BS EN ISO 21254-3:2011

BSI Standards Publication

Lasers and laser-related equipment — Test methods for laser-induced damage threshold

Part 3: Assurance of laser power (energy) handling capabilities (ISO 21254-3:2011)

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National foreword

This British Standard is the UK implementation of EN ISO 21254-3:2011. It supersedes BS EN ISO 11254-3:2006 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CPW/172/9, Electro-optical systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Lasers et équipements associés aux lasers - Méthodes d'essai du seuil d'endommagement provoqué par laser - Partie 3: Possibilités de traitement par puissance (énergie) laser (ISO 21254-3:2011)

Laser und Laseranlagen - Prüfverfahren für die laserinduzierte Zerstörschwelle - Teil 3: Zertifizierung der Belastbarkeit hinsichtlich Laserleistung (-energie) (ISO 21254-3:2011)

This European Standard was approved by CEN on 14 July 2011.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN ISO 21254-3:2011) has been prepared by Technical Committee ISO/TC 172 "Optics and photonics" in collaboration with Technical Committee CEN/TC 123 “Lasers and photonics” the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2012, and conflicting national standards shall be withdrawn at the latest by January 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 11254-3:2006.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of ISO 21254-3:2011 has been approved by CEN as a EN ISO 21254-3:2011 without any modification.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 21254-3 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 9, *Electro-optical systems*.

This first edition of ISO 21254-3:2011 cancels and replaces ISO 11254-3:2006, which has been technically revised.

ISO 21254 consists of the following parts, under the general title *Lasers and laser-related equipment — Test methods for laser-induced damage threshold*:

— *Part 1: Definitions and general principles*

— *Part 2: Threshold determination*

— *Part 3: Assurance of laser power (energy) handling capabilities*

— *Part 4: Inspection, detection and measurement* [Technical Report]

Introduction

This part of ISO 21254 describes two methods of verifying the power density (energy density) handling capability of optical components, both coated and uncoated.

The methods will give consistent measurement results and can therefore be used for acceptance testing or to produce results which can be compared between test laboratories.

The methods are applicable to all combinations of laser wavelengths and pulse lengths. Comparison of laser damage threshold data can, however, be misleading unless the measurements have been carried out at identical wavelengths and pulse lengths.

Lasers and laser-related equipment — Test methods for laser-induced damage threshold —

Part 3: Assurance of laser power (energy) handling capabilities

WARNING — The extrapolation of damage data can lead to an overestimation of the laser-induced damage threshold. In the case of toxic materials (e.g. ZnSe, GaAs, CdTe, ThF_4, chalcogenides, Be, Cr, Ni), this can lead to serious health hazards. See ISO 21254-1:2011, Annex A, for further comments.

1 Scope

This part of ISO 21254 specifies two methods of verifying the power density (energy density) handling capability of optical surfaces.

The first method provides a rigorous test that fulfils the requirements at a specified confidence level in the knowledge of potential defects.

The second method provides a simple, and hence inexpensive, test for an empirically derived test level.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11145, *Optics and photonics — Lasers and laser-related equipment — Vocabulary and symbols*

ISO 21254-1:2011, *Lasers and laser-related equipment — Test methods for laser-induced damage threshold — Part 1: Definitions and general principles*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11145 and ISO 21254-1 and the following apply.

3.1
assurance level
ϕ
energy density/power density/linear power density of the laser radiation incident on the optical surface of the component being tested

3.2
assurance area
A_ϕ
area over which the value of $H(x,y,z)$ is equal to or greater than the assurance level ϕ

3.3
confidence level
γ
probability of successful completion of the assurance test

3.4
flat-top beam
beam which has a broad area of nearly constant peak intensity (or fluence)

3.5
fraction of test area to be exposed
f_{test}
proportion of the total area of the optical component which has to be interrogated to achieve a certain confidence level

3.6
area to be tested
A_{test}
area of the optical component which has to be interrogated to achieve a certain confidence level

3.7
horizontal overlap
Ω_x
proportion of overlapping beam area of two consecutive pulses in direction x

3.8
vertical overlap
Ω_y
proportion of overlapping beam area of two consecutive pulses in direction y

3.9
distance between test sites
d_{ts}
separation of test sites

4 Symbols and units of measurement

The symbols and units of measurement are compiled in Table 1. In addition, the terms and definitions given in ISO 21254-1 apply.

