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BSI Standards Publication

Nuclear instrumentation — Constructional requirements and classification of radiometric gauges

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National foreword

This British Standard is the UK implementation of EN 62598:2013. It is identical to IEC 62598:2011. It supersedes BS EN 60405:2007 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee NCE/2, Radiation protection and measurement.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Nuclear instrumentation - Constructional requirements and classification of radiometric gauges

(IEC 62598:2011)

Instrumentation nucléaire - Exigences de construction et classification pour les jauges radiométriques (CEI 62598:2011)

Strahlungsmessgeräte - Konstruktionsanforderungen und Klassifikation radiometrischer Messanordnungen (IEC 62598:2011)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This document (EN 62598:2013) consists of the text of IEC 62598:2011 prepared by IEC/TC 45 "Nuclear instrumentation".

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2014-07-22
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-07-22

This document supersedes EN 60405:2007.

EN 62598:2013 includes the following significant technical changes with respect to EN 60405:2007:

– 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 EN 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".

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

Endorsement notice

The text of the International Standard IEC 62598:2011 was approved by CENELEC as a European Standard without any modification.

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

		International Electrotechnical Vocabulary - 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 (mod)	2003	Radiation protection instrumentation - Neutron ambient dose equivalent (rate) meters	EN 61005	2004
IEC 61010-1 + corr. May	2010 2011	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements	EN 61010-1	2010
IEC 61326	Series	Electrical equipment for measurement, control and laboratory use - EMC requirements	EN 61326	Series
IEC 61336	1996	Nuclear instrumentation - Thickness measurement systems utilizing ionizing radiation - Definitions and tests methods	-	-
ISO 361	1975	Basic ionizing radiation symbol	-	-
ISO 921	1997	Nuclear energy - Vocabulary	-	-

Publication	Year	Title	EN/HD	Year
ISO 2919	1999	Radiation protection - Sealed radioactive sources - General requirements and classification	-	-

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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".

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 ≥ 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

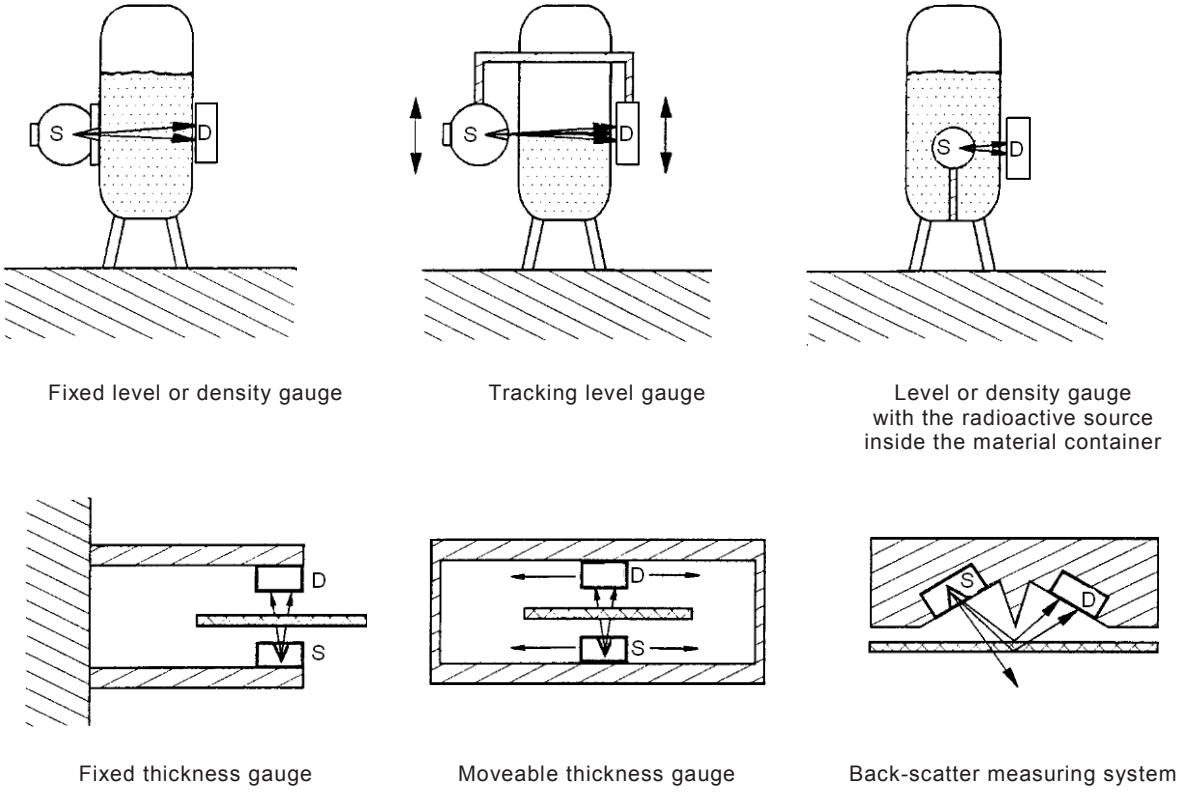
3.10
useful radiation; useful beam
portion of radiation that is emitted by the radioactive source and used for measurement

