SLOVENSKI STANDARD
SIST EN 12544-3:2000

01-oktober-2000

Neporuġitveno preskuġanje - Meritve in ugotavljanje elektriļ ne napetosti na rentgenski cevi - 3. del: Spektrometrijska metoda

Non-destructive testing - Measurement and evaluation of the X-ray tube voltage - Part 3: Spectrometric method

Zerstörungsfreie Prüfung - Messung und Auswertung der Röntgenröhrenspannung - Teil 3: Spektrometerverfahren

Essais non destructifs - Mesurage et évaluation de la tension des tubes radiogenes - Partie 3: Méthode spectrométrique

Ta slovenski standard je istoveten z: EN 12544-3:1999

ICS:

19.100	Neporušitveno preskušanje	Non-destructive testing

SIST EN 12544-3:2000 **en**

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 12544-3

September 1999

ICS 19.100

English version

Non-destructive testing - Measurement and evaluation of the X-ray tube voltage - Part 3: Spectrometric method

Essais non destructifs - Mesurage et évaluation de la tension des tubes radiogènes - Partie 3: Méthode spectrométrique

Zerstörungsfreie Prüfung - Messung und Auswertung der Röntgenröhrenspannung - Teil 3: Spektrometer-verfahren

This European Standard was approved by CEN on 16 August 1999.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 12544-3:1999 E

Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 138 "Non-destructive testing", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2000, and conflicting national standards shall be withdrawn at the latest by March 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

In the framework of its scope, Technical Committee CEN/TC 138 entrusted CEN/TC 138/WG 1 "Ionizing radiation" with preparing the following standard:

EN 12544-3, *Non-destructive testing - Measurement and evaluation of the X-ray tube voltage - Part 3: Spectrometric method.*

EN 12544-3 is a part of series of European Standards; the other parts are the following:

EN 12544-1, *Non-destructive testing - Measurement and evaluation of the X-ray tube voltage - Part 1: Voltage divider method.*

EN 12544-2, *Non-destructive testing - Measurement and evaluation of the X-ray tube voltage - Part 2: Constancy check by the thick filter method.*

Introduction

In order to cover the different requirements for the measurement of the X-ray tube voltage, three different methods are described in EN 12544-1 to EN 12544-3.

The voltage divider method (EN 12544-1) 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 (EN 12544-2) describes a constancy check. This method is recommended for the regular stability check of an X-ray system.

The spectrometric method (EN 12544-3) 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 is the recommended method 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.

1 Scope

This standard specifies the test method for a non-invasive measurement of X-ray tube voltages using the energy spectrum of X-rays (spectrometric method). It covers the voltage range from 10 kV to 500 kV.

The intention is to check the correspondence of the actual voltage with the indicated value on the control panel of the X-ray unit. It is intended to measure the maximum energy only and not the complete X-ray spectrum.

The procedure is applicable for tank type and constant potential X-ray units.

2 Definitions

For the purposes of this standard, the following definitions apply:

2.1 Energy dispersive photon detector

A photon detector, e. g. Ge based detector, which responds to incident photons with electric pulses, whose amplitude are a measure for the energy of the photons.

2.2 Multi channel analyser

An electronic device which is capable of sorting incoming electric pulses according to their amplitude.

NOTE The pulses are sorted into storage registers or channels in such a way that the contents of a register or channel is increased by one if a pulse occurs with the corresponding amplitude.

2.3 Energy spectrum

The graphical representation of the contents of the channels versus the energy.

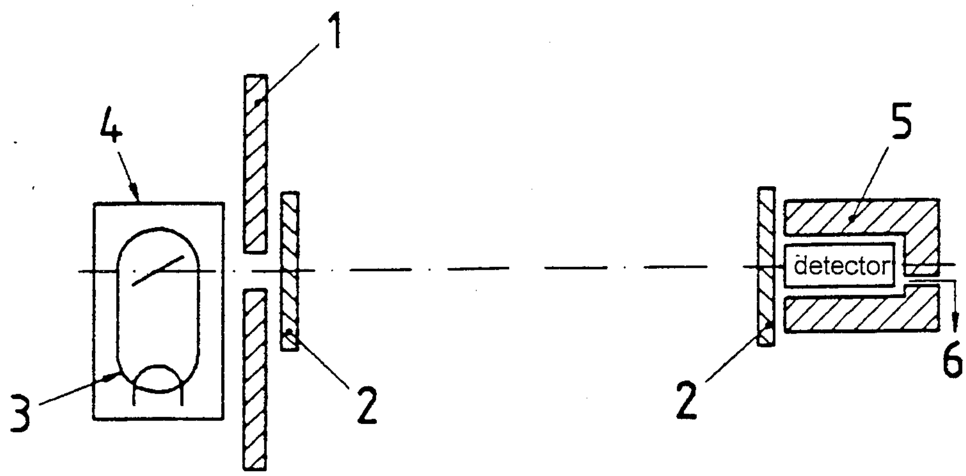
2.4 Pile-up

Effect of two or more pulses which are too close to each other and which causes their amplitude to be added in the spectrum.

3 Test method

3.1 Principle

An energy dispersive photon detector is located in the collimated direct beam of the X-ray tube under test (figure 1). The output pulses of the detector are counted and analysed by a multichannel analyzer.



Key

1 Collimator and additional lead shielding
2 Filter
3 X-ray tube
4 tube housing
5 lead shielding
6 pulse output to amplifier and multichannel analyser

Figure 1: Configuration for energy measurements

3.2 Equipment

The following equipment is required for the measurements:

3.2.1 Detector

Its energy range shall be at least 20% higher than the highest expected maximum energy. The energy resolution shall be about 1 keV Full Width at Half Maximum.

For ease of filtering and shielding a detector with low efficiency but with sufficient resolution shall be chosen, as X-ray tubes usually produce sufficiently high dose rate.

In order to allow as far as possible only direct radiation to hit the detector, the detector shall be carefully shielded with highly absorbing materials against leakage and scattered radiation.

3.2.2 Filters

In order to attenuate the soft radiation, filters of Al, Fe, Cu, Pb or W shall be used (see Annex A).

The measurement of the maximum energy may be disturbed by the K-edge and the characteristic lines of a filter. Therefore, filter materials above the given value U_{min} according to table 1 shall be used:

Table 1 – Minimum voltages for some filter materials

Filter	U_{min} kV
Al	10
Fe	15
Cu	20
Pb	180
W	140

The thickness of the filters, the diameter of the collimated beam, and the distance between tube and detector have to be chosen to give a sufficiently low count rate of photons which can be properly processed by detector and electronics. A count rate which is too high would generate pile-up and thus may cause misinterpretations of the energy spectrum.

When using lead filters, a layer of 1 mm of tin in front of the detector window shall be used to reduce secondary radiation significantly.

3.2.3 Electronics

Pulse shaping generator and amplifier shall be thoroughly checked and adjusted in respect to optimum decay of the pulses and to a linear amplitude behaviour.

The cable between amplifier and multichannel analyzer shall be impedance matched to both devices, so that it is properly terminated on both ends.

3.2.4 Multichannel analyzer

The multichannel analyzer shall be calibrated so that one channel is from 0,23 keV to 0,27 keV wide. The total energy range shall be at least 20% higher than the highest expected energy.

The calibration can be done using the characteristic lines of radioisotopes such as Ir 192, Am 241or Ba 133. This is done by placing a weak radioisotope in front of the detector. Then the line spectrum is recorded and the abscissa is calibrated for the energy according to the location of the peak maxima.

3.3 Measurement

After setup and calibration the X-ray tube is switched on, and after the voltmeter of the unit has reached the preset value of the voltage, the measurement may be started. If there is no indication of the actual voltage at the control unit of the X-ray tube, the measurement may be started at least 30 seconds after switching on the tube.

During one measurement, a minimum number of 1000 pulses per keV, shall be counted.

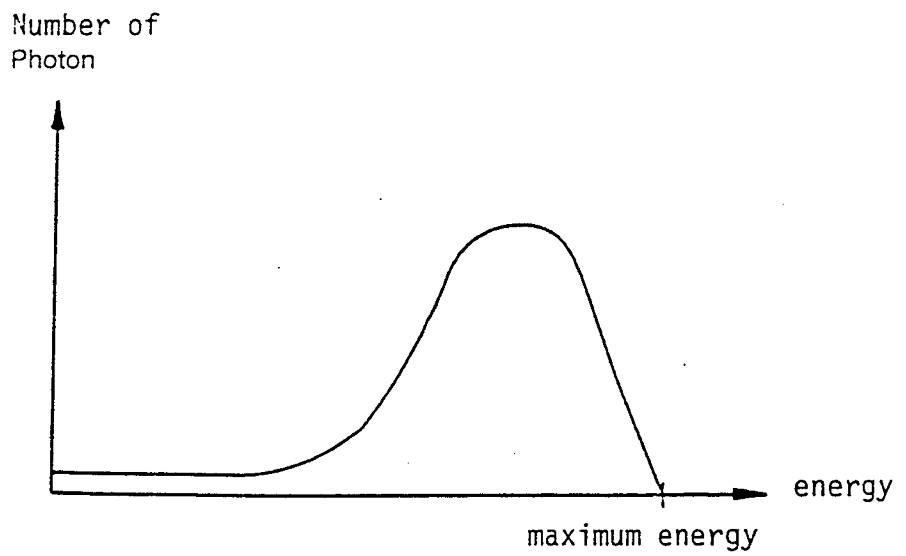


Figure 2 – Schematic shape of an X-ray spectrum after attenuation by a filter

The shape of the measured spectrum shall be similar to that in figure 2. The maximum shall be clearly discernible, and not distrubed by characteristic lines presented by real spectrum (see figure 3).