BS EN 60613:2010

BSI Standards Publication

Electrical and loading characteristics of X-ray tube assemblies for medical diagnosis

National foreword

This British Standard is the UK implementation of EN 60613:2010. It is identical to IEC 60613:2010. It supersedes BS 6058:1989 which will be withdrawn on 1 April 2013.

The UK participation in its preparation was entrusted by Technical Committee CH/62, Electrical Equipment in Medical Practice, to Subcommittee CH/62/2, Diagnostic imaging equipment.

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

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Electrical and loading characteristics of X-ray tube assemblies for medical diagnosis

(IEC 60613:2010)

Caractéristiques électriques et de charge des gaines équipées pour diagnostic médical
(CEI 60613:2010)

Elektrische und Belastungs-Kennwerte von Röntgenstrahlern für die medizinische Diagnostik
(IEC 60613:2010)

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Foreword

The text of document 62B/774/FDIS, future edition 3 of IEC 60613, prepared by SC 62B, Diagnostic imaging equipment, of IEC TC 62, Electrical equipment in medical practice, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60613 on 2010-04-01.

This standard supersedes EN 60613:1990. It constitutes a technical revision. EN 60613:2010 has been adapted to apply to the present technology.

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The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2011-01-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2013-04-01

Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 60613:2010 was approved by CENELEC as a European Standard without any modification.

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Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60601-1	2005	Medical electrical equipment - Part 1: General requirements for basic safety and essential performance	EN 60601-1	2006
IEC 60601-1-3	2008	Medical electrical equipment - Part 1-3: General requirements for basic safety and essential performance - Collateral Standard: Radiation protection in diagnostic X-ray equipment	EN 60601-1-3	2008
IEC/TR 60788	2004	Medical electrical equipment - Glossary of defined terms	-	-

CONTENTS

ELECTRICAL AND LOADING CHARACTERISTICS OF X-RAY TUBE ASSEMBLIES FOR MEDICAL DIAGNOSIS

1 Scope

This International Standard applies to X-RAY TUBE ASSEMBLIES either with a rotating ANODE X-RAY TUBE or a stationary ANODE X-RAY TUBE, intended for use in medical diagnosis.

For an X-RAY TUBE HEAD, its X-RAY TUBE ASSEMBLY aspects are also within the scope.

This International Standard covers performance-related definitions and conditions of electrical and LOADING characteristics of X-RAY TUBE ASSEMBLIES in relation to their behaviour during and after energization and, where appropriate, methods of presentation and measurement of these characteristics. This International Standard is therefore relevant for the MANUFACTURER and the RESPONSIBLE ORGANIZATION.

NOTE "Measurement" in this standard is always related to practical use. Consequently, "measurement" is meant to consume only a negligible part of the life of the X-RAY TUBE ASSEMBLY.

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 60601-1:2005, *Medical electrical equipment – Part 1: General requirements for basic safety and essential performance*

IEC 60601-1-3:2008, *Medical electrical equipment – Part 1-3: General requirements for basic safety and essential performance – Collateral Standard: Radiation protection in diagnostic X-ray equipment*

IEC/TR 60788:2004, *Medical electrical equipment – Glossary of defined terms* (available only in English)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC/TR 60788:2004, IEC 60601-1:2005 and IEC 60601-1-3:2008 and the following apply.

3.1
X-RAY TUBE VOLTAGE
potential difference applied to an X-RAY TUBE between the ANODE and the CATHODE. Usually X-RAY TUBE VOLTAGE is expressed by its peak value in kilovolts (kV)

[IEC 60601-1-3:2008, 3.88]

3.2
NOMINAL X-RAY TUBE VOLTAGE
highest permitted X-RAY TUBE VOLTAGE for SPECIFIC operating conditions

[IEC 60601-1-3:2008, 3.42]

NOTE 1 For different operating conditions of the X-RAY TUBE, for example continuous operation, intermittent operation, short-time operation, different types of X-RAY TUBE HOUSINGS, there may be different values of the above NOMINAL X-RAY TUBE VOLTAGE.

NOTE 2 Additionally, values may be given for the highest permitted potential difference between ANODE and earth and between CATHODE and earth.

3.3
X-RAY TUBE CURRENT
electric current of the ELECTRON beam incident on the TARGET of an X-RAY TUBE. Usually, the X-RAY TUBE CURRENT is expressed by its mean value in milliamperes (mA)

[IEC 60601-1-3:2008, 3.85]

NOTE See Annex B for further considerations.

