

 Eskom	STANDARD	NUCLEAR OPERATING UNIT
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Title: **Radiation Protection
Requirements for Industrial
Radiography**

Unique Identifier: **238-40**

Alternative Reference Number: **None**

Area of Applicability: **U**

Documentation Type: **ST**

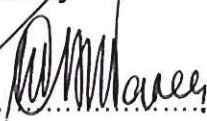
Revision: **0**

Total Pages: **19**

Next Review Date: **May 2015**

Disclosure Classification: **CONTROLLED
DISCLOSURE**

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ADDITIONAL CLASSIFICATION INFORMATION

Business Level: 2 –Generation Division

Working Document: 3 – For Reference

Importance Classification: **Applicable to Radiation Protection and Safety of radiation sources**NNR Approval: **Yes**Safety Committee Approval: **No**ALARA Review: **Yes**Functional Control Area: **Radiation Protection****NOTE:**

With the changes to the Eskom structure the names in documents will be inconsistent for a period of time.

The terms Nuclear Division, Nuclear Operating Unit are to be seen as referring to the integrated high level description of the Koeberg Operating Unit.

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1. INTRODUCTION

This standard specifies the radiation protection requirements for industrial radiography for the Eskom Nuclear and Generation Divisions and in terms of the Eskom Radiation Protection Policy EPL 32-227 and Standard EST 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 radiation protection requirements for industrial radiography in terms of Eskom Policy EPL 32-227, Eskom standard EST 32-226 and the Nuclear Division Manual 238-19 relating to radiation protection and safety of radiation sources.

2.2 APPLICABILITY

This standard is applicable to Group IV hazardous substances (radioactive sources) defined in the Nuclear 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] EST 32-226: Eskom Standard, Requirements and rules for radiation protection and the safety of radiation sources.
- [2] EPL 32-227: Eskom Policy, Radiation Protection and safety of radiation sources.
- [3] GGR 0992: Rev 1, Plant Safety Regulations.
- [4] 238-19: Nuclear Division radiation protection manual.
- [5] 238-35: Nuclear Division Radiation protection dose and risk limits.
- [6] 238-43: Nuclear Division Requirements for radiation workers.

3.2 INFORMATIVE

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

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

4. DEFINITIONS AND ABBREVIATIONS

4.1 DEFINITIONS

- 4.1.1 **Authority:** Written authority issued by the relevant regulator.
- 4.1.2 **Authorisation(s):** See authority.
- 4.1.3 **Barrier:** A physical obstruction or barrier tape.

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- 4.1.4 **Biological monitoring:** A planned programme for periodic collection and analysis of body fluids.
- 4.1.5 **Directorate:** Radiation Control, Department of Health.
- 4.1.6 **Dose:** A measure of the radiation received or “absorbed” by a target. The quantities termed absorbed dose, organ dose, equivalent dose, effective dose, committed equivalent dose or committed effective dose are used, depending on the context.
- 4.1.7 **Enclosed exposure facility:** A permanent, shielded installation or structure designed for industrial radiography, which incorporates a fixed exposure device and in which such work is regularly performed.
- 4.1.8 **Eskom:** is used for Eskom Holdings SOC Limited, its divisions and wholly owned subsidiaries.
- 4.1.9 **Functional radiation monitor:** A radiation monitoring instrument with a valid calibration certificate that has been source-response checked.
- 4.1.10 **Guide tube:** A flexible or rigid sheath or tube for guiding the source assembly from the source container to the working position.
- 4.1.11 **Industrial radiographer:** A person Authorised by the Directorate: Radiation Control, Department of Health to perform industrial radiography.
- 4.1.12 **Industrial radiography:** Work involving the examination of the structure of materials by non-destructive methods, utilizing ionizing radiation.
- 4.1.13 **Medical surveillance:** A planned programme of periodic examinations (which should include clinical examinations, biological monitoring or medical tests) by an Occupational Health Practitioner.
- 4.1.14 **Occupational health practitioner (OHP):** An occupational medical practitioner or nurse practitioner with a qualification in occupational health recognized by his/her respective statutory councils.
- 4.1.15 **Over-exposure:** Any exposure of a person to ionizing radiation to an extent that the legal limits are exceeded.
- 4.1.16 **Radiation Protection Controller (RPC):** The Radiation Protection Controller is appointed by the Eskom Power Station or Installation Manager in writing to ensure that industrial radiography contractors comply with the Eskom requirements contained in this standard. The Radiation Protection Controller shall have successfully completed the relevant Eskom training.
- 4.1.17 **Radiation Protection Officer (RPO):** A Level III person certified in radiography or a Level II radiographer with the Directorate: Radiation Control, Department of Health approval who performs industrial radiography on Eskom premises.
- 4.1.18 **Radiation worker:** Any person who is potentially exposed to radiation through his occupation to more than 1mSv per annum.
- 4.1.19 **Remote control system:** A device that enables gamma radiography apparatus to be operated at a safe distance, and which comprises a winding cable, winding cable sheath and winding control mechanism, for example, reel with crank handle.
- 4.1.20 **Source assembly:** The pen shaped device or “pigtail” in which a sealed radioactive nuclide is incorporated.
- 4.1.21 **Source container:** The shielding container in which a sealed radioactive nuclide is transported and stored.
- 4.1.22 **Source encapsulation:** The small outer metal sheath which surrounds a radioactive source and which connects it to the source assembly.

