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INTERNATIONAL STANDARD

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

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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- withdrawn,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.

5 Portable XRF analysis system requirements

5.1 General

The device shall be designed or controlled in such a way that the shielding limits the dose equivalent rates at all accessible points, when used in accordance with manufacturer's instructions. The maximum dose rate at any accessible point shall be less than the applicable internationally specified limits for non-occupationally exposed persons. It shall be the responsibility of the owner to verify that this maximum dose rate is less than that specified in appropriate local or national regulations pertaining to continuously occupied working places where these are more restrictive.

The accompanying documents should include information that it is the responsibility of the user to observe all necessary radiation protection procedures including maintaining the labeling, shielding and safety circuits and to ensure that the actual limit values, specified in appropriate national regulations, are not exceeded.

5.2 Classification

5.2.1 General

For the purpose of this standard two classes of X-ray systems are recognized. They are closed beam X-ray analysis and open beam X-ray analysis system. For a fully enclosed X-ray beam XRF analysis device, the X-ray analysis system shall be designed to restrict or prohibit operation if the X-ray beam is not contained within a closed measuring chamber.

Portable XRF analysis systems covered by this standard should be designed so that all possible X-ray beam paths are fully enclosed. However, operational requirements such as the following may make the use of a fully closed beam system during normal operation impractical:

a) frequent changes of attachments and configuration;
b) a need for making measurements of objects too large to insert into an enclosure with the X-ray beam on;
c) motion of specimen and detector over wide angular range; and
d) measurement of samples that sit in predefined and fixed positions.

5.2.2 Closed beam portable XRF analysis system

A closed beam portable XRF system is one in which all possible X-ray paths are fully closed according to the requirements of 5.4. For example, the use of interlocked beam ports or an interlocked enclosure around the whole X-ray system may qualify the system as a closed beam system.

NOTE Closed beam systems become open beam systems during the period when interlocks are disabled.

5.2.3 Open beam portable XRF analysis system

If a portable instrument does not comply with all of the requirements of 5.4, it shall be classified as an open beam portable XRF Analysis System.

5.3 General safety requirements for all portable XRF analysis systems

5.3.1 Dose equivalent limitation

Dose equivalent limitations listed below are based primarily on requirements in IEC 61010-1, 12.2. More restrictive dose equivalent limitations may be defined by local regulatory authorities. Those dose equivalent limitations shall apply for any XRF device utilized within the local regulatory jurisdiction.

The portable XRF system shall include a beam stop, trap or other barrier with sufficient shielding so that the dose equivalent rate at 10 cm from the outer surface in any direction due to transmitted primary beam and any unwanted, stray, or anticipated accidental scatter and leakage radiation from components such as high voltage rectifiers shall not exceed 40 μSv (4 mrem) in a week in any accessible region 10 cm from the outside surface of the device. Assuming that an individual may be in the vicinity of the equipment while it is operating for as long as 40 h per week, the dose equivalent rate should not exceed 1 μSv in 1 h (0,1 mrem in 1 h).

The above description does not refer to the primary beam of the open beam XRF device.

NOTE Applicable regulations may vary.

5.3.2 Radiation safety circuit

5.3.2.1 General

All instruments covered by this standard shall employ a fail-safe safety circuit to prevent inadvertent operation of the analyzer and inadvertent exposure of the operator or public to the X-ray beam. The features of the safety circuit identified in the following subclauses shall be employed unless otherwise agreed upon by the user and the manufacturer: all features of the safety circuit shall be interlocked so that failure of any one feature shall prevent the generation of X-rays.

5.3.2.2 Primary power safety lock

5.3.2.2.1 General

A primary safety lock shall be employed to control power to all radiation generating components and to prevent any measurement action prior to placing the primary safety lock in the action enable position. The primary safety lock should consist of either a software key lock or a hardware key lock or both.

5.3.2.2.2 Hardware key lock

The hardware key lock shall be employed. The key lock switch shall have ON/OFF positions. The key captured in the ON position only enables X-ray generation. Removal shall be in the OFF position and no X-rays shall be generated, or deactivate XRF device.