3.4
CATHODE EMISSION CHARACTERISTIC
dependence of the X-RAY TUBE CURRENT on variables, for example FILAMENT CURRENT, X-RAY TUBE VOLTAGE

3.5
ENVELOPE
vacuum-wall of the X-RAY TUBE

3.6
ENVELOPE CURRENT
electric current, flowing via a conducting part of an ENVELOPE

3.7
ENVELOPE VOLTAGE
potential difference between an X-RAY TUBE-conducting ENVELOPE part and earth

3.8
LOADING
in an X-RAY GENERATOR, act of supplying electrical energy to the ANODE of an X-RAY TUBE

[IEC 60601-1-3:2008, 3.34]

3.9
X-RAY TUBE LOAD
electrical energy supplied to an X-RAY TUBE expressed by a combination of values of LOADING FACTORS

3.10
LOADING FACTOR
factor influencing by its value the X-RAY TUBE LOAD, for example X-RAY TUBE CURRENT, LOADING TIME, CONTINUOUS ANODE INPUT POWER, X-RAY TUBE VOLTAGE and PERCENTAGE RIPPLE

[IEC 60601-1-3:2008, 3.35]

3.11
LOADING TIME
time determined according to a SPECIFIC method, during which the ANODE INPUT POWER is applied to the X-RAY TUBE

[IEC 60601-1-3:2008, 3.37]

3.12
CYCLE TIME
for a series of single LOADINGS: time interval from the beginning of a LOADING to the beginning of the next, identical LOADING

for a series of serial LOADINGS: time interval from the beginning of a serial LOADING to the beginning of the next, identical serial LOADING

3.13
ANODE INPUT POWER
power applied to the ANODE of an X-RAY TUBE to produce X-RADIATION

3.14
NOMINAL ANODE INPUT POWER
highest constant ANODE INPUT POWER that can be applied for a single X-RAY TUBE LOAD in a SPECIFIC LOADING TIME and under SPECIFIED conditions

3.15
NOMINAL RADIOGRAPHIC ANODE INPUT POWER
NOMINAL ANODE INPUT POWER which can be applied for a single X-RAY TUBE LOAD with a LOADING TIME of 0,1 s and a CYCLE TIME of 1,0 min, for an indefinite number of cycles

NOTE 1 In this application, RADIOSCOPY is not applied.

NOTE 2 With this definition mammographic and dental X-ray are included, see A.3.3 in Annex A.

3.16
NOMINAL CT ANODE INPUT POWER
NOMINAL ANODE INPUT POWER which can be applied for a single X-RAY TUBE LOAD with a LOADING TIME of 4 s and a CYCLE TIME of 10 min, for an indefinite number of cycles

3.17
X-RAY TUBE ASSEMBLY INPUT POWER
mean power applied to an X-RAY TUBE ASSEMBLY for all purposes before, during and after LOADING, including power applied to the stator of a rotating ANODE X-RAY TUBE, to the filament and to any other device included in the X-RAY TUBE ASSEMBLY

3.18
NOMINAL CONTINUOUS INPUT POWER
SPECIFIED highest X-RAY TUBE ASSEMBLY INPUT POWER, which can be applied to an X-RAY TUBE ASSEMBLY continuously

3.19
CONTINUOUS ANODE INPUT POWER
SPECIFIED highest ANODE INPUT POWER, which can be applied to the ANODE continuously

NOTE 1 CONTINUOUS ANODE INPUT POWER may be determined by subtracting all power other than the ELECTRON beam power, such as filament heating, ANODE drive, from the NOMINAL CONTINUOUS INPUT POWER.

NOTE 2 If not SPECIFIED otherwise, CONTINUOUS ANODE INPUT POWER is the referenced LOADING FACTOR for determining the LEAKAGE RADIATION.

3.20
CT SCAN POWER INDEX
CTSPI
characteristic of an X-RAY TUBE ASSEMBLY intended for use in COMPUTED TOMOGRAPHY for a SPECIFIED range of LOADING TIMES for single LOADINGS, for a given CYCLE TIME, as follows

$$\mathrm{CTSPI} = \frac{1}{(t_{max} - t_{min})} \int_{t_{min}}^{t_{max}} P(t)\,\mathrm{d}t$$

where

t_{max} is the upper limit of the LOADING TIME in seconds,
t_{min} is the lower limit of the LOADING TIME in seconds, and
P(t) is the function representing the SINGLE LOAD RATING in kilowatts

NOTE The CTSPI represents the effective power for PATIENT throughput in CT scanning.

3.21
NOMINAL CT SCAN POWER INDEX
NOMINAL CTSPI
CTSPI, calculated for a lower limit of the LOADING TIME of 1 s, an upper of the LOADING TIME of 25 s and a CYCLE TIME of 10 min

3.22
RADIOGRAPHIC RATINGS
for the operation of an X-RAY TUBE, SPECIFIED combinations of conditions and LOADING FACTORS, under which the SPECIFIED limits of loadability of the X-RAY TUBE are attained

3.23
SINGLE LOAD RATING
highest permitted X-RAY TUBE LOAD given by a relationship between constant ANODE INPUT POWER and LOADING TIME for one LOADING under SPECIFIED conditions

3.24
SERIAL LOAD RATING
highest permitted X-RAY TUBE LOAD given by the relationship between ANODE INPUT POWER and LOADING TIME for the total of a SPECIFIED series of individual X-RAY TUBE LOADS with SPECIFIED LOADING FACTORS under SPECIFIED conditions

4 Presentation of the electrical characteristic

4.1 X-RAY TUBE VOLTAGE

The X-RAY TUBE VOLTAGE shall be given as the peak value, in kilovolts.