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.

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).



Key

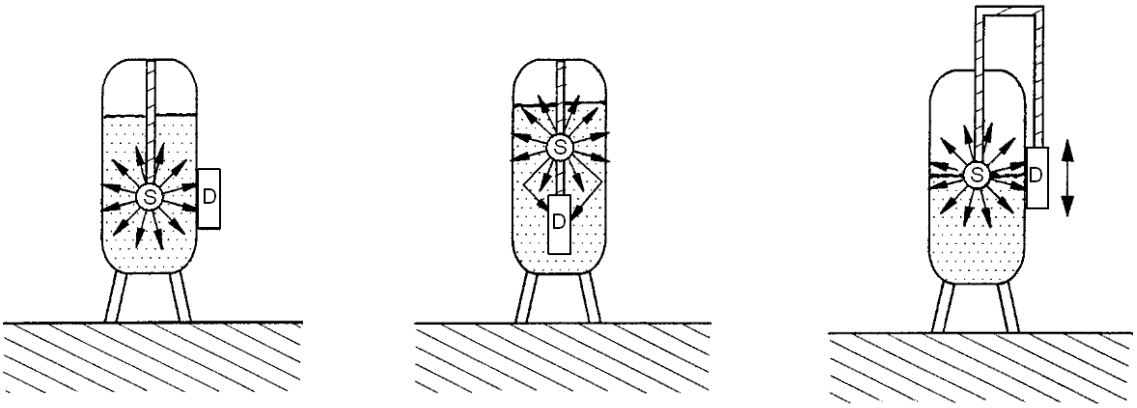
D detector housing

S source housing

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).



Gauge with the radioactive source inside the material container

Gauge with the radioactive source and the detector inside the material container

Tracking level gauge with the radioactive source inside the material container

IEC 534/11

Key

D detector housing

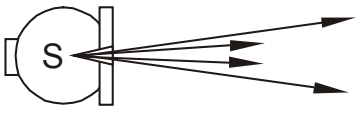
S source housing

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 mSvh	> 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

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.

6 Protection against ionizing radiation

6.1 General requirements

The shielding of the gauge shall be so designed, or the gauge shall be installed, in such a way that the dose equivalent rate at the points which are accessible for non-occupationally exposed persons does not exceed the values specified in appropriate national regulations pertaining to continuously occupied working places.

The accompanying documents shall include information that it is the responsibility of the user to observe the radiation labelling and shielding or barriers and to ensure that the actual limit values, specified in appropriate national regulations, are not exceeded.

The dose rates with the “shutter closed” should be as low as reasonably achievable, e.g., Class 7.

Radiation profiles of gauges could be influenced by the individual application on site and shall require additional measurement after installation (see Annex A).

6.2 Requirements for Category A gauges

The source housing shall ensure that the dose equivalent rate for the respective dose rate class is adhered to in accordance with 4.4.

The source housing shall be equipped with shutters for interrupting the useful beam.