5.3.2.2.3 Software key lock

A pass word protected software “key lock” may be provided in lieu of a hardware safety key lock or as an addition to a hardware key lock. This type of key lock, if provided by the manufacturer, shall incorporate a unique user name and password for each operator. If a software key lock is provided, the function of the key lock shall be equivalent to the function of a hardware key lock.

5.3.2.3 High voltage “ON” fail-safe warning light

A red light shall be activated to indicate that there is voltage applied to the power supply. If the red light is not operable, the safety circuit shall not permit flow of current to the X-ray tube.

5.3.2.4 X-ray “ON” fail-safe warning light

When the beam interlock or sensor is engaged (e.g., instrument trigger is pulled), the X-ray “ON” light(s) shall be activated indicating the generation of X-rays. If the light is not operable, it shall be impossible to generate X-rays. The light shall be located either:

a) near any switch which activates the high voltage to energize an X-ray tube; and

b) in a conspicuous location near the ionizing radiation source housing, or radiation beam(s), or visible from all instrument access areas.

5.3.2.5 Operator trigger interlock

When the beam interlock or sensor is engaged (the instrument trigger is pulled) the X-ray "ON" light shall be activated indicating the generation of X-rays. This light shall be red (and may be flashing) unless national regulations specify another colour for danger.

5.4 Requirements for a closed beam portable XRF analysis system

5.4.1 General

The requirements for a closed beam portable X-ray system are, in addition to the general requirements in 5.3:

5.4.2 The source of ionizing radiation, beam paths, detector and/or other devices shall be enclosed in a chamber, coupled chambers, beam pipes or by the solid sample itself such that no part of the body can enter the beam path during normal operation. If the sample or sample holder completes the enclosure, the radiation safety circuit (see 5.3.2 above) shall include a physically interlocked sensor(s) and/or software control which shall prevent X-rays from being produced if the solid sample is not in place.

5.4.3 The inherent shielding of the beam enclosure shall be sufficient to limit the maximum dose equivalent rate at all points 10 cm from the outer surface of the enclosure to less than 1 μSv/h (less than 0,1 mrem/h) when the X-ray tube is operating at full rated power and maximum rated accelerating potential (IEC 61010-1, 12.2 leakage or scatter limit).

5.4.4 Each port of the radiation source housing shall be provided with a beam shutter interlocked with the X-ray accessory apparatus coupling, or collimator, in such a way that the port will be open only when the enclosure collimator or coupling is in place. In multi-port systems, shutters at unused ports shall be secured to prevent casual opening.

5.4.5 The system enclosure, sample chamber, and other related safety features shall be interlocked with the X-ray tube high voltage supply and/or a shutter in the primary beam so that no X-ray beam can enter the sample chamber while it is open.

5.4.6 The interlock required by 5.4.4 shall be fail-safe in design.

5.4.7 If there is more than one beam port in the analyzer housing or more than one X-ray tube, all requirements under 5.4.4 shall be satisfied for each port or X-ray tube associated with the system.

5.5 Requirements for an open beam portable XRF analysis system

5.5.1 General

The requirements for an open beam X-ray system are in addition to general requirements in 5.3. In many applications, open beam devices utilize the sample as one barrier to the primary beam.

The following subclauses provide requirements or recommendations that are intended to create a level of protection similar to that provided by a closed beam system.

5.5.2 Beam interlock or sensor

5.5.2.1 General

If a sample cover completes the beam enclosure, the radiation safety circuit (see 5.3.2 above) shall include a physically interlocked sensor and/or software control which shall prevent X-rays from being produced if the sample cover is not in place.

This beam interlock or sensor is utilized to prevent X-rays from being generated for more than 2 s if a solid sample is not in place. This beam interlock or sensor shall terminate the high voltage to the X-ray tube thus preventing the further generation of X-rays. At least two of the sensor types proposed below shall be provided by the manufacturer. The manufacturer shall describe any other feature(s) employed to interrupt the high voltage to the X-ray tube if a solid sample is not in place.

