

Recommendations for

Installed exposure rate meters, warning assemblies and monitors for X or gamma radiation of energy between 80 keV and 3 MeV

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The Nuclear Engineering Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following Government department and scientific and industrial organizations:

- Association of Consulting Engineers*
- British Electrical and Allied Manufacturers' Association (BEAMA)
- British Insurance (Atomic Energy) Committee
- Electricity Supply Industry in England and Wales*
- Health and Safety Executive*
- Hevac Association
- Institution of Mechanical Engineers
- Institution of Nuclear Engineers*
- Lloyd's Register of Shipping
- National Radiological Protection Board*
- Scientific Instrument Manufacturers' Association*
- United Kingdom Atomic Energy Authority*
- Water-tube Boilermakers' Association

The organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

- Association of University Protection Officers
- British Industrial Measuring and Control Apparatus Manufacturers' Association
- British Institute of Radiology
- British Nuclear Forum
- British Steel Industry
- Business Equipment Trade Association
- Control and Automation Manufacturers' Association (BEAMA)
- Electronic Engineering Association
- Hospital Physicists' Association
- Ministry of Defence
- Society for Radiological Protection
- Individual companies

This British Standard, having been prepared under the direction of the Nuclear Engineering Standards Committee, was published under the authority of the Executive Board on 31 August 1978

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National foreword

This British Standard is identical with IEC Publication 532 “*Installed exposure rate meters, warning assemblies and monitors for X or gamma radiation of energy between 80 keV and 3 MeV*”.

The standard has been prepared under the direction of the Nuclear Engineering Standards Committee and the UK took part in the work of IEC sub-committee 45B that prepared IEC 532.

The formal decisions or agreements of the IEC on technical matters, prepared by technical committees on which all the national committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

They have the form of recommendations for international use and they are accepted by the national committees in that sense.

Cross-references. For each of the following International Standards referred to in the text, there is an equivalent British Standard; these are as listed below:

International Standard	Corresponding British Standard
IEC 38:1975	BS 77:1958 <i>Voltages for a.c. transmission and distribution systems</i> (Related)
IEC 68	BS 2011 <i>Basic environmental testing procedures</i> (Identical)
IEC 231:1967 IEC 231A:1969	BS 4877:1972 <i>Recommendations for general principles of nuclear reactor instrumentation</i> (Technically equivalent)
IEC 278:1968	BS 4308:1968 <i>Documents supplied with electronic measuring instruments</i> (Identical)

NOTE The reference to IEC 293, for which there is no corresponding British Standard, constitutes informative matter only, but since no mandatory requirements are involved, the validity of this British Standard is not affected.

Additional information. The text of the International Standard uses the Röntgen (symbol: R) as the unit of exposure. While the use of this unit is expected to continue for some time, it is intended that it will eventually disappear in favour of the SI unit of exposure, the coulomb per kilogram (symbol: C/kg). The conversion equation is: 1 R = 258 µC/kg.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This standard applies to installed exposure rate meters, warning assemblies and monitors, defined in Section 1, and intended to measure the exposure rate due to X or gamma radiation of energy between 80 keV and 3 MeV for the purposes of radiation protection.

NOTE Assemblies of this type are commonly defined as area radiation monitors. They are normally employed to determine continuously the radiological situation in working areas in which the radiation field may change with time, for example nuclear reactors, particle accelerators, hot laboratories, fuel reprocessing plants, etc., and to provide alarms when the radiation field goes outside predetermined limits.

This standard does not apply to assemblies used for reactor control. As regards rate meters used both for radiological safety purposes and as part of the protective system of a reactor, such instruments should in the first instance fulfil the requirements for the reactor protection system (see IEC Publication 231, General Principles of Nuclear Reactor Instrumentation, and IEC Publication 231A, First supplement to Publication 231 [1967]).

The assemblies considered in this standard comprise at least:

- a detector sub-assembly (e.g. ionization chamber, Geiger-Müller counter tube, etc.);
- a measuring sub-assembly, which may be fitted into a centralized panel, with signal outputs and contacts capable of activating alarm or other trip circuits for the purposes of radiation protection.

This standard is also applicable to installed exposure rate measuring assemblies designed for special application (e.g. very high exposure rates). However, some of the requirements may need to be amended or supplemented according to the particular characteristics of such assemblies.

This standard is not applicable to criticality monitors or to assemblies intended to give information about operational parameters of nuclear plants for control purposes.

Assemblies designed to perform combined functions shall comply with the requirements pertaining to each of these functions. Assemblies intended for, and designed to perform, only one function but which are also capable of executing other functions need only comply with the requirements for their intended function but compliance with the requirements for the other functions is desirable.

