after irradiation is discontinued, unless otherwise specified;

P_{15} is the power output of the test sample 15 min after irradiation is discontinued, unless otherwise specified;

P_B is the power output of the test sample before irradiation begins;

A_0 is the change in optical transmittance of the test sample immediately after irradiation;

A_{15} is the change in optical transmittance of the test sample 15 min after irradiation.

7.5.3 The results of the reference measurements should be used to normalize the test results if significant system instability is noted.

$$A_{REF} = -10 \log (P_E'/P_B') \quad \text{dB}$$

where

P_E' is the power measured by the reference detector at the end of the measurement;

P_B' is the power measured by the reference detector before irradiation begins.

7.5.4 Normalized test results that account for system instability are calculated with the following formulae:

$$A_{0NOR} = A_0 - A_{REF}$$

$$A_{15NOR} = A_{15} - A_{REF}$$

7.6 *Documentation*

7.6.1 The following data shall be reported:

- date of test;
- title of test;
- length of test sample exposed to radiation;
- test wavelengths;
- test temperatures;
- test reel diameter;
- test dose and dose rate;
- change in attenuation ΔA (environmental background radiation test);

– change in optical transmittances A_0 and A_{15} (adverse nuclear environment).

– characteristics of test sample such as fibre type, cable type, dimensions and composition.

– chart recording of test events.

7.6.2 The following test equipment information shall be available for inspection upon request for non-military applications:

– description of radiation source;

– description of dosimeters used;

– type of optical source, model number and manufacturer;

– description of optical filtres or monochromator;

– description of cladding mode stripper;

– description of input launch simulator and launch conditions used;

– type of optical splitter used;

– description of detection and recording apparatus;

– description of the characteristics of temperature chamber;

– date of latest calibration of test equipment;

– name or identification number of operator.

7.7 *Summary*

The following details shall be specified in the detail specification:

– type of test sample to be tested;

– test reel diameter;

– test temperature(s);

– failure or acceptance criteria;

– number of samples;

– test wavelengths;

– total dose and dose rate;

– other test conditions.

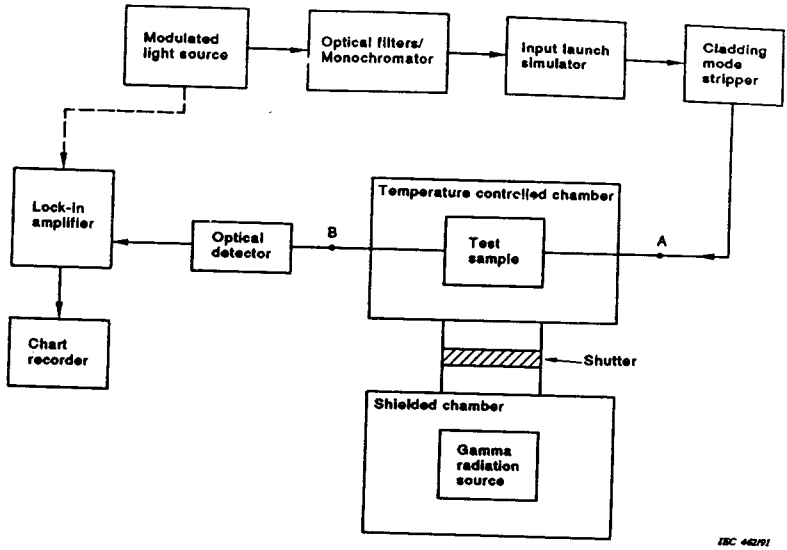
Modulated light source
Optical filters/ Monochromator
Input launch simulator
Cladding mode stripper
Lock-in amplifier
Optical detector
B
Temperature controlled chamber
Test sample
A
Chart recorder
Shutter
Shielded chamber
Gamma radiation source
IEC 462/91

Figure 2

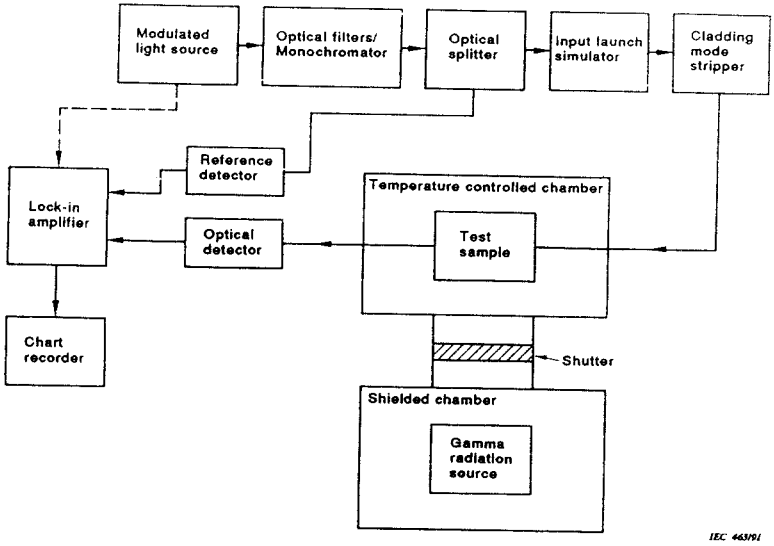
Modulated light source
Optical filters/ Monochromator
Optical splitter
Input launch simulator
Cladding mode stripper
Reference detector
Lock-in amplifier
Optical detector
Temperature controlled chamber
Test sample
Chart recorder
Shutter
Shielded chamber
Gamma radiation source
IEC 463/91

Figure 3