INTERNATIONAL STANDARD

ISO 16526-2

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Non-destructive testing — Measurement and evaluation of the X-ray tube voltage —

Part 2: Constancy check by the thick filter method

Essais non destructifs — Mesurage et évaluation de la tension des tubes radiogènes —

Partie 2: Contrôle de la constance selon la méthode du filtre épais

Reference number
ISO 16526-2:2011(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 16526-2 was prepared by CEN (as EN 12544-2:2000) and is submitted for approval under a special “fast-track procedure”, by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 5, *Radiation methods*, in parallel with its approval by the ISO member bodies (see the *ISO/IEC Directives*, Part 1, “Fast-track procedure”).

ISO 16526 consists of the following parts, under the general title *Non-destructive testing — Measurement and evaluation of the X-ray tube voltage*:

— *Part 1: Voltage divider method*

— *Part 2: Constancy check by the thick filter method*

— *Part 3: Spectrometric method*

Introduction

In order to cover the different requirements for the measurement of the X-ray tube voltage, three different methods are described in ISO 16526-1 to ISO 16526-3.

The voltage divider method (ISO 16526-1) enables a direct and absolute measurement of the average high voltage of constant potential X-ray systems on the secondary side of the high voltage generator.

The thick filter method (ISO 16526-2) describes a constancy check. This method is recommended for the regular stability check of an X-ray system.

The spectrometric method (ISO 16526-3) is a procedure for non-invasive measurement of the X-ray tube voltage using the energy spectrum of the X-rays. This method can be applied for all X-ray systems and shall be applied whenever the voltage divider method is not applicable, e. g. in case of tank units where it is not possible to connect the voltage divider device.

Non-destructive testing — Measurement and evaluation of the X-ray tube voltage —

Part 2: Constancy check by the thick filter method

1 Scope

This part of ISO 16526 specifies a constancy check of a X-ray system where mainly the X-ray voltage is checked and also the tube current and the constitution of the target which can be changing due to ageing of the tube.

The thick filter method is based on a measurement of the dose rate behind a defined thick filter using defined distances between the X-ray tube, the filter and the measuring device.

This method is very sensitive to changes of the voltage, but it does not provide an absolute value for the X-ray tube voltage. Therefore, a reference value is needed and, it is recommended to find this reference, for example, within the acceptance test of the system.

The thick filter method is a rather simple technique and may be applied by the operator of an X-ray system to perform regularly a constancy check of the system.

The method can also be applied for consistency checks after changing components which may affect the X-ray tube voltage.

This method can be applied for all types of X-ray systems, i. e. for constant potential, half wave and impulse wave generators with a tube current larger than 1 mA.

2 Principle and equipment

The equipment to be used includes the following components, see figure 1:

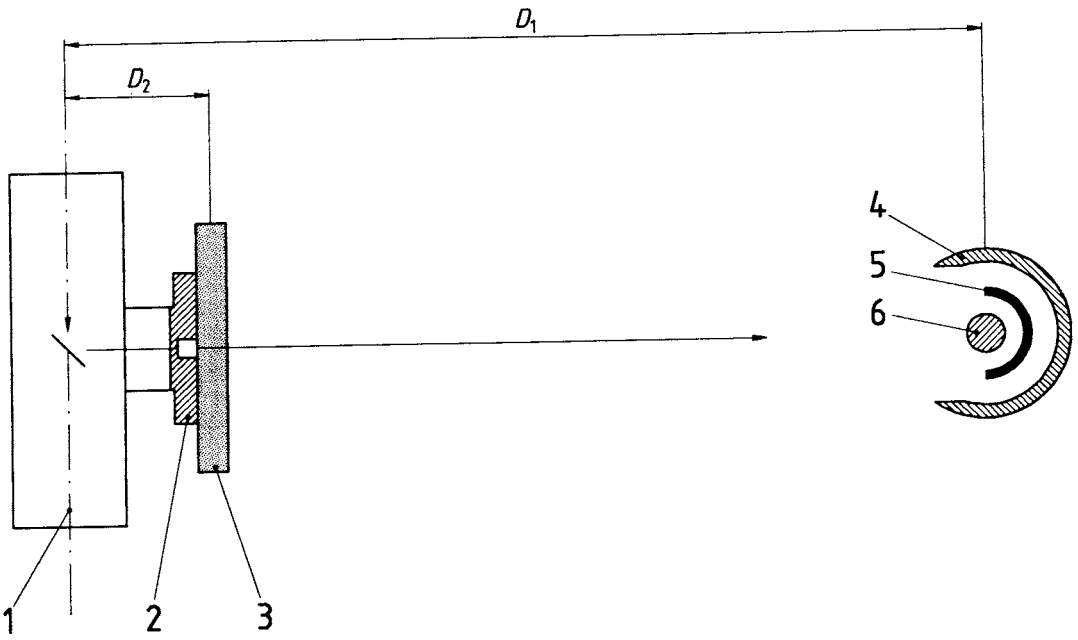
– the X-ray system;