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- 4.1.23 **Trainee:** A person who has successfully completed an approved examination in industrial radiography, but who has not yet obtained the necessary 6 months practical experience under the supervision of a qualified industrial radiographer.

4.2 ABBREVIATIONS

Abbreviation	Description
ALARA	As Low As Reasonably Achievable
Bq	Becquerel
B(U)	Type B package for transporting sources
Ci	Curie
DRC	Directorate Radiation Control, Department of Health
ESKOM	Eskom Holdings SOC Limited, its Divisions and wholly owned subsidiaries
GBq	Giga-Becquerel
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
mSv	millisievert
mSv/h	millisievert per hour
OHP	Occupational Health Practitioner
RPC	Radiation Protection Controller
RPO	Radiation Protection Officer
NECSA	South African Nuclear Energy Corporation
SABS	South African Bureau of Standards
TLD	A thermoluminescent device that measures and records the amount of radiation an individual is exposed to

5. REQUIREMENTS

5.1 RESPONSIBILITIES

- 5.1.1 The responsibilities for the radiological protection programme in Eskom are defined in Eskom Policy, EPL 32-227, Radiation protection and safety of radiation sources, Eskom Standard, EST 32-226, Requirements and rules for radiation protection and safety of radiation sources and GGR 0992, Plant Safety Regulations.
- 5.1.2 The requirements for radiation workers in Eskom employment are defined in, 238-43: Nuclear Division Requirements for radiation workers.
- 5.1.3 Responsibilities of the industrial radiography contractor:
- 5.1.3.1 The industrial radiography contractor shall be responsible for demonstrating to Eskom, his/her compliance with the requirements in the Code of Practice for Industrial Radiography (IRCP91-1), this standard, and his/her company procedures.
- 5.1.3.2 If there is conflict between the procedures and the Code of Practice for Industrial Radiography (IRCP91-1), the current Code of Practice for Industrial Radiography shall prevail. However, the conflict shall be resolved before work commences.

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5.2 ADMINISTRATION AND MEDICAL REQUIREMENTS

- 5.2.1 The industrial radiography contractor(s) appointed by Eskom shall be responsible for implementing and demonstrating compliance with the following administrative requirements:
- 5.2.1.1 An application for an authority to possess and use a radioactive nuclide for industrial radiography on Eskom premises has been submitted to and approved by the DRC.
 - 5.2.1.2 Persons nominated to act as Radiation Protection Officers or Assistant Radiation Protection Officers on Eskom premises shall have passed an examination approved by the DRC before they assume these positions.
 - 5.2.1.3 The DRC and the applicable Eskom Radiation Protection Controller have been informed in writing of changes to appointments of Radiation Protection Officers or Acting Radiation Protection Officers appointed by the contractor on Eskom premises.
 - 5.2.1.4 Industrial Radiographers and their assistants working on Eskom premises have been registered with the DRC.
 - 5.2.1.5 Industrial radiography procedures used on Eskom premises are adequate for the tasks.
- 5.2.2 The industrial radiography contractor(s) appointed by Eskom shall be responsible for implementing and demonstrating compliance with the following medical requirements:
- 5.2.1.6 Health registers have been established and are maintained for each Industrial Radiographer and his/her assistants working on Eskom premises.
 - 5.2.1.7 Industrial Radiographers and their assistants working on Eskom premises have valid medical certification. Copies of this certification shall be made available to Eskom upon request.
 - 5.2.1.8 Medical examinations of Industrial Radiographers and their assistants working on Eskom premises have been carried out by an occupational health practitioner.
 - 5.2.1.9 Industrial Radiographers and their assistants working on Eskom premises have been subjected to medical surveillance and/or biological monitoring when it is suspected or confirmed that a worker has received a radiation dose in excess of 50 mSv in one year or 100 mSv over a five year period. These examinations shall include a blood test.
 - 5.2.1.10 Industrial Radiographers and their assistants working on Eskom premises have been subjected to medical surveillances and/or biological monitoring if the individual has received a large exposure in a short period of time, for example, in excess of 10 mSv in a week.
 - 5.2.1.11 Industrial Radiographers and their assistants working on Eskom premises have been subjected to medical surveillances and/or biological monitoring whenever an occupational health practitioner deems it necessary.
 - 5.2.1.12 Industrial Radiographers and their assistants working on Eskom premises have been issued with copies of their complete dose records when work on Eskom premises is completed.
 - 5.2.1.13 Industrial Radiographers and their assistants working on Eskom premises have been subjected to further radiation worker medical examination(s) at the end of radiation work on Eskom premises.

5.3 EQUIPMENT SPECIFICATIONS

- 5.3.1 The industrial radiography contractor(s) appointed by Eskom shall be responsible for implementing and demonstrating compliance with the following requirements relating to equipment and radioactive source containers used on Eskom premises:
- 5.3.1.1 The source containers shall comply with the requirements of the IAEA for the source container to be used.

