

Specification for

Portable bore-hole logging equipment (down to 300 m): general characteristics

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- British Insurance (Atomic Energy) Committee
- Electricity Supply Industry in England and Wales*
- Health and Safety Executive*
- Hevac Association
- Institution of Mechanical Engineers
- Lloyd's Register of Shipping
- National Radiological Protection Board*
- Scientific Instrument Manufacturers' Association*
- The Institution of Nuclear Engineers*
- 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 Design and Construction Limited
- 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
- Nuclear Power Co. (Risley) Ltd.
- Nuclear Power Group
- Society for Radiological Protection

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National foreword

This British Standard is identical with IEC 576:1977 *Portable bore-hole logging equipment (down to 300 m): General characteristics*. The National appendix, on page 13, is part of IEC 421 (see note 2 below).

The standard has been prepared under the direction of the Nuclear Engineering Standards Committee and the United Kingdom took part in the work of the International Electrotechnical Commission (IEC) Technical Committee No. 45, which prepared IEC 576.

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.

Terminology. The text of the International Standard has been accepted as suitable for publication, without deviation, as a British Standard.

Some terminology is not identical with that used in British Standards; attention is especially drawn to the following.

Wherever the word “Standard”, referring to this publication, appears, it should be interpreted as “British Standard”.

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

International Standard	Corresponding British Standard
IEC 68-2-30:1969	BS 2011:1977 <i>Basic environmental testing procedures</i> Part 2.1 Db:1977 <i>Damp heat, cyclic (12 + 12-hour cycle)</i>
IEC 86:1976	BS 397:1976 <i>Specification for primary cells and batteries</i>
IEC 258:1968	BS 90:1975 <i>Direct acting electrical recording instruments and their accessories</i>
IEC 348:1971	BS 4743:1971 <i>Safety requirements of electronic measuring apparatus</i>
IEC 359:1971	BS 4889:1973 <i>Method for specifying the performance of electronic measuring equipment</i>
IEC 412:1973	BS 5210:1975 <i>Standard dimensions of scintillators</i>

(All the above standards are identical or technically equivalent)

NOTE 1 The reference to the following International Standards, for which there are no corresponding British Standards, constitutes informative matter only, and since no mandatory requirements are involved, the validity of this British Standard is not affected.

IEC 50 (391):1975 – IEV Chapter 391, *Detection and measurement of ionizing radiation by electrical means*.

IEC 201:1965, *Power sources for portable prospecting equipment for radioactive materials*.

IEC 253:1967, *Power supply for air and land vehicle-mounted prospection equipment for radioactive materials*.

NOTE 2 There is no corresponding British Standard for IEC 421:1973 *Portable prospecting radiation meters with Geiger-Muller counter tube (linear scale instruments)*. The Committees responsible for them having been consulted, their technical requirements are hereby confirmed as being acceptable. The relevant portions of the text are reproduced in this standard as a National appendix and, insofar as they are called up in the main body of this dual-numbered standard as requirements to be complied with, they are to be regarded as mandatory for the purposes of this standard.

NOTE 3 *Textual errors.* When the text of this International Standard was adopted, the printing errors, listed below, were noticed. They have been corrected in this British Standard and have been reported to IEC in a proposal to amend the text of the International Standard.

Clause 7 (pages 2 and 3) and subclause 14.6.2 (page 8). The circuit time constants “RC” have been deleted and replaced by “RC”. Table I. “k Pa” has been deleted and replaced by “kPa”.

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 to iv, pages 1 to 20, 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.

Chapter I. General

1 Scope

This standard applies to equipment consisting of easily transportable autonomous components, and is intended for measurements of rock radioactivity or for measurements concerned with the evaluation and working of deposits. It does not apply to simple instruments for exploration at less than 20 m in depth, nor to vehicle-mounted equipment.

The equipment includes:

1.1 One or several measuring probes (natural background gamma logging).

1.2 A device for the mechanical and electrical connection of the probe with the measuring equipment which may include:

- a supporting cable with a winder and pulley measuring the length of cable released (bathymeter) for logging where the probe descends by gravity (vertical or subvertical dips of more than 55 grades [50°] with respect to the horizontal),
- a rigid or semi-rigid device to move the probe forward in holes having dips of less than 55 grades (50°) with respect to the horizontal.

