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NORME INTERNATIONALE

Nuclear instrumentation – Constructional requirements and classification of radiometric gauges

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Instrumentation nucléaire – Exigences de construction et classification pour les jauges radiométriques

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**NUCLEAR INSTRUMENTATION –
CONSTRUCTIONAL REQUIREMENTS
AND CLASSIFICATION OF RADIOMETRIC GAUGES**

FOREWORD

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International Standard IEC 62598 has been prepared by IEC technical committee 45: Nuclear instrumentation.

This standard cancels and replaces the second edition of IEC 60405, issued in 2003. It constitutes a technical revision (see Introduction).

This bilingual version, published in 2011-05, corresponds to the English version.

The text of this standard is based on the following documents:

FDIS	Report on voting
45/718/FDIS	45/721/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

This International Standard is based on the second edition of IEC 60405 which was published in 2003. It modifies or supplements it with additional provisions, where required by current needs.

Compared to the second edition of IEC 60405, the following major changes have been made:

- Introduction of Category C for stand alone source housings intended for fixed radiometric gauges and associated test procedures.
- The system classification code has been amended by one digit indicating the applied revision of IEC 62598 and by a second digit indicating the fire test conditions.
- The term dose rate class shall be used instead of radiation protection class. Class 7, or alternatively E, represents the current ICRP regulations.
- Introduction of fire resistance classes.
- Revision of the procedure for dose equivalent measurements.
- Addition of Annex A (informative) "Guidelines for the installation of radiometric gauges".

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NUCLEAR INSTRUMENTATION – CONSTRUCTIONAL REQUIREMENTS AND CLASSIFICATION OF RADIOMETRIC GAUGES

1 Scope and object

This International Standard applies to the manufacture and installation of electrical measuring systems and instruments utilizing radioactive sources (radiometric gauges, hereinafter called gauges). It also applies to source housings intended for use in the aforementioned measuring systems. This standard applies to equipment, which is not related to power production or to the fuel cycle.

It does not apply to portable gauges which, because of their construction and purposes for use, are intended to be operated as mobile equipment and it does not apply to gauges operated with X-ray tubes, but it can be analogously applicable to these gauges.

The object of this standard is to specify constructional requirements for the design of instruments utilizing radioactive sources in regard of radiation protection. This standard does not take into account mechanical or electrical hazards.

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.

IEC 60050-394:2007, *International Electrotechnical Vocabulary (IEV) – Part 394: Nuclear instrumentation – Instruments, systems, equipment and detectors*

IEC 60476:1993, *Nuclear instrumentation – Electrical measuring systems and instruments utilizing ionizing radiation sources – General aspects*

IEC 60692:1999, *Nuclear instrumentation – Density gauges utilizing ionizing radiation – Definitions and test methods*

IEC 60846-1:2009, *Radiation protection instrumentation – Ambient and/or directional dose equivalent (rate) meters and/or monitors for beta, X and gamma radiation – Part 1: Portable workplace and environmental meters and monitors*

IEC 60846-2:2007, *Radiation protection instrumentation – Ambient and/or directional dose equivalent (rate) meters and/or monitors for beta, X and gamma radiation – Part 2: High range beta and photon dose and dose rate portable instruments for emergency radiation protection purposes*

IEC 60982:1989, *Level measuring systems utilizing ionizing radiation with continuous or switching output*

IEC 61005:2003, *Radiation protection instrumentation – Neutron ambient dose equivalent (rate) meters*

IEC 61010-1:2010, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements*

IEC 61326 (all parts), *Electrical equipment for measurement, control and laboratory use – EMC requirements*

IEC 61336:1996, *Nuclear instrumentation – Thickness measurement systems utilizing ionizing radiation – Definitions and test methods*

ISO 361:1975, *Basic ionizing radiation symbol*

ISO 921:1997, *Nuclear energy – Vocabulary*

ISO 2919:1999, *Radiation protection – Sealed radioactive sources – General requirements and classification*

3 Terms and definitions

For the purposes of this document, the terms and definitions as specified in ISO 921, IEC 60050-394 and IEC 60476, as well as the following apply.

3.1

collimation device

device for restricting the radiation in one or more directions

3.2

detector housing

that portion of the measuring head that includes the detector

NOTE This assembly may be incorporated with the source housing, especially in the case of a back-scatter measurement system.

