

---

**INTERNATIONAL STANDARD**



**3157**

---

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

---

**Radioluminescence for time measurement instruments —  
Specifications**

*Radioluminescence pour les instruments horaires — Spécifications*

First edition — 1975-05-01

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO 3157:1975](#)

<https://standards.iteh.ai/catalog/standards/sist/c621070e-c224-439b-8c24-5550f20bba07/iso-3157-1975>

---

UDC 681.113/.114 : 681.11-758.35

Ref. No. ISO 3157-1975 (E)

**Descriptors:** clocks, luminescence, specifications, legibility, radiation protection, radioluminescent deposits, colour, tests, ageing tests (materials), adhesion tests.

Price based on 4 pages

## FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3157 was drawn up by Technical Committee ISO/TC 114, *Horology*,\* and circulated to the Member Bodies in December 1973.

It has been approved by the Member Bodies of the following countries :

Czechoslovakia	Japan	Switzerland
Egypt, Arab Rep. of	Romania	United Kingdom
France	South Africa, Rep. of	U.S.S.R.

No Member Body expressed disapproval of the document.

© International Organization for Standardization, 1975 •

Printed in Switzerland

\* On 19 July 1966, the Council of the Organization for Economic Co-operation and Development (OECD) adopted a recommendation concerning protection against radiation from radioluminescent watches and clocks.

This document was the result of work by the Health and Security Committee of the European Nuclear Energy Agency (ENEA), carried out in collaboration with the International Atomic Energy Agency (IAEA).

Circulated by the IAEA in 1968 as No. 23 of the "Safety" collection, it has been used as the basis for this International Standard.

# Radioluminescence for time measurement instruments — Specifications

## 1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies requirements for the optical, mechanical and radioactive characteristics of the radioluminescent deposits fixed on time measurement instruments, together with the methods of test relating to them.

The first part (clause 4) applies to all time measurement instruments which include components (hands, dials, bezels, etc.) bearing radioluminescent deposits.

The second part (clause 5) applies to the deposits themselves, whether they are fixed on the time measurement instruments in question, or on special supports.

## 2 DEFINITIONS

**2.1** A time measurement instrument bearing radioluminescent deposits shall correspond to the specifications in clause 4.

**2.2** A radioluminescent deposit intended for time measurement instruments shall correspond to the specifications in clause 5.

## 3 TERMINOLOGY

**3.1** In this International Standard, the terms in *italics* have the same meaning as in current International documents. In particular, explicit reference will be made to the International Lighting Vocabulary (3rd Edition, common to the CIE and IEC, Publication CEI 50(45)). Consequently, it is specified that the *luminous intensities* are, until further notice, defined on the basis of  $V(\lambda)$ , the *photopic luminous efficiency function* defining the mean eye for *photometry*. Certain terms must, however, be specially defined.

**3.2 radioluminescence** : *Luminescence* caused by the radiation of a radionuclide within certain crystalline powders (ZnS, Zn<sub>2</sub>SiO<sub>4</sub>, etc.).

**3.3 radioluminescent deposit** : A radioluminescent substance in powder form mixed with a binder and fixed on a support.

**3.4 special time measurement instruments** : Instruments designed for uses which require considerable *luminosity*. They are generally used or worn intermittently. Because of this, the quantity of radioactive substance used is greater.

## 4 SPECIFICATIONS AND TEST METHODS FOR TIME MEASUREMENT INSTRUMENTS

### 4.1 Legibility

**4.1.1** For watches using radioluminescent substances, the following quality criteria apply :

a) At least four hour markings shall be used. It is permissible to use only three, however, when the instrument includes an aperture.

b) The 12 shall be differentiated from the other markings.

c) The hour-hand shall be differentiated from the minute-hand.

d) If only four markings are used, the total *luminous intensity*, i.e. that of the whole (hands + markings) shall be at least 25 ncd\*. However, in the case of three markings, permitted above, this lower limit is reduced to 22 ncd.

e) If more than four markings are used, the above threshold is increased by 3 ncd per additional marking.

f) The pair of hands, taken in isolation, shall have a *luminous intensity* of 10 ncd or more.

