International Standard

ISO 17514

Second edition
2024-03

Time-measuring instruments — Photoluminescent deposits — Test methods and requirements

Instruments de mesure du temps — Dépôts photoluminescents — Méthodes d'essais et exigences

Reference number
ISO 17514:2024(en)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword ..... **iv**
Introduction ..... **v**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 Test methods and requirements **2**
4.1 Tests on sample 2
4.1.1 General 2
4.1.2 Test sample 2
4.1.3 Colours 2
4.1.4 Luminous intensity 2
4.1.5 Ageing resistance 3
4.1.6 High/low temperature resistance 4
4.2 Tests on complete time-measuring instruments and on components 5
4.2.1 Visibility 5
4.2.2 Legibility 5
4.2.3 Adhesion 6
Annex A (informative) **Conditions for the visual examination** **7**
Annex B (normative) **Adhesion** **8**
Annex C (informative) **Visibility and legibility limits** **9**
Bibliography **10**

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 114, *Horology*, Subcommittee SC 5, *Luminescence*.

This second edition cancels and replaces the first edition (ISO 17514:2004), which has been technically revised.

The main changes are as follows:

— precisions have been added in the different test methods;

— the method of the ageing resistance test has been changed;

— in 4.2, tests on components and on time-measuring instruments has been separated;

— adhesion tests (refers to ISO 3157 in ISO 17514:2004) have been added in this document.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Luminescent deposits on watch components (hands, dial, bezel) give the possibility to read the time in the dark. Radioluminescent deposits were common in the past but are not used anymore except for certain products under certain conditions which may be the subject of national regulations. Nowadays, photoluminescent products are mainly used. Their properties have been considerably improved these last years.

The present document describes test methods performed only on photoluminescent deposits, including some which were described in ISO 3157 and ISO 4168 concerning radioluminescent deposits, these standards having been withdrawn.

Time-measuring instruments — Photoluminescent deposits — Test methods and requirements

1 Scope

This document specifies the test methods of various aspects of the photoluminescent deposits applied to time-measuring instruments, together with the requirements related to them.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
photoluminescent deposit
composite material made of photoluminescent pigment and binding, which can accumulate luminous energy and release it as visible light, and destined to be applied on a support

3.2
luminous intensity
light intensity for a remote observer

Note 1 to entry: This is expressed as nanocandelas (ncd), millicandelas (mcd) are also accepted.

Note 2 to entry: The definition given differs from the definition given in ISO 80000-7 and is used only within the scope of this document.

3.3
luminance
ratio of the light intensity to the surface unit of emission for a remote observer

Note 1 to entry: This is expressed as nanocandelas per square centimetre (ncd/cm^2), millicandelas per square metre (mcd/m^2) are also accepted.

Note 2 to entry: The definition given differs from the definition given in ISO 80000-7 and is used only within the scope of this document.

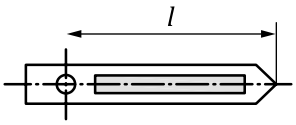
3.4
legibility
ability to the time-measuring instrument with luminescent items (hands, dial...) to be read distinctly

3.5
legibility limit
minimum *luminous intensity* (3.2) with which indications from the time-measuring instrument can be read distinctly

3.6
visibility
ability to the luminescent item to be seen distinctly

3.7
hand length
distance between the hole's centre and the end showing the indication of hours and minutes

Note 1 to entry: See Figure 1



Key
l hand length

Figure 1 — Hand length

4 Test methods and requirements

4.1 Tests on sample

4.1.1 General

If two samples need to be compared, parameters and test conditions shall be the same and reported in the test report.

4.1.2 Test sample

Apply (30 ± 1) mg of photoluminescent deposit to a plane surface area of (1 ± 0,03) cm^2 white support. The deposit thickness is homogeneous on all the area.

The white colour shall be the safety white N°9003 of the RAL (Reichsausschuss für Lieferbedingungen) colour range or a similar white colour checked by *L*a*b** measurements.

4.1.3 Colours

Colour checking shall be done by comparative visual examination in daylight or under any lamp reproducing the daylight, like a D65 light source. The D65 spectrum is defined by the relative spectral power distribution [$S(\lambda)$] in ISO/CIE 11664-2.

Samples compared each other shall have a similar state of charge and as close to zero as possible. For this purpose, they should be stored in the dark until their luminous intensity decreases and reaches a value equal to or lower to 3 ncd. The discharge is accelerated when samples are stored at temperature between 40 °C and 50 °C. Then, they are simultaneously taken out of the dark room and submitted to the colour control.

The number of person(s) carrying out the visual examination is defined by the contracting parties.

*L*a*b** measurements according to CIE 015 are a possible alternative.

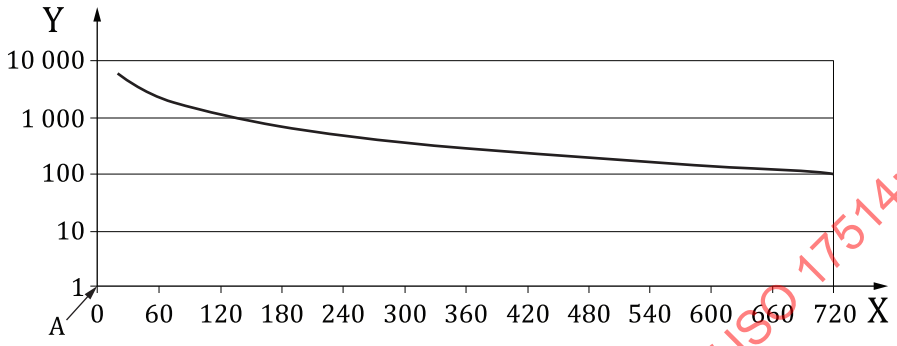
4.1.4 Luminous intensity

Luminous intensity of the test sample shall be checked according to the following procedures:

a) Store the test sample in the dark until the luminous intensity of the sample decreases to a value equal to or lower to 3 ncd; the discharge is accelerated when the sample is stored at temperature between 40 °C and 50 °C; if this method is used, the sample should return to room temperature before step b);

b) Put the test sample under the D65 light source at 400 lx for 20 min; an exposition under 500 lx for 10 min is also accepted if these test conditions are specified in the test report;

c) Measure the luminous intensity of the test sample with a photometer for 7 h immediately after the step b), continuously or, if the apparatus used doesn't permit it, by doing periodical measurements: the first one after 30 min, the following ones at regular periods, at least every hour. Note that the higher the number of measurements, the more accurate the results. The operator is aware that luminous intensity is very high immediately after the exposition under D65 light. Some cautions may be necessary, as using filters to not damage the photometer. Generally, luminous intensity values between the end of D65 light exposition and 10 min after are difficult to measure (see the Figure 2 as an example).



Key

X time (min)

Y luminous intensity (ncd)

A end of activation

NOTE The origin (time = 0) is the first measurement after D65 light exposition. The values during the first 10 min are difficult to measure, so they are not shown on the figure.

Figure 2 — Example of luminous intensity measurements against the time

Throughout the test steps b) and c), the ambient temperature shall be (23 ± 5) °C. Nevertheless, measurements, which permit to compare samples, shall be carried out within a maximum temperature range of 4 °C. The relative humidity shall be (50 ± 20) %.

NOTE Luminous intensity is generally measured on 1 cm^2 samples, but luminance can also be measured.

4.1.5 Ageing resistance

4.1.5.1 Procedure

Ageing resistance of the test sample shall be checked according to the following procedures:

a) measure the luminous intensity of the test sample according to 4.1.4;

b) expose the sample to light sources correctly filtered, emitting a radiance with a spectrum close to the one of the sun. The energetic dose shall be 7,8 MJ/m^2.

c) visually inspect the test sample in the conditions specified in Annex A;

d) measure again the luminous intensity according to 4.1.4.

4.1.5.2 Apparatus

Information concerning equipment used for the ageing resistance test under sunlight, test conditions and operating procedure are specified in ISO 14368-4:2020, 4.10.

Use a Xenon lamp or a metallic halide lamp. The parameters to be used are specified in Table 1 so that the energetic dose received by the sample is identical whatever the lamp used.

Table 1 — Parameters for the xenon lamp and for the metallic halide lamp

Parameter	Xenon lamp	Metallic halide lamp
Energetic dose, E_d	7,8 MJ/m^2	7,8 MJ/m^2
Irradiance (max), I	60 W/m^2 (290 nm to 400 nm)	30 W/m^2 (320 nm to 400 nm)
Black standard temperature, T_{bs}	(65 ± 5) °C	(35 ± 5) °C
Exposure duration (min), t_e	36 h	72 h

The energetic dose is calculated with Formula (1):

$$E_d = I \times t_e \quad (1)$$

where

E_d is the energic dose, in J/m^2;

I is the irradiance, in W/m^2;

t_e is the exposure duration, in s.

Filtering should minimize irradiance under 290 nm and above 800 nm. The irradiance on sample surfaces is fixed between 290 nm and 400 nm. A relative humidity of (60 ± 5) % is recommended.

4.1.5.3 Requirements

The test sample is compared with a reference sample. It shall not have any discoloration, crack, damage, breakage or any exfoliation. If discoloration is observed, and in agreement between the contracting parties, the discoloration level may be determined by a grey scale.

The intensity luminous loss between before and after the ageing resistance test, measured at least every hour, shall not be more than 10 %. The requirement applies to all measurements done (every hour).

4.1.6 High/low temperature resistance

4.1.6.1 Procedure

High/low temperature resistance of the test sample shall be checked according to the following procedures:

a) measure the luminous intensity of the test sample according to 4.1.4;

b) store the test sample at the temperature of (80 ± 5) °C and at the relative humidity of (50 ± 20) % for 1 h;

c) test sample is taken out of the high temperature test chamber and placed in an environment where the temperature is (23 ± 5) °C and the relative humidity is (50 ± 20) %. Allow the test sample cool during at least 30 min;

d) store the test sample at the temperature of (–20 ± 5) °C for 1 h;

It is allowed to use one chamber. In this case, the temperature of the test chamber should be continuously and uniformly reduced from (80 ± 5) °C to (–20 ± 5) °C for a duration of at least 30 min.

e) Visually inspect the test sample in the conditions specified in Annex A;

f) Measure again the luminous intensity according to 4.1.4.

The low temperature test may be carried out first, then the high temperature test.

4.1.6.2 Requirements

The test sample is compared with a reference sample. It shall not have any discoloration, crack, damage, breakage or any exfoliation. If necessary and in agreement between the contracting parties, the discoloration level may be determined by a grey scale.

The intensity luminous loss between before and after the high/low temperature resistance test, measured at least every hour, shall not be more than 10 %. The requirement applies to all measurements done (every hour).

4.2 Tests on complete time-measuring instruments and on components

4.2.1 Visibility

4.2.1.1 General

The visibility test is applied on one component (hand, dial index…) or a set of components. The aim of the test is to ensure that the light emission by components is sufficient during a minimal duration of storage in the dark.

4.2.1.2 Procedure

The inspector shall enter the dark room at least 10 min before attempting the visual inspection. Recommended distances necessary for visual inspection are 30 cm for watch components, 50 cm for table clock component and 150 cm for wall clock components.

The number of person(s) carrying out the visual examination is defined by the contracting parties.

Visibility of any component or set of components shall be checked according to the following procedures:

a) Store the component or the set of components in the dark until it is not detectable by naked eye;

b) Put the component or the set of components under the D65 light source at 400 lx for 20 min, and then store it in the dark; an exposition under 500 lx for 10 min is also accepted if these test conditions are specified in the test report;

c) Visually inspect the component or set of components for its visibility in the dark room (without any ambient light) after a 3 h storage, then at chosen times, during a recommended overall duration of 7 h.

   Any other durations defined between contracting parties shall be specified in the test report.

Throughout the test steps b) and c), the ambient temperature shall be (23 ± 5) °C. Nevertheless, measurements, which permit to compare samples, shall be carried out within a maximum temperature range of 4 °C. The relative humidity shall be (50 ± 20) %.

4.2.1.3 Requirements

The component or the set of components shall be clearly seen after a storage duration fixed between contracting parties. The different components from the set of components shall be clearly distinguished.

See Annex C for the recommended values.

4.2.2 Legibility

4.2.2.1 General

The legibility test is intended to complete time-measuring instruments. The aim of the test is to ensure that the time reading is possible during a minimal duration of storage in the dark.

4.2.2.2 Procedure

The inspector shall enter the dark room at least 10 min before attempting the visual inspection. Recommended distances necessary for visual inspection are 30 cm for watches, 50 cm for table clocks and 150 cm for wall clocks.

The number of person(s) carrying out the visual examination is defined by the contracting parties.

Legibility of any time-measuring instrument shall be checked according to the following procedures:

a) Store the time-measuring instrument in the dark until it is not detectable by naked eye;

b) Put the time-measuring instrument under the D65 light source at 400 lx for 20 min, and then store it in the dark; an exposition under 500 lx for 10 min is also accepted if these test conditions are specified in the test report;

c) Visually inspect the time-measuring instrument for its legibility in the dark room (without any ambient light) after a 3 h storage, then at chosen times, during a recommended overall duration of 7 h.

   Any other durations defined between contracting parties shall be specified in the test report.

Throughout the test steps b) and c), the ambient temperature shall be (23 ± 5) °C. Nevertheless, measurements, which permit to compare samples, shall be carried out within a maximum temperature range of 4 °C. The relative humidity shall be (50 ± 20) %.

4.2.2.3 Requirements

Hour and minute hands shall be clearly identified (seen and distinguished) after a storage duration fixed between contracting parties.

NOTE Time legibility doesn't need that the second hand is visible.

The 12 o'clock direction on the dial shall be clearly identified (seen and distinguished) after a storage duration fixed between contracting parties.

See Annex C for the recommended values.

4.2.3 Adhesion

The test methods specified in Annex B shall be used to control the photo-luminescent deposit adhesion on the components.

Annex A
(informative)

Conditions for the visual examination

A.1 General

This annex specifies the method and test conditions for the visual examination of photoluminescent deposit.

The aims of visual examination are to

— check the photoluminescent deposit colour on a sample with a reference sample,

— control the photoluminescent deposit to detect the possible presence of defects such as discoloration, crack, damage, breakage or exfoliation and any defects due to a lack of adhesion such as chipping of the deposit,

— control the visibility in the dark of any component with photoluminescent deposit, and

— control in the dark the legibility of time on a time-measuring instrument.

A.2 Procedure

A.2.1 Visual examination in the light

The sample is placed against a background, whose colour makes a good contrast with the colour of the photoluminescent deposit.

Illuminate the sample with an intensity of more than 500 lx using white light close to natural light. A standard light source D65 with intensity of more than 500 lx shall be used, when arbitration is needed.

The sample is placed and held under normal service conditions, at the distance of distinct vision, usually 30 cm.

When the visual examination is done to check the colour by comparing two samples, these samples shall be equally charged. The samples are stored in the dark until their luminous intensity decreases to a value equal to or lower to 3 ncd. Then, they are extracted from the dark room simultaneously before carrying out the control.

When the control is done to detect any presence of defects, a magnifying glass with a magnifying capability of ×4 or less may be used if a naked eye control is too difficult.

The number of person(s) carrying out the visual examination is defined by the contracting parties.

A.2.2 Visual examination in the dark

The inspector enters the dark room at least 10 min before attempting the visual inspection. Recommended distances necessary for visual inspection are 30 cm for watches, 50 cm for table clocks and 150 cm for wall clocks.

The number of person(s) carrying out the visual examination is defined by the contracting parties.

Annex B
(normative)

Adhesion

B.1 General

Adhesion of the photoluminescent deposit on the components shall be checked through visual inspections before and after the test to be run according to B.2, B.3 or B.4 depending on the nature of the tested component.

B.2 Adhesive tape test

An adhesive tape test may be used as an adhesion test when the photoluminescent deposit is on dials or on hands.

Use an adhesive tape with a peel adhesion of 2,9 N/cm to 3,3 N/cm. The tape is adhered to the surface where the photoluminescent product is deposited, ensuring that bubbles between the tape and the surface are eliminated. After 10 s, tear the tape quickly with the force perpendicular to the surface. The tape used shall not leave any glue residues on the surface.

NOTE For hands where photoluminescent deposits fill empty cavities, depending the deposition method, the adhesive tape is applied on the hand side where the tape adheres to the photoluminescent deposit.

B.3 Adhesion test for hands by folding

The photoluminescent deposit can be applied on bulk hands, on hollow hands or can fill empty cavities (the last case is the most common).

For hand lengths, *l*, of 15 mm or less, hands shall be bent around a cylinder with a radius of (12,5 ± 1) mm.

For hand lengths, *l*, of over 15 mm, hands shall be bent around a cylinder with a radius equal to the length of the hand, *l*, with a tolerance of ±1 mm.

Generally, the back side of the hand is in contact with the cylinder and not the visible side. For special cases of hands, the side in contact with the cylinder have to be determined by agreement between the contracting parties.

In the case of special designs, if it is not possible to bend the hands around a cylinder, they shall be subjected to the vibration test specified for rigid components in B.4.

B.4 Adhesion tests for rigid components

The dials and rigid components shall be subjected to sinusoidal vibrations communicating an acceleration of greater than 20 m/s^2 (peak value), at a selected frequency between 25 Hz and 100 Hz, for a period such that the frequency multiplied by the time, expressed in seconds, is equal to 90 000.

A table moves according to the sinusoidal vibrations described before. The component is fixed on the table in the way that the side which emits light is directed upwards (e.g. position dial up CH for a dial) and they are no clearance between the table and the component. Therefore, it is submitted to the vibrations.

B.5 Requirements

The photoluminescent deposit shall have no cracks, damages, breakages or exfoliations.