If the shutter of the device is remote-controlled or servo-controlled the shutter shall automatically close if any failure of the control circuits occurs (e.g., failure of power supply). After elimination of the fault, the shutter shall not automatically open until the system is intentionally returned to its normal operating mode.

6.3 Requirements for Category B gauges

For Category B gauges, an additional shielded housing shall be provided for storing the source holder/radioactive source when not in use, unless the radioactive source is incorporated in a source housing with a shutter.

The shielding housing shall ensure that the dose equivalent rate for the respective dose rate class is adhered to in accordance with 4.4 and this class shall be used for "shutter closed" indication in the classification according to 10.1.

The shielding housing shall form a rigid assembly with the gauge if the dose equivalent rate exceeds national regulatory limits for a non-shielded source.

The shielding housing shall include a safety lock in order to prevent unauthorized access to the source holder/source.

6.4 Requirements for Category C stand alone source housings

The stand alone source housing shall ensure that the dose equivalent rate for the respective dose rate class is adhered to in accordance with 4.4.

The source housing shall be equipped with a shutter for interrupting the useful beam.

If the shutter of the device is remote-controlled or servo-controlled the shutter shall automatically close if any failure of the control circuits occurs (e.g., failure of power supply).

After elimination of the fault, the shutter shall not open until the system is intentionally returned to its normal operating mode.

The shielding housing shall include a safety lock in order to prevent unauthorized access to the source.

6.5 Resistance of the source housing in case of fire

A source housing and its shielding device, if any, intended to withstand a case of fire shall be constructed in such a way that the dose equivalent rate does not exceed the values of national regulatory limits or 10 mSv/h at a distance of 1 m, whichever is lower, for a fire of a specified time-temperature condition according to Table 3. The radioactive source shall remain shielded.

If the requirements of 9.3 are met, the gauge shall be classified into a fire resistance class according to Table 3. The fire resistance class shall be indicated within the classification code of 10.1.

If the fire test conditions are not met or no test is performed, "N" shall be stated for the fire test condition.

Table 3 – Fire resistance classes

Time (min)	**Temperature** (°C)	**Fire resistance class**
No test conducted		N
5	538	K
30	800	F
60	945	D
120	1 050	A

6.6 Detector housing

The detector housing shall be designed in conformity with the dose rate class to which the gauge is assigned so that the dose equivalent rate that applies to the relevant class is adhered to in accordance with 4.4.

6.7 Measuring head

In the case of integrated instruments in which the source and the detector are accommodated in one housing, the housing shall comply with the requirements for both the source housing and the detector housing.

7 Other safety devices

7.1 General

In addition to the requirements of Clauses 5 and 6, the gauges shall be fitted with safety devices as specified in 7.2 to 7.4.

7.2 Protection against non-authorized use

The gauges shall include a safety function (lock-out) in order to prevent use by non-authorized persons (e.g., opening the shutter or moving of the source).

7.3 Indication of the shutter position

A special indicating device shall be provided on, or in the immediate vicinity of source housings equipped with shutters. It shall clearly indicate whether the shutters are in the open position or completely closed. The indication shall be done by providing unambiguous information on the condition of the shutter.

Colour may be additionally used in combination with the aforementioned marking. A not closed shutter shall be indicated by red or orange and a closed shutter shall be indicated by green or white colour.

The gauge shall be designed so that upon a technical or mechanical failure the shutter indicator does not provide a false indication of ”safe condition” if the failure of the indicator cannot be otherwise indentified.

An additional shielding housing of a Category B gauge shall provide a means which indicates whether the source is in the shielded or in the unshielded position.

7.4 Additional warning device

Radiometric gauges with remote-controlled shutters, where routine activities are required to be manually performed in the immediate vicinity of the gauge (e.g., insertion of the material to be measured), shall also be fitted with warning lights providing fail safe operation of the shutter position.

A red or orange warning light shall be used for the shutter position “not closed” and a green or white warning light for the position “fully closed”, unless national regulations specify other system-related requirements.

These additional warning lamps shall be mounted next to the gauge so that they are easily visible.