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- 5.3.1.2 The source container has a locking facility so that it can be locked in the shielded position.
- 5.3.1.3 The source container is marked with the trefoil symbol with the word "Radioactive", the maximum rating of the container, the manufacturer's type and serial number.
- 5.3.1.4 The source container displays the IAEA approved transport index label (see Appendix A) as well as a label indicating the type of nuclide, the activity on a specified date and the serial number of the radioactive source.
- 5.3.1.5 When the source is in the shielded position the dose rate does not exceed the following limits:
- 2 mSv/h at any point on the surface of the container;
 - 2×10^{-2} mSv/h at any point 1 m from the surface of a portable container (containers that weigh less than 50kg);
 - 5×10^{-2} mSv/h at any point 1 m from the surface of a mobile container (containers that are not portable but can easily be moved); and
 - 10^{-1} mSv/h at any point 1 m from the surface of a fixed container (containers with restricted mobility).
- 5.3.1.6 If the source container does not meet these requirements, the radioactive source shall not be permitted to enter Eskom property.
- 5.3.1.7 The source shall be secured to prevent unauthorised operation of the remote control device when the operator is not in attendance, for example it shall have a removable winding handle.
- 5.3.1.8 Apparatus for gamma radiography should preferably be provided with a visual indicator to show whether the source assembly is in the secured, or working, position. Such an indicator shall, however, at no time be used in place of prescribed monitoring procedures.
- 5.3.1.9 During storage or transport, apparatus for gamma radiography shall be fitted, at each end, with suitable protective caps or plugs to protect the source assembly from water, sand or other foreign matter.
- 5.3.1.10 The winding cables used for industrial radiography in open areas shall be at least 8 m long. Deviations from this requirement shall be approved by the DRC. Guide tubes shall be as short as practicable.
- 5.3.1.11 The coupling between the source assembly and the winding cable shall be such that it cannot be unintentionally disconnected under normal and reasonably foreseeable abnormal conditions.
- 5.3.1.12 The source assembly shall be automatically secured when it is cranked back into the fully retracted position within the source container.
- 5.3.1.13 The dimensions of the winding cable, winding cable sheath, guide tube, and associated connectors and couplings shall be within the tolerances specified by the manufacturer of the source container.
- 5.3.1.14 An exposure head or similar device designed to prevent the source assembly from passing out of the end of the guide tube shall be attached to the outermost end of the guide tube during radiographic operations.
- 5.3.1.15 Only lubricants specified by the manufacturer of the source container shall be used on radiography equipment and associated accessories. Usually graphite powder is recommended. Oils shall not be used.

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5.4 SPECIFICATIONS FOR ENCLOSED EXPOSURE FACILITIES (PERMANENT TESTING FACILITIES)

- 5.4.1 The industrial radiography contractor(s) appointed by Eskom shall be responsible for implementing and demonstrating compliance with the following requirements when industrial radiography is conducted in enclosed exposure facilities on Eskom premises:
- 5.4.1.1 The remote control unit shall be placed outside the enclosure.
 - 5.4.1.2 An enclosed exposure facility shall not be located in an area zoned for domestic use.
 - 5.4.1.3 The facility shall be clearly marked with radiation warning signs, the name and telephone number of a person to be contacted in the event of an emergency, shall appear at the entrance to the facility.
 - 5.4.1.4 The facility shall incorporate a means to indicate positively that an exposure is underway. In the case of a gamma radiography installation, the facility shall incorporate warning lights activated by a radiation detector. In the case of an electrically activated unit, the facility shall incorporate warning lights linked to the on-off mechanism of the unit.
 - 5.4.1.5 Facilities in which electrically activated gamma radiography apparatus is installed shall have interlock systems, which prevent exposure if one of the entrance doors is opened before exposure or opened during exposure. Resumption of exposure shall be possible only after manual restart at the control panel, after the door has been closed.
 - 5.4.1.6 Facilities in which manually activated gamma radiography apparatus is used shall have a safety system which either prevents access to the facility during exposure, or which gives an audible alarm if attempts are made to enter it.
 - 5.4.1.7 Radiographic apparatus, which is not manually operated, shall be designed so that system failure automatically causes the apparatus to return to the secured mode. In addition, gamma radiography apparatus shall be provided with a manual means of returning the source assembly to the shielded position.
 - 5.4.1.8 Enclosed exposure facilities shall be provided with a device which makes it possible for a person accidentally left in the room, to open one of the doors easily and leave.
 - 5.4.1.9 In facilities having more than one entrance door, the doors that are not controlled by the operator shall be lockable from the inside and the door under his control, lockable from the outside. If the facility has only one door it shall be lockable from the outside.
 - 5.4.1.10 The radiation dose rate outside the exposure facility shall comply with the requirements above, and be at a distance of 1 m from the outer surface of an enclosed installation and shall preferably not exceed 2.5×10^{-3} mSv/h or 7.5×10^{-3} mSv/h, when the properties of the radiation source correspond to the maximum ratings stated for that enclosed installation.
 - 5.4.1.11 Enclosed installations shall be provided with a sign stating the maximum rating and limitations on the primary beam directions established for that installation.