Table 1 — Symbols and units of measurement

Symbol	Unit	Term
γ		confidence level
f_{test}		fraction of test area to be exposed
N_d		number of damage-initiation sites
ϕ	J/cm^2, W/cm^2, W/cm	assurance level
A_{ϕ}	cm^2	assurance area
A_{test}	cm^2	area to be tested
Ω_x		horizontal overlap
Ω_y		vertical overlap
d_{ts}		distance between test sites

5 Test methods

5.1 Principle

This part of ISO 21254 provides methods that will give a high level of confidence in the power density (energy density) handling capability of the component tested.

The methods can be used in a wide variety of applications, including: non-destructive testing, witness sampling, lot sampling and sub-aperture inspection. The level of confidence that the component does not contain a defect with a lower damage threshold than the acceptable irradiation strength increases with the percentage fraction of the area tested. These confidence levels are discussed in Annexes B and C.

Discussions shall be held between the test house and the user/component manufacturer to define the confidence level required and the number of shots per site (1-on-1 or S-on-1 testing) and the pulse-repetition frequency at which the tests are to be carried out.

This will define parameters such as the assurance area, A_{ϕ}, the distance between test sites, d_{ts}, and the total number of sites, N_{ts}, to be irradiated.

The apparatus for, general principles of and sampling for laser-induced damage testing are described in ISO 21254-1. A laser system with a suitable beam preparation system delivering laser radiation with a reproducible flat-top spatial profile is required for the assurance of laser power (energy) handling capabilities.

In this test, sampled test sites on the specimen surface are irradiated at an agreed or specified irradiation strength, irradiating in sequence a fraction of the specimen area and verifying that no damage is observed. Enough test sites on the optical surface under test shall be irradiated so that a given confidence level can be established.

Since the observation of any damage during a test constitutes a failure, this test can be non-destructive for parts for which this is considered acceptable.

The microscopic examination of the test site before and after irradiation is used to detect any damage.

The fluence-handling capability of an optical surface under irradiation by short pulsed lasers is usually expressed in units of energy density, i.e. joules per square centimetre.

The power-handling capability of an optical surface under irradiation by cw (continuous-wave) lasers or quasi-cw lasers is usually expressed in units of linear power density, i.e. watts per centimetre. The proper physical parameter and units for scaling results obtained with quasi-cw and cw-lasers is the linear power density, expressed in watts per centimetre.

5.2 Test methods

5.2.1 General

In tests that sample the ability of a specimen to withstand laser irradiation, it is possible to define two types of test.

The first, a type 1 test, allows the determination of a confidence level that permits no more than a certain number of defects to exist within the area tested. The type 1 test is described in 5.2.2.

The second, a type 2 test, is designed usually empirically, to be used on a specific specimen for a specific use. Such tests are employed to provide cost-effective screening at a high rate in an industrial environment. It should be noted that such empirically derived tests were the first widely used laser damage tests in production systems. The criteria that need to be specified to define a type 2 test are given in 5.2.3.

5.2.2 Type 1 test

Depending on the application, select the assurance level, ϕ, the confidence level, γ, and the number of defects, N_d, per specimen (usually the responsibility of the user).

Use Figure 1 to determine the fraction, f_{test}, of the area to be tested, A_{test}, that is to be exposed.

Determine (by measurement) A_ϕ from the power-density or energy-density profile of the irradiating beam in the target plane.

Determine the number of interrogations, N_{ts}, that will need be made to expose the fraction f_{test} of the surface under test:

$$N_{ts} = \frac{A_{test} \cdot f_{test}}{A_\phi} \quad (1)$$

Determine the distance between test sites, d_{ts}, for hexagonal close-packed arrays and for square arrays:

$$d_{ts} = \sqrt{\frac{2A_{test}}{N_{ts}\sqrt{3}}} \quad \text{for hexagonal close packed arrays} \quad (2)$$

$$d_{ts} = \sqrt{\frac{A_{test}}{N_{ts}}} \quad \text{for square arrays} \quad (3)$$