**4.1.2** For time measurement instruments not worn on the person, the minimum values of the *luminous intensities* above are doubled; points a), b), and c) of 4.1.1 also remain valid.

These specifications apply within the framework of present techniques; but they do not constitute a limitation on the development of new techniques based, for example, on the use of non-luminescent markings on dials the whole surface of which is luminescent.

\* nanocandelas

**4.2 Nature of the radionuclides used**

4.2.1 Only the use of the following radionuclides is authorized :

- Tritium** (<sup>3</sup>H) For marking : **T**
- Promethium** (<sup>147</sup>Pm) For marking : **Pm**
- Radium** (<sup>226</sup>Ra) For marking : **Ra**

4.2.2 The use of different radionuclides on the same time measurement instrument is prohibited.

NOTE — Attention is drawn to the fact that certain national regulations may prohibit or limit the use of one of the radionuclides listed above.

**4.3 Total radioactivity of the instruments**

The tables give, for each category of instrument and type of radionuclide, the maximum values authorized for the mean radioactivity of the instruments of a lot, according to document No. 23 of the IAEA "Safety Series", and the radioactivity of an instrument considered individually.

a) TIME MEASUREMENT INSTRUMENTS WORN ON THE WRIST

Radionuclide	Maximum activity of a lot (per instrument)	Maximum activity of an isolated instrument
<sup>3</sup> H	5 mCi	7,5 mCi
<sup>147</sup> Pm	0,1 mCi	0,15 mCi
<sup>226</sup> Ra	0,1 μCi	0,15 μCi

b) TIME MEASUREMENT INSTRUMENTS WORN ELSEWHERE THAN ON THE WRIST

<sup>3</sup> H	5 mCi	7,5 mCi
<sup>147</sup> Pm	0,1 mCi	0,15 mCi

c) TIME MEASUREMENT INSTRUMENTS NOT WORN OR CARRIED ON THE PERSON

<sup>3</sup> H	7,5 mCi	10 mCi
<sup>147</sup> Pm	0,15 mCi	0,2 mCi
<sup>226</sup> Ra	0,15 μCi	0,2 μCi

d) SPECIAL TIME MEASUREMENT INSTRUMENTS

Radionuclide	Maximum activity of an isolated instrument
<sup>3</sup> H	25 mCi
<sup>147</sup> Pm	0,5 mCi
<sup>226</sup> Ra	1,5 μCi

NOTE — The use of radium (<sup>226</sup>Ra) for time measurement instruments worn on the person is strictly limited to wrist watches, even in the case of special time measurement instruments.

**4.4 Protection against radioactivity**

The envelope of the time measurement instrument (case, glass and protective varnish) shall be so constituted that the user is protected against any direct contact with the components treated with radioluminescent material, and that the low-energy β-radiations are sufficiently absorbed.

In any case, any deposit of radioluminescent material shall be protected by a thickness of transparent non-radioactive material equal to 50 mg/cm<sup>2</sup> or more.

The mechanical strength of this protection shall be sufficient to bear the stresses encountered under normal conditions of use and, as far as reasonably practicable, during possible accidents.

**4.5 Checking of the radioactivity**

The activity may be checked, in relation to the requirements specified in 4.3, on the time measurement instrument fitted with its normal protection (glass). A method based on photometric measurement is authorized. If the measurement of the *Bremsstrahlung* (T, Pm) is used, account shall be taken of the attenuation due to the glass and to the deposit itself. The thicknesses of the glass and the deposit are either measured or estimated by convention at 50 mg/cm<sup>2</sup> each. This is without prejudice to the requirements specified in 4.4.

When uncertainty resulting from the above-mentioned methods of checking makes it impossible to guarantee that the requirements specified in 4.3 are complied with, a destructive method shall be used to measure the activity. Such a destructive method shall consist in isolating the radionuclide from the other constituents of the luminescent substance, or from the deposit, and converting it into a form suitable for as accurate a measurement as possible to be made.