3.3

measuring head

subassembly comprising one or several radioactive sources and detectors along with compensation sensors, if necessary, and devices that can be used to measure and correct the effects of undesirable influences

NOTE The measuring head may consist of separate source-housing and detector-housing subassemblies and it may include electronic devices for signal processing.

3.4

permanently installed radiometric gauge

radiometric gauge that is permanently installed at the measuring location

NOTE The measuring location may also be situated on mobile equipment (e.g., on a ship or a vehicle). The detector housing and the source housing may be installed both rigidly fixed and movable. The mobility of the system is limited and determined by the purpose for which it was designed.

3.5

radiometric gauge

control and measuring assembly consisting of at least one radioactive source, at least one detector and the mechanical devices required for non-destructive measurement of a process quantity

3.6

sealed source

radioactive source that is sealed in a solid and inert capsule or is permanently incorporated in solid and inert materials so that dispersion of radioactive substances under normal conditions of use is substantially prevented; at least one dimension shall be $\geq 0,2$ cm

3.7**source holder**

device used to support and fix the radioactive source

NOTE In the context of this standard the term source holder means the part of the device which supports or holds the source, e.g., the shutter or a part of the housing.

3.8**source housing**

that portion of the measuring head which includes the radioactive source, its holder and primary shielding device and shutter mechanism, if any

NOTE If the source housing is not part of a measuring head the term stand alone source housing is used (see 3.9).

3.9**stand alone source housing**

device which includes the radioactive source, its holder, primary shielding, collimator and optional shutter mechanism

3.10**useful radiation; useful beam**

portion of radiation that is emitted by the radioactive source and used for measurement

4 Classification of radiometric gauge types**4.1 Category A: Radiometric gauges with restricted beam**

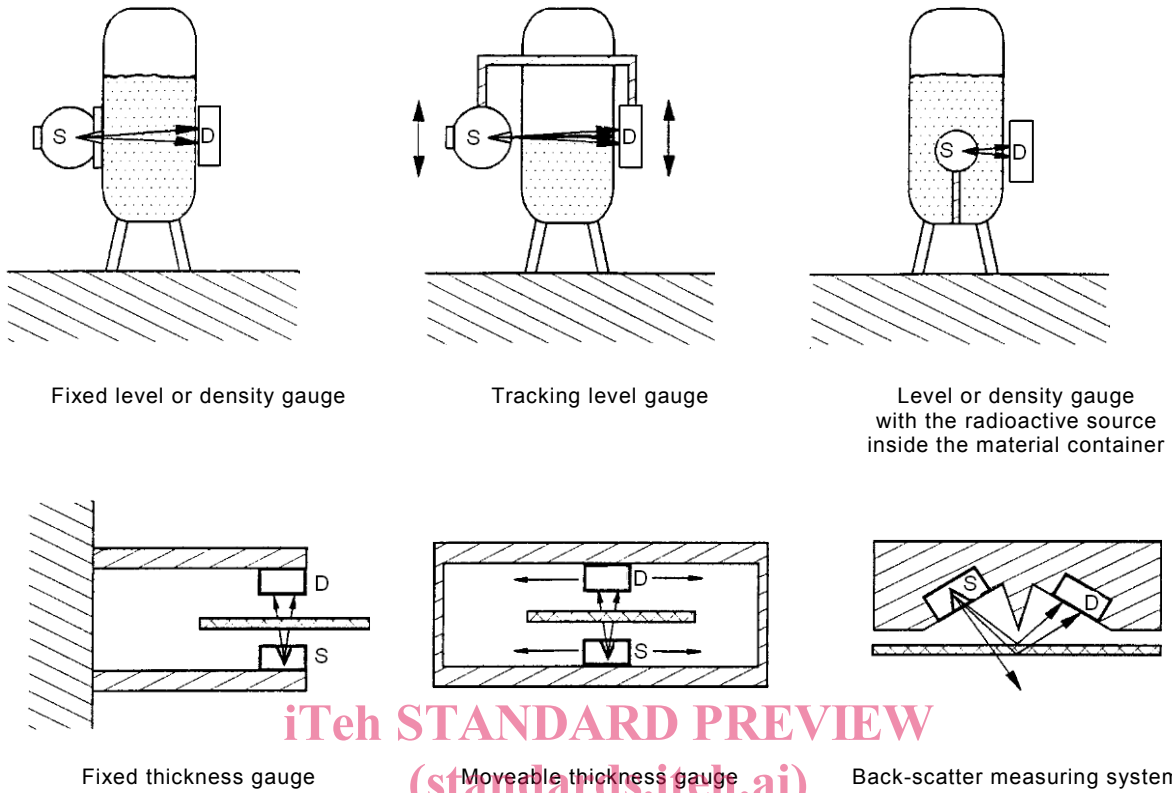
Category A comprises gauges equipped with a device for collimation of the radiation, thereby restricting the useful beam.

