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**INTERNATIONAL STANDARD**



**3157**

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**Radioluminescence for time measurement instruments —  
Specifications**

*Radioluminescence pour les instruments horaires — Spécifications*

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## 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.

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\* 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,  $Zn_2SiO_4$ , 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.