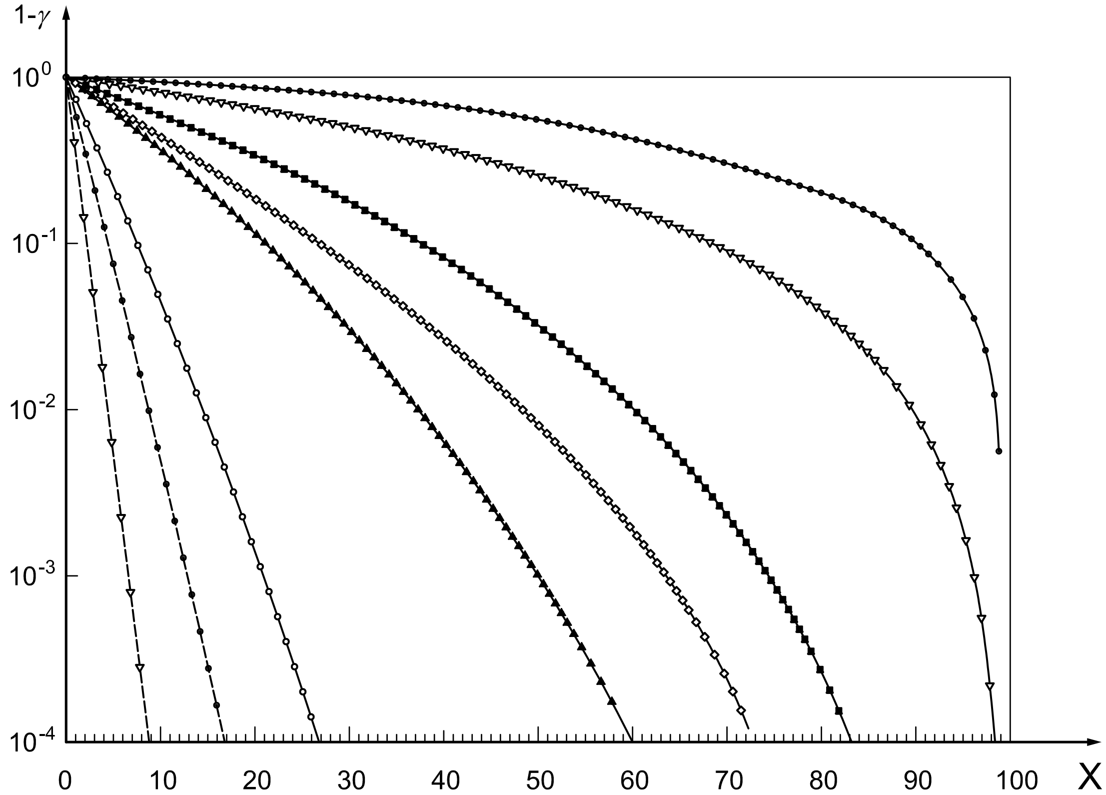
Calculate the overlap, Ω_x:

$$\Omega_x = \frac{\iint H(x,y) \cdot H(x - d_{ts}, y)\, dx dy}{\iint H(x,y)^2\, dx dy} \quad (4)$$

It might not be possible in all cases to perform an unconditioned assurance test, i.e. Ω_x or Ω_y << 1. Also note that, if $H(x,y)$ is significantly unsymmetric, it is necessary to calculate Ω_y and to consider using a different site spacing in the x- and y-directions:

$$\Omega_y = \frac{\iint H(x,y) \cdot H(x, y - d_{ts})\, dx dy}{\iint H(x,y)^2\, dx dy} \quad (5)$$

Irradiate the optical surface under test step by step for N_{ts} test sites. Each test site shall be separated by a distance corresponding to that in a hexagonal closed-packed array with a lattice constant of d_{ts}. For an S-on-1 test, each test site shall be irradiated with the required number of pulses for the particular application. If there is damage at any site, the part is considered to have failed the test and shall be disposed of accordingly. If the part under test resists irradiation (no damage at any site), then it is considered to have passed the test for the particular test parameters used.



Key

X percentage of the area tested

1 defect	10 defects
2 defects	30 defects
5 defects	50 defects
7 defects	100 defects

Figure 1 — Operating-characteristic curve

NOTE The derivation of the curve in Figure 1, called the operating-characteristic (OC) curve, is based on a defect-dominated damage mechanism. Details of the derivation of the OC curve are given in Annex C.

5.2.3 Type 2 test

In order to specify a type 2 test, the following parameters shall be specified and controlled:

— assurance level, ϕ;

— area over which at least this assurance level applies, A_{ϕ};

— number of spots tested, N_{ts};

— number of shots to which each spot is exposed, S;

— pulse-repetition frequency in an S-on-1 test, f_p;

— distance between test sites, d_{ts}.

If the user does not specify these parameters, then the testing laboratory shall use the maximum spot area at which a sufficient level of irradiation for assurance can be produced. The test laboratory shall also propose an irradiation pattern without spot overlap (e.g. 10 rows of 10 discrete spots over the centre of the area to be tested).