5.5 STORAGE REQUIREMENTS

- 5.5.1 The industrial radiography contractor appointed by Eskom shall demonstrate compliance with the following storage requirements for storage of industrial radiography sources on Eskom premises:
- 5.5.1.1 When in storage, source containers containing radioactive sources shall be locked in the shielded position.
 - 5.5.1.2 Warning signs clearly indicating the presence of radioactive material, shall be displayed at the entrance to the source storage facility.
 - 5.5.1.3 Dose rates outside the source storage facility shall not exceed 2.5×10^{-3} mSv/h.

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- 5.5.1.4 A notice containing the names and contact telephone numbers of persons to be contacted in the event of an emergency shall be displayed at the entrance to the source storage facility.
- 5.5.1.5 The source storage facility shall be lockable and entry into the storage facility shall be controlled.
- 5.5.1.6 The Industrial Radiographer using the source on Eskom premises shall ensure the source is returned safely to the source storage facility after use.
- 5.5.1.7 No radioactive material shall be stored with, or in close proximity to, any corrosive, combustible or explosive materials.
- 5.5.1.8 A logbook shall be maintained for a source on Eskom premises. The radioactive source container shall be signed in and out of the storage facility and the radiation dose levels on the surface of the container recorded. The serial number of the radiation monitor and its physical condition shall be noted.

5.6 TRAINING REQUIREMENTS

- 5.6.1 The industrial radiography contractor appointed by Eskom shall demonstrate compliance with the following training requirements:
 - 5.6.1.1 Prior to commencement of industrial radiography work, Eskom shall be satisfied that personnel performing radiography are suitably trained. Personnel shall be subject to Eskom approval in accordance with the relevant approval process.
 - 5.6.1.2 An Industrial Radiographer shall have completed a suitable course in industrial radiography and undergone a practical training period of not less than 6 months;
 - 5.6.1.3 Assistants shall be given sufficient training to carry out their functions safely; the training shall include the risks associated with ionizing radiation. The knowledge and understanding of this training shall be evaluated; and
 - 5.6.1.4 all radiation workers, for example radiographers, trainees, assistants and operators shall be re-trained annually; the training shall include the radiation health and safety aspects relating to their work.
 - 5.6.1.5 The Radiation Protection Officer on Eskom premises shall regularly observe the performance of all radiation workers during actual radiographic operations in order to establish whether correct operating procedures and Departmental requirements are being adhered to. Each worker shall be observed at least once every 3 months.
 - 5.6.1.6 Where a radiation worker has not participated in a radiographic operation for more than 3 months, or where a worker has not used a particular type of radiographic apparatus for the same period, the Radiation Protection Officer on Eskom premises shall observe the individual's performance the next time he participates in radiographic operations.
 - 5.6.1.7 An Eskom Radiation Protection Officer shall ensure that all persons performing or assisting in industrial radiography on Eskom premises, have the necessary training and are familiar with the correct operating and safety procedures.
 - 5.6.1.8 The training records of personnel performing industrial radiography or assisting in radiography, including the 3-month surveillance reports performed by the Radiation Protection Officer, shall be available to Eskom on request.
 - 5.6.1.9 Records shall be kept of all training and observations conducted on Eskom premises and shall be available to Eskom on request. These records shall include details of the performance of radiographers during observations as well as information regarding attendance and content of training courses. As far as periodic training and training of radiographic assistants and operators are concerned, records shall be kept of tests or other methods which have been used to

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determine the individual's knowledge and understanding of safety requirements and operating procedures.

- 5.6.1.10 The Eskom Radiation Protection Controller shall have undergone the prescribed Eskom training (i.e. the "Radiation Protection Officer Training Course") or any equivalent, approved training programme. In addition the individual shall be classified as a radiation worker.

6. HANDLING PROCEDURES FOR CONDUCTING INDUSTRIAL RADIOGRAPHY

6.1 GENERAL REQUIREMENTS

- 6.1.1 On Eskom premises, industrial radiography shall only be performed by:
- 6.1.1.1 A qualified radiographer who has been granted a personal authority from the DRC to perform such work; or
 - 6.1.1.2 A trainee Industrial Radiographer under the direct supervision of a fully qualified and Authorised Industrial Radiographer; or
 - 6.1.1.3 In the case of a trainee, the qualified radiographer shall be physically present at all times during radiography work, and shall be fully responsible for the actions of the trainee.