– a specified collimator;

– a specified filter;

– suitable dose meter or dose rate meter;

– a film for the prove of good collimation and dose meter or dose rate meter adjustment.



Key

1 X-ray tube
2 collimator
3 thick filter
4 lead shield
5 film
6 dose meter

Figure 1 – Setup of the thick filter method

It is possible to apply any type of filter and distances. Two aspects are important:

– To obtain reproducible values, the collimator, the filter and the dose rate meter shall be identical and, the focus to filter distance D_2 and the focus to dose rate meter distance D_1 shall be fixed for the reference and all subsequent measurements.

– The filter material and thickness shall be selected according to figure 2.

The requirements concerning the dose meter or dose rate meter are:

– The long term stability shall be 3 times better than the tolerance of the measured values. A regular stability check of the dose rate meter, using a radioactive source, is necessary.

– The device shall have adequate measuring ranges.

– The exposure time shall be selected to obtain values between 50 % and 100 % of the scale. Three or more measurements shall be taken and the results shall be averaged.

The diameter of the selected collimator shall be as small as possible. The area of homogeneous radiation intensity at the dose meter or dose rate meter shall be equal or less then 3 times of the size of the detection chamber of the dose meter. This shall be proven with a film exposure due to the requirement of exact adjustment. This radiograph marked with the date of measurement may be used for documentation. Figure 3 shows a typical radiograph of a dose meter which is well adjusted corresponding to figure 1.

NOTE : The results of the measurement arrangement are reliable if it provides the same value in horizontal and vertical adjustment.

Using the thick filter method, the measured values will change approximately 5 to 10 times faster (leverage factor) than the X-ray voltage changes. That means for example that 5 % of the X-ray tube voltage change corresponds to 25 % to 50 % of the measured dose rate.