An example of a defined type 2 test is given in the latter part of Annex B.

NOTE The type 2 test has been shown to have a high degree of utility in industrial (large-scale) applications.

6 Accuracy

A calibration error budget as outlined in ISO 21254-1 shall be prepared to determine the overall accuracy of the measurement facility. Variations in the pulse-repetition rate, total energy or beam power, spatial profile and temporal profile shall be included in the error budget.

7 Test report

For the purpose of documenting and presenting the measurement data, the test report shall include the information specified in ISO 21254-1:2011, Clause 8, items a) to c), the type of assurance test which was performed, plus the following information.

a) Test conditions:

- source parameter settings;
- assurance test area;
- pulse energy;
- pulse duration;
- pulse-repetition rate.

b) Test results:

- whether the part tested passed or failed the test;
- if the result was a failure, then a photomicrograph should be included showing the damaged site.

A test report containing the test specifications and the test results shall be prepared and supplied to the user. An example is given in Annex A.

Annex A
(informative)

Example of a test report

Assurance of energy-handling capability in accordance with ISO 21254-3

Test institute

Name of institute:	Tres Gatos Laser Testing Corporation, Santa Monica, CA, USA
Tester/date:	Ben L. Gato 05/10/2001

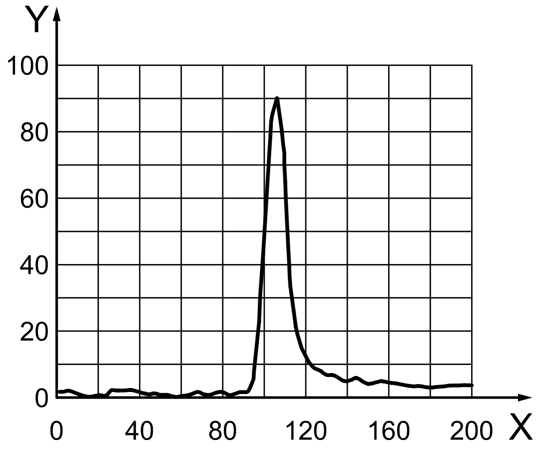
Specimen

Type of specimen:	Original part, HR at 193 nm on CaF_2
Manufacturer:	Blinding Light Optical, Salem, MA, USA
Storage, cleaning:	Normal laboratory conditions
Specification:	Highly reflective mirror, R > 99,5 % at 193 nm, 0 rad angle of incidence, standard coating for normal use in excimer lasers
Part identification, date of production:	BLO, 05/10/2001
Serial number of part:	BLO 3328-5570-193

Test specification

Laser parameters

Wavelength:	193 nm
Angle of incidence:	0 rad
Polarization state:	unpolarized
Pulse-repetition frequency:	200 Hz
Effective beam diameter in target plane:	6,6 mm
Pulse duration:	13,0 ns
Effective pulse duration:	12,5 ns

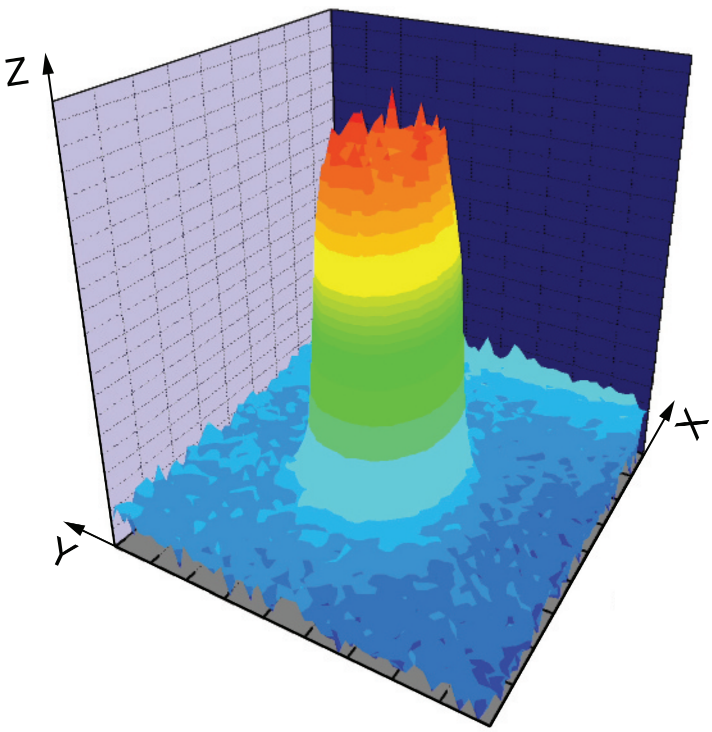


Key

X time, in nanoseconds

Y power, in arbitrary units

Figure A.1 — Temporal profile



Key

X length scale, in millimetres

Y length scale, in millimetres

Z fluence, in arbitrary units

Figure A.2 — Spatial profile

Error budget

a) Random variations:

pulse-to-pulse energy stability	± 7 %
pulse-to-pulse spatial-profile stability	± 3 %
pulse-to-pulse temporal-profile stability	± 10 %

b) Systematic variations:

energy monitor calibration	± 8 %
overall energy density measurement reproducibility	± 8 %
overall energy density measurement uncertainty	± 10 %

Test procedure

Type of test:	type 1
Assurance level:	6,5 mJ/cm^2
Confidence level:	97 %
Defect density per part:	5
Area tested:	4,9 cm^2
Conditioned test? (Yes or No):	No
Pulse-repetition frequency:	200 Hz
Number of shots per site:	100 000
Number of shots per specimen:	800 000
Arrangement of test sites:	hexagonal close-packed (see Figure A.3)
Distance between test sites:	6,7 mm
Number of specimens tested:	1
Total number of sites for the test:	8
Damage detection:	post-test inspection, Nomarski microscope
Storage of the specimen:	manufacturer's box, PE, normal room conditions
Test environment:	clean, filtered air
Cleaning:	manual cleaning with lens paper, isopropanol and acetone
Test result:	pass

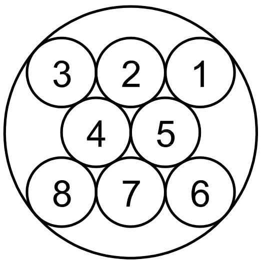


Figure A.3 — Arrangement of test sites

Annex B
(informative)

Notes on use

B.1 General

This annex discusses the use of this part of ISO 21254, from a typical note giving instructions to the test laboratory to the testing of the specimen in question and the resulting test report.

A typical note giving instructions on the assurance test could be as follows:

> "*Coated optical surface to be certified at 10 J/cm^2 to 95 % confidence that there are no more than 2 damage-initiation sites over the clear aperture. The clear aperture for this part has an area of 10 cm^2.*"

B.2 Type 1 test

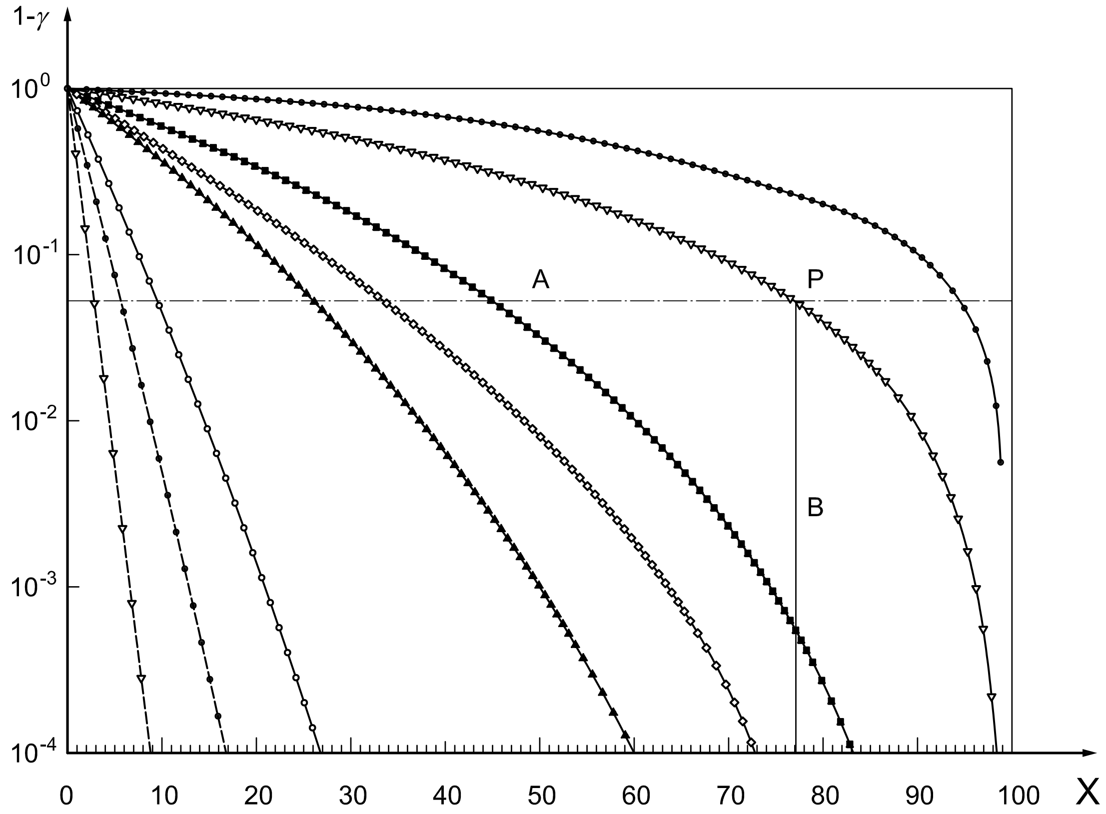
The parameters of the assurance test are given in the instructions in the note given in the last two sentences of Clause B.1.