5.5.2.2 Low count rate safety sensor

5.5.2.2.1 General

A device shall be employed to continually monitor the low count rate from the detector. During analyses of a sample, the device shall stop X-ray generation, if the count rate falls below the minimum level that would indicate the presence of a sample. This level shall be stated by the manufacturer.

5.5.2.2.2 Infrared (IR) sensor

An IR proximity sensor may be employed to stop X-ray generation if the analyzer is not in contact with the sample. The IR sensor should not function if the sample is > 5 mm from the front surface of the instrument. The manufacturer shall state the maximum distance where the IR is functional.

NOTE IR sensors may not function properly if the surface of tested object is very dark or black.

5.5.2.2.3 Electromechanical sensor

An electromechanical proximity sensor may be employed to stop X-ray generation if the analyzer is not in contact with the sample. The electromechanical sensor should not function if the sample is > 5 mm from the front surface of the analyzer. The manufacturer shall state the maximum distance range where the electromechanical sensor is functional.

5.5.3 Guard or sample holder

An accessory sample holder may be utilized, where applicable, to confine the beam when small or thin samples are analyzed. An interlock should be provided to stop X-ray generation while the accessory sample holder is open.

5.5.4 Secondary push button high voltage safety switch

A push button high voltage safety switch may be incorporated in the instrument design to satisfy local regulations. If installed, the push button high voltage safety switch shall be activated (i.e., pressed) before X-rays are generated even if all the other safety functions described in 5.3 and 5.5 are operational. Release of the switch shall disable the generation of X-rays.

6 Warning labels and indicators

6.1 General

Warning labels and indicators shall be provided on the XRF Analyzer. In addition warnings and indications should be provided on the display screens where applicable. The following labels and indicators are provided as an example of how to clearly identify various safety features. All labels and indicators shall meet the local regulatory requirements, if different from those below. The text may be in a language other than English as appropriate.

6.2 The analyzer shall have a label, if applicable near the key lock, which reads:

CAUTION
THIS EQUIPMENT PRODUCES X-RAYS WHEN OPERATED
TO BE OPERATED ONLY BY AUTHORIZED PERSONNEL

6.3 The power switch (which may be the key lock) shall have the power logo:

I/O

6.4 There shall be an unambiguous visual indication visible to the user when the X-rays are on. The indication shall be in the form of a light as well as a warning symbol and/or text. The text may read:

X-RAYS ON

6.5 A label shall be placed near each X-ray port that includes the appropriate radiation symbol and that warns not to expose any part of body to the X-ray beam:

WARNING
HIGH INTENSITY X-RAYS
DO NOT EXPOSE ANY PART OF BODY TO THE BEAM

6.6 A label shall be mounted by the manufacturer near the handle. It shall include the following:

CAUTION
RADIATION GENERATING MACHINE
FOR SAFE USE SEE OPERATION MANUAL
MODEL# SERIAL# DATE OF MFG.TUBE RATING ___ kV ___mA
Name, Address and Phone Number of Manufacturer

7 Test requirements

7.1 General

The testing procedures provided below present acceptable methods for determining performance parameters. Procedures that can be demonstrated to be at least equivalent shall also be acceptable. All of the acceptance criteria provided below shall be the minimum requirements.

7.2 External electromagnetic noise

The manufacturer should perform tests to verify performance of the safety circuits when the system is exposed to external electromagnetic or high-energy radiation sources. The manufacturer shall specify the testing performed.

7.3 Special tests

Special tests are those agreed upon between the user and the manufacturer to provide special safety performance data. The test procedures for the special tests shall be agreed upon between the user and the manufacturer.

7.4 Temperature test

7.4.1 Test equipment

The device shall be tested in a temperature chamber capable of achieving and maintaining the minimum and maximum temperatures defined in Annex A when the device is operating with its normal heat load. Two chambers may be used if necessary to provide the required temperatures. Means shall be provided for monitoring the performance of the safety features of the device during the temperature test.

