SLOVENSKI STANDARD
SIST-TP CEN/TR 17108:2017

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Neporušitvene preiskave - Osvetlitev pri preiskavah s penetranti in magnetnimi delci, dobra praksa

Non-destructive testing - Lighting in penetrant and magnetic particle testing, good practice

Zerstörungsfreie Prüfung - Beleuchtung in Eindring- und Magnetpulverprüfung , bewährte Verfahren

Essais non destructifs - Bonnes pratiques d□éclairage lors des contrôles par ressuage et par magnétoscopie

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19.100 Neporušitveno preskušanje Non-destructive testing

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TECHNICAL REPORT

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English Version

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (CEN/TR 17108:2017) has been prepared by Technical Committee CEN/TC 138 "Non-destructive testing", the secretariat of which is held by AFNOR.

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

1 Scope

This Technical Report describes the good practices of lighting under UV-A radiation and in white light as used for penetrant testing (PT) and magnetic particle testing (MT) for improved probability of detection (POD).

This informative document deals with the irradiance and the illuminance used in PT and MT. It is intended for:

— manufacturers, who are encouraged to supply the criteria and the restrictions on use of their products, as well as detailed characteristics for the appropriate choice and the optimum use of sources available on the market;

— users, to enable them to make the best use of lighting sources for efficient inspection in working conditions;

— supervision and training personnel, who may design and optimally arrange inspection areas, recommend the principles of visual ergonomics for ensuring inspector efficiency, comfort and safety.

2 Normative references

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

EN 170, *Personal eye-protection — Ultraviolet filters — Transmittance requirements and recommended use*

EN 12464-1, *Light and lighting — Lighting of work places — Part 1: Indoor work places*

CEN/TR 16638, *Non-destructive testing — Penetrant and magnetic particle testing using blue light*

EN 62471, *Photobiological safety of lamps and lamp systems (IEC 62471)*

EN ISO 12706, *Non-destructive testing — Penetrant testing — Vocabulary (ISO 12706)*

EN ISO 12707, *Non-destructive testing — Magnetic particle testing — Vocabulary (ISO 12707)*

ISO/CIE 19476 (CIE S 023/E), *Characterization of the performance of illuminance meters and luminance meters*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in EN ISO 12706, EN ISO 12707 and the following apply.

3.1
centroid wavelength
mathematically weighted mean output wavelength sharing in two equal parts the spectrum emitted by a source

3.2
colour rendering index
CRI
degree of agreement between the colour appearance of objects illuminated by the considered source and that of the same objects illuminated by a reference illuminant, under specified viewing conditions

3.3
colour temperature
***T*cp**
temperature of a planckian (or black body) radiator, the radiation of which has the same chromaticity as a given stimulus, expressed in Kelvin (K)

3.4
LEDs
light-emitting diodes

3.5
maculopathy
impaired function of the macula which degrades colour vision and leads to a decrease of visual acuity

3.6
mesopic vision
twilight or medium vision between the photopic vision and the scotopic vision

3.7
photopic vision
daytime or high-luminance vision where only the cone optic cells are active

Note 1 to entry: In photopic vision, the 555 nm wavelength (green-yellow) is the human eyes maximum sensitivity.

3.8
scotopic vision
night-time or in low luminance vision where only the rod optic cells are active

Note 1 to entry: In scotopic vision, the 505 nm (blue-green or turquoise.) wavelength is the human eyes maximum sensitivity.

4 Fluorescent techniques, inspection booth, lights and visual ergonomics

4.1 Lights: UV-A beam spectral characteristics

4.1.1 General

UV-A LED lamps technology needs to be understood since they are used for lighting in NDT methods using fluorescent materials, ISO 3059 deals with requirements but the following clauses provide technical explanation and guidance for the use of UV-A lamps in NDT.

4.1.2 Symmetry of the spectrum around the centroid wavelength

The optical brighteners used in penetrants and some fluorescent pigments used in the MT detection media usually absorb 80 % of the radiation energy between 340 nm and 380 nm. Therefore for UV-A LEDs a symmetrical, Gaussian emission spectrum around the peak output wavelength is recommended.

The optical brighteners used in penetrants and some fluorescent pigments used in the MT detection media have an absorption peak between 360 nm and 370 nm. The centroid wavelength of the UV-A source shall be close to the peak absorption so that the radiation is more efficient to excite the dyes of the fluorescent penetrants and the pigments of the fluorescent detection media.

These conditions are met when the centroid wavelength is close to the central wavelength (emission peak).

4.1.3 Unwanted visible light of the UV-A spectrum: limitation of the emission > 380 nm

The eye is sensitive to wavelengths greater than 380 nm. The 380 nm to 420 nm area (violet light and extreme violet) is emitted as a stray light by most of UV-A source.

This violet can cause, as UV-A, visual blue haze by exciting some proteins in the eye.

Vision of the direct violet and indirect blue haze effect leads to increasing the noise which impairs the detection of indications.