Step 1: Determine the fraction of the test area, f_{test}, to be interrogated at the test level of 10 J/cm^2 to certify to a 95 % level of confidence that there are no more than 2 damage-initiation sites. To determine f_{test}, consult Figure 1. Using Figure B.1, make the following construction. Draw a horizontal line (A) with the value 0,05, this value being the complement of the confidence (which can also be called the risk). Continue this line until it intersects the curve corresponding to N_{d} = 2, i.e. point P. Then construct a line (B), perpendicular to A, through P. The intersection of B with the horizontal axis is the fraction of the surface area that should be interrogated, i.e. 0,77 or 77 %. Figure B.1 illustrates this process.

Step 2: Determine the area of the laser test spot that is at or above 10 J/cm^2, A_{10}. The determination of A_{10} requires knowledge of the spatial profile, $H(y,z)$. For the purposes of this example, it is assumed that the spatial fluence profile is an ideal "top-hat" distribution of radius 1 mm. Specifically,

$$H(y,z) = \begin{cases} H_0 & \text{if } \sqrt{y^2+z^2} \leqslant 1\text{ mm} \\ 0 & \text{if } \sqrt{y^2+z^2} > 1\text{ mm} \end{cases} \tag{B.1}$$

For this fluence distribution, A_{10} is π mm^2, i.e. 0,031 cm^2.



Key

X percentage of the area tested

1 defect

2 defects

5 defects

7 defects

95 % confidence [0,05 % Pr (S)]

10 defects

30 defects

50 defects

100 defects

A horizontal line

B perpendicular line

P intersection between line A and line B

Figure B.1 — Fraction of surface required to be tested for a confidence level of γ, for various values of N_d

Step 3: The next step is the calculation of the number of interrogation sites, N_{ts}, required to expose 77 % of the clear aperture area, A_{test}, to 10 J/cm2:

$$N_{ts} = \frac{A_{test} f_{test}}{A_{10}} = 249 \tag{B.2}$$

Step 4: Determination of the spacing between the interrogation sites is the next step. The most efficient arrangement of a two-dimensional lattice is a hexagonal closed-packed array, in which each site has six neighbours, each of which is equidistant. If the distance between test sites is denoted by d_{ts},

$$d_{ts} = \sqrt{\frac{2A_{test}}{N_{ts}\sqrt{3}}} \quad \text{for hexagonal close-packed arrays} \tag{B.3}$$

$$d_{ts} = \sqrt{\frac{A_{test}}{N_{ts}}} \quad \text{for square arrays} \tag{B.4}$$

Step 5: Solving for d_{ts} in the present case gives a centre-to-centre distance of 1,9 mm for a hexagonal close-packed array.

Step 6: In the present case, there is no overlap as d_{ts} is greater than the spot diameter. Thus $\Omega = 0$.

Step 7: Exposure of the part is the final step in the procedure. The part is interrogated 249 times with a distance of 1,9 mm between sites, and each site is monitored for damage. If all sites are exposed without any damage being observed, the part is certified as passing the test.

B.3 Type 2 test

In the case of a type 2 test, the following parameters are fixed:

a) the assurance level, ϕ;

b) the assurance area, A_ϕ;

c) the number of interrogations, N_{ts};

d) the number of shots per interrogation site, S;

e) the pulse-repetition frequency, f_p, if $S > 1$;

f) the distance between the test sites, d_{ts}.