6.2 RADIOGRAPHY IN OPEN AREAS

- 6.2.1 The industrial radiography contractor appointed by Eskom shall ensure implementation of the following requirements during industrial radiography in open areas:
- 6.2.1.1 Before commencing work, an Industrial Radiographer shall ensure that he/she, and the other members of the radiography team (i.e. radiographers, trainee radiographers and assistants), are wearing personal dosimeters (TLD), and that he/she has in his/her possession a functioning radiation monitor. In addition, every member of the radiography team shall be wearing a functioning digital audible-alarm dosimeter with a history function.
 - 6.2.1.2 The Industrial Radiographer shall have the equipment necessary for setting up barriers for example, barrier rope, mechanical supports, etc., as well as radiation warning signs and, in the case of night-work, warning lights.
 - 6.2.1.3 Radiography equipment, accessories and auxiliary apparatus (i.e. radiation monitors, alarm dosimeters, etc.) shall be checked daily by the Industrial Radiographer before and after use, and the condition of such equipment noted in the logbook. If any equipment is not in a proper working order, radiography shall not be carried out.
 - 6.2.1.4 Appropriate collimators shall be used for reduction of the field size of the primary beam to the minimum practicable size necessary for the performance of the work. Where it is not possible to use a collimator, other appropriate shielding material shall be used.
 - 6.2.1.5 Barriers shall be erected in non-controlled zones at a distance calculated prior to commencing the exposure, to ensure that the instantaneous dose rate at the barrier is as low as is reasonably achievable and does not exceed 10^{-2} mSv/h. Once the radiography unit has been activated, the radiation level at the barriers shall be checked with a monitor and the barriers moved, if necessary, to ensure that levels are acceptably low.
 - 6.2.1.6 The Industrial Radiographer shall ensure, during the course of his work, that no individual is exposed to radiation in excess of the following levels:-
 - a. Workers not wearing personal dosimeters: 2×10^{-2} mSv in any one day or less than 1 mSv in a year.
 - b. Members of the public: 4×10^{-3} mSv in any one day.

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- 6.2.1.7 Warning signs and, at night, warning lights shall be prominently displayed at the barrier and shall be visible from all directions.
- 6.2.1.8 Before commencing the exposure, the Industrial Radiographer shall ensure that no people are within the demarcated area.
- 6.2.1.9 Boundaries of adjacent sites on which industrial radiography is done shall not overlap. If overlap is unavoidable, close liaison shall be maintained between operators responsible for the overlapping sites to avoid accidental exposure.
- 6.2.1.10 During the exposure the Industrial Radiographer, or one of his assistants, shall be in attendance near the demarcated area in order to take immediate corrective measures if any unplanned entry into the area takes place.
- 6.2.1.11 After rewinding a source assembly and before rolling up the guide tube, the Industrial Radiographer shall personally ensure, by monitoring the entire circumference of the source container, as well as the length of the guide tube, that the radioactive source has indeed safely returned to the fully shielded position. Once this has been established, the Industrial Radiographer shall lock the source container.
- 6.2.1.12 Before a site is vacated, the Industrial Radiographer shall ensure, by monitoring, that all radiation sources are locked in the fully shielded condition or switched off, as appropriate, and returned to the source container store or to the transport vehicle and that all boundary-defining equipment has been removed. The Industrial Radiographer shall inform the Radiation Protection Controller when this has been carried out.
- 6.2.1.13 When radioactive sources exceeding 1100 GBq (30 Ci) of Iridium or 300 GBq (8 Ci) of Cobalt are used, the following procedures shall apply:
- Two qualified Industrial Radiographers shall be present at all times during use of the radioactive source.
 - The winding gear shall be long enough to ensure a distance of at least 15 m between the winding unit and the source container.
 - Emergency equipment for example, additional shielding material, long-handled tongs, emergency transport containers, etc., should be present at the site where the work is performed.
- 6.2.1.14 Radiography apparatus containing radioactive sources shall not be left unattended unless it is locked in an approved storage facility, or is under transport and is temporarily stored.
- 6.2.1.15 A radiography team operating one radiography unit, shall consist of one radiographer and at least one assistant to implement the following emergency requirements:
- The source control equipment or any other means shall be used to render the source safe.
 - A radiation survey meter shall be used to confirm the situation.
 - The Radiation Protection Officer and/or the Radiation Protection Controller shall be informed of the emergency as soon as practicable.

6.3 RADIOGRAPHY IN ENCLOSED EXPOSURE FACILITIES

- 6.3.1 The industrial radiography contractor appointed by Eskom shall ensure the following requirements are implemented during industrial radiography in enclosed exposure facilities:
- 6.3.1.1 Before commencing the exposure, the operator shall ensure that there is nobody inside the enclosed exposure facility.

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- 6.3.1.2 The exposure shall be terminated in accordance with the correct termination procedures. The use of safety devices such as interlocks for exposure termination is not permitted.
- 6.3.1.3 Before entering the enclosed exposure facility after an exposure, the operator shall make certain that the exposure has been terminated. If manually activated gamma radiography apparatus is used, the operator shall use a functioning radiation monitor to monitor the source container, as well as the length of the guide tube, to ensure that the radioactive source has indeed safely returned to the fully shielded position.
- 6.3.1.4 When the facility is not in use, the unit shall be rendered inoperable by locking the control panel and removing the key, or by deactivating the winding gear, for example by locking or removing the handle in the case of manually operated units.
- 6.3.1.5 The operator shall ensure compliance with all the limitations on the use of the enclosed installation for example, the limitations with respect to beam direction and source activity of industrial radiography equipment. If these conditions are not satisfied, the installation is no longer considered to be an enclosed installation, and the work shall be carried out in accordance with the requirements for open installations.
- 6.3.1.6 Persons performing radiography in an enclosed exposure facility shall wear personal dosimeters such as direct reading dosimeters and TLDs.