4.2 NOMINAL X-RAY TUBE VOLTAGE

The NOMINAL X-RAY TUBE VOLTAGE shall be given as the peak value, in kilovolts.

4.3 X-RAY TUBE CURRENT

The X-RAY TUBE CURRENT shall be given as the average value in milliamperes.

4.4 CATHODE EMISSION CHARACTERISTIC

CATHODE EMISSION CHARACTERISTICS are given as a family of curves in which the X-RAY TUBE CURRENT is shown as a function of the FILAMENT CURRENT and, if appropriate, of further characteristics of the CATHODE, each curve corresponding to an X-RAY TUBE VOLTAGE while specifying its waveform, and other factors as appropriate. If appropriate, the relationship between FILAMENT CURRENT and filament voltage shall be indicated and also its dependence on other characteristics of the CATHODE.

4.5 ENVELOPE characteristics

4.5.1 ENVELOPE CURRENT

If the ENVELOPE CURRENT is to be stated, it shall be given as the percentage value of X-RAY TUBE CURRENT under SPECIFIED conditions.

4.5.2 ENVELOPE VOLTAGE

If the ENVELOPE VOLTAGE is to be stated, it shall be given in kilovolts with respect to earth.

5 LOADING of an X-RAY TUBE

5.1 LOADING TIME

5.1.1 Units

The LOADING TIME shall be given in seconds.

5.1.2 Measurement

LOADING TIME is measured as the time interval between:

– the instant that the X-RAY TUBE VOLTAGE has risen for the first time to a value of 75 % of the peak value; and
– the instant at which it finally drops below the same value.

If LOADING is controlled by electronic switching of the HIGH VOLTAGE, using a grid in an electronic tube or in the X-RAY TUBE, the LOADING TIME may be determined as the time interval between the instant when the TIMING DEVICE generates the signal to start the IRRADIATION and the instant when it generates the signal to terminate the IRRADIATION.

If LOADING is controlled by simultaneous switching in the primaries of both the high-voltage circuit and the heating supply for the filament of the X-RAY TUBE, the LOADING TIME shall be determined as the time interval between the instant when the X-RAY TUBE CURRENT first rises above 25 % of its maximum value and the instant when it finally falls below the same value.

NOTE 1 See also definition 3.11.

NOTE 2 The LOADING TIME is preferably measured at the tube input to minimise the influence of HV-cable-capacitance.

NOTE 3 For field-testing, a reasonable approximation of the LOADING TIME can be obtained by measuring the IRRADIATION TIME, for which the SPECIFIC method according to the definition in IEC 60601-1-3:2008 is chosen in this International Standard as the time period during which the AIR KERMA RATE exceeds 50 % of its peak value.

5.2 CYCLE TIME

The CYCLE TIME shall be given in minutes or seconds, as appropriate.

6 Input power

6.1 ANODE INPUT POWER

The ANODE INPUT POWER shall be given in kilowatts for SPECIFIED conditions of LOADING.

6.2 NOMINAL ANODE INPUT POWER

The NOMINAL ANODE INPUT POWER shall be given in kilowatts.

6.3 NOMINAL RADIOGRAPHIC ANODE INPUT POWER

The NOMINAL RADIOGRAPHIC ANODE INPUT POWER shall be given in kilowatts.

6.4 NOMINAL CT ANODE INPUT POWER

The NOMINAL CT ANODE INPUT POWER shall be given in kilowatts.

6.5 X-RAY TUBE ASSEMBLY INPUT POWER

The X-RAY TUBE ASSEMBLY INPUT POWER shall be given in watts.

6.6 NOMINAL CONTINUOUS INPUT POWER

The NOMINAL CONTINUOUS INPUT POWER shall be given in watts.

Unless otherwise SPECIFIED, the ambient temperature shall be between 20 °C and 25 °C.

6.7 CONTINUOUS ANODE INPUT POWER

The CONTINUOUS ANODE INPUT POWER shall be given in watts.

6.8 CT SCAN POWER INDEX (CTSPI)

The CT SCAN POWER INDEX shall be given in kilowatts.

6.9 NOMINAL CT SCAN POWER INDEX (NOMINAL CTSPI)

The NOMINAL CT SCAN POWER INDEX shall be given in kilowatts.

7 RADIOGRAPHIC RATINGS

7.1 General

RADIOGRAPHIC RATINGS shall provide application-relevant parametric information on LOADING FACTORS, in any form of presentation (tables, graphs ...) which is supporting the application. If a NOMINAL ANODE INPUT POWER is SPECIFIED, the RADIOGRAPHIC RATINGS shall at least encompass the set of LOADING FACTORS pertinent to the SPECIFIED NOMINAL ANODE INPUT POWER.