For the purposes of this example, consider the design of a test on a hypothetical 5 cm by 5 cm window.

This part of ISO 21254 gives the process and parameters that should be specified to achieve a repeatable result. It does not give guidance on the values of the parameters for a type 2 test. This is the responsibility of the user, manufacturer or test organization.

For the 5 cm by 5 cm window, the user has defined the following values:

a) the assurance level, $\phi = 10$ J/cm^2;

b) the assurance area, $A_\phi = 15$ mm^2;

c) the number of interrogations, $N_{ts} = 5$;

d) the number of shots per interrogation site, $S = 200$;

e) the pulse-repetition frequency, $f_p = 20$ Hz;

f) the distance between the test sites, the maximum possible.

In the case of this hypothetical test, the window being tested is exposed initially at site 1 to 200 shots (see Figure B.2). If no damage is observed, then the laser is repositioned to site 2, where again 200 shots are fired. This process continues until either site 5 has received its 200 shots or damage is observed.

Dimensions in millimetres

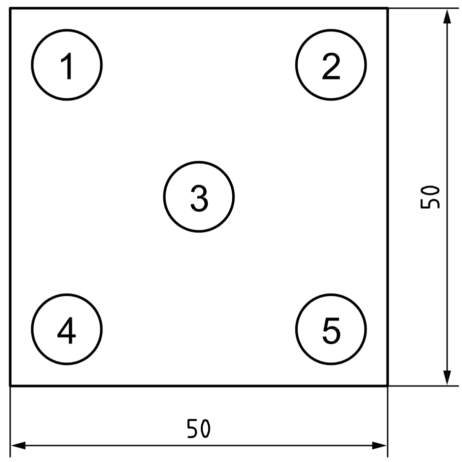


Figure B.2 — Type 2 test spot layout (typical)

Annex C
(informative)

Details of the derivation of the operating-characteristic curve

This annex provides details of the derivation of the operating-characteristic curve relating the probability of a successful test to the fraction of the test area interrogated, characterized by the number of damage sites, N_d.

The derivation begins with the derivation of the probability of damage on the first shot, denoted $P(D_1)$, which is given by:

$$P(D_1) = 1 - e^{\frac{-A_\phi N_d}{A_{test}}} \quad (C.1)$$

The probability of survival (no damage) on the first shot, denoted $P(ND_1)$, is the complement of $P(D_1)$, namely:

$$P(ND_1) = e^{\frac{-A_\phi N_d}{A_{test}}} \quad (C.2)$$

The probability of survival on the second shot is the product of the probabilities of survival on the first and second shots. The value of $P(ND_2)$ is given by:

$$P(ND_2) = e^{\frac{-A_\phi N_d}{A_{test} - A_\phi}} \quad (C.3)$$

The reason for subtracting A_ϕ is that there are no defects in the first spot interrogated, therefore the N_d defects are in the remaining fraction of A_{test}. So the probability of survival on the second shot, $P(S_2)$, is given by:

$$P(S_2) = P(ND_1) \cdot P(ND_2) = e^{\frac{-A_\phi N_d}{A_{test}}} \cdot e^{\frac{-A_\phi N_d}{A_{test} - A_\phi}} \quad (C.4)$$

From Equation (C.4), it is clear that the value of $P(S_n)$, the probability of survival on the nth shot, is given by:

$$P(S_n) = e^{\frac{-A_\phi N_d}{A_{test}}} \cdot e^{\frac{-A_\phi N_d}{A_{test} - A_\phi}} \ldots e^{\frac{-A_\phi N_d}{A_{test} - (n-1) A_\phi}} \quad (C.5)$$