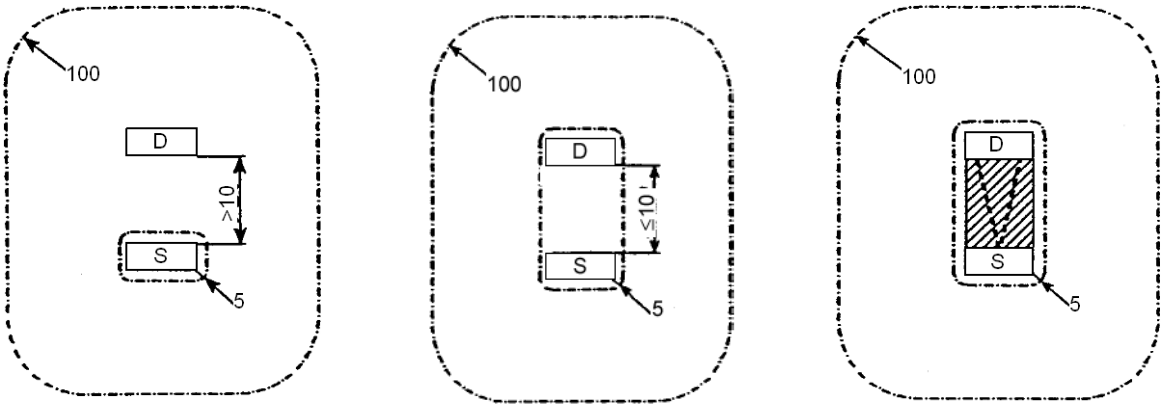
8 Determination of the dose equivalent rate

8.1 General

Dose equivalent rates in the vicinity of the radiometric gauge shall be measured at the distances as specified below or extrapolated from values that are measured at other distances.

The maximum dose equivalent rate shall be determined for each service condition mentioned below at distances of 5 cm and 100 cm from the nearest accessible surface of the combined source/detector housing (see Figures 4 and 5) or of the stand alone source housing (see Figure 6). In addition, the maximum distances from the gauge shall be given for any dose equivalent rates specified in appropriate national regulations. The average values may be typically determined over an area of 100 cm^2.

Dimensions in centimetres



a) Shutter in closed position. Distance between housings > 10 cm

b) Shutter in closed position. Distance between housings ≤ 10 cm

c) Shutter in open position

IEC 536/11

Key

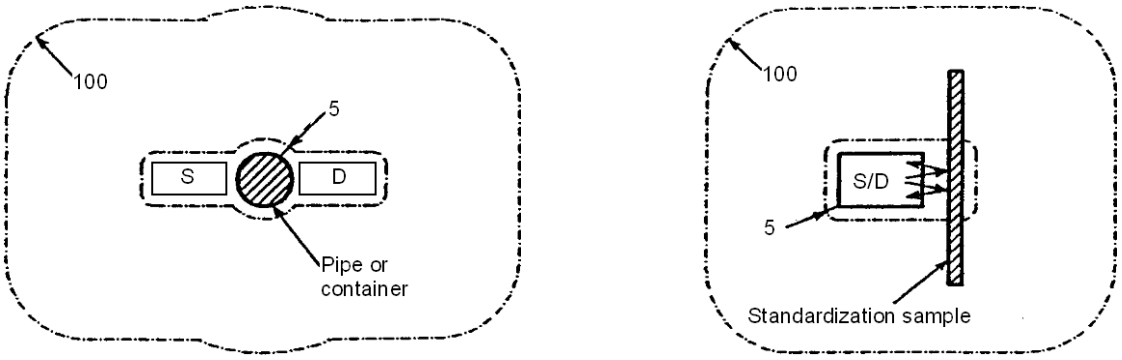
D detector housing

S source housing

NOTE No measurements are made within the shaded area.