7.2 SINGLE LOAD RATING

The SINGLE LOAD RATING shall be presented as curves or as a table of numerical values showing constant ANODE INPUT POWER as a function of LOADING TIME and CYCLE TIME for appropriate LOADING FACTORS, for example NOMINAL FOCAL SPOT VALUE, ANODE SPEED and others.

7.3 SERIAL LOAD RATING

SERIAL LOAD RATINGS shall be presented as curves or as a table of numerical values with values of the CYCLE TIME and the appropriate LOADING FACTORS, for example, ANODE INPUT POWER for an individual X-RAY TUBE LOAD, LOADING TIME of an individual X-RAY TUBE LOAD, total number of LOADINGS or the duration of a series of LOADINGS, number of individual X-RAY TUBE LOADS per second.

8 Presentation of data

If single data values are presented in compliance with this International Standard, such values shall be designated as follows:

<Term according to Clause 3> <value> <unit> IEC 60613:2010

If graphs or tables are presented in compliance with this International Standard, a reference to IEC 60613:2010 shall be given.

Annex A
(informative)

Rationale and historical background

A.1 Overview

The purpose of this annex is to state the general objectives and approach used in creating the 3rd edition of this standard, and to clarify the inclusion of those items which are substantially new to this edition, as well as to clarify why some items are no longer described.

A.2 History: basis of 1st and 2nd editions

The subject matter of these earlier editions was the electrical and thermal ratings of medical X-RAY TUBE ASSEMBLIES and their LOADING characteristics. Therefore, the thermal/electrical construction and operating mechanisms of X-RAY TUBES existing at the time of the earlier editions of the standard had a significant impact on the content of those early versions. Historically, medical X-RAY TUBES have been primarily constructed with glass ENVELOPES which act as the insulating support between the electrically charged ANODE and CATHODE electrodes. As such, it was not necessary or practical to define the electrical potential of this insulating ENVELOPE, which takes on an ambiguous charge state at any particular point of its surface. It was sufficient to state the potential difference between the ANODE and the CATHODE, or the potential of these electrodes relative to earth. Regarding the thermal/LOADING characteristics, most medical rotating ANODE X-RAY TUBES were constructed in such a way as to temporarily store the heat generated in the bremsstrahlung process and then dissipate it through the very non-linear thermal RADIATION process. Further, at the time of the earlier editions, applications were primarily directed at RADIOGRAPHY. In the meantime, vascular and CT applications, implying different LOADING conditions (relatively long exposures, heavy PATIENT throughput) have to be considered.

A.3 Problems and solutions: objectives of the 3rd edition

A.3.1 General

Technical advancements in X-RAY TUBE design have lead to improvements, particularly in the thermal operation of X-RAY TUBES that have made the application of the previous edition of the standard inadequate. The main advancements and their impacts on the application of the standard are described below.

A.3.2 Advent of metal/ceramic ENVELOPE construction

One of the advancements that have been widely adopted in the industry, especially for high-power X-RAY TUBES, is the use of metallic ENVELOPES, often with ceramic, i.e. non-glass insulators. These ENVELOPES can carry a substantial fraction of the overall X-RAY TUBE CURRENT during operation as backscattered ELECTRONS from the TARGET are collected on the inner surfaces of the metallic ENVELOPE and conducted back through to the HIGH-VOLTAGE GENERATOR. Because it is important to know what the intended electrical connection scheme is between the tube and generator, this edition of the standard has added a section of terms and definitions specifically related to the ENVELOPE'S electrical configuration.

A.3.3 Thermal ratings definitions moved away from heat-content based definitions

The older editions of the standard described the tube's thermal performance in terms of characteristics such as the heat storage content, the heat dissipation rate, heating curves and cooling curves. Before the widespread availability of computers integrated into X-ray imaging systems, this data was intended to be used by the technologist to calculate the X-RAY TUBE'S thermal state prior to applying a given LOADING or load sequence. In modern X-RAY EQUIPMENT, feedback algorithms track the tube's thermal state and prevent accidental overloading of the tube's thermal limits, making the need for such detailed thermal information obsolete.

At the same time, changes in tube design made these defined characteristics less useful for estimating the thermal performance of a given X-RAY TUBE. First, rotating ANODE heat storage ratings increased rapidly with the advent of high-throughput CT systems (and to some degree with certain cardio-vascular X-ray applications). The nature of the construction of high storage ANODES is such that thermal time lags within the TARGET disk are often significant and cannot be adequately modelled by the simple heating/cooling assumptions rooted in the previous versions of the standard. Second, in more recent years, innovations in the cooling of rotating ANODES has lead to cooling behaviours that are quite different from those of the assumed radiation-dominated models of the older versions of the standard. With these advancements and others on the horizon, it became apparent that the usefulness of the older definitions was diminished and that a new approach was called for.

