

	Standard	Nuclear Operating Unit
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Title: **Requirements for Radiological Surveillance Instrumentation**

Document Identifier: **238-44**

Alternative Reference Number: **NSN-044**

Area of Applicability: **Generation Division**

Functional Area: **Radiation Protection**

Revision: **1**

Total Pages: **12**

Next Review Date: **April 2024**

Disclosure Classification: **Controlled Disclosure**

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Nuclear Additional Classification Information

Business Level: **2**

Working Document: **3 – For reference**

Importance Classification: **Not Applicable**

NNR Approval: **Yes, letter k28457N, NAR-2006**

Safety Committee Approval: **Not Applicable**

ALARA Review: **Yes**

Functional Control Area: **Radiation protection**

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1. INTRODUCTION

This standard specifies the radiological surveillance instrumentation requirements for the Eskom Generation Division in terms of the Eskom Radiation Protection Policy 32-227 and Standard 32-226. Eskom is committed to ensure that nuclear and radiation safety receives the highest priority to provide for the protection of persons and the environment against harmful ionising radiation in accordance with the safety principles and requirements addressed in the Eskom Radiation Protection Policy and Standard.

2. SCOPE

2.1 PURPOSE

This standard specifies the requirements for radiological surveillance instrumentation in terms of Eskom Policy 32-227, Eskom standard 32-226 and the Generation Division Radiation Protection Manual, 238-19 relating to radiation protection and safety of radiation sources.

2.2 APPLICABILITY

This standard is applicable to Group III hazardous substances (electronic products), Group IV hazardous substances (radioactive sources), radioactive material, restricted material, special nuclear material and radioactive waste defined in the Generation Division Radiation Protection Manual, 238-19.

3. NORMATIVE/INFORMATIVE REFERENCES

The following normative references contain provisions that, through reference in the text, constitute requirements listed in this document. Parties using this document shall apply the most recent edition of the documents listed below, unless otherwise specified in the applicable statutory and regulatory requirements:

3.1 NORMATIVE

- [1] 238-19: Generation Division Radiation Protection Manual.
- [2] 32-226: Eskom Standard, Radiation Protection and safety of radiation sources.
- [3] 32-227: Eskom Policy, Radiation Protection and safety of radiation sources.
- [4] IEC 60325: Radiation protection instrumentation – Alpha, beta and alpha/beta (beta energy >60 keV) contamination meters and monitors
- [5] IEC 60671: Radiation protection instrumentation - Portable, transportable or installed equipment to measure X or gamma radiation for environmental monitoring
- [6] IEC 60761: Equipment for continuous monitoring of radioactivity in gaseous effluents
- [7] IEC 60846: Radiation protection instrumentation – Ambient and/or directional dose equivalent (rate) meters and/or monitors for beta, X and gamma radiation
- [8] IEC 61017: Radiation protection instrumentation - Portable, transportable or installed equipment to measure X or gamma radiation for environmental monitoring
- [9] IEC 61098: Radiation protection instrumentation – Installed personnel surface contamination monitoring assemblies.

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- [10] ISO 4037: X and gamma reference radiation for calibrating dosimeters and dose rate meters and for determining their response as a function of photon energy

3.2 INFORMATIVE

The following informative references were used during the development of this document. Although listed, the informative references are not mandatory requirements.

- [11] 238-1: Nuclear Division Integrated Management System.

- [12] ISO/IEC 17025: General requirements for the competence and testing of calibration laboratories.