Figure 4 – Schematic representation of isodistance gauging faces in the case of thickness gauges

Dimensions in centimetres



a) Level and density gauges

b) Back-scatter measuring system

IEC 537/11

Key

D detector housing

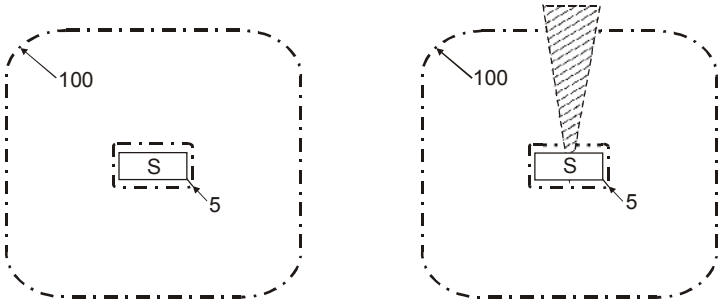
S source housing

S/D combined source/detector housing

NOTE The container depicted in Figure 5 a) may also be another appliance for storing or carrying medium, for example a conveyor belt in case of a bulk flow measurement.

Figure 5 – Schematic representation of isodistance gauging faces in the case of level and density gauges and back-scatter gauges

Dimensions in centimetres



a) Shutter in closed position. b) Shutter in open position

IEC 538/11

Key

S source housing

NOTE The dimensions of the shaded area should be taken from the data sheet or other technical specification of the gauge. No measurements are made within this area.

Figure 6 – Schematic representation of isodistance gauging faces in the case of stand alone source housings

The local dose equivalent rates shall be determined under the following operating conditions:

a) shutter (if any) in closed position, gauge out of operation (working beam shielded, source in the protected position);

b) shutter (if any) in the open position, gauge in operation – for a transmission gauge: without the material to be measured, for a back-scatter gauge: in the simulator position.

8.2 Dose equivalent rate measurements in the case of closed shutters

Where the distance between the source housing and the detector housing is ≤ 10 cm, radiation measurements shall be performed as indicated in Figure 4b).

8.3 Dose equivalent rate measurements in the case of open shutters

The dose equivalent rate shall be measured as shown in Figure 4c) and Figure 6.

Radiation measurement may be made in the useful beam for information.

8.4 Procedure for dose equivalent rate measurements

Appropriate measuring instruments according to IEC 60846-1 and IEC 60846-2 (photon and beta radiation) or IEC 61005 (neutron radiation) shall be used for measuring the dose equivalent rate.

a) In every case the measuring quantity shall be the ambient dose equivalent $\dot{H}^{*}(10)$.

b) In the case of sources having a photon energy below 20 keV, additional measurement with the measuring quantity directional dose equivalent $\dot{H}'(0,07)$ shall be undertaken.

For neutron dose rate measurements at a distance of 5 cm, calculation from measurements at 1 m is permitted.

8.5 Determining the relevant values of the dose equivalent rate

For calculation of the dose equivalent rates for dose rate classification according to Table 1, values in terms of $\dot{H}^*(10)$ for penetrating radiation are to be used. Values in terms of $\dot{H}'(0,07)$ shall be divided by ten before applying Table 1 for classification.

Where both $\dot{H}^*(10)$ and $\dot{H}'(0,07)$ are relevant, the lowest class of the different measuring quantities shall be used for classification of the entire gauge.

9 Test methods

9.1 General

Where proof of the properties required cannot be verified by the prototype tests specified in 9.2 through 9.4 this proof shall be determined by other means (e.g., calculations and evaluation of the material characteristics).

The reasons that test results cannot be obtained shall be given in the type test report as well as the calculation and evaluation results.

Certified properties are to be regarded as verified in accordance with the certificate.

Unless otherwise stated, these tests shall be carried out by the manufacturer on prototypes or on parts with comparable constructional characteristics and the results shall be recorded in a test report.

9.2 Temperature cycle test on the shutters and the source holder

9.2.1 Requirements

It shall be verified by these tests that the proper functioning of the safety devices (shutter, source holder) is ensured within the operating temperature range specified. In particular cases, the temperature cycle test may be confined to certain functions of the safety related gauge parts.

The temperature cycle test shall be carried out in a climatic chamber at maximum and minimum temperatures in accordance with Table 2.

The proper functioning of the safety device of the source housing shall be verified during the test.