Manufacturer shall minimize the emission of violet light by carefully selecting the LEDs, the filter, and using a well-controlled thermal management system to prevent any drift leading to an increase of unwanted violet output.

This visible violet to which the eye is sensitive is not fully filtered by Wood filters nor by all the UV-blocking goggles; this comes at the cost of the contrast at the inspection stage on all types of metal parts (except yellow metals that naturally absorb violet and blue).

Bright surfaces strongly reflect violet light, requiring the inspector to guide the relative position of the parts to avoid this reflection; matt surfaces turn to a purplish colour background regardless of the orientation of the beam.

4.1.4 Radiometric specifications: UV-A/violet ratio

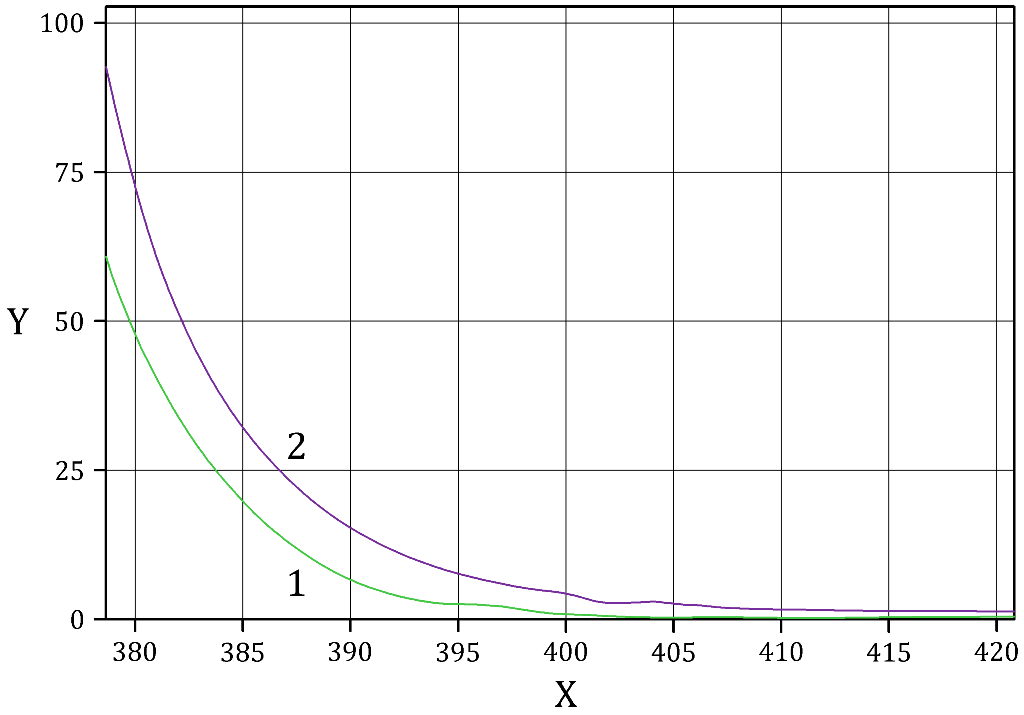
Violet light is the 380 nm 420 nm area.

In order to take into account the data described in the previous clause, the manufacturer or the supplier shall state the measurements relevant to the UV-A/ violet ratio in the product data sheet (user manual, procedure, product manual, etc.).

The result may be given in the form of a ratio calculated by analysing the spectrum with a spectrophotometer positioned at the beam centre, then, by discriminating the UV-A area up to 380 nm and the violet area, 380 nm to 420 nm.

For professional purposes, UV-A sources should be used so as to minimize their effect, as follows:

— a Wood filter or similar, to remove violet as much as possible, shall be an integral part of the source.