Foremost, the new standard should better enable the description and comparison of the "clinically relevant" performance of the X-RAY TUBE, as a service to the PATIENT and customer community. With this approach in mind along with a few other "clean-up" objectives, the changes to the 3rd edition of the standard were made based on the following list of goals:

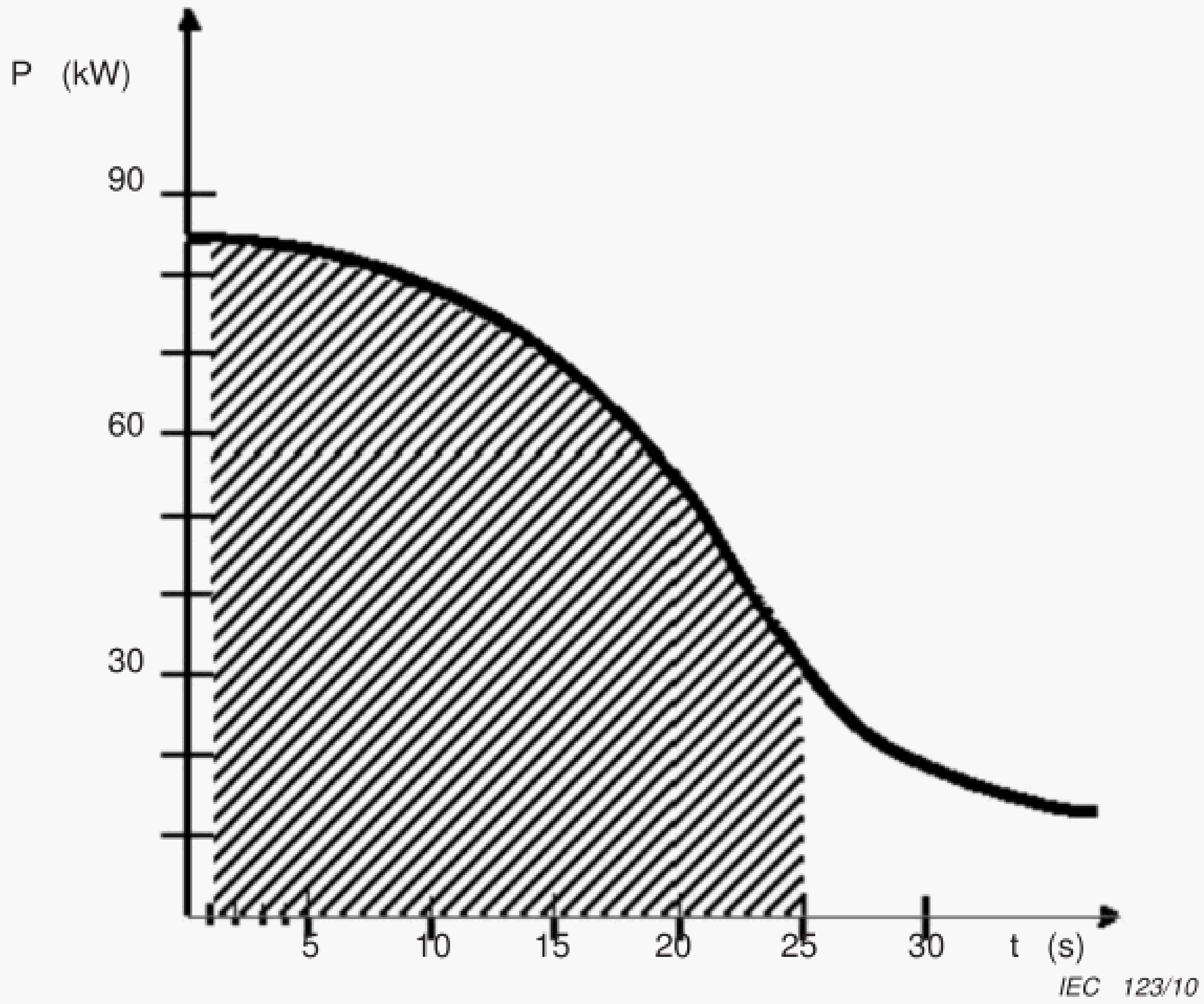
- Wherever possible, eliminate definitions that take special laboratory conditions to verify, such as heat content, and replace them with definitions that are verifiable by an end-user, such as power and time. An example of the application of this goal is to specify the initial thermal state of an ANODE in terms of a steady-state CYCLE TIME, which can be reproduced in a clinical setting, instead of a thermal storage state (HU or joules), which can only be directly verified in a laboratory setting. Heat units (HU) had been introduced in the past to compare multipulse X-RAY GENERATORS to single or 2-pulse X-RAY GENERATORS.
- Apply definitions that represent clinically relevant conditions. Thus, for example, move away from defining the NOMINAL ANODE INPUT POWER for a CT tube at the traditional exposure time of 0,1 s, since this is not a common technique for typical clinical scan sequences (hence, leading to the new definition of NOMINAL CT ANODE INPUT POWER). Further, as "PATIENT throughput" is highly relevant for both clinical applications and for the thermal characteristics of the X-RAY TUBE, the new term "CYCLE TIME" has been introduced. The notion of CYCLE TIME is the new approach for defining the NOMINAL ANODE INPUT POWER, namely defining that power for an indefinite series of PATIENTS/such LOADINGS, hereby simulating daily practice.
- Strive for a *minimum* set of power-definitions, although there are many different "clinically relevant conditions" which each could lead to a thermal rating definition tuned to the particular condition. Ultimately, one NOMINAL radiographic rating and one NOMINAL CT-rating appears to cover the clinical conditions sufficiently. For the radiographic rating, the traditional exposure time of 0,1 s covers also the traditional reference exposure time of 1,0 s for certain applications, such as mammography and dental X-ray because the loadability at 1,0 s exposure is not much different from the loadability at 0,1 s exposure for these applications.
- Choose SPECIFIED conditions for the definitions that are clinically aggressive, but realistic. Since the clinical usage parameters of a given type of X-RAY TUBE are wide-ranging, what should we choose for an exposure technique to represent a particular rating? The guidance here was to choose something that definitely falls within accepted clinical practice, but was on the aggressive side of the distribution of clinical techniques (from the standpoint of LOADING techniques) in order that the clinically relevant performance of various X-RAY TUBES are better delineated.