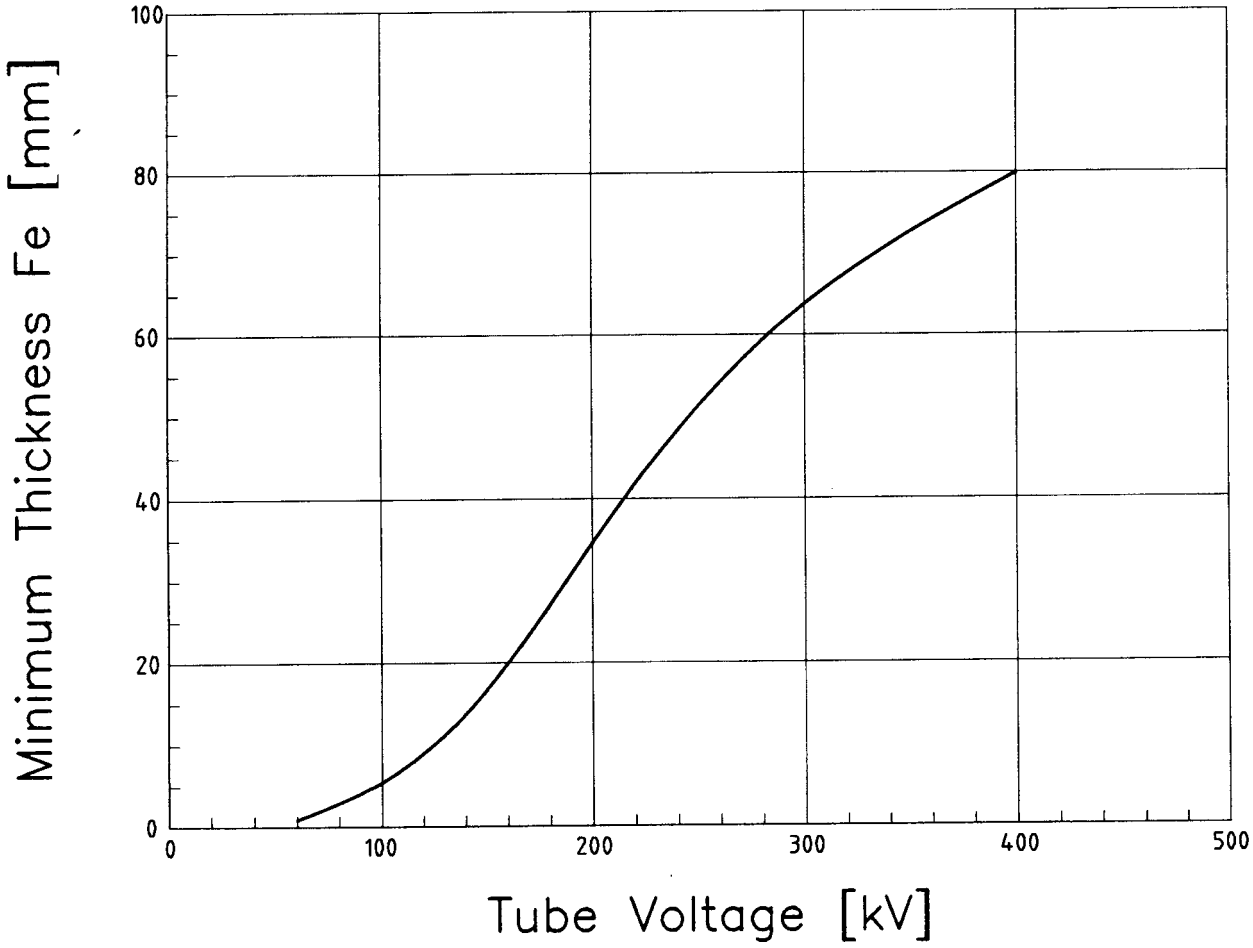


Figure 2 – Minimum filter thickness values

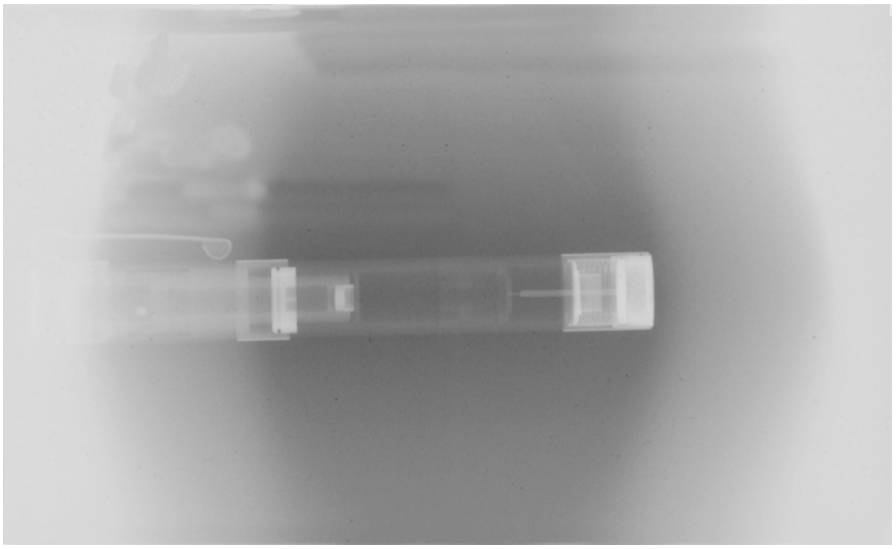


Figure 3 – Radiograph of the well-adjusted dose meter corresponding to figure 1

3 Measurement

In order to carry out the constancy check of an X-ray system or the consistency check of an X-ray system to compare different components the dose rate is measured using a filter as given in figure 2 or thicker.

3.1 Leverage factor

For the first application of the thick filter method the leverage factor L_v shall be determined corresponding to the selected setup. The dose value shall be measured at 100 % (D_{100}) and at 95 % (D_{95}) of the test voltage.

NOTE The leverage factor should be adjusted between 6 and 8. This is a compromise which considers limitations in exposure time. A high leverage factor is recommended for high accuracy of the method.

The leverage factor is calculated by equation (1)

$$L_v = (1 - D_{95} / D_{100}) / 0{,}05 \quad (1)$$

3.2 Constancy check

The constancy test of the tube shall be repeated regularly at the given voltage. The arrangement corresponding to figure 1 shall be used with the same collimator, thick filter (thickness and material) and the same calibrated dose meter for the constancy check. The constancy of the tube voltage is confirmed if the measured dose value or dose rate value has been reproduced within the required tolerance T (in %) which is calcualted by equation (2).

$$T = 100 \cdot | (D_{100measured} - D_{100nominal}) | / (D_{100nominal} \cdot L_v) \quad (2)$$

Within the reference measurement all essential parameters (distances D1 and D2, filter material and thickness, type of dose meter or dose rate meter) shall be documented. The arrangement shall be identical for all subsequent measurements.

An example is given in Annex A.

4 Test report

The test report of the measurements shall contain at least the following information:

a) reference to this part of ISO 16526, i.e. ISO 16526-2:2011;