1.3 A radiometric indicator, usually a counting ratemeter.

1.4 Possibly a recording device, usually of analogue type, the operation of which is proportional to the movement of the probe. Use could also be made of a digital recording device or of a data acquisition system which records probe position in the hole.

2 Object

To establish uniform requirements for the characteristics of each component and for each corresponding test method.

3 Terminology

The general terminology is in agreement with the definitions of IEC Publication 421, Portable Prospecting Radiation Meters with Geiger-Müller Counter Tube (Linear Scale Instruments).

For evaluation of functional performances, the terminology fixed by IEC Publication 359, Expression of the Functional Performance of Electronic Measuring Equipment, has been applied.

The term “probe” is used within the meaning of Chapter 391 of the International Electrotechnical Vocabulary (I.E.V.), Detection and Measurement of Ionizing Radiation by Electric Means:

“That part of a radiation measuring assembly consisting of an envelope of convenient geometrical form containing a radiation detector and possibly a preamplifier and certain functional units. Its form and construction are usually such as to permit its operation in places of difficult access, or remote from the associated apparatus, or for scanning of a surface or volume.” (I.E.V. 391-13-05)

4 Test conditions

Unless otherwise mentioned in this standard for certain types of instruments, the reference conditions, the standard test conditions, the rated and the limit operating conditions, the storage and transport conditions are the same as for the Geiger-Müller counter tube prospecting portable radiation meters and are described in IEC Publication 421.

5 Categories of instruments

Two categories of instruments are defined, differing by the environmental conditions that they shall withstand.

Category A: Instruments intended for use in temperate or tropical regions.

Category B: Instruments intended for use in cold regions.

These categories are divided into accuracy classes, as in Sub-clause 14.2.

Chapter II. Requirements

Section 1. Probe

The probe consists of a casing containing the detector and the electronic circuits necessary for shaping the signals and supplying power.

As uranium content ranges from a few millionths to several tenths, the flux densities intercepted vary in a ratio of more than 10^4 . In view of the random character of the phenomenon measured, it may be desirable to provide several types of probe to cover this range.

6 Shell

6.1 The shell of the probe shall be of non-corrosive material resistant to abrasion and mechanical forces and not having any magnetic effect on the components inside it; the recommended materials are stainless steel, brass or bronze. Special care should be taken in using stainless steel/stainless steel threaded joints, because of possible problems in dismantling.

6.2 The probe diameter shall be compatible with that of the holes being explored. Diameters of uranium prospecting holes ranging approximatively from 27 mm to 152 mm, the recommended probe diameters are:

22 ± 1 mm	25 ± 1 mm	32 ± 1 mm	43 ± 1 mm	52 ± 2 mm
$\frac{7}{8}$ in	1 in	$1\frac{3}{8}$ in	$1\frac{11}{16}$ in	$2\frac{1}{16}$ in

6.3 The length of the probe shall not exceed 1.5 m.

6.4 The probe shall be waterproof and able to withstand the pressures of water or dirt encountered in the bore-holes; the thickness of the body of the probe should be not less than 1 mm; each probe should be checked under a water pressure of $8 \cdot 10^6$ Pa maintained for 1 h. On completion of this test, the device should be checked for proper functioning.

6.5 The connecting of the probe to the end of the cable shall not require any special tools and it shall be possible to perform the operation rapidly.

7 Detector and associated electronic circuits

The detection device is usually a Geiger-Müller counter tube or a scintillator. When selecting the dimensions of the detector, in particular the length, account should be taken of the type of working conditions envisaged: the thickness of the anomalies to be detected, the rate of exploration, the response time of the measuring circuit, the mode of measurement (at a single point, at a number of discrete points or continuously).

The reason for this is that, in order to record the maximum value of an anomaly of slight thickness, it is necessary for the detector to “dwell” opposite that anomaly for two circuit time constants ($2 RC$) for a 13 % approximation and $4 RC$ for a 2 % approximation.

With continuous advancement of the detector, the detector length must be sufficient for this. Furthermore, it must be considered in this case that the rise and fall “fronts” seem lengthened on the analogue record by a value corresponding to $4 RC$ and that the apparent length of the anomaly is increased by the detector and fall front lengths.