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The gauge shall be designed in such a way that the radiation, except for the useful beam, is attenuated in conformity with the requirements of this standard (see Figure 1).



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Key

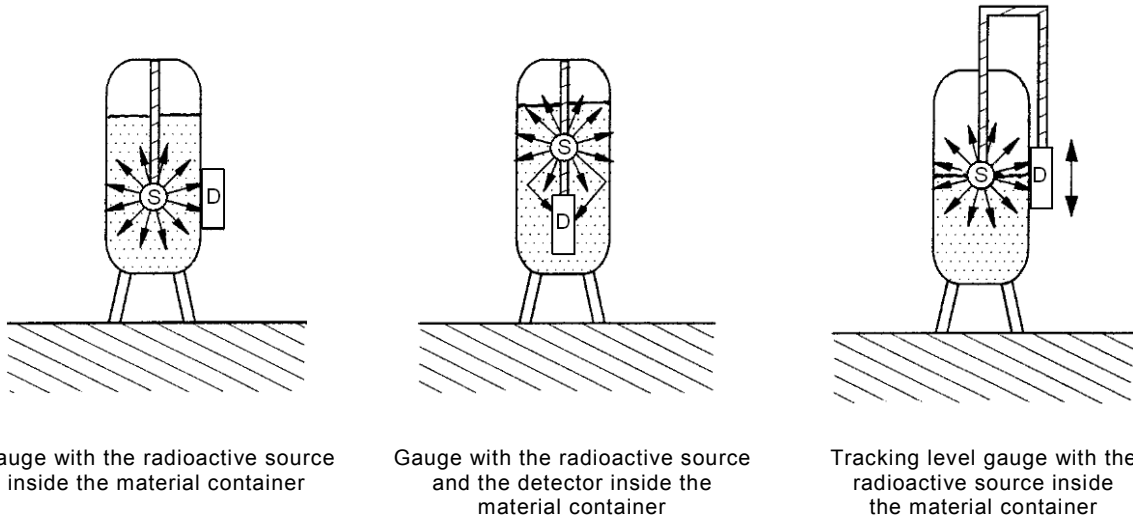
- D detector housing
- S source housing

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Figure 1 – Schematic arrangement of Category A gauges

4.2 Category B: Radiometric gauges with omnidirectional beam

Category B comprises gauges without a device for collimation of the radiation in one or more directions of the useful beam or where the alignment does not comply with the requirements of Category A gauges (see Figure 2).



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Key

- D detector housing
S source housing

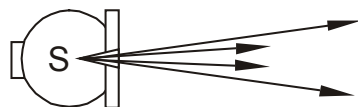
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Figure 2 – Schematic arrangement of Category B gauges

4.3 Category C: Stand alone source housings for fixed radiometric gauges

Category C comprises stand alone source housings for radiometric gauges equipped with shielding and properties for collimation of the useful beam. The source housing shall be designed in such a way that the radiation, except for the useful beam, is attenuated in conformity with the requirements of this standard (see Figure 3).

NOTE Such source housings are used in fixed level or density gauging systems in which the source housing and the detector are independent units and the useful beam is not restricted by the detector but by additional radiation protection measures.



IEC 535/11

Figure 3 – Category C stand alone source housing for fixed level or density gauges

4.4 Dose rate classes

The gauges shall be classified into the dose rate classes as specified in Table 1, when the dose equivalent rate is measured according to Clause 8.

NOTE The classification of the gauges into dose rate classes simplifies the approval procedure and facilitates the use in practice.