This standard is not applicable to the operating characteristics of indicating or recording instruments as such (e.g. indicating meters, recorders, alarms, etc.). The characteristics of such instruments shall be in conformity with the general requirements appropriate to them.

2 Object

This publication specifies standard general characteristics, general test procedures, radiation, electrical, safety and environmental characteristics and the identification certificate for the assemblies mentioned in the scope.

Section 1. Terminology

3 Degrees of requirements

In this standard, the following terminology is employed:

- the word “shall” signifies a mandatory requirement;
- the word “should” signifies strongly recommended;
- the word “may” signifies an acceptable method, or an example of good practice.

4 Definitions applicable to this standard

4.1

exposure rate meter

a radiation meter intended to measure the exposure rate due to X or gamma radiation and including one or several radiation detectors and associated sub-assemblies or basic function units

4.2

exposure rate warning assembly

an assembly intended to give a visual or audible warning that the exposure rate due to X or gamma radiation exceeds some predetermined value or that the measured value is not within some predetermined limits

4.3

exposure rate monitor

an assembly having the functions of both an exposure rate meter and an exposure rate warning assembly

4.4

conventionally true exposure rate

the best available estimate of the exposure rate at the point of test (see Clause 11)

4.5**indicated exposure rate**

value of the exposure rate as indicated by the measuring assembly under test

4.6**coefficient of variation**

ratio of the standard deviation σ to the arithmetic mean $\bar{x}$ of a set of n measurements x_i , given by the formula:

$$V = \frac{\sigma}{\bar{x}} = \frac{1}{\bar{x}} \sqrt{\frac{1}{n-1} \sum (x_i - \bar{x})^2}$$

4.7 intrinsic error

difference between indicated exposure rate and conventionally true exposure rate, determined when the assembly is under reference conditions

5 Test nomenclature**5.1 Qualification tests**

Set of tests performed in order to verify that the requirements of a specification are fulfilled.

NOTE Qualification tests are subdivided into type tests and routine tests, as defined below.

5.1.1 Type tests

Those qualification tests which are performed on one assembly or on a small number of assemblies considered to be representative of an industrial production, and which, in principle, are not repeated on each assembly.

5.1.2 Routine tests

Those qualification tests which are performed on each production assembly.

5.2 Acceptance tests

Contractual tests performed in the presence of a user or his representative in order to verify the quality of a delivery. These tests are, in general, selected from the qualification tests, although the methods of performing them may be different.

Section 2. General requirements**6 General**

The accuracy requirements in this standard are established for displays of the analogue type. For numerical displays, corresponding values of indication shall be adopted.

Assemblies shall be designed so as to limit as far as possible any undesirable response to electromagnetic and ionizing radiations other than X or gamma.

The reading scale shall be graduated in units of exposure rate, for example in R/h. The lower limit for the effective range of measurement is defined as 10 % of the scale maximum on the most sensitive range (linear graduation) or 1.5 times the lowest significant rate marked on the scale (logarithmic graduation).

The total effective range of measurement shall be at least three decades (some applications may require a range of up to six decades).

In the case of an assembly provided with a linear scale, it shall be possible to change the ranges of measurement in such a way that the ratio between adjacent scales does not exceed 10. This ratio should be held to approximately three (for instance scales such as 10, 25, 100, etc., i.e. ratios of 2.5 and 4).

In the case where it is likely that there will be large variations in the level of radiation, assemblies with manual switching should be avoided. The use of a logarithmic scale is preferred.

If a control for setting zero or a reference point is available, it shall be effective in the presence of radiation.

The position of the geometrical centre of the sensitive volume of the detector shall be indicated on the outer surface.

Measuring assemblies which contain trip circuits should, if possible, be so arranged that interruption or failure of the power supply or component failure causing loss of signal, will result in actuation of a trip circuit to produce an alarm. Failure of the power supply should not disable the alarm. Indication of power failure shall be provided.

The apparatus should be able to operate within the specification with a cable length between probe and measuring assembly of at least 100 m. Greater lengths should be subject to agreement between manufacturer and user. The maximum permissible cable length shall be stated.

A facility for a recorder output should be provided.

Controls and settings shall be so designed that access to them can be controlled (i.e. by authorized persons).

7 Alarms

The equipment shall have facilities for operating both audible and visual alarms in both the following modes:

- 1) alarms to hold on until reset;
- 2) alarms to clear automatically on reduction of exposure rate below alarm level.

In both cases, it should be possible to interrupt the audible alarm by deliberate action without, however, interrupting the visual alarm.