9.2.2 Procedure

The time required for the source housing to reach the temperature of the climatic chamber shall be determined by test or by calculation (in this subclause the time required for stabilizing the temperature is called “stabilizing time”).

Before starting the test, the dose equivalent rate shall be measured and recorded at distances of 5 cm and 100 cm from the source housing (useful beam shielded, radioactive source in protected position).

The relative air humidity of the heating chamber should be between 40 % and 70 % at the beginning of the test (at a room temperature of approximately 20 °C).

The heating chamber shall be allowed to cool down to the lowest temperature as specified for the temperature class of the gauge in Table 2, and this temperature shall be maintained during the stabilizing time and for an additional period of 1 h.

Following this temperature exposure, the proper functioning of the safety devices shall be checked.

After this test, the heating chamber shall be heated to room temperature (approximately 20 °C). Following the stabilizing time and an additional period of 1 h, the proper functioning of the safety devices shall be checked again.

The heating chamber shall be heated to the maximum temperature specified for the temperature class of the gauge in Table 2 and this temperature shall be maintained during the stabilizing time and for an additional period of 1 h.

Following this temperature exposure, the proper functioning of the safety devices shall be checked.

After this test, the heating chamber shall be allowed to cool down to room temperature (approximately 20 °C). Following the stabilizing time and an additional period of 1 h, the proper functioning of the safety devices shall be checked. After that the source housing shall be removed from the climatic chamber and shall be checked for any apparent damage.

The dose equivalent rate that emanates from the source housing with "closed shutters" shall be measured. The values shall be recorded and compared with those existing before the test was conducted. The values shall not be different from the original values by more than the expected from statistical variation.

9.3 Test for checking the resistance of the shutter, the source holder and the source container in case of fire

9.3.1 Requirements

The purpose of the test is to verify that the dose equivalent rate does not exceed national regulatory limits or 10 mSv/h at a distance of 1 m, whichever is lower, after a fire with specified time-temperature conditions according to Table 3 and that the radioactive source is retained by the source housing.

9.3.2 Procedure

This test should be carried out with a dummy source instead of a real source.

The source housing is introduced into a furnace preheated to at least the specified temperature and heated until equilibrium is achieved and then maintained at the specified time-temperature condition. Subsequently, the source housing is taken out of the furnace and allowed to attain ambient temperature (approximately 20 °C).

The source housing is then checked to determine that the radioactive source (source dummy) is retained by the source housing.

If the source has moved (e.g. due to the melting of the shielding material) the dose equivalent rates that would occur in the case of a real source shall be determined. The dose equivalent rates derived shall meet the requirements of 9.3.1.

9.4 Test for checking the mechanical resistance of the shutter and the source holder

9.4.1 Requirements

In this requirement, the test is additionally concerned with the mechanical resistance of the shutter and source holder to the stress associated with transportation as well as the stress that might occur in operation.

9.4.2 Procedure

This test should be carried out without the source being installed or with a dummy source instead of the real source.

The shutter is operated manually or by means of an automatic testing device in the following order starting from closed position:

Full cycle of operation: “Shutter open – Shutter closed”

In the case of remote-controlled or servo-controlled shutter devices, a minimum of 3 000 full test cycles shall be carried out; in the case of manually-actuated shutters 300 full test cycles shall be carried out.

After completion of the test runs, the shutter and the source holder shall be checked for damage or ageing.