4. DEFINITIONS AND ABBREVIATIONS

4.1 DEFINITIONS

- 4.1.1 **Accuracy:** The degree of agreement of the observed value with the true value of the quantity being measured. Maintained within limits specified by the instrument manufacturer.
- 4.1.2 **Calibration:** To determine and adjust the response of a detector to give a reading accurate within predetermined acceptance criteria, relative to radiation sources and/or electronic signals, over the range of the detector. Sources and/or instruments are used that have been standardized against a measurement system traceable to a recognized national or international standard laboratory or bureau to ensure that the detector response is accurate within prescribed limits.
- 4.1.3 **Check source:** A radioactive source, not necessarily calibrated, which is used to confirm the operation of the instrument.
- 4.1.4 **Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).
- 4.1.5 **Eskom:** is used for Eskom Holdings SOC Limited, its divisions and wholly owned subsidiaries.
- 4.1.6 **Exposure:** The act or condition of being subject to irradiation. Exposure can be either external exposure (irradiation by sources outside the body), or internal exposure (irradiation by sources inside the body). Exposure shall be classified as; either normal exposure, potential exposure, occupational exposure, public exposure or emergency exposure.
- 4.1.7 **Ionising radiation:** Radiation capable of producing ion pairs in biological material(s).
- 4.1.8 **Practice:** Any human activity that introduces sources of exposure or exposure pathways, in addition to those of natural background radiation levels, or extends exposure to additional people, or modifies the network of exposure pathways from existing sources; so as to increase the exposure, or the likelihood of exposure, to people, or the number of people exposed.
- 4.1.9 **Protection and safety:** The protection of people against exposure to ionising radiation or radioactive substances and the safety of radiation sources, including the means for achieving such protection and safety, such as the various procedures and devices for keeping peoples' doses and risks as low as reasonably achievable.
- 4.1.10 **Public exposure:** Exposure incurred by members of the public from radiation sources.
- 4.1.11 **Radiation protection:** The protection of people from the effects of exposure to ionising radiation and the means of achieving this.
- 4.1.12 **Radiation:** See ionising radiation.

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4.1.13 **Regulatory authority:** Authority designated by government for regulatory purposes in connection with radiological protection and occupational health and safety, i.e. the National Nuclear Regulator and the Directorate: Radiation Control, Department of Health.

4.1.14 **Response:** The instrument reading.

4.1.15 **Source:** Anything that may cause radiation exposure, by emitting ionising radiation, or releasing radioactive substances, or materials.

4.2 ABBREVIATIONS

Abbreviation	Description
ALARA	As Low As Reasonably Achievable
CSIR	Council for Scientific and Industrial Research
ESKOM	Eskom Holdings SOC Limited, its Divisions and wholly owned subsidiaries
ICRU	International Commission on Radiation Units and Measurements
IEC	International Electrotechnical Commission
ISO	International Standards Organisation
KvP	Kilovolt, peak
Mev	Mega-electronvolt
NNR	National Nuclear Regulator
SABS	South African Bureau of Standards

5. REQUIREMENTS

5.1 ACQUISITION OF INSTRUMENTATION

- 5.1.1 Instruments shall be compatible for use in the monitoring environment and shall detect the radiations of interest.
- 5.1.2 Parameters shall include sensitivity, accuracy, range, precision and response time shall meet the manufacturer's specifications.
- 5.1.3 Instruments shall be reviewed with regards to ease of maintenance and calibration.
- 5.1.4 Instrument reliability shall be such that it can be used in a power plant environment.
- 5.1.5 Maintenance support from the instrument manufacturer should be considered.

5.2 PRE-CALIBRATION TESTS

- 5.2.1 The pre-calibration tests should be implemented as per the manufacturer's specifications.

5.3 CALIBRATION REQUIREMENTS FOR PORTABLE INSTRUMENTATION

- 5.3.1 Instruments shall be calibrated at specified frequencies.
- 5.3.2 New instruments shall be calibrated prior to being placed into service, unless supplied with a manufacturer's calibration certificate.

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5.3.3 Instruments shall be calibrated after any maintenance or repair work has been performed on them (excluding battery replacement).

5.3.4 Instruments shall be calibrated whenever their operation is suspect.

5.3.5 Calibrations should be carried out at a minimum of two points in the range of the full scale.

5.4 STANDARD INSTRUMENTS

5.4.1 Secondary standards and derived standards used for the calibration of radiation measurement equipment in Eskom shall be traceable to the national measuring standards maintained by the CSIR or SABS.

5.4.2 Calibration of secondary and derived standards shall be re-established after maintenance, or repair or at intervals specified by the relevant regulator.

5.5 SECONDARY STANDARD INSTRUMENT REQUIREMENTS

5.5.1 Energy Response

5.5.1.1 The instrument's energy response to X-and gamma rays of different energies shall be determined for at least six different energies in the range 50 kVp, 1 mm aluminium half-value layer to 1.33 MeV [cobalt]. The energy response shall be determined for all the ionisation chambers to be used with the instrument.

5.5.2 Repeatability

5.5.2.1 The repeatability of the instrument shall be better than 0.1 %.

5.5.3 Intrinsic Error

5.5.3.1 The average intrinsic error of the instrument over the full range and for all scales shall not exceed the following values:

- a. Dose: $\pm 5\%$ against the National Measuring Standard
- b. Dose Rate: $\pm 5\%$ against the National Measuring Standard.

5.5.4 Leakage of Ionisation Chambers

5.5.4.1 The leakage of the chambers shall not exceed the following values:

- a. 0.6 cubic centimetre chamber: 1.5×10^{-14} A
- b. 35 cubic centimetre chamber: 2×10^{-14} A
- c. 600 cubic centimetre chamber: 1.5×10^{-14} A

5.5.5 Calibration

5.5.5.1 The instrument shall be calibrated by the CSIR or SABS every 12 months ± 2 months, or after repairs that would affect its performance.

5.5.6 Routine Tests

5.5.6.1 The intrinsic error of the secondary standard shall be verified against a reference source before use.

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5.5.6.2 The secondary standard shall be recalibrated when the intrinsic error differs by more than $\pm 5.0\%$ from the calibrated value.

5.5.6.3 Leakage measurements shall be performed on the chambers before use.

5.5.6.4 New instruments shall be calibrated before use or be supplied with calibration certificates.

5.6 RADIATION MEASURING EQUIPMENT

5.6.1 Alpha and Beta Portable and Fixed Contamination Instruments

5.6.1.1 Calibration

- a. These instruments shall be calibrated based on the manufacturer's manual or calibration certificate.

5.6.1.2 Routine tests

- a. IEC 60325 shall be used as a guideline to perform the applicable radiation and/or electrical tests that indicate that the instrument is responding accurately.
- b. Calibration shall be performed after instrument repairs.

5.6.2 X-Ray, Gamma, and Alpha/Beta Portable Dose Rate Instruments

5.6.2.1 Calibration

- a. These instruments shall be calibrated based on the manufacturer's manual or calibration certificate

5.6.2.2 Routine tests

- a. IEC 60846 shall be used as a guideline to perform the applicable radiation and/or electrical tests that indicate that the instrument is responding accurately.
- b. Calibration shall be performed after instrument repairs.

5.6.2.3 Portable neutron dose rate instruments

- a. Neutron measuring instruments shall be calibrated against derived standard instruments calibrated by the CSIR using suitable neutron sources.

5.6.3 Radioactive Aerosol Contamination Meters And Monitors

5.6.3.1 Calibration

- a. These instruments shall be calibrated based on the manufacturer's manual or calibration certificate

5.6.3.2 Routine tests

- a. IEC 60671 shall be used as a guideline to perform the applicable radiation and/or electrical tests that indicate that the instrument is responding accurately.
- b. Calibration shall be performed after instrument repairs.

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5.6.4 Installed Personnel Contamination Monitors

5.6.4.1 Calibration

- a. These instruments shall be calibrated based on the manufacturer's manual or calibration certificate

5.6.4.2 Routine tests

- a. IEC 61098 shall be used as a guideline to perform the applicable radiation and/or electrical tests that indicate that the detector is responding accurately.
- b. Calibration shall be performed after instrument repairs.

5.6.5 X-Ray or Gamma Radiation Meters For Environmental Monitoring

5.6.5.1 Calibration

- a. These instruments shall be calibrated based on the manufacturer's manual or calibration certificate.

5.6.5.2 Routine tests

- a. IEC 61017 shall be used as a guideline to perform the applicable radiation and/or electrical tests that indicate that the detector is responding accurately.
- b. Calibration shall be performed after instrument repairs.

5.6.5.3 Analytical instrumentation

- a. Analytical instrumentation such as gamma spectrometers, alpha, beta counters and liquid scintillation counters shall be calibrated at a frequency specified by the relevant regulator and/or after repair.
- b. A reference source shall be used daily (when in use) to verify the calibration of gamma spectrometry systems.
- c. For all types of analytical instrumentation the Minimum Detectable Activity shall be determined as appropriated for their intended use.

5.7 CALIBRATION AND REFERENCE SOURCES

- 5.7.1 When a source is used to calibrate a detector relative to the radiation emitted by the source, the source shall be calibrated using a secondary standard traceable to the National Radiation Standard maintained by the CSIR or SABS or to a recognized international standard.
- 5.7.2 All sources of radiation used for the determination of energy response shall comply with ISO 4037.
- 5.7.3 Neutron, alpha and beta sources shall be calibrated against national standards or against recognized international standards.
- 5.7.4 Check source parameters should be established against derived standards.
- 5.7.5 Check sources shall be recorded in a logbook.

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- 5.7.6 Should the instrument reading vary by more than $\pm 20\%$ from the check source parameters, the instrument should be recalibrated.
- 5.7.7 Permanent build-in sealed sources in apparatus such as static electricity eliminators, level gauges, density meters and thickness gauges must be leak tested every 24 months. Other sealed sources must be leak tested every 6 months or as prescribed by the relevant regulator
- 5.7.8 All sources shall be recorded in a source register. The source register shall contain the following information:
- 5.7.8.1 Number of sources
 - 5.7.8.2 Type of radionuclide(s)
 - 5.7.8.3 Source activity
 - 5.7.8.4 Intended use of sources
 - 5.7.8.5 Location of sources
 - 5.7.8.6 Serial number of sources

5.8 PERFORMANCE CHECKS FOR PORTABLE INSTRUMENTS

- 5.8.1 Performance checks shall be developed for each type of instrument.
- 5.8.2 Performance checks shall be performed routinely.
- 5.8.3 A battery check (if applicable) shall be included as part of the performance check.
- 5.8.4 A detector response check shall be performed.

5.9 ENVIRONMENTAL CONDITIONS RELATING TO CALIBRATIONS

- 5.9.1 Due consideration shall be given to temperature, humidity, lighting, vibration, dust control, cleanliness and other factors affecting measurement.
- 5.9.2 Temperature, humidity and pressure measuring devices should be present in the calibration facility.
- 5.9.3 The background radiation shall be low, known and stable during the calibration period and shall be accounted for during calibration.

5.10 INVENTORY REQUIREMENTS

- 5.10.1 An adequate supply of instruments shall be maintained to meet the radiation protection programme associated with Eskom practices.

5.11 FIXED INSTALLED RADIATION DETECTION INSTRUMENTS

- 5.11.1 A suitable programme shall be established to verify operability of fixed installed radiation detection instruments.

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6. ACCEPTANCE:

This following people were informed of the request submitted to the National Nuclear Regulator (NNR) via letter K-28414-E and the NNR response via letter k28414N relating to implementation of administrative changes to this document.

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7. REVISIONS

Date	Rev.	Compiler	Remarks
March 2022	1	M Maree	Administrative changes implemented in accordance with letter k28414N dated, 22 March 2022.
December 2019	0B	M Maree	NNR approval via letter k26060N dated 6 December 2019 for extension of review date from October 2019 to May 2020.
September 2018	0A	M Maree	NNR approval via letter k24608N dated, 4 September 2018 for implementation of administrative changes.
March 2012	0	M Maree	NNR approval via letter k20275N dated, 12 March 2012 for implementation of Radiation Protection Standards.

8. DEVELOPMENT TEAM

This document has been developed by Marc Maree.

9. ACKNOWLEDGEMENTS

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