7.4.2 Preparation

The time required for temperature stabilization of the entire device at the temperature extremes shall be determined. The time may be determined experimentally or by calculation. The functionality of the safety interlock shall be verified at the temperature extremes.

7.4.3 Procedure

The device shall be placed in the chamber at room temperature and checked for proper operation of the safety features. The ambient air temperature shall be decreased to the low value shown in Annex A for the appropriate Usage Group(s) and shall be maintained at that value for the stabilization time plus 1 h. After achieving stabilization the operation of the safety devices shall be verified and then again after 30 min and at the conclusion of this stage of the temperature cycle. The temperature shall be increased to room temperature and maintained for the stabilization time. At the conclusion of this stage of the cycle, the operation of the safety features shall again be verified.

The ambient air temperature shall be increased to the high value shown in the Annex A and maintained at that value for the stabilization time plus 1 h. After achieving stabilization the operation of the safety devices shall be verified and then again after 30 min and at the conclusion of this stage of the temperature cycle. The temperature shall be decreased to room temperature and maintained for the stabilization time. At the conclusion of this stage of the cycle, operation of the safety features again shall be verified. The device shall be removed from the chamber and examined visually for defects. Stray radiation of the device shall be measured and recorded and the integrity of the safety circuit shall be verified.

7.4.4 Evaluation

During the temperature cycle there shall be no failure causing loss of function of the safety features. The visual examination shall reveal no defect that could result in loss of function of the safety features. Stray radiation at the conclusion of the temperature test shall not exceed the value recorded prior to the test. The X-ray tube source shall continue to operate within the original system radiation safety design specifications with no increase in applied voltage or current.

7.4.5 Ambient temperature tests

The analysis system shall be tested for rated range II (see Annex A) by being placed in an environmental chamber. Tests are to be conducted at temperatures of –10 °C, 0 °C, 30 °C, and 50 °C, remaining at each temperature for at least the period of time required for the system to reach equilibrium and conduct measurements of stray radiation. It is recommended that temperature ramp rates be established based on the equipment being tested and a protocol established by the manufacturer. Ramp rates are typically set to at least 10 °C per 5 min. Signal levels are to be monitored continuously, even during temperature changes, to evaluate the effects of thermal gradients. All elements of the safety circuit should be operational during these tests. If any other temperatures are necessary or appropriate for the equipment being tested, the manufacturer should so state in the report and provide the laboratory test results.

These tests are to be conducted with no samples (open beam) or a stainless steel sample simulator (closed beam). The stray radiation tests specified below shall be performed at each temperature specified in this test.

7.5 Stray radiation

7.5.1 Equipment

For purposes of these tests when measuring X-ray radiation, the standard instrument shall be a survey meter capable of measuring down to at least 200 nSv/h. The gamma and X-ray energy response of the survey meter shall be uniform within ±25 % over an energy range of 15 keV to 120 keV. Other survey meters may be used when they are corrected for response against the instrument for the radiation to be measured. The window density thickness of the standard survey meter shall be no greater than 7 mg/cm^2. The survey meter used for these tests shall have been calibrated to the centre of the probe's active volume within 12 months prior to the date of these tests. The survey meter shall be calibrated against at least one gamma radiation standard between 15 keV and 120 keV such as Am-241 to an accuracy of ±10 % of full scale at a point within the rated energy range.

7.5.2 Procedure

For measurement of stray radiation, the portable X-ray tube XRF analyzer shall be set at the maximum acceleration voltage (e.g., 35 kV) and current (e.g., 10 μA) to achieve maximum emission/rate within the operating parameters established for the specified analyses. In general, the isodose contours for measuring stray radiation shall be 10 cm, 30 cm, and 100 cm from the nearest accessible surfaces of the X-ray tube XRF instrument.

NOTE Where the sample provides one boundary of the closed beam, a standard sample of the material to be analyzed (e.g., stainless steel 304) > 2 mm thick shall be in place.