A.3.4 CTSPI definition

ANODE HEAT CONTENT was eliminated from the standard. It has been widely used to estimate the power-throughput capability of an imaging system, in particular of a CT system. As stated above, ANODE HEAT CONTENT was becoming less and less useful in accurately fulfilling this estimate. It was desirable to replace this role by defining a new characteristic which was based solely on clinical performance per the above-stated goals. It was also desirable that this new defined characteristic be based on parameters which were already defined under the new 3rd edition. Thus, the new term for CT, CT SCAN POWER INDEX (CTSPI), has the following features:

- is based on the SINGLE LOAD RATING curve as it is defined in the 3rd edition of this standard;
- involves a “black box” approach that specifies performance which is not tied to the design technology inside the tube itself. This approach can be used to make performance assessments independent of how the tube is constructed, and can be verified by the end user;
- provides a more accurate representation of the power-throughput capability of the CT tube than the storage-based definition of the prior editions of the standard;
- has units of kW in line with the overall stated goals for the 3rd edition.

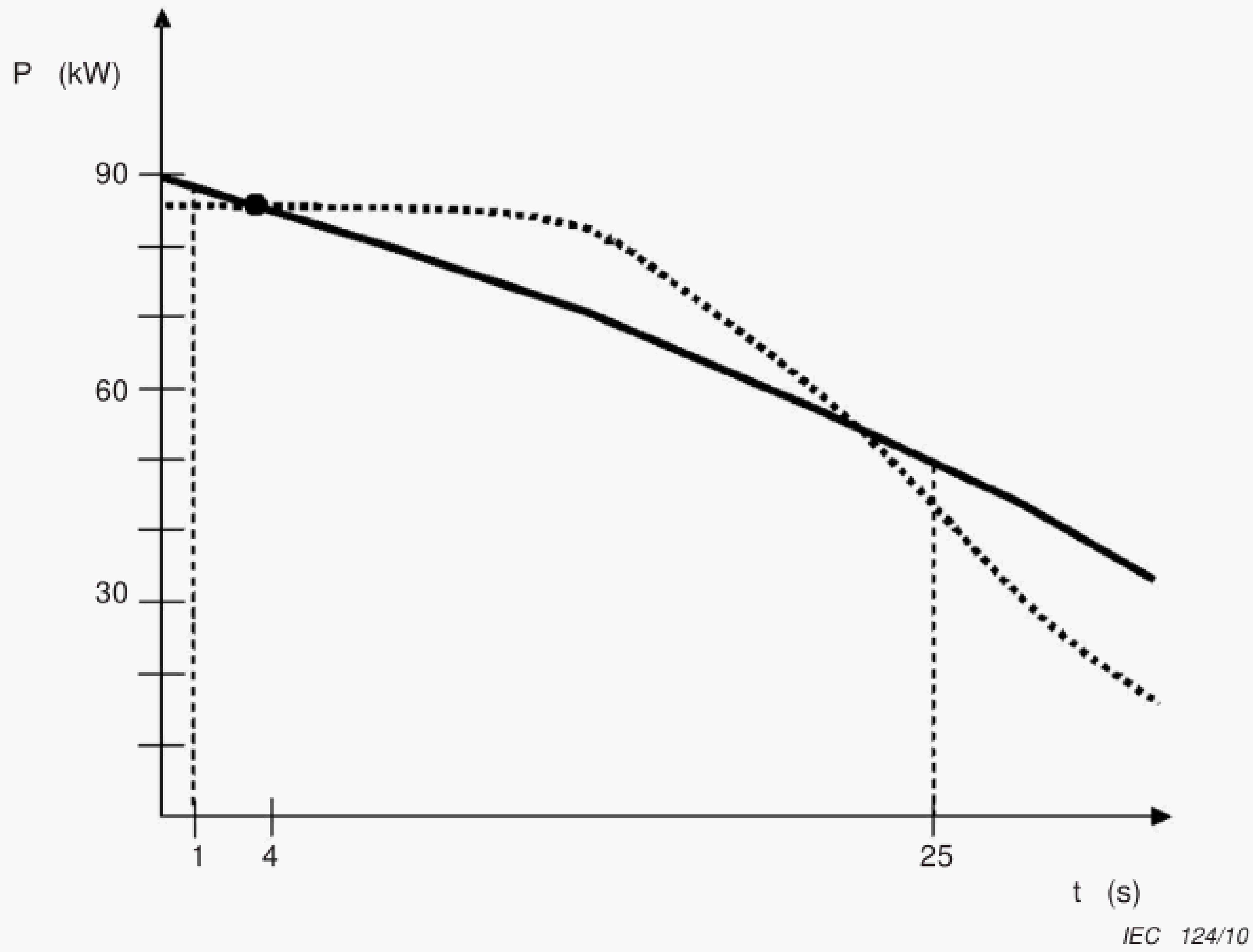
Under the 3rd edition, the NOMINAL CT ANODE INPUT POWER gives the maximum load capability of the tube at a particular scan time (4 s) which can be repeated indefinitely during a cycle of 10 min. The CTSPI broadens this to include the tube’s load capability over a wider range of clinically relevant scan times. It is in fact the area under the SINGLE LOAD RATING curve normalized over the range of scan times (Figure 1). It can be considered as a single-number representation of the SINGLE LOAD RATING curve for the purpose of estimating power throughput under clinically relevant conditions (scan times and PATIENT CYCLE TIMES).