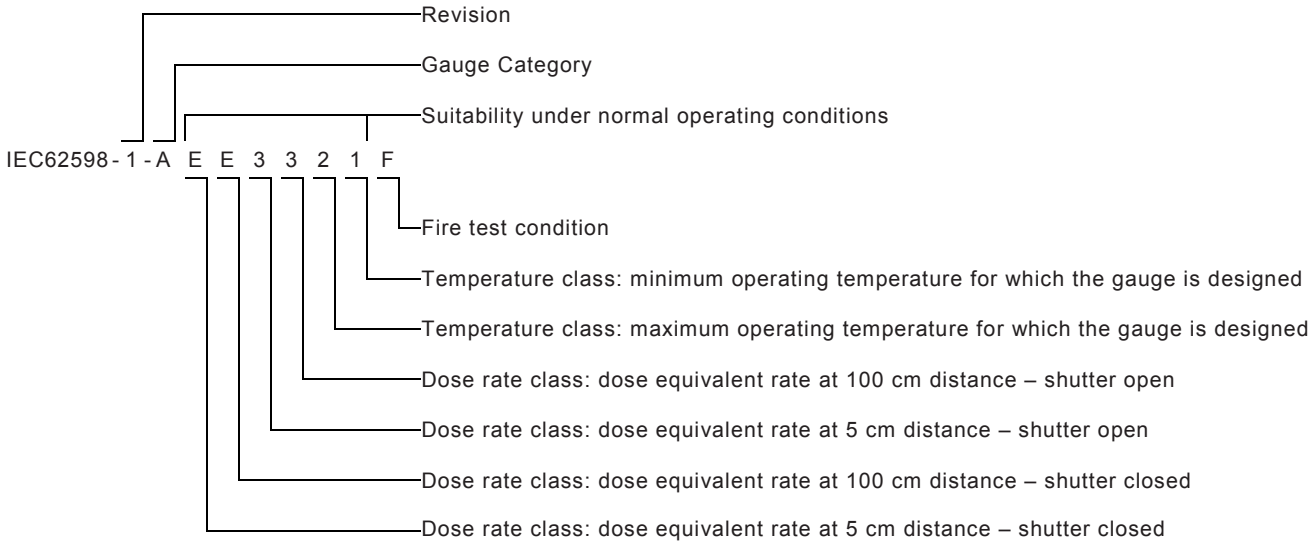
10 System classification coding and labelling

10.1 Classification code

The documentation for each radiometric gauge or source housing shall contain a classification code indicating the gauge category, the dose rate classes and temperature classes in accordance with Clause 4, and the standard designator IEC 62598-1. This code may also be placed on the source housing.

NOTE The classification may depend on the source characteristics (e.g., activity, temperature range, radionuclide, encapsulation, accident conditions).

The system classification code structure shall be as follows:



10.2 Labelling

The following information, as a minimum, shall be clearly marked on an appropriate place of the source housing so that the marking remains legible for the entire period of use of the gauge:

a) the manufacturer's name and address;

b) type and serial number of the gauge;

c) radionuclide;

d) activity of the source (including reference date).

In addition, the source housing shall be marked with the radiation symbol in accordance with ISO 361. When the source housing is incorporated into an additional outer housing, the marking of an easily visible radiation symbol shall also be placed on the outside of that housing.

11 Accompanying documents

The following information shall be given in the accompanying documents supplied to user:

– user responsibilities;

– the information on labelling given in Clause 10 and an application that the classification is in accordance with the provisions given in IEC 62598;

– gauge description, operating principle, design drawings, technical features, classification code and the associated radionuclide and activity, type and activity of the radionuclides actually used;

– functional description of the source shutter;

– installation and service conditions to be observed insofar as they may have influence on the dose equivalent rate in the vicinity surrounding the gauge;

– dose equivalent rate information in accordance with Clause 8;

– leak test certificate of the source;

– information on how periodic leakage tests of the source are to be performed;

– guideline for inventory control and end of use source disposal management;

– in the case of dose rate class 1 (see Table 1) specification of the respective dose rate value(s);

– in the case of temperature class 7 (see Table 2): specification of the respective temperature(s);

– instructions for appropriate radiation protection measures.

Annex A
(informative)

Guidelines for the installation of radiometric gauges

These guidelines are intended to give examples of aspects which may be considered in design, operation or servicing of gauging systems.