NOTE — For example, for tritiated substances, a suitable method consists in destruction of the luminescent deposit by combustion, collection of the liberated water and measurement of its activity with a liquid scintillator.

**4.6 Marking**

The marking specified below is obligatory only for special time measurement instruments. It is intended for the information of the horologist as well as the user.

It shall be effected, legibly and indelibly, on the dial of the instrument.

It shall comprise one of the three following indications :

- T 25** for deposits activated by tritium
- Pm 0,5** for deposits activated by promethium
- Ra 1,5** for deposits activated by radium

These indications give the value, in millicuries for tritium and promethium deposits and in microcuries for radium deposits, of the maximum authorized radioactivity.

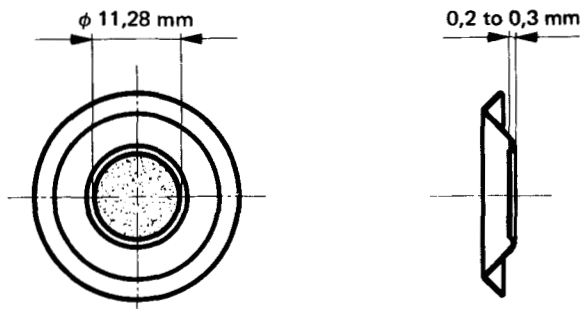
**4.7 Checking of the marking**

The marking shall be checked by visual inspection.

**5 SPECIFICATIONS AND TEST METHODS FOR RADIOLUMINESCENT DEPOSITS**

The specifications relating to the deposits can be checked, unless special restrictions are indicated :

- a) on the finished instruments;
- b) on the dials (see clause 1 and 5.5);
- c) on a sample placed on a standard support made of stainless steel having a *reflectivity* between 0,2 and 0,3, comprising a circular coupelle containing a circular cup with a surface area of 1 cm<sup>2</sup>, intended to hold 50 mg of powder;



- d) on standard hands (see clause 1 and 5.5);
- e) on the rectangular support defined for the checking of the colours (5.1.2).

**5.1 Colours**

**5.1.1 STANDARDIZED COLOURS**

- 1 – white
- 3 – yellow
- 5 – greenish-yellow
- 7 – green
- 9 – blue-green

This list is not restrictive, and, on agreement between the manufacturer and the user, other colours may be used.

**5.1.2 CHECKING OF THE COLOURS**

The colours of the deposits shall be checked by visual examination, in daylight, without sun, on samples as defined in 5 c).

The colours shall be compared with those of reference standards consisting of 50 mg of non-activated luminescent powder deposited on a surface of 1 cm<sup>2</sup> at one end of a standard support of the following design, made of stainless steel having a *reflectivity* between 0,2 and 0,3. The standards must be stored in the dark.



NOTE – The standards are prepared and stored at the Laboratoire Suisse de Recherches Horlogères and may be supplied on request by the Secretariat of ISO/TC 114.

**5.2 Specific luminous intensity**

The quality of the deposits is characterized by their *luminous intensity per unit mass of powder* when they are examined in layers of 50 mg of powder per square centimetre, on a support having a *reflectivity* between 0,2 and 0,3.

**5.2.1 ALLOCATION OF QUALITY CLASSES**

It is recommended that the specific *luminous intensities* expressed in *microcandelas* per gram of powder ( $\mu\text{cd/g}$ ), be included between the intervals given in the table below.

The minimum values indicated are imperative.

The maximum values are only given as an indication.

Class	Minimum value	Maximum value
1	2,5	3,15
2	4	5
3	6,3	8
4	10	12,5
5	16	20
6	25	31,5
7	40	50
8	63	80

NOTE – If necessary, supplementary classes 9, 10 etc. may be introduced by using the R5 series of preferred numbers.

**5.2.2 CHECKING OF THE SPECIFIC LUMINOUS INTENSITY**

The deposit shall be applied on a standard support as specified in 5 c).