b) X-ray system, type and fabrication number;

c) the X-ray parameters: voltage (kV), current (mA) and the selected focus size, preferably the nomimal voltage and the maximum current;

d) type and size of collimator;

e) filter type and thickness, preferably with identification number;

f) dose rate meter, or dose meter, also with identification number;

g) focus to filter distance;

h) focus to dose rate meter distance;

i) drawing of the setup if it deviates from figure 1;

j) the measured value and the measured leverage factor;

k) the date of the measurement;

l) the deviation from the reference value;

m) name and signature of operator.

Annex A
(informative)

Example for application

The usage of this part of ISO 16526 needs exact adjustment and shielding. It is designed for the application of inexpensive equipment.

Some reference values are given for orientation of users in table A.1. Due to deviations in the adjustment as well as the equipment, considerable differences to the given data are possible.

The applied X-ray tube was of the constant potential type.

An usual pen-type dose meter was used for the measurements of the dose values. The absolute accuracy of the dose meter read out is expected to be not better than 20 %. Nevertheless, the final accuracy amounts to about 3 % if a leverage factor of 6,6 is presupposed.

Table A.1 – Parameter for thick filter method

Tube voltage kV	D_1 mm	D_2 mm	Collimator diameter mm	Thick filter thickness	D_{100} mSv	D_{95} mSv	Exposure mAmin	L_v
150	1000	210	15	20 mm Fe	2,00	1,32	75	6,8
200	1000	217	15	35 mm Fe	1,60	1,08	75	6,5
300	1000	232	15	65 mm Fe	1,83	1,25	150	6,3
400	1000	240	15	80 mm Fe	1,80	1,20	90	6,6

EXAMPLE For a constancy check at 200 kV and the conditions described above (table A.1) the D_{100} value should be always obtained between 1,1 mSv and 2,1 mSv to prove a deviation within the tolerance of $T \leq 5$ %.

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