P(kW): power
t(s): scan time

Figure A.1 – Example: SINGLE LOAD RATING chart showing CTSPI calculation area for scan time interval of 1 s to 25 s

The CTSPI gives the advantage of capturing the essential information from the SINGLE LOAD RATING curve and representing it as a single value. It is possible for two different CT tubes to have the same value for the NOMINAL CT ANODE INPUT POWER while having significantly different CTSPI values (Figure 2), so NOMINAL CT ANODE INPUT POWER alone is not sufficient to characterize the power-throughput performance of the tube. In the 3rd edition, the NOMINAL CT ANODE INPUT POWER replaces the NOMINAL ANODE INPUT POWER as a single-value estimate of loadability of CT tubes. Likewise, the CTSPI replaces the ANODE HEAT CONTENT as a single-value estimate of PATIENT throughput.



P(kW): power
t(s): scan time

The areas under each curve (representing the performance over a wide range of scan times) are different, which would be borne out in a CTSPI calculation.

Figure A.2 – Example: SINGLE LOAD RATING curves for two different CT tubes, both having the same value of NOMINAL CT ANODE INPUT POWER

It is noted that the definition of CTSPI was purposely kept simple by basing it upon the defined SINGLE LOAD RATING curve for a given tube as opposed to other possibilities of using more complex SERIAL LOAD RATING curves (this SINGLE LOAD RATING curve is the same curve from which the NOMINAL CT ANODE INPUT POWER is derived). The 3rd edition standardizes the values to be used in the calculation of CTSPI and calls this value the NOMINAL CT SCAN POWER INDEX. The normalization conditions are: 10 min CYCLE TIME (per definition of the SINGLE LOAD RATING curve), and lower and upper values of the scan time range of 1 s and 25 s respectively. These were chosen using the guideline of considering clinically relevant but aggressive scan techniques. The 10 min CYCLE TIME represents a PATIENT throughput of 6 PATIENTS per hour; the scan times of 1 s and 25 s represent realistic boundaries for scan times on modern CT scanners, making CTSPI a simple and straightforward way of representing the PATIENT throughput of the CT tube.

For details see [1][1)].

A.3.5 MAXIMUM CONTINUOUS HEAT DISSIPATION changed names

As mentioned before, definitions will no longer be based on "heat content" and the like. In this line of thinking, the MAXIMUM CONTINUOUS HEAT DISSIPATION is re-named into NOMINAL CONTINUOUS INPUT POWER, thereby logically connected to the term defined in 3.17: X-RAY TUBE ASSEMBLY INPUT POWER. The same logic for name-giving has been applied to the two terms ANODE INPUT POWER and CONTINUOUS ANODE INPUT POWER (see A.3.6).