Table 1 – Dose rate classes

	Dose rate class						
	1	2	3	4	5	6	7 or E
Maximum dose equivalent rate at a distance of 5 cm	Not in compliance	> 1 mSv/h ≤ 5 mSv/h	> 0,5 mSv/h ≤ 1 mSv/h	> 0,05 mSv/h ≤ 0,5 mSv/h	> 7,5 μSv/h ≤ 0,05 mSv/h	> 3,0 μSv/h ≤ 7,5 μSv/h	≤ 3,0 μSv/h
Maximum dose equivalent rate at a distance of 100 cm	Not in compliance	> 0,1 mSv/h ≤ 0,5 mSv/h	> 25 μSv/h ≤ 0,1 mSv/h	> 7,5 μSv/h ≤ 25 μSv/h	> 2,5 μSv/h ≤ 7,5 μSv/h	> 1,0 μSv/h ≤ 2,5 μSv/h	≤ 1,0 μSv/h

NOTE 1 The numbering of the classes starts from 2 for reasons of backward compatibility with IEC 60405 Edition 2, now withdrawn. Class 1 of the first and second editions of IEC 60405 are no longer applicable.

NOTE 2 Class 7 or E : This class relates to current ICRP regulations. Classes 7 and E are equivalent.

NOTE 3 Referring to 10.1 to each gauge four shielding classes are assigned. Two for "shutter closed" at 5 cm and 100 cm respectively and two for "shutter open" at 5 cm and 100 cm respectively.

NOTE 4 The dose equivalent rate can be measured in terms of $\dot{H}^*(10)$ and/or $\dot{H}'(0,07)$, see 8.4.

4.5 Temperature class

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In conformity with the maximum and minimum operating temperature values on which the design is based the gauges shall be classified into temperature classes as specified in Table 2.

NOTE The gauges are classified into separate temperature classes for both the maximum operating temperature and the minimum operating temperature (see 10.1).

Table 2 – Temperature classes

	Temperature class						
	1	2	3	4	5	6	7
Maximum operating temperature	No test conducted	50 °C	70 °C	100 °C	200 °C	400 °C	Other value
Minimum operating temperature	No test conducted	10 °C	0 °C	- 10 °C	- 20 °C	- 40 °C	Other value

If the temperature class corresponding to the testing range of an incorporated source (e.g., according to ISO 2919) is lower than that of the source housing the temperature class of the source only shall be used.

5 General requirements

5.1 Measuring gap

In order to prevent persons placing their hands or any other part of their body in the useful beam, the gauges shall be constructed in such a way that the measuring gap is kept to a practical minimum. This also includes any other points where access to the useful beam is likely to occur. Where there is potential to expose body parts the user shall install additional protective devices.

5.2 Source holder

The source holder shall be designed and constructed in such a way that:

- a) an easy installation and de-installation of the radioactive source is feasible under radiologically safe conditions;
- b) a reliable positioning of the source is feasible under radiologically safe conditions.

5.3 Source housing

The source housing shall be designed and constructed in such a way that:

- a) the radioactive source is protected under normal operating conditions against impacts which could damage it if no other means are provided in the gauge for such protection;
- b) dismantling of the radioactive source by non-authorized persons is prevented (e.g., by providing a safety lock, special tools which are necessary to open the housing, or by security sealing procedures);
- c) it withstands the adverse physical and chemical influences expected in accordance with the user's information (e.g., by means of installing an additional protective hood or any other installation-related measures);
- d) the radioactive source is secured in a manner to prevent the radioactive source from falling out even in the event of mechanical damage to the housing or in case of fire;
- e) it is possible to carry out source leakage tests under radiologically safe conditions.

5.4 Alignment of the useful beam

The source and detector heads shall be aligned so that the collimating properties of Category A gauges restrict the useful beam so that it does not extend beyond the detector or its shields with no measured material in the measuring gap, provided this is necessary to conform to permissible limit values in accordance with 6.1. For Category B and C gauges, the stand alone source housing or the source housing should reduce the dose equivalent rate outside the useful beam to levels as low as practical.

5.5 Other requirements

In addition to the specified constructional requirements, the gauges shall comply with the provisions as laid down in the respective valid version of the appropriate national regulations currently in force.

Additional non-safety relevant information on instruments and systems for which this standard is applicable is given in IEC 60692, IEC 60982 and IEC 61336. General constructional requirements for electrical measuring, control and laboratory instruments are given in IEC 61010-1. Electromagnetic compatibility (EMC) requirements are given e.g., in the IEC 61326 series. Safety requirements and tests for classification of the sealed sources used in the gauges are given in ISO 2919.