

Guide to

Ionizing radiation thickness meters for materials in the form of sheets, coatings or laminates

[IEC title: Ionizing radiation thickness meters for materials in the form of sheets, coatings or laminates]

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- British Insurance (Atomic Energy) Committee
- Electricity Supply Industry in England and Wales*
- Health and Safety Executive*
- Institution of Nuclear Engineers*
- Lloyd's Register of Shipping
- National Radiological Protection Board*
- Radiochemical Centre*
- 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 experts

This British Standard, having been prepared under the direction of the Nuclear Engineering Standards Committee, was published under the authority of the Executive Board and comes into effect on 31 March 1980

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Contents

	Page
Cooperating organizations	Inside front cover
National foreword	iii
Section 1. General	
1 Scope	1
2 Object	1
3 Definitions related to the measurement or control function	1
3.1 Thickness meter (ionizing radiation)	1
3.2 Transmission thickness meter (ionizing radiation)	1
3.3 Beta (gamma) backscatter thickness meter	1
3.4 X-ray fluorescence thickness meter	1
3.5 Rated range	1
3.6 Effective range	1
3.7 Mass per unit area (surface mass, surface density, mass cross-section)	1
3.8 Influence quantity	2
3.9 Total measurement	2
3.10 Effective measurement area	2
3.11 Reference conditions	2
3.12 Rated range of use	2
3.13 Resolution	2
3.14 Geometrical resolution length	2
4 Definitions related to the apparatus	2
4.1 Measuring head	2
4.2 Electrical measuring sub-assembly	2
4.3 Traversing mechanism	2
4.4 Measuring gap	2
4.5 Pass line	2
4.6 Reference pass line	2
4.7 Sample profile error	2
4.8 Pass line error	2
4.9 Mean response time	3
4.10 Mean settling time	3
4.11 Electrical instability	3
4.12 Overall radiometric instability	3
Section 2. General requirements	
5 General	3
5.1 Thickness meters in general	3
5.2 Traversing transmission thickness meters	3
Section 3. Test requirements	
6 Determination of the limits of error	3
6.1 Test procedure	3
6.2 Performance characteristics	4
6.3 Influence quantities	5
7 Other performance characteristics	5
7.1 Mean settling time	5
7.2 Resolution	5
7.3 Geometrical resolution length	6
7.4 Mean response time	6
7.5 Measurement areas	6

	Page
Appendix A	9
National appendix Electrical measuring instruments utilizing radioactive sources (IEC 476)	10
Figure 1 — Profil error curve	4
Figure 2 — Output response curve	6
Figure 3	8
Publications referred to	Inside back cover

National foreword

This British Standard is identical with IEC Publication 577 “*Ionizing radiation thickness meters for materials in the form of sheets, coatings or laminates*” published by the International Electrotechnical Commission (IEC) in 1977.

This British Standard has been prepared under the direction of the Nuclear Engineering Standards Committee and the UK took part in the work of IEC Technical Committee 45 that prepared IEC 577.

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 and conventions. The text of the International Standard has been approved as suitable for publication, without deviation, as a British Standard. Some terminology and certain conventions are not identical with those used in British Standards; attention is especially drawn to the following.

Cross-references

International Standard	Corresponding British Standard
IEC 359:1971	BS 4889:1973 <i>Method for specifying the performance of electronic measuring equipment</i> (Technically equivalent)
ISO 921:1972	BS 3455:1973 <i>Glossary of terms used in nuclear science and technology</i> (Technically equivalent)
ISO 1677:1977	BS 5288:1976 <i>Sealed radioactive sources</i> (Technically equivalent)

There is no British Standard equivalent for IEC 476, which is therefore reproduced in its entirety in this standard as a National appendix. There are no British Standard equivalents for IEC 50, IEC 181, IEC 232, IEC 293 and IEC 405. The technical committee has reviewed their provisions, and has decided that they are acceptable for use in conjunction with this standard.

Related British Standards for IEC 50 are BS 661:1969 “*Glossary of acoustical terms*” and BS 4727 “*Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms*”.

NOTE *Textual errors.* In the caption to Figure 1 “Profile error curve” should be read as “Profile error curve”. In 6.2.5 “ $\pm 0.1 \text{ g/m}^2/24 \text{ hours at } 100 \text{ g/m}^2$ ” should be read as “ $\pm 0.1 \text{ g/m}^2 \text{ per } 24 \text{ hours at } 100 \text{ g/m}^2$ ”.

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 16, 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.

Section 1. General

1 Scope

This standard relates to definitions, test methods and procedures for all radioactive isotope meters designed either for continuous operation or for check measurements on materials in the form of sheets, coatings or laminates. It applies to systems with output signals directly related to the measured quantity as well as to those related to a difference from a set value of the quantity. Safety aspects of equipment are not considered herein.

2 Object

The thickness meters considered in this standard are generally custom-built for industrial applications covering a very wide range of industries and specifications; in consequence, a standard covering design or performance specifications is impractical. Restricted standards for particular types of equipment or for particular fields of application may be prepared in due course.