A.3.6 Specification of power for measurement of LEAKAGE RADIATION

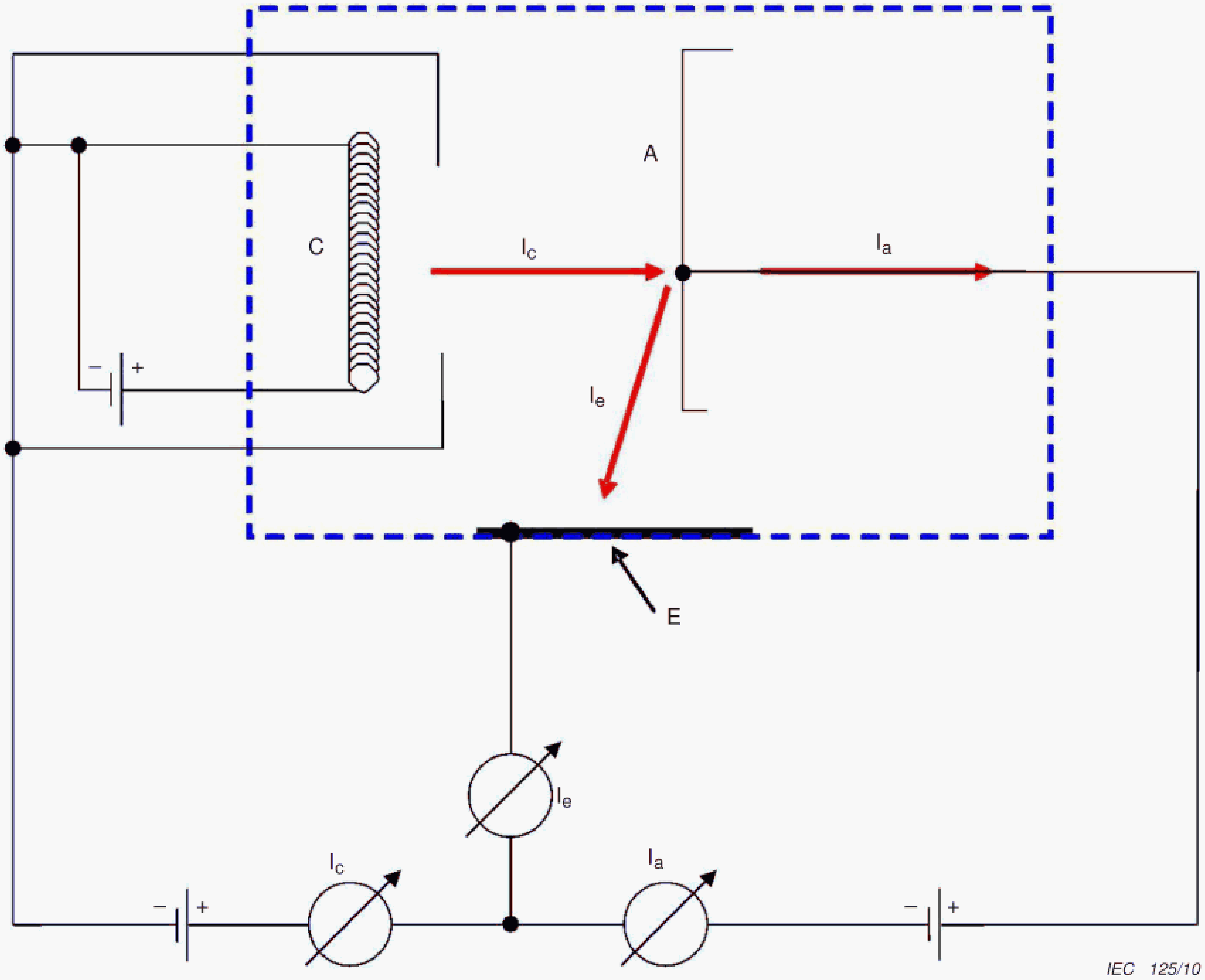
The definition of NOMINAL CONTINUOUS INPUT POWER contains energy sources which are not related to X-RADIATION, such as the stator power and the filament power, and therefore is not precise enough for the purpose of specifying a technique for LEAKAGE RADIATION. Therefore, a new term, the CONTINUOUS ANODE INPUT POWER, was established for this purpose. This new

1) Figures in square brackets refer to the Bibliography.

term represents only the power supplied to the X-RAY TUBE which goes into the production of X-rays, and is therefore the correct one to associate with LEAKAGE RADIATION.

Annex B
(informative)

Measurement of the X-RAY TUBE CURRENT



A ANODE

C CATHODE

E ENVELOPE

I_a ANODE current

I_c CATHODE emission current

I_e ENVELOPE CURRENT

Figure B.1 – Electrical schematic of X-RAY TUBE CURRENT measurement

The X-RAY TUBE CURRENT is not necessarily equivalent to the ANODE current, (Figure B.1, current I_a) due to the effects of e.g. ENVELOPE CURRENT (Figure B.1, current I_e).

In the case of a non-conducting ENVELOPE, e.g. glass, the ENVELOPE CURRENT is zero, and the X-RAY TUBE CURRENT equals both I_c and I_a.

Bibliography

[1] LOUNSBERRY, Brian D.; UNGER, Christopher D. "New CT tube performance specifications", in *Medical Imaging 2004: Physics of Medical Imaging*. Edited by Yaffe, Martin J.; Flynn, Michael J. Proceedings of the SPIE, 2004,Volume 5368, pp. 621-632 (*only available in English*)

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