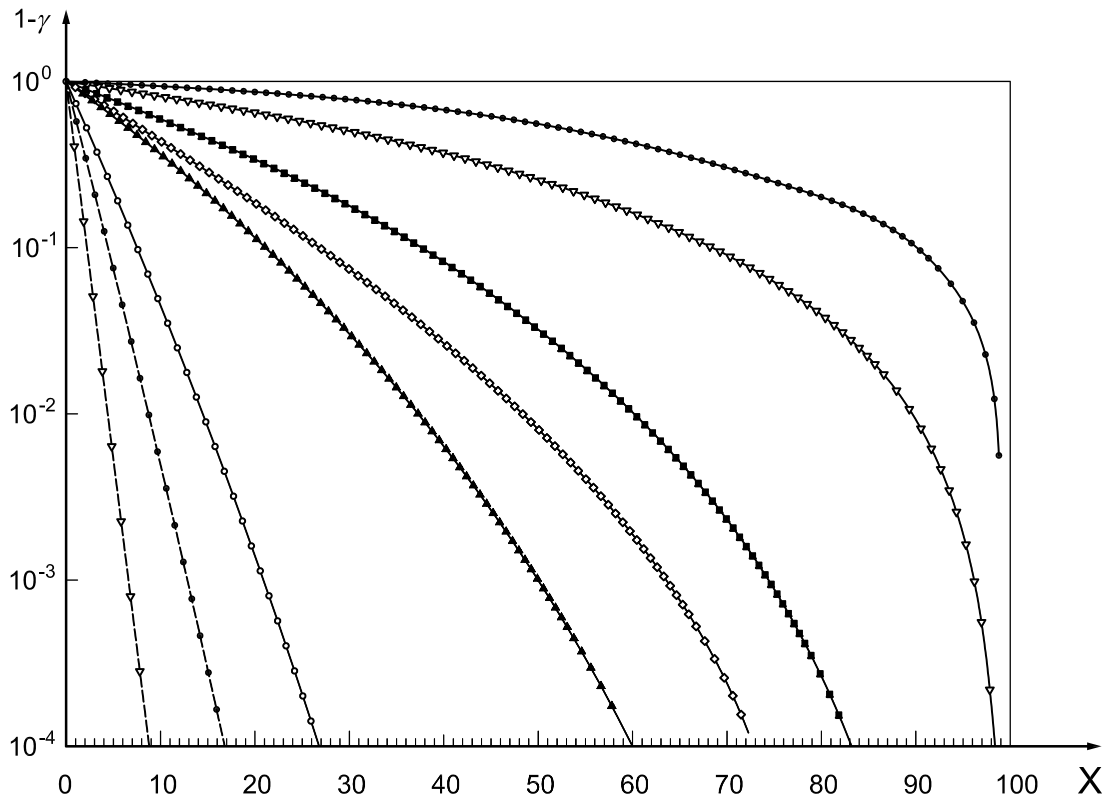
Equation (C.5) can be shown to be dimensionless by factoring out A_{test} from the exponents, as follows:

$$P(S_n) = e^{-\frac{A_\phi}{A_{test}} N_d} \cdot e^{\frac{-\frac{A_\phi}{A_{test}} N_d}{1 - \frac{A_\phi}{A_{test}}}} \ldots e^{\frac{-\frac{A_\phi}{A_{test}} N_d}{1 - (n-1)\frac{A_\phi}{A_{test}}}} \quad (C.6)$$

Letting $u = \frac{A_\phi}{A_{test}}$, i.e. the area of the laser spot relative to the area to be tested, it can be seen that u is the reciprocal of the number of interrogations needed to expose A_{test}. So the quantity $(n - 1)u$ is the fraction of the total area to be tested that has been interrogated (up to the nth interrogation). Thus, Equation (C.6) can be written as follows:

$$P(S_n) = e^{-u N_d} \cdot e^{\frac{-u N_d}{1-u}} \ldots e^{\frac{-u N_d}{1-(n-1)u}} \quad (C.7)$$

A plot of Equation (C.7) is given in Figure C.1.



Key

X percentage of the area tested

—•—	1 defect	—▲—	10 defects
—▽—	2 defects	—○—	30 defects
—■—	5 defects	--•--	50 defects
—◇—	7 defects	--▽--	100 defects

Figure C.1 — Operating-characteristic curve

Figure C.1 shows that $P(S_n)$ will vary strongly with the number of defects and the fraction of the assurance area interrogated. Further, $P(S_n)$ decreases monotonically with increasing area tested. Thus, survival can be interpreted as the determination that fewer than N_d defects are in the assurance area. But there is a finite probability that the specimen under test will fail early or will have more than N_d defects and not fail. The smaller this complimentary probability is made, the more certain that, in the assurance area, the number of defects does not exceed N_d. Therefore, γ is taken to be the confidence in the validity of the outcome of the assurance test.

For example, if very little of the area is interrogated, the optical surface is expected to survive except at the highest defect densities. So there is low confidence in a small-area test determining the maximum number of defects in the assurance area, and the value of γ is small. Conversely, if a large fraction of the area is interrogated, it is possible to discriminate even between N_d values of 1 and 2. As a result, γ is large and there is high confidence that there are less than N_d defects in the assurance area. This leads to the assignment of the name confidence to γ.

Bibliography

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