6.4 PERIODIC TESTING AND MAINTENANCE OF EQUIPMENT

- 6.4.1 The industrial radiography contractor appointed by Eskom and/or manufacturer(s) of industrial radiography sources and equipment shall be responsible for ensuring that all industrial radiography equipment in use on Eskom premises complies with the periodic testing and maintenance requirements prescribed by the DRC.
- 6.4.2 Documentary evidence of all of equipment tests shall be made available to Eskom for inspection purposes.

6.5 RADIATION MONITORING REQUIREMENTS

- 6.5.1 The industrial radiography contractor appointed by Eskom shall demonstrate to Eskom that all the radiation monitoring requirements are complied with during industrial radiography on Eskom premises.
- 6.5.2 The industrial radiography contractor appointed by Eskom shall ensure that all the members of an industrial radiography team (i.e. radiographers, trainee radiographers and assistants) as well as operators, shall be issued with a TLD.
- 6.5.3 In the case of work with radionuclides in open areas, all members of the industrial radiography team, as well as any other workers, who are likely to receive more than 2×10^{-1} mSv during any one day, shall, in addition to the above, be issued with a digital audible-alarm dosimeter with a history function. The alarm dosimeter shall be set to give an alarm signal at a dose rate of 5 m Sv/h and shall be able to give a clear audible response at dose rates in excess of 500 m Sv/h without saturation. Daily doses shall be accurately recorded, and those records shall be kept for a period of at least 5 years.
- 6.5.4 Digital audible-alarm dosimeters shall be checked for correct response to radiation at an approved facility, at periods not exceeding 26 months.
- 6.5.5 The dosimeters specified, shall be worn by radiation workers (i.e. attached to their clothing) during the course of their work.
- 6.5.6 Each industrial radiography team shall have a radiation monitor (dose-rate meter) with a range sufficient to measure 10^{-2} mSv/h through to at least 10 mSv/h. When radiation levels exceed the maximum readings in their measurement ranges, they shall continue to indicate that fact and

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shall provide an audible warning. This monitor used by the industrial radiographer on Eskom premises shall be calibrated at an approved facility at periods not exceeding 7 months, and after servicing of the instrument.

- 6.5.7 Before starting work, the radiation workers shall ensure that their dosimeters and monitors are in place and in proper working order. If not, the industrial radiography work shall not be carried out.

6.6 DOSE LIMITATION

- 6.6.1 The industrial radiography contractor appointed by Eskom shall demonstrate to Eskom that the dose limitations prescribed by the DRC are complied with during industrial radiography on Eskom premises.
- 6.6.2 Radiation doses to individuals shall at all times be kept as low as is reasonably achievable (ALARA).
- 6.6.3 In addition to the requirement of ALARA, the industrial radiography contractor appointed by Eskom, and radiation workers, shall ensure that radiation doses to individuals (including themselves) do not exceed the limits specified by the DRC.
- 6.6.4 The dose limits specified in 238-35: Nuclear Division Radiation protection dose and risk limits, are applicable.

6.7 TRANSPORT

- 6.7.1 The industrial radiography contractor appointed by Eskom shall demonstrate that the transport regulations prescribed by the DRC are complied with during transportation of industrial radiography sources to and from Eskom premises.
- 6.7.2 Radioactive sources used for industrial radiography shall be transported to and from Eskom premises in accordance with the requirements of the current edition of "Regulations for the Safe Transport of Radioactive Materials", published by the IAEA, as well as relevant regulations prescribed by the Directorate.
- 6.7.3 An enclosed and lockable vehicle shall be used to transport radioactive sources. An open vehicle may be used if work is done on site.
- 6.7.4 The vehicle shall be fitted with a satellite vehicle recovery system. The system shall provide countrywide coverage, including border posts, and shall be backed by the resources of the South African Police Services.
- 6.7.5 The source container shall be firmly secured to the vehicle during transportation.
- 6.7.6 In general, a vehicle shall not be left unattended with a radioactive source in it. However, an exception can be made if a person is required to make an over-night stop during transportation of a radioactive source, and a suitable storage facility is not available. In such a case the radiography apparatus shall be considered as being in transit during the night. The vehicle shall be securely locked and parked in the safest possible area. Where practicable, the vehicle shall be left on the premises of a police station during the night.
- 6.7.7 Three removable transport labels (see figure 2, Appendix A) shall be displayed on a vehicle during transportation of radioactive sources; one sign on each side and one on the rear of the vehicle. The name and telephone number of a person to be contacted in the event of an emergency shall also appear adjacent to the transport labels. Transport labels shall be removed when the radioactive material is no longer in the vehicle.
- 6.7.8 The source container shall be locked in the shielded ("off") position during transport.
- 6.7.9 The source container shall bear IAEA approved transport labels, in accordance with the radiation levels associated with the unit (see figure 1, Appendix A).