For example, at a rate of 0.6 m/min and with $2 RC = 2$ s, 2 cm of detector length are necessary to determine the amplitude of a “fine and collimated” anomaly within 13 % (4 cm for 2 %). The rise front is 4 cm longer and the apparent length of the anomaly is increased by the detector length plus 4 cm.

With a 10-cm detector and $2 RC = 4$ s, the maximum speed to define such an anomaly within 13 % shall be 1.5 m/min (0.75 m/min within 2 %).

7.1 Geiger-Müller counter tube probes

The Geiger-Müller counter tube probes are often used for localization, evaluation and working of radioactive ore deposits.

The probe can comprise one or several Geiger-Müller counter tubes.

7.1.1 Dimensions

The effective length shall be not greater than 10 cm, to permit precise localization.

7.1.2 Associated electronic circuits

The associated electronic circuits shall be such that after passing through 300 m of logging cable connected to the recommended measuring equipment, and depending on the use of the probe, the following characteristics are obtained:

- a) in an infinite homogeneous medium, containing 0.1 % uranium in equilibrium, $14 < Z_{eq}^{1)} < 18$, or equivalent model (under consideration):
 - the counting rate shall be greater than 40 c.s⁻¹;
 - the difference of the detection efficiencies between two probes of the same type shall be not greater than $\pm 7\%$ under normal test conditions, $\pm 10\%$, $\pm 15\%$ respectively under rated and limit operating conditions;
 - the resolution time shall be not greater than 120 μ s;
- b) in an ore containing 1 % uranium, in equilibrium, infinite and homogeneous, $14 < Z_{eq}^{1)} < 18$, or equivalent model (under consideration):
 - the fractional counting loss shall be not greater than 6 %;
- c) the output impedance shall be as low as possible, preferably less than 50 Ω . The amplitude of the signals transmitted should be not less than 250 mV for a counting rate of 500 c.s⁻¹. The pulse rise time should be between 0.1 μ s and 2 μ s. The output shall be capable of sustaining a short circuit without damage.

7.1.3 Power supply

The power supply can either be built into the probe or be delivered through the cable.

A) Built-in primary power supply

The cells or batteries shall be easy to replace on site without the need for tools, the rated operating life shall not be less than 20 h and preferably more than 40 h. *The life time corresponds to the length of operation within the rated characteristics (signal amplitude, counting rate, behaviour relative to temperature).*

Recommended nominal power supply voltages at the probe level: 6 V, 12 V.

Operation shall be possible from 5.5 V to 7.5 V or from 11 V to 15 V according to IEC Publication 253, Power Supply for Air and Land Vehicle-mounted Prospection Equipment for Radioactive Materials.

B) Primary power supply on the surface

The circuit shall be such that the probe can be powered through the cable (normal measurements) or without cable (tests); the supply can be specifically for the probe or be common to both the probe and the measuring equipment on the surface. The primary source shall preferably be composed of R20 cells (see IEC Publication 86, Primary Cells and Batteries, and IEC Publication 201, Power Sources for Portable Prospecting Equipment for Radioactive Materials). The rated operating life shall be not less than 8 h when the supply is common to both the probe and the measuring equipment on the surface.

In no case shall the power supply voltage exceed the safety extra-low voltage as defined in IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus.

Recommended nominal power supply voltages at the probe level: 6 V, 12 V.

Operation shall be possible from 5.5 V to 7.5 V or from 11 V to 15 V according to IEC Publication 253.

7.2 Scintillation detector probe

Apart from special applications, the probe does not normally consist of more than one scintillator. This type of probe is mainly chosen for geologic and prospecting survey, firstly because of its high output, favourable for measurements at low fluence rates, and secondly because of the spectral response of the scintillator which can lead to corrections of low-energy transmission.

Scintillation probes are also used for evaluation work, but the treatment of the measurements requires particular attention.

7.2.1 Scintillator dimensions

Recommended scintillator effective diameters and effective length should be chosen from the values of IEC Publication 412. Standard Dimensions of Scintillators, with the tolerance class 1.0 (± 1 mm).

¹⁾ Z_{eq} : Matrix equivalent atomic number.