Key

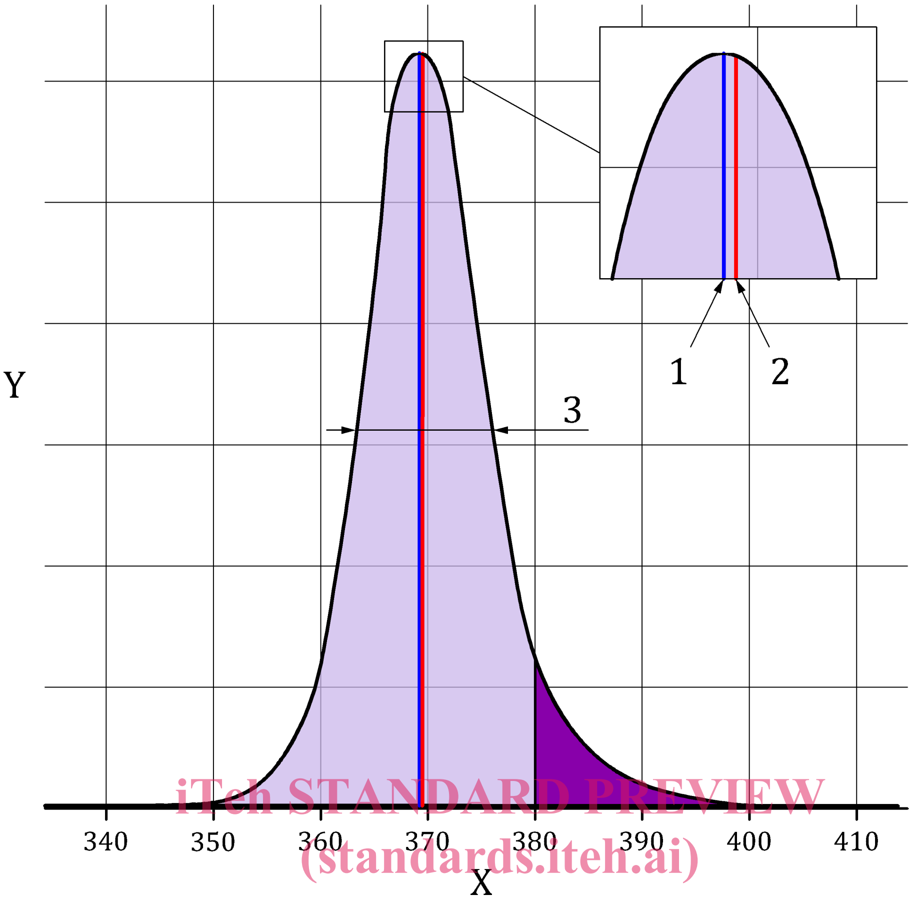
X wavelength (nm)

Y relative scale

1 green curve: UV-A spectra with Wood filter in the violet range

2 purple curve: UV-A spectra without Wood filter in the violet range

Figure 1 — Example of reduction of the violet light 380 nm to 420 nm by a source fit with a Wood filter



Key

X wavelength (nm)

Y relative irradiance

1 central wavelength: 368,9 nm

2 centroid wavelength: 369,5 nm

3 full width half maximum: 10,9 nm

NOTE The left side in light violet colour corresponds to UV-A and the right side in dark violet colour to visible violet

Figure 2 — Example of measured spectrum

4.1.5 Thermal management (cooling), sustaining performances

A poor thermal management will cause beam instability, spectrum shift with violet increase and power loss.

In case of LED sources, the elements ensuring the extraction of calories shall be maintained in an optimal operation condition (e.g. dust filter replacement, removing dust deposits on coolers, renewal of thermal paste during LED maintenance etc.).

An automatic circuit-breaker system shall be built-in to take action in case of overheating; leading to a non-compliance of the beam (wavelength shift beyond 370 nm and violet versus UV-A ratio increase for LEDs).

Regarding LED sources: during their use, no decrease of power, likely to reduce the irradiance without notice by the operator, shall ever be acceptable as a means to prevent overheating.

For UV source not intended to be used continuously the manufacturer shall state the maximum time to be used.

4.2 UV-A beam geometrical characteristics

4.2.1 General

The variety of inspection circumstances and the variety of part sizes and localizations, such as large individual parts or grapes of small sized parts, need our attention to choose adequate lighting scenari; a good choice leads to visual performance enhancement and better POD.

4.2.2 Geometric consideration for use

The pattern and the beam size of the source in use should be fitted to the surface of the area inspected on the parts and the arrangement thereof (if parts are displayed as “clusters” or as “trays” of several parts). The way the human eye works and, particularly, the roles of the fovea and of the peripheral vision shall be taken into account during inspection.

Therefore, several types of beam patterns should be considered: wide or narrow, with sharp or progressive edges to adapt the beam to the spatial conditions and orientation on the inspection zone to use the full capability of detection of the human vision.

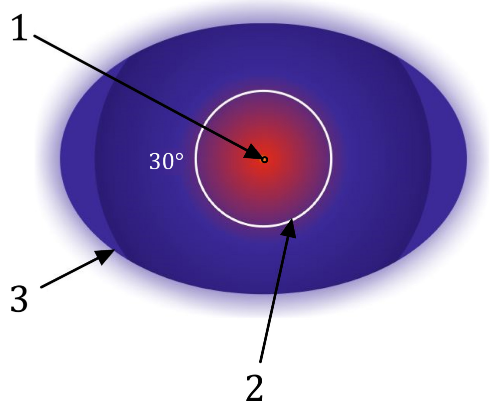
A practical test of the source for the specific application is always helpful before choosing the beam pattern.

The field of vision may be considered as three areas:

1) The fovea is the central area of the macula (see Figure 3). It is located on the optical axis of the eye where only the cone optic cells are tightly present. At this level, the vision is more accurate and more detailed than for the rest of the retina;

2) The near peripheral vision utilizes rod and cone sensors and provides a more general vision capability. This is a much wider area of the visual field than the foveal region;

3) The far peripheral vision is the remaining angular range of vision.



Key

1 fovea / macula

2 near peripheral vision

3 far peripheral vision

Figure 3 — Illustration of the vision areas