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- 6.7.10 The source container shall not be transported in the passenger compartment of the transport vehicle and shall be positioned as far as possible from any persons in the vehicle. The maximum dose rate, at the position of any person in the vehicle, shall not exceed 2×10^{-2} mSv/h (ref 14).
- 6.7.11 Industrial radiography source containers may be dispatched by public freight transport (i.e. by ship, air or road) provided that the above requirements are met and the gauge is accompanied by properly completed transport documents specifying the radioactive content.
- 6.7.12 If a source container is, or appears to be, damaged in transport the following actions shall be taken:
- 6.7.13 The person or persons responsible for the container at the time of the incident shall notify the holder of the authority and the DRC.
- 6.7.14 The owner shall ensure that the source container is carefully examined to verify that it continues to comply with the Regulations by carrying out a radiation survey on the container.

6.8 EMERGENCY PROCEDURES

- 6.8.1 The industrial radiography contractor appointed by Eskom shall demonstrate compliance with the following emergency planning requirements:
- 6.8.1.1 The industrial radiography contractor appointed by Eskom shall develop an Emergency Procedure. The procedure shall include a contingency plan describing processes to be followed in an event of a radiation incident.
- 6.8.2 The contingency plan shall address the following:
- 6.8.2.1 the immediate actions to be taken following a radiation incident;
- 6.8.2.2 the internal and external notification processes including notification of Eskom;
- 6.8.2.3 the procedures for dealing with the incident and returning the situation to normal; and
- 6.8.2.4 the instructions regarding medical handling of individuals exposed accidentally.
- 6.8.3 The industrial radiography contractor appointed by Eskom shall issue a copy of the Emergency Procedure to the responsible Eskom Radiation Protection Controller at an Eskom Power Station.
- 6.8.4 The relevant Power Station Manager and the Generation Safety & Assurance Division shall be informed of the radiation incident.
- 6.8.5 The DRC shall be notified immediately of any radiation incident on Eskom premises. A report shall be submitted by the industrial radiography contractor appointed by Eskom to the Power Station Manager, Corporate Specialist (Radiation Protection) and the DRC within 7 days in instances when:
- 6.8.5.1 Any person is overexposed, or is suspected of being overexposed on Eskom premises;
- 6.8.5.2 The industrial radiography contractor appointed by Eskom is not able to deal with an emergency situation in a safe and acceptable manner with the equipment at his disposal, or if he does not have personnel who are trained to handle such situations.
- 6.8.5.3 There is the likelihood of radioactive contamination occurring, or having occurred, as a result of an incident on Eskom premises.
- 6.8.5.4 A radioactive source is missing on Eskom premises.
- 6.8.5.5 The source assembly is unintentionally disconnected from the control cable on Eskom premises.
- 6.8.5.6 The source assembly on Eskom premises cannot be retracted to its fully shielded position and secured in that position.

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6.8.5.7 A component (critical to safe operation) fails to properly perform its intended function.

6.8.6 The following information shall be included in these reports:

6.8.6.1 a description of the problem;

6.8.6.2 the cause of the incident, if known;

6.8.6.3 the manufacturer and model number of equipment involved;

6.8.6.4 the place, time and date of the incident;

6.8.6.5 the actions taken to restore the situation to normal;

6.8.6.6 the corrective actions planned to prevent recurrence; and

6.8.6.7 the personnel involved in the incident, including their qualifications.

6.8.7 Industrial Radiographers and their assistants working on Eskom premises shall not attempt to retrieve a source, or recover a radioactive source, not in the shielded position unless they are suitably trained.

6.8.8 In the event of an overexposure the individual shall immediately be referred to an Occupational Health Practitioner for medical examination. A Blood sample shall be drawn from all people possibly exposed to more than 50 mSv per month and send for biological dosimetry.

6.8.9 If the digital audible-alarm dosimeter alarms are triggered, the individual shall cease work and leave the demarcated area immediately (ensuring that the equipment is placed in safe storage, if necessary). The cause of the alarm shall be investigated by the Radiation Protection Officer and/or the Eskom Radiation Protection Controller. The RPO and the Eskom RPC shall review the findings, before the individual is allowed to continue with industrial radiography.

6.8.10 In the event of an overexposure or suspected overexposure, the personal dosimeter(s) (TLD) of the person(s) shall be forwarded to the SABS for processing.

6.8.11 The industrial radiography contractor appointed by Eskom shall ensure that the following emergency equipment is available, preferably on Eskom premises for use during an emergency:

6.8.11.1 1 m long tongs;

6.8.11.2 2 m long tongs;

6.8.11.3 pliers;

6.8.11.4 screwdriver;

6.8.11.5 adjustable spanner or wrench;

6.8.11.6 6 personal radiation monitoring device (TLD, direct reading dosimeter).

6.8.11.7 dummy source or photograph (incorporating an indication of the physical dimensions) of the dummy source;

6.8.11.8 two survey meters (one of them suitable for high dose rates);

6.8.11.9 other hand tools which are appropriate for the particular equipment;

6.8.11.10 bags of lead shot (2 kilogram per bag), at least two of which are required for Iridium-192 sources;

6.8.11.11 a lead pot with wall thickness greater than 4 centimetre and/or lead sheet.