The present aim is to prepare a standard which "facilitates comparison of equipments of differing specifications" by laying down general recommendations and test procedures.

The numerical magnitudes of the various quantities have been omitted in this standard since these are generally agreed upon between user and supplier according to the particular requirements.

In this standard, the term "thickness" is taken to mean mass per unit area. Radiometric thickness meters in general measure mass per unit area and can be termed thickness meters only if the effective atomic number and density of the material being measured are known, or if the meter is calibrated against actual production samples and if the effective atomic number and density of the material produced do not change in relation to these samples.

However, it will be assumed that the result of the measurement is expressed either as a thickness or a mass per unit area according to the particular application.

These test methods may be applied to instruments with fixed or traversing mechanisms for transmission, backscattering and X-ray fluorescence.

3 Definitions related to the measurement or control function

3.1

thickness meter (ionizing radiation)

a measuring assembly that includes an ionizing radiation source and is designed to measure non-destructively the thickness of a material by means of ionizing radiation [International Electrotechnical Vocabulary (I.E.V.) 392-04-01]

3.2

transmission thickness meter (ionizing radiation)

a thickness meter that utilizes the radiation transmitted through the material being measured (I.E.V. 392-04-02)

3.3

Beta (gamma) backscatter thickness meter

a thickness meter that includes a beta (gamma) radiation source and that utilizes the radiation backscattered by the material being measured and any backing material adjacent to the material being measured

3.4

X-ray fluorescence thickness meter

a thickness meter that utilizes the X-ray fluorescence excited in the material to be measured or in the supporting material (I.E.V. 392-04-04)

3.5

rated range

the range of a quantity to be measured, observed, supplied or set, which the manufacturer has assigned to the apparatus (IEC Publication 359, Expression of the Functional Performance of Electronic Measuring Equipment)

3.6

effective range

the part of the rated range where measurements can be made within the stated limits of error (IEC Publication 359)

NOTE The effective range may be subdivided in order to characterize the instrument more fully.

3.7

mass per unit area (surface mass, surface density, mass cross-section)

a quantity equal to the product of the density (mass of a unit volume) of a material and the thickness of the same material

the mass per unit area may be calculated in practice by weighing a sample of material and dividing by its known area

3.8 influence quantity

any quantity, generally external to an apparatus, which may affect its performance (IEC Publication 359)

NOTE A change in the value of one performance characteristic may affect another performance characteristic.

3.9 total measurement area

the maximum area of a given material located at the reference pass line which contributes 100 % of the instrument signal

3.10 effective measurement area

the area of a given material located at the reference pass line which provides the optimum correlation between the instrument signal and the sheet variable being measured (Typically, this area will be in the range of 65 % to 95 % of the total measured area.)

3.11 reference conditions

a set of values with tolerances, or restricted ranges of influence quantities and, if necessary, of influencing characteristics, specified for making comparison and calibration tests (IEC Publication 359)

3.12 rated range of use

the range of values for an influence quantity within which the requirements concerning operating error are satisfied (IEC Publication 359)

3.13 resolution¹⁾

the smallest change of the quantity being measured that can be observed or detected. Due regard shall be given to the statistical nature of the signal

3.14 geometrical resolution length¹⁾

the minimum length in a specified direction of a standard sample having a determined mass per unit area which can be measured with a given accuracy

4 Definitions related to the apparatus

4.1 measuring head

in a (ionizing radiation) thickness meter, a sub-assembly comprising the radiation source, the radiation detector and associated devices

4.2 electrical measuring sub-assembly

a sub-assembly which, by means of incorporated electrical or electronic devices, serves to process the electrical quantities delivered by the measuring head and to supply electrical quantities having convenient values for measurement purposes

4.3 traversing mechanism

an assembly which allows the measuring head to be traversed across the material being measured

4.4 measuring gap

transmission thickness meter: the distance between opposing faces of the radiation-emitting assembly and the detector assembly between which the material being measured is located

backscattering thickness meter: the distance from the nearest face of the emitting assembly or the detector assembly to the rearmost surface of the material being measured or to the surface of the backing material

4.5 pass line

the path which the material to be measured has to follow in the measuring gap

4.6 reference pass line

the pass line in the measuring gap corresponding to the position of the material in which calibration is normally made. It is usually defined at specified distance from either the surface of the source-holder housing or the surface of the detector housing

4.7 sample profile error

the error resulting when scanning the measuring head over the length of the traversing mechanism with a standard sample located at the pass line under reference conditions

the error may be expressed as a deviation from the measured value of each standard sample

4.8 pass line error

an indication error which is caused by a movement of the material in the measuring gap in a direction perpendicular to the pass line

¹⁾ In the case of thickness measurements, the resolution and the geometrical resolution length are a function of the effective measured area, of the settling time of the instrument and of the speed of scanning the product.