7.6 Open beam radiation level

7.6.1 General

Typical plots of the open beam measurements, specific for the given model/type of the instrument, shall be provided by the manufacturer with each portable or handheld XRF analyzer. Radiation measurements in the open beam shall be made only by the manufacturer using appropriate security/safety provisions. These shall be performed to characterize at least:

a) The high dose equivalent rates at the surface, 5 cm, 10 cm, 30 cm and 100 cm.

b) The geometrical size of the X-ray beam.

NOTE Safety circuitry is disabled for this test.

7.6.2 Equipment

Measurements shall be made with the same instrument or dosimeter (e.g., TLD) that is used for stray radiation measurements. Since the geometric correction of an ion chamber may be difficult, special dosimetric devices such as bare TLDs may be required to determine the actual dose equivalent rate. When bare TLD dosimeters or other small dose measurement devices are used, they shall be calibrated for the expected X-ray energy and shall be placed at the same distances as used for the instrument measurements.

7.6.3 Measurement procedure

Place the survey meter with the sensitive volume centred at 5 cm, 10 cm, 30 cm, and 100 cm directly in the beam with the effective centre of the ion-chamber at the measurement distances. The dose equivalent rate at the surface is estimated by plotting the 4 measurements and performing semi-log extrapolation back to the closest point where a part of the body can approach the X-ray tube. Narrow beam correction factors may be required.

7.6.4 Dosimeter procedure

Place the bare TLD dosimeter on a low scatter surface (e.g., 2,5 micron plastic sheet) at the centre of the beam at the surface, 5 cm, 10 cm, 30 cm, and 100 cm.

NOTE The cross-section of the X-ray beam may be defined by visual examination of X-ray sensitive film that has been placed in the beam.

The size and shape of the beam is determined by the boundary where the doserate is 1 % of the maximum. Plot the results of the TLD measurements on semi-log paper. The typical plots of the open beam measurements, specific for the particular model/type of the instrument, shall be provided with each portable or handheld XRF analyzer.

Annex A
(normative)

Recommended standard values and ranges of influence quantities

A.1 Two usage groups are utilized

I. For indoor use and under conditions which are normally found in laboratories and factories and where apparatus will be handled carefully.

II. For use in more harsh environments but having protection from full extremes.

A.2 Climatic conditions

A.2.1 Ambient temperature

Reference Value:		+20 °C ± 2 °C
Rated ranges of	I	+5 °C to +40 °C
	II	–10 °C to +50 °C
Limit range of operation:	unless otherwise stated equal to the rated range of use	
Limit range for storage and transport:		–25 °C to +60 °C

A.2.2 Relative humidity of the air

Because extreme values of both temperature and humidity are likely to occur simultaneously, the manufacturer shall test the operation of the safety circuit at both the minimum and the maximum relative humidity for both the minimum and maximum temperatures specified above:

Relative humidity: 40 % to 95 % excluding condensation

A.3 Power supplies - battery

A.3.1 General

The manufacturer shall determine the time that the instrument is fully functional (be able to detect and identify) using one battery under standard test conditions.

A.3.2 Requirements

The manufacturer shall state battery lifetimes and any associated operating temperature requirement. The manufacturer shall also state the minimum voltage required for satisfactory operation of the instrument. The minimum voltage is defined as that voltage where there is less than 10 % change in indicated reading (compared to the response with fresh batteries) and/or when the instrument becomes unable to perform correct element analysis or alloy identification.

A.3.3 Test method

The instrument shall be equipped with fully charged new battery. All functional circuits shall be switched on and remain on during the test. The instrument shall be turned on (i.e., X-ray tube activated) and a sufficient number of analyses shall be undertaken and the element or alloy shall be correctly identified after the manufacturer's recommended warm-up period and every hour thereafter. The battery lifetime shall be the time when the battery voltage falls to 90 % of the nominal battery voltage, or the battery voltage falls to the minimum value specified by the manufacturer, or when the elemental composition of a test sample is no longer correctly identified, whichever occurs first.

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