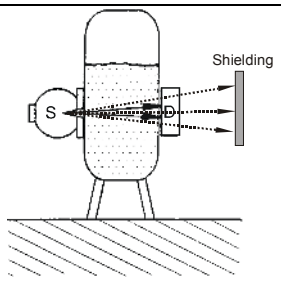
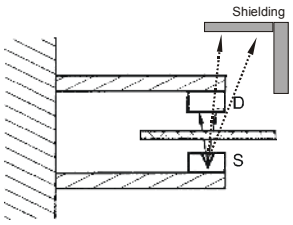
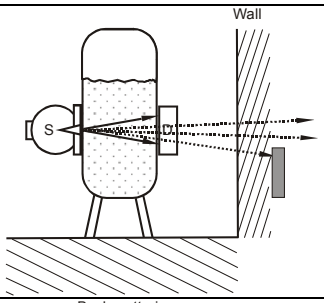
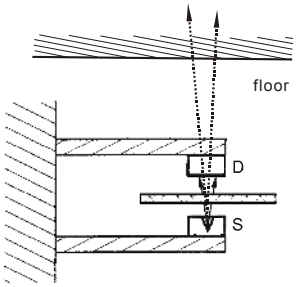
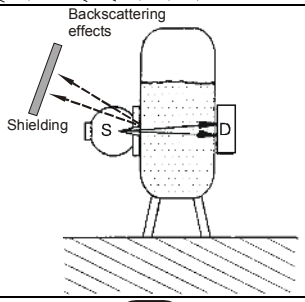
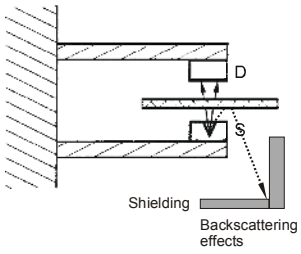
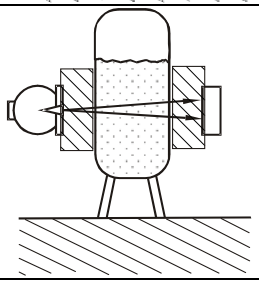
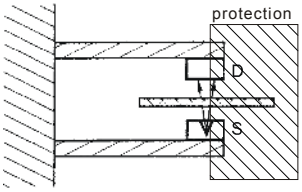
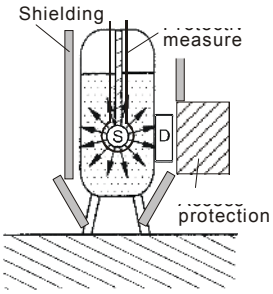
A radiation protection risk analysis before installation to verify the protective measures by measurements before operational use.

a) Due to the purpose of shielding penetrating radiation (e.g., gamma radiation) the source housing or auxiliary screening measures may have a considerable weight that can easily exceed several 100 kg. This should be taken into consideration when planning
   - mounting brackets or consoles,
   - installation with e.g., cranes,
   - access to the source housing for service purposes.

b) For reduction of the possible dose exposure, the useful beam should not be directed towards places of high foot traffic. Besides that, the dose equivalent rate at the detector side should be considered as well as the dose equivalent rate at the source housing. While reduction of the dose equivalent rate at the source housing is possible by increasing the distance (inverse square law), this is unlikely to apply to the detector side because the distance to the source is already considerable. Also the dose equivalent rate at the detector should be considered under worst conditions (e.g., empty vessel).

c) Access to the useful beam between source housing and e.g., vessel at least in case of Category A or C gauges should be restricted.

d) Figure A.1 gives examples of protection principles which may be considered in design or operation of gauging systems.

In direction of the useful beam increased dose rates are to be expected and may require additional shielding or area with restricted access. The dose rate values at a certain point may differ significantly depending on the kind and condition of medium or whether medium is present or not.		
Walls, floors and ceilings do not provide sufficient shielding in every case. Additional shielding or restricted areas may be required.		
Backscattering effects should be taken into consideration. Such effects may depend on the properties of the medium to be measured or on geometrical circumstances of the application. Subsequent fittings may change the backscattering conditions.		
Sufficient access protection should be provided. Protective measures should be taken for maintenance / servicing activities where additional shielding have to be removed or the restricted area has to be accessed		
Appropriate protection against chemical and mechanical influences should be provided to keep the source under control in any event. If the vessel walls do not provide appropriate shielding additional shielding and/or restricted areas may be required around the vessel.		intentionally left blank
Locally increased dose rates should be taken in consideration between adjacent gauges.	intentionally left blank	intentionally left blank

IEC 539/11

Figure A.1 – Examples of protection methods and principles

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