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6.9 DISPOSAL AND EXCHANGE

6.9.1 The industrial radiography contractor appointed by Eskom shall demonstrate compliance with the following requirements relating to disposal and exchange industrial radiography sources used on Eskom premises:

6.9.1.1 The industrial radiography contractor appointed by Eskom shall not dispose of radioactive sources without the approval of the Directorate.

6.9.1.2 If the industrial radiography contractor appointed by Eskom wishes to discard a radioactive source at NECSA Pelindaba, application shall be made to the DRC.

6.9.1.3 If the industrial radiography contractor appointed by Eskom wishes to exchange a short half-life radioactive source such as Iridium-192, permission need not be obtained from the DRC. The holder is, however, required to provide NECSA with a Departmental "exchange form".

7. RECORDS

Copies of personnel dose records and instrument calibration certificates shall be made available to Eskom for review.

8. DEVELOPMENT TEAM

This document has been developed on behalf of the Nuclear and Generation Divisions by Marc Maree.

9. ACCEPTANCE AND AUTHORISATION

This document was reviewed by key stakeholders in the Nuclear and Generation Divisions listed in Appendix B:

10. APPENDICES

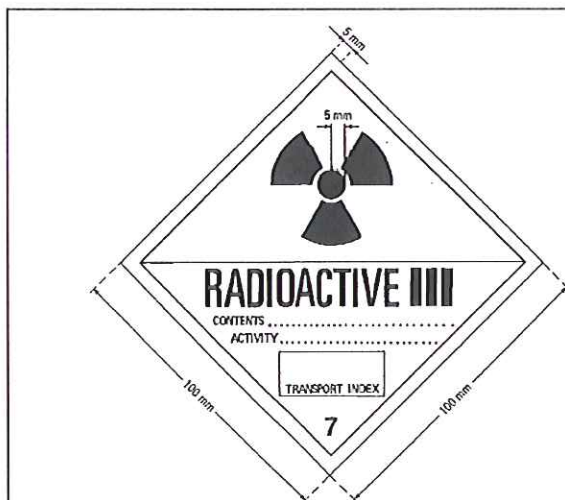
A – IAEA approved transport index label

B – Acceptance and Authorisation

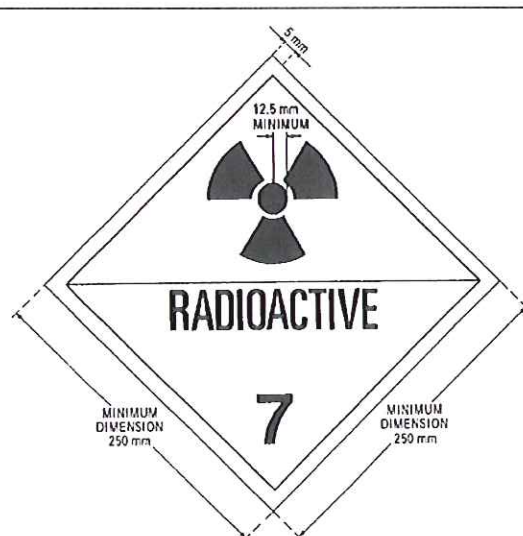
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APPENDIX A: IAEA APPROVED TRANSPORT INDEX LABEL

**Figure 1:**

Category III - Yellow label. The background colour of the upper half of the label shall be yellow and the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

**Figure 2:**

Placard. Minimum dimensions are given; when larger dimensions are used the relative proportions shall be maintained. The figure '7' shall not be less than 25 mm high. The background colour of the upper half of the placard shall be yellow and the lower half white, the colour of the trefoil and the printing shall be black.

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APPENDIX B: ACCEPTANCE AND AUTHORISATION

This document was sent for review to the following people:

Woodhall D (Douglas)	Nemadodzi NM (Marcus)
Karsten T (Tertius)	Govender T (Thegan)
Mokoto N (Naomi)	Nani C (Christopher)
Nicholls D (Dave)	Van Geuns A (Arnold)
Fourie J (Julian)	Ramluckun S (Saluja)
Featherstone K (Keith)	Mkwai MG (Gladman)
Khehla S (Shandu)	Van Niekerk FC (Christo)
Rakgolela NMK (Karabo)	Conradie TA (Thomas)
Kuzelj A (Anthony)	Prinsloo CJ (Johan)
Dean JS (John)	Prince SS (Shireen)
Jappie (Shamuel)	Khumalo IF (Phil)
Nair J (Julian)	Lacock R (Ryno)
Hector J (Jason)	

Review comments on the draft document were addressed as required.

11. REVISION INFORMATION

Date	Rev.	Compiler	Remarks
May 2012	0	M Maree	This radiation protection standard was compiled in accordance with the Nuclear Division Integrated Management System, Manual 238-1 and supersedes Eskom Standard ESKASABH3 and Generation Standard GGS 1300.

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