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INTERNATIONAL STANDARD

Nuclear instrumentation – Portable X-ray fluorescence analysis equipment utilizing a miniature X-ray tube

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NUCLEAR INSTRUMENTATION – PORTABLE X-RAY FLUORESCENCE ANALYSIS EQUIPMENT UTILIZING A MINIATURE X-RAY TUBE

FOREWORD

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International Standard IEC 62495 has been prepared by committee 45: Nuclear instrumentation.

The text of this standard is based on the following documents:

FDIS	Report on voting
45/717/FDIS	45/731/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

NUCLEAR INSTRUMENTATION – PORTABLE X-RAY FLUORESCENCE ANALYSIS EQUIPMENT UTILIZING A MINIATURE X-RAY TUBE

1 Scope and object

This International Standard is applicable to the radiological safety of portable handheld X-ray fluorescence (XRF) analysis equipment utilizing a miniature X-ray tube as the source of ionizing radiation for industrial applications.

The following are beyond the scope of this standard:

a) portable XRF analysis equipment utilizing a radioactive source(s);

b) large fixed installation XRF analysis equipment utilizing an X-ray tube;

c) veterinary and medical applications for portable XRF analysis.

The object of this standard is to establish performance specifications for general radiation, electrical, safety and environmental characteristics of the design and operation, and test methods in relation to radiological safety for portable XRF analysis equipment utilizing a miniature X-ray tube. The proposed performance specifications are aimed at minimizing and avoiding the health risk associated with the use of these devices. Analytical performance specifications are beyond the scope of this standard.

Portable XRF analyzers utilizing low power, miniature X-ray tubes as sources of ionizing radiation represent a new class of industrial equipment. The miniature X-ray tube replaces the small radioisotope sources (e.g., Fe-55, Co-57, Cd-109, Am-241 and Cm-244) that have been used in portable analyzers for applications such as analysis of lead in paint, alloy identification, and soil screening for hazardous materials.

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 60692:1999, *Nuclear Instrumentation – Density gauges utilizing ionizing radiation – Definitions and test methods*

IEC 60982:1989, *Level measuring systems utilizing ionizing radiation with continuous or switching output*

IEC 61010-1:2010, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements*

IEC 61326 (all parts): *Electrical equipment for measurement, control and laboratory use – EMC requirements*

IEC 61336:1996, *Nuclear Instrumentation – Thickness measurement systems utilizing ionizing radiation – Definitions and test methods*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

3.1
closed beam X-ray system
a closed beam X-ray system is one in which the beam path cannot be entered by any part of the body during normal operation

3.2
collimation device
device for restricting the useful radiation in one or more directions

3.3
detector housing; detector assembly
that portion of the measuring head which includes the radiation detector. This assembly may be incorporated with the X-ray beam generator housing

3.4
electronic measuring assembly
assembly that supplies the equipment power, processes the signals delivered by the measuring head, and delivers the output signals for the XRF analyzer

3.5
fail safe design
when no single failure or foreseeable combination of failures can place a system into an unsafe configuration or mode

3.6
handheld instrument
a portable instrument that is designed to operate when held in the hand

3.7
interlock
a device or engineered system that precludes access to an area of radiation hazard either by preventing entry or by automatically removing the hazard

3.8
isodose contour
an imaginary surface extending around the instrument where there is a specified dose equivalent rate

3.9
leakage radiation
all radiation coming from within the source housing, except the useful beam

3.10
measuring head; measuring assembly
assembly comprising one or more X-ray generators and radiation detectors along with any compensation sensors

3.11
normal conditions
operation under conditions suitable for collecting data as recommended by a manufacturer of the portable X-ray fluorescence analysis equipment

3.12
open beam X-ray system
an open beam X-ray system is one in which the beam path could be entered by any part of the body at any time

3.13
portable instrument
an instrument that must be able to operate with complete functionality, continuously on batteries

3.14
primary beam
ionizing radiation from an X-ray anode or secondary target which is allowed to pass by a direct path through an aperture in the tube housing for use in conducting X-ray measurements

3.15
radiation generating machine
an assembly consisting of a least one X-ray generator used in an X-ray fluorescence analysis system

3.16
safety circuit
safety circuit is designed to provide assurance that personnel are safe from accidental exposure to radiation from the X-ray tube (e.g.,if a light indicating "X-RAY ON" fails, the production of X-rays will be prevented, or if a shutter status indicator fails, the shutter shall close)

3.17
safety features
properties of a device designed to preclude unintended exposure to sources of radiation. Safety features may include, but are not limited to, radiation containment, shutters, radiation beam collimation, shielding, beam ON-OFF indicators, key-locked power ON-OFF switches, and safety interlocks

3.18
scattered radiation
radiation that has been deviated in direction and/or energy by passing through matter

3.19
stray radiation
the sum of leakage and scattered radiation

3.20
system barrier
that portion of an X-ray fluorescence analyzer which clearly defines the transition from the primary beam to the outside of the device and provides such shielding as may be required to limit the dose equivalent rate to the outside of the device during normal operation (e.g., a shielded enclosure immediately around the X-ray tube)

3.21
useful beam
radiation that passes through the window, aperture, cone or other collimation device and is used for making measurements

3.22
warning device
a visible or audible signal that warns personnel of a potential radiation hazard

3.23
X-ray accessory apparatus
any portion of an X-ray device that is external to the radiation source housing and into which an X-ray beam is directed for making X-ray measurements or for other uses

3.24
X-ray fluorescence measurement system
radiation gauge that utilizes X-ray fluorescence to analyze a material

[IEC 60050-394:2007, 394-37-05]

3.25
X-ray generator
that portion of an X-ray system that provides the X-ray tube, the accelerating (high) voltage and current for the X-ray tube

3.26
X-ray system
assemblage of components for the controlled generation and use of ionizing radiation, including all X-ray accessory apparatus

4 General requirements

4.1 System description

The manufacturer shall provide a description of the analysis system. This shall include:

a) principle of measurement;
b) field of application – intended uses;
c) X-ray tube and radiation characteristics – type, number, maximum operational voltage, current and wattage and physical and electrical characteristics;
d) stray radiation profiles; and
e) primary beam dose measurements.

4.2 Safety considerations

The manufacturer shall provide a description of the radiation safety circuit and features that are designed to prevent accidental exposure to the operator and public during normal operation of the portable instrument. The description shall indicate the fail-safe features of the radiation safety circuit and provide instructions for testing these features.

The manufacturer shall indicate if the portable analyzer meets closed beam requirements (see 5.2.2) or meets open beam requirements (see 5.2.3).

4.3 Other requirements

In addition to the requirements specified in this standard, the devices may be required to comply with the relevant national, regional, state or local regulations where applicable.

Additional non-safety information on instruments and systems that is relevant to this standard is given in IEC 60692, IEC 60982 and IEC 61336. General constructional requirements for electrical measuring, control and laboratory instruments are given in IEC 61010-1. Electromagnetic compatibility (EMC) requirements are given in IEC 61326.

4.4 Training

Manufacturer or their agent shall provide adequate training material with each instrument on the use and safety aspects of instrument operation. The documentation accompanying each instrument shall include information to provide training to potential operators. It is the responsibility of the owner of the device user to provide sufficient training to operators of the device.