The *luminous intensity* shall be checked after the luminescent deposit has been kept in darkness for at least 3 h.

The *luminous intensity* is measured with a photometer equipped with photomultiplier tube showing a response curve corresponding to  $V(\lambda)$ , the photopic luminous efficiency function (see 3.1), or any other equipment assuring an equivalent precision.

The characteristics of the standards used for this measurement and the radioluminescent deposits shall be similar. They shall present a satisfactory stability and be periodically checked by an official organization.

The *luminous intensity* shall be evaluated in relation to the mass of the powder in the deposit, in conformity with the specifications given in 5.2.1.

NOTE – ISO carbon 14 standards are prepared and stored at the Laboratoire Suisse de Recherches Horlogères. They are checked periodically and may be supplied on request by the Secretariat of ISO/TC 114.

**5.3 Resistance to ageing.**

**5.3.1 NATURE OF THE TEST**

It is considered that simultaneous exposure to heat, humidity and activating light constitutes a test of accelerated ageing which validly simulates the conditions of real ageing.

**5.3.2 PROCEDURE**

Place the deposit in a crystallizer (a glass container, in the form of a cylinder with a flat bottom and straight sides, the height of which is equal to approximately half of the diameter) containing water at normal temperature. The support must not be immersed. Cover the crystallizer with a sheet of polyethylene 0,1 mm thick. Place a 300 W high-pressure mercury vapour lamp with ultra-violet radiation 300 mm above the deposit.

Bring the crystallizer to  $55 \pm 2^\circ\text{C}$  and then switch on the lamp. Maintaining this temperature, expose to radiation for 3 h.

**5.3.3 ESTIMATION OF THE RESISTANCE TO AGEING**

The *luminous intensity* of the deposit shall be measured before and after the test. The loss in *luminous intensity* shall be less than 10 %.

**5.4 Adhesion**

**5.4.1 PROCEDURE FOR DIALS AND RIGID COMPONENTS**

The dials and rigid components shall be subjected to sinusoidal vibrations communicating an acceleration of over  $20 \text{ m/s}^2$  at a selected frequency between 25 and 100 Hz, for a period of time such that the frequency multiplied by the time, expressed in seconds, is equal to 90 000.

**5.4.2 PROCEDURE FOR HANDS**

a) Hands with a length of 15 mm or less shall be bent round a cylinder with a radius of 12,5 mm.

b) Hands with a length of over 15 mm shall be bent round a cylinder with a radius equal to the length of the hand, with a tolerance of  $\pm 1 \text{ mm}$ .

c) If, in the case of special designs, it is not possible to bend the hands round a cylinder, they shall be subjected to the vibration test specified for rigid components (see 5.4.1).

**5.4.3 ESTIMATION OF THE ADHESION**

Following these tests, examine the dials and hands as well as their immediate surroundings. The presence of alterations such as splits and cracks or of perceptible debris shall be considered grounds for rejection. Detached particles are revealed by means of an ultra-violet lamp.

**5.5 Insolubility**

**5.5.1 PROCEDURE**

Immerse the deposit to a depth of at least 3 mm for 24 h in distilled water, at a temperature between  $18^\circ\text{C}$  and  $25^\circ\text{C}$ . Then measure the activity of the water. For 50 mg of deposit, it shall be less than :

- 100  $\mu\text{Ci}$  for tritium deposits,
- 6  $\mu\text{Ci}$  for promethium deposits,
- $0,3 \times 10^{-3} \mu\text{Ci}$  for radium deposits.

**5.5.2 CHECKING OF THE INSOLUBILITY**

Carry out checks on standard deposits as defined in 5 c) which have been prepared in accordance with the instructions of the manufacturer of the luminous powder and which have undergone the test specified in 5.4.1.

Quality control may also be carried out on luminous components (dials and hands) which have undergone the tests specified in 5.4. The mass of the powder in the deposit shall then be measured or calculated, the maximum authorized activity of the water being considered proportional to the mass of the powder in